OAKVILLE

North Oakville Creeks Subwatershed Study

APPENDICES

August 2006

TSH
engineers
architects
planners

PARISH
geomorphic

Natural Resource Solutions Inc.
Aquatic, Terrestrial and Wetland Biologists

Donald G. Weatherbe Associates

Morrison Environmental Limited
Groundwater Consultants

EWRG
Environmental Water Resources Group Ltd.

Percent Impervious Values for Future Conditions

Subcatchments	Area (ha)	Percent Imperviousness	Impervious Area
FM1101	18.94	1.1%	0.2
FM1102	46.56	26.4%	12.3
FM1103	11.71	78.9%	9.2
FM1001	149.43	0.6%	0.9
FM1002	29.37	0.9%	0.3
FM1104	63.33	54.2%	34.3
FM1003a	98.25	1.1%	1.1
FM1003b	27.43	2.1%	0.6
FM1004	7.27	3.4%	0.2
FM1105	48.57	58.4%	28.4
FM1106	15.18	79.0%	12.0
FM1005	30.30	0.6%	0.2
FM1107	21.55	50.7%	10.9
FM1007a	50.80	0.1%	0.1
FM1007b	18.12	0.4%	0.1
FM1007c	66.39	0.2%	0.1
FM1007d	27.49	0.5%	0.1
FM1008	5.30	0.0%	0.0
FM1006	23.03	0.6%	0.1
FM1006a	10.49	0.0%	0.0
FM1006a+b			0.0
FM1108	59.82	29.2%	17.5
FM1109	26.69	44.2%	11.8
FM1009	60.12	0%	0.0
FM1110	16.91	78.2%	13.2
FM1110.1	26.23	53.4%	14.0
FM1010	80.88	0%	0.0
FM1011	7.24	0%	0.0
FM1111	99.65	23.4%	23.3
FM1112	8.45	39.0%	3.3
FM1113	18.58	63.4%	11.8
MC1012	31.53	1.1%	0.3
MC1114	94.93	37.2%	35.3
TC1115	33.61	43.6%	14.7
GO1116	47.16	50.9%	24.0
SM1117	83.84	17.4%	14.6
SM1117a	12.53	69.4%	8.7
SM1118	8.01	54.6%	4.4
SM1020	116.75	0.1%	0.1
SM1021	29.90	0.0%	0.0
SM1022	8.10	0.0%	0.0
ES1	46.74	7.0%	3.3
ES2	39.30	39.2%	15.4
ES3	18.44	21.1%	3.9
ES4	80.58	14.6%	11.8
ES6	131.41	59.5%	78.2
ES7	37.90	6.0%	2.3
ES8	42.82	5.2%	2.2

Subcatchments	Area (ha)	Percent Imperviousness	Impervious Area
ES5	170.97	26.2%	44.9
ES9	24.67	38.8%	9.6
OC1	43.93	50.3%	22.1
SC1	84.37	39.7%	33.5
WM1	146.10	44.2%	64.5
WM2	53.96	50.0%	27.0
EM1	190.10	50.7%	96.5
EM2	14.62	59.4%	8.7
EM3	29.14	66.3%	19.3
EM4	122.94	53.6%	66.0
MC1	59.61	54.5%	32.5
MC2	29.99	62.8%	18.8
JC1041	20.47	0.0%	0.0
JC1042	2.16	0.0%	0.0
JC1043	1.43	0.0%	0.0
JC1044	19.81	2.3%	0.5
J2	14.12	44.3%	6.3
J1	16.73	61.1%	10.2
J3	17.87	78.8%	14.1
JC1045	33.73	0.8%	0.3
J4	16.81	76.0%	12.8
J5	36.96	73.2%	27.1
J6	32.70	41.8%	13.7
J7	98.95	69.6%	68.9
J8	37.00	75.5%	27.9
J9	174.09	39.5%	68.8
JC1046	81.07	1.4%	1.2
JC7b	68.35	67.4%	46.1
JC8b	27.89	16.8%	4.7
JC10	48.92	9.6%	4.7
J11	26.70	78.9%	21.1
J12	12.43	79.1%	9.8
J13	28.51	55.7%	15.9
J14	46.93	4.2%	2.0
J15	40.41	17.5%	7.1
J16	74.29	51.7%	38.4
J17	134.48	43.4%	58.4

Planning Authorities Interagency Review

Terms of Reference

1. Purpose

Recognizing the urban context of North Oakville, the purpose of the Planning Authorities Interagency Review is to allow the Town of Oakville (Town), Region of Halton (Region) and Ministry of Municipal Affairs and Housing (MMAH) to develop options for a common policy framework with respect to the potential elements of the natural heritage/open space system which would be suitable for the urban context of North Oakville, and reflect provincial smart growth principles for input to the Subwatershed Study, which in turn will all be an input to the Secondary Plan. This process will include collectively analysing, assessing and interpreting available data with respect to potential candidate earth and life science areas of natural and scientific interest (ANSI'S), provincially significant wetlands (PSW's) and the hydrological significance of the Trafalgar Moraine, as well as woodlots, corridors and linkages as other potential elements of the system.

The Planning Authorities Interagency Review will also include an assessment of the preliminary Secondary Plan natural heritage/open space system policy framework to determine if it reflects the directions in the initial policy framework options and all other final approved policy, within the north Oakville urban context.

2. Location

The North Oakville lands are located south of Highway 407 and north of Regional Road 5 between Ninth Line and the west boundary of the Town of Oakville.

3. Background

The Town of Oakville adopted Official Plan Amendment No. 198 (OPA 198) in May 2002. The Amendment brings the lands in North Oakville into the urban envelope. However, no development can occur prior to the preparation of Secondary Plans.

OPA 198 provides a framework for the preparation of those Secondary Plans. In particular, as a basis for the Secondary Plans, a Subwatershed Study must be undertaken. The Subwatershed Study is intended, among other matters, to identify and evaluate natural features and provide the Town with the foundation for the establishment of a natural heritage/open space system for North Oakville.

To date, in accordance with the policy direction in OPA 198, the Town has, with respect to the Subwatershed Study:

i) established Terms of Reference which were approved by the Region (which also represents the provincial interest in its delegated capacity) and Conservation Halton;
ii) included in the Terms of Reference the identification and assessment of wetlands, ANSI's and the associated characteristics of the Trafalgar Moraine;
iii) retained in 2002 an inter-disciplinary team of environmental consultants to conduct the Subwatershed Study for all the North Oakville lands and adjacent lands as necessary to define external connections;
iv) appointed a Technical Advisory Committee (TAC) to provide input to the study on which the Region and Conservation Halton each have three representatives;
v) invited the Ministry of Natural Resources (MNR) to attend the TAC meetings.

Further, in accordance with the policy direction in OPA 198, the Town has also, with respect to the Secondary Plan:

i) retained a multi-disciplinary team of consultants to develop a Secondary Plan for the lands east of Sixteen Mile Creek (East Secondary Plan), which includes the Subwatershed study team to ensure that the objectives of the Subwatershed Plan are integrated into the Secondary Plan;
ii) approved a work program for the East Secondary Plan which includes a charrette which will involve the community in the development of a vision and master plan for the area; and,
iii) will be undertaking the preparation of one or two Secondary Plans for the lands west of the Creek (West Secondary Plan(s) using a process similar to that used for the lands east of Sixteen Mile Creek.

Through the Subwatershed Study process, the Town's consultants have collected a significant amount of data with respect to the natural features and functions of the North Oakville lands. The draft Subwatershed Characterization Report for the lands east of Sixteen Mile Creek was published in January 2002 and includes the data collected to that time for the lands west of the Creek. The fieldwork for this area is expected to be completed by May 20, 2003, including additional data collection requested by MNR. Data collection for the lands west of Sixteen Mile Creek is on going and is expected to be completed by May 20, 2003.

The following additional information is also available:

i) The Region through the Five Year Review of its Official Plan has collected information on environmentally significant areas (ESA's), and significant woodlands; and,
ii) The Ministry of Natural Resources conducted field work in 2002 with respect to certain natural features with a focus on the identification of provincially significant wetlands, potential candidate life science ANSI's and a potential candidate earth science ANSI in North Oakville and/or

Milton. MNR is currently conducting additional fieldwork with respect to certain natural features, which will be completed in the spring of 2003.

4. Interagency Review Composition

The membership of the Interagency Review will consist of the Planning Approval authorities being the Town, the Region and MMAH. Each Member will appoint a senior planning official to act as its representative to the Interagency Review as follows:

i) Town of Oakville – Commissioner of Planning and Development (or Delegate);
ii) Region of Halton – Commissioner of Planning and Public Works (or Delegate);
iii) Ministry of Municipal Affairs and Housing – Assistant Deputy Minister, Municipal Services Division (or Delegate).

The administrative co-ordinator of the Interagency Review will be the Town's Commissioner of Planning and Development, while MMAH will facilitate and co-ordinate the Province's role throughout the Review through its "one-window" planning service.

Conservation Halton and MNR will be Participants in the Interagency Review to provide technical advice as set out in Section 5 of the Terms of Reference. Senior planning officials may also involve their staff as required to provide advice.

5. Technical Advisors

Conservation Halton and MNR will be Participants in the Review and will provide advice and assistance in understanding the potential elements of the natural heritage/open space system.

In addition, other Technical Advisors will be participants in the Review and will provide advice and assistance as follows:

i. Town – Consultants for the Subwatershed Study and Secondary Plan; and,

ii. Region –any consultants retained with respect to the update of the environmental features for the Five-Year Official Plan Review.

The technical advisors will also be available, as necessary, for discussions with the Members and the other technical advisors.

6. Base Data

All available Technical Data relevant to the Review will be provided by the Members as a basis for the Review as follows:

i) Town - data collected through the Subwatershed Study prior to May 20, 2003;
ii) Region - data collected as part of the Five-Year Review of the Regional Official Plan prior to May 20, 2003; and,
iii) MMAH – data collected by MNR prior to May 20, 2003.

There has already been some reporting on the data collection process made available to the public. However, relevant information which has not yet been made available will be released at a meeting of the Subwatershed Technical Advisory Committee meeting scheduled for May 23, 2003. Provincial information will be released by MMAH as part of the "one window" approach.

It is not anticipated that any additional technical work will be required beyond the work required to prepare the Technical Data. However, if further work is determined to be necessary through the Interagency Review, the Town, the Region and MMAH will agree to a reasonable formula for sharing any costs associated with this additional technical work.

7. Interagency Review Process

The Planning Authorities Interagency Review process will be a component of the Subwatershed Study It will also serve as an input to Phase II of that Study to the tasks related to "Analysis of Conditions" and "Impact Analysis". In turn, the Subwatershed Study and Interagency Review will also serve an input to the Secondary Plan Process. (see attached Schedule A: Process Map)

The purpose of the Planning Authorities Interagency Review is to allow the Town of Oakville (Town), Region of Halton (Region) and Ministry of Municipal Affairs and Housing (MMAH) to develop options for a common policy framework with respect to the potential elements of the natural heritage/open space system which would be suitable for the urban context of North Oakville, and reflect provincial smart growth principles for input to the Subwatershed Study, which in turn will all be an input to the Secondary Plan. This process will include collectively analysing, assessing and interpreting available data with respect to potential candidate earth and life science areas of natural and scientific interest (ANSI'S), provincially significant wetlands (PSW's) and the hydrological significance of the Trafalgar Moraine, as well as woodlots, corridors and linkages as other potential elements of the system.

The Interagency Review will also include an assessment of the preliminary Secondary Plan natural heritage/open space system policy framework to determine if it reflects the directions in the initial policy framework options and all other final approved policy, within the north Oakville urban context.

The analysis, assessment and interpretation of the Technical Data by the Members will be carried out in the context of:

i) the Town's intent to establish a natural heritage/open space system within North Oakville through the Subwatershed Study and the Secondary Plans, including associated updates of Figures F1 and F2 of the Official Plan;

ii) the Provincial Policy Statement;

iii) the Regional Official Plan , as amended;

iv) the Oakville Official Plan;

v) the desire of the Members to implement within North Oakville the Province's smart growth principles of promoting and planning for growth by balancing the goals of creating strong communities, building vibrant communities and promoting a clean and healthy environment.

Any common position developed as part of the Interagency Review, will be provided to the Town and its Subwatershed and Secondary Plan consultants as input to those studies. This input will provide to the public through the public input component of Phase II of the Subwatershed Study in September 2003. It will also provide in turn input to the East Secondary Plan. Further, when the work on the West Secondary Plan(s) commences, the results of the review will provide, through the Subwatershed Study, an input to that process. This input may require the reconstitution of the Review team to provide input to the draft Secondary Plan(s) for that area.

It should be noted, however, that while the Members will work toward reaching a common position, it is possible that there may be no consensus on some or all matters. In the event that the Members differ in their conclusions, they will each release their individual conclusions through the Subwatershed Study process and this information will also be made available as input to the Secondary Plan(s).

Further, where a common position has not been achieved at the completion of the Review (for the lands east of Sixteen Mile Creek and for the lands west of Sixteen Mile Creek respectively), it is recognized that each Member will take whatever steps they deem appropriate, in accordance with their individual responsibilities as set out in legislation and policy. In any event, upon completion of the Review for the lands east of Sixteen Mile Creek and the lands west of Sixteen Mile Creek respectively, MNR will identify any provincially significant natural heritage features and areas within the North Oakville area in accordance with their responsibilities as set out in legislation and policy.

8. Interagency Review Schedule

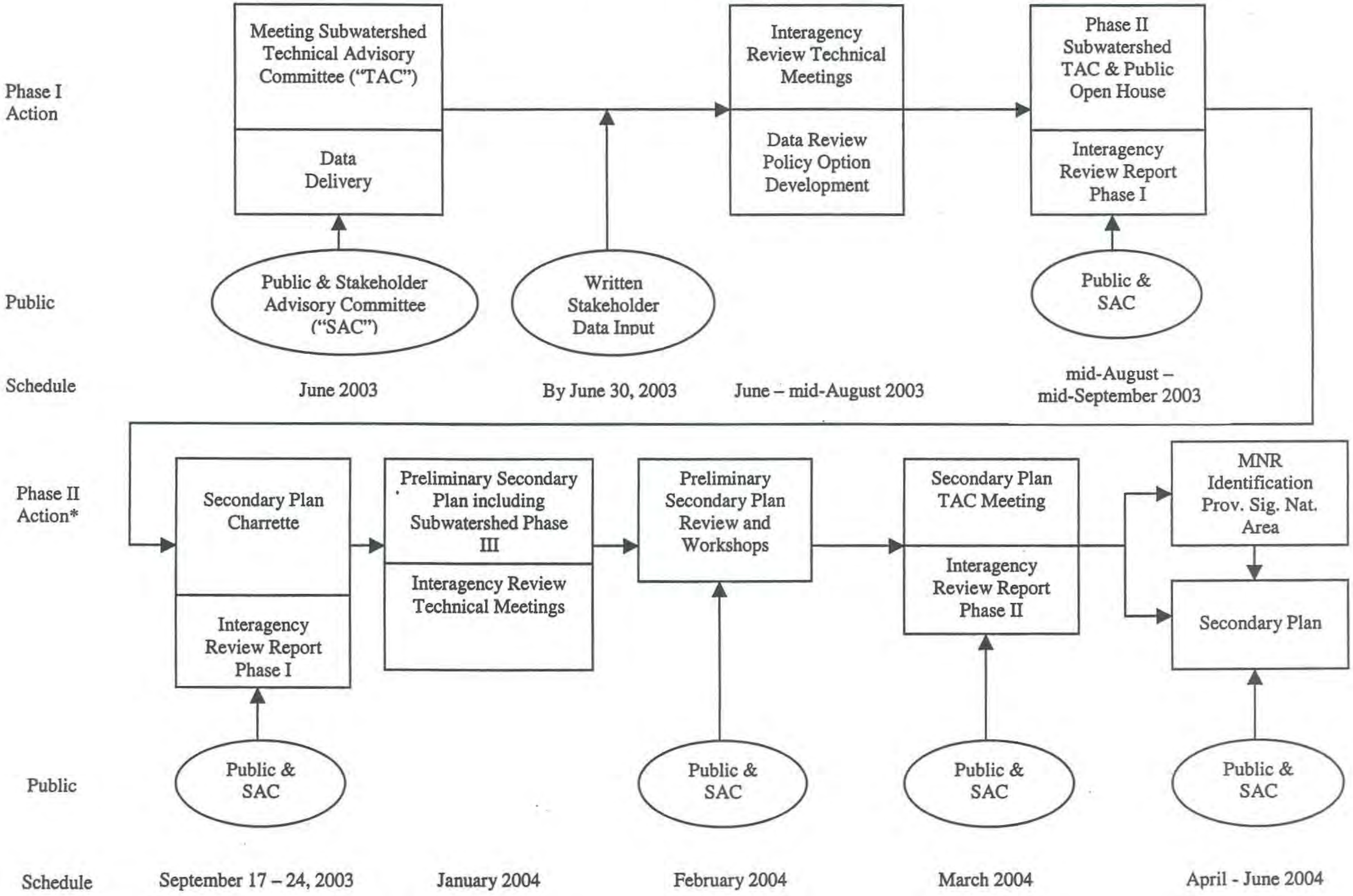
The focus of the Interagency Review will be between May and August 2003 (See Schedule A: Process Map). The conclusions of the review with respect to policy framework options will be included in the draft Phase II Subwatershed Study Report to be released for public review and comment in September 2003. This information will also be available as input to the East Secondary Plan charrette. Prior to finalization of the results of the Review, the Members will carry out an assessment of the natural heritage/open space system policy framework of the preliminary Secondary Plan, taking into account submissions from the public, as well as other information arising from the Subwatershed and Secondary Plan processes.

9. OPA 198

It is recognized by the Members that the approval of OPA 198 at this time is appropriate, with the assessment of the Technical Data being conducted through the Subwatershed Study and Secondary Plan(s) and the Members will support the purpose and role of the Interagency Review at the Ontario Municipal Board.

The Members acknowledge and respect that OPA 198 is under appeal and before the OMB and they undertake to amend and modify the terms of this Interagency Review so as to respect any determination of the OMB.

PROCESS MAP: DEVELOPMENT
NATURAL HERITAGE/OPEN SPACE SYSTEM – MAY 16, 2003



*Note: When the work on the West Secondary Plan(s) commences, the results of the review will provide, through the Subwatershed Study, an input to that process. This input may require the reconstitution of the Review team to provide input to the draft Secondary Plan(s) for that area.

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NORTH OAKVILLE
PLANNING AUTHORITIES INTERAGENCY REVIEW

PHASE I REPORT

Final Report

SEPTEMBER 3, 2003

To: **The Technical Advisory Committee North Oakville Subwatershed Study**
From: **The Planning Authorities Interagency Review**
Date: **September 4, 2003**
Re: **North Oakville Planning Authorities Interagency Review Phase I Report**

As you are aware, the purpose of the Planning Authorities Interagency Review (IAR) is to allow the Province, represented by the Ministry of Municipal Affairs and Housing (MMAH), the Region of Halton, and the Town of Oakville, with technical assistance from the Ministry of Natural Resources and Conservation Halton, *"to develop options for a common policy framework with respect to the potential elements of the natural heritage/open space system which would be suitable for the urban context of North Oakville, and reflect provincial smart growth principles for input to the Subwatershed Study, which in turn will all be input to the Secondary Plan."* Once the preliminary Secondary Plan(s) are completed which reflect the Subwatershed Study work to date, the IAR will conduct an assessment of the preliminary Secondary Plan natural heritage/open space system policy framework to determine if it reflects the directions in the initial policy framework.

In accordance with the Terms of Reference of the Planning Authorities Interagency Review (IAR), attached is the Phase I Report which is to serve as input to the Subwatershed Study.

The report outlines the process followed by the IAR, including the Guiding Principles which formed the basis for the Review. It also sets out the general approach to the proposed natural heritage/open space system and the related policy framework approach.

It should be noted that although the Terms of Reference for the IAR indicated that the purpose of the Review was "to develop options for a common policy framework", only one policy direction is presented. This reflects the fact that a consensus was reached on the proposed policy framework approach.

That policy framework approach recommends the establishment of "core areas" in which development would be prohibited with certain exceptions. In addition to "core" areas, linkages are also identified, although the ultimate size, location and width of the linkages will be dependent on a number of factors and the Subwatershed Study and Secondary Plan(s) should provide detailed direction with respect to the linkages. Finally, the policy framework provides direction with respect to natural features outside the "core" areas, with respect to buffers and with respect to transportation and utility corridors.

The policy framework approach represents a consensus of opinion between the Province, the Region and the Town and we are pleased to submit it for consideration as part of the Subwatershed Study:

Ministry of Municipal Affairs and Housing	Regional Municipality of Halton	Town of Oakville

1. INTRODUCTION

1.1 PURPOSE

The purpose of the Planning Authorities Interagency Review (IAR) is to allow the Province, represented by the Ministry of Municipal Affairs and Housing (MMAH), the Region of Halton, and the Town of Oakville to work collectively at a technical level *"to develop options for a common policy framework with respect to the potential elements of the natural heritage/open space system which would be suitable for the urban context of North Oakville, and reflect provincial smart growth principles for input to the Subwatershed Study, which in turn will all be input to the Secondary Plan."* This report outlines the results of the IAR.

1.2 NATURAL HERITAGE AND WATER RESOURCES

The IAR process focused on the identification of a sustainable natural heritage system, with an emphasis on natural features such as wetlands, woodlands, ANSI's/ESA's and wildlife habitat. The IAR process also recognized that water resources are an important part of the natural environment and took them into account in the review where they formed part of the natural heritage/open space system, particularly rivers, streams and associated valley systems. However, they were not the focal point of the IAR as it was recognized that they would be dealt with primarily through the Subwatershed Study for North Oakville. In particular, the Subwatershed Study will identify features requiring protection for hydrological reasons and will address issues such as water balance, stream density and stormwater best management practices. It is recognized though that watercourse features not specifically identified as part of the natural heritage/open space system will further enhance the connectivity of the system.

1.3 REVIEW AREA

The area which is the subject of the IAR is known as "North Oakville". It is bounded by:

i)	North	Highway 407
ii)	East	Ninth Line
iii)	South	Regional Road 5 (Dundas Street)
iv)	West	Tremaine Road.

1.4 REPORT OUTLINE

The report reflects the three areas explored by the IAR and is comprised of the following sections:

i) Section 2 Guiding Principles
ii) Section 3 Natural Heritage Features Review
iii) Section 4 Policy Framework Approach.

2. GUIDING PRINCIPLES

2.1 INTRODUCTION

This section outlines the background to the IAR and the Guiding Principles on which the Review was based.

2.2 BACKGROUND

The Town of Oakville has placed a priority on the development of a linked natural heritage/open space system for North Oakville. This priority is reflected in the policies of Official Plan Amendent No. 198, which brings North Oakville into the urban area. It is also reflected in the fact that the North Oakville Natural Heritage Inventory and Analysis Study was the first background study initiated by the Town with respect to North Oakville. Further the Town is in the process of preparing the Subwatershed Study for North Oakville, a study that, together with the Secondary Plans for this area, is intended to establish the linked natural heritage/open space system.

While the Town has the responsibility for developing the linked natural heritage/open space system, it has always been recognized that the Ministry of Municipal Affairs and Housing, and the Region of Halton, as planning authorities, with input from the Ministry of Natural Resources and Conservation Halton, also have important roles in the determination of the components of the system and the related policy framework.

The need to provide a forum for direct input from these agencies prior to finalization of a linked system was initially identified in 2002 with respect to the Trafalgar Moraine. On April 22, 2002, Council adopted a resolution, which states that:

"That the Town support and continue to explore the potential for an interagency assessment of the Trafalgar Moraine, in conjunction with the Province of Ontario, Region of Halton and Conservation Halton."

The interagency review was also referenced in the preamble to the motion adopting Official Plan Amendment No. 198 on May 29, 2002.

Since those actions of Council, the Province carried out additional field research in North Oakville which was completed in the spring of 2003. It was determined therefore, that the best timing for the start of the interagency review would be near the end of the data collection period.

2.3 TERMS OF REFERENCE

The Terms of Reference for the Planning Authorities Interagency Review were developed and agreed upon by the Province, the Region and the Town. They are attached to this report as Appendix A. Among other matters, the Terms of Reference outline the purpose of the review, the review process, the schedule of the review and the role of the members who are the Province, the Region and the Town.

The Terms of Reference establish the IAR process as a component of Phase II of the Subwatershed Study. In turn the Subwatershed Study and Interagency Review will serve as input to the Secondary Plan for East of Sixteen Mile Creek. The work program for the Secondary Plan for West of Sixteen Mile Creek will also provide for input related to the Interagency Review at an appropriate point in that Study. Once a preliminary Secondary Plan(s) is completed which reflects the Subwatershed Study work to that date, the IAR will conduct an assessment of the preliminary Secondary Plan natural heritage/open space system policy framework to determine if it reflects the directions in the initial policy recommended in this report and all other final approved policy, within the North Oakville urban context.

2.4 GUIDING PRINCIPLES

The initial step in the IAR process was the development of a set of "Guiding Principles" to form a basis for the review. These are outlined below and should be considered in the preparation of the Secondary Plan(s):

"

1. To design a natural heritage/open space system (the "system") that reflects North Oakville's urban context as envisioned in Regional Plan Amendment No. 8 and OPA 198.

2. To use a systems approach to arrive at a viable, functioning system that includes all key natural features within an urban context.

3. To recognize that form and function will vary throughout the system, and activities will vary accordingly.

4. To take into account environmental, social and economic values in developing the system.

5. To create Town policies through this process that will recognize the existing provincial policy framework, but will also be reflective of the agreed upon principles of the Interagency Review.

6. In developing the system, consideration needs to be given to the ability of the Town to implement the system."

3. NATURAL HERITAGE FEATURES REVIEW

3.1 INTRODUCTION

This section reviews the key steps in the creation of the proposed natural heritage management strategy, which forms the basis for the development of the IAR policy framework approach outlined in Section 4. These steps included a review of the regional context and the development of the natural features inventory for North Oakville.

3.2 REGIONAL CONTEXT

The natural heritage/open space system for North Oakville cannot be developed in isolation. It must recognize the regional context. The regional greenlands system is illustrated in Map 1. Some of the key features identified include:

i) the Niagara Escarpment;
ii) the north-south linkages along the stream corridors through Oakville, which extend from Lake Ontario through North Oakville, and in the case of Sixteen Mile Creek and Bronte Creek, connect to the Niagara Escarpment; and,
iii) the east-west linkage north of the 407 along the East Sixteen Mile Creek;.

3.3 NATURAL FEATURES INVENTORY

As a basis for the development of the natural feature inventory for North Oakville, a series of technical meetings were held to review all the available data related to vegetation, fauna, species movement, watercourses, and Areas of Natural and Scientific Interest/Environmentally Sensitive Areas (ANSI's/ESA's). These sessions utilized the data provided by the Province, the Region, Conservation Halton and the Town through its subwatershed study, as well as submissions received from the public and landowners prior to June 30, 2003. The resulting inventory is illustrated on Map 2 and the sources on which it is based are found in Appendix B. Map 2 reflects the available data, without any analysis. It incorporates the following features:

i) wetlands;
ii) woodlands;
iii) hedgerows;
iv) ANSI's and potential candidate ANSI's;
v) cultural thickets, meadows and savannahs;and,
vi) rivers, streams and associated valleys

3.4 NATURAL HERITAGE MANAGEMENT STRATEGY

3.4.1 General Approach

The key conclusion about the natural environment of the Study Area, which was reached based on the inventory, is that its significance rests on its biological diversity, the interrelationships of its flora and fauna and its significant natural features. In the context of the IAR Guiding Principles, therefore, a management strategy was developed, the objective of which was to ensure a connected natural heritage/open space system which will maintain the key natural heritage features to protect the diversity and function of the natural environment of the area ensuring its sustainability as North Oakville develops for urban uses.

The critical concern in a situation where urban development is proposed is the encroachment effects of such development on natural features. Urban encroachment effects can extend well into natural features resulting in the loss of species and functions that the natural heritage/open space system was designed to protect and preserve, and where appropriate, enhance.

To mitigate such effects and ensure the establishment of a viable, functioning sustainable system, rather than protecting individual features, the Interagency Review focused on the determination of key features which should be protected, together with related lands which are required to protect the function of those features and provide for the long term sustainability of a connected natural heritage/open space system within the urban context. Together, these form "core" natural areas, which when linked together, create the basis for a proposed natural heritage/open space system for North Oakville. The proposed system is illustrated conceptually on Map 3.

The recommended approach is systems based and is comprised of "core" natural areas connected by a system of linkages, which together are to form the framework for a sustainable natural heritage/open space system. The system will be subject to refinement through the Subwatershed Study and Secondary Plan processes, including a review of land uses adjacent to the core areas which will further support their function.

3.4.2 Core Area Criteria

The criteria used to establish the "core" areas more specifically are:

i) Diversity - Areas with diverse habitats and/or supporting a rich assemblage of species;
ii) Size - Sufficient size to protect interior habitat;
iii) Contiguous – Designed to create contiguous units;
iv) Connectivity – The unit can be linked with other units;
v) Significance – Areas supporting significant species or habitats;

vi) Representativeness – Areas which include appropriate representational features associated with a life or earth science ANSI designation or a candidate life or earth science ANSI designation, including the Trafalgar Moraine candidate earth science ANSI; and,

vii) Overall watershed functionality including hydrologic processes which protect the flow regime of the receiving streams.

3.4.3 Linkages

In addition, to "core" areas, linkages were also identified. These follow natural features whenever possible, particularly stream corridors. The ultimate size, location and width of the linkages will be dependent on a number of factors. While no minimum width is identified for linkages, they must be of sufficient size and character to ensure the functionality and sustainability of the natural heritage/open space system. Narrow linkages are not acceptable for the scale of the natural heritage/open space system being proposed for North Oakville.

3.4.4 Trafalgar Moraine

With respect to the hydrological significance of the Trafalgar Moraine, the major hydrological characteristic of this landform is that it is part of a headwater area. As a result, the IAR developed the natural heritage/open space system recognizing that the watershed characteristics associated with the landform provided by the Moraine will be protected through directions in the Subwatershed Study which will require:

i) the protection of various hydrologically significant wetlands;
ii) the protection of significant rivers, streams and associated valleys; and,
iii) the protection of the hydrological function of other receiving streams.

Further, with respect to the recharge/discharge function, the amount of recharge is generally low given the "tight" soils of this till moraine and generally dispersed across the landscape. Where there is some localized potential for either concentrated recharge or discharge it will be protected in the core areas.

The IAR, based on this above understanding of the hydrological function of the Moraine and the measures set out to address that function, determined that it was not necessary to delineate the Moraine in its entirety. In keeping with the core area criteria, areas of the Moraine which represent key landform features associated with the candidate earth science Trafalgar Moraine ANSI would be protected in the core area designations. These designations also protect candidate life science ANSI's.

3.4.5 Features Outside Core Areas

Through the Subwatershed Study certain additional woodlots and wetlands will be identified for protection for hydrological reasons. The protection of these features will also have ecological benefits.

Woodlots and wetlands not included in "core" areas, other than those which will be required to be protected for hydrological reasons, would be protected through the development process where feasible given the planned development (e.g. incorporation into a park, school or stormwater pond site) and would perform minor environmental (e.g. seasonal value for migration)and aesthetic functions.

4. POLICY FRAMEWORK APPROACH

4.1 INTRODUCTION

This section reviews the existing provincial and regional policy approach to the natural environment, as well as the policies of the Town's Official Plan. It then discusses a proposed policy framework approach to implement the Natural Feature Implementation Strategy outlined in Section 3. This policy framework approach has regard for the Provincial Policy Statement and generally conforms with the Regional Official Plan.

4.2 EXISTING POLICY FRAMEWORK

4.2.1 Provincial Policy Statement

Section 3 of the Planning Act requires that, in exercising any authority that affects planning matters, planning authorities "shall have regard to" policy statements issued under the Act.

Relevant sections of the Provincial Policy Statement include Section 1.1.1a) which directs that urban areas are to be the focus of growth. However, recognizing this context, Section 2.3, Natural Heritage, identifies specific natural heritage features and areas (e.g. significant wetlands, significant areas of natural and scientific interest) and provides direction as to whether development and site alteration is permitted and the conditions which must be met if development and site alteration are to be permitted.

Development and site alteration are prohibited in significant wetlands and significant portions of the habitat of endangered and threatened species. In other features and areas, including significant woodlands and significant areas of natural and scientific interest, development and site alteration may be permitted if it has been demonstrated that there will be no negative impacts on the natural features or the ecological functions for which the area is identified.

It should also be noted that Section 2.3.3 states:

"The diversity of natural features in an area, and the natural connections between them should be maintained, and improved where possible."

With respect to water quality and quantity, it should also be noted that the Provincial Policy Statement states in Section 2.4:

"The quality and quantity of ground water and surface water and the function of sensitive ground water recharge/discharge areas, aquifers and headwaters will be protected or enhanced."

4.2.2 Region of Halton Official Plan

The Regional Plan is based on a Regional Structure, which is categorized into three functional systems (Part II, Section F2), The Urban System, The Rural System and The Greenlands System. The Greenlands System consists of the designations of Escarpment Natural Area, Greenlands A, Greenlands B and Regional Waterfront Parks. Policies are also provided with respect to the protection of Environmentally Sensitive Areas.

The policies for the Greenlands System are found in Part III, Section D. The goal of the Greenlands System (Section D1b) is:

"to maintain as a permanent landform an interconnected system of natural areas and open space that will preserve areas of significant ecological value while providing, where appropriate, some opportunities for recreation."

The Regional Plan designates on Map 1 lands in North Oakville along Sixteen Mile Creek and Joshua's Creek as Greenlands A and B.

The Regional Plan also directs in Part IV, Section A4b4 that trees should be recognized and protected as a renewable natural resource and, specifically provides:

"A4b4(e) Discourage development proposals from locating within Woodlots and Forests.

A4b4(f) Require that all development proposals, to the maximum degree possible, preserve existing trees and plant additional trees in accordance with good forestry management practice.

A4b4(g) Require all development proposals to submit, at the time of initial application, an inventory of trees on site and at subsequent stages of the application, a tree saving and planting plan."

The Five Year Review of the Regional Official Plan which is currently underway is intended to add Significant Woodlands to the Greenland system as Greenlands B. Regional Council has provided direction regarding Offficial Plan changes, however, a proposed amendment has not yet been prepared.

4.2.3 Town of Oakville Official Plan

The Town's Official Plan includes detailed goals and objectives with respect to the natural environment in Part B Section 8, Greenlands and Section 9, Environmental Management. In particular, the first goal directs that a greenlands system be created:

"To create a greenlands system of parkland, open spaces and natural areas which preserves the integrity of the natural environment, enhances urban form, improves the quality of life and provides for the diversity of recreational opportunities while minimizing the disruption of natural features."

This direction is reinforced in Part D, Section 4, Greenlands which states:

"The plan envisages an integrated Greenlands system which provides a continuous linkage between parks, open spaces, natural areas and the waterfront."

This direction is implemented through Section 4.3.2 e) which establishes that subwatershed plans shall be the primary mechanism for identifying areas and systems of environmental or natural features prior to urban development. The policies then go on to establish direction with respect to the use of the Natural Area designation and the individual natural features. The policies provide for Natural Areas where no development may be permitted, as well as Natural Areas where development may be permitted, which are also identified as Natural Areas, but with the additional caveat "Requiring Further Study". Natural areas include valleylands, riverine flood plains, wetlands, areas of natural and scientific interest, environmentally sensitive areas, woodlands, natural corridors and wildlife habitat. They are individually identified on Schedules "F1" and "F2" and specific policies are provided for each type of feature in Part D, Section 4.3.2.

4.3 PROPOSED POLICY FRAMEWORK APPROACH

4.3.1 General

The Terms of Reference for the IAR indicated that the purpose of the Review was "to develop options for a common policy framework". However, while options were considered, a consensus was reached on the following proposed policy framework approach. Therefore, only one direction is presented.

The proposed policy framework approach would build on the current policies of the Town of Oakville Official Plan. However, the policies would also reflect the specific circumstances of North Oakville. The policy framework provides direction with respect to "core" areas and linkages, as well as features outside the natural heritage/open space system.

4.3.2 Core Areas

The "core" areas, including any required buffers around the natural features, would be designated "Natural Area" in the appropriate Secondary Plan. Development would be prohibited in these areas, with the exception of specified transportation and/or utility corridors, which would generally be located outside the core areas and natural features. (See proposed policy direction below). The location of trails could also be considered, although they would generally be located outside the natural features.

4.3.3 Linkages

In addition, to "core" areas, linkages were also identified. As noted previously, the ultimate size, location and width of the linkages will be dependent on a number of factors. The Subwatershed Study and Secondary Plan should provide detailed direction with respect to each linkage, recognizing that they must be of sufficient size and character to ensure the functionality of the natural heritage/open space system. Trails may also be located in these areas. In addition, through the Subwatershed Study and the Secondary Plan, there will be a further detailed examination of the potential to provide for additional linkages.

4.3.4 Natural Features

Features, other than the "core" areas and features required to be protected for hydrological reasons, would be designated in a new designation "Natural Features". This designation would direct that the features should be maintained and integrated with the proposed development whenever possible. Each feature would be the subject of an assessment at the subdivision stage, which would determine if it is feasible to integrate it as part of the development from an environmental and land use perspective.

4.3.5 Hydrological Features

Additional policies will be developed for watercourses and other features to be protected for hydrological reasons, recognizing that the protection of these features will also have ecological benefits. These policies will be based on detailed direction, which will be provided by the Subwatershed Study. However, in accordance with Provincial, Regional and Town policy, development would be prohibited in any identified floodplains and areas with erosion hazards.

4.3.6 Buffers

Guidelines for buffers should be established through the subwatershed study and policy included in the secondary plan(s). Buffers will permit no development and shall be regarded as part of the natural feature.

4.3.7 Transportation and Utility Corridors

North Oakville is to be developed as a "transit friendly" community. Transit systems operate most effectively and efficiently with a grid system of roads. As a consequence, it may be necessary to allow additional transportation and/or utility corridors to cross the "core" areas provided the need for the project has been demonstrated and there is no reasonable alternative to avoid a core area. Such corridors may be considered through the Secondary Plan process subject to the following criteria:

i) the number of corridors shall be kept to the minimum and shall be required as transit routes or utility corridors;

ii) corridors shall be located outside of natural features and where the core area is narrowest and along the edges of cores wherever possible in order to minimize fragmentation;

iii) the width of the corridor shall be kept to a minimum; and,

iv) the exact location of the corridor shall be only be determined after the preparation of an Environmental Impact Statement, or an Environmental Assessment where required.

It will also be necessary to allow transportation and/or utility corridors to cross linkages. The crossings of linkages may be considered through the Secondary Plan process subject to criteria i), iii) and iv) above. In addition, the implications of the potential transitway along Highway 407 will be considered through the Subwatershed and Secondary Plan processes.

NORTH OAKVILLE
PLANNING AUTHORITIES INTERAGENCY REVIEW

PHASE II REPORT

April 13, 2006

Background

The Planning Authorities Interagency Review (IAR) process allows an opportunity for the Ministry of Municipal Affairs and Housing (MMAH), the Region of Halton, and the Town of Oakville, with technical assistance from the Ministry of Natural Resources and Conservation Halton, to reach a common position on a natural heritage and open space system suitable within the urban context of North Oakville.

The IAR process had two phases:

1. Phase I was "to develop options for a common policy framework with respect to the potential elements of the natural heritage/open space system which would be suitable for the urban context of North Oakville, and reflect provincial smart growth principles for input to the Subwatershed Study, which in turn will all be input to the Secondary Plan. " *(IAR Terms of Reference, March 5, 2005)*
2. Phase II was to "include an assessment of the preliminary [draft] Secondary Plan natural heritage and open space system policy framework [and mapping] to determine if it reflects the directions in the initial policy framework options and all other final approved policy, within the north Oakville urban context". *(IAR Terms of Reference, March 5, 2005)*

Phase I culminated in a report dated September 3, 2003, which has since been used in the North Oakville secondary planning process.

Purpose

The purpose of this report is to provide a review of the proposed natural heritage system for the North Oakville planning area, and mapping and policy framework for the draft North Oakville East Secondary Plan, dated April 12, 2006, in context of the ongoing planning program for the North Oakville planning area.

Basis

Town staff has prepared:

- Figure NOW 3 & NOE 3 Natural Heritage Component of the Natural Heritage and Open Space System including Other Hydrological Features for the North Oakville planning area, dated April 12, 2006 (Figure NOW 3 & NOE3), which illustrates the general configuration of the natural heritage system. This map is attached as Appendix A to this report.

- A revised draft North Oakville East (NOE) Secondary Plan, dated April 12, 2006, for those lands east of Sixteen Mile Creek, which includes policies addressing the natural heritage system and mapping that reflects the configuration of the appropriate portion of the natural heritage system identified in Appendix A.

Town staff has advised the IAR members that the secondary plan to be prepared for the lands west of Sixteen Mile Creek (i.e. NOW – North Oakville West) will contain a similar natural heritage policy framework as has been developed for the draft NOE Secondary Plan, dated April 12, 2006, and will generally reflect the natural heritage system layout identified in Appendix A of this report.

Comments

The IAR has reviewed the two products noted in the foregoing in the context of the six guiding principles developed through the Phase I process. The result of this review is outlined in the following table.

Guiding Principles	**Analysis**
1. To design a natural heritage/open space system (the "system") that reflects North Oakville's urban context as envisioned in Regional Plan Amendment No. 8 and OPA 198.	• Figure NOW 3 and NOE 3 for the North Oakville planning area provides a linked natural heritage system within an urban context. • The draft policies and mapping for NOE allow appropriately limited road and utility crossings. • The draft policies for NOE allow appropriately limited uses within the natural heritage system.
2. To use a systems approach to arrive at a viable, functioning system that includes all key natural features within an urban context.	• A systems approach was used to develop the natural heritage system, which includes the protection of core preserve and linkage preserve areas. • All key natural features have been incorporated into the natural heritage system. Other features, which due to their location, size, limited functionality, etc. have not been included in the natural heritage system, as it is recognized that they will likely not be sustainable in an urban context.
3. To recognize that form and function will vary throughout the system, and activities will vary accordingly.	• Figure NOW 3 and NOE 3 for the North Oakville planning area generally recognizes the varying form and function of the core preserve and linkage preserve areas. • The draft policies for NOE appropriately recognize the varying form and function of the core preserve and linkage preserve areas. • The draft policies for NOE appropriately recognize and limit activities and uses within the natural heritage system.
4. To take into account environmental, social and economic values in developing the system.	• All values appear to have been appropriately considered.
5. To create Town policies through this process that will recognize the existing provincial policy framework but will also be reflective of the agreed upon principles of the Interagency Review.	• Regard has been given to Section 2 of the 1997 Provincial Policy Statement in drafting the NOE policies. • The draft NOE policies appropriately reflect the direction of the IAR to provide for a natural heritage system within an urban context.

Guiding Principles	Analysis
6. In developing the system, consideration needs to be given to the ability of the Town to implement the system	• The draft NOE policies appropriately recognize that the natural heritage system lands need not to be purchased by any public agencies or that they are free or open to the public. • The draft NOE policies appropriately recognize that opportunities for enhanced management could be increased through public securement of the lands, for which multiple options can be explored

Conclusion

Based on the foregoing, the IAR members have concluded that the proposed natural heritage system generally shown on Figure NOW 3 and NOE 3 for the North Oakville planning area and the mapping and policy framework for the draft NOE Secondary Plan, dated April 12, 2006, appropriately reflect the directions and guiding principles resulting from the Phase I exercise. This conclusion has been reached on the review of the documents referenced in this report.

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Ministry of Municipal Affairs
and Housing

Jane Clohecy, MCIP, RPP
Director, Planning and
Transportation Services,
Regional Municipality of
Halton

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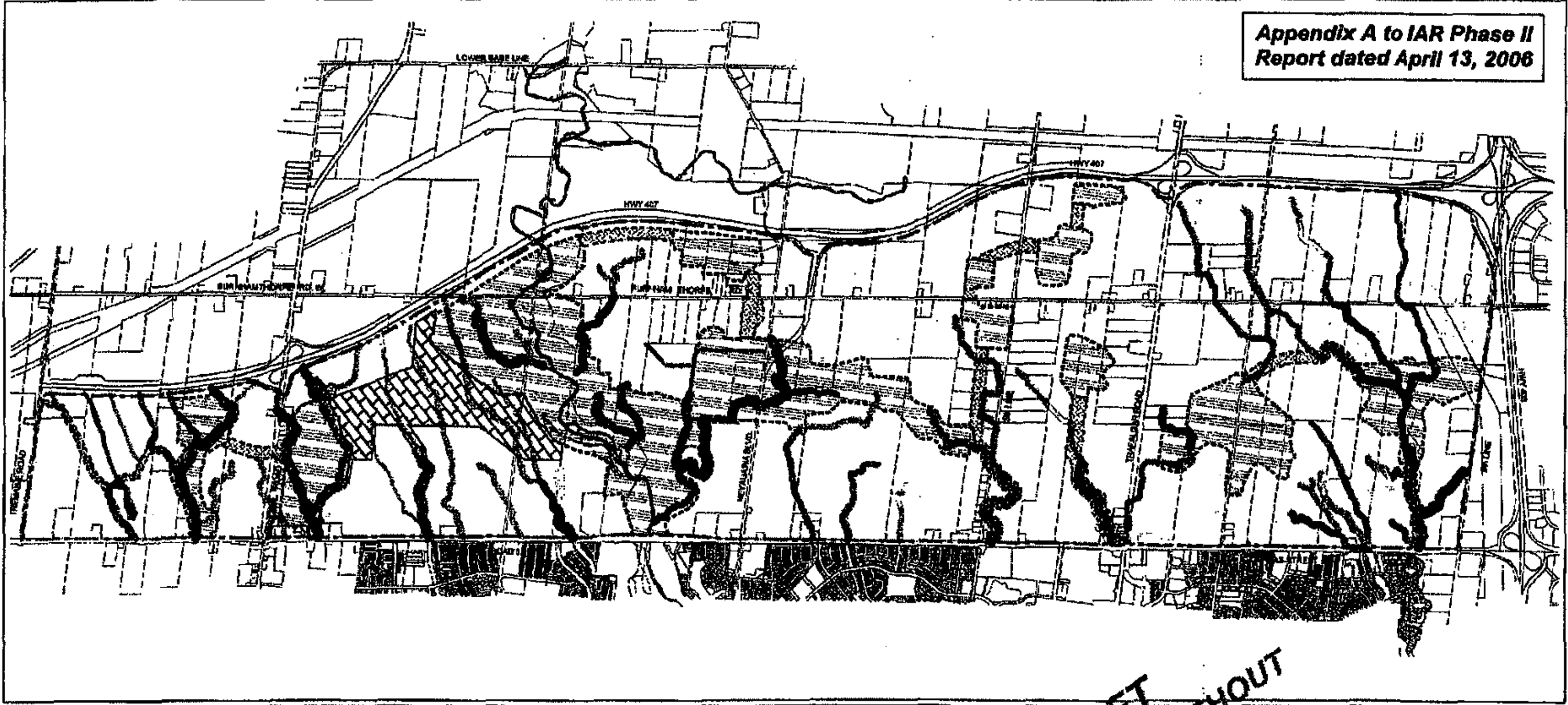
Division
Town of Oakville

Appendix A to IAR Phase II Report dated April 13, 2006



LEGEND

- SECONDARY PLAN AREA BOUNDARY
- CORE PRESERVE AREA
- CORE PRESERVE AREA
- LINKAGE PRESERVE AREA
- HIGH CONSTRAINT STREAM CORRIDORS
- MED. CONSTRAINT STREAM CORRIDORS
- LINKAGE AREA

OTHER HYDROLOGICAL FEATURES

- LOW CONSTRAINT STREAM CORRIDORS
- HYDROLOGIC FEATURES "A"
- HYDROLOGIC FEATURES "B"

DRAFT
CONFIDENTIAL WITHOUT PREJUDICE
For Review and Discussion

Town of Oakville

North Oakville
Secondary Plan

FIGURE NOW 3 & NOE 3
Natural Heritage Component of Natural Heritage and Open Space System Including Other Hydrological Features
April 12, 2006

Terms of Reference
for the
North Oakville Creeks Subwatershed Studies

January 2002

PART 1 – OVERVIEW

Issues

The impacts of current and future development and changes in land use within the areas of Town of Oakville, north of Dundas Street, are of concern.

The purpose of this project is to develop a subwatershed plan that allows sustainable development while ensuring maximum benefits to the natural and human environments on a watershed basis. The subwatershed areas of study include the Joshua's Creek, Morrison Creek, Munn's Creek, Shannon Creek, Osenego Creek and Sixteen Mile Creek. Specifically, the following issues with respect to environmental and downstream impacts from development must be addressed.

How can the servicing of existing development and expansion infrastructure of future development take place such that:

1) The aquatic habitat in the creeks within the subwatershed areas are maintained or where possible, enhanced

2) Discharges from proposed land uses to the receiving watercourses do not degrade the existing levels of biological diversity and productivity, nor adversely impact on stream forms

3) Any necessary alteration to the stream systems within the subwatershed incorporates the objectives of achieving natural stable channel form and appropriate habitat characteristics

4) All proposed development is planned and implemented to optimized compatibility with the natural features and their associated functions as well as recreational, cultural resources and features.

5) Groundwater resources and functions are maintained and, if possible, enhanced, including investigation of flow paths and maintenance of these paths where required, considering the aquatic habitat requirements of the stream.

6) The quality of groundwater is not adversely impacted by proposed SWM measures (i.e. infiltration basins) and/or proposed land use. Any proposed servicing does not detrimentally lower the water table or adversely effect the groundwater resources.

7) Stormwater runoff is controlled to ensure that Peak Flow Rates and associated flood levels are not increased as a result of the proposed development.

8) That existing watercourses, of any form, are identified, reviewed in sufficient detail that appropriate polices are established to protect and enhance them.

9) The prolonged discharge from detention facilities does not increase downstream peak flows or channel erosion Stormwater management considerations for quality treatment and protection of stream morphology.

10) That areas downstream are not negatively impacted through the implementation of the recommended stormwater management best management practices.

Study Goals and Objectives

The objective of the Subwatershed Plans is to provide an overall strategic framework for resource management within each of the subwatershed areas and the reaches of the various Creeks. The study must provide sufficient detail to support the completion of Secondary Plan Servicing studies. Future Neighbourhood (i.e. Secondary Plan level) and any future site specific stormwater and groundwater management plans will implement these strategic objectives in the development of the lands designated for urban use.

The specific goals and objectives of the Subwatershed Plan are:

1) Goal

- To minimize the threat to life and the destruction of property and natural resources from flooding, and preserve (or re-establish, where possible) natural floodplain hydrologic functions.

Objectives

- To ensure that runoff from developing and urbanizing areas is controlled such that it does not increase the frequency and intensity of flooding at the risk of threatening life and property.
- To adopt appropriate land use controls and development standards to prevent development in natural flood hazard and erosion hazard areas

- To ensure that new development incorporates the most appropriate development form and mitigation measures necessary to optimize compatibility with natural features and their associated functions

2) **Goal**

- To restore, protect, and enhance water quality and associated aquatic resources and water supplies for watercourses, including their associated hydrologic and hydrogeologic functions, within the subwatershed areas.

Objectives

- Protect stream morphological and fluvial character; restore, where appropriate and feasible, sinuosity; maintain physical habitat attributes (pools, riffles etc.), diversity and fluvial processes (bedload transport, energy reduction through sinuosity, etc.); and prevent increase in erosion and deposition, through maintenance of hydrological regime.

- To prevent the accelerated enrichment of streams and contamination of waterways from runoff containing nutrients, pathogenic organisms, organic substances, and heavy metals and toxic substances.

- To maintain or restore a natural vegetative canopy along streams where required to ensure that mid-summer stream temperatures do not exceed tolerance limits of desirable aquatic organisms.

- To minimize the disturbance of the streambed and prevent streambank erosion and, where practical, to restore eroding streambanks to a natural or stable condition.

- To restore, rehabilitate, or enhance water quality and associated resources through the implementation of appropriate Best Management Practices on the land.

- To ensure that hydrogeologic functions are preserved and maintained and take full advantage of stream and groundwater discharge/baseflow enhancement opportunities .

- To maintain and enhance the aquatic habitat.

- To minimize disturbance of wetlands, preserving and/or enhancing the habitat and functions they provide.

- Provide appropriate buffers to wetlands, watercourses, and valley lands to maintain or enhance their biological health and meet objectives of long term sustainability of these features.

3) Goal

- To restore, protect, develop and enhance the natural heritage, historic, cultural, recreational, and visual amenities of rural and urban stream corridors.

Objectives

- To ensure that environmental resource constraints are fully considered in establishing land use patterns in the subwatershed.
- To ensure that existing wildlife linkages are preserved and that opportunities for improving these linkages are considered/implemented as part of any future development.
- To retain, preserve or maintain natural heritage features (i.e. open space and visual amenities) in urban and rural areas by establishing and maintaining greenbelts along stream corridors and adjacent natural areas and maintaining linkage between these areas.
- To ensure that development in the stream corridor is consistent with the historical and cultural character of the surroundings and reflects the need to protect visual amenities.
- To ensure that the recreational and fisheries potential of a stream corridor are developed to the fullest extent practicable.

The Study Approach

The Subwatershed Studies will include:

Watershed Synopsis

a. Assessing the existing and potential subwatershed resources (physical, natural, social and economic).

b. Determining the existing and future land uses, per OPA 198. Relating the proposed land use to subwatershed resources.

c. Identifying existing and future problems and opportunities to correct these problems.

Identification of Subwatershed Opportunities and Targets

d. Setting targets to be met and identifying opportunities, which will be developed.

e. Establishment of constraint and opportunity mapping

Watershed Plan Development and Evaluation

f. Developing several scenarios to meet the long term subwatershed goals and objectives.

g. Evaluating the effectiveness of the various subwatershed plans in meeting the subwatershed objectives, targets and enhancement opportunities.

Final Plan Subwatershed Plan

h. Recommending a subwatershed plan and developing implementation strategies and frame work for subsequent studies; example Stormwater and Groundwater Management Plans.

i. Providing for a monitoring and evaluation program to ensure the plan's success and to verify that predicted performance is achieved and to allow for adaptive management response.

Future site specific Stormwater and Groundwater Management Studies completed as part of the Secondary Planning Process will describe in detail the specific measures which will be undertaken to implement the management objectives and meet the targets and further opportunities defined in the Subwatershed Plan.

PART II – STUDY ORGANIZATION

General

The study will generally follow the process described in the document, "Subwatershed Planning" (MOE, MNR 1993) and must also be consistent with the goals, objectives and targets of the Watershed Plans where they have been completed subject to updating requirements of such plans to meet current guidelines and design criteria.

The Region and the Town have policies in place specifically related to watershed and subwatershed planning. The study will conform to Sections A3b2 and A3b5 of the Regional Official Plan in addition to Part C, 10.5(d) of the Town of Oakville Official Plan.

Relationship to Secondary Planning

It is intended that the Subwatershed Study be completed prior to or in conjunction with the preparation of the Secondary Plans for this area to determine and mitigate any impacts of the proposed development on the natural resources and provide protection against the natural hazards of flooding and erosion. As such, the Subwatershed Study must provide technical support to the secondary plans land use planning process. The Subwatershed study must outline the preferred stormwater and environmental management strategy for the Secondary Plan Area. The Secondary Plan Studies must evaluate in greater detail the implementation of the recommended plan in order to facilitate the land use and infrastructure planning process .

Environmental Assessment Act

The subwatershed planning process may lead to recommendations which include works or undertakings that are subject to the Environmental Assessment Act. The intent of the EA Act is to provide for the protection, conservation and wise management of the environment through planning and informed decision-making. Successful planning under the EA Act consists of five key features:

- consult with all affected parties;
- consider a reasonable range of alternatives to the undertaking and alternative methods of implementation;
- consider all aspects of the environment;
- systematically evaluate the environmental effects of each alternative considered;
- provide clear complete documentation.

The fundamental EA principles shall be incorporated into the subwatershed planning process. The information developed through this planning process should satisfy Phases 1 and 2 of the Municipal Engineers Association (MEA) Class EA requirements. The consultant should review the types of projects that could be anticipated as a result of the subwatershed plan and determine what specific Class EA requirements will need to be incorporated in the plan. The steps are as follows: evaluate alternatives to projects; select preferred options; and incorporate documentation of Class EA requirements into the subwatershed plan

Canadian Environmental Assessment Act (CEAA)

The preferred management strategies, will also need to be consistent with the requirements of the Federal Fisheries Act and the "no net loss" policy. It is intended that the subwatershed plan will provide general criteria for construction activities, facilities and structures which will impact, or could, potentially impact, upon fish habitat. Notwithstanding, the direction outlined within this plan, final design plans may still require approval by the various regulating agencies, however the adherence to the design criteria outlined herein will facilitate both planning and design, as well as ultimate agency review.

Public Participation

a) In order to obtain public input on the formation and evaluation of various water management plans, the consultant will hold three Public Meetings during the course of the study, as follows.

i) - Notification of the study.
- Review of subwatershed Goals and Objectives, work program.
- To be held during the Background Report review period.

ii) - Review of management Objectives and Plan alternatives and review of background data collection
- To be held during the Characterization Report review period.

iii) - Review of evaluated alternatives and preferred Plan.
- To be held during the Draft Final Report review period.

The public meetings will take the form of Open Houses and public meetings.

Technical Advisory Committee

The TAC will be chaired by the Town and have the following representation:

- Town – 4, includes Chairperson
- Conservation Halton – 3
- Region – 3
- Stakeholder Advisory Committee – 2
- Landowners - 2 .

The TAC meetings will be made available to the general public for attendance purposes. The Landowners and Stakeholder Advisory Committee members will have 'observer' status.

Geographic Information Systems

It is expected that data and mapping will be organized and developed with the use of GIS. ARC/INFO is preferred for mapping and figures. All files are to be prepared in "DXF" format, or as specified by the Town's Manager of GIS Services. All digital information, data, sketches, drawings and reports generated by the consultant for the purpose of this study shall become the property of the Town of Oakville, Conservation Halton and the Region of Halton. All new data being incorporated into the GIS shall be at a scale of 1:10,000 or larger.

Reports

a) After carrying out the background review, the Consultant will prepare a ***Background Report*** *which will cover all data sources of information.*

b) After carrying out the initial inventories and assessment, the Consultant will prepare a ***Characterization Report***. This report will contain but not be limited to:

- watershed hydrogeology report
- watershed hydrology (existing)
- floodplain mapping
- existing and future land use
- flood and erosion problems
- natural heritage features identification and evaluation
- fishery inventory and fish habitat assessment
- water quality evaluation

- summary of applicable Provincial and Municipal policies that will aid in achieving subwatershed goals and objectives
- list of alternatives/measures that are considered to mitigate potential adverse impacts

c) After carrying out the Characterization Report the Consultant will prepare an ***Interim Report***. This report will detail the following:

- Impact of future development (Water Quality and Quantity – flooding and erosion)
- Development of alternate mitigation measures
- Detailed evaluation of the various mitigation measures
- Preliminary Recommendations for preferred management measures
- diskettes of model input/output

d) The Consultant will prepare and distribute the Final Report. The ***Final Report*** will consist of:

- the General Report which describes the final Subwatershed Plan and Implementation and Monitoring Strategy
- the Technical Report which documents the study findings and describes in detail the Plan and Implementation and Monitoring components
- Technical Appendix Reports documenting each of the detailed Inventory and Assessment Studies.
- One digital copy of all GIS mapping collected or developed in the preparation of the subwatershed plan (.e00 or shape file format (ARC/INFO, ArcView))
- All documents and supporting data collection, analysis and models to be supplied to the Town in digital format
- Licensed copies of the Hydrologic and Hydraulic models including all input/output data to be supplied to the Town and Conservation Halton

e) Report Distribution

- One copy of each interim report will be prepared for each member of the Advisory Team.

Copies of the Final Report will be distributed as follows:

- fifteen copies each of the General Report and Technical Report.

Meetings

The Consultant will allow for at least six Project Team meetings and three formal presentations:

- start up

- presentation of work plan
- presentation of the background review, including a walking tour of the study area
- evaluation of the plan alternatives
- presentation of the Characterization Report
- presentation of the Interim Report
- presentation of the plan alternatives
- presentation of Final Report
- final report presentation to the Subwatershed Study Team
- final report presentation to municipal council

Summary of Study Components

Each component is summarized in two parts. The first portion of the summary deals with the background review and assessment work. The second portion deals with the scenario testing and formulation of the final plan.

Hydrology

A detailed hydrologic model should be developed and calibrated for the sub-watershed for the existing, and future development scenario. The model should be a continuous, deterministic, hydrologic model, approved by the Technical Advisory Committee, with strong physical representation of surface runoff, base flows, and surface groundwater interaction. At the completion of the study the consultant will be required to supply the Town of Oakville and Conservation Halton, with a licensed version of the hydrologic model, including program documentation, along with all digital input files, if required.

The subwatershed physical feature mapping such as subwatershed boundary, watercourses, drainage swales and wetland features should be verified, and sub basins determined to establish nodes at points of interest. The intent of the modeling is to provided the details required for subdivision planning. The model should be calibrated to provide comparable flows at the sub basin outlet to those determined in the previous watershed studies. The model input parameters should be compared to the previous watershed studies and modified to represent the more detailed subwatershed model. Calibration of the hydrologic model should be based on both specific storm events, and low flow measurements. Model calibration will have to be completed to the satisfaction of the Technical Advisory Committee.

Revise hydrology to reflect future development condition scenarios. Investigate the impact of post development flows and volumes on flood levels, stream erosion and base flows. Optimize scenarios to reduce adverse affects, incorporate water conservation techniques and develop enhancement opportunities.

Undertake an erosion potential analysis based on the erosion data collected to understand the erosion processes that are occurring, identify areas which are highly prone to erosion or where structures may be at risk, and determine the threshold flows for erosion at strategic points in the subwatershed.

Flood Plain Management

Update the flood hydrology for the future condition. Where necessary update existing floodlines using updated future flow rates. Identify areas subject to flood damage and the consequences of flooding. Identify erosion susceptible areas. Identify flow and volume constraints. Determine base flows and drought characteristics of stream discharge. Floodplain mapping for all areas of future development will be required.

It will be necessary to develop flood lines for all watercourses not currently included in the existing flood plain mapping which are located in any areas where future development will occur, where the upstream drainage areas are greater than ½ half square mile (125 ha). This analysis should be completed in accordance with the standards set out in the FDRP program based on the flows resulting from the ultimate development scenario. The U.S. Army Corps of Engineers HEC II back water model or HEC RAS model is acceptable for the hydraulic analysis. For tributaries which have drainage areas less than ½ square mile (125 ha) floodplain mapping may not be required, however alternate methods to ensure adequate hydraulic capacity may be required.

Hydrogeology

The goals of the subwatershed study with respect to hydrogeology include the following components.

Conceptual Model

To establish a geological and hydrogeological conceptual model for the subwatershed, determining the key characteristics of the bedrock and overburden systems and their function in terms of controlling groundwater movement, availability, and quality in the subwatershed. An integral component is to assess the interaction between the groundwater system and the surface water system and to determine the overall role or function of this interaction in an ecosystem context. Particular reference to the Trafalgar Moraine will be a integral component of the model and field investigations (drilling/monitoring) will be necessary to confirm the functions of this feature.

Mapping

Map regional groundwater flows and quality in the subwatershed. Identify existing recharge-discharge zones to maintain/enhance baseflow and instream water temperature. Identify suitable sites for urban stormwater infiltration to avoid contamination of the groundwater table. Identify areas of potential recharge to the regional groundwater aquifer. Determine potential groundwater storage available. Determine the groundwater contribution to maintaining the existing natural areas (wetlands, environmentally sensitive areas, Trafalgar Moraine, etc.).

Protection and Mitigation Measures

Determine the impact of wells and other development on groundwater levels. Generate development scenarios that incorporate infiltration opportunities and water conservation techniques to enhance or maintain groundwater levels and quality.

Water Quality

Assess the existing water quality of the reaches of the various creeks. Note existing sources of pollution and recommend remedial action. Investigate the impact of existing urban development. Identify opportunities for water quality enhancement, where possible.

Recommend water quality objectives based on stream use: aesthetics, fishery. Prescribe practices and techniques to maintain/enhance, where possible the water quality. Assess development scenarios against water quality objectives. Establish a water quality monitoring program to monitor progress.

Stream Morphology

One of the objectives is to protect stream morphological and fluvial character; restore, where appropriate and feasible, sinuosity; maintain physical habitat attributes (pools, riffles etc.), diversity and fluvial processes (bedload transport, energy reduction through sinuosity, etc.); and prevent increase in erosion and deposition, through maintenance of hydrological regime.

Characterize each reach of the subwatershed using the Rosgen classification system and, based on the morphological attributes of each channel reach, determine the physical and biological health of the watercourses.

This study component would also include provision of recommendations relating to watercourse system attributes to provide guidance for open space blocks and design guidance for the stream rehabilitation opportunities.

Fish and Aquatic Habitats

Initial assessment work would include existing habitat assessment, spawning survey, benthic inventory and fisheries inventory. Identification of stream baseflow sources and investigation of opportunities for baseflow and habitat enhancement. Identify current sources of degradation. The consultant would work closely with Conservation Halton and the Ministry of Natural Resources when carrying out this assessment work.

Set targets to ensure maintenance or enhancement, where possible, of stream baseflow and temperatures. Recommend practices and techniques to achieve or exceed targets. Applying recommended practices and techniques, investigate the impact of proposed urban development scenarios.

Natural Heritage Areas

Identify the wetlands, wood lots, wildlife travel corridors, wildlife habitat areas as well as any Areas of Natural and Scientific Interest (ANSI's) and Environmentally Sensitive Areas (ESA's) that may be located within or adjacent to the study area. Identify the relationships between the wildlife and the natural areas. Identify the resource management role of the existing wetlands and woodlots in flood attenuation, wildlife habitat, water quality enhancement. Confirm boundaries of natural heritage areas.

Review previous evaluation methodologies and provide recommendations for appropriate evaluation methodologies for use in the subwatershed study as necessary.

Set detailed technical objectives and targets for appropriate preservation, protection and enhancement of natural features and their functions, which will need to be met by proposed development. Specify the best management practices that should be considered to meet these targets. The function served by the natural areas should be protected or enhanced, where possible, by the proposed management practices.

Investigate the impact of urban development. Recommend practices and techniques to mitigate development impacts and restore the natural ecosystem.

Relationships Between Study Components

Define relationships between study area components required for the description of the overall subwatershed system.

Assess the impacts of different plans on these relationships.

Land-Water Management

Determine existing and future land use, as per OPA 198. Relate proposed land use to subwatershed resources. Identify isolated resource areas and opportunities to link isolated areas to main corridors.

Comment on land use scenarios that will meet future land use needs and minimize impacts on the environment, particularly the environment along the stream corridors.

Implementation and Monitoring Plan

Recommend an implementation strategy, including phasing, cost sharing, pubic awareness program development, public land acquisition, enforcement and updating. Recommend a monitoring program to measure the plan's success.

Part III – Tasks To Be Carried Out

The work to be carried out for each major study component is described in detail in the following section.

1. Background Review

a) Background information on the study area will be collected from all available sources and by field inspection. Including but not restricted to the following:

Hydrology

- Previous subwatershed studies and stormwater management studies
- aerial photos
- topographic and photo base maps
- flow records, high water marks, precipitation
- water use

Hydrogeology

- regional ground water studies (technical reports, pump tests, quality data, etc.)
- carryout drilling, installation of groundwater level monitoring equipment and data collection/analysis, as necessary to provide sufficient information to verify understanding of the hydrogeologic functions and nature of the Trafalgar Moraine
- soils reports
- surficial soils and quaternary geology of area (i.e. Trafalgar Moraine)
- existing well records, levels and quality
- reports of contamination
- complaint files (MOE)

Natural Heritage and Aquatic Habitat

- wetland evaluation and assessments and review/utilization of any available evaluations completed by the Ministry of Natural Resources and Conservation Authority.
- fisheries inventories assessment
- water quality assessment
- Trafalgar Moraine
- identify potential pollution point sources to the stream, i.e. storm outfalls, old dump sites
- identify enhancement opportunities for all environmental components
- Review of previous study evaluation methodologies and based on consultation with stakeholders, provide recommendations for any necessary revisions to the previous evaluation methodology for use in the subwatershed study and additional information needs.
- Carry out any necessary additional inventory of flora and fauna to address any information gaps noted during the background review of previous studies and inventories.
- Identify ANSI's and ESA's

Municipal Land Use Planning

- existing and future land use
- Official Plans and Zoning By-laws
- Population projections, population densities
- Planning and development studies
- Existing and future transportation corridors

Engineering

- existing and future servicing corridors

The background review will include all relative reports and information sources.

b) The consultant will layout a frame work for the organization, management and presentation of resource data.

c) The consultant will identify all wetlands, ponds, drainage paths, and defined watercourses using aerial photos and field inspections. During the field inspections, the Consultant will also observe and comment on existing land uses, vegetative cover, quantity of flow, wildlife and fish habitat and pollution sources.

d) Data deficiencies should be identified and requirements for field monitoring of specific parameters or characteristics to augment the data base should be made. Standards will have to be specified for collection of additional data. Additional field data shall be collected where necessary and added to the existing databases such that the level of detail will support the decision making process of the subwatershed study.

e) Consideration should be given to post development monitoring requirements when sighting locations of additional stations. Additional data requirements identified by field survey.

f) The consultant will prepare a base map of the study area which can be used throughout the study to overlay subwatershed attributes and plan components.

g) After carrying out the review, the Consultant will prepare a background report which will:

- summarize the findings of the review;
- formulate an issue and problem statement;
- prepare a detailed work plan for the study.

The background report should be prepared in such a way that it can be used as introductory chapters in the final study report (see Schedule A).

h) the consultant will work closely with the Technical Advisory Committee chairman and members of other on-going studies.

2. *Analysis*

Hydrology and Hydraulics

This subwatershed plan will recommend an array of runoff control measures to be carried out in Secondary Plan and Subdivision Plan Level Studies to ensure that downstream peak flows are not increased, and do not cause downstream channel erosion and that stormwater runoff is appropriately treated to meet water quality targets. The recommendations will need to be defined in sufficient detail to support completion of the subsequent secondary planning level studies. Tasks to be carried out by the Consultant are:

a) The Consultant will, based on background information and field investigation provide a recommendation for the appropriate number of streamflow gauges for review and approval by the Technical Steering Committee. The consultant will initiate the streamflow monitoring program as early as possible in the study process and continue the monitoring program throughout the duration of the study. The method of flow measurement will be confirmed during the start-up stage and may consist of:

- continuous flow gauging and recording,
- local rainfall recording
- staff gauges with local high flow observers,
- collection of high water and debris line data following high flow events,
- seasonal instream measurement of spot baseflow, particularly in conjunction with water quality sampling and fish and benthic sampling.

b) The hydrology study will be undertaken in accordance within appropriate Engineering Standards.

c) Return frequency flows will be determined based on the existing pre-development condition. Post-development storm flows will be developed for the proposed future land use scenarios for both uncontrolled conditions and with the recommended stormwater management controls in-place .

Return period flood estimates will be made using continuous simulation and frequency analysis for a minimum of 30 years of data.
The effectiveness of stormwater management mitigation plans must be confirmed through continuous simulation results and frequency analysis for both peak flow control and erosion mitigation performance. The preferred plan will also be tested relative to the Municipal design storms along with several historical events including the Regional Event.

d) It is required that an appropriate hydrologic watershed model be used for all subwatershed areas. The model should be a continuous, deterministic, hydrologic model, approved by the Technical Steering Committee, with strong physical representation of surface runoff, base flows, and surface groundwater interaction The Consultant is to ensure the model accounts for the following processes:

- soil infiltration
- soil moisture
- channel storage
- full seasonal effects (snow accumulation and melt)

e) The watershed model of the existing condition will be verified with available flow records and high water marks and streamflow/rainfall data collected during the study.

f) The results of the predevelopment modeling will be used to set targets for outflow control rates which will be provided and return period flow rates at key locations and are all weighted flow rates for smaller development areas.

g) The Consultant will assess the impact of development on stream peak flows, cumulative excess shear and flow duration.

In addition to these initial scenarios, the Consultant must be prepared as part of the testing of alternative plans, to test the sensitivity of flows and volumes to variations in land use density and best management practices.

h) Flood plain mapping will be extended where necessary and existing floodlines within the subwatershed revised using updated future flow rates. Floodplain mapping for all area of future development will be required. It will be necessary to develop flood lines for all watercourses not currently included in the existing flood plain mapping which are located in any areas where future development will occur, where the upstream drainage areas are greater than ½ half square mile (125 ha). This analysis should be completed in accordance with the standards set out in the FDRP program based on the flows resulting from the ultimate development scenario. The U.S. Army Corps of Engineers HEC II back water model or HEC RAS model is acceptable for the hydraulic analysis. For tributaries which have drainage areas less than ½ square mile (125 ha) floodplain mapping may not be required, however alternate methods to ensure adequate hydraulic capacity may be required.

Erosion

a) The Consultant will identify, by field inspection, sites where bank erosion is taking place or could potentially occur.

b) The Consultant will estimate erosive velocities and identify, using the hydraulic study results, sites that may be subject to erosion under existing and post-development conditions and will undertake a flow duration exceedance analysis based on existing, future and ultimate conditions.

c) The Consultant will identify flow constraints, which may avoid or reduce future bank and bed erosion problems.

Hydrogeology

The purpose of this assessment is to:

a) determine the groundwater contribution to baseflow and to the natural systems (wetlands, etc.);

b) determine the quality of groundwater resources;

c) determine potential changes in groundwater quantity and quality due to any proposed development ;

d) determine the impact on groundwater levels relating to private wells;

e) determine how to protect groundwater quality from degradation by surface activities or artificial recharge;

f) determine recharge and discharge areas;

g) identify those recharge sites which are suitable for urban stormwater infiltration (i.e. avoid contamination of regional groundwater table);

h) identify areas suitable for recharge to the regional groundwater table;

i) determine the storage available in the groundwater aquifer.

In order to meet these objectives, the consultant will:

j) review and assess all available information on the hydrogeology of the area

k) using existing information, prepare geologic mapping of the aquifer system together with appropriate cross-sections;

l) outline data deficiencies and estimate the cost of additional drilling and sampling required to remedy these deficiencies;

m) prepare hydrogeologic mapping including aquifer distribution, recharge and discharge areas, potentiometric surfaces, flow directions, cross-sections, existing problem areas and permit holders;

n) calculate water budget and aquifer characteristics;

o) in conjunction with the findings from the Hydrology section, determine the groundwater contribution to maintaining baseflow and to maintaining the natural systems (wetlands, etc.);

p) set targets for infiltration runoff to maintain or enhance baseflows.

q) sample and describe groundwater quality in the aquifer system;

r) determine the effect of existing and proposed municipal wells on ground water and surface water quality, quantity and stream baseflow;

s) determine what areas are susceptible to ground water contamination and recommend what land use or management practices should be apply to these areas;

t) identify opportunities for urban stormwater infiltration (avoid contamination of regional ground water table);

u) Recommend a long term monitoring program to evaluate the effectiveness of the plan recommendation and allow for adaptive management response.

Stream Morphology

Characterize each reach of the subwatershed using the Rosgen classification system and, based on the morphological attributes of each channel reach, determine the physical and biological health of the watercourses as well as providing guidance for necessary spatial considerations for the stream and rehabilitation opportunities.

Recommend a long term monitoring program to evaluate the effectiveness of the plan recommendation and allow for adaptive management response.

Water Quality Assessment and Monitoring

The water quality monitoring and assessment tasks associated with this study include:

a) assessment of the existing stream water quality and setting realistic long term objectives compatible with stream use: aesthetics, and targeted fish habitat;

b) recommend appropriate volumetric requirements and other design criteria for stormwater management facilities (i.e. source and end-of pipe - as appropriate);

c) identify pollution sources, loading and source control measures, both short term and long term for urban and rural areas;

d) recommend a long term water quality monitoring program to measure the plan's success, verify performance and allow for adaptive management response;

e) evaluate the impact of the subwatershed reservoirs or ponds have upon the stream water quality and temperature. Where necessary, recommend remedial measures.

Natural Heritage Assessment (Environmentally Sensitive Policy Areas, Wetlands of Provincial Significance, Regulated Areas, Watercourses)

The Consultant will:

a) Review previous studies on the natural heritage areas.

b) Identify wetlands, woodlots, wildlife corridors, wildlife habitat areas and Areas of Natural and Scientific Interest (ANSI's) and Environmentally Sensitive Areas (ESA's) that may be located within or adjacent to the study area.

c) Define relationships between wildlife and natural areas.

d) Where necessary to ensure appropriate level of knowledge/documentation complete inventory of the vegetative and wildlife resources of each area, confirm previous findings;

e) In conjunction with the Hydrology and Hydrogeology section, determine the water needs of these natural systems and appropriate buffers.

f) Identify the circumstances, which promote the observed resources. Set targets and recommend practices to ensure their maintenance or enhancement, where possible.

g) Investigate the impact of the existing and proposed land use changes, municipal wells, and servicing are having and will have on these natural areas. Suggest practices and techniques to maintain the natural resources.

h) Investigate opportunities to restore and enhance natural heritage areas in strategic locations.

i) Identify opportunities to link isolated natural areas to the main corridors.

Fishery Inventory and Fish Habitat Assessment

Upon consultation with the Conservation Halton and the Ministry of Natural Resources, the consultant will compile existing fisheries data and carry out the following additional studies.

a) Fish habitat assessment of the main channel and all tributaries in accordance with the appropriate standards.
b) Any necessary spawning surveys as determined based on the background review and initial fieldwork.
c) Benthic inventory at representative stations. Compile a list of aquatic invertebrates present at time of sampling. Usually collected by surber sampler, seine net and dip net.
d) Fisheries inventory at representatives stations. List of fish species present at the time of sampling.
e) Identify existing habitat features which are critical for maintenance of the existing fishery using information obtained in a).
f) Identify existing habitat features which may be presently limiting fish production (e.g. Elevated temperatures, sedimentation).
g) Using the information obtained, suggest opportunities from enhancement of fish production as development proceeds. (e.g. infiltration of stormwater, removal of onstream ponds or structures, placement of spawning gravel over upwelling areas)
h) Examine fisheries problems and opportunities created under a variety of subwatershed development scenarios.
i) Through interaction with other disciplines develop a preferred approach which documents habitat maintenance/enhancements.

3. Formation and Evaluation of Subwatershed Management Plans

<u>Watershed Synopsis</u>

a) The consultant will summarize the targets, constraints and opportunities identified in the subwatershed Synopsis:

  - land use targets and constraints
  - recreation targets and constraints
  - flood flow and volume constraints for flood and erosion control
  - constraints on urban development to meet flows and volume targets
  - susceptibility of groundwater to contamination from urban [illegible]
  - potential recharge and discharge zones to maintain/enhance baseflow and water temperature in the stream

- existing sources of pollution and corresponding remedial action
- water quality targets based on stream use
- constraints on urban development to maintain/enhance water quality
- circumstances which promote the target fish species
- constraints on urban development to enhance fish habitat
- natural heritage areas (wetlands, environmentally sensitive areas, stream corridors, regulated areas, ANSIs, ESA's)

Watershed Targets and Opportunities

b) The Consultant will consolidate the list of targets and constraints to fulfill the subwatershed Goals and Objectives.

Plan Development

c) using constraint analysis, develop a stream corridor management boundary for the streams within the subwatersheds. The stream corridor should be determined so as to include natural, cultural and historic features where protection and preservation is important to meet the goals and objectives of the study. Features to be included are floodplains, wetlands, erosion prone areas, significant wildlife areas, ecologically important areas and stream or waterway related recreational areas.

d) The Consultant will prepare a list of Conservation Practices, based on applicable Federal, Provincial, Watershed and Municipal policies, guidelines, and objectives, which address stream flow, water quality, wetlands, fisheries, soil erosion and general resource conservation requirements. (This list is intended to be used as a guide and starting point in formulating alternative plan components).

e) The Consultant will investigate alternative measures and techniques to address targets and constraints for flooding, erosion, water quality, natural resources and fish habitat under present and future conditions. These measures may include:

- the identified conservation practices and variations on them
- programs and works to address existing problems
- considerations for type, density, and location of development
- works to be incorporated during individual site development
- centralized works to be implemented prior to development;

f) The Consultant will combine various measures and techniques to formulate alternative plans which will meet the Subwatershed Plan Goals

Final Subwatershed Plan

g) the Consultant will evaluate and compare each of the plans. The evaluation will be based upon:

   a) how well the Study's goals and objectives are met;
   b) environmental impacts of each plan (physical, natural and social).

h) Review and analyze applicable Provincial, Regional and Municipal plans and policies to ensure that any recommended subwatershed management plans are consistent with the existing plans and policies.

i) Recommend a preferred plan.

4. *Implementation Plan*

The Consultant will recommend an implementation strategy for the plan which will ensure that the Management Objectives will be met. The implementation strategy will include but not be limited to:

- phasing of required works
- public awareness program
- reflecting the appropriate implementations and directions in Secondary Plans, Zoning By-laws and Draft Plans
- directions to development proponents on site-specific studies and assessments
- available plan review mechanisms such as conditions of subdivision draft plan approval, site plan control
- enforcement measures such as Zoning, Fill Regulations, Site Plan Agreements and corresponding responsibilities for inspection
- enhancement programs
- timing and responsibilities for further study
- recommend additional plans and studies (e.g. Secondary Plan Level Studies) and Terms of Reference thereof

5. *Monitoring*

a) The Consultant will recommend a monitoring program to evaluate the effectiveness of the plan recommendation and allow for adaptive management response, The monitoring will include:

- short and long term station network for streamflow, groundwater, water quality, fish and benthic surveys, as well as stream form, and natural heritage features.
- monitoring and reporting [illegible] and long term
- sources of long term funding

- follow-up and enforcement responsibilities tied in with implementation strategy
- monitoring of fish habitat features

6. Project Timing

The Background Report is anticipated to be completed approximately 2 months following the study commencement.

The timing of the Subsequent Reports will be subject to, status of data collection (i.e. rainfall and streamflow), status of the available background data and need to undertake field work assessments.

LIST OF PREVIOUS STUDIES/REPORTS

Hydrogeological Assessment Report, Trafalgar Moraine, Town of Oakville, December 2001, prepared by Morrison Environmental Ltd.

North Oakville Natural Heritage Inventory and Analysis, LGL Limited et al. al., May 1999 (prepared for the Town of Oakville)

Subwatershed Impact Study Sub-Basin 7B Joshua's Creek, Marshall Macklin Monaghan, March 1999 (prepared for Bayshire Investments Limited)

Halton Aquifer Management Plan, Phase 1 Report, Background Hydrogeology, February 1996

Sixteen Mile Creek Watershed Plan, prepared in support of the Halton Urban Structure Plan, February 1996

West Oak Trails Subwatershed Impact Study for Taplow Creek, McCraney Creek and the East Branch of Fourteen Mile Creek, Final Report, Cosburn Patterson Mather Limited et. al., May 1995

West Oak Trails, Subwatershed Impact Study for Taplow Creek, McCraney Creek and the East Branch of fourteen Mile Creek, Final Report, Cosburn Patterson Mather Limited et. al., May 1995 (prepared for the Town of Oakville)

Sixteen Mile Creek Watershed Plan, Technical Report # 2, Evaluation of Potential Development Impacts, prepared in support of the Sixteen Mile Creek Watershed Plan and the Halton Urban Structure Plan, February 1995

Sixteen Mile Creek Watershed Plan, Technical Report # 3, Regional Hydrogeology, prepared in support of the Sixteen Mile Creek Watershed Plan and the Halton Urban Structure Plan, February 1995

Sixteen Mile Creek Watershed Plan, Technical Report # 4, Natural Environment, prepared in support of the Sixteen Mile Creek Watershed Plan and the Halton Urban Structure Plan, February 1995

Joshua's Creek Watershed Plan, Marshall Macklin Monaghan Limited, 1992

Appendices for Glen Oak Creek Subwatershed Impact Management Study, UMA Engineering, Draft, June 1992 (prepared for the Town of Oakville)

Fourteen Mile Creek, McCraney Creek Watershed Planning Study, Triton Engineering Services Ltd. et al. al., February 1992, Town of Oakville

Geology and Water Resources of the East and Middle Oakville Creeks, IHD Representative Drainage Basin, (Oakville), Ontario Ministry of the Environment, 1979a

A Hydrogeologic Study of Environmentally Sensitive Areas in the Region of Halton, Ecologistics Limited and Conestoga-Rovers Ltd., 1977 (prepared for the Halton Region Conservation Authority, Regional Municipality of Halton, Grand River Conservation Authority and the Credit River Conservation Authority)

Appendix AA - Test Catchment Design Case

In order to test the feasibility of the recommended measures for hydrologic, hydrogeological and water quality controls, a design example was set up for one of the catchments in the North Oakville Creeks Subwatershed area. The WM-1 subcatchment, a 38.2ha headwater area south of Burnhamthorpe Road in the West Morison Creek catchment, was chosen. The existing land use includes a small proportion of residential/commercial with the remainder being undeveloped woodlot and agriculture.

A. Hydrologic Criteria

A SWM pond was sized to handle the Regional storm to the two-year storm with outflow rates equal to the predevelopment runoff for these storms. The active storage volume for the maximum event (Regional Storm) required is 3.5ha-m. Assuming an average depth of 1.5 to 1.0m, then the area needed for the pond is 2.3 to 3.5ha or 6 to 9% of the land area. This amount of land is not excessive in comparison with other developing subwatersheds in southern Ontario. Pits or topographic depressions in the area account for 770m^3 or 0.077ha-m and additional storage can easily be accommodated in the pond sized above without changing the area required

Site Characteristics

The subcatchment characteristics are shown in **Table AA1.**

Table AA1
Subcatchment Characteristics

Land Use	% of Total Area	% Impervious
Light Employment	45 %	70 %
Transition	13 %	70 %
Character Area	14 %	60 %
Residential	19 %	60 %
Core	9 %	0 %
Total Area	38.22 ha	

Sizing Criteria

The SWM pond maintains existing return period (2-year through Regional Storm) peak flow rates. The pond stage storage curve (**Table AA2**) was determined using a hydrological model (GAWSER) to route flows to the downstream end of the watershed. The pond release rates are equal to the unit area flow rate multiplied by the drainage area. **Table AA3** shows the calculations. We have not included a permanent pool for water quality. Streambank erosion has not been considered in sizing the pond.

Stormwater Pond Size

Table AA2
Stormwater Pond Size - Pond Stage Storage Curve

Storm Return Period	Outflow Rate m^3/s	Storage Volume ha-m
Regional	1.75	3.500
100-year	0.57	1.500
50-year	0.55	1.200
25-year	0.54	1.100
10-year	0.44	1.000
5-year	0.39	0.900
2-year	0.15	0.700

Comments

Assuming an average pond depth of 1m, the storage volume for the 100-year is approximately 4% of the total subcatchment area but does not include items such as wetlands, access roads, and sediment forebay. A more appropriate percentage would be approximately 5%. Assuming and average pond depth of 1.5m, the pond area for the Regional Storm is approximately 6% with a final value of approximately 7%.

Table AA3
Pond Release Rates

Total Drainage Area 38.2ha
Catchment: West Morrison Creek
Culvert: MW-D3
GAWSER Hyd No.2154

				Release Rate	
Pond Release Rates:	Regional	0.044	m^3/s/ha	1.68	m^3/s
	100 year	0.015	m^3/s/ha	0.57	m^3/s
	50 year	0.014	m^3/s/ha	0.54	m^3/s
	25 year	0.012	m^3/s/ha	0.46	m^3/s
	10 year	0.009	m^3/s/ha	0.34	m^3/s
	5 year	0.007	m^3/s/ha	0.27	m^3/s
	2 year	0.004	m^3/s/ha	0.15	m^3/s

Pit Volumes

The pit volumes (**Table AA4**) have been estimated at approximately 0.057ha-m. The total is easily included within the storage volume of the SWM pond.

Table AA4
Topographic Depressions - Volumes

Pit Number	Area ha	Average Depth m	Volume m^3
19	0.011	1.0	110.0
20	0.003	1.0	30.0
21	0.002	1.0	20.0
22	0.002	1.0	20.0
23	0.010	1.0	100.0
24	0.002	1.0	20.0
25	0.001	1.0	10.0
26	0.004	1.0	40.0
27	0.001	1.0	10.0
28	0.016	1.0	160.0
29	0.005	1.0	50.0
		Total	570.0m^3 0.057ha-m
Ponds			
21	0.036	1.0	360.0
20	0.041	1.0	410.0
		Total	770.0m^3 0.077ha-m

B. Erosion Control Criteria

Any requirement to add storage volume would apply to the more frequent events (2 to 10-year return period) as flows might be restricted further. This would not affect the overall storage sized for the more severe events (*e.g.,* 100-year return and Regional storm) and could easily be accommodated in the pond sized for these larger events.

Erosion threshold calculations were undertaken for the WM-1 test catchment in North Oakville to determine permissible flows without causing excessive erosion. The method for erosion threshold calculation was based in part on indicators of active processes (*e.g.,* widening or entrenchment) and channel substrate. Chow's (1959) method for cohesive substrate was selected. A single characteristic riffle cross-section was extracted from the MOC-4 detailed site for the erosion threshold calculation (**Table AA5**). The critical depth at this site was calculated to be 0.12m. Based on these values, flow depth should not exceed this value post-development for more time than it does now so as not to increase or decrease current erosion rates. The size of the SWM ponds should be designed in consequence of this flow depth. The ponds should be of sufficient size so that the critical flow depth of 0.12m is not exceeded more frequently than it was during pre-development.

Table AA5 **Erosion threshold calculations for Site MOC-4**	
Test Catchment Erosion Thresholds	
PARAMETER	MOC-4
Average Bankfull Width (m)	3.14
Average Bankfull Depth (m)	0.26
Bankfull Gradient (%)	0.60
Bed Material D_{50} (m)	0.0000052
Bed Material D_{84} (m)	0.0053
Manning's n at Bankfull	0.033
Average Bankfull Velocity (ms^{-1})	0.96
Average Bankfull Discharge (m^3s^{-1})	0.78
Flow competence (ms^{-1}) @ D_{50}	0.018
Flow competence (ms^{-1}) @ D_{84}	0.43
Tractive Force at Bankfull (Nm^{-2})	15.30
Critical Shear (Nm^{-2})	7.20*
Stream Power per Unit Width (Wm^{-2})	14.63
Critical Depth (m)	0.12
Method	**Chow (1959)**

C. Hydrogeological Criteria - Due to the heavy soils (Halton/Wildfield Till) infiltration into deep soils is very slow. Infiltration targets are very difficult to achieve. As a result for this test catchment, additional infiltration to deep aquifers is assumed to be not practical. Note however that some additional water loss may be achieved by surface infiltration to top soils, although this would have limited to no effect on base flow maintenance and deep aquifer recharging.

An estimate of the infiltration volumes needed to "maintain" existing infiltration volumes for the example catchment was made. The results are based on an estimated infiltration rate of 40mm/yr under existing conditions.

Given the the land uses projected and the imperviousness estimates provided, an estimated 60mm/yr of additional infiltration over the remaining "unpaved" portion of the area would satisfy the objective of maintaining infiltration at predevelopment conditions. Thus the total infiltration needed for these unpaved areas is estimated at 100mm/yr. This is difficult to achieve considering the soil conditions.

Calculations follow:

Assumptions and Inputs

- WM-1 Area = 38.22 Ha
- Estimated Natural Infiltration = 40 mm/yr (from Analysis Report
- Land use and Imperviousness estimates for each Land use type provided in **Table AA6**
- Estimated potential infiltration for Halton/Wildfield Till = 100 mm/yr
- Estimated potential infiltration for fine to medium sand = 200 mm/yr

Table AA6
Calculation of Infiltration Post Development

Land Use	% of Total Area	Area	% Impervious	Impervious Area	Infiltration Volume
	ha	ha		ha	m^3/yr
Light Employment	45	17.20	70	12.04	2063.9
Transition	13	4.97	70	3.48	596.2
Character Area	14	5.35	60	3.21	856.1
Residential	19	7.26	60	4.36	1161.9
Core	9	3.44	0	0.00	1375.9
Totals		38.22		23.08	6054.0
Percent total impervious area			60.4		

Calculation of amount to infiltrate for post development to meet predevelopment levels

Predevelopment Infiltration - post development infiltration =

15288 - 6054=9234.0 m^3/yr

Calculation of amount in mm over remaining pervious area

Equivalent to an additional 60mm/yr over the remaining 15.4ha of "pervious" area

Area need to infiltrate 9234m^3/yr through Halton Till = $\frac{9234m^3/yr}{0.1\ m/yr}$

= 92340m^2

= 9.2ha

Calculation of area need to infiltrate 9200m^3/yr through fine to medium sand (such as a sand filter)

$\frac{9234m^3/yr}{0.2\ m/yr}$ = 46170m^2

=4.6ha

= 12% of the catchment area

Therefore, additional measures, other than an infiltration gallery, are needed in order to match pre-development infiltration.

D. Water Quality Criteria

Targets

The steps described in **Appendix D - Step-by-Step Procedure for Calculation Stormwater Quality Targets and Evaluating the Efficiency of Control Measures** were followed in this analysis.

Step-by-Step Procedure

1. Establish phosphorus target for the area beings developed.

Step 1. Calculate runoff volume for the undeveloped area.
Step 2. Calculate total phosphorus target based on the predevelopment load (**Table AA7)**.

Table AA7
Predevelopment Land use

Existing Land Use	% of Total Area	Area	runoff coef	Runoff Volume - 1000 m3	Conc TP mg/L	TP Load Kg/yr
Residential/Commercial	13%	4.9686	0.460	17.94	0.36	6.46
Woodlot	9%	3.4398	0.150	4.05	0.2	0.81
Agriculture	78%	29.8116	0.295	69.09	0.2	13.82
Total	100%	38.22		91.09		21.09

Therefore the predevelopment load is 21.09Kg/year of TP. This value is the target.

Step 3. Calculate post development runoff volume and TP load (**Table AA8**).

Table AA8
Calculation of Loading Target

Oakville North Pollutant Loading Model — **Test Catchment WM 1 Uncontrolled Loadings**

Land Use	Area - ha	Runoff coefficient	Runoff Volume - 1000 m3	TSS EMC mg/L	TSS Load - tonnes	TP EMC-mg/L	Total Phosphorus Load - Kg/yr
Light Employment	17.20	0.755	102	70	7.14	0.3	30.58
Transition	4.97	0.740	29	70	2.02	0.3	8.66
Character Area	5.35	0.670	28	70	1.97	0.3	8.44
Residential	7.26	0.690	39	91	3.58	0.36	14.16
Core	3.44	0.150	4	70	0.28	0.2	0.81
Total	38.22		202				62.65
						Target	21.09
						Reduction in load to achieve target	41.56

2. Account for infiltration measures at source and in conveyance system (Step 4).

No deep aquifer infiltration measures are anticipated based on the hydrogeological analysis above (other than infiltration incidental to the surface retention measures described in Step 5).

3. Account for surface retention measures that reduce overall flow and TP load reduction (Step 5).

Table AA9
Runoff Coefficient for Developed Area WM-1

Land Use	**% of Total Area**	**Area**	**% Impervious**	**Impervious Area**	**Imp. Area Runoff coeff.**	**Pervious area - ha**	**Pervious Area Runoff Coeff**	**Combined Runoff Coefficient**
	ha	ha		ha				
Light Employment	45	17.20	70	12.04	0.95	5.16	0.3	0.755
Transition	13	4.97	70	3.48	0.95	1.49	0.25	0.740
Character Area	14	5.35	60	3.21	0.95	2.14	0.25	0.670
Residential	19	7.26	60	4.36	0.95	2.90	0.3	0.690
Core	9	3.44	0	0.00	0.95	3.44	0.15	0.150
Totals		38.22		23.08		15.14		
Percent of total area impervious			60.4					

Note that for this calculation in **AA9**, there is a runoff coefficient for pervious as well as impervious areas. This is based on the assumption that on an annual basis, runoff occurs even from grassed areas.

To indicate the effect of rooftop drainage diverted to grassed areas, a calculation of an adjusted runoff coefficient is made in **Table AA10**.

Table AA10
Runoff Coefficient Adjustments for Impervious Areas Draining to Pervious Areas

Land Use	**Rooftop area % of Impervious Area**	**% of Rootops drain to Pervious**	**Adjust-ment to Imp Area % Reduction**	**Adju-sted Imp area**	**Adjusted Pervious area**	**Modified Combined Runoff Coefficient**	**Run-o-ff Volume - 1000 m^3**	**Volume reduction 1000 m^3**
Light Employment	50	20	10	10.84	6.36	0.71	96	6.14
Transition	50	20	10	3.13	1.84	0.69	27	1.91
Character Area	50	20	10	2.89	2.46	0.63	26	1.76
Residential	50	25	12.5	3.81	3.45	0.64	37	2.78
Core	0	0	0	0.00	3.44	0.15	4	0.00
						total>	190	12.60
					runoff reduction % of uncontrolled			6.23
					runoff reduction in mm units			32.96

The effective impervious area is reduced to 20.67ha while the pervious area is increased to 17.55ha. Note that while this is a 14.4% reduction in impervious area, the percent runoff reduction is only 6.23%. This is because a portion of the roof runoff directed to pervious surfaces still runs off on an annual basis. The adjustments to the runoff coefficients accounts for this phenomenon.

The flow reduction is accompanied by an equivalent load reduction of TP of 3.95kg/year which is 9.5% of the target reduction of 41.56 kg/year

4. Account for end-of-pipe SWM ponds to meet total suspended solids targets (sized for the reduced runoff) for the watershed, and account for the TP load reduced as well (Step 6)

With the measures in place, the performance of the end-of-pipe SWM pond is calculated. Results are shown in **Table AA11**. Note that it is assumed that the Core Area does not drain to the SWM pond. Two calculations were made, once with the SWM pond as a stand alone measure and also as part of a treatment train, with the infiltration/retention measure (rooftop downspouts draining to grass) preceding the SWM pond. Note that the second case results in reduced performance of the pond, since some of the load to it has already been removed.

Table AA11
Performance of End-of-Pipe Control for WM 1

				Performance if Preceded by Infiltration/retention controls		**Performance as stand-alone unit**	
	TSS End of Pipe Efficiency %	TP End of Pipe Efficiency %	Area Applied - %	TSS Load Reduction - Tonnes	TP Load Reduction Kg	TSS Load Reduction - Tonnes	TP Load Reduction - Tonnes
Light Employment	80	65	100	5.36	18.68	5.71	19.88
Transition	80	65	100	1.51	5.26	1.62	5.63
Character Area	80	65	100	1.48	5.14	1.58	5.49
Residential	80	65	100	2.66	8.55	2.86	9.20
Core	80	65	0	0.00	0.00	0.00	0.00
	Total			11.01	37.63	11.76	40.197

The stand alone performance of the SWM pond is shown first in **Table AA12**.

Table AA12
Performance of Control Measures for Total Phosphorus

Control Measures	Load Reduction Kg/yr	% of target reduction achieved
Level 1 ponds stand alone	40.20	96.71

The combined performance of the measures compared to the target is given below in **Table AA13.**

Table AA13
Performance of Control Measures for Total Phosphorus

Control Measures	Load Reduction Kg/yr	% of target reduction achieved
Infiltration/ retention	3.95	9.49
Level 1 ponds	37.63	90.54
Total	41.58	100.03

The pond sizing is based on the MOE *Stormwater Management Planning and Design Manual* (MOE, 2003). The manual has a sizing table (Table 3.2) which identifies the required SWM pond for different impervious percentages. Using this table, the effect of the infiltration/detention measures can be calculated. The permanent pool can be 7% smaller in volume, with a saving in construction cost (**Table AA 14**).

Table AA14 SWM Pond Sizing with and without consideration of Infiltration/Retention Measure		
	Case 1 No Infiltration/retention	**Case 2 With Infiltration/ retention**
Drainage area	38.22	38.22
Case 1		
Impervious area ha	23.08	20.67
Impervious %	60.39	54.08
Extended Detention m3	1528.8	1528.8
Permanent Pool m3	6213.68	5651.1
Total Pond volume m3	7742.48	7179.9
Assumed Depth of perm pool -m	2	2.00
Perm Pool area m^2	3106.84	2825.55

It is assumed the extended detention volume is accounted for by the active storage in the stormwater control pond sized for flood control purposes. The area required for the permanent pool of up to $3107m^2$ or 0.31ha can be accommodated in the 2.3ha area minimum sized pond for flood control purposes.

5. If TP targets are not met with the combined measures, repeat the process with additional control (Step 6 plus)

- Upgrade the end-of pipe pond to remove more TSS and TP.
- Add additional infiltration or surface retention measures.
- Add additional structural measures to remove TSS and TP, either in the conveyance system or end-of-pipe.

This step is not necessary in this example.

The target of achieving no increase in loading of TP was achieved by a combination of roof drainage to pervious areas and the provision of a SWM pond. It was assumed that 20 to 25% of roof areas could be drained to grassed areas which reduces water volume and phosphorus loadings to the SWM pond. The SWM pond is sized for an enhanced level of protection with an annual removal efficiency of 80% for TSS and 65% for total phosphorus. The SWM wet pool pond volume required is up to $6213m^3$, or 0.62ha-m. This volume is in addition to the active storage volume required for flood and erosion protection and would be provided inside the same land area (footprint). The SWM pond then would achieve several functions.

Oakville North Subwatersheds Study
List of Reports

Report No.	Report Title	Year	Author
1.0	Strategic Land Use Options Study Final Report	Jun-00	Hemson Consulting
2.0	North Oakville Natural Heritage Inventory and Analysis	May '99, rev. Nov. '00	LGL
3.0	Sixteen Mile Creek Watershed Plan	Feb-96	Gore & Storrie and Ecoplans
4.0	Compendum to Sixteen Mile Creek Watershed Plan		
5.0	Sixteen Mile Creek Watershed Plan Technical Report #1 Model Calibration	Feb-95	Gore & Storrie
6.0	Sixteen Mile Creek Watershed Plan Technical Report #2 - Evaluation of Potential Development Impacts	Feb-95	Gore & Storrie
7.0	Sixteen Mile Creek Watershed Plan Technical Report #3 - Regional Hydrogeology	Feb-95	Gore & Storrie
8.0	Sixteen Mile Creek Watershed Plan Technical Report #4 - Natural Environment	Feb-95	Ecoplans
9.0	Final Report on Joshua's Creek Watershed Plan Study Volume 2: Technical Appendices	May-92	Marshall Macklin Monaghan
10.0	Joshua's Creek Sub-Basin 7B Subwatershed Impact Study Final Report	Apr-00	Marshall Macklin Monaghan
11.0	Subwatershed Impact Study Sub-Basin 8 Joshua's Creek	Sep-92	Marshall Macklin Monaghan
12.0	West Oak Trails - Subwatershed Impact Study for Taplow Creek, McCraney Creek and the East Branch of Fourteen Mile Creek	May-95	Cosburn Patterson Wardman
13.0	Glen Oak Creek Subwatershed Impact Management Study	Dec-93	UMA Engineering
14.0	Glen Oak Creek Subwatershed Impact Management Study - Appendices	Dec-93	UMA Engineering
15.0	Subwatershed Study East Morrison Creek	Apr-95	Cosburn Patterson Wardman
16.0	Addendum to Master Drainage Study - West Morrison Creek	Mar-94	Marshall Macklin Monaghan
17.0	Master Drainage Study - West Morrison Creek	Mar-90	Marshall Macklin Monaghan
18.0	Fourteen Mile Creek - McCraney Creek Watershed Planning Study + Appendices.	Feb-92	Triton Engineering
19.0	Fourteen Mile Creek East Branch, Scoped Subwatershed Plan East of Regional Road 25.	May-00	Philips Engineering
20.0	Fourteen Mile Creek Main and West Branches Subwatershed Plan.	Jun-00	Philips Engineering
21.0	Highway 407 West Section, Freeman Interchange to Oakville Link with Highway 403: Fish and Habitat, 1999 Review of Existing Conditions.	Sep-99	SNC Lavalin
22.0	Joshua's Creek Watershed Plan Study, Volumes 1 and 2.	May-92	MMM & LGL
23.0	Sale of the Oakville Land Assembly Environmental Study Report.	2000	Ecoplans
24.0	Master Drainage Plan - Morrison and Wedgewood Creeks	Aug-79	Procter and Redfern
25.0	Stormwater Implementation Study (Osenego/Shannon Creeks)	May-95	Cosburn Patterson Wardman
26.0	Joshua's Creek Floodplain Mapping Study	Jul-88	MM Dillon Limited
27.0	Sixteen Mile Creek Master Drainage Plan (East Tributary)	Jan-90	Rand Engineering Corporation
28.0	Master Drainage Study - Johsua's Creek Upstream of Upper Middle Road	Jul-89	Marshall Macklin Monaghan
29.0	Environmental Impact Assessment - Oakville Waste Disposal Site, Regional Muncipality of Halton	1975	Hydrology Consultants Limited
30.0	Regional Municipality of Halton - Oakville Landfill Site Hydrogeological Study	1980	MM Dillon and Gartner Lee
31.0	Closed Oakville Fourth Line Landfille Site 1989/99 Biennial Monitoring Report	Jun-00	Jagger Hims Limited
32.0	Halton Region Official Plan Review - Technical Background Paper #6: Rationale and Methodolgy for Determining Significant Woodlands in the R	April 2002	Gartner Lee Limited
33.0	Halton Region Official Plan Review - Technical Background Paper #7: Environmentally Sensitive Area Update Study	April 2002	Mirek Sharp & Region of Halton
34.0	Halton Region Official Plan Review - Technical Background Paper #8: Update of Significant Wetlands in the Region of Halton	June 2002	Region of Halton
35.0	Halton Region Official Plan Review - Technical Background Paper #9: Update of Areas of Natural and Scientific Interest in the Region of Halton	June 2002	Region of Halton

Figure B1 (b)
North Oakville- Storage Table Data

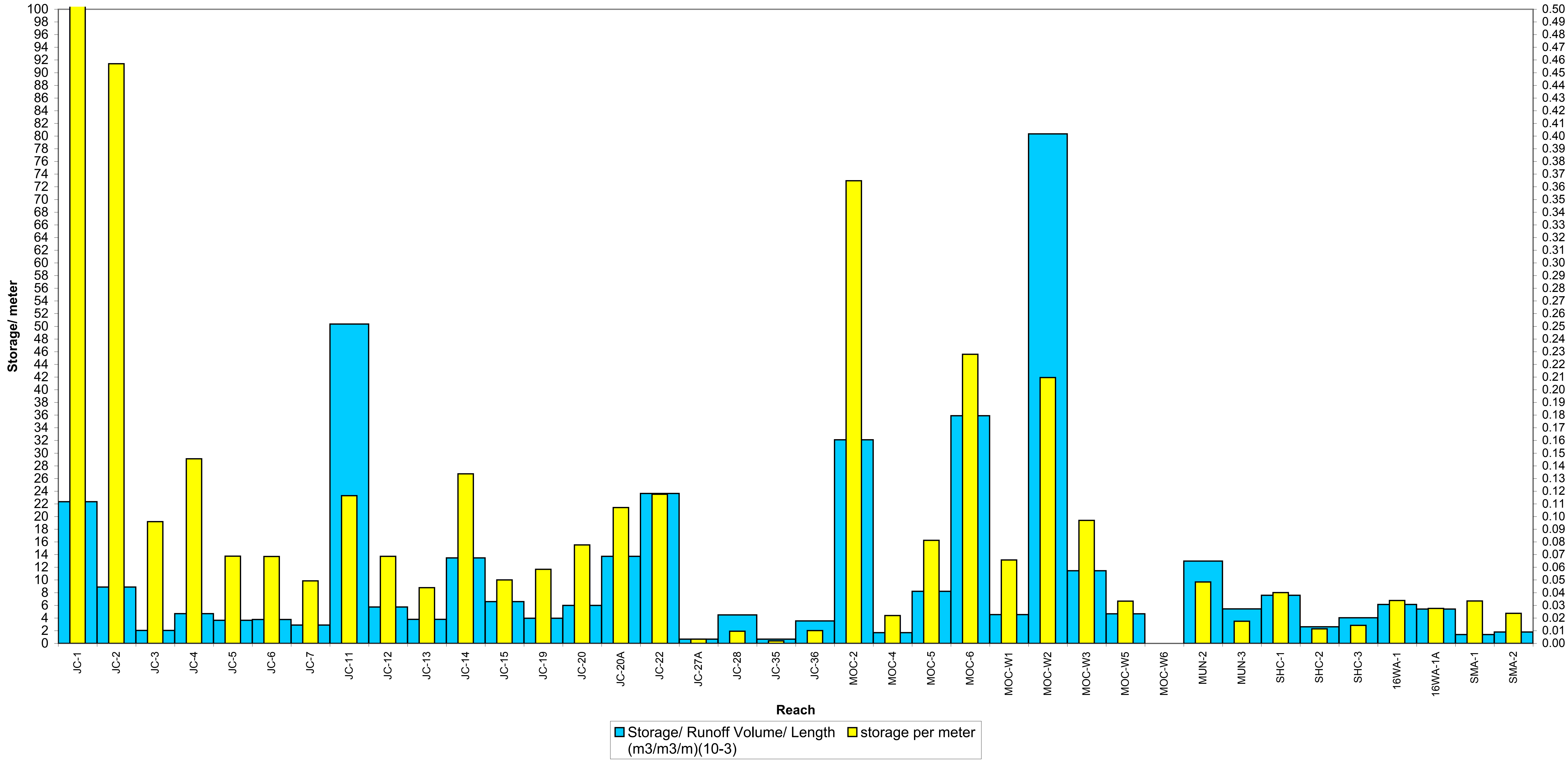


Figure B1 (a)

North Oakville- Storage Table Data

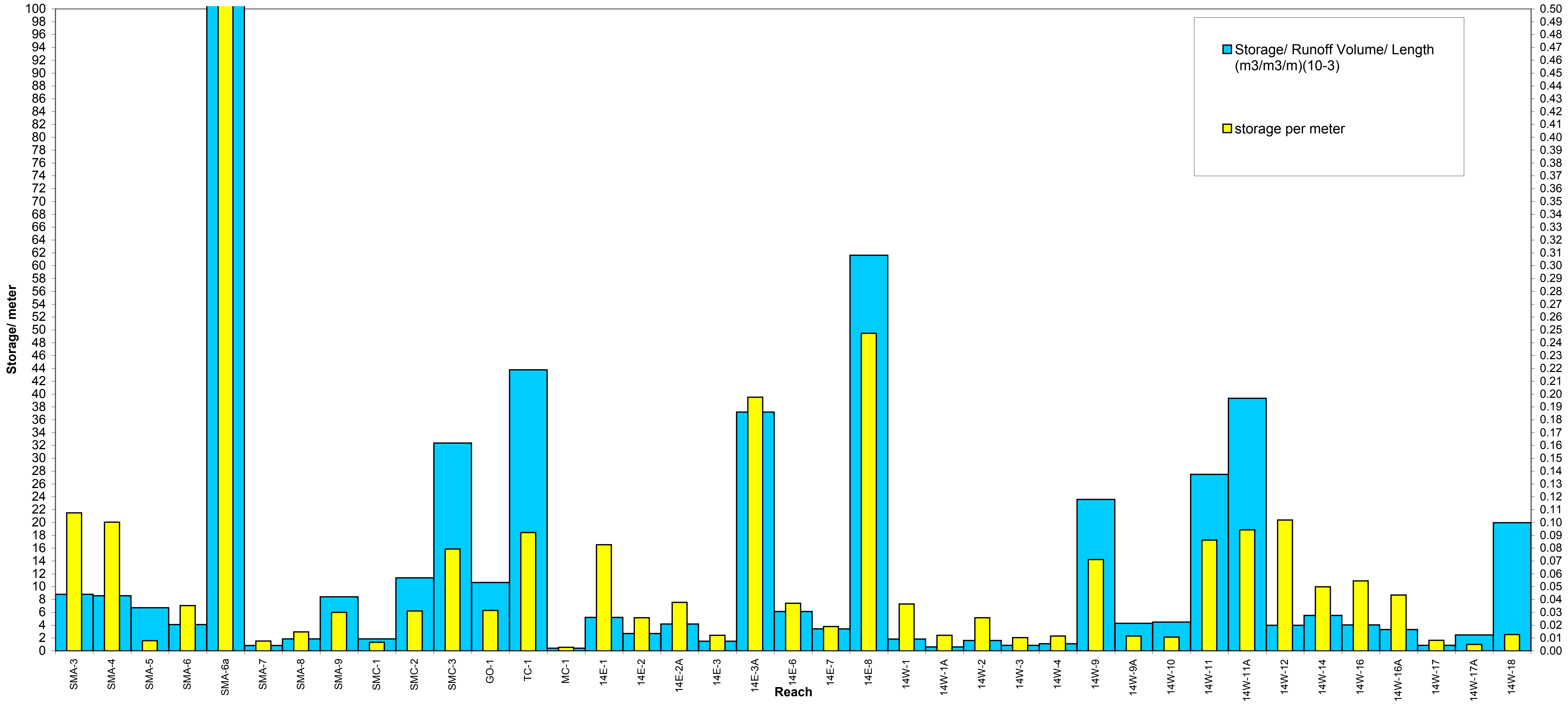


TABLE B1

NORTH OAKVILLE SUBWATERSHED STUDY

STORAGE TABLE

Management Reach	Reach Length	Hydraulic Sections	Storage (m3)			Drainage Area	Cumulative Area	Runoff Volume (250mm x Area)	Storage per Meter (m^3/m)			Storage/ Runoff Volume			Storage/ Runoff Volume/ Length $(m^3/m^3/m)(10^{-3})$			Notes	Flows (m3/s)		
	m		REGIONAL	25YR	2YR	Ha	Ha	m3	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR		Regional	25 YR	2 YR
Joshua's Creek																					
JC-1	381.89	X-Sect 9.093-9.418	98140	3540	1310	8.1	920.1	2300285	256.9850	9.2697	3.4303	0.0427	0.0015	0.0006	0.1117	0.0040	0.0015		42.90	11.30	3.80
JC-2	819.41	X-Sect 9.418-10.253	74910	6470	2740	10.9	823.7	2059292	91.4194	7.8959	3.3439	0.0364	0.0031	0.0013	0.0444	0.0038	0.0016		39.48	10.40	3.50
JC-2 North						10.9	763.7												37.30	9.83	3.30
JC-3	538.92	X-Sect 10.253-10.636	10350	3580	1580	21.7	752.8	1882022	19.2051	6.6429	2.9318	0.0055	0.0019	0.0008	0.0102	0.0035	0.0016		36.91	9.72	3.27
JC-4	198.50	X-Sect 10.636-10.866	5780	1450	530	2.9	495.9	1239652	29.1191	7.3050	2.6701	0.0047	0.0012	0.0004	0.0235	0.0059	0.0022		26.98	7.11	2.39
JC-5	399.00	X-Sect 10.866-11.173	5490	1840	760	11.5	301.7	754362	13.7594	4.6115	1.9048	0.0073	0.0024	0.0010	0.0182	0.0061	0.0025		18.59	4.90	1.65
JC-6	710.28	X-Sect 11.173-11.807	9730	3320	1460	17.3	290.2	725555	13.6988	4.6742	2.0555	0.0134	0.0046	0.0020	0.0189	0.0064	0.0028		18.06	4.76	1.60
JC-7	607.00	X-Sect 11.807-12.230	5990	1960	840	20.2	272.9	682344	9.8682	3.2290	1.3839	0.0088	0.0029	0.0012	0.0145	0.0047	0.0020		17.24	4.54	1.53
JC-8	800.35	X-Sect 12.516-12.664	4960	1290	530	57.6	57.6	144036	6.1973	1.6118	0.6622	0.0344	0.0090	0.0037	0.0430	0.0112	0.0046		5.37	1.41	0.48
JC-9	436.30	X-Sect 12.286-13.138 - JC-8	22950	6600	1330	14.4	158.2	395395	52.6014	15.1272	3.0484	0.0580	0.0167	0.0034	0.1330	0.0383	0.0077		11.45	3.02	1.01
JC-9 West						34.6	143.8												10.66	2.81	0.94
J10	1018.12	X-Sect 13.138 - 13.144	42730	20760	3630	109.2	109.2	272963	41.9697	20.3906	3.5654	0.1565	0.0761	0.0133	0.1538	0.0747	0.0131		4.50	1.20	0.40
JC-11	991.41	X-Sect -12.220-12.241	23090	12740	13420	37.0	37.0	92500	23.2901	12.8504	13.5363	0.2496	0.1377	0.1451	0.2518	0.1389	0.1463		1.70	0.46	0.16
JC-12	187.82	X-Sect -10.810-11.041	2580	910	390	6.5	191.2	478088	13.7366	4.8451	2.0765	0.0054	0.0019	0.0008	0.0287	0.0101	0.0043		13.21	3.48	1.11
JC-13	780.45	X-Sect 11.041-11.715	6850	2460	1060	26.2	184.7	461738	8.7770	3.1520	1.3582	0.0148	0.0053	0.0023	0.0190	0.0068	0.0029		12.87	3.39	1.08
JC-14	520.77	X-Sect 11.715-11.763	13920	19740	18200	37.0	158.5	396338	26.7299	37.9057	34.9485	0.0351	0.0498	0.0459	0.0674	0.0956	0.0882		8.10	2.20	0.80
JC-15	701.93	X-Sect 11.763-11.767	7020	5470	3810	121.5	121.5	303838	10.0010	7.7928	5.4279	0.0231	0.0180	0.0125	0.0329	0.0256	0.0179		6.64	1.80	0.66
JC-19	616.75	X-Sect -10.700-11.119	7210	2520	950	28.2	235.2	588026	11.6903	4.0859	1.5403	0.0123	0.0043	0.0016	0.0199	0.0069	0.0026		15.42	4.06	1.29
JC-20	700.86	X-Sect 11.119-11.829	10890	3060	1300	82.3	207.0	517553	15.5382	4.3661	1.8549	0.0210	0.0059	0.0025	0.0300	0.0084	0.0036		14.01	3.69	1.18
JC-20A	461.00	X-Sect 11.829-11.832	9880	370	160	124.8	124.8	311878	21.4318	0.8026	0.3471	0.0317	0.0012	0.0005	0.0687	0.0026	0.0011		6.80	0.42	0.16
JC-22	799.54	X-Sect -9.306-9.310	18800	1370	650	79.6	79.6	198890	23.5136	1.7135	0.8130	0.0945	0.0069	0.0033	0.1182	0.0086	0.0041		6.84	1.80	0.57
JC-27	722.68	X-Section 9 - 12	610	230	100	22.9	22.9	57345	0.8441	0.3183	0.1384	0.0106	0.0040	0.0017	0.0147	0.0055	0.0024		1.55	0.42	0.13
JC-27A	300.76	X-Section 1-3	200	60	30	11.5	80.3	200708	0.6650	0.1995	0.0997	0.0010	0.0003	0.0001	0.0033	0.0010	0.0005		3.96	1.07	0.34
JC-28	729.04	X-Section 13-17	1410	520	230	11.5	34.4	86018	1.9341	0.7133	0.3155	0.0164	0.0060	0.0027	0.0225	0.0083	0.0037		2.10	0.57	0.18
JC-29	203.20	X-Section 17-18	350	140	50	22.9	22.9	57345	1.7224	0.6890	0.2461	0.0061	0.0024	0.0009	0.0300	0.0120	0.0043		1.55	0.42	0.13
JC-30	306.79	X-Sect -9.093-9.096	31530	1630	270	8.7	8.7	21868	102.7735	5.3131	0.8801	1.4419	0.0745	0.0123	4.6998	0.2430	0.0402		1.31	0.34	0.11
JC-31	1191.11	X-Section 19 - 23	22390	15750	4190	21.9	21.9	54669	18.7976	13.2230	3.5177	0.4096	0.2881	0.0766	0.3438	0.2419	0.0643		1.29	0.30	0.10
JC-32	203.69	X-Sect 9.795-9.797	660	250	110	35.0	35.0	87471	3.2402	1.2274	0.5400	0.0075	0.0029	0.0013	0.0370	0.0140	0.0062		3.69	0.97	0.31
JC-35 lower						8.7	8.7												1.31	0.34	0.11
JC-35	931.15	X-Sect -9.794-9.795	380	130	60	5.4	49.2	122924	0.4081	0.1396	0.0644	0.0031	0.0011	0.0005	0.0033	0.0011	0.0005		4.77	1.26	0.40
JC-36	788.79	X-Section 4-8	1600	580	280	45.9	45.9	114690	2.0284	0.7353	0.3550	0.0140	0.0051	0.0024	0.0177	0.0064	0.0031		2.25	0.53	0.18
East Morrison																					
MOC-2	1519.94	X-Section 17 - 30	110900	7050	1780	80.3	181.8	454535	72.9635	4.6383	1.1711	0.2440	0.0155	0.0039	0.1605	0.0102	0.0026		8.84	2.32	0.79
MOC-4	949.89	X-Section 3-8	4170	800	150	47.6	205.7	514330	4.3900	0.8422	0.1579	0.0081	0.0016	0.0003	0.0085	0.0016	0.0003		9.70	2.55	0.87
MOC-5	1037.98	X-Section 8-16	16880	5300	1760	158.2	158.2	395455	16.2623	5.1061	1.6956	0.0427	0.0134	0.0045	0.0411	0.0129	0.0043		7.97	2.09	0.71
MOC-6	768.36	X-Section 30-40	35030	6630	1900	101.6	101.6	253910	45.5904	8.6287	2.4728	0.1380	0.0261	0.0075	0.1796	0.0340	0.0097		5.71	1.50	0.51
West Morrison																					
MOC-W1	1055.87	X-Section 3-10.75	13890	4000	1660	54.0	231.1	577810	13.1550	3.7883	1.5722	0.0240	0.0069	0.0029	0.0228	0.0066	0.0027		8.80	2.40	0.80
MOC-W2	950.71	X-Section 20-22	39860	6260	1420	41.7	41.7	104350	41.9267	6.5846	1.4936	0.3820	0.0600	0.0136	0.4018	0.0631	0.0143		2.44	0.66	0.22
MOC-W3	1084.71	X-Section 10.75-16	21040	2800	560	20.9	135.4	338535	19.3969	2.5813	0.5163	0.0622	0.0083	0.0017	0.0573	0.0076	0.0015		5.89	1.61	0.54
MOC-W5	581.39	X-Section 16-19	3880	1600	780	114.5	114.5	286360	6.6736	2.7520	1.3416	0.0135	0.0056	0.0027	0.0233	0.0096	0.0047		5.20	1.42	0.47
MOC-W6	170.00	X-Section 19-23	1920	700	310																
Munn's Creek																					
MUN-1	398.00	X-Section 1-6	550	190	90	17.8	17.8	44500	1.3819	0.4774	0.2261	0.0124	0.0043	0.0020	0.0311	0.0107	0.0051		1.40	0.38	0.14
MUN-2	349.21	X-Section 3-5	3380	480	160	8.5	59.7	149125	9.6791	1.3745	0.4582	0.0227	0.0032	0.0011	0.0649	0.0092	0.0031		2.70	0.73	0.26
MUN-3	545.22	X-Section 5-9	1900	750	370	51.1	51.1	127821	3.4849	1.3756	0.6786	0.0149	0.0059	0.0029	0.0273	0.0108	0.0053		2.41	0.65	0.23
Shannon's Creek																					
SHC-1	524.76	X-Section 3-6	4210	940	440	14.1	84.5	211125	8.0227	1.7913	0.8385	0.0199	0.0045	0.0021	0.0380	0.0085	0.0040		3.60	0.90	0.30
SHC-2	576.49	X-Section 6-8	1330	430	200	14.1	70.4	175938	2.3070	0.7459	0.3469	0.0076	0.0024	0.0011	0.0131	0.0042	0.0020		3.14	0.78	0.26
SHC-3	928.85	X-Section 8-11	2650	690	310	56.3	56.3	140750	2.8530	0.7429	0.3337	0.0188	0.0049	0.0022	0.0203	0.0053	0.0024		2.66	0.66	0.22
16 Mile Creek																					
16WA-1	434.95	X-Section 3-6	2940	680	250	6.3	88.0	219925	6.7593	1.5634	0.5748	0.0134	0.0031	0.0011	0.0307	0.0071	0.0026		3.60	0.90	0.30
16WA-1A	231.78	X-Section 6-9	1280	400	170	6.3	81.7	204216	5.5225	1.7258	0.7335	0.0063	0.0020	0.0008	0.0270	0.0085	0.0036		3.41	0.85	0.28
16WA-2	314.79	X-Section 10-12	610	190	90	6.3	25.1	62836	1.9378	0.6036	0.2859	0.0097	0.0030	0.0014	0.0308	0.0096	0.0046		1.41	0.35	0.12
16WA-3	299.75	X-Section 12-14	690	230	50	6.3	18.9	47127	2.3019	0.7673	0.1668	0.0146	0.0049	0.0011	0.0488	0.0163	0.0035		1.13	0.28	0.09
16WA-4	399.97	X-Section 14-18	710	623	120	12.6	12.6	31418	1.7751	1.5579	0.3000	0.0226	0.0198	0.0038	0.0565	0.0496	0.0095		0.84	0.21	0.07
16WA-5	68.64	X-Section 19-20	370	120	60	6.3	50.3	125671	5.3904	1.7482	0.8741	0.0029	0.0010	0.0005	0.0429	0.0139	0.0070		2.37	0.59	0.20
16WA-6	954.97	X-Section 20-25	2280	720	330	18.9	44.0	109963	2.3875	0.7539	0.3456	0.0207	0.0065	0.0030	0.0217	0.0069	0.0031		2.14	0.54	0.18
16WA-7	554.05	X-Section 25-29	1170	360	160	12.6	25.1	62836	2.1117	0.6498	0.2888	0.0186	0.0057	0.0025	0.0336	0.0103	0.0046		1.41	0.35	0.12
16WA-8	449.34	X-Section 29-34	1510	490	220	12.6	12.6	31418	3.3605	1.0905	0.4896	0.0481	0.0156	0.0070	0.1070	0.0347	0.0156		0.84	0.21	0.07
SMA-1	703.07	X- Section 1-7	4700	1660	630	22.8	383.0	957450	6.6850	2.3611	0.8961	0.0049	0.0017	0.0007	0.0070	0.0025	0.0009		16.40	4.10	1.10
SMA-2	1023.90	X-Section 26-30	4860	1580	600	17.1	212.1	530325	4.7466	1.5431	0.5860	0.0092	0.0030	0.0011	0.0090	0.0029	0.0011		10.53	2.63	0.71

TABLE B1

NORTH OAKVILLE SUBWATERSHED STUDY

STORAGE TABLE

Management Reach	Reach Length	Hydraulic Sections	Storage (m3)			Drainage Area	Cumulative Area	Runoff Volume (250mm x Area)	Storage per Meter (m^3/m)			Storage/ Runoff Volume			Storage/ Runoff Volume/ Length ($m^3/m^3/m$)(10^{-3})			Notes	Flows (m3/s)		
	m		REGIONAL	25YR	2YR	Ha	Ha	m3	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR		Regional	25 YR	2 YR
SMA-3	165.09	X-Section 30-32	3550	1100	390	8.6	195.0	487515	21.5030	6.6629	2.3623	0.0073	0.0023	0.0008	0.0441	0.0137	0.0048		9.89	2.47	0.66
SMA-4	748.59	X-Section 33-37	15000	2580	600	29.8	186.4	466110	20.0376	3.4465	0.8015	0.0322	0.0055	0.0013	0.0430	0.0074	0.0017		6.00	1.60	0.60
SMA-5	489.51	X-Section 38-40	780	250	90	19.0	19.0	47375	1.5934	0.5107	0.1839	0.0165	0.0053	0.0019	0.0336	0.0108	0.0039		1.08	0.29	0.11
SMA-6	606.14	X-Section 41-43	4280	1380	490	137.7	137.7	344342	7.0611	2.2767	0.8084	0.0124	0.0040	0.0014	0.0205	0.0066	0.0023		4.78	1.27	0.48
SMA-6a	140.00	X-Section 43-45	23950	3350	450	129.6	129.6	324092	171	23.9286	3.2143	0.0739	0.0103	0.0014	0.5278	0.0738	0.0099		4.57	1.22	0.46
SMA-7	738.14	X-Section 8-13	1140	390	140	22.8	148.1	370175	1.5444	0.5284	0.1897	0.0031	0.0011	0.0004	0.0042	0.0014	0.0005		8.04	2.01	0.54
SMA-8	919.89	X-Section 14-15, 21-25	2710	980	390	68.3	125.3	313225	2.9460	1.0653	0.4240	0.0087	0.0031	0.0012	0.0094	0.0034	0.0014		7.09	1.77	0.48
SMA-9	496.16	X-Section 16-20	2970	850	310	57.0	57.0	142375	5.9860	1.7132	0.6248	0.0209	0.0060	0.0022	0.0420	0.0120	0.0044		3.93	0.98	0.26
SMB-1	152.62	No Flow Data				18.0	81.0	202375	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	No Model			
SMB-2	225.69	No Flow Data				9.0	27.0	67458	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	No Model			
SMB-3	321.53	No Flow Data				18.0	18.0	44972	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	No Model			
SMB-4	620.39	No Flow Data				36.0	36.0	89944	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	No Model			
SMC-1	718.13	X-Section 1 -11	960	350	150	13.8	57.6	144025	1.3368	0.4874	0.2089	0.0067	0.0024	0.0010	0.0093	0.0034	0.0015		2.27	0.59	0.17
SMC-2	253.62	X-Section 11-14	1580	950	630	4.6	43.8	109469	6.2297	3.7457	2.4840	0.0144	0.0087	0.0058	0.0569	0.0342	0.0227		1.85	0.48	0.14
SMC-3	127.39	X-Section 14-15	2020	1370	1110	7.8	39.2	97950	15.8572	10.7546	8.7136	0.0206	0.0140	0.0113	0.1619	0.1098	0.0890		1.70	0.44	0.13
SMC-4	466.35	X-Section 19-23	300	110	50	15.7	15.7	39180	0.6433	0.2359	0.1072	0.0077	0.0028	0.0013	0.0164	0.0060	0.0027		0.86	0.22	0.07
SMC-5	174.59	X-Section 16-18	170	60	30	15.7	15.7	39180	0.9737	0.3437	0.1718	0.0043	0.0015	0.0008	0.0249	0.0088	0.0044		0.86	0.22	0.07
Glen Oak Creek																					
GO-1	768.01	X-Section 3-8	4830	940	390	47.2	47.2	117975	6.2890	1.2239	0.5078	0.0409	0.0080	0.0033	0.0533	0.0104	0.0043		2.20	0.59	0.21
Taplow Creek																					
TC-1	246.35	X-Section 3-4.5	4540	150	50	4.8	33.7	84200	18.4288	0.6089	0.2030	0.0539	0.0018	0.0006	0.2189	0.0072	0.0024		1.50	0.41	0.14
TC-2	1239.47	X-Section 4.5-12	1910	720	320	19.2	28.9	72171	1.5410	0.5809	0.2582	0.0265	0.0100	0.0044	0.0214	0.0080	0.0036		1.34	0.37	0.12
TC-2A	562.48	X-Section 12-15	460	170	80	9.6	9.6	24057	0.8178	0.3022	0.1422	0.0191	0.0071	0.0033	0.0340	0.0126	0.0059		0.59	0.16	0.05
McCraney Creek																					
MC-1	950.24	X-Section 3-11	530	330	140	0.0	106.0	264900	0.5578	0.3473	0.1473	0.0020	0.0012	0.0005	0.0021	0.0013	0.0006		5.70	1.50	0.60
MC-1 North						20.0	75.9												4.44	1.17	0.47
MC-2	1087.49	X-Section 11-17	5440	1690	790	40.1	55.9	139636	5.0023	1.5540	0.7264	0.0390	0.0121	0.0057	0.0358	0.0111	0.0052		3.53	0.93	0.37
MC-3	268.87	X-Section 17-19	3210	1290	700	15.8	15.8	39425	11.9387	4.7978	2.6035	0.0814	0.0327	0.0178	0.3028	0.1217	0.0660		1.37	0.36	0.14
MC-4	1191.63	X-Section 4.5-34	13310	1450	730	30.1	30.1	75158	11.1696	1.2168	0.6126	0.1771	0.0193	0.0097	0.1486	0.0162	0.0082		2.22	0.58	0.23
14 Mile Creek																					
14E-1	243.28	X-Section 3-6	4020	1470	550	4.1	253.6	633975	16.5245	6.0425	2.2608	0.0063	0.0023	0.0009	0.0261	0.0095	0.0036		10.90	2.90	1.00
14E-2	409.53	X-Section 6-8.5	2110	630	180	8.1	152.8	381886	5.1523	1.5384	0.4395	0.0055	0.0016	0.0005	0.0135	0.0040	0.0012		7.45	1.98	0.68
14E-2A	605.61	X-Section 8.5-12	4570	1530	660	16.3	144.6	361539	7.5461	2.5264	1.0898	0.0126	0.0042	0.0018	0.0209	0.0070	0.0030		7.15	1.90	0.66
14E-3	636.49	X-Section 12-13	1550	500	170	4.1	128.3	320843	2.4352	0.7856	0.2671	0.0048	0.0016	0.0005	0.0076	0.0024	0.0008		6.54	1.74	0.60
14E-3 North						4.1	89.0												4.97	1.32	0.46
14E-3A	109.29	X-Section 32-39	4320	1340	540	4.1	85.0	212449	39.5279	12.2610	4.9410	0.0203	0.0063	0.0025	0.1861	0.0577	0.0233		4.80	1.28	0.44
14E-4	860.08	X-Section 13.5-22	4140	1530	690	35.2	35.2	88047	4.8135	1.7789	0.8023	0.0470	0.0174	0.0078	0.0547	0.0202	0.0091		2.48	0.66	0.23
14E-5	419.38	X-Section 39-43	3000	1030	450	80.9	80.9	202275	7.1534	2.4560	1.0730	0.0148	0.0051	0.0022	0.0354	0.0121	0.0053		4.63	1.23	0.42
14E-6	433.80	X-Section 23-25	3220	850	400	8.1	96.8	241915	7.4227	1.9594	0.9221	0.0133	0.0035	0.0017	0.0307	0.0081	0.0038		5.29	1.41	0.49
14E-7	791.72	X-Section 25-31	3010	1010	450	24.4	88.6	221567	3.8018	1.2757	0.5684	0.0136	0.0046	0.0020	0.0172	0.0058	0.0026		4.95	1.32	0.45
14E-8	166.97	X-Section 31 - 31.4	8260	1360	260	4.1	64.2	160524	49.4703	8.1452	1.5572	0.0515	0.0085	0.0016	0.3082	0.0507	0.0097		3.89	1.04	0.36
14E-8A	375.40	Outside Study Area				60.1	60.1	150350	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	3.70	0.99	0.34
14E-9	389.84	X-Section 1-8	990	300	130	27.4	43.1	107825	2.5395	0.7695	0.3335	0.0092	0.0028	0.0012	0.0236	0.0071	0.0031		1.20	0.32	0.11
14E-10	472.64	X-Section 8-13	910	470	340	15.7	15.7	39345	1.9254	0.9944	0.7194	0.0231	0.0119	0.0086	0.0489	0.0253	0.0183		0.56	0.15	0.05
14W-1	120.66	X-Section 3-4	880	120	50	2.7	316.4	790986	7.2932	0.9945	0.4144	0.0011	0.0002	0.0001	0.0092	0.0013	0.0005		14.70	3.90	1.20
14W-1A	572.34	X-Section 4-6	1390	500	250	8.9	313.7	784298	2.4286	0.8736	0.4368	0.0018	0.0006	0.0003	0.0031	0.0011	0.0006		14.61	3.88	1.19
14W-2	297.03	X-Section 17-18	1530	430	170	14.0	254.5	636356	5.1511	1.4477	0.5723	0.0024	0.0007	0.0003	0.0081	0.0023	0.0009		12.49	3.31	1.02
14W-3	768.68	X-Section 24-25	1580	500	180	14.7	192.3	480663	2.0555	0.6505	0.2342	0.0033	0.0010	0.0004	0.0043	0.0014	0.0005		10.12	2.68	0.83
14W-4	354.52	X-Section 25-28	820	170	40	4.9	167.4	418383	2.3130	0.4795	0.1128	0.0020	0.0004	0.0001	0.0055	0.0011	0.0003		9.12	2.42	0.74
14W-5	177.16	Outside Study Area				2.7	93.6	233875	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	5.89	1.56	0.48
14W-5A	505.30	Outside Study Area				16.5	16.5	41235	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	1.60	0.43	0.13
14W-5B	684.90	Outside Study Area				74.3	74.3	185768	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	4.96	1.32	0.40
14W-6	227.75	X-Section 28-30	2460	890	310	3.3	68.9	172250	10.8012	3.9077	1.3611	0.0143	0.0052	0.0018	0.0627	0.0227	0.0079		4.69	1.24	0.38
14W-7	419.07	Outside Study Area				9.9	65.6	164014	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	4.52	1.20	0.37
14W-8	345.12	Outside Study Area				55.7	55.7	139305	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	4.00	1.06	0.33
14W-9	157.38	X-Section 18-19	2240	550	230	4.9	48.3	120673	14.2331	3.4947	1.4614	0.0186	0.0046	0.0019	0.1179	0.0290	0.0121		3.59	0.95	0.29
14W-9A	167.88	X-Section 19-19.5	390	160	80	4.9	43.4	108415	2.3231	0.9531	0.4765	0.0036	0.0015	0.0007	0.0214	0.0088	0.0044		3.31	0.88	0.27
14W-10	649.88	X-Section 19.5 - 23	1400	490	210	20.3	38.5	96158	2.1543	0.7540	0.3231	0.0146	0.0051	0.0022	0.0224	0.0078	0.0034		3.03	0.80	0.25
14W-10A	371.68	Outside Study Area				18.2	18.2	45450	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	1.73	0.46	0.14
14W-11	609.72	X-Section 6-11	10530	2630	1350	12.0	50.3	125650	17.2701	4.3134	2.2141	0.0838	0.0209	0.0107	0.1374	0.0343	0.0176		3.70	0.98	0.30
14W-11A	356.17	X-Section 11-16	6710	810	360	6.0	38.3	95750	18.8396	2.2742	1.0108	0.0701	0.0085	0.0038	0.1968	0.0238	0.0106		3.02	0.80	0.25
14W-12	732.73	X-section 3-5, 5.5-5.75	14930	2820	1130	17.3	409.6	1024075	20.3757	3.8486	1.5422	0.0146	0.0028	0.0011	0.0199	0.0038	0.0015		19.20	5.20	1.80
14W-13	941.05	X-Section 20-24	2800	940	440	25.8	25.8	64464	2.9754	0.9989	0.4676	0.0434	0.0146	0.0068	0.0462	0.0155	0.0073		2.41	0.65	0.23

TABLE B1
NORTH OAKVILLE SUBWATERSHED STUDY
STORAGE TABLE

Management Reach	Reach Length	Hydraulic Sections	Storage (m3)			Drainage Area	Cumulative Area	Runoff Volume (250mm x Area)	Storage per Meter (m^3/m)			Storage/ Runoff Volume			Storage/ Runoff Volume/ Length ($m^3/m^3/m$)(10^{-3})			Notes	Flows (m3/s)		
	m		REGIONAL	25YR	2YR	Ha	Ha	m3	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR	REGIONAL	25YR	2YR		Regional	25 YR	2 YR
14W-14	1614.84	X-Section 14-17,11.75-12,12.5-13	16110	4690	1980	18.5	144.2	360464	9.9763	2.9043	1.2261	0.0447	0.0130	0.0055	0.0277	0.0081	0.0034		8.77	2.38	0.82
14W-14 South						6.2	6.2												0.83	0.22	0.08
14W-15	813.23	X-Section 17-19	1900	660	300	125.7	125.7	314200	2.3364	0.8116	0.3689	0.0060	0.0021	0.0010	0.0074	0.0026	0.0012		7.92	2.14	0.74
14W-16	165.84	X-Section 6-7	1810	590	270	5.8	216.2	540501	10.9143	3.5577	1.6281	0.0033	0.0011	0.0005	0.0202	0.0066	0.0030		11.89	3.22	1.11
14W-16A	690.09	X-Section 7-9	6010	1810	730	23.1	210.4	526093	8.7090	2.6229	1.0578	0.0114	0.0034	0.0014	0.0166	0.0050	0.0020		11.65	3.16	1.09
14W-17	217.93	X-Section 10-10.5	360	110	40	155.1	155.1	387833	1.6519	0.5048	0.1835	0.0009	0.0003	0.0001	0.0043	0.0013	0.0005		9.27	2.51	0.87
14W-17A	140.60	X-Section 11-11.5	140	50	30	32.3	32.3	80629	0.9958	0.3556	0.2134	0.0017	0.0006	0.0004	0.0123	0.0044	0.0026		2.85	0.77	0.27
14W-18	373.12	X-Section 38-44	950	380	170	4.9	10.2	25508	2.5461	1.0185	0.4556	0.0372	0.0149	0.0067	0.0998	0.0399	0.0179		1.12	0.30	0.09
14W-19	606.80	Outside Study Area				12.1	32.3	80800	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	2.66	0.70	0.22
14W-19A	346.51	Outside Study Area				5.3	5.3	13250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	0.68	0.18	0.06
14W-20	764.85	X-Section 31-37	890.0	330.0	150.0	14.9	14.9	37153	1.1636	0.4315	0.1961	0.0240	0.0089	0.0040	0.0313	0.0116	0.0053		1.48	0.39	0.12
14W-20A	461.00	Outside Study Area				20.2	20.2	50500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	Not in Model	1.87	0.50	0.15

🟩 --> Green Reach

🟦 --> Not in Study Area

🟨 --> New Reaches for flows only.

MEETING AGENDA
OAKVILLE NORTH SUBWATERSHEDS STUDY
TOWN OF OAKVILLE

Technical Advisory Committee (TAC)
Meeting No.1
Friday, May 3, 2002
9:30 a.m. – 12:30 p.m.
Oakville Town Hall
Trafalgar Room

1.0 Introduction of Study Team Members and TAC

2.0 Role of the TAC

3.0 Overview of Scope of Work
  - Work Plan
  - Flow Chart

4.0 Summary of Progress to Date
  - Environmental (Dave Stephenson)
  - Hydrogeology (Dave Sawicki)
  - Hydrology (Carrie Curtis)
  - Geomorphology (John Parish)

5.0 Background Information (What is available)
  - Reports
  - Modelling
  - Field Data

6.0 Next Steps

7.0 Discussion of Potential TAC Watershed Bus Tour (Dates/Availability)

8.0 Public Process

9.0 Question and Answer Session

10.0 Adjourn

Oakville North Subwatersheds Study
East of 16 Mile Creek
TAC Meeting No. 2
Oakville Town Hall
June 20, 2002 – 1:30 p.m

Agenda Items

1. Background Information
2. Review of Work to Date and Preliminary Findings
    - Environmental
    - Geomorphology
    - Hydrogeology
    - Hydrology
3. Data Transfer/Data Sharing
4. Discussion of Issues
5. Bus Tour for Councilors
6. Discussion of Table of Contents for Existing Conditions/Background Review Report
7. Next Steps

Handouts

1. TAC Meeting No. 1 Revised Meeting Minutes
2. Progress Update
3. List of Background Information Collected to Date
4. Key Issues

Oakville North Subwatersheds Study

East of 16 Mile Creek

TAC Meeting No. 3

Oakville Town Hall

September 10, 2002

Time: 9:00 a.m – 12:00 p.m.

Agenda Items

1. Review of Work to Date
    - Environmental
    - Geomorphology
    - Hydrogeology
    - Hydrology
2. Data Transfer/Data Sharing
3. Status Report From Developers Group
4. Discussion of Issues
5. Draft Report Comments and Timing
6. Public Meeting
7. Status of the Oakville North - West Study
8. Next Steps

Handouts

1. Progress Update

OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE
TOWN OF OAKVILLE

AGENDA

Time: **Wednesday, November 20/02, 9:00 a.m. – 12:00 noon**

Place: **Town of Oakville**

	Item	Time
1.	Review of past minutes - Information received and not received	9:00
2.	Data Sharing for east side	9:15
3.	Overview and Discussion of Report and characterization findings - Discussion on opportunities and constraints	9:25
4.	Feedback from Open House	10:30
5.	Discussion of “Vision” for Oakville North and recap of Objectives	10:45
6.	Discuss work plan for West Side - Field work - Monitoring - Data for background review - Air quality	11:15
7.	Next meeting	11:40
8.	Other business - Secondary Planning Process	11:45
9.	Adjourn	

Ray Tufgar

RHT/sk
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OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE MEETING NO. 5

AGENDA

DATE: **Thursday, January 23, 2003**
TIME: **9:00 a.m. to 12 noon**
PLACE: **Trafalgar Room, Oakville Town Hall**

Items for Discussion:

1.0 Welcome and Introductions (John Kwast)
    -Review of minutes (Ray Tufgar/Roslyn Kostyk)

2.0 Vision and Objectives (Ray Tufgar)
    -Recap / update

3.0 Background reports list (Roslyn Kostyk)

4.0 Overview of Analysis Approach (Ray Tufgar)
- Links to Secondary Plan Process

5.0 Analysis Discussion & Study Update – *East and West Side* (Study Team)
    - Classification System
        -Streams
        - Geomorphology
        - Aquatic
        - Hydrology, hydraulics
        - Environmental

        -Terrestrial
        - Woodlots
        - Wetlands
        - Linkages

6.0 Other Issues
    -Report issues and comments
    -Biosolids
    -Status of parallel studies
    - Region Servicing Studies (Doug Corbett/Carolyn Hart)
    - Developer's Studies (Nancy Mather)
    - Other Studies (?)

    -Additional Field Work

7.0 Public Meeting

8.0 Other Items

9.0 Next Meeting

10.0 Adjourn

OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE MEETING NO. 6
AGENDA

DATE: **Friday, May 23, 2003**
TIME: **10:00 a.m. to 12 noon**
PLACE: **Committee Room No. 1, Oakville Town Hall**

Items for Discussion:

1.0 Welcome and Introductions (John Kwast)

2.0 Inter-Agency Review Process (David Cash/Liz Howson)

3.0 Presentation of data from Ministry of Natural Resources (John Pisapio)

4.0 Review of Meeting Minutes (Roslyn Kostyk-Lusk)
  - Update on Status of Subwatershed Study – East and West

5.0 Next Steps (Ray Tufgar)

6.0 Next TAC Meeting – tentatively scheduled for Thursday, September 4, 2003 (9-12 pm)

7.0 Next Public Open House – tentatively scheduled for evening of Thursday, September 4, 2003

8.0 Adjourn

OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE MEETING NO. 7
AGENDA

DATE: **Thursday, September 4, 2003**
TIME: **9:30 a.m. to 12 noon**
PLACE: **Committee Room No. 1, Oakville Town Hall**

Items for Discussion:

1.0 Welcome and Introductions (John Kwast)

2.0 Inter-Agency Review Process (David Cash)

3.0 Review of Meeting Minutes (Roslyn Lusk)

4.0 Update on Status of Subwatershed Studies – East and West

- **Terrestrial** (Dave Stephenson/Ray Tufgar)
  - Woodlots
  - Wetlands
  - Linkages
- **Streams** (John Parish/Dave Stephenson/Roslyn Lusk)
  - Geomorphology
  - Aquatic
  - Hydrology, hydraulics
  - Environmental

5.0 Presentation of Draft Analysis Report (Ray Tufgar)

6.0 Next Steps (Ray Tufgar)

7.0 Other Issues
-Report issues and comments
-Status of parallel studies
- Secondary Plan East of 16 Mile Creek(Liz Howson/Ray Tufgar)
- Secondary Plan West of 16 Mile Creek (Rob Thun)
- Developer's Studies
- Other Studies (?)

8.0 Next TAC Meeting – schedule a tentative date

9.0 Public Open House –Thursday, September 4, 2003 (4pm to 8pm)

10.0 Adjourn

OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE MEETING NO. 8

AGENDA

DATE: **Wednesday, December 17, 2003**
TIME: **1:30 p.m. to 4 p.m.**
PLACE: **Trafalgar Room, Oakville Town Hall**

Items for Discussion:

1.0 Welcome and Introductions (John Kwast)

2.0 Inter-Agency Review Update (Peter Cheatley)

3.0 Update on Comments Received on Subwatershed Study Reports (Ray Tufgar)

4.0 Update on Status of Subwatershed Analysis Report

- **Terrestrial** (Dave Stephenson/Ray Tufgar)
  - Woodlots
  - Wetlands
  - Linkages
- **Streams**
  - Fisheries (Rob Steele)
  - Water Quality (Don Weatherbe)
  - Geomorphology (John Parish)
  - Hydrology, hydraulics (Ray Tufgar/Chris Doherty)
  - Hydrogeology (Dave Sawicki)

5.0 Outline of Management Strategy Framework (Ray Tufgar)

6.0 Next Steps (Ray Tufgar)

7.0 Next TAC Meeting – schedule a tentative date

8.0 Adjourn

OAKVILLE NORTH SUBWATERSHED STUDY
TECHNICAL ADVISORY COMMITTEE MEETING NO. 9

AGENDA

DATE: **Thursday, February 12, 2004**
TIME: **9:00 a.m. to 12 p.m.**
PLACE: **Committee Room 1, Oakville Town Hall**

Items for Discussion:

1.0 Welcome and Introductions (John Kwast)

2.0 Inter-Agency Review Update

3.0 Update on Comments Received on Subwatershed Study Reports (Ray Tufgar)

4.0 Update on Draft Management Strategy Report

Natural Heritage Strategy

- **Terrestrial** (Dave Stephenson/Ray Tufgar)
  - Woodlots
  - Wetlands
  - Linkages
- **Streams**
  - Fisheries (Rob Steele)
  - Geomorphology (John Parish)
  - Hydrology/Hydraulics (Ray Tufgar/Chris Doherty)
  - Hydrogeology (Dave Sawicki)
- **Stormwater Management**
  - Quantity Control (Ray Tufgar/Chris Doherty)
  - Quality Control (Don Weatherbe)

5.0 Outline of Implementation Plan (Ray Tufgar)

6.0 Next Steps (Ray Tufgar)

7.0 Next TAC Meeting – schedule a tentative date

8.0 Adjourn

COUNCILLOR'S SUBWATERSHED TOUR
MONDAY, OCTOBER 21, 2002 (2:00 pm – 5:00 pm)

Tour starts at Oakville Town Hall

General Comments:

- All headwater stream systems except for 16 Mile Creek
- Relatively flat at lower end
- More variation in topography at upstream end
- Generally till soils
- Terrestrial features are distributed across the site
- Streams exhibit similar conditions, some have more defined valleys (ie. Joshua's Creek)
- All streams dried up during the late summer
- Some stream sections have well defined riparian corridors
- Some agricultural impacts on streams – loss of riparian corridor, straightening of watercourse
- Streams are typically stable but some erosion exists
- Different variations in wood lot descriptions
- Wildlife movement occurs both east-west within site, as well as north-south along the stream corridors
- Aquatic health in the streams is generally poor but improves south of Dundas Street
- Surface depressions with no outlet distributed across site
- Significant farming practices

Location Number	Site Description	Narrative
1	Morrison Creek East	• Provides a moderately well defined stream and valley system • Drains approximately 612 hectares • Riparian corridor exists along lower section • Channelized section behind gas station • On-line pond on west tributary • Stream is intermittent • Agriculture has impacted upper sections of stream (ploughed through) • Creek bed is primarily muck, silt – some limited gravel sections
2	Morrison Creek West	• Moderately well defined stream and valley section – not as pronounced as Morrison East • Drains approximately 93 hectares • Riparian corridor exists along lower section • Small cattail marsh and pond just above Dundas Street. • Some gravel and associated stream • Habitat limited to reach below 6th Line • Good riparian cover in lower sections of watercourse • Impacted by agriculture above 6th Line – riparian corridor lost • Some marsh areas in upper part of watershed • On-line ponds downstream of Dundas Street

Location Number	Site Description	Narrative

COUNCILLOR'S SUBWATERSHED TOUR
MONDAY, OCTOBER 21, 2002 (2:00 pm – 5:00 pm)

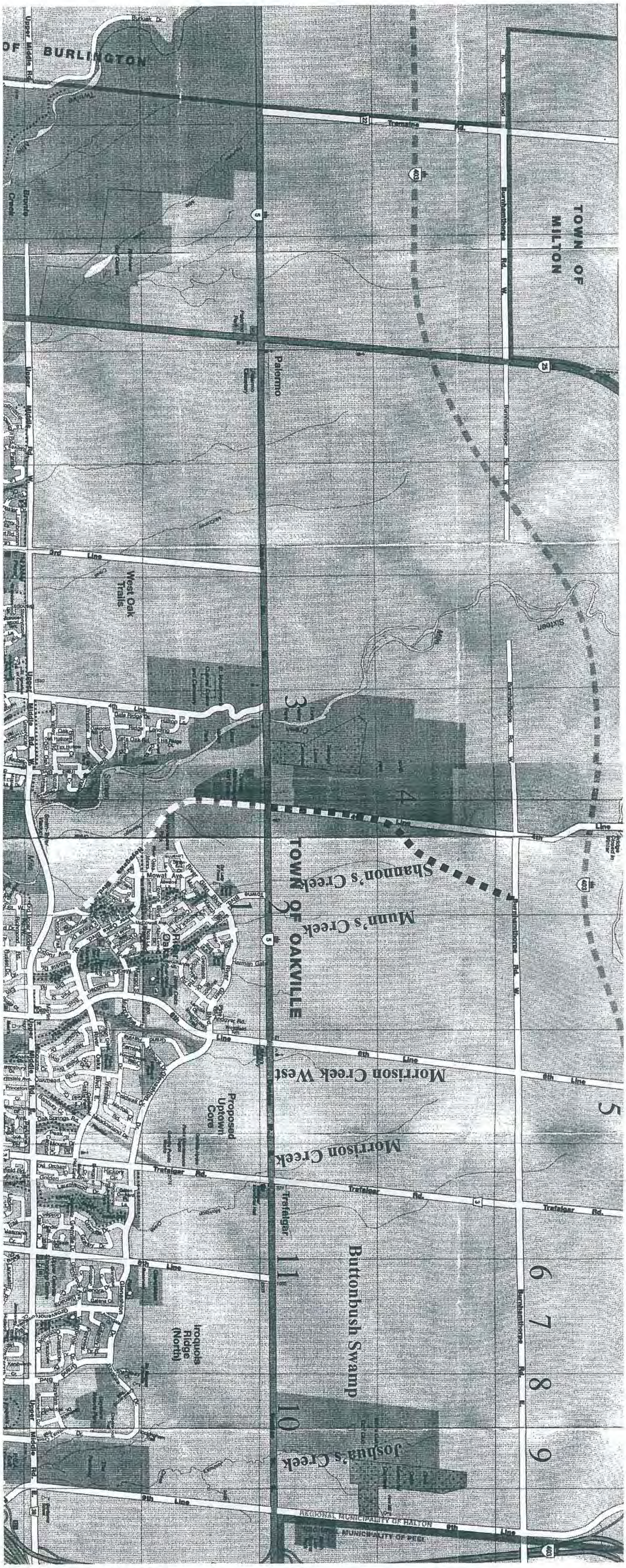
2 to 3	Travelling along Dundas from 6th Line to Neyagawa (passing Munn's Creek and Shannon's Creek)	• Crossing Shannon's and Munns' Creeks • Not as well defined as rest • Drainage areas are approximately 171 and 91 hectares respectively • Impacted by agriculture and generally a lack of riparian cover • Some on-line ponds on each • Each connect to marsh areas • Downstream section of Shannon's Creek is enclosed
3 (deboard bus for walking tour)	16 Mile Creek	• Two main tributaries to Sixteen Mile Creek • Drains approximately 814 hectares in total • Valley and associated topographic relief provides for entirely different physical stream conditions (fluvial geomorphology) • Both streams are quite steep and have a valley system at the lower reaches • Both are deepening with time • They generally lack riparian cover, and there has been some straightening in the past • Both are typically bedrock and cobble streams with some silted portions • On-line ponds are located on each • The south stream originates in a wooded area
3 to 4	Travelling along Dundas from 16 Mile Creek to Tremaine Road	• Crossing over 14 Mile Creek, McCraney Creek, Taplow and Glen Oaks Creeks • Similar conditions to creeks east of 16 Mile Creek • Headwaters segment of each • 14 Mile Creek is the most well defined stream and valley system of all – similar to Joshua's Creek • Terrestrial features are distributed across the site
4 to 5	Near 403 Headwaters of 14 Mile Creek Travelling North along Tremaine to Site of "centroid of Trafalgar Moraine"	• In the headwater area for 14 Mile Creek • Near the centroid of the Trafalgar Moraine • Different topography to west of Tremaine than to East of Tremaine

COUNCILLOR'S SUBWATERSHED TOUR
MONDAY, OCTOBER 21, 2002 (2:00 pm – 5:00 pm)

Location Number	Site Description	Narrative
5 to 6	Travelling East along Lower Base Line to Bronte Road. South on Bronte Road to Dundas. West on Dundas to Neyagawa. North on Neyagawa to tributary into North Park	• Between 14 Mile Creek and Glen Oaks / Taplow Creeks • Close to divide between Creek systems
6 (deboard bus for walking tour)	Tributary into North Park – South 16 Mile Creek	• South stream to 16 Mile Creek • Well defined stream and valley at downstream end • Large woodlot of headwater to 16 Mile Creek tributary – Sugar Maple and Beech deciduous forest, to Oak and Hickory deciduous forest. Some marsh areas. Some rare species or habitats • Landfill site downstream – being monitored to ensure that stream is not impacted upon
6 to 7	North on Neyagawa to Burnhamthorpe. West along Burhamthorpe to 6th Line. North on 6th Line to Moore Reservoir.	• Upper headwater portions of Morrison Creek and tributary to 16 Mile Creek • More relief in topography • Sections have been altered by agricultural uses • Some on-line ponds for private use • Note that some landowners have left buffers along the streams • Surface depressions with no visible outlets • Note farm with cattle access to stream
7	Moore Reservoir	• Location of rainfall gauge • Location of one of the boreholes • Oak – hardwood wood lot behind reservoir • Located at very top of drainage divide
7 to 8	Travel South on 6th Line to Burnhamthorpe. East on Burhamthorpe past Joshua's Creek tributaries	• Similar to west of 6th Line • Within headwaters of Joshua's Creek and East Morrison Creek • Crossing headwater tributaries of East Morrison Creek • On-line pond • Buffers along streams • Across Trafalgar Road – crossing headwaters of Joshua's Creek • Note the areas with depressions that hold runoff • Some landowners have left buffers • Buttonbush Swamp area that we will look at is to the south

COUNCILLOR'S SUBWATERSHED TOUR
MONDAY, OCTOBER 21, 2002 (2:00 pm – 5:00 pm)

Location Number	Site Description	Narrative
8 to 9	Travel East along Burnhamthorpe to 9th Line. South on 9th Line to Dundas. West on Dundas to Joshua Creek.	• At Location #8 – White Elm lowland deciduous forest – main tributary to Joshua's • Travelling adjacent to Joshua's Creek • Some small tributaries cross under 9th Line to Joshua's Creek • Pass cultural savannah • Contains rare species or habitat • Pass Glen Oaks Memorial Gardens
9 (Stop)	White Oaks Golf Club (Joshua's Creek)	• White Oaks Golf Club straddles Joshua's Creek • Joshua's Creek has approximate drainage of 610 hectares • Well defined valley and stream system • The valley and riparian system makes up a large woodlot that extends to Burnhamthorpe (cultural savannah and cultural meadow) • One Buttonbush Swamp area drains to Joshua's Creek • Some sections of Joshua's Creek have been channelized • Stream has significant reaches with silt-muck along the invert, but there are reaches of cobble and stone • There is evidence of some groundwater contribution, however intermittent. Watercress was observed in one location
9 to 10	West along Dundas to Trafalgar Road. North on Trafalgar Road to Church adjacent to Buttonbush Swamp	• Crossing from Joshua's Creek to East Morrison Creek • Cultural meadow and White Elm deciduous forest near Trafalgar Road
10 (deboard bus for walking tour)	Buttonbush Swamp	• A number of Buttonbush Swamp areas located within study area • This one is adjacent to a bulrush mineral swamp, a silver-maple mineral deciduous swamp, and a cultural meadow • Man-made pond within the area • Part of a fairly large area comprised of a variety of upland and lowland areas • Some rare species / habitat in the area
10 to Oakville Town Hall	Travel south down Trafalgar Road to Oakville Town Hall	N/A


TOWN OF MILTON
OF BURLINGTON
TOWN OF OAKVILLE
Palermo
West Oak Trails
Proposed Uptown Core
Iroquois Ridge (North)
Buttonbush Swamp
Shannon's Creek
Munn's Creek
Morrison Creek West
Morrison Creek
Joshua's Creek
Bronte Creek
Sixteen
Upper Middle Rd.
Tremaine Rd.
Burnhamthorpe Rd. W.
Burnhamthorpe Rd. E.
3rd Line
4th Line
6th Line
8th Line
9th Line
Trafalgar Rd.
Trafalgar
Mowat Ave.
Andover Rd.
REGIONAL MUNICIPALITY OF HALTON
REGIONAL MUNICIPALITY OF PEEL
403
25
5
3
3
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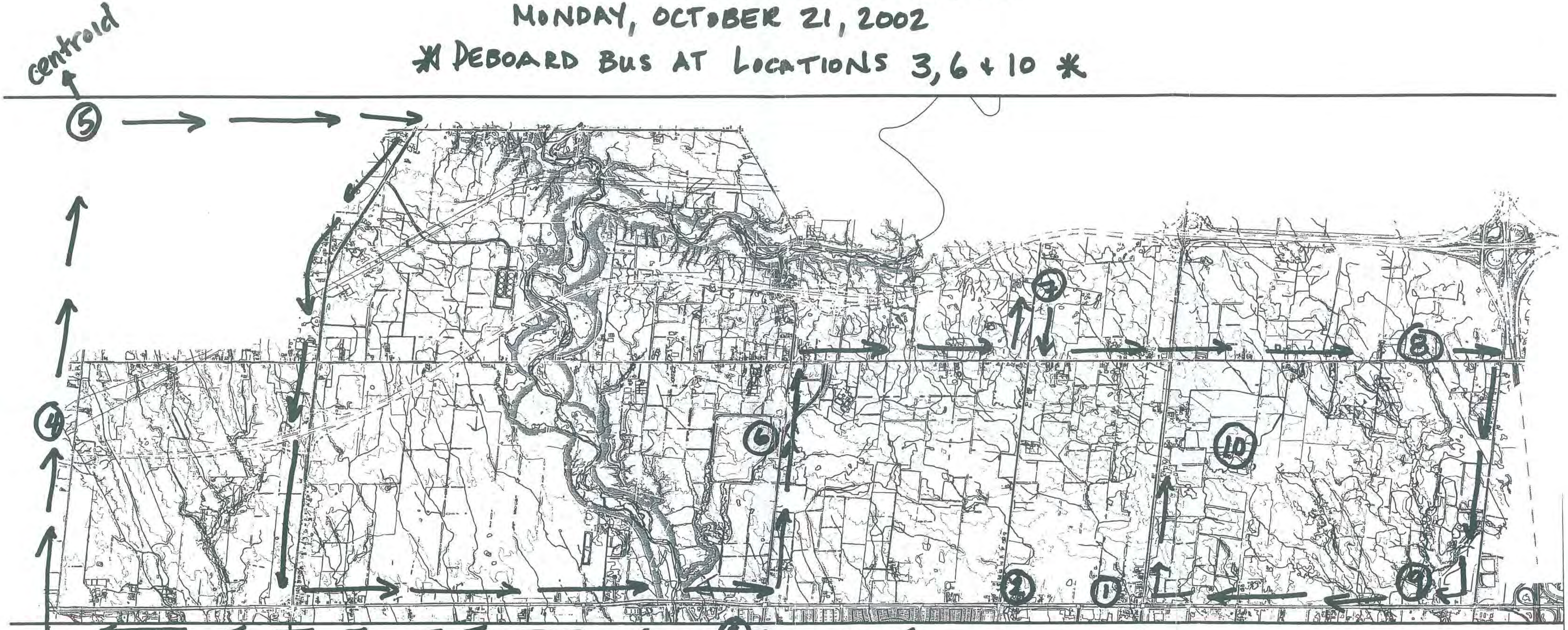
11

COUNCILLOR'S BUS TOUR
OAKVILLE NORTH SUBWATERSHED
MONDAY, OCTOBER 21, 2002
* DEBOARD BUS AT LOCATIONS 3, 6 + 10 *



OAKVILLE

Town of Oakville
Planning Services Department
1225 Trafalgar Road, Oakville, Ontario L6J 5A6 905-845-6601

Drawn: Don Toy
dtoy@town.oakville.on.ca
extension 3044

Checked: John Vlahovic
jvlahovic@town.oakville.on.ca
extension 3041

Plan Showing Lands North of Dundas Street

May 10, 2002

Scale 1:5000

ⓧ START/END

LANDS NORTH OF DUNDAS

Open House #1
October 30, 2002

SubWatershed Study
East of 16 Mile Creek

OAKVILLE

INTRODUCTION

Welcome to the Town of Oakville's Open House #1 for the North Oakville Subwatershed Study (East of 16 Mile Creek). The focus of this evening is to present you with the preliminary results from the characterization phase of the study and to solicit questions, comments and/or information from you. This Open House is an important part of the subwatershed planning process. In order to develop a comprehensive subwatershed management strategy, community comments must be considered. Please read the information provided in this handout and visit the stations set up around the Atrium to view and discuss the preliminary findings with the consultants. The stations are as follows:

Station Number	**Study Component**	**Consultants / Town of Oakville**
1	Planning	Peter Cheatley,Town of Oakville Lynne Gough, GoughConsulting
2	Environmental	Dave Stephenson/ Rob Steele Natural Resource Solutions
3	Hydrogeology	Dave Sawicki, Morrison Environmental Ltd.
4	Hydrology	Ray Tufgar/ Roslyn Kostyk, Totten Sims Hubicki Associates
5	Geomorphology	John Parish/Susi Kostyniuk, Parish Geomorphic
6	3-D Visualization	Town of Oakville

Other Town Staff available tonight include: David Cash (Commissioner, Planning and Development), John Kwast (Manager, Development and Engineering), Robert Thun (Planner), and Doug Gates (Town Solicitor).

BACKGROUND/HISTORY

In 1987, officials with the Region of Halton realized that the impact of growth in the Greater Toronto Area would be significant. The Region began planning for the growth with a comprehensive study, the "Halton Urban Structure Review".

The study concluded with a report issued in 1994, called the "Halton Urban Structure Plan" (HUSP), which identified which areas in Halton should be slated for the growth, and included a framework to guide decisions about development. In 1999, the HUSP was implemented when Halton Regional Council adopted Amendment #8 to the Region's Official Plan. This designated the land between Dundas Street and Highway 407 in Oakville as urban; it was formerly designated agricultural.

The Ontario Planning Act requires the local official plan to conform to the Regional Official Plan, so Oakville was obliged to amend its Official Plan. An environmental background study "North Oakville Natural Heritage Inventory and Analysis" was completed in 1999, and the "North Oakville Strategic Land Use Options Study" was completed in 2000. Official Plan Amendment (OPA) 198, which designated North Oakville for urban uses, was introduced in 2001 for public comment, and was approved by Oakville Council on May 29, 2002. OPA 198 was appealed to the Ontario Municipal Board (OMB) in June 2002.

CURRENT PHASE: PLANNING PROCESS

The Town is at Step 7 of a 12 step Official Plan Amendment Process. This step involves background studies and secondary plans. OPA 198 has indicated that eight background studies are to be completed:

1. Infrastructure Staging Plan
2. Subwatershed Study *
3. Transportation and Traffic Study
4. Market Study
5. Financial Impact Analysis
6. Urban Design Study
7. Trafalgar Moraine Study
8. Linkages of the Natural Heritage/Open Space System Special Study

* In this case, as per Council's direction, the Subwatershed Study was initiated earlier in the process.

A Technical Advisory Committee (TAC) comprised of 4 members from the Town, 3 members from Conservation Halton, 3 members from the Region, 2 members from the Stakeholder Advisory Committee (SAC) and 2 members from the landowners, have been involved in the Subwatershed Study since its initation in the spring of 2002. The TAC meetings are open to the general public for attendance purposes, while the landowners and the SAC members have 'observer' status on the committee.

SUBWATERSHED MANAGEMENT STUDY

Subwatershed management provides a framework upon which a strategy is developed to manage the ecosystem of an area as a unit. Given the comprehensive and complex nature of the watershed, an **ecosystem approach** is the most appropriate and all inclusive management strategy.

The watershed ecosystem is made up of the wildlife, vegetation, people and physical landscape that occupies the watershed, and by the ecological processes that link these components. Degradation of the quality of any of these components will affect the entire ecosystem. For example, if water is polluted or streamflows are depleted, it will have a negative impact on fish. If woodlots and wetlands are removed, there will be a loss of wildlife habitat. Either of these conditions will have an effect on the quality of life for the human residents.

The major connecting link in a watershed ecosystem is the flow of water. This flow pattern is called the **water budget**. How and where the water in the watershed flows determines the quality of the water, the shape and stability of streambanks, the health and diversity of the vegetation, and the availability of fish and wildlife habitat.

In a relatively natural watershed, the flow of water is controlled by topography, soil type and vegetation. As human use of a watershed increases all of these characteristics can change, altering the water budget. The changed water budget then results in changes in the quality of both ground and surface water, the size and shape of stream channels and the stability of streambanks, vegetation cover, and fish and wildlife habitat. These unintentional changes caused by the change in water budget often reduce the ability of the human population to use and enjoy the resources of the watershed.

The **ecosystem approach** requires description of the existing ecosystems' conditions, description of stresses on the ecosystems, identification of indicators of ecosystem health, and the impact of the stresses. An integrated set of policies and management practices must be developed which considers people as an integral part of ecosystems. This is in contrast to past approaches where environmental policies relating to resource management have typically been done independent from the human population and did not consider potential community concerns as part of the ecosystems.

Inherent in the ecosystem approach is the concept of **carrying capacity**, which requires an attempt to understand the limits of an ecosystem's ability to support various life forms and land use activities. Human activities are then managed in a way that do not exceed these natural limits. When the carrying capacity is respected, the ecosystem remains healthy. The **ecosystem approach** used in this watershed study applies the concepts of carrying capacity and ecosystem health in evaluating land use scenarios and watershed management options.

The major requirement, as well as the major benefit, of the ecosystem approach is that the people planning for human modification of the ecosystem have a conceptual understanding of the way in which the ecosystem functions and can anticipate, with some degree of confidence, the impact of human activities on ecological functions.

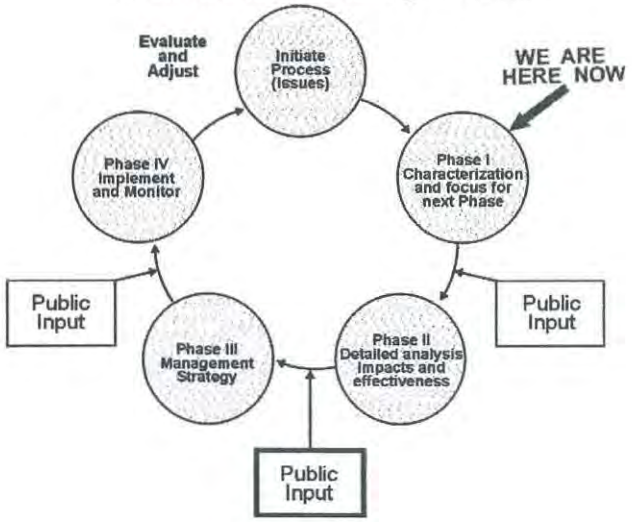
What is the Subwatershed Management Study Process?

Watershed management is an evolving science. The evolution of the science is a response to the recognized needs of managing our resources and guiding future land use decisions. New management philosophies and tools are being developed to provide the most effective approach. The common thread through this evolution is that a broad perspective is needed to ensure that the plan meets environmental and societal needs. It is important that watershed management recognizes **environmental, social and economic conditions** to ensure that all three elements are included and provide a "balanced" approach.

Public participation is a critical component of subwatershed planning process. Although a comprehensive, blended (economic, social, environmental) approach is necessary, community needs and values should be taken into account in developing a management strategy. This will assist in facilitating acceptance of the strategy and provide a sustainable plan.

In developing a subwatershed management strategy, a series of steps are followed to understand how a subwatershed works, what are the stresses and what management strategy is needed to protect and enhance subwatershed characteristics and processes. The steps that are followed include:

Subwatershed Planning Process



PHASE I: PRELIMINARY CHARACTERIZATION

Station 1: *Planning*

- The basis for planning North Oakville is OPA 198.
- Secondary plans will proceed after the completion of the Subwatershed Study.

Station 2: *Environmental*

- There are significant terrestrial features, including both "upland" forest areas and wetland areas, which are distributed across the study area (Oakville North).
- Potential terrestrial linkages exist for wildlife both along watercourse corridors (north/south direction) and in an east-west direction within the study area.
- A number of significant plant and wildlife species and their habitat exist within the study area.
- Aquatic habitat and associated fishery resources are typically poor in the study area but improve below Dundas Street.

Station 3: *Hydrogeology*

- The soils are typically clayey silt till soils that are relatively low permeability and have a relatively low infiltration rate.
- Groundwater that infiltrates into the earth can: i) return to the atmosphere through transpiration from plant; ii) infiltrate to depth, recharging any aquifers that are present; or, iii) move laterally to creeks and streams.
- Local groundwater supplies are typically derived from the underlying bedrock, however well yields are low and groundwater quality is poor.
- The contribution of groundwater to stream flows is small and intermittent.
- Groundwater discharge areas appear confined to stream courses and existing swales. Recharge, by definition, occurs in areas where there is no discharge. The recharge in the area, albeit small, occurs across the entire study area where there is no discharge.

Station 4: *Hydrology*

- All streams in the study area are intermittent, with no base flow in the late summer.
- The watercourses are a mixture of natural channels as well as some channelized (straightened) sections in the agricultural areas.
- There are no identified areas with flood potential at this time.

Station 5: *Geomorphology*

- The streams are relatively stable with only localized sections that demonstrate erosion potential.
- Some stream sections (primarily the reaches near Dundas Street) have well defined valley sections.
- The streams discharging to 16 Mile Creek are steep and deeply incised.

Station 6: *3-Dimensional Visualization*

- Aerial views of study area show various different features encountered during the characterization phase.

SUBWATERSHED STUDY TEAM

The study team completing this project has a broad range of expertise. Our team members have worked together in the past on similar projects and have proven to provide a comprehensive and effective approach. Each of the study team members is represented at different stations around the Atrium.

Totten Sims Hubicki (TSH) is a multi-disciplinary consulting firm that specializes in providing engineering, architectural and planning services to municipalities and other public agencies including Conservation Authorities and Provincial and Federal agencies. TSH's areas of expertise include watershed management, water resources engineering, municipal engineering, environmental engineering, architectural services, structural engineering and planning.

Continued on page 4...

TSH has provided leadership in the development of watershed and subwatershed management science and has assisted Provincial Agencies and Conservation Authorities in the development of guidelines and policies in this area of expertise.

TSH is responsible for providing the overall Project Management for the North Oakville Subwatershed (East) Study, as well as completing the hydrology, hydraulics and water quality components of the Study. Please visit Station 4 - Hydrology for further information regarding TSH and their role in the Subwatershed Study.

Natural Resource Solutions is an environmental consulting firm comprised of staff with expertise in terrestrial, wetland and aquatic biology. Staff have worked throughout Ontario on a wide range of projects. These projects have included research, management and impact analyses. Staff have particular expertise in the identification and management of significant and sensitive biological communities, and providing innovative and practical solutions to biological issues.

Natural Resource Solutions is responsible for completing the environmental component of the Subwatershed Study by providing an analysis of impacts by integrating biological and physical components of the ecosystem. Please visit Station 2 - Environmental for further information regarding Natural Resource Solution and their role in the Study.

Morrison Environmental Limited is an engineering firm specializing in hydrogeology and environmental earth sciences. Morrison Environmental's expertise includes the evaluation, development, and management of groundwater resources. The firm has recently completed the Hydrogeological Study of the Trafalgar Moraine, making the team particularly familiar with the issues related to groundwater conditions in the area.

Morrison Environmental is responsible for completing the hydrogeology component of the Subwatershed Study. Please visit Station 3 - Hydrogeology for further information regarding Morrison Environmental and their role in the Study.

Parish Geomorphic Limited, is dedicated to providing expertise in the field of geomorphology, with an emphasis on the application of fluvial geomorphology. Fluvial geomorphology is the science that assesses the shape and form of a watercourse and the contributing physical processes. Typical applications of fluvial geomorphology include inventory and assessments (primarily for watershed planning), erosion assessment and analysis for crossing structures, and stormwater management.

Parish Geomorphic is responsible for completing the geomorpholgy component of the Subwatershed Study. Please visit Station 5 - Geomorphology for further information regarding Parish Geomorphic and their role in the Study.

CONTACTS

For further information regarding any of the characterizations/issues discussed at this evening's Open House, please contact either:

Mr. John Kwast
Town of Oakville
Planning Department
(905) 845-6601 x3320
Jkwast@town.oakville.on.ca

Mr. Ray Tufgar
Project Manager
Totten Sims Hubicki
(519) 886-2160 x224
rtufgar@tsh.ca

WEB SITE

Other staff reports and studies pertaining to North Oakville are available on the Town's Website at www.town.oakville.on.ca

COMMENT CARD

Please remember to fill out a comment card as you leave the Open House. Thank you for your participation.

Technical Advisory Committee (including Observers)	
Member	**Affiliation**
John Kwast	Town of Oakville
Robert Thun	Town of Oakville
Peter Cheatley	Town of Oakville
Janis Olbina	Town of Oakville
Doug Corbett	Halton Region
Carolyn Hart	Halton Region
Heather Malcolmson	Halton Region
Ray Guther	Conservation Halton
Dave Featherstone	Conservation Halton
Brenda Axon	Conservation Halton
Mary Trudelle	SAC
Gerard Chaisson	SAC
Lynne Gough	Gough Consulting
Colin McGregor	Trinison Management Corp.
Nancy Mather	Stantec Consulting
Dave Stephenson	Natural Resource Solutions
Dave Sawicki	Morrison Environmental
John Parish	Parish Geomorphic
Ray Tufgar	Totten Sims Hubicki

TAC SUBWATERSHED TOUR

1) Towne Blvd.
    - Creek has been rerouted during development
2) Dynasty Restaurant adjacent to Munn's Creek
3) Lions Valley Park (if we can get down the hill in the bus)
    - Steep banks along Sixteen Mile Creek – can possibly see the inflow from tributaries
4) Drainage course near the landfill
    - Note direction of flow
5) Moore Reservoir
    - Note well drilling and weather station
6) Farm with cows and no buffer
    - Note farming practices
7) Joshua's Creek tributary
8) Joshua's Creek tributary
9) Joshua's Creek tributary
    - Note flows at locations 7,8 and 9 and relate to location 10
10) White Oaks Golf Club (Joshua's Creek)
11) Buttonbush Swamp (if possible)
    - There are several buttonbush swamps with the main ones located east of Trafalgar, north of Dundas. These require a hike from the road, time permitting.

FLUVIAL GEOMORPHOLOGY SUMMARY

Stream - Reach # North Oakville West 14W-1

Location: Upstream of Dundas Street, east of Bronte Road
Length surveyed: 497m
Number of cross-sections: 10
Date of Survey: 27-Nov-02

Controlling Factors

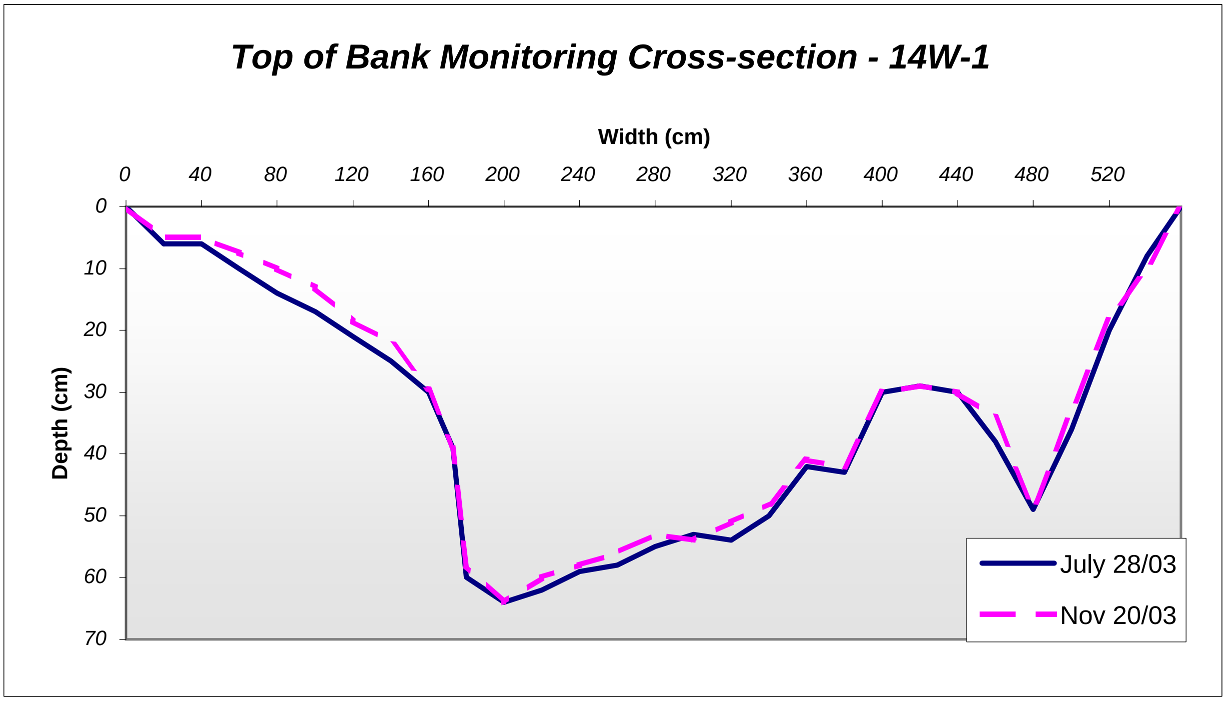
Geology / Soils: Queenston Shale, Halton Till

Modifying Factors

Surrounding Land Use: Scrubland
General Riparian Vegetation: Mainly tall herbs and grasses with Elm, Willow,and Apple trees
Existing Channel Disturbances Dundas Street crossing
Woody Debris: None to major

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.37 - 4.74	3.81
Bankfull Depth (m)	0.25 - 0.51	0.34
Width / Depth	7.42 - 11.38	11.38
Wetted Width (m)	0.37 - 2.84	1.33
Water Depth (m)	0.04 - 0.34	0.12
Width / Depth	7.18 - 27.95	12.76
Entrenchment (m)	6.76-16.24	9.41
Entrenchment Ratio	1.59-3.43	2.48
Manning's n		0.035


Top of Bank Monitoring Cross-section - 14W-1

Bank Characteristics

	Range	Average
Bank Height (m)	0.6 - 1.8	1
Bank Angle (degrees)	8 - 68	47.1
Root Depth (cm)	9 - 24	14.9
Protected by vegetation (%)	10 - 90	66.1
Amount of undercut (cm)	11 - 34	16.5
Banks with undercuts (%)		30

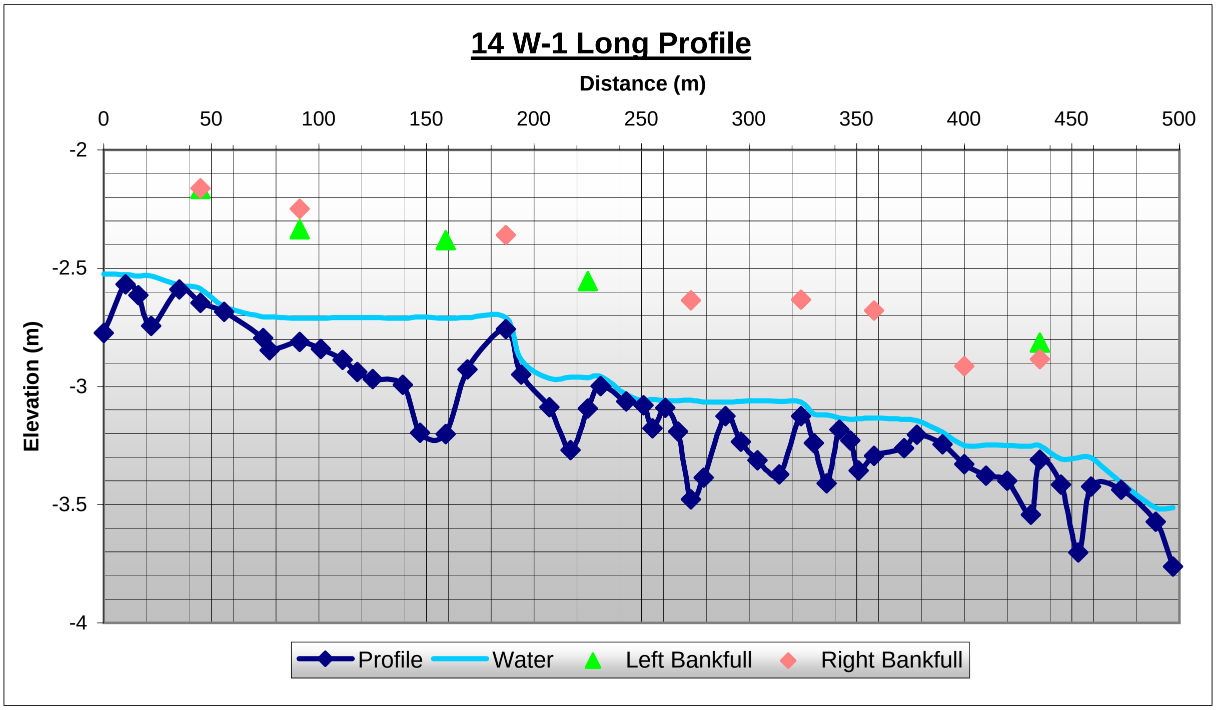
Materials		**Soil shear strength (kg/cm^2)**
cl		0.47
cl/vfs		0.41
cl/si/vfs	*	0.42
cl/si/fs		0.40
cl/si		0.38
cl/si/cs		0.33

*** dominant material**

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.18	%
Inter-Pool Gradient	0.22	%
Inter-Riffle Gradient	2.70	%
Riffle Gradient	1.17	%
Riffle Length	13.63	m
Riffle-Pool Spacing	20.75	m
Max Pool Depth	0.72	m



Substrate Characteristics

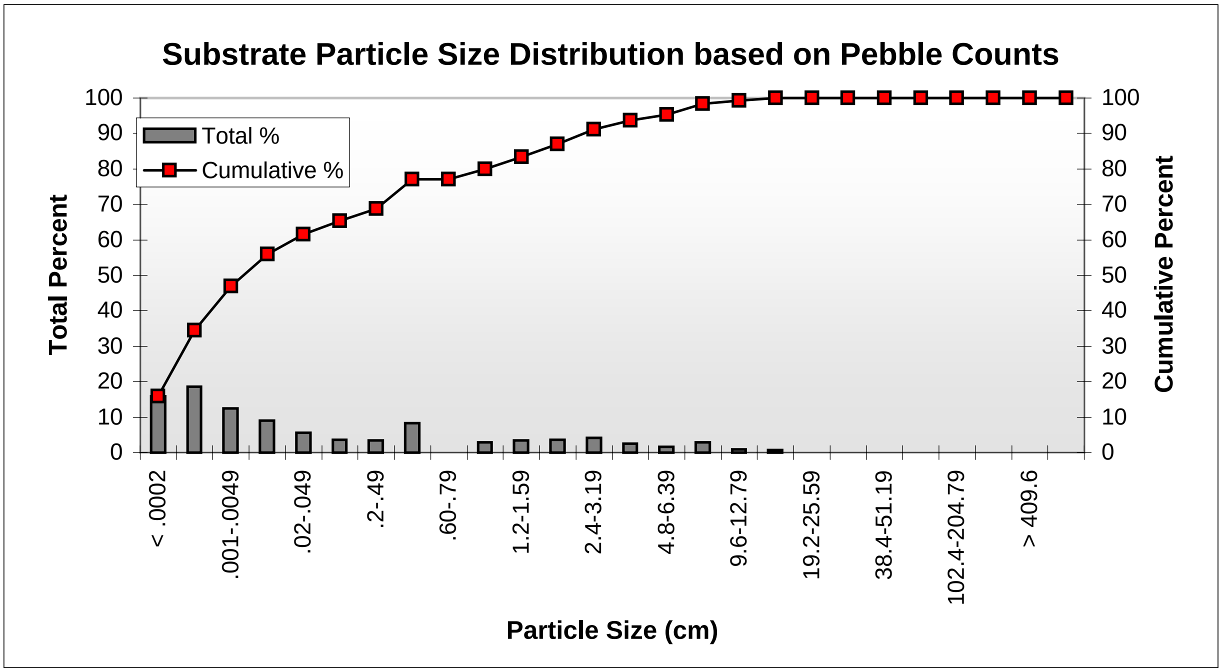
Particle Shape (cm)		**Range**	**Average**
	X	1.5 - 14	5.95
	Y	1.5 - 9	4.48
	Z	0.5 - 7	2.88
Hydraulic Roughness (cm)			
	Maximum	0.25 - 9	3.43
	Median	0.10 - 3.0	0.95
	Minimum	0.0 - 0.25	0.09
Embeddedness (%)		5-95	43

Sub-pavement

Part. Size	**% of subpavement on site**	**Part. Size**	**% of subpavement on site**
cl	37.8	**P**	5.2
si	17	**1 cm**	0
vfs	13.7	**2 cm**	0
fs	8.4	**3 cm**	0
ms	7.0	**4 cm**	0
cs	4.7	**5 cm**	0
vcs	6.2		

Particle Sizes (cm)

	Pebble Counts
D10	NaN
D50	0.006
D84	1.5
D90	2.6



Field Observations

Site 1 has an eroded right bank with exposed Willow tree roots.
The banks of Site 2 contain dune grasses.
Site 3 has a right bank that is higher and more vertical with the thalweg by it.
Site 4 is at the top of a riffle containing a mid channel vegetation bar with stagnant water towards right bank.
Site 5 is a pool area with eroded vertical faced banks.
Site 6 is at the bottom of a pool on a bend with a higher right bank than the left bank.
Site 7 is a the top of a riffle and contains mid channel grasses.
Site 8 is a pool area with a fine substrate.
Site 9 is a riffle area on a bend with the thalweg flowinf towards the right bank.
Site 10 is within a riffle with herbs and grass laying across the channel.

FLUVIAL GEOMORPHOLOGY SUMMARY

Stream - Reach #   North Oakville West 16WA-1

Location: Upstream of Dundas Street

Length surveyed: 59.25 meters
Number of cross-sections: 10
Date of Survey: 21-Jul-03

Controlling Factors

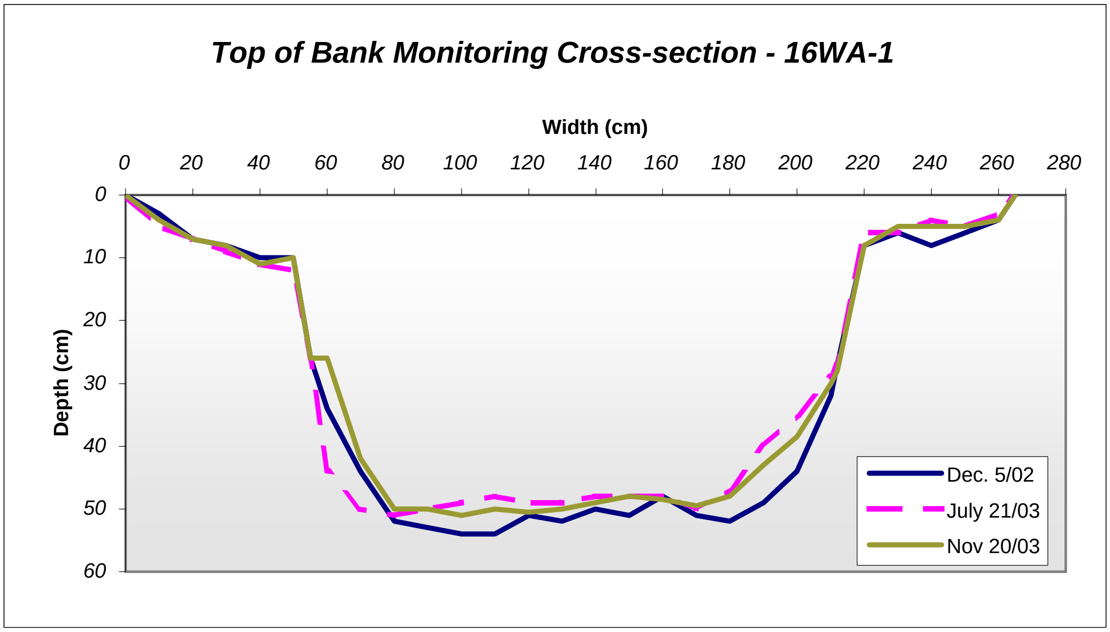
Geology / Soils: Halton Till

Modifying Factors

Surrounding Land Use: Scrublanc
General Riparian Vegetation: Tall and short herbs and grasses, some shrubs and tree
Existing Channel Disturbances: Dundas Street crossin
Woody Debris: none to minor

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	1.29-2.55	1.87
Bankfull Depth (m)	0.21-0.32	0.26
Width / Depth	4.45-11.18	7.47
Wetted Width (m)	n/a	n/a
Water Depth (m)	n/a	n/a
Width / Depth	n/a	n/a
Entrenchment (m)	6.76-21.65	15.54
Entrenchment Ratic	4.59-13.12	8.11
Manning's r		0.035


Top of Bank Monitoring Cross-section - 16WA-1

PARISH Geomorphic Ltd.

Bank Characteristics

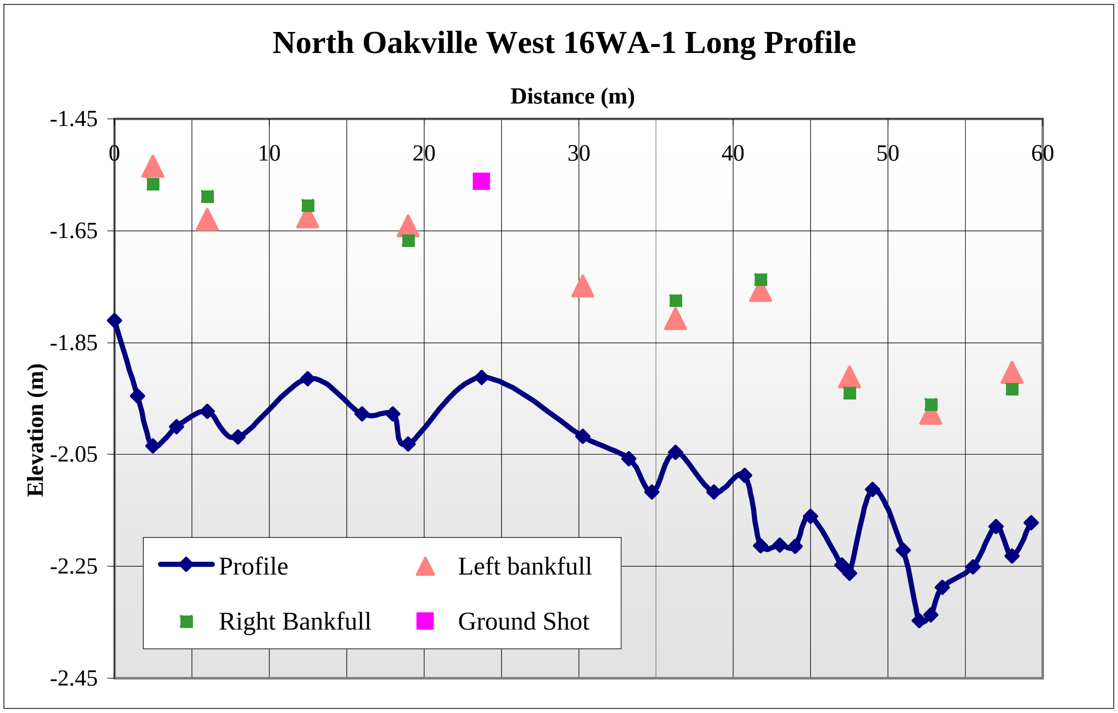
	Range	Average	
Bank Height (m)	0.35-1.50	0.60	
Bank Angle (degrees)	9-90	53.0	
Root Depth (cm)	3-22	10.3	
Root Density ***(1=Low - 5=High)***	1-4	2.4	*(Category)*
Protected by vegetation (%)	5-30	8.3	
Amount of undercut (cm)	11-32	17	
Banks with undercuts (%)		25%	

Materials		**Torvane values (kg/cm2)**	
cl/si		0.24	
cl	*	0.31	
si/vfs		0.10	* = dominant material
si/vfs/cl		0.15	

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.66	%
Inter-Pool Gradient	n/a	%
Inter-Riffle Gradient	n/a	%
Riffle Gradient	n/a	%
Riffle Length	n/a	m
Riffle-Pool Spacing	n/a	m
Max Pool Depth	n/a	m



Substrate Characteristics

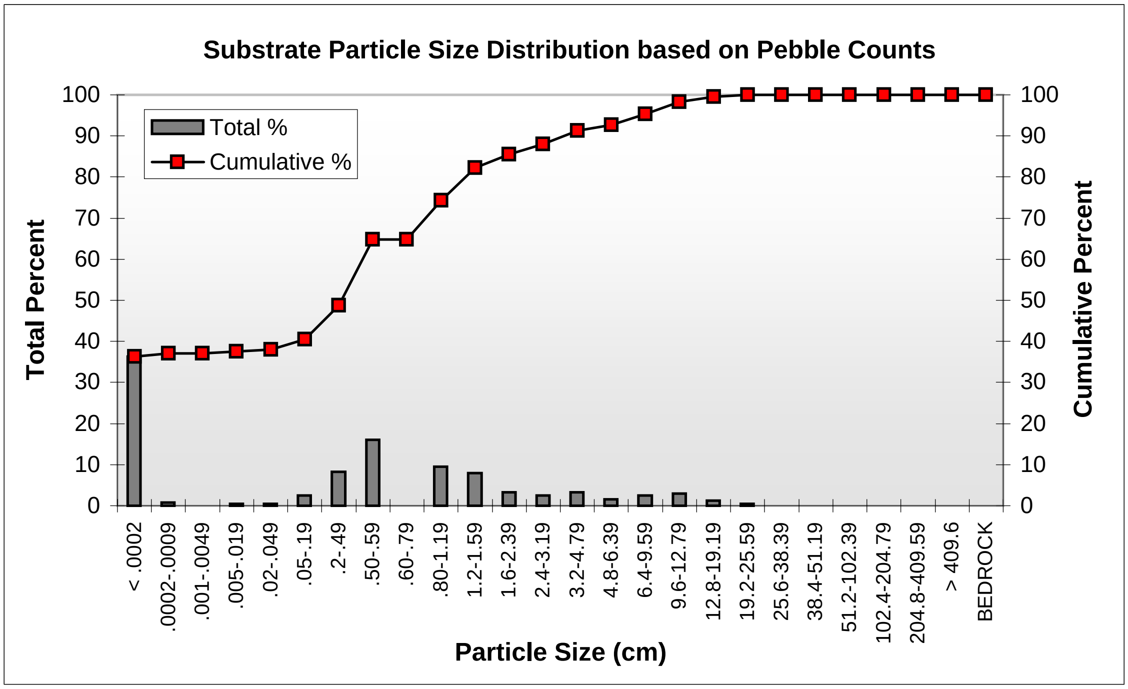
Particle Shape (cm)		Range	Average
	X	2-26	10.92
	Y	1.5-22	7.8
	Z	0.5-10.5	2.72
Hydraulic Roughness (cm)			
	Maximum	1-8	5.05
	Median	0.25-1.0	0.53
	Minimum	0	0
Embeddedness (%)		20-100	52.00

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	100.00	P	--
si	--	1 cm	--
vfs	--	1.5cm	--
fs	--	2 cm	--
ms	--	3 cm	--
cs	--	4 cm	--
vcs	--	bedrock	--

Particle Sizes (cm)

	Pebble Counts
D10	Nan
D50	0.36
D90	3.53



Field Observations

- Dry channel
- Exposed clay till subpavement
- Exposed treet roots
- Vertical, eroded banks
- Dense vegetation on banks
- Island formation

FLUVIAL GEOMORPHOLOGY SUMMARY

Joshua Creek - JC-13

Location: Downstream of Burnhamthorpe Road between Trafalgar Road and Ninth Line
Length surveyed: 173.0m
Number of cross-sections: 10
Date of Survey: June 7/02

Controlling Factors

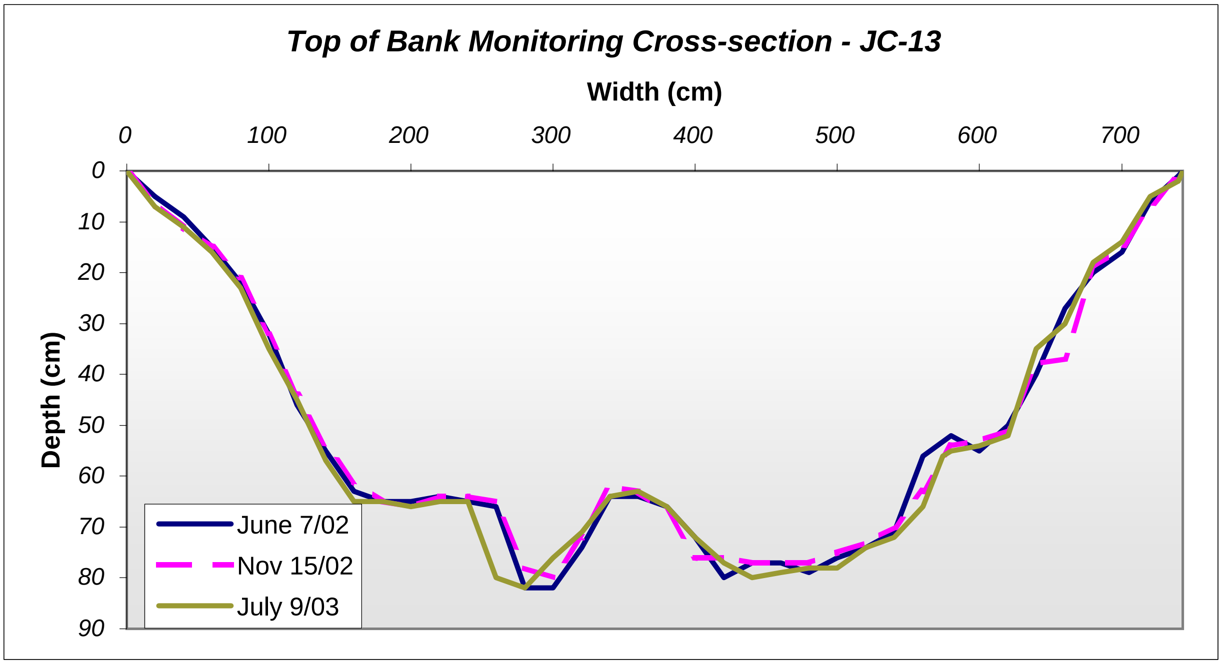
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: grass meadow and scrub forest
General Riparian Vegetation: tall herbaceous vegetaition, shrubs, trees
Existing Channel Disturbances the reach appears straightened
Woody Debris: minor woody debris

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.06-5.0	2.92
Bankfull Depth (m)	0.159-0.324	0.24
Width / Depth	6.75-27.30	13.00
Wetted Width (m)	0.63-2.6	1.34
Water Depth (m)	0.019-0.213	0.09
Width / Depth	5.49-124.74	31.80
Entrenchment (m)	6.58-9.42	8.15
Entrenchment Ratio	1.58-4.16	2.97
Manning's n		0.03


Top of Bank Monitoring Cross-section - JC-13

Hydrology

Measured **Discharge (cms)** 0.03 (upstream end of reach at road crossing)

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1.5	0.7	
Bank Angle (degrees)	13-80	39.5	
Root Depth (cm)	4.0-15	8.3	
Root Density ***(1=Low - 5=High)***	n/a	n/a	*(Ranking)*
Protected by vegetation (%)	40-90	76.5	
Amount of undercut (cm	12	12	
Banks with undercuts (%	5%		

Materials	**Torvane values (kg/cm2)**	
cl/vfs/si	0.24	
sl/si/vfs	0.32	
*clay	0.32	* = dominant material
cl/cs	0.24	
cl/vfs	0.3	
cl/si	0.34	
vcs/cs/cl	0.23	
cl/cs/si	0.15	

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.65	%
Inter-Pool Gradient	0.59	%
Inter-Riffle Gradient	0.88	%
Riffle Gradient	3.34	%
Riffle Length	2.96	m
Riffle-Pool Spacing	8.78	m
Max Pool Depth	0.25	m

Substrate Characteristics

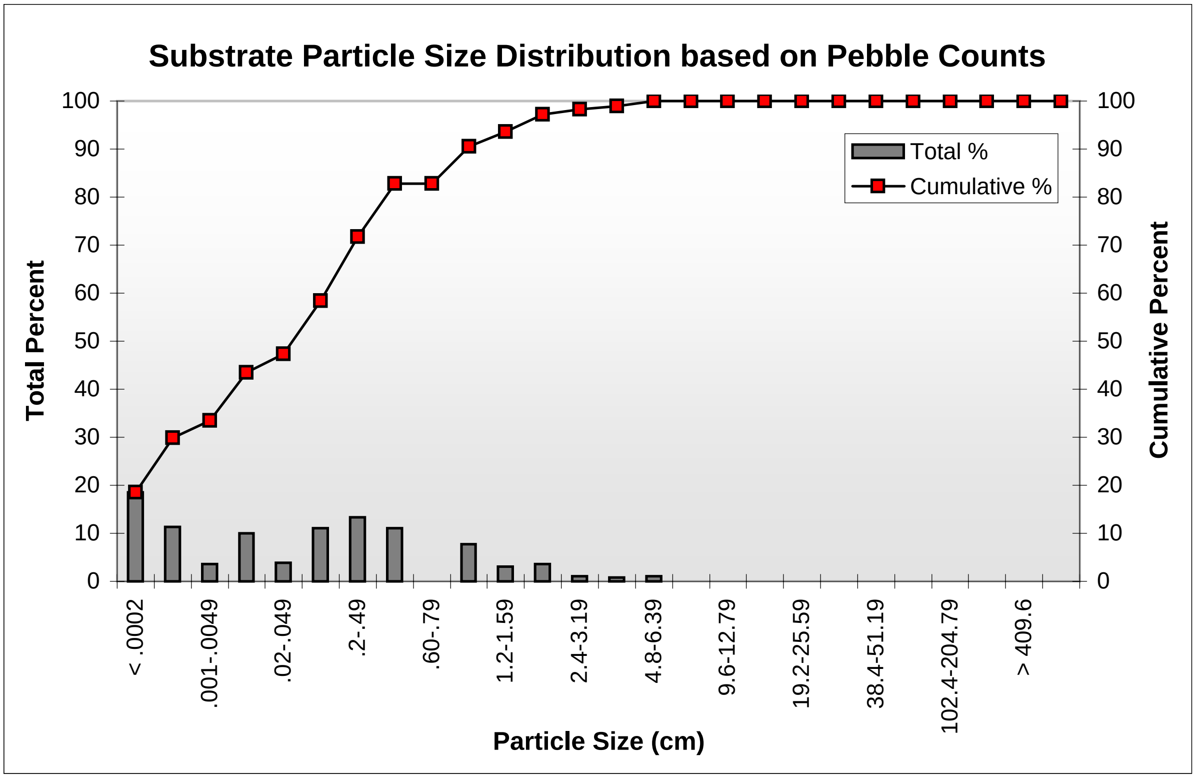
Particle Shape (cm)		Range	Average
	X	2.0-19	5.26
	Y	1.0-12	3.76
	Z	0.5-6	1.74
Hydraulic Roughness (cm)			
	Maximum	0-6	1.9
	Median	0-1.5	0.4
	Minimum	0-0.3	0
Embeddedness (%)		20-100	73

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	318	**P**	6.4
si	17.3	**1 cm**	3.2
vfs	5	**1.5cm**	0
fs	11.4	**2 cm**	0.5
ms	1.8	**3 cm**	0.5
cs	10.5	**4 cm**	0
vcs	11.8	**5 cm**	0

Particle Sizes (cm)

	Pebble Counts
D10	< 0.0002
D50	0.083
D90	1.16



Field Observations

- narrow entrenched channel
- straight sections
- dense grasses on some banks
- deposition in the centre o fthe channel at some cross-sections
- water was turbid
- grasses in channel
- channel splitting observed

FLUVIAL GEOMORPHOLOGY SUMMARY

Joshua Creek - JC3

Location: main channel of Joshua Creek upstream of Dundas, northwest of cemetery
Length surveyed: 180m
Number of cross-sections: 10
Date of Survey: June 6/02

Controlling Factors

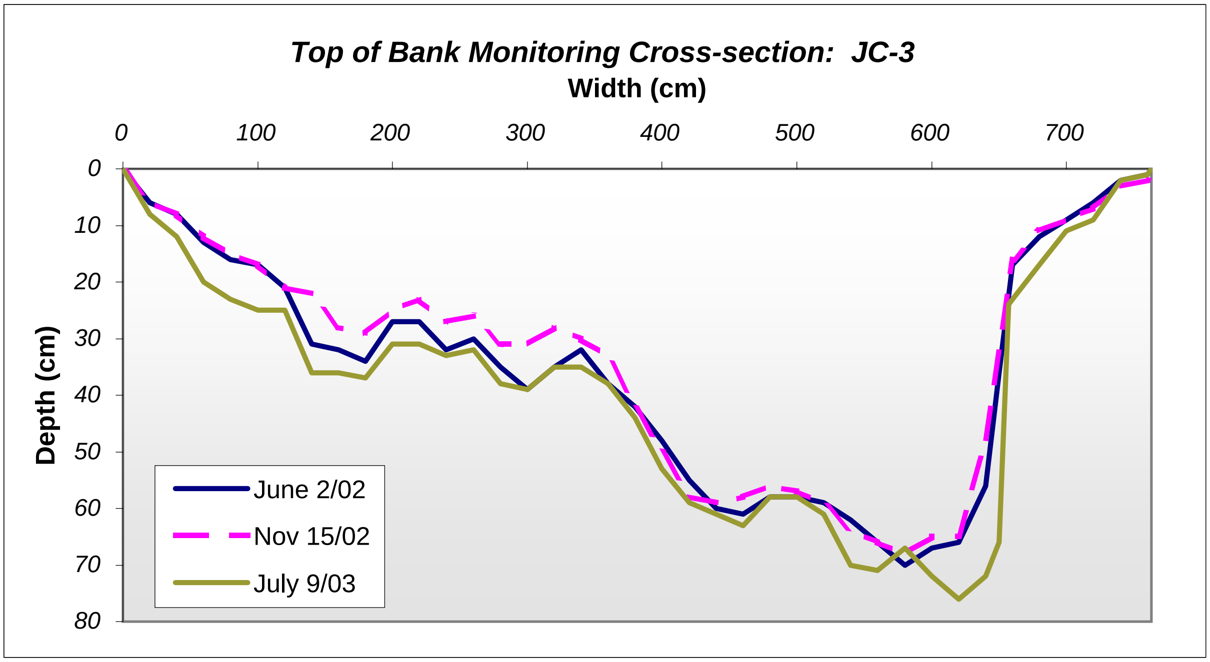
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: scrubforest
General Riparian Vegetation: tall herbaceous vegetation, shrubs, trees
Existing Channel Disturbances none
Woody Debris: moderate amount of woody debris

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	3.58-7.86	4.99
Bankfull Depth (m)	0.204-0.516	0.31
Width / Depth	7.54-38.53	17.90
Wetted Width (m)	0.95-3.37	2.39
Water Depth (m)	0.038-0.341	0.14
Width / Depth	6.74-71.05	28.93
Entrenchment (m)	12.58-22.86	17.17
Entrenchment Ratio	2.31-4.45	3.58
Manning's n		0.033



PARISH Geomorphic Ltd.

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1	0.6	
Bank Angle (degrees)	12.0-84	51.8	
Root Depth (cm)	7.0-46	17.1	
Root Density ***(1=Low - 5=High)***			*(Ranking)*
Protected by vegetation (%)	40-85	71.3	
Amount of undercut (cm	5.0-18	11.9	
Banks with undercuts (%	40		

Materials	**Torvane values (kg/cm2)**	
*cl/si	0.27	
cl/si/vfs	0.37	
si/vfs/cl	0.27	* = dominant material
cl/fs/vfs	0.35	
cl/fs	0.22	
cl/vfs	0.14	
clay	0.30	
cl/si/fs	0.18	

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.70	%
Inter-Pool Gradient	1.25	%
Inter-Riffle Gradient	0.95	%
Riffle Gradient	4.84	%
Riffle Length	4.68	m
Riffle-Pool Spacing	8.91	m
Max Pool Depth	0.32	m

Substrate Characteristics

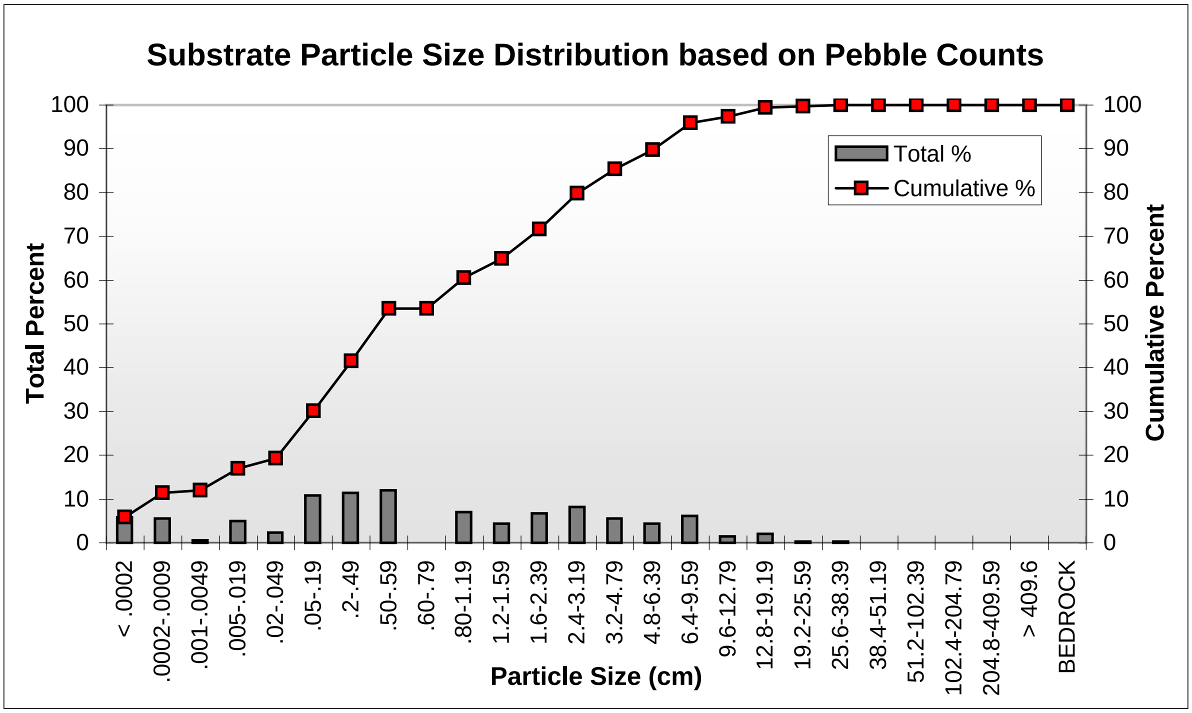
Particle Shape (cm)		**Range**	**Average**
	X	5.5-25	13
	Y	4.0-22	9.5
	Z	0.3-8	2.41
Hydraulic Roughness (cm)			
	Maximum	0.3-22	6.5
	Median	0-2	1.2
	Minimum	0-.5	0.2
Embeddedness (%)		5-100	34

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	2.3	P	5.9
si	3.2	1 cm	5.5
vfs	*3.2*	1.5cm	2.7
fs	*5.9*	2 cm	1.4
ms	*2.3*	3 cm	n/a
cs	*6.4*	4 cm	n/a
vcs	*6.8*	5 cm	n/a

Particle Sizes (cm)

	Pebble Counts
D10	0.0007
D50	0.56
D90	6.51



Field Observations

- grasses in channel
- high flow channel observed on different sides of the channel along reach
- bedrock exposed at several cross-sections
- significant bank erosion
- macrophytes in channel
- vegetation growing on mid-channel deposit
- sections very depositional

FLUVIAL GEOMORPHOLOGY SUMMARY

Morrison Creek - MOC-4

Location: North of Dundas Road at Trafalgar Road
Length surveyed: 169 m
Number of cross-sections: 10
Date of Survey: 12-Jun-02

Controlling Factors

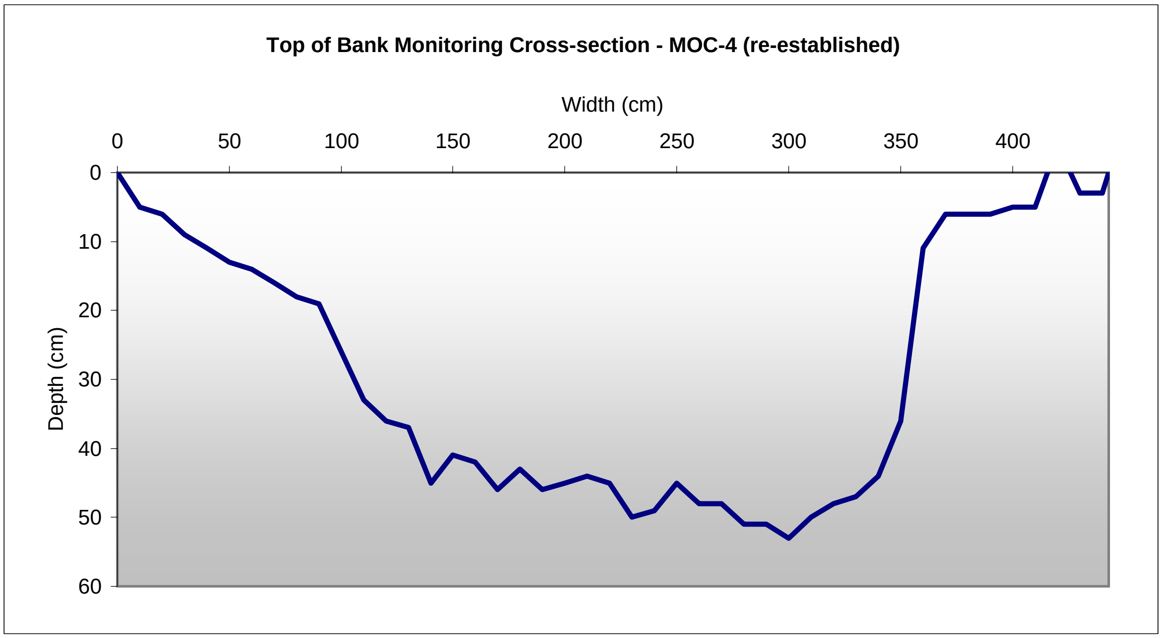
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: agricultural land
General Riparian Vegetation: tall grasses and herbs, shrubs and trees
Existing Channel Disturbances culvert at upstream end, previously straightened
Woody Debris: minor

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.45-3.69	3.14
Bankfull Depth (m)	0.212-0.347	0.26
Width / Depth	9.18-17.41	12.25
Wetted Width (m)	0.59-2.0	1.29
Water Depth (m)	0.33-0.101	0.06
Width / Depth	10.11-51.47	25.72
Entrenchment (m)	11.69-20.53	14.19
Entrenchment Ratic	3.17-7.12	4.61
Manning's r		0.033


Top of Bank Monitoring Cross-section - MOC-4 (re-established)

Hydrology

Measured	**Discharge (cms)**	0.55

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1.2	0.6	
Bank Angle (degrees)	19-61	34.3	
Root Depth (cm)	7.0-25	15.5	
Root Density ***(1=Low - 5=High)***	1.0-3.0	2.4	*(Ranking)*
Protected by vegetation (%)	20-80	46.8	
Amount of undercut (cm		0	
Banks with undercuts (%		0%	

Materials	**Torvane values (kg/cm2)**
*clay	0.28
cl/si	0.26
si/cl	0.27

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.60	%
Inter-Pool Gradient	2.74	%
Inter-Riffle Gradient	0.74	%
Riffle Gradient	2.45	%
Riffle Length	6.08	m
Riffle-Pool Spacing	19.5	m
Max Pool Depth	0.12	m

Substrate Characteristics

Particle Shape (cm)		**Range**	**Average**
	X	3-31.5	8.18
	Y	2.0-19	5.64
	Z	0.25-4	1.46
Hydraulic Roughness (cm)			
	Maximum	0-8	2.2
	Median	0-0.5	0.1
	Minimum	0	0
Embeddedness (%)		20-100	76.6

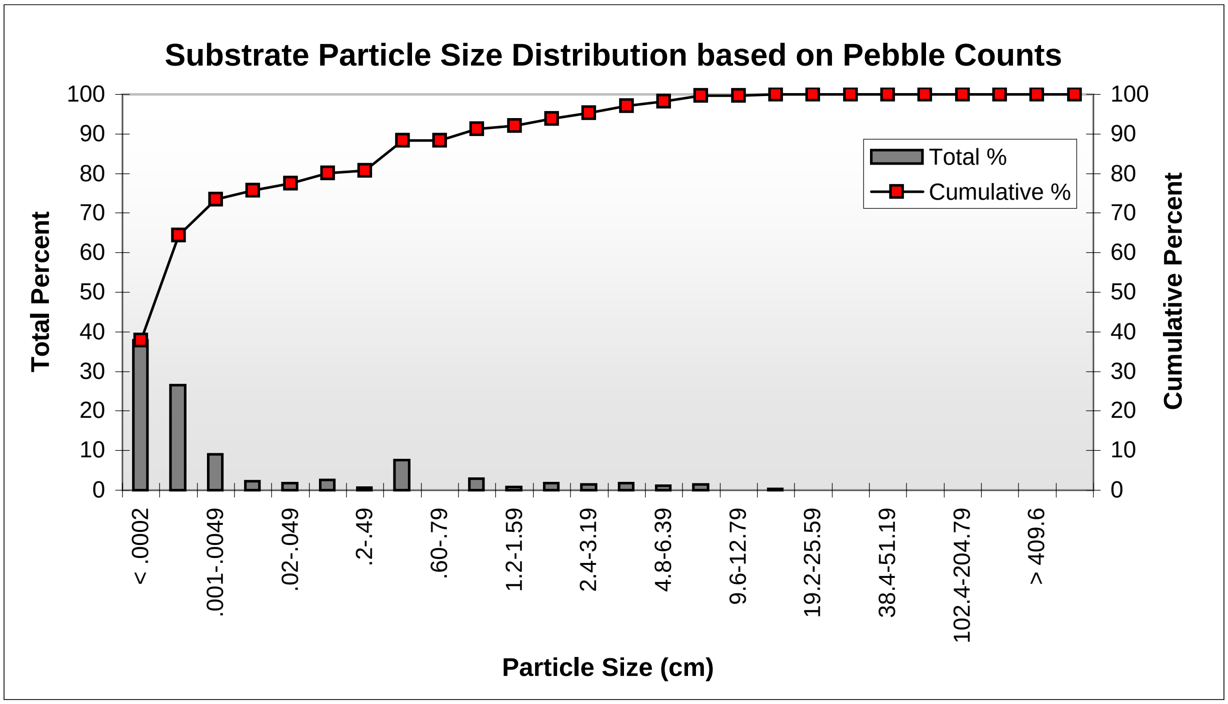
Sub-pavement

Part. Size	% of subpavement on site
cl	72.5
si	13.8
vfs	1.3
fs	0
ms	0
cs	0
vcs	0

Part. Size	% of subpavement on site
P	0
1 cm	0
1.5cm	0
2 cm	0
3 cm	0
4 cm	0
5 cm	0
bedrock	12.5

Particle Sizes (cm)

	Pebble Counts
D10	<0.0002
D50	0.00052
D90	1.02



Field Observations

subpavement - large, chunky pieces of shale surrrounded by silt and clay

- shale within silt and clay

- in channel vegetation was dense (cattails)
- banks exposd below bankfull
- exposed tree roots along portions of the reach
- poorly defined morphology

Photo 1. Reach JC-1 at bank erosion.

Photo 2. Reach JC-1 at bank erosion.

Photo 1. Reach JC-2 at golf course.

Photo 2. Reach JC-2 at wide pool.

Photo 1. Reach JC-3 at bank erosion.

Photo 2. Reach JC-3 at channel.

Photo 1. Reach JC-4 with fallen and leaning trees.

Photo 1. Reach JC-5 with accretion on point bars.

Photo 1. Reach JC-6 with formation of chutes.

Photo 1. Reach JC-7 general channel conditions.

Photo 1. Reach JC-8 densely vegetated channel.

Photo 1. Reach JC-9 grassed channel between agricultural fields.

Photo 1. Reach JC-10 grassed channel between agricultural fields.

Photo 1. Reach JC-11 straight channel with evidence of cattle grazing.

Photo 1. Reach JC-12 depression in field.

Photo 1. Reach JC-13 with slumping banks.

Photo 1. Reach JC-19 with leaning and fallen trees.

Photo 2. Reach JC-19 in woodlot.

Photo 1. Reach JC-20 with poor bed morphology.

Photo 1. Reach JC-21 – dry, grassed channel.

Photo 1. Reach JC-22 general channel conditions.

Photo 1. Reach JC-25 vegetated swale.

Photo 1. Reach JC-30 general conditions.

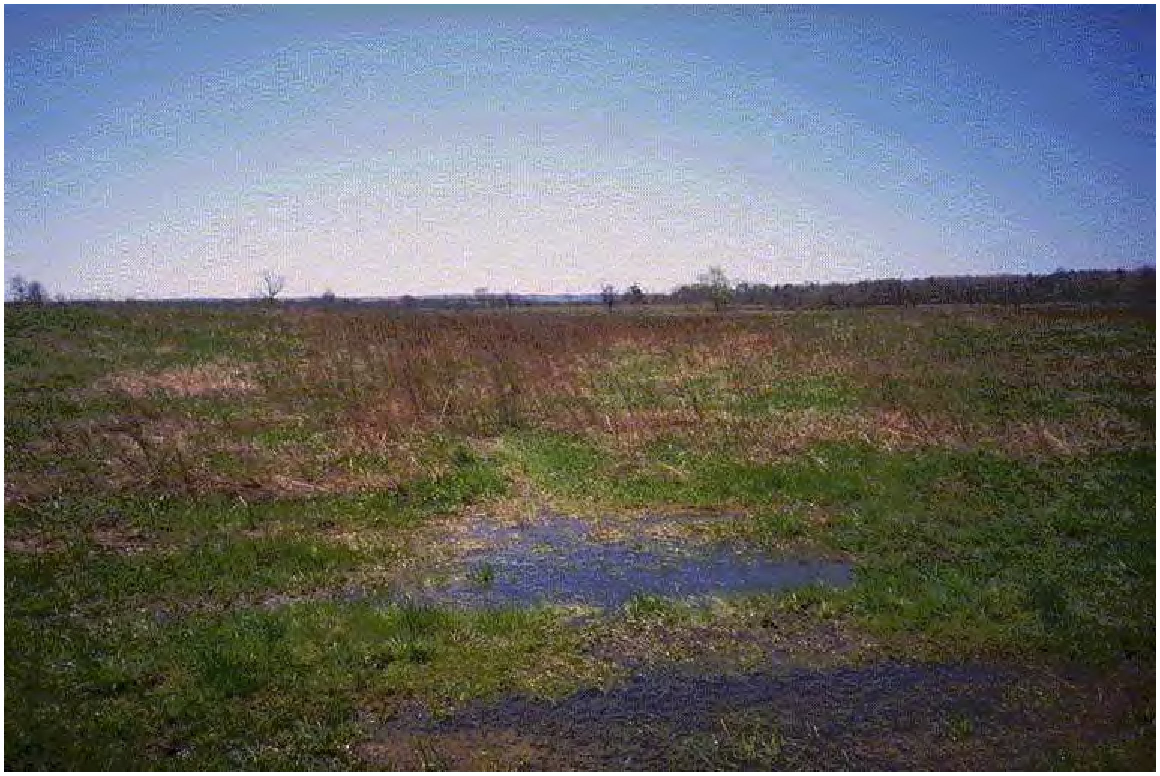


Photo 1. Reach MOC-2 general conditions at upstream extent of reach.

Photo 2. Reach MOC-2 at Trafalgar Road.

Photo 1. Reach MOC-4 densely vegetated channel.

Photo 2. Reach MOC-4 densely vegetated channel.

Photo 1. Reach MOC-W3 agricultural drain.

Photo 2. Reach MOC-W3 agricultural drain.

Photo 1. Reach SHC-1 swale.

Photo 1. Reach SHC-2 swale.

Photo 1. Reach SHC-3 swale.

Photo 1. Reach MOC-W1 looking downstream from 6th Line culvert.

Photo 1. Reach MOC-W2 looking upstream from 6th Line.

Photo 1. Reach 14W-17 and 14W-16a looking downstream from Tremaine.

Photo 2. Reach 14W-17 and 14W-17a looking downstream from Tremaine.

Photo 1. Reach JC-35 looking downstream towards golf course.

Photo 2. Reach JC-35 looking downstream towards golf course.

Photo 1. Reach JC-31 looking upstream from Dundas ditch.

Photo 2. Reach JC-31 looking upstream at swale.

Photo 1. Reach JC-32 looking upstream at sight.

Photo 1. Reach JC-36 general conditions.

Photo 2. Reach JC-36 looking upstream.

Photo 3. Reach JC-36 looking downstream.

Photo 4. Reach JC-36 banks and substrate.

Photo 1. Reach SMA-1 bank erosion.

Photo 2. Reach SMA-1 valley wall contact.

Photo 1. Reach SMA-2 general conditions.

Photo 2. Reach SMA-2 general conditions.

Photo 3. Reach SMA-2 at culvert.

Photo 1. Reach SMA-3 general conditions.

Photo 1. Reach SMA-4 general conditions.

Photo 2. Reach SMA-4 general conditions.

Photo 3. Reach SMA-4 general conditions.

Photo 1. Reach SMA-5 general conditions.

Photo 2. Reach SMA-5 general conditions.

Photo 1. Reach SMA-6 general conditions.

Photo 2. Reach SMA-6 general conditions.

Photo 1. Reach SMA-7 general conditions.

Photo 2. Reach SMA-7 general conditions.

Photo 3. Reach SMA-7 general conditions.

Photo 1. Reach SMA-8 general conditions.

Photo 2. Reach SMA-8 general conditions.

Photo 1. Reach SMA-9 general conditions.

Photo 1. Reach SMB-1 general conditions.

Photo 2. Reach SMB-1 general conditions.

Photo 1. Reach SMB-2 general conditions.

Photo 2. Reach SMB-2 general conditions.

Photo 1. Reach SMB-3 general conditions.

Photo 2. Reach SMB-3 general conditions.

Photo 1. Reach SMB-4 general conditions.

Photo 2. Reach SMB-4 general conditions.

Photo 1. Reach SMC-1 general conditions.

Photo 2. Reach SMC-1 general conditions.

Photo 1. Reach SMC-2 general conditions.

Photo 2. Reach SMC-2 general conditions.

Photo 1. Reach SMC-3 general conditions.

Photo 2. Reach SMC-3 general conditions.

Photo 1. Reach SMC-4 general conditions.

Photo 1. Reach SMC-5 general conditions.

Photo 1. Reach 14W-11 downstream portion of reach

Photo 2. Reach 14W-11 large pool.

Photo 3. Reach 14W-11a looking upstream at 407.

Photo 4. Reach 14W-11a looking upstream at 407.

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Photo 5. Reach 14W-11 looking upstream (mid-reach).

Photo 1. Reach 14E-1 looking downstream towards pond.

Photo 1. Reach 14E-2 swale.

Photo 1. Reach 14E-4 swale.

Photo 1. Reach 14E-5 general conditions.

Photo 1. Reach 14E-6 looking upstream.

Photo 2. Reach 14E-6 looking upstream.

Photo 1. Reach 14E-7 general conditions.

Photo 2. Reach 14E-7 general conditions.

Photo 1. Reach MC-1 general conditions.

Photo 2. Reach MC-1 general conditions.

Photo 3. Reach MC-1 general conditions.

Photo 1. Reach MC-3 general conditions - swale.

Photo 1. Reach MC-4 general conditions.

Photo 2. Reach MC-4 general conditions.

Photo 1. Reach 16WA-1 general conditions.

Photo 2. Reach 16WA-1 general conditions.

Photo 3. Reach 16WA-1A general conditions.

Photo 1. Reach 16WA-2 general conditions.

Photo 1. Reach 16WA-3 general conditions.

Photo 1. Reach 16WA-4 general conditions.

Photo 1. Reach 16WA-5 general conditions.

Photo 1. Reach 16WA-6 general conditions.

Photo 1. Reach 16WA-7 general conditions.

Photo 2. Reach 16WA-7 general conditions.

Photo 1. Reach 16WA-8 collapsed culvert.

Photo 8. Reach 16WA-8 general conditions.

Photo 1. Reach GO-1 (formerly GO-10) general conditions.

FLUVIAL GEOMORPHOLOGY SUMMARY

Sixteen Mile Creek Trib. - SMA-4

Location:	upstream of Neyagawa Drive across from the landfill
Length surveyed:	157.5m
Number of cross-sections:	10
Date of Survey:	12-Jun-02

Controlling Factors

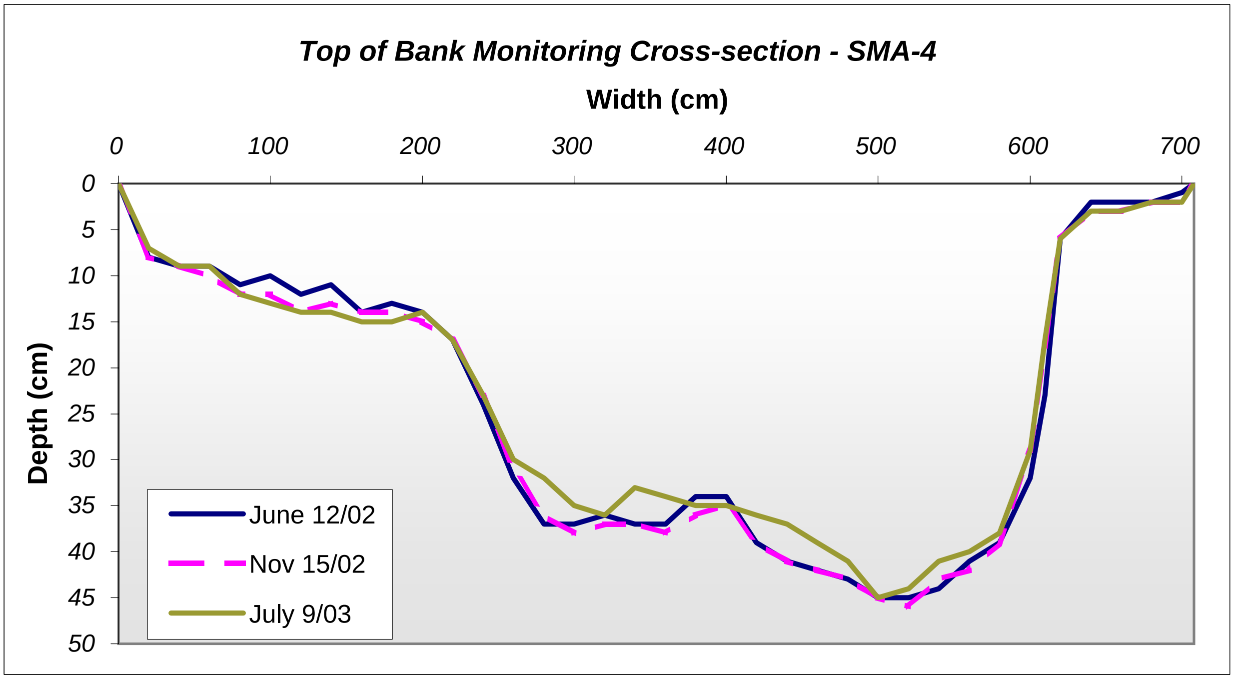
Geology / Soils:	underlain by Glacial Till

Modifying Factors

Surrounding Land Use:	deciduous forest
General Riparian Vegetation:	Short grass, tall herbs, shrubs, and trees (Maple, Oak, Hickory)
Existing Channel Disturbances	culvert
Woody Debris:	large amount of organic debris

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.67-7.8	4.58
Bankfull Depth (m)	0.177-0.309	0.26
Width / Depth	9.11-44.07	18.79
Wetted Width (m)	0.43-1.75	0.90
Water Depth (m)	0.01-0.078	0.05
Width / Depth	10.86-43.00	21.48
Entrenchment (m)	19.78-36.20	25.18
Entrenchment Ratio	3.05-9.61	5.84
Manning's n		0.033


Top of Bank Monitoring Cross-section - SMA-4

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1.3	0.8	
Bank Angle (degrees)	11.0-70	32.6	
Root Depth (cm)	8.0-53	21.4	
Root Density ***(1=Low - 5=High)***	2.0-4.0	2.7	*(Ranking)*
Protected by vegetation (%)	10.0-70.0	32.8	
Amount of undercut (cm	10.0-20.0	15	
Banks with undercuts (%		10%	

Materials	**Torvane values (kg/cm2)**
*cl/si	0.26
si	0.11
si/cl	0.17
clay	0.41

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.55	%
Inter-Pool Gradient	0.68	%
Inter-Riffle Gradient	0.96	%
Riffle Gradient	3.34	%
Riffle Length	4.27	m
Riffle-Pool Spacing	9.04	m
Max Pool Depth	0.13	m

Substrate Characteristics

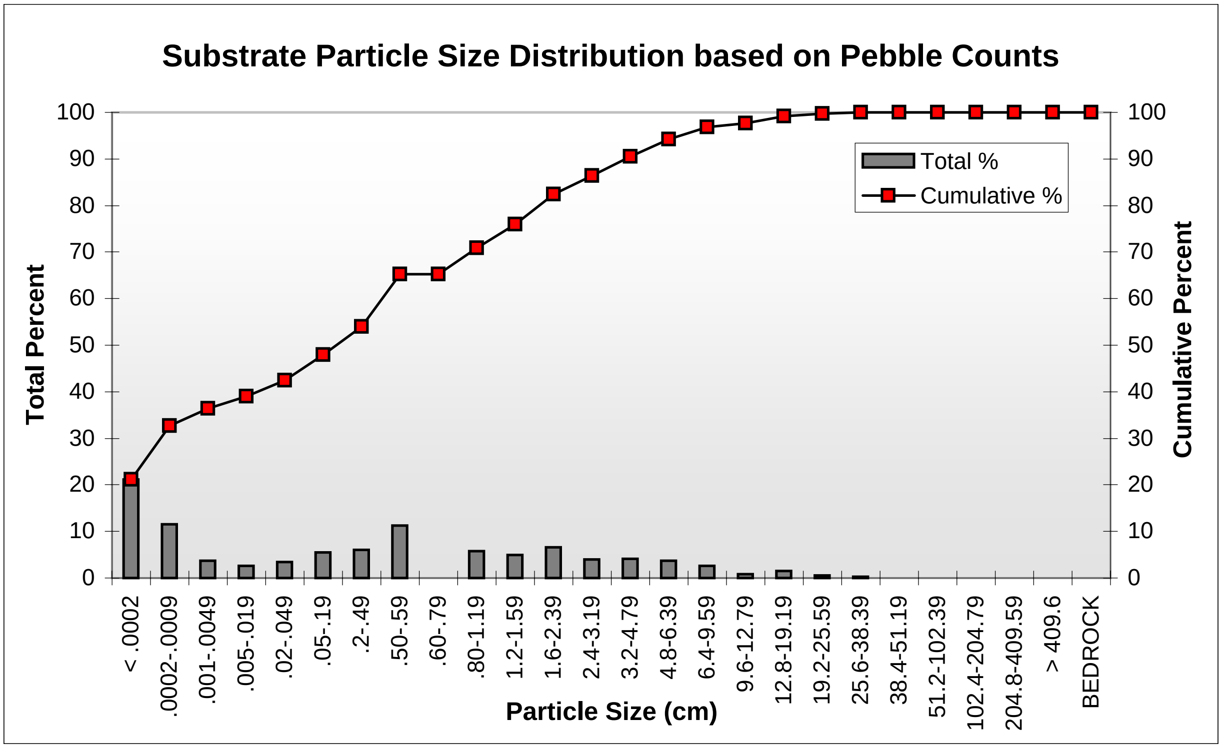
Particle Shape (cm)		Range	Average
	X	2.5-26	7.58
	Y	1.5-15	5.13
	Z	0.5-2.5	1.44
Hydraulic Roughness (cm)			
	Maximum	0-14	3.7
	Median	0-3	0.8
	Minimum	0-0.3	0.1
Embeddedness (%)		30-100	65.5

Sub-pavement

Part. Size	**% of subpavement on site**	**Part. Size**	**% of subpavement on site**
cl	64.4	**P**	5
si	2.8	**1 cm**	1.1
vfs	1.7	**1.5cm**	0
fs	2.2	**2 cm**	1.1
ms	2.2	**3 cm**	0
cs	3.3	**4 cm**	0
vcs	5	**5 cm**	0
		Bdr.	11.1

Particle Sizes (cm)

	Pebble Counts
D10	< 0.0002
D50	0.29
D90	4.57



Field Observations

- vegetaion (herbaceous material) in the channel
- high flow channel behind right bank
- coarse material was embedded in clay/silt, some coarse material was shale
- large chunks of shale on bed at some cross-sections
- stagnant water at some locations

FLUVIAL GEOMORPHOLOGY SUMMARY

Stream - Reach # North Oakville West 14W-1

Location: Upstream of Dundas Street, east of Bronte Road
Length surveyed: 497m
Number of cross-sections: 10
Date of Survey: 27-Nov-02

Controlling Factors

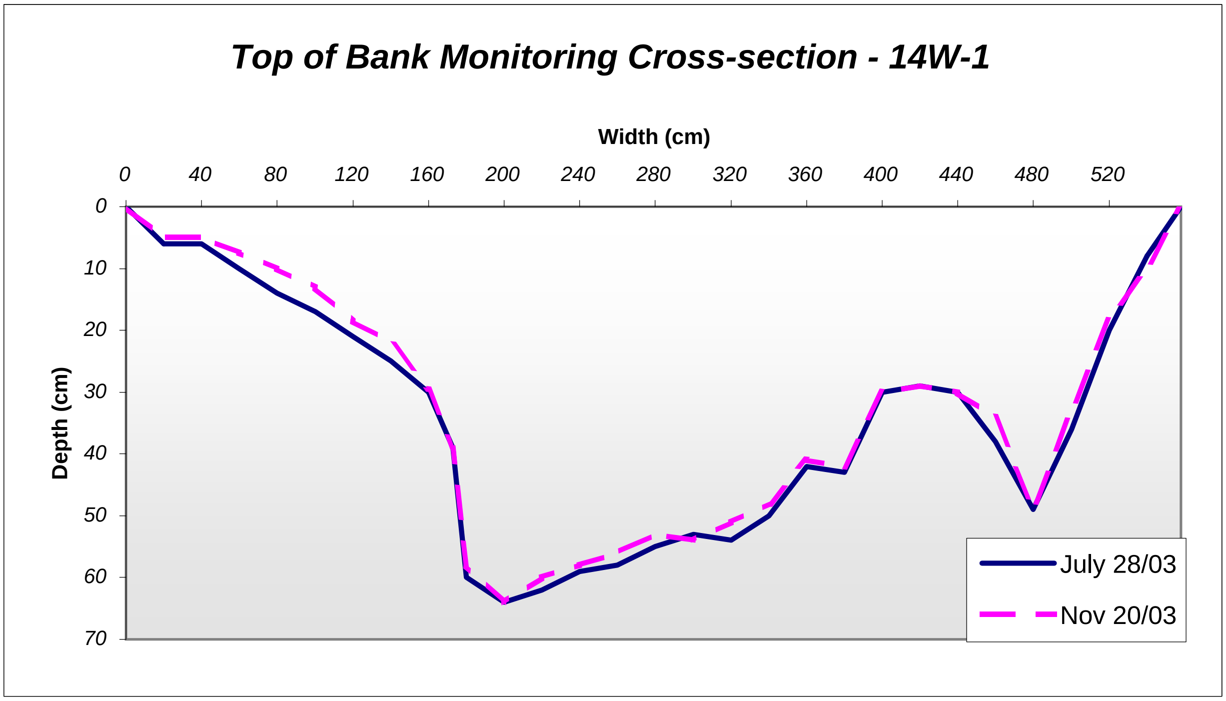
Geology / Soils: Queenston Shale, Halton Till

Modifying Factors

Surrounding Land Use: Scrubland
General Riparian Vegetation: Mainly tall herbs and grasses with Elm, Willow,and Apple trees
Existing Channel Disturbances Dundas Street crossing
Woody Debris: None to major

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	2.37 - 4.74	3.81
Bankfull Depth (m)	0.25 - 0.51	0.34
Width / Depth	7.42 - 11.38	11.38
Wetted Width (m)	0.37 - 2.84	1.33
Water Depth (m)	0.04 - 0.34	0.12
Width / Depth	7.18 - 27.95	12.76
Entrenchment (m)	6.76-16.24	9.41
Entrenchment Ratio	1.59-3.43	2.48
Manning's n		0.035



Bank Characteristics

	Range	Average
Bank Height (m)	0.6 - 1.8	1
Bank Angle (degrees)	8 - 68	47.1
Root Depth (cm)	9 - 24	14.9
Protected by vegetation (%)	10 - 90	66.1
Amount of undercut (cm	11 - 34	16.5
Banks with undercuts (%		30

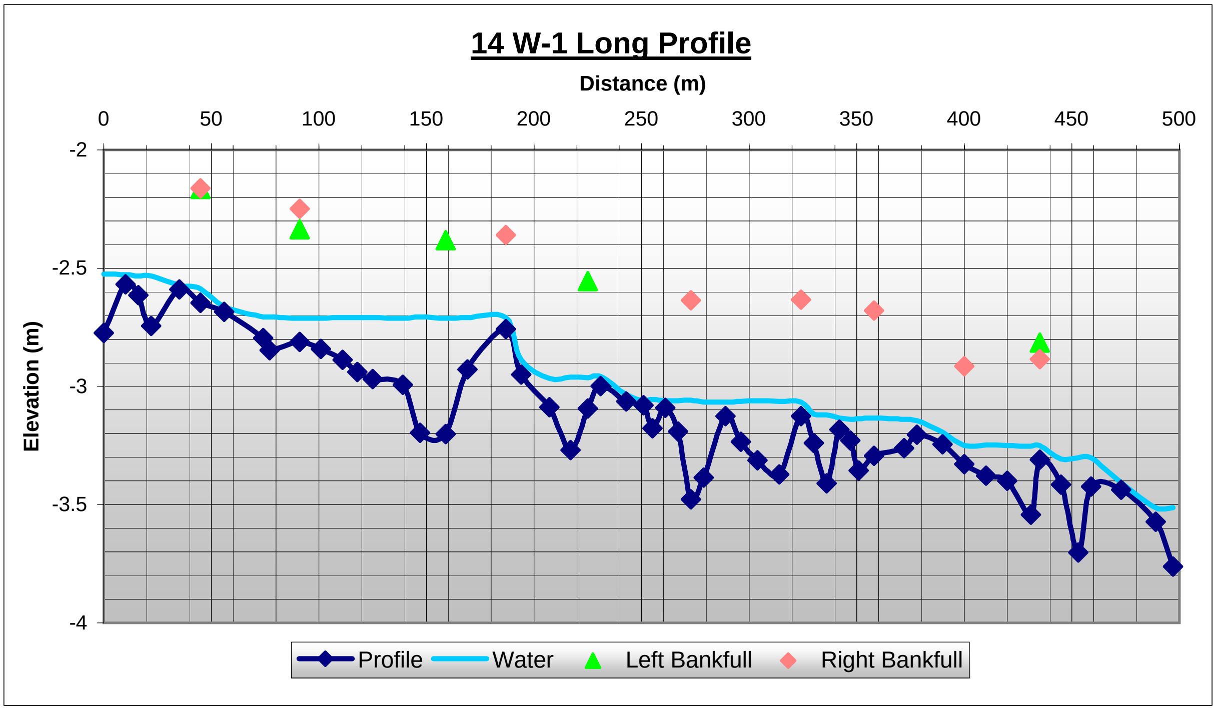
Materials		**Soil shear strength (kg/cm^2)**
cl		0.47
cl/vfs		0.41
cl/si/vfs	*	0.42
cl/si/fs		0.40
cl/si		0.38
cl/si/cs		0.33

*** dominant material**

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.18	%
Inter-Pool Gradient	0.22	%
Inter-Riffle Gradient	2.70	%
Riffle Gradient	1.17	%
Riffle Length	13.63	m
Riffle-Pool Spacing	20.75	m
Max Pool Depth	0.72	m



Substrate Characteristics

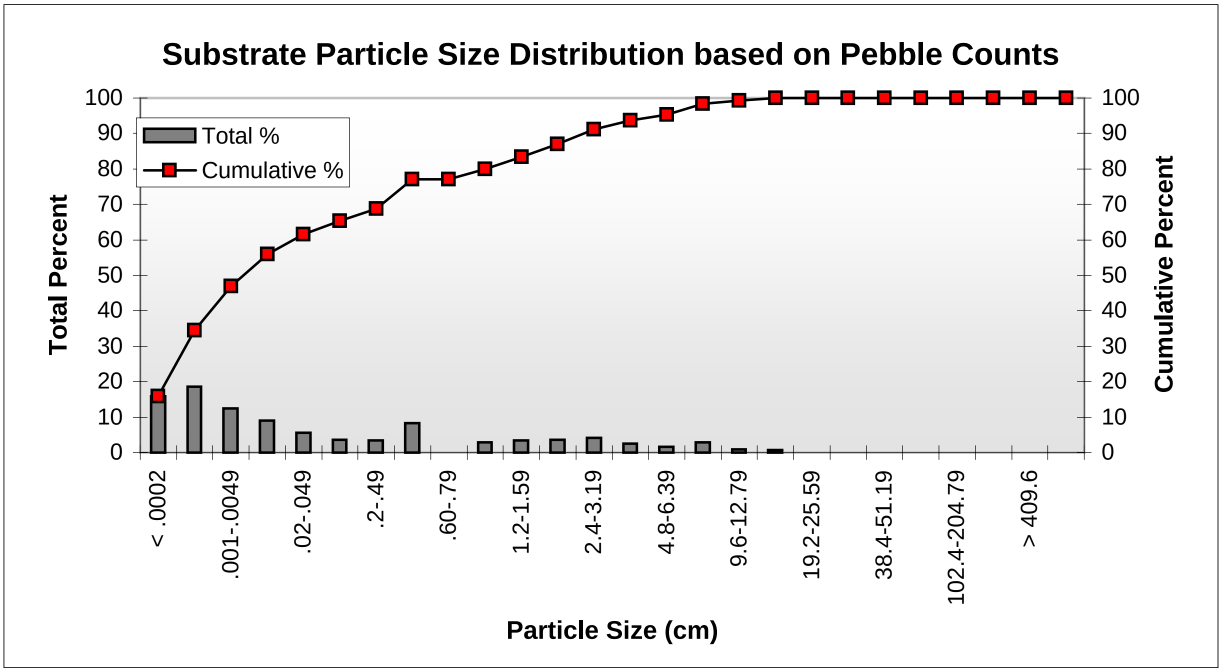
Particle Shape (cm)		**Range**	**Average**
	X	1.5 - 14	5.95
	Y	1.5 - 9	4.48
	Z	0.5 - 7	2.88
Hydraulic Roughness (cm)			
	Maximum	0.25 - 9	3.43
	Median	0.10 - 3.0	0.95
	Minimum	0.0 - 0.25	0.09
Embeddedness (%)		5-95	43

Sub-pavement

Part. Size	**% of subpavement on site**	**Part. Size**	**% of subpavement on site**
cl	37.8	**P**	5.2
si	17	**1 cm**	0
vfs	13.7	**2 cm**	0
fs	8.4	**3 cm**	0
ms	7.0	**4 cm**	0
cs	4.7	**5 cm**	0
vcs	6.2		

Particle Sizes (cm)

	Pebble Counts
D10	NaN
D50	0.006
D84	1.5
D90	2.6



Field Observations

Site 1 has an eroded right bank with exposed Willow tree roots.
The banks of Site 2 contain dune grasses.
Site 3 has a right bank that is higher and more vertical with the thalweg by it.
Site 4 is at the top of a riffle containing a mid channel vegetation bar with stagnant water towards right bank.
Site 5 is a pool area with eroded vertical faced banks.
Site 6 is at the bottom of a pool on a bend with a higher right bank than the left bank.
Site 7 is a the top of a riffle and contains mid channel grasses.
Site 8 is a pool area with a fine substrate.
Site 9 is a riffle area on a bend with the thalweg flowinf towards the right bank.
Site 10 is within a riffle with herbs and grass laying across the channel.

FLUVIAL GEOMORPHOLOGY SUMMARY

Stream - Reach #   North Oakville West 16WA-1

Location: Upstream of Dundas Street

Length surveyed: 59.25 meters
Number of cross-sections: 10
Date of Survey: 21-Jul-03

Controlling Factors

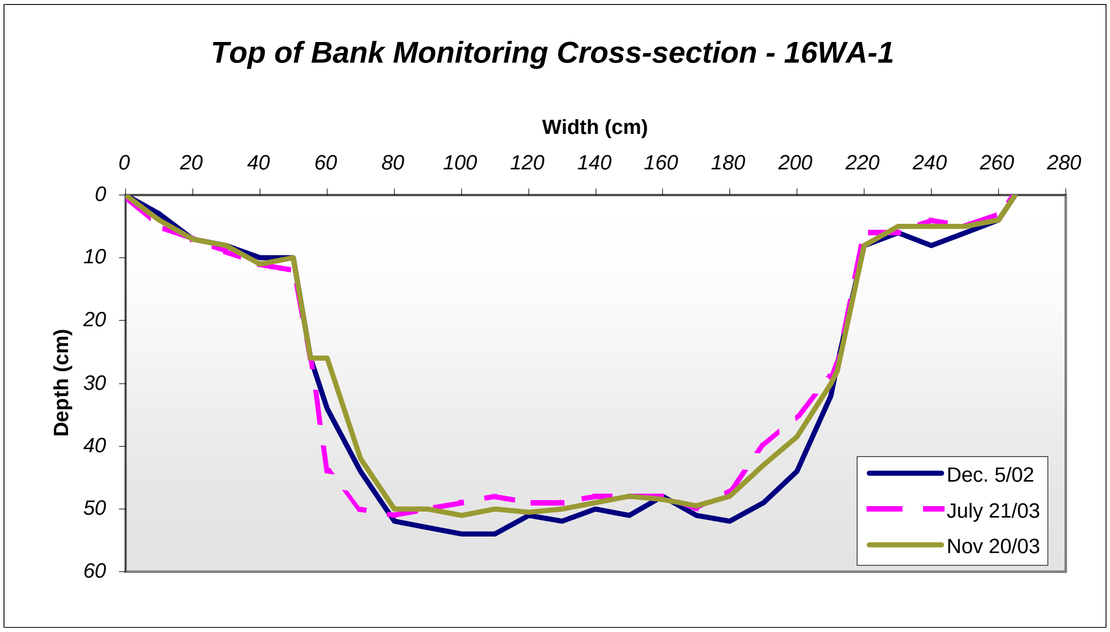
Geology / Soils: Halton Till

Modifying Factors

Surrounding Land Use: Scrublanc
General Riparian Vegetation: Tall and short herbs and grasses, some shrubs and tree
Existing Channel Disturbances: Dundas Street crossin
Woody Debris: none to minor

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	1.29-2.55	1.87
Bankfull Depth (m)	0.21-0.32	0.26
Width / Depth	4.45-11.18	7.47
Wetted Width (m)	n/a	n/a
Water Depth (m)	n/a	n/a
Width / Depth	n/a	n/a
Entrenchment (m)	6.76-21.65	15.54
Entrenchment Ratic	4.59-13.12	8.11
Manning's r		0.035



Top of Bank Monitoring Cross-section - 16WA-1

Bank Characteristics

	Range	Average	
Bank Height (m)	0.35-1.50	0.60	
Bank Angle (degrees)	9-90	53.0	
Root Depth (cm)	3-22	10.3	
Root Density ***(1=Low - 5=High)***	1-4	2.4	*(Category)*
Protected by vegetation (%)	5-30	8.3	
Amount of undercut (cm)	11-32	17	
Banks with undercuts (%)		25%	

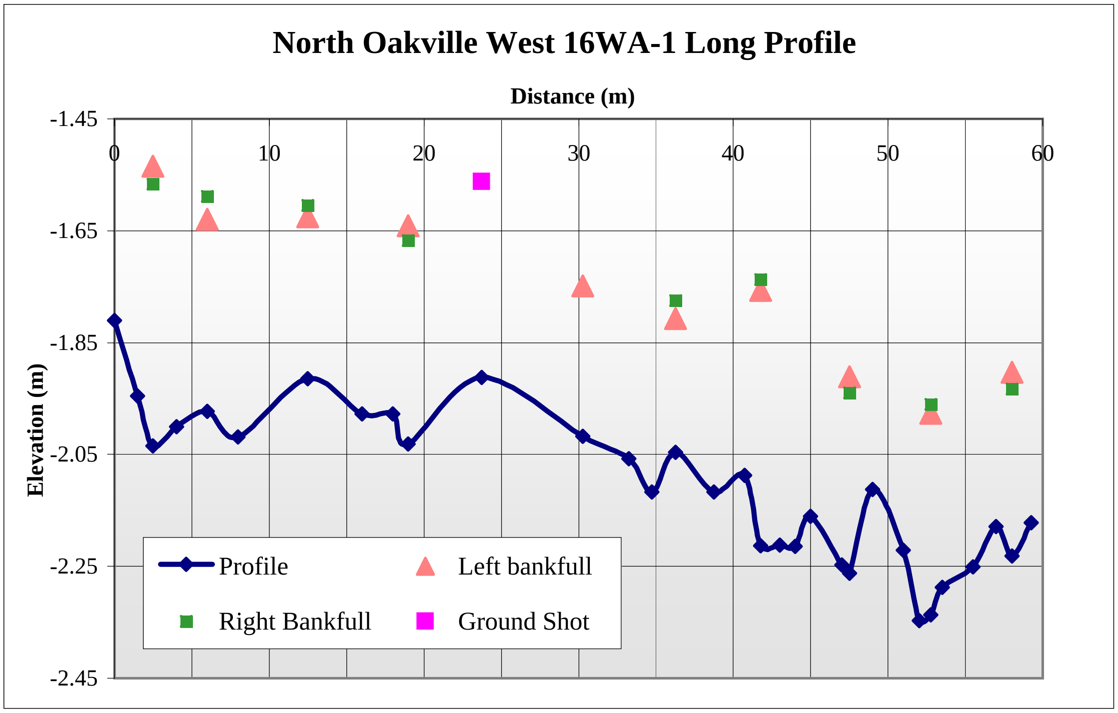
Materials		**Torvane values (kg/cm2)**
cl/si		0.24
cl	*	0.31
si/vfs		0.10
si/vfs/cl		0.15

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.66	%
Inter-Pool Gradient	n/a	%
Inter-Riffle Gradient	n/a	%
Riffle Gradient	n/a	%
Riffle Length	n/a	m
Riffle-Pool Spacing	n/a	m
Max Pool Depth	n/a	m


North Oakville West 16WA-1 Long Profile

Substrate Characteristics

Particle Shape (cm)

	Range	Average
X	2-26	10.92
Y	1.5-22	7.8
Z	0.5-10.5	2.72

Hydraulic Roughness (cm)

Maximum	1-8	5.05
Median	0.25-1.0	0.53
Minimum	0	0

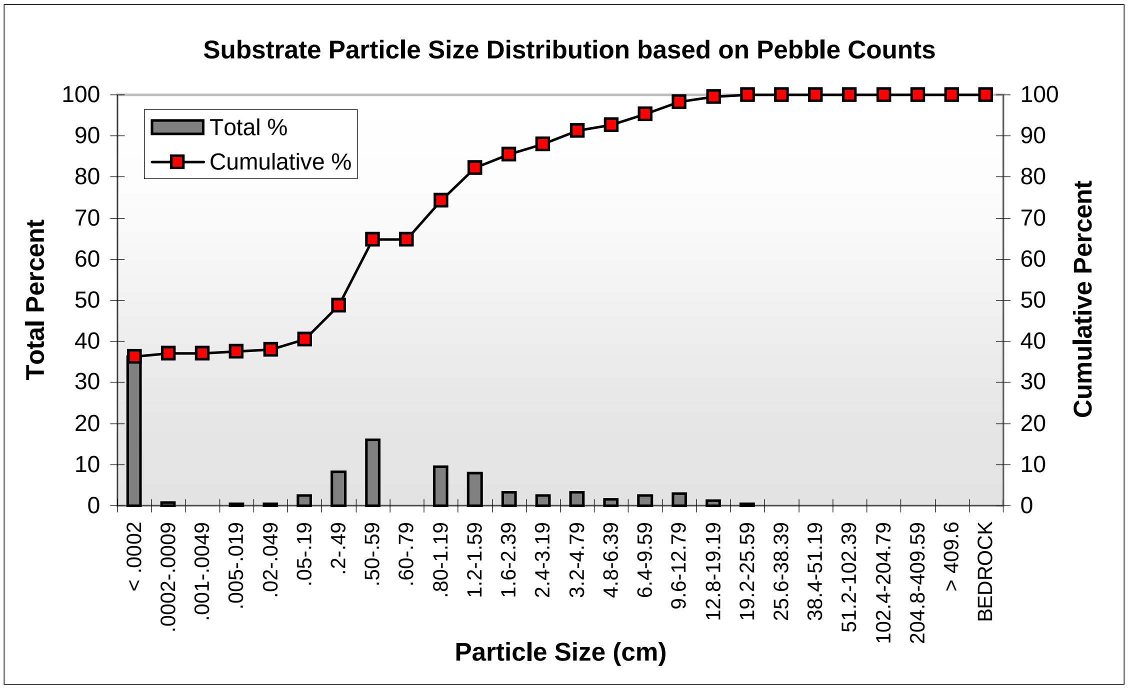
Embeddedness (%)	20-100	52.00

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	100.00	P	--
si	--	1 cm	--
vfs	--	1.5cm	--
fs	--	2 cm	--
ms	--	3 cm	--
cs	--	4 cm	--
vcs	--	bedrock	--

Particle Sizes (cm)

	Pebble Counts
D10	Nan
D50	0.36
D90	3.53



Field Observations

- Dry channel
- Exposed clay till subpavement
- Exposed treet roots
- Vertical, eroded banks
- Dense vegetation on banks
- Island formation

FLUVIAL GEOMORPHOLOGY SUMMARY

Joshua Creek - JC-13

Location:	Downstream of Burnhamthorpe Road between Trafalgar Road and Ninth Line
Length surveyed:	173.0m
Number of cross-sections:	10
Date of Survey:	June 7/02

Controlling Factors

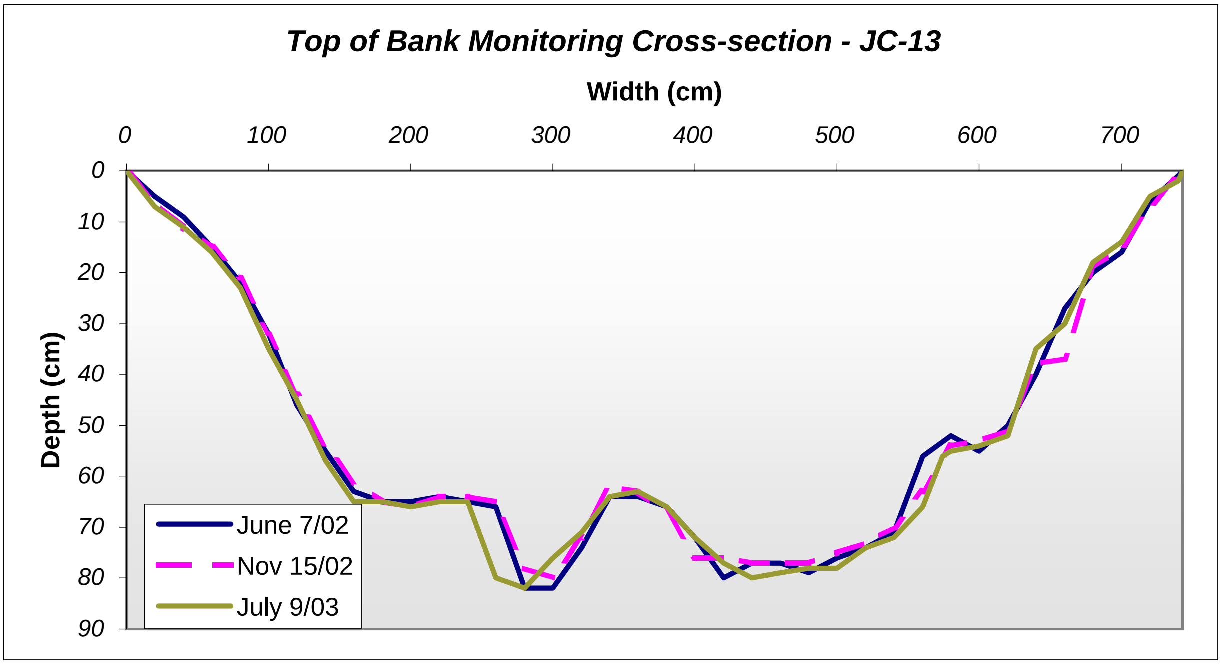
Geology / Soils:	underlain by Glacial Till

Modifying Factors

Surrounding Land Use:	grass meadow and scrub forest
General Riparian Vegetation:	tall herbaceous vegetaition, shrubs, trees
Existing Channel Disturbances	the reach appears straightened
Woody Debris:	minor woody debris

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.06-5.0	2.92
Bankfull Depth (m)	0.159-0.324	0.24
Width / Depth	6.75-27.30	13.00
Wetted Width (m)	0.63-2.6	1.34
Water Depth (m)	0.019-0.213	0.09
Width / Depth	5.49-124.74	31.80
Entrenchment (m)	6.58-9.42	8.15
Entrenchment Ratio	1.58-4.16	2.97
Manning's n		0.03



Top of Bank Monitoring Cross-section - JC-13

PARISH Geomorphic Ltd.

Hydrology

Measured **Discharge (cms)** 0.03 (upstream end of reach at road crossing)

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1.5	0.7	
Bank Angle (degrees)	13-80	39.5	
Root Depth (cm)	4.0-15	8.3	
Root Density ***(1=Low - 5=High)***	n/a	n/a	*(Ranking)*
Protected by vegetation (%)	40-90	76.5	
Amount of undercut (cm	12	12	
Banks with undercuts (%	5%		

Materials	**Torvane values (kg/cm2)**	
cl/vfs/si	0.24	
sl/si/vfs	0.32	
*clay	0.32	* = dominant material
cl/cs	0.24	
cl/vfs	0.3	
cl/si	0.34	
vcs/cs/cl	0.23	
cl/cs/si	0.15	

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.65	%
Inter-Pool Gradient	0.59	%
Inter-Riffle Gradient	0.88	%
Riffle Gradient	3.34	%
Riffle Length	2.96	m
Riffle-Pool Spacing	8.78	m
Max Pool Depth	0.25	m

Substrate Characteristics

Particle Shape (cm)		Range	Average
	X	2.0-19	5.26
	Y	1.0-12	3.76
	Z	0.5-6	1.74
Hydraulic Roughness (cm)			
	Maximum	0-6	1.9
	Median	0-1.5	0.4
	Minimum	0-0.3	0
Embeddedness (%)		20-100	73

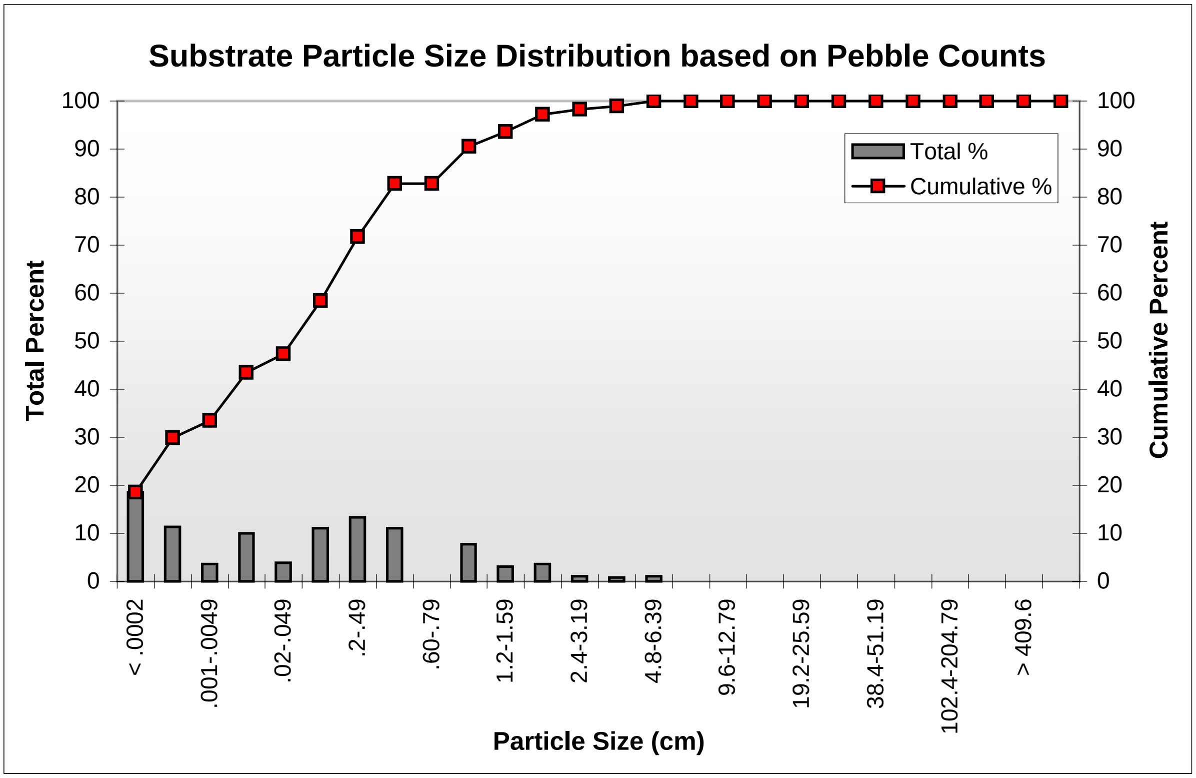
Sub-pavement

Part. Size	**% of subpavement on site**
cl	318
si	17.3
vfs	5
fs	11.4
ms	1.8
cs	10.5
vcs	11.8

Part. Size	**% of subpavement on site**
P	6.4
1 cm	3.2
1.5cm	0
2 cm	0.5
3 cm	0.5
4 cm	0
5 cm	0

Particle Sizes (cm)

	Pebble Counts
D10	< 0.0002
D50	0.083
D90	1.16


Substrate Particle Size Distribution based on Pebble Counts

Field Observations

- narrow entrenched channel
- straight sections
- dense grasses on some banks
- deposition in the centre o fthe channel at some cross-sections
- water was turbid
- grasses in channel
- channel splitting observed

FLUVIAL GEOMORPHOLOGY SUMMARY

Joshua Creek - JC3

Location: main channel of Joshua Creek upstream of Dundas, northwest of cemetery
Length surveyed: 180m
Number of cross-sections: 10
Date of Survey: June 6/02

Controlling Factors

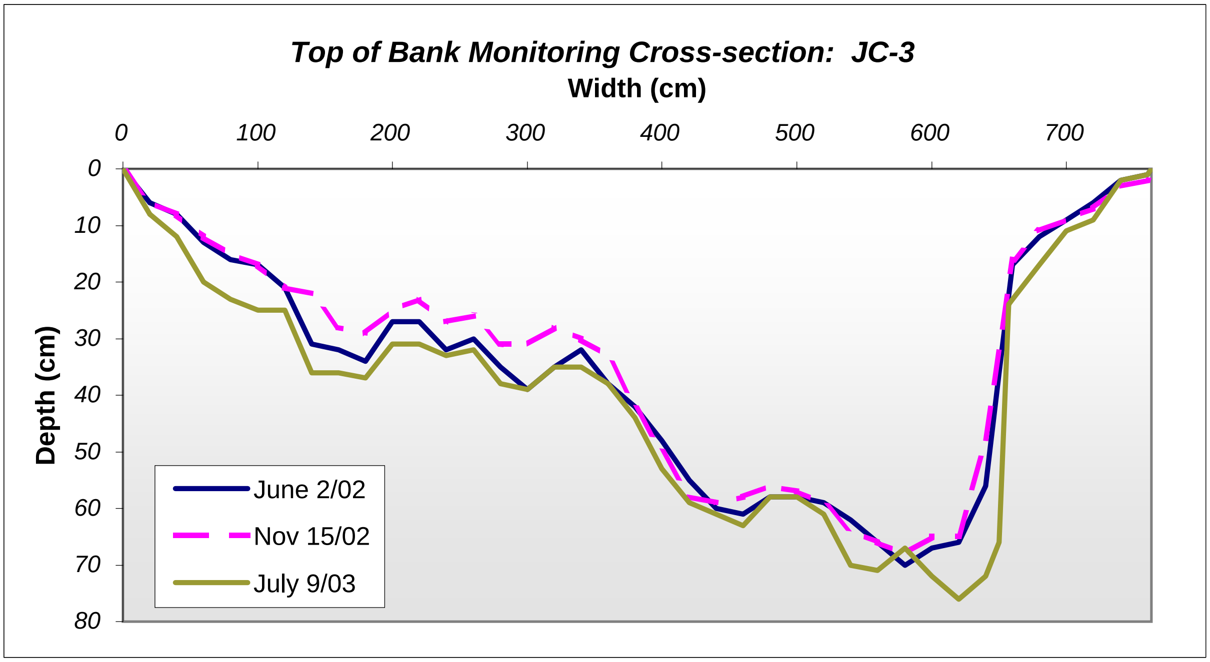
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: scrubforest
General Riparian Vegetation: tall herbaceous vegetation, shrubs, trees
Existing Channel Disturbances none
Woody Debris: moderate amount of woody debris

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	3.58-7.86	4.99
Bankfull Depth (m)	0.204-0.516	0.31
Width / Depth	7.54-38.53	17.90
Wetted Width (m)	0.95-3.37	2.39
Water Depth (m)	0.038-0.341	0.14
Width / Depth	6.74-71.05	28.93
Entrenchment (m)	12.58-22.86	17.17
Entrenchment Ratio	2.31-4.45	3.58
Manning's n		0.033


Top of Bank Monitoring Cross-section: JC-3

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1	0.6	
Bank Angle (degrees)	12.0-84	51.8	
Root Depth (cm)	7.0-46	17.1	
Root Density ***(1=Low - 5=High)***			*(Ranking)*
Protected by vegetation (%)	40-85	71.3	
Amount of undercut (cm	5.0-18	11.9	
Banks with undercuts (%	40		

Materials	**Torvane values (kg/cm2)**
*cl/si	0.27
cl/si/vfs	0.37
si/vfs/cl	0.27
cl/fs/vfs	0.35
cl/fs	0.22
cl/vfs	0.14
clay	0.30
cl/si/fs	0.18

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.70	%
Inter-Pool Gradient	1.25	%
Inter-Riffle Gradient	0.95	%
Riffle Gradient	4.84	%
Riffle Length	4.68	m
Riffle-Pool Spacing	8.91	m
Max Pool Depth	0.32	m

Substrate Characteristics

Particle Shape (cm)		**Range**	**Average**
	X	5.5-25	13
	Y	4.0-22	9.5
	Z	0.3-8	2.41
Hydraulic Roughness (cm)			
	Maximum	0.3-22	6.5
	Median	0-2	1.2
	Minimum	0-.5	0.2
Embeddedness (%)		5-100	34

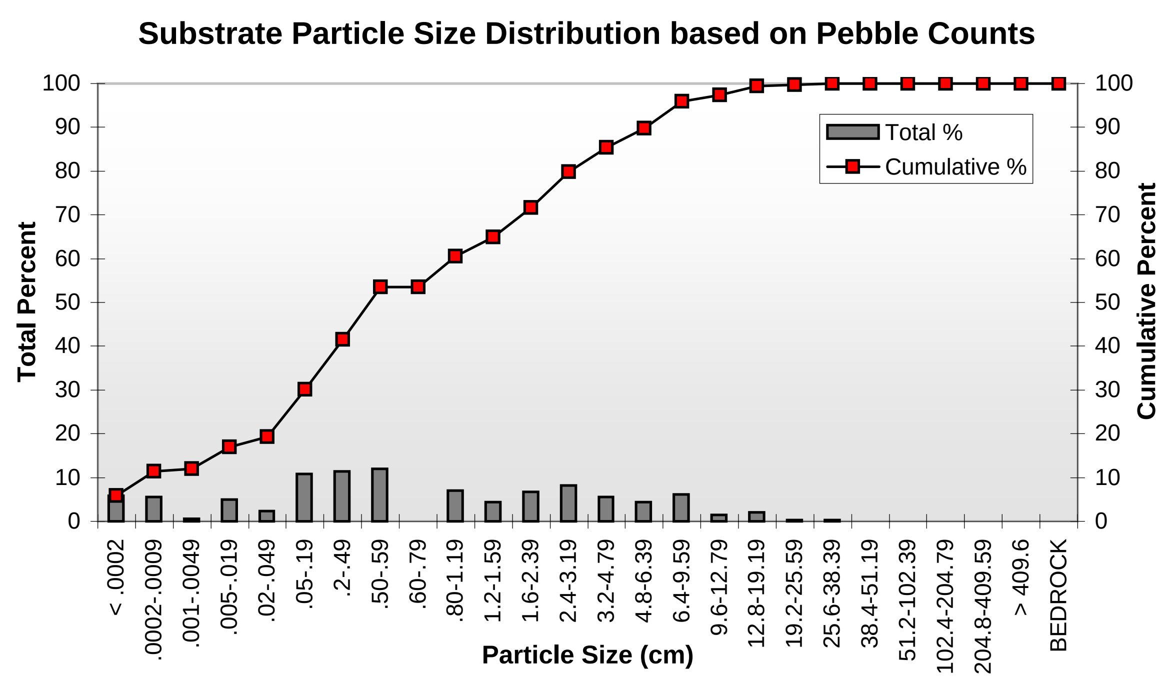
Sub-pavement

Part. Size	% of subpavement on site
cl	2.3
si	3.2
vfs	*3.2*
fs	*5.9*
ms	*2.3*
cs	*6.4*
vcs	*6.8*

Part. Size	% of subpavement on site
P	5.9
1 cm	5.5
1.5cm	2.7
2 cm	1.4
3 cm	n/a
4 cm	n/a
5 cm	n/a

Particle Sizes (cm)

	Pebble Counts
D10	0.0007
D50	0.56
D90	6.51



Field Observations

- grasses in channel
- high flow channel observed on different sides of the channel along reach
- bedrock exposed at several cross-sections
- significant bank erosion
- macrophytes in channel
- vegetation growing on mid-channel deposit
- sections very depositional

FLUVIAL GEOMORPHOLOGY SUMMARY

Morrison Creek - MOC-4

Location: North of Dundas Road at Trafalgar Road
Length surveyed: 169 m
Number of cross-sections: 10
Date of Survey: 12-Jun-02

Controlling Factors

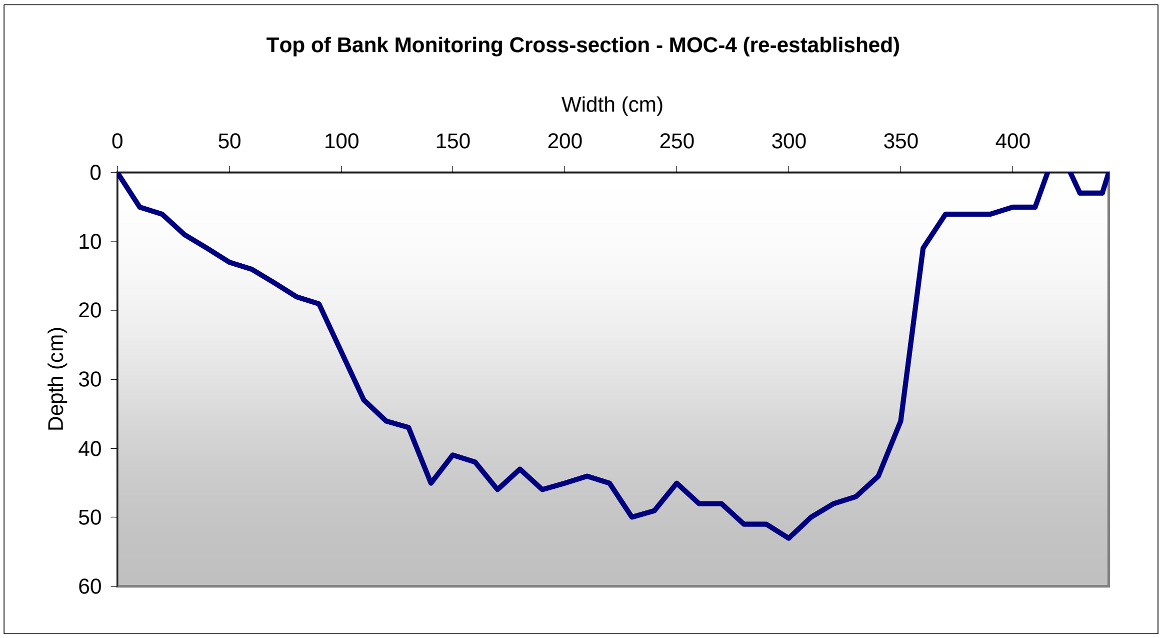
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: agricultural land
General Riparian Vegetation: tall grasses and herbs, shrubs and trees
Existing Channel Disturbances culvert at upstream end, previously straightened
Woody Debris: minor

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.45-3.69	3.14
Bankfull Depth (m)	0.212-0.347	0.26
Width / Depth	9.18-17.41	12.25
Wetted Width (m)	0.59-2.0	1.29
Water Depth (m)	0.33-0.101	0.06
Width / Depth	10.11-51.47	25.72
Entrenchment (m)	11.69-20.53	14.19
Entrenchment Ratio	3.17-7.12	4.61
Manning's n		0.033



Top of Bank Monitoring Cross-section - MOC-4 (re-established)

Hydrology

Measured **Discharge (cms)** 0.55

Bank Characteristics

	Range	**Average**	
Bank Height (m)	0.4-1.2	0.6	
Bank Angle (degrees)	19-61	34.3	
Root Depth (cm)	7.0-25	15.5	
Root Density ***(1=Low - 5=High)***	1.0-3.0	2.4	*(Ranking)*
Protected by vegetation (%)	20-80	46.8	
Amount of undercut (cm		0	
Banks with undercuts (%		0%	

Materials	**Torvane values (kg/cm2)**
*clay	0.28
cl/si	0.26
si/cl	0.27

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.60	%
Inter-Pool Gradient	2.74	%
Inter-Riffle Gradient	0.74	%
Riffle Gradient	2.45	%
Riffle Length	6.08	m
Riffle-Pool Spacing	19.5	m
Max Pool Depth	0.12	m

Substrate Characteristics

Particle Shape (cm)		**Range**	**Average**
	X	3-31.5	8.18
	Y	2.0-19	5.64
	Z	0.25-4	1.46
Hydraulic Roughness (cm)			
	Maximum	0-8	2.2
	Median	0-0.5	0.1
	Minimum	0	0
Embeddedness (%)		20-100	76.6

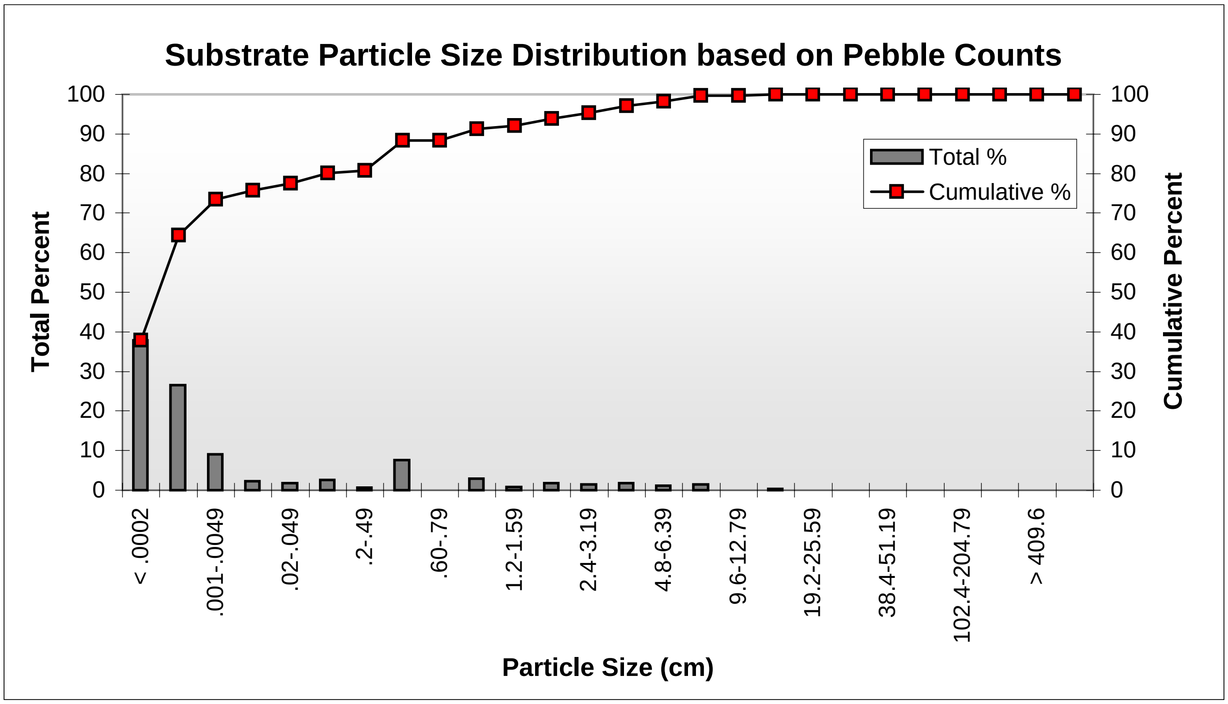
Sub-pavement

Part. Size	**% of subpavement on site**
cl	72.5
si	13.8
vfs	1.3
fs	0
ms	0
cs	0
vcs	0

Part. Size	**% of subpavement on site**
P	0
1 cm	0
1.5cm	0
2 cm	0
3 cm	0
4 cm	0
5 cm	0
bedrock	12.5

Particle Sizes (cm)

	Pebble Counts
D10	<0.0002
D50	0.00052
D90	1.02



Field Observations

subpavement - large, chunky pieces of shale surrrounded by silt and clay
- shale within silt and clay

- in channel vegetation was dense (cattails)
- banks exposd below bankfull
- exposed tree roots along portions of the reach
- poorly defined morphology

Photo 1. Reach JC-1 at bank erosion.

Photo 2. Reach JC-1 at bank erosion.

Photo 1. Reach JC-2 at golf course.

Photo 2. Reach JC-2 at wide pool.

Photo 1. Reach JC-3 at bank erosion.

Photo 2. Reach JC-3 at channel.

Photo 1. Reach JC-4 with fallen and leaning trees.

Photo 1. Reach JC-5 with accretion on point bars.

Photo 1. Reach JC-6 with formation of chutes.

Photo 1. Reach JC-7 general channel conditions.

Photo 1. Reach JC-8 densely vegetated channel.

Photo 1. Reach JC-9 grassed channel between agricultural fields.

Photo 1. Reach JC-10 grassed channel between agricultural fields.

Photo 1. Reach JC-11 straight channel with evidence of cattle grazing.

Photo 1. Reach JC-12 depression in field.

Photo 1. Reach JC-13 with slumping banks.

Photo 1. Reach JC-19 with leaning and fallen trees.

Photo 2. Reach JC-19 in woodlot.

Photo 1. Reach JC-20 with poor bed morphology.

Photo 1. Reach JC-21 – dry, grassed channel.

Photo 1. Reach JC-22 general channel conditions.

Photo 1. Reach JC-25 vegetated swale.

Photo 1. Reach JC-30 general conditions.

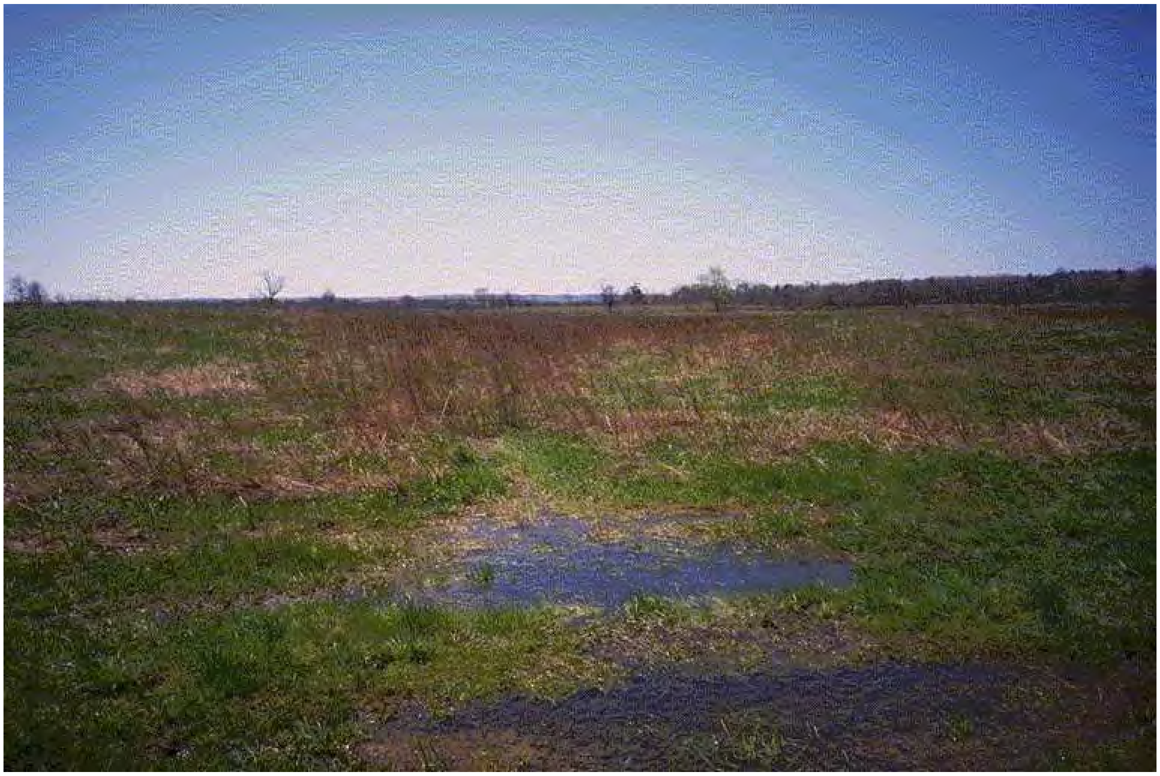


Photo 1. Reach MOC-2 general conditions at upstream extent of reach.

Photo 2. Reach MOC-2 at Trafalgar Road.

Photo 1. Reach MOC-4 densely vegetated channel.

Photo 2. Reach MOC-4 densely vegetated channel.

Photo 1. Reach MOC-W3 agricultural drain.

Photo 2. Reach MOC-W3 agricultural drain.

Photo 1. Reach SHC-1 swale.

Photo 1. Reach SHC-2 swale.

Photo 1. Reach SHC-3 swale.

Photo 1. Reach MOC-W1 looking downstream from 6th Line culvert.

Photo 1. Reach MOC-W2 looking upstream from 6th Line.

Photo 1. Reach 14W-17 and 14W-16a looking downstream from Tremaine.

Photo 2. Reach 14W-17 and 14W-17a looking downstream from Tremaine.

Photo 1. Reach JC-35 looking downstream towards golf course.

Photo 2. Reach JC-35 looking downstream towards golf course.

Photo 1. Reach JC-31 looking upstream from Dundas ditch.

Photo 2. Reach JC-31 looking upstream at swale.

Photo 1. Reach JC-32 looking upstream at sight.

Photo 1. Reach JC-36 general conditions.

Photo 2. Reach JC-36 looking upstream.

Photo 3. Reach JC-36 looking downstream.

Photo 4. Reach JC-36 banks and substrate.

Photo 1. Reach SMA-1 bank erosion.

Photo 2. Reach SMA-1 valley wall contact.

Photo 1. Reach SMA-2 general conditions.

Photo 2. Reach SMA-2 general conditions.

Photo 3. Reach SMA-2 at culvert.

Photo 1. Reach SMA-3 general conditions.

Photo 1. Reach SMA-4 general conditions.

Photo 2. Reach SMA-4 general conditions.

Photo 3. Reach SMA-4 general conditions.

Photo 1. Reach SMA-5 general conditions.

Photo 2. Reach SMA-5 general conditions.

Photo 1. Reach SMA-6 general conditions.

Photo 2. Reach SMA-6 general conditions.

Photo 1. Reach SMA-7 general conditions.

Photo 2. Reach SMA-7 general conditions.

Photo 3. Reach SMA-7 general conditions.

Photo 1. Reach SMA-8 general conditions.

Photo 2. Reach SMA-8 general conditions.

Photo 1. Reach SMA-9 general conditions.

Photo 1. Reach SMB-1 general conditions.

Photo 2. Reach SMB-1 general conditions.

Photo 1. Reach SMB-2 general conditions.

Photo 2. Reach SMB-2 general conditions.

Photo 1. Reach SMB-3 general conditions.

Photo 2. Reach SMB-3 general conditions.

Photo 1. Reach SMB-4 general conditions.

Photo 2. Reach SMB-4 general conditions.

Photo 1. Reach SMC-1 general conditions.

Photo 2. Reach SMC-1 general conditions.

Photo 1. Reach SMC-2 general conditions.

Photo 2. Reach SMC-2 general conditions.

Photo 1. Reach SMC-3 general conditions.

Photo 2. Reach SMC-3 general conditions.

Photo 1. Reach SMC-4 general conditions.

Photo 1. Reach SMC-5 general conditions.

Photo 1. Reach 14W-11 downstream portion of reach

Photo 2. Reach 14W-11 large pool.

Photo 3. Reach 14W-11a looking upstream at 407.

Photo 4. Reach 14W-11a looking upstream at 407.

Photo 5. Reach 14W-11 looking upstream (mid-reach).

Photo 1. Reach 14E-1 looking downstream towards pond.

Photo 1. Reach 14E-2 swale.

Photo 1. Reach 14E-4 swale.

Photo 1. Reach 14E-5 general conditions.

Photo 1. Reach 14E-6 looking upstream.

Photo 2. Reach 14E-6 looking upstream.

Photo 1. Reach 14E-7 general conditions.

Photo 2. Reach 14E-7 general conditions.

Photo 1. Reach MC-1 general conditions.

Photo 2. Reach MC-1 general conditions.

Photo 3. Reach MC-1 general conditions.

Photo 1. Reach MC-3 general conditions - swale.

Photo 1. Reach MC-4 general conditions.

Photo 2. Reach MC-4 general conditions.

Photo 1. Reach 16WA-1 general conditions.

Photo 2. Reach 16WA-1 general conditions.

Photo 3. Reach 16WA-1A general conditions.

Photo 1. Reach 16WA-2 general conditions.

Photo 1. Reach 16WA-3 general conditions.

Photo 1. Reach 16WA-4 general conditions.

Photo 1. Reach 16WA-5 general conditions.

Photo 1. Reach 16WA-6 general conditions.

Photo 1. Reach 16WA-7 general conditions.

Photo 2. Reach 16WA-7 general conditions.

Photo 1. Reach 16WA-8 collapsed culvert.

Photo 8. Reach 16WA-8 general conditions.

Photo 1. Reach GO-1 (formerly GO-10) general conditions.

FLUVIAL GEOMORPHOLOGY SUMMARY

Sixteen Mile Creek Trib. - SMA-4

Location: upstream of Neyagawa Drive across from the landfill
Length surveyed: 157.5m
Number of cross-sections: 10
Date of Survey: 12-Jun-02

Controlling Factors

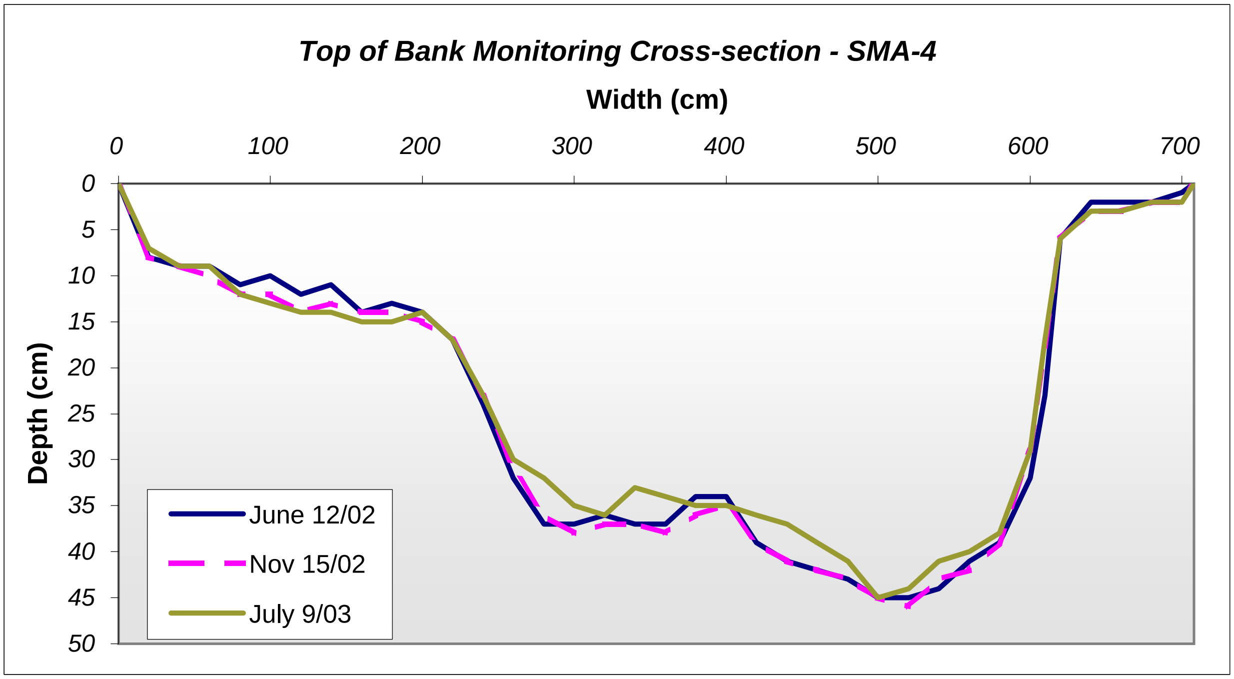
Geology / Soils: underlain by Glacial Till

Modifying Factors

Surrounding Land Use: deciduous forest
General Riparian Vegetation: Short grass, tall herbs, shrubs, and trees (Maple, Oak, Hickory)
Existing Channel Disturbances culvert
Woody Debris: large amount of organic debris

Cross-Sectional Characteristics

	Range	**Average**
Bankfull Width (m)	2.67-7.8	4.58
Bankfull Depth (m)	0.177-0.309	0.26
Width / Depth	9.11-44.07	18.79
Wetted Width (m)	0.43-1.75	0.90
Water Depth (m)	0.01-0.078	0.05
Width / Depth	10.86-43.00	21.48
Entrenchment (m)	19.78-36.20	25.18
Entrenchment Ratic	3.05-9.61	5.84
Manning's r		0.033



Top of Bank Monitoring Cross-section - SMA-4

Bank Characteristics

	Range	Average	
Bank Height (m)	0.4-1.3	0.8	
Bank Angle (degrees)	11.0-70	32.6	
Root Depth (cm)	8.0-53	21.4	
Root Density ***(1=Low - 5=High)***	2.0-4.0	2.7	*(Ranking)*
Protected by vegetation (%)	10.0-70.0	32.8	
Amount of undercut (cm)	10.0-20.0	15	
Banks with undercuts (%)		10%	

Materials	**Torvane values (kg/cm2)**
*cl/si	0.26
si	0.11
si/cl	0.17
clay	0.41

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.55	%
Inter-Pool Gradient	0.68	%
Inter-Riffle Gradient	0.96	%
Riffle Gradient	3.34	%
Riffle Length	4.27	m
Riffle-Pool Spacing	9.04	m
Max Pool Depth	0.13	m

Substrate Characteristics

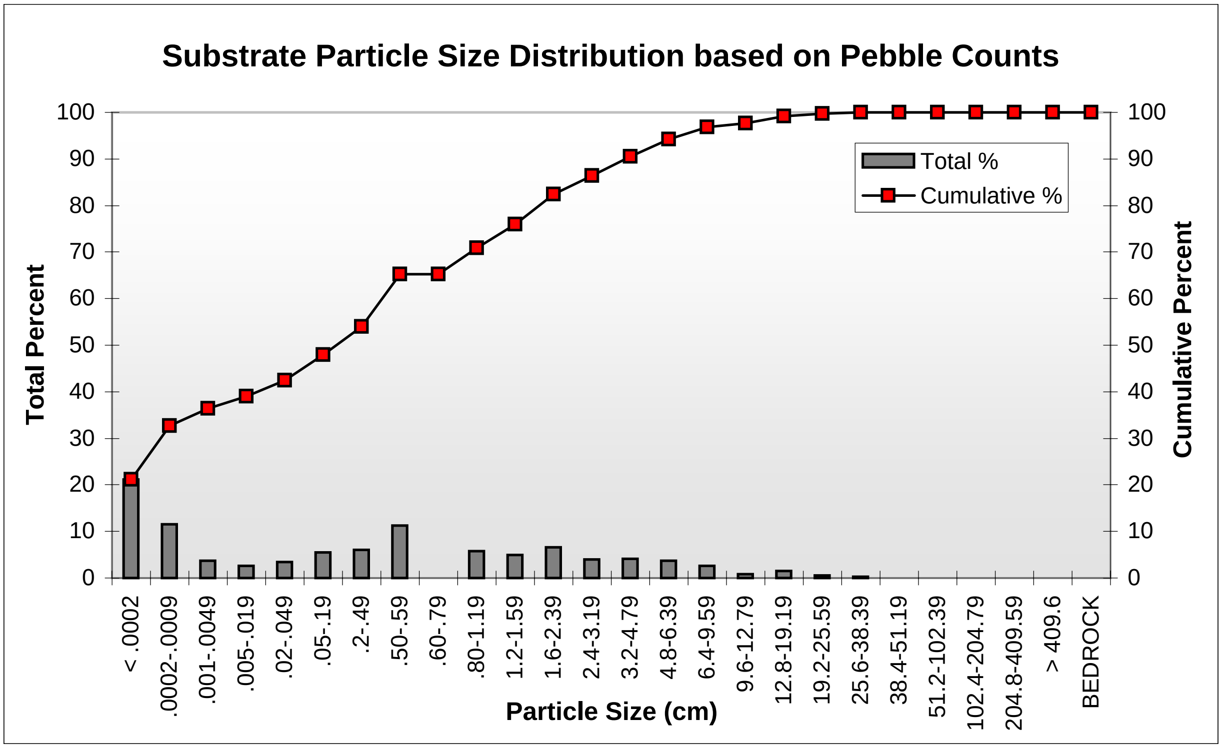
Particle Shape (cm)		Range	Average
	X	2.5-26	7.58
	Y	1.5-15	5.13
	Z	0.5-2.5	1.44
Hydraulic Roughness (cm)			
	Maximum	0-14	3.7
	Median	0-3	0.8
	Minimum	0-0.3	0.1
Embeddedness (%)		30-100	65.5

Sub-pavement

Part. Size	**% of subpavement on site**	**Part. Size**	**% of subpavement on site**
cl	64.4	**P**	5
si	2.8	**1 cm**	1.1
vfs	1.7	**1.5cm**	0
fs	2.2	**2 cm**	1.1
ms	2.2	**3 cm**	0
cs	3.3	**4 cm**	0
vcs	5	**5 cm**	0
		Bdr.	11.1

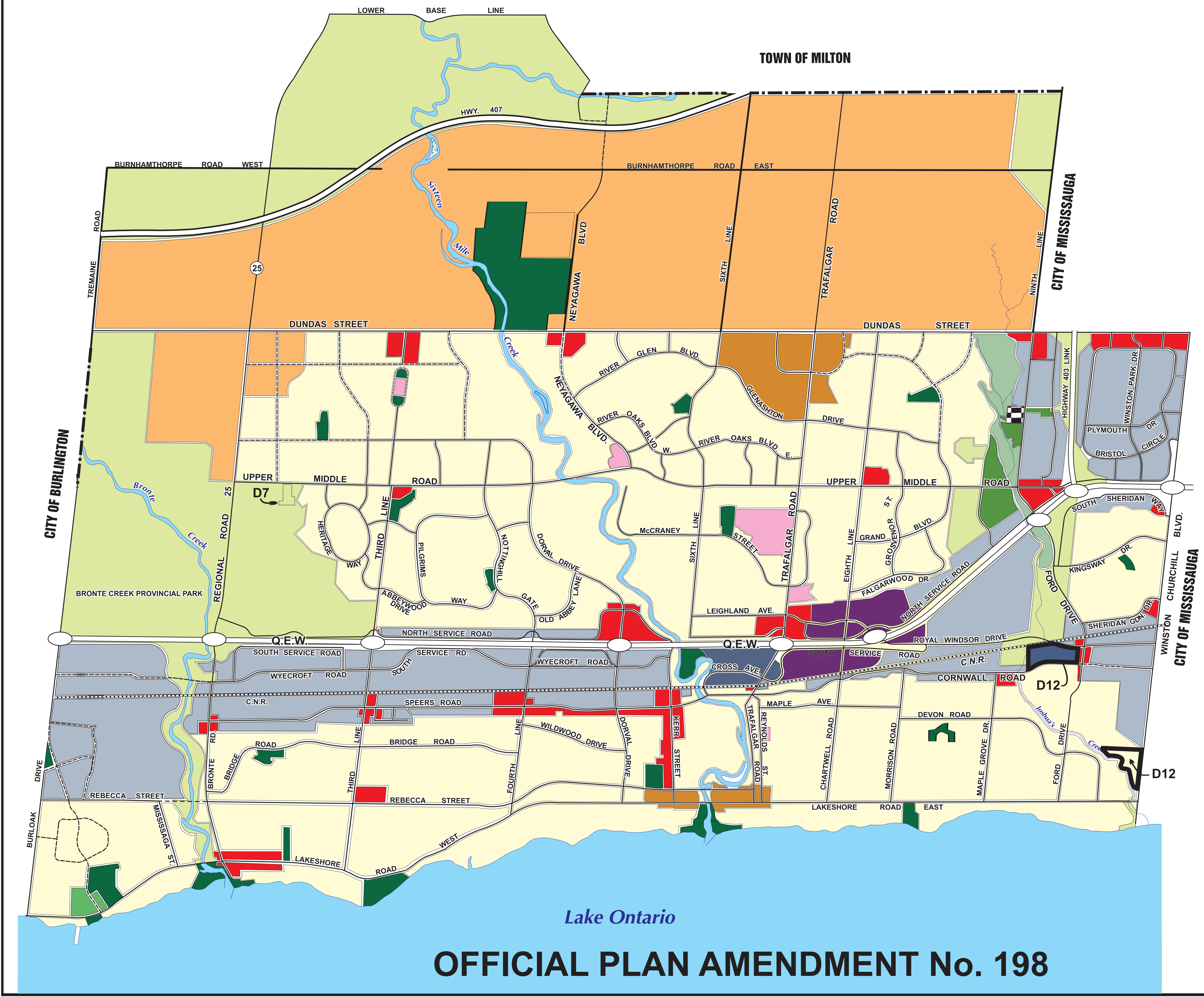
Particle Sizes (cm)

	Pebble Counts
D10	< 0.0002
D50	0.29
D90	4.57



Field Observations

- vegetaion (herbaceous material) in the channel
- high flow channel behind right bank
- coarse material was embedded in clay/silt, some coarse material was shale
- large chunks of shale on bed at some cross-sections
- stagnant water at some locations



OFFICIAL PLAN AMENDMENT No. 198

Legend

- ▭ Urban Residential
- 🟦 Mixed Use
- 🟪 Employment
- 🟥 Commercial (excluding most NCC and CCC designations)
- ▩ Industrial
- 🟧 Central Business District and Uptown Business Core
- ▩ Institutional
- 🟩 Parkland (over 6ha)
- 🟩 Private Open Space
- 🟩 Open Space/Utility Corridor
- ▥ Transportation Centre
- ▩ Parkway Belt
- ▦ Former Sanitary Landfill Site/ Waste Disposal Assessment Area
- 🟧 Urban Special Study Area
- 🟩 Waterfront Complementary Area
- ⬭ Interchange

NOTE: This figure forms part of the Official Plan and must be read together with the text and the accompanying tables at the front of this document.

GENERAL LAND USE

FIGURE B

Town of Oakville
Official Plan

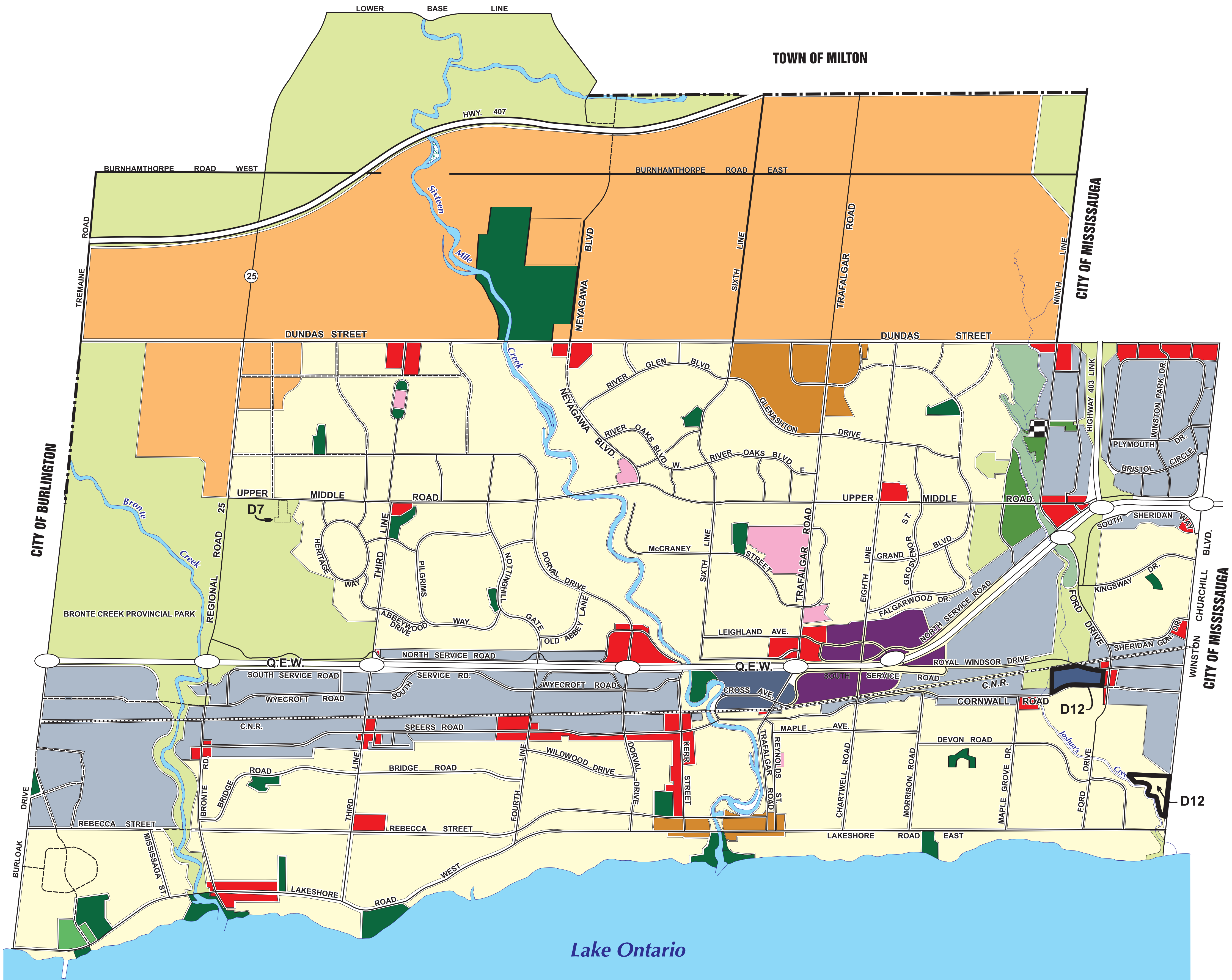
Planning Services Department
Corporate Drafting & Design Office

February 2002

NORTH

0 500 1000 1500 2000 2500

SCALE IN METRES



OFFICIAL PLAN AMENDMENT No. 198

Legend

- 🟨 Urban Residential
- 🟦 Mixed Use
- 🟪 Employment
- 🟥 Commercial (excluding most NCC and CCC designations)
- ⬜ Industrial
- 🟧 Central Business District and Uptown Business Core
- 🟪 Institutional
- 🟩 Parkland (over 6ha)
- 🟩 Private Open Space
- 🟩 Open Space/Utility Corridor
- ▥ Transportation Centre
- 🟨 Parkway Belt
- ▦ Former Sanitary Landfill Site/ Waste Disposal Assessment Area
- 🟧 Urban Special Study Area
- 🟩 Waterfront Complementary Area
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NOTE: This figure forms part of the Official Plan and must be read together with the text and the accompanying tables at the front of this document.

GENERAL LAND USE

FIGURE B

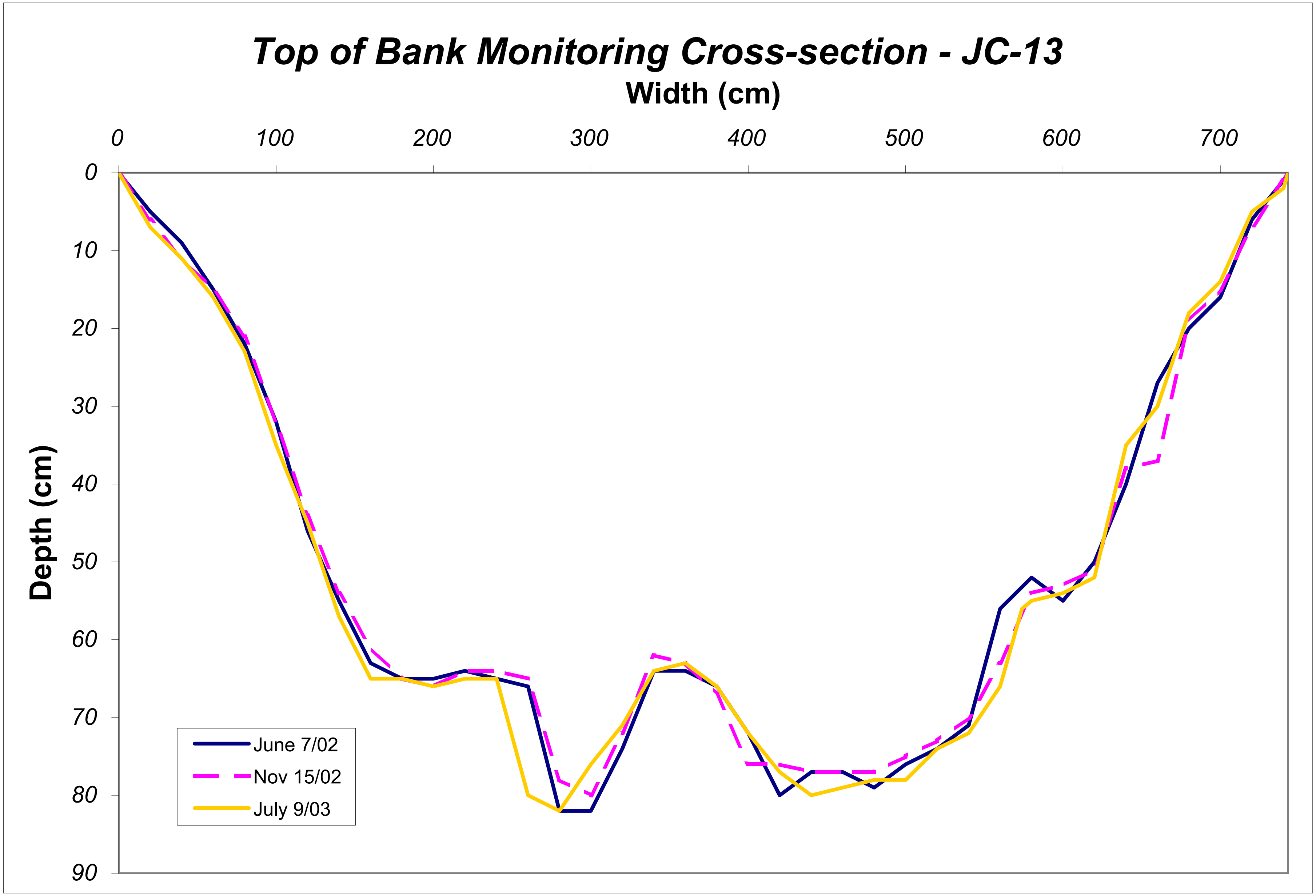
NORTH

Town of Oakville
Official Plan

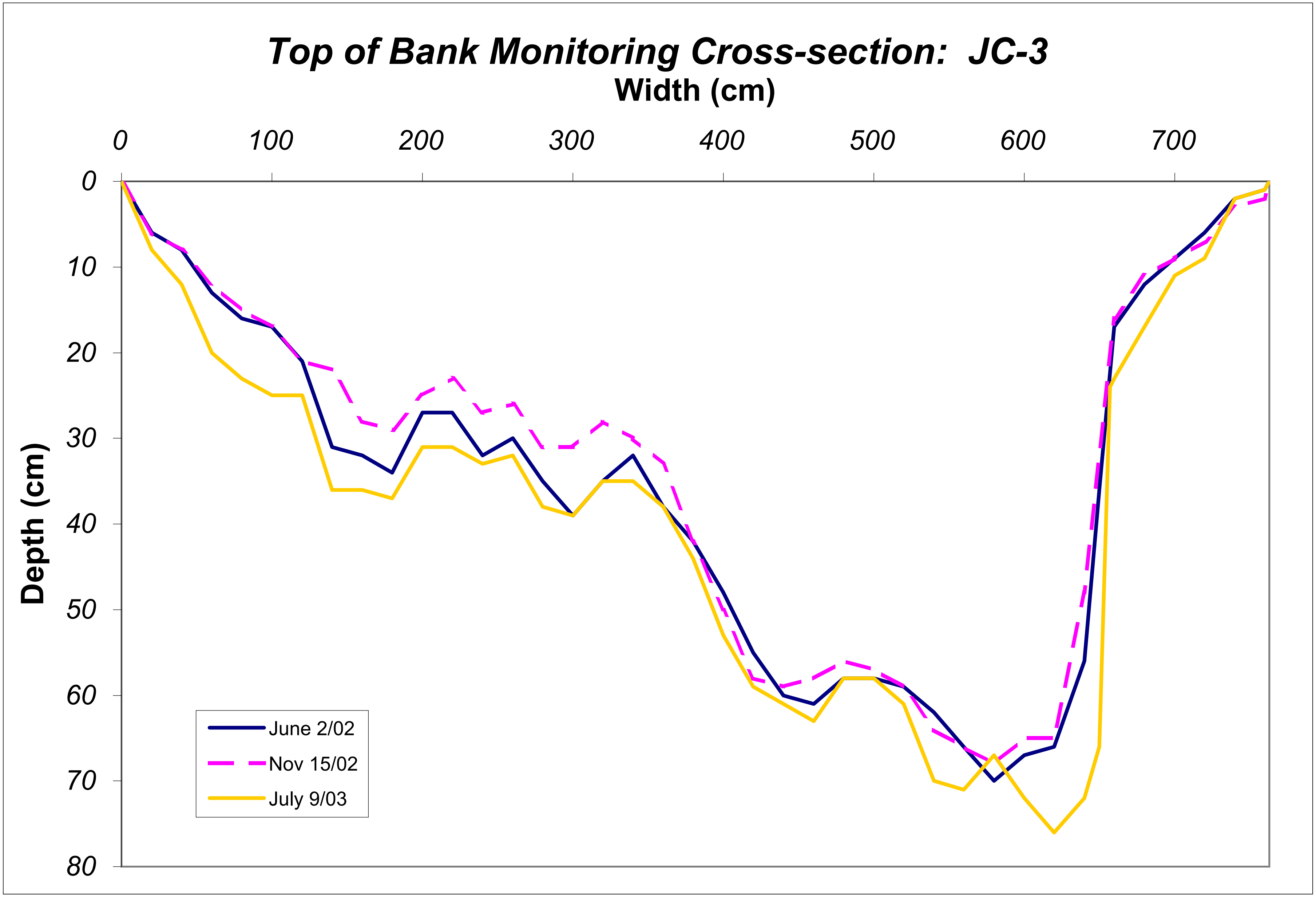
Planning Services Department
Corporate Drafting & Design Office

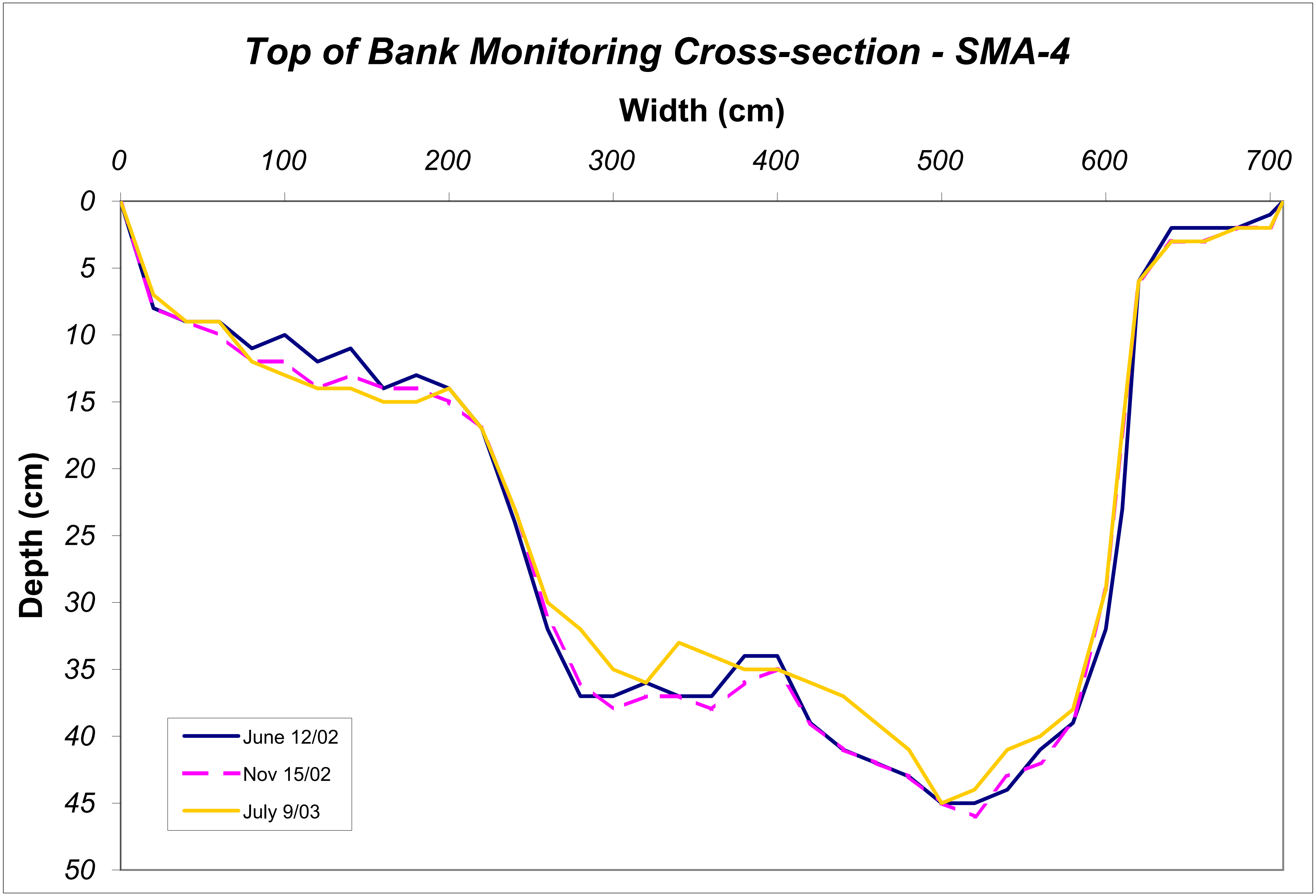
February 2002

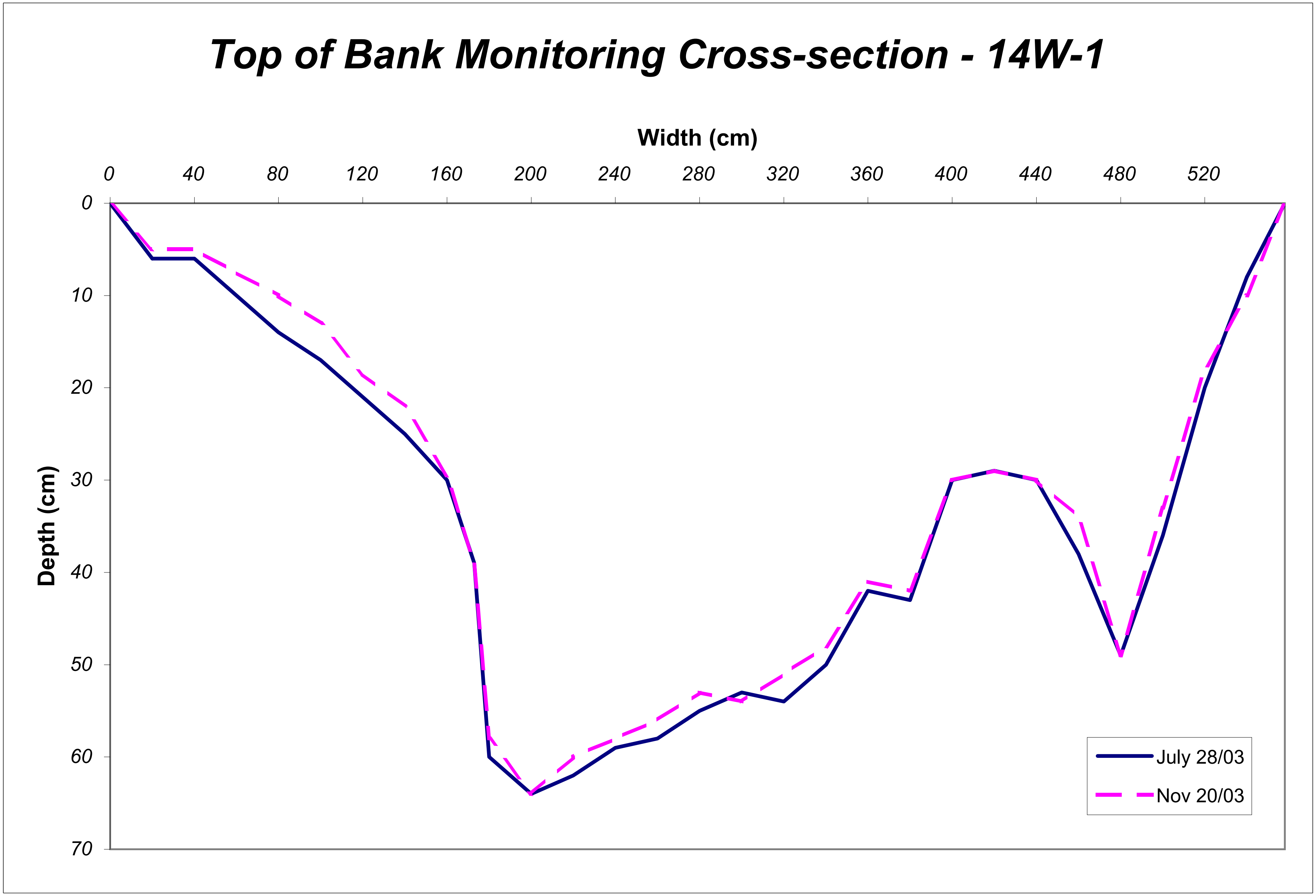
0 500 1000 1500 2000 2500
SCALE IN METRES



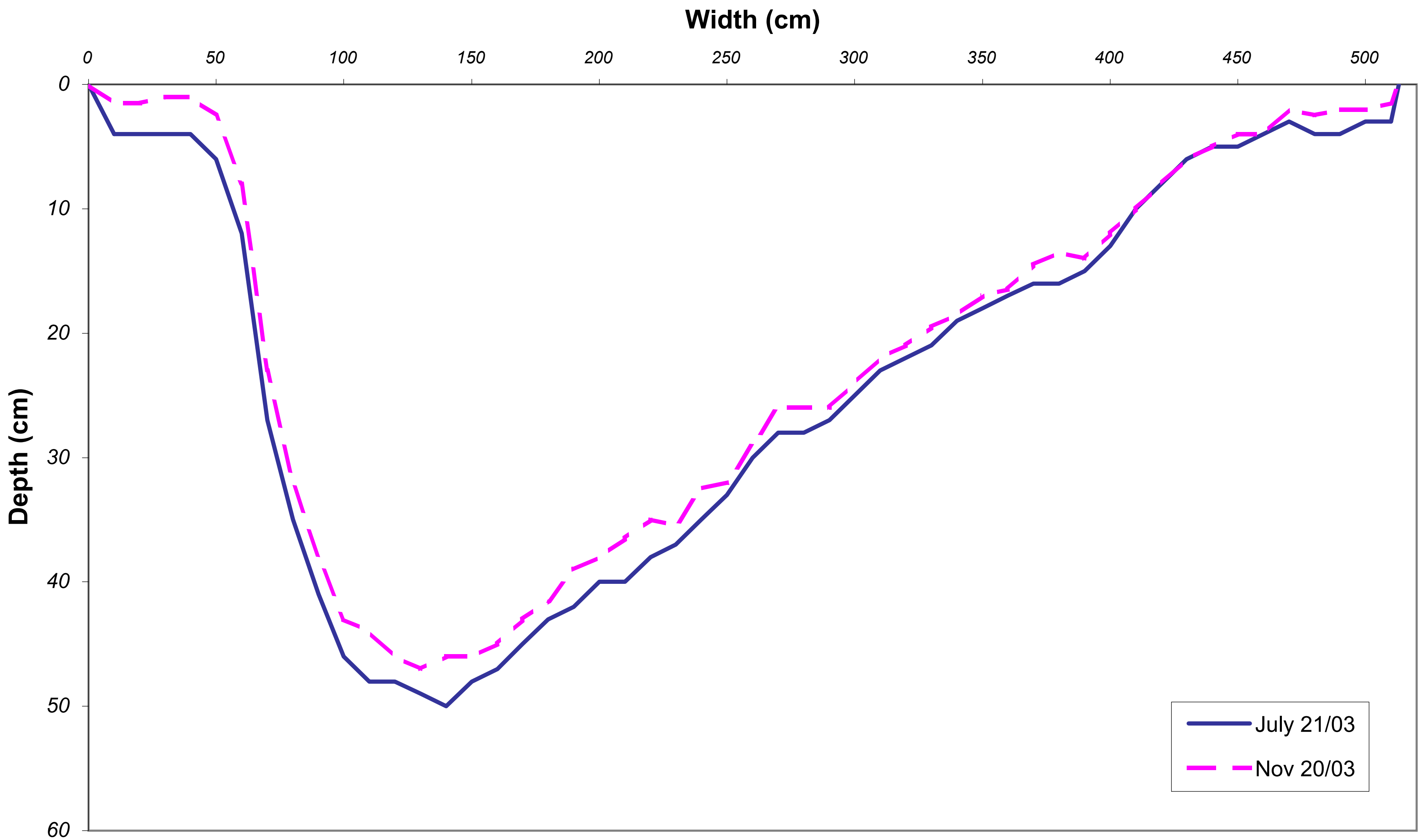
Top of Bank Monitoring Cross-section - JC-13
Width (cm)
0
100
200
300
400
500
600
700
Depth (cm)
0
10
20
30
40
50
60
70
80
90
June 7/02
Nov 15/02
July 9/03

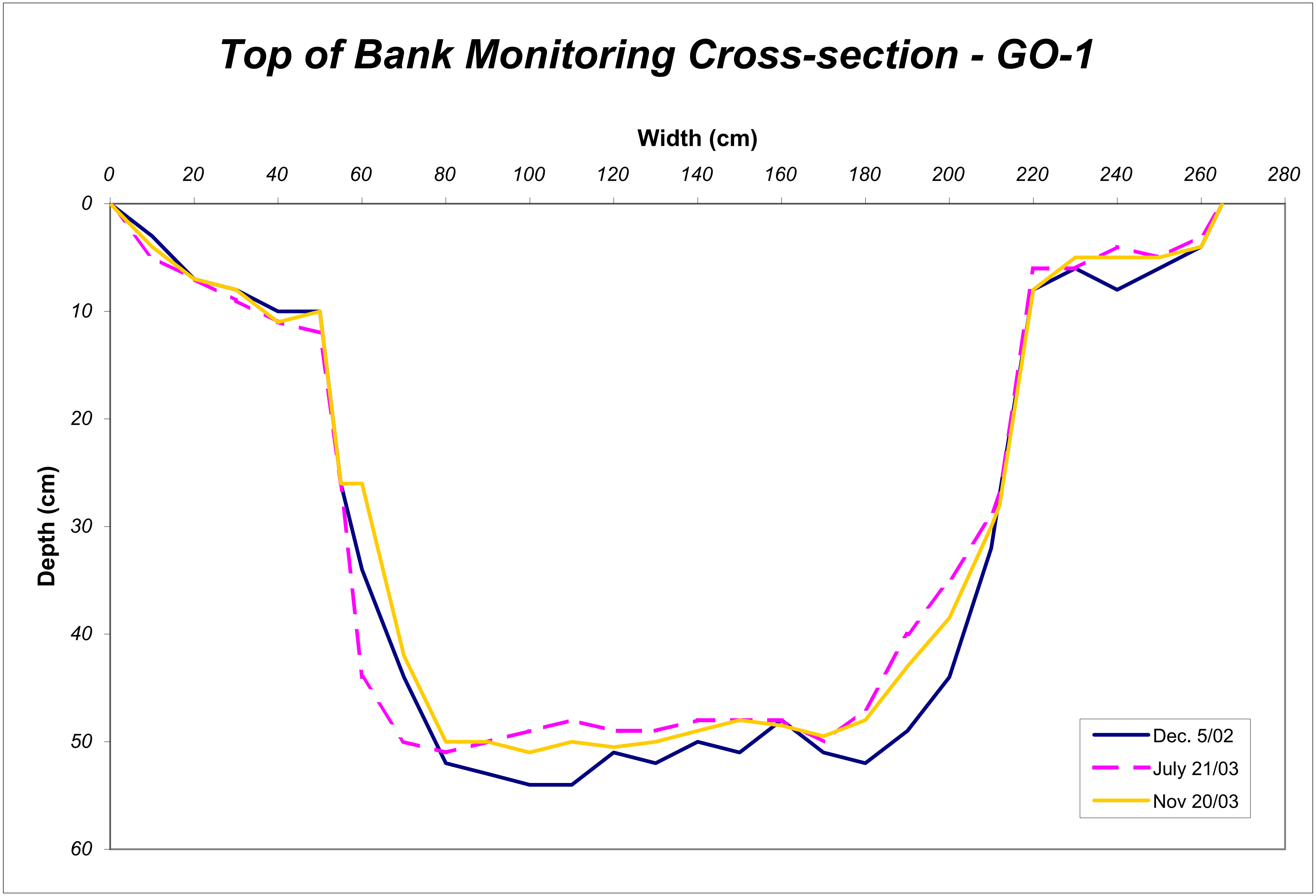

Top of Bank Monitoring Cross-section: JC-3
Width (cm)
0
100
200
300
400
500
600
700
Depth (cm)
0
10
20
30
40
50
60
70
80
June 2/02
Nov 15/02
July 9/03

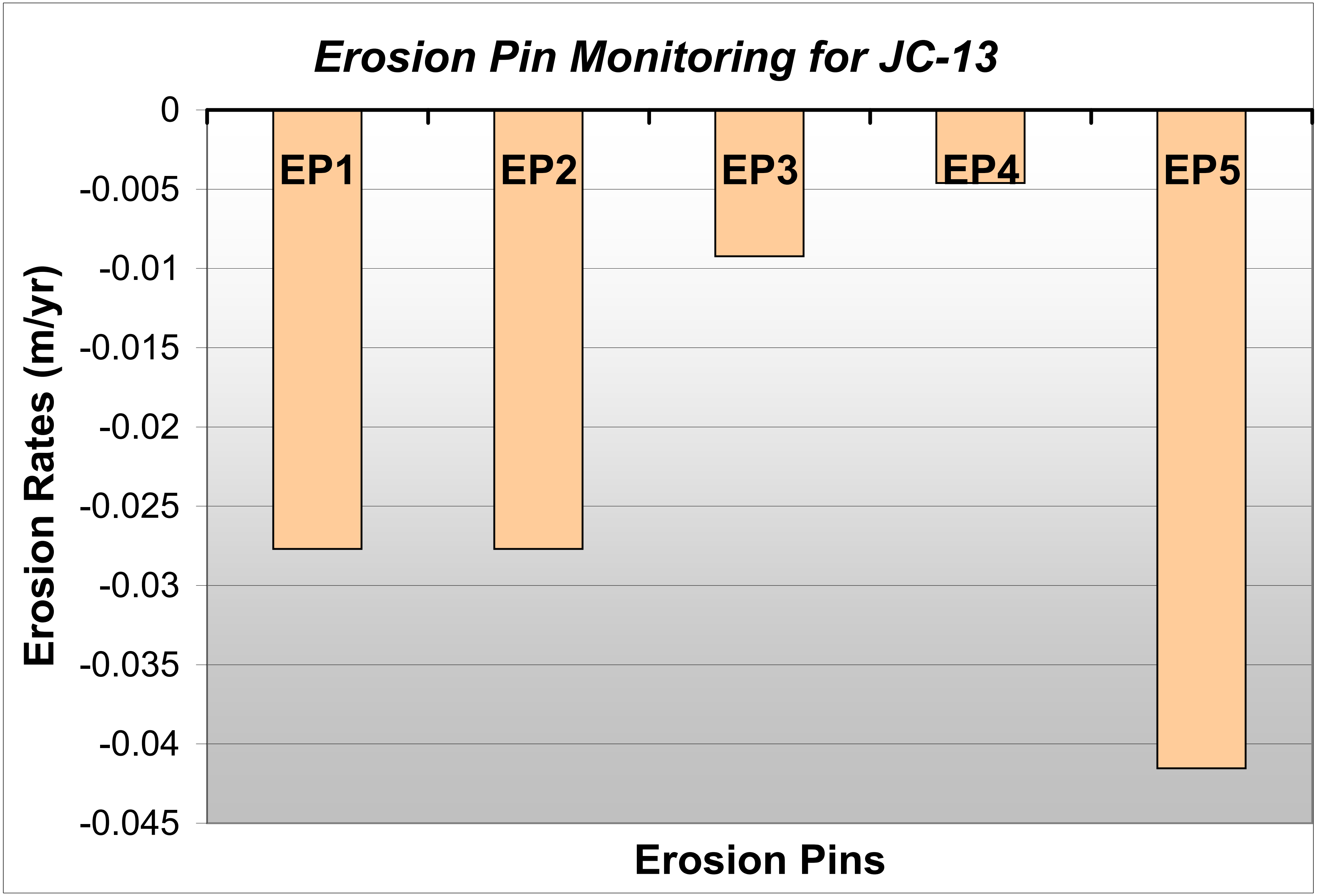

Top of Bank Monitoring Cross-section - SMA-4
Width (cm)
0
100
200
300
400
500
600
700
Depth (cm)
0
5
10
15
20
25
30
35
40
45
50
June 12/02
Nov 15/02
July 9/03

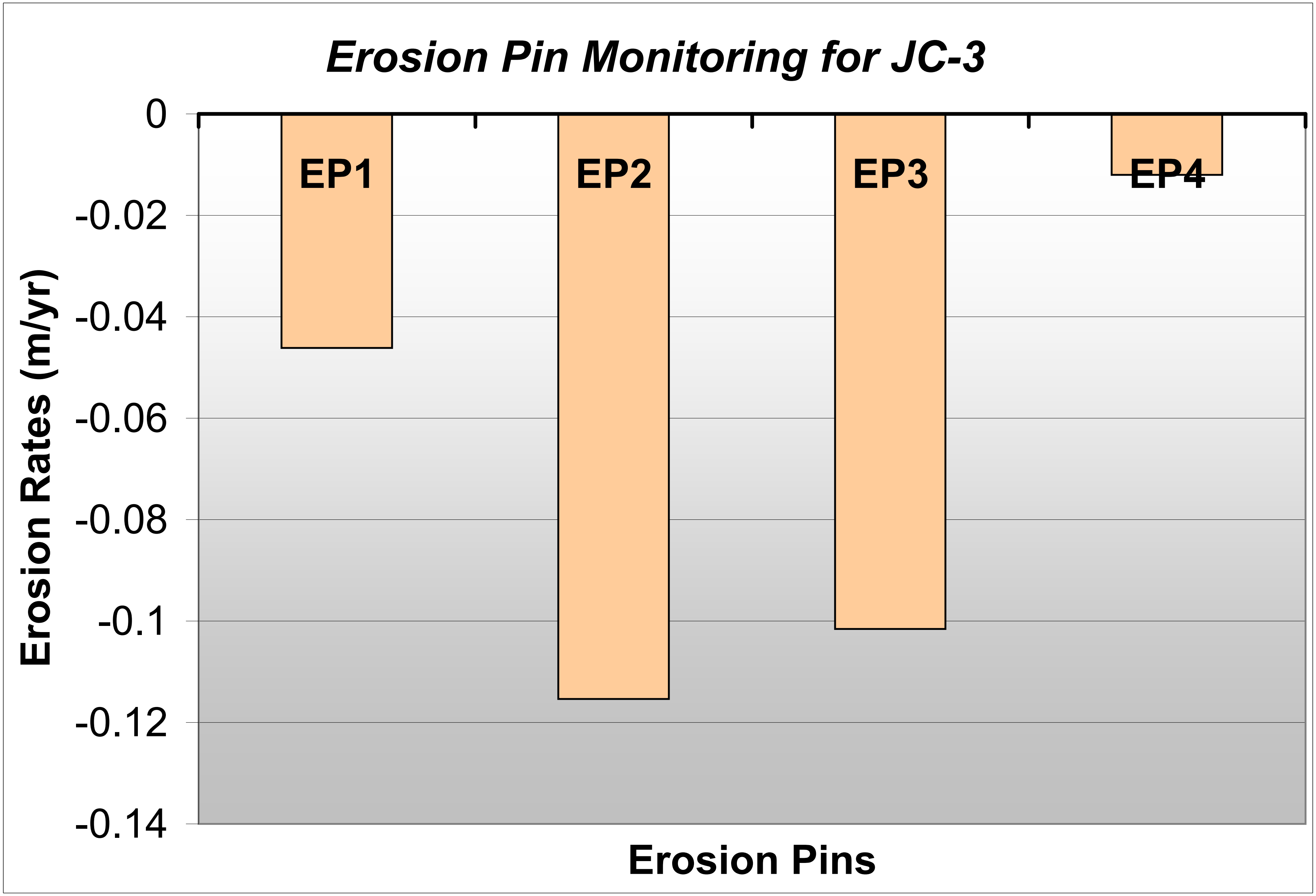

Top of Bank Monitoring Cross-section - 14W-1
Width (cm)
0
40
80
120
160
200
240
280
320
360
400
440
480
520
Depth (cm)
0
10
20
30
40
50
60
70
July 28/03
Nov 20/03

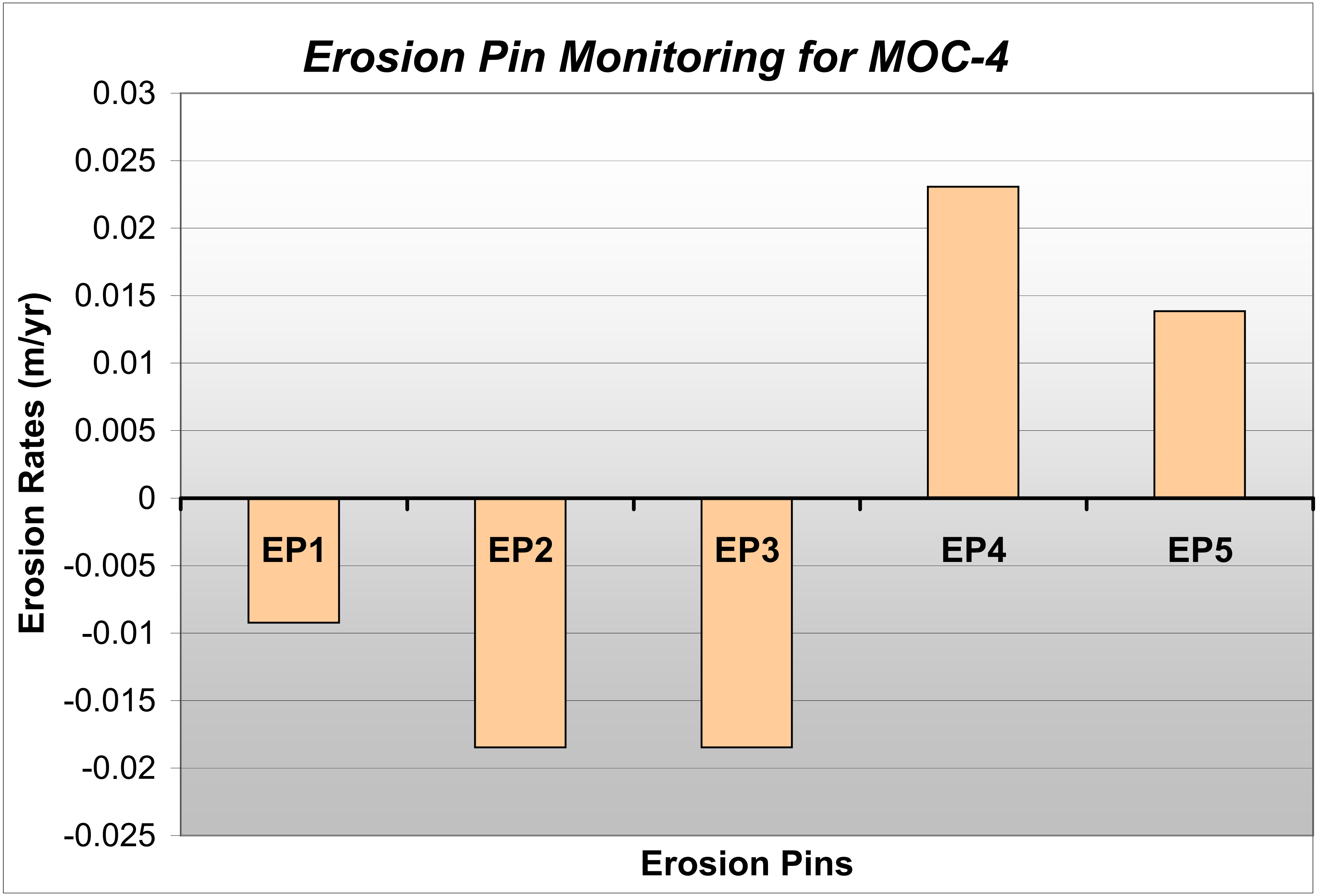
Top of Bank Monitoring Cross-section - 14W-7

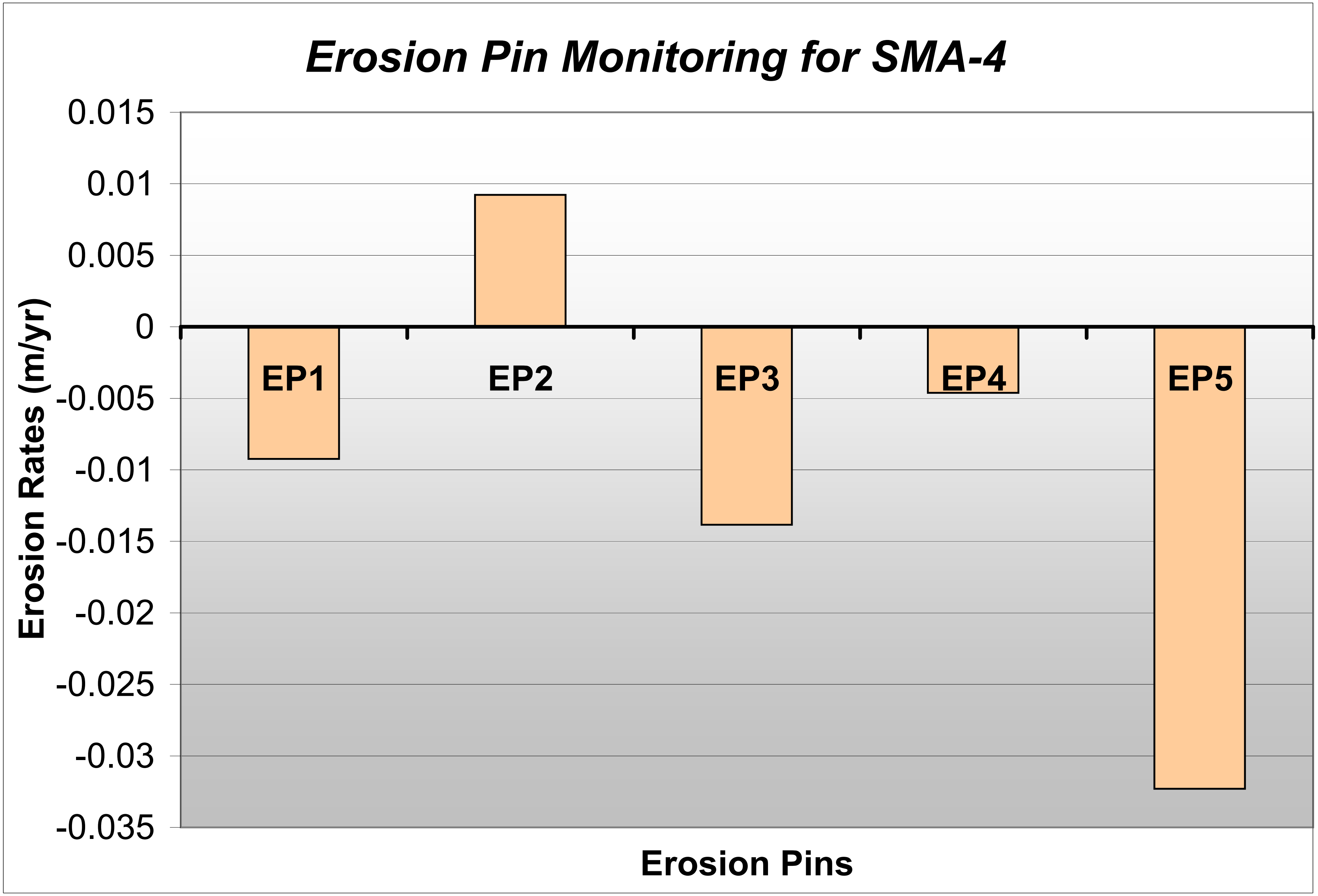


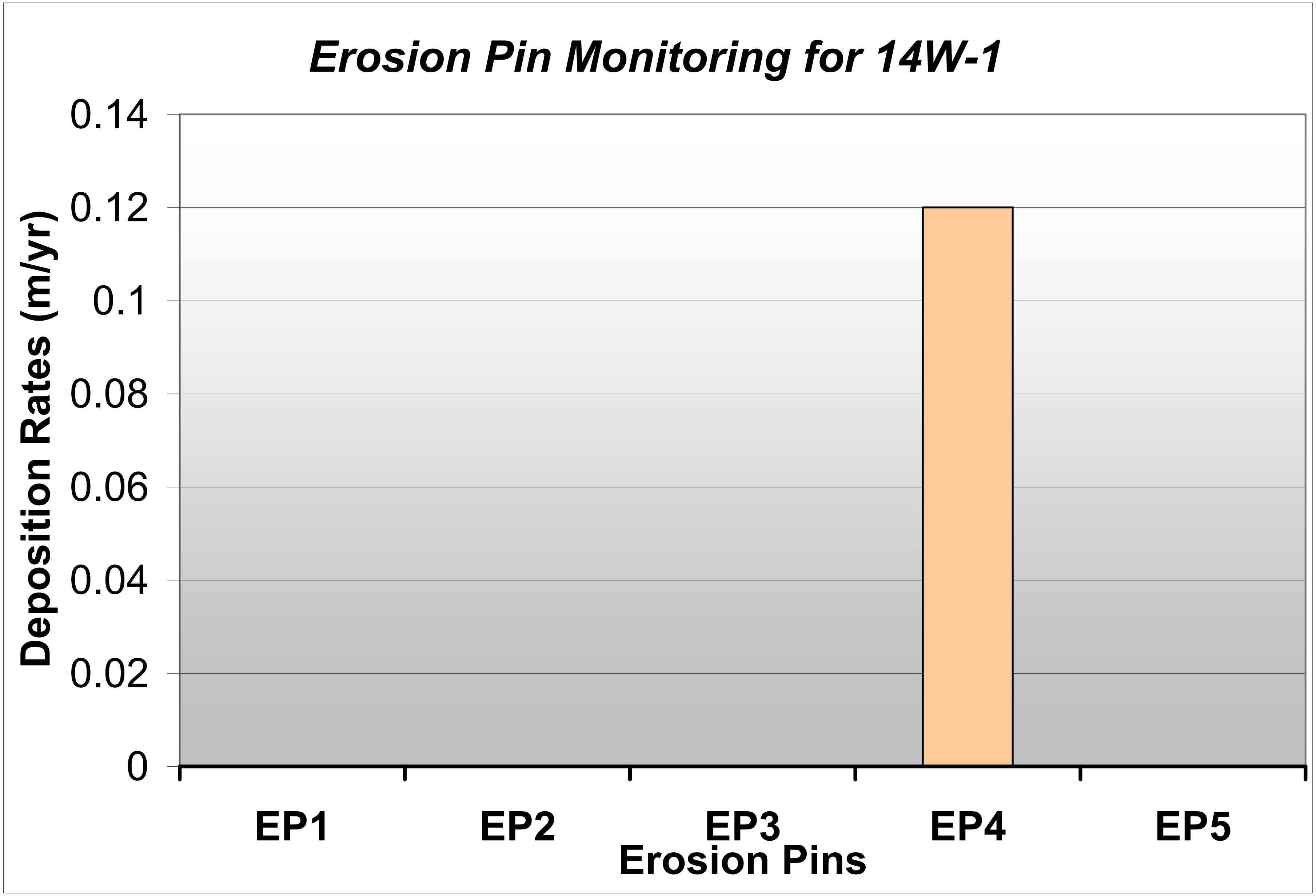

Top of Bank Monitoring Cross-section - GO-1
Width (cm)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Depth (cm)
0
10
20
30
40
50
60
Dec. 5/02
July 21/03
Nov 20/03

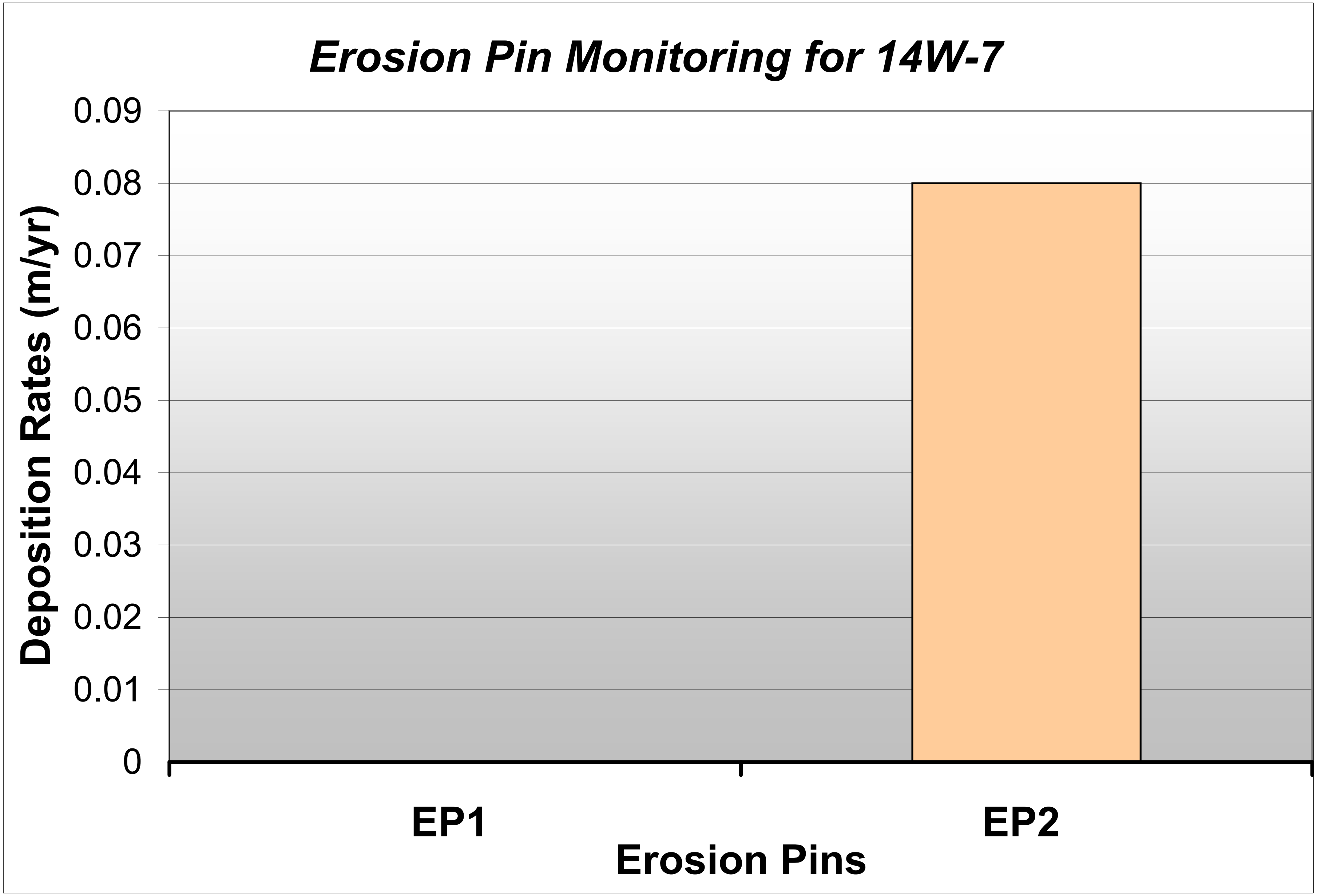

Erosion Pin Monitoring for JC-13
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
-0.04
-0.045
Erosion Rates (m/yr)
EP1
EP2
EP3
EP4
EP5
Erosion Pins

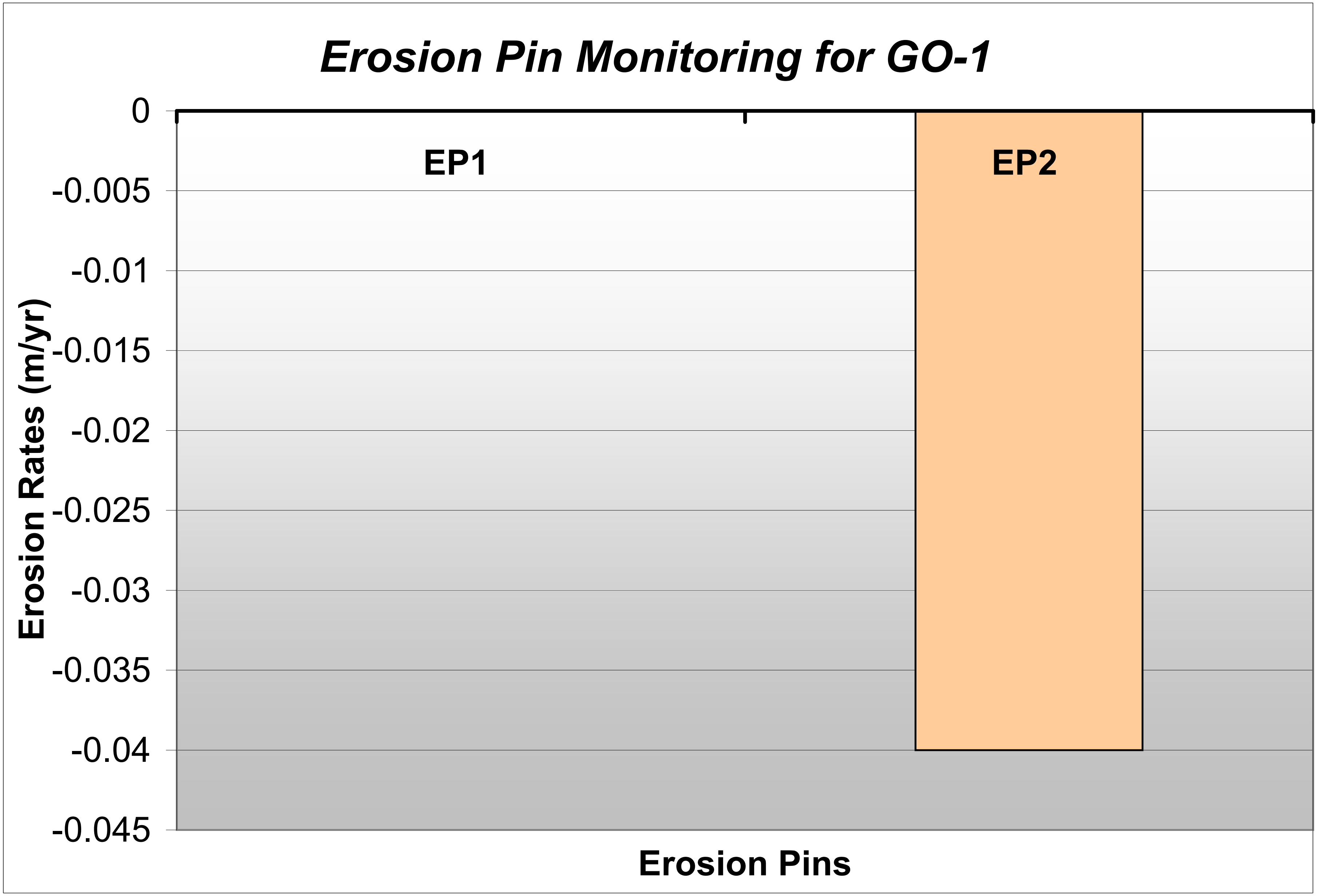

Erosion Pin Monitoring for JC-3
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
Erosion Rates (m/yr)
EP1
EP2
EP3
EP4
Erosion Pins

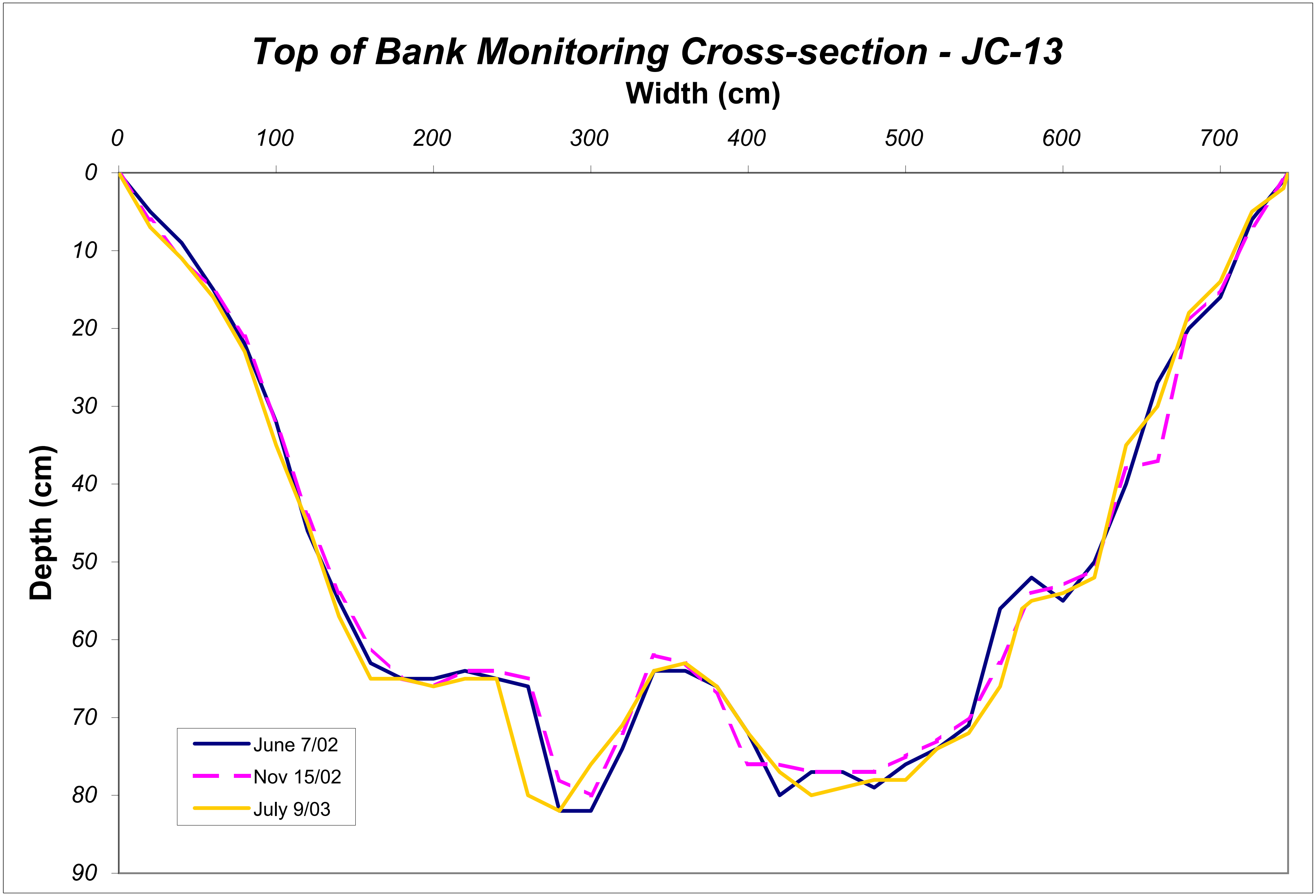

Erosion Pin Monitoring for MOC-4
Erosion Rates (m/yr)
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
EP1
EP2
EP3
EP4
EP5
Erosion Pins


Erosion Pin Monitoring for SMA-4
Erosion Rates (m/yr)
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
EP1
EP2
EP3
EP4
EP5
Erosion Pins

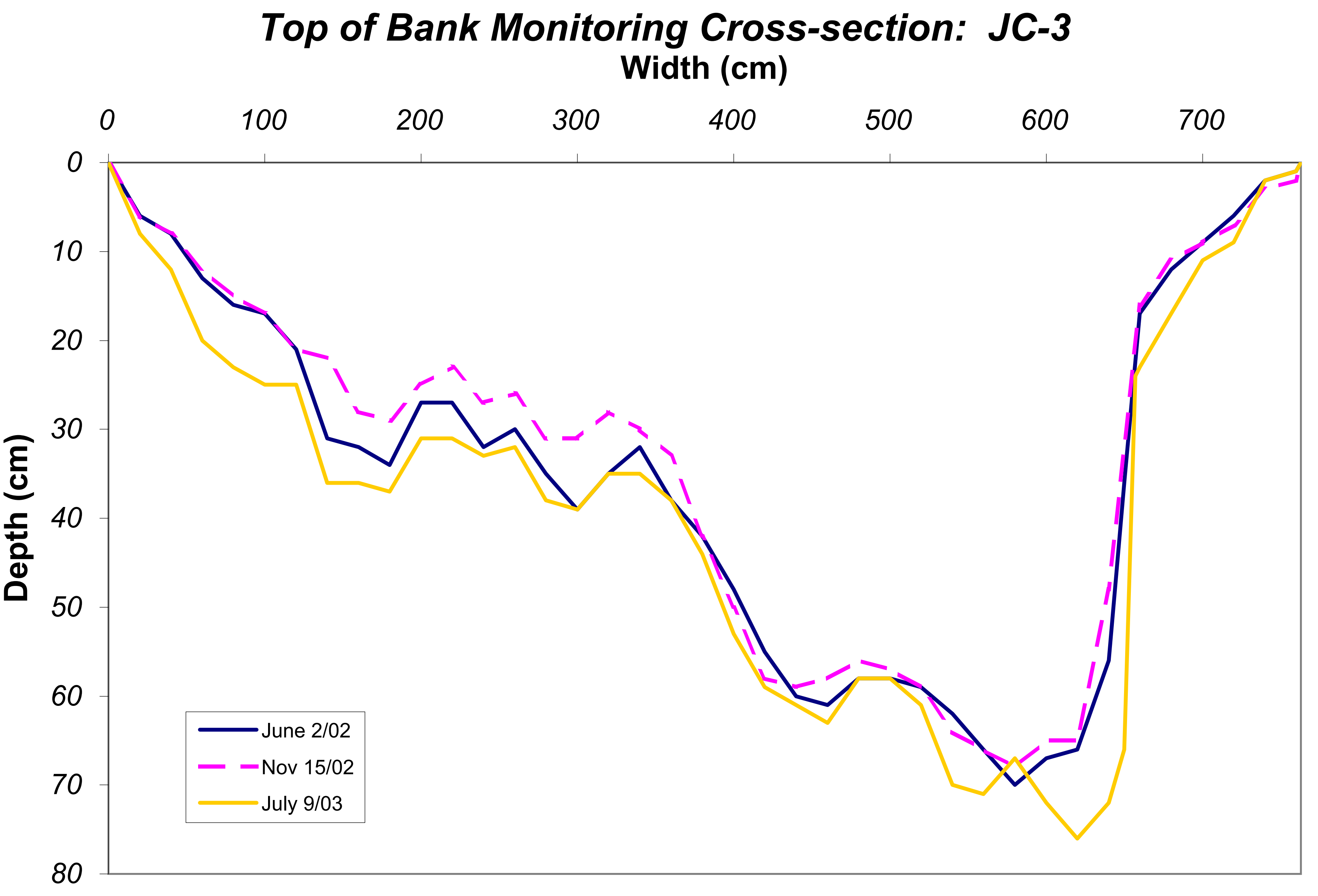

Erosion Pin Monitoring for 14W-1
Deposition Rates (m/yr)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
EP1
EP2
EP3
EP4
EP5
Erosion Pins

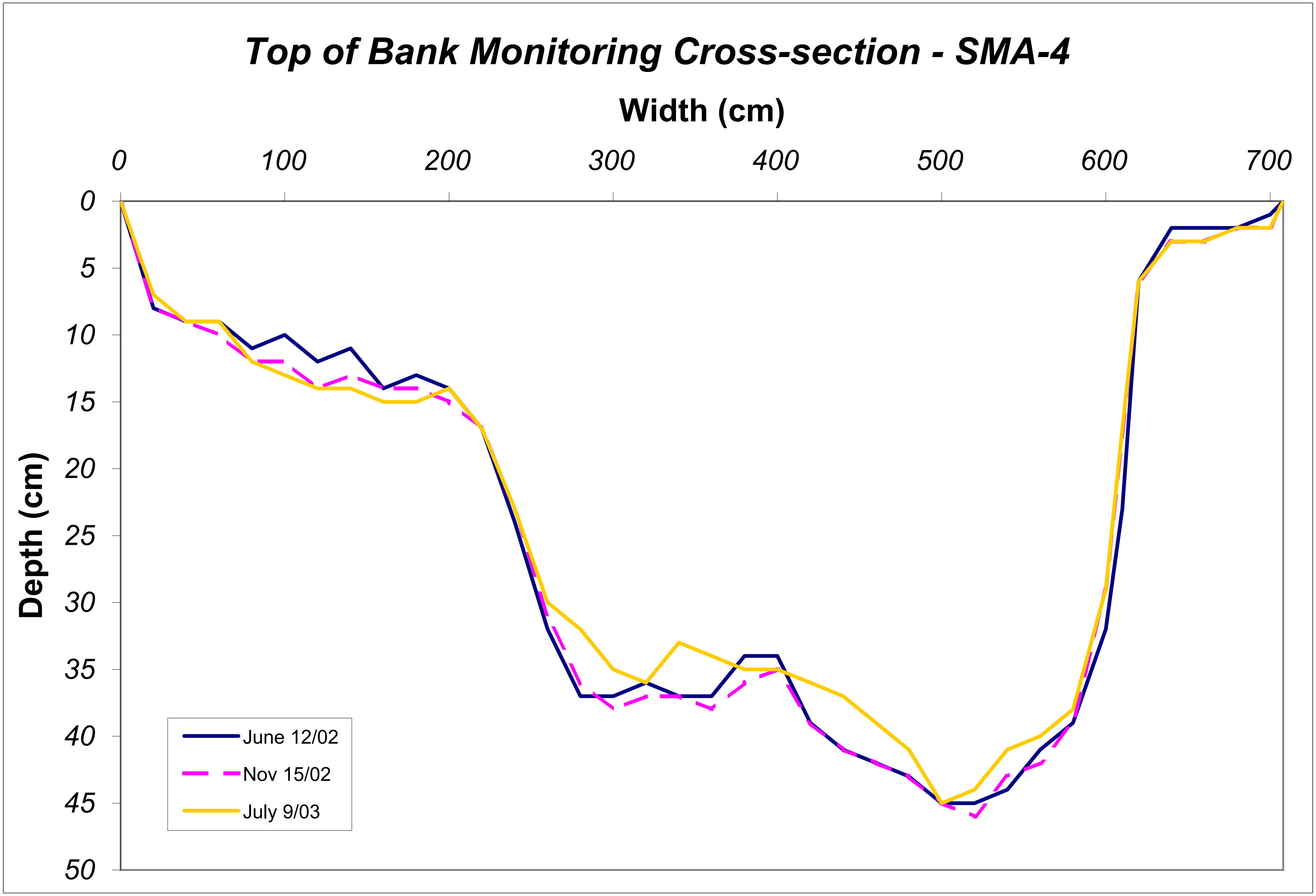

Erosion Pin Monitoring for 14W-7
Deposition Rates (m/yr)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
EP1
EP2
Erosion Pins


Erosion Pin Monitoring for GO-1
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
-0.04
-0.045
Erosion Rates (m/yr)
EP1
EP2
Erosion Pins



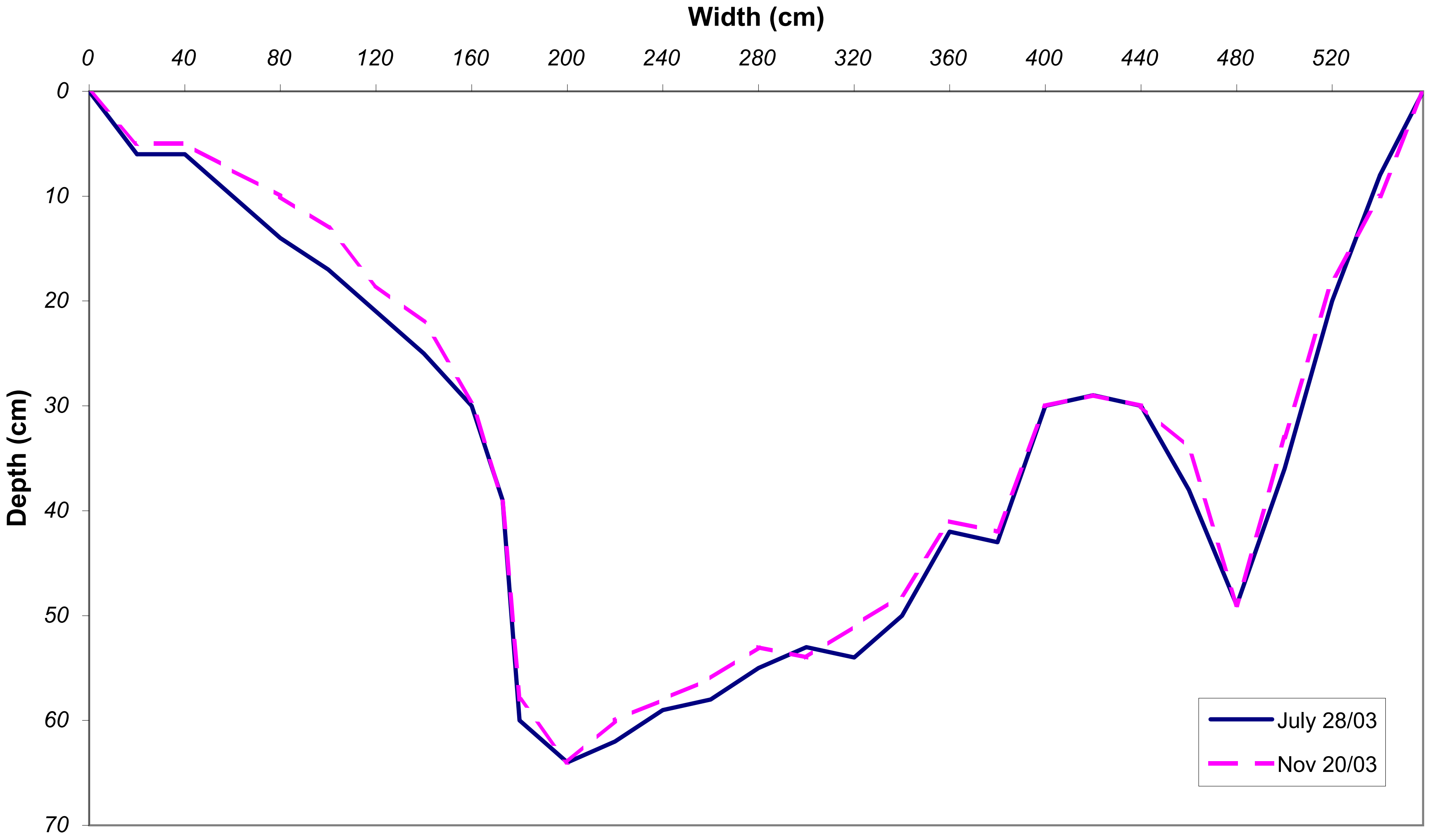
Top of Bank Monitoring Cross-section - JC-13

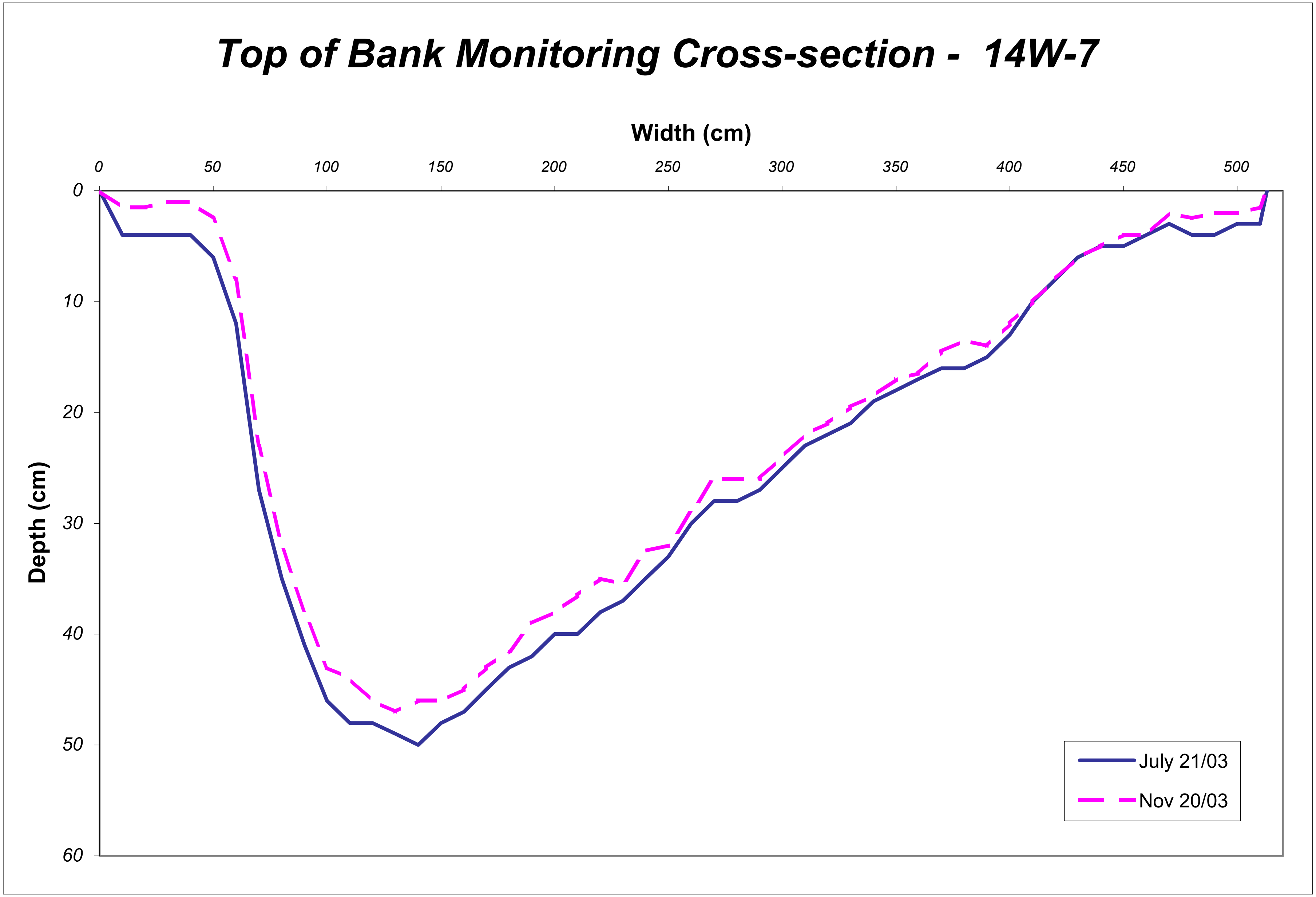

Top of Bank Monitoring Cross-section: JC-3
Width (cm)
0
100
200
300
400
500
600
700
Depth (cm)
0
10
20
30
40
50
60
70
80
June 2/02
Nov 15/02
July 9/03

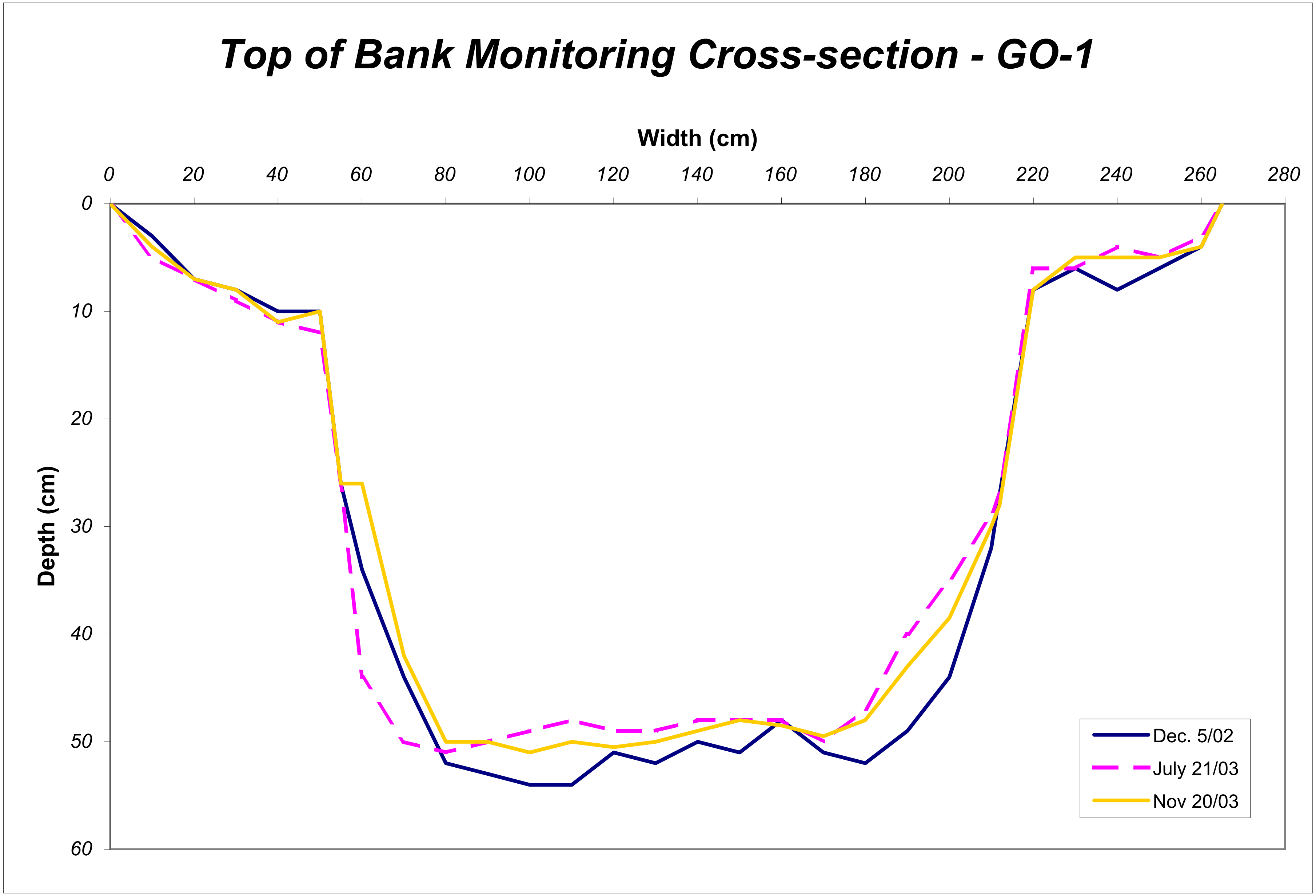


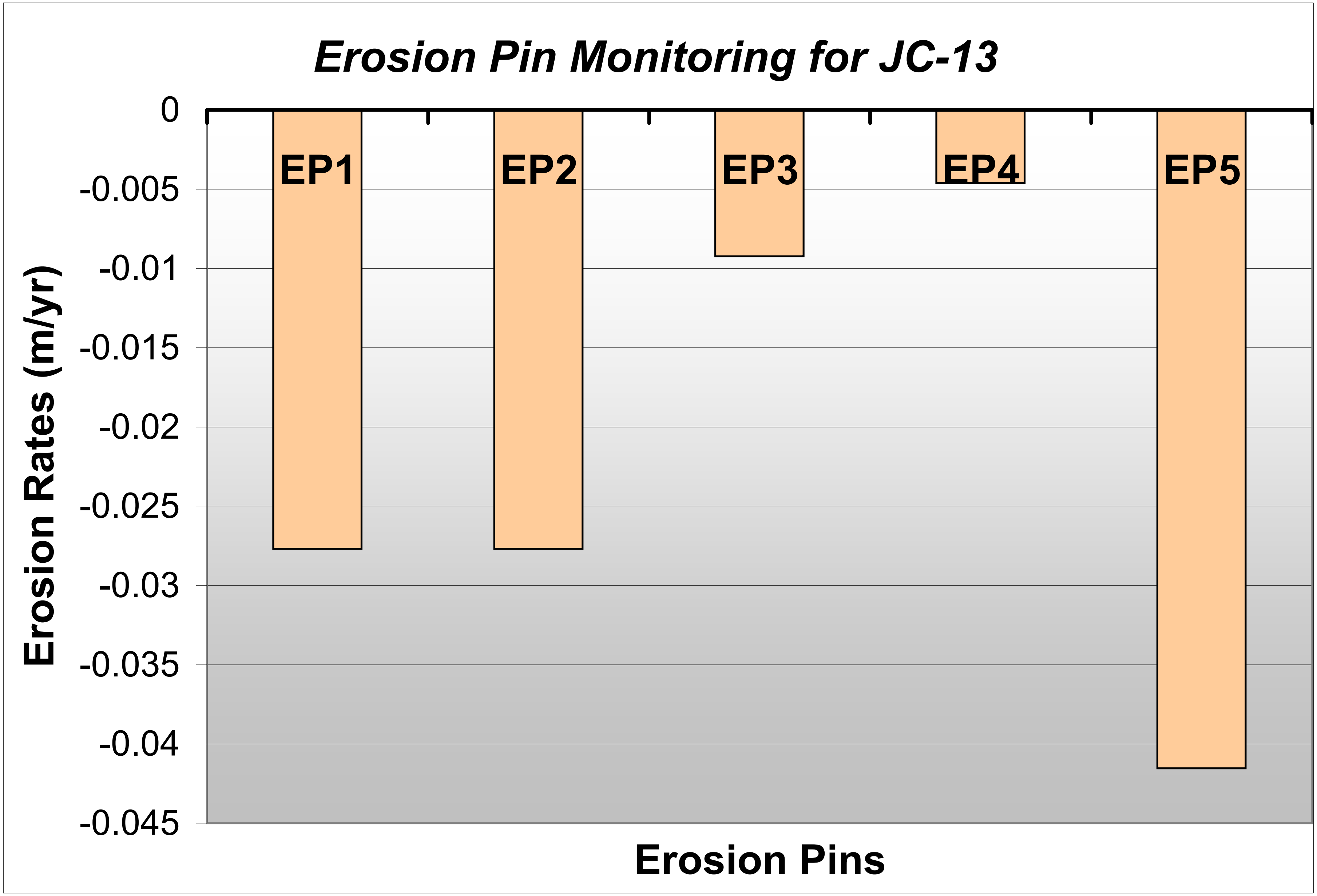
Top of Bank Monitoring Cross-section - SMA-4

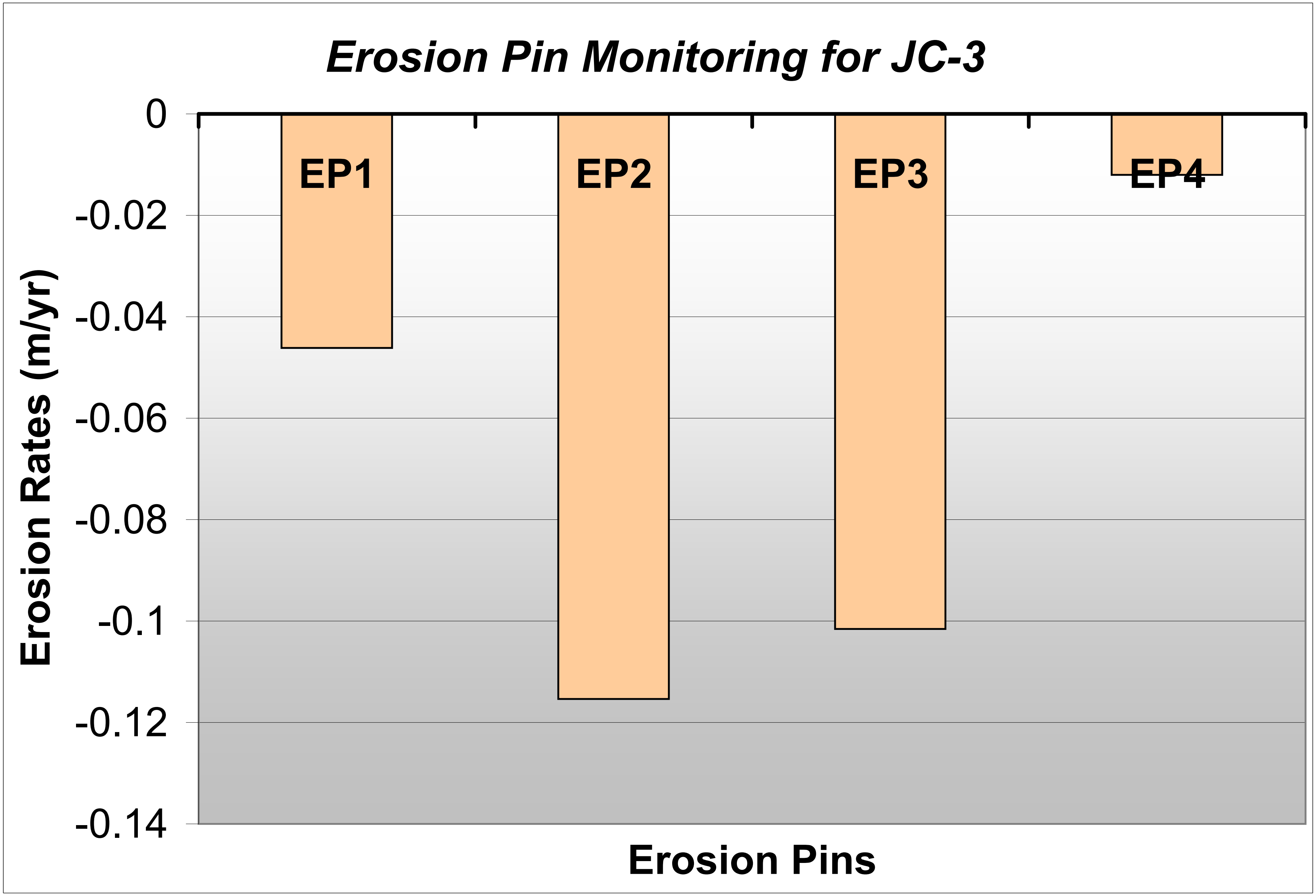
Top of Bank Monitoring Cross-section - 14W-1

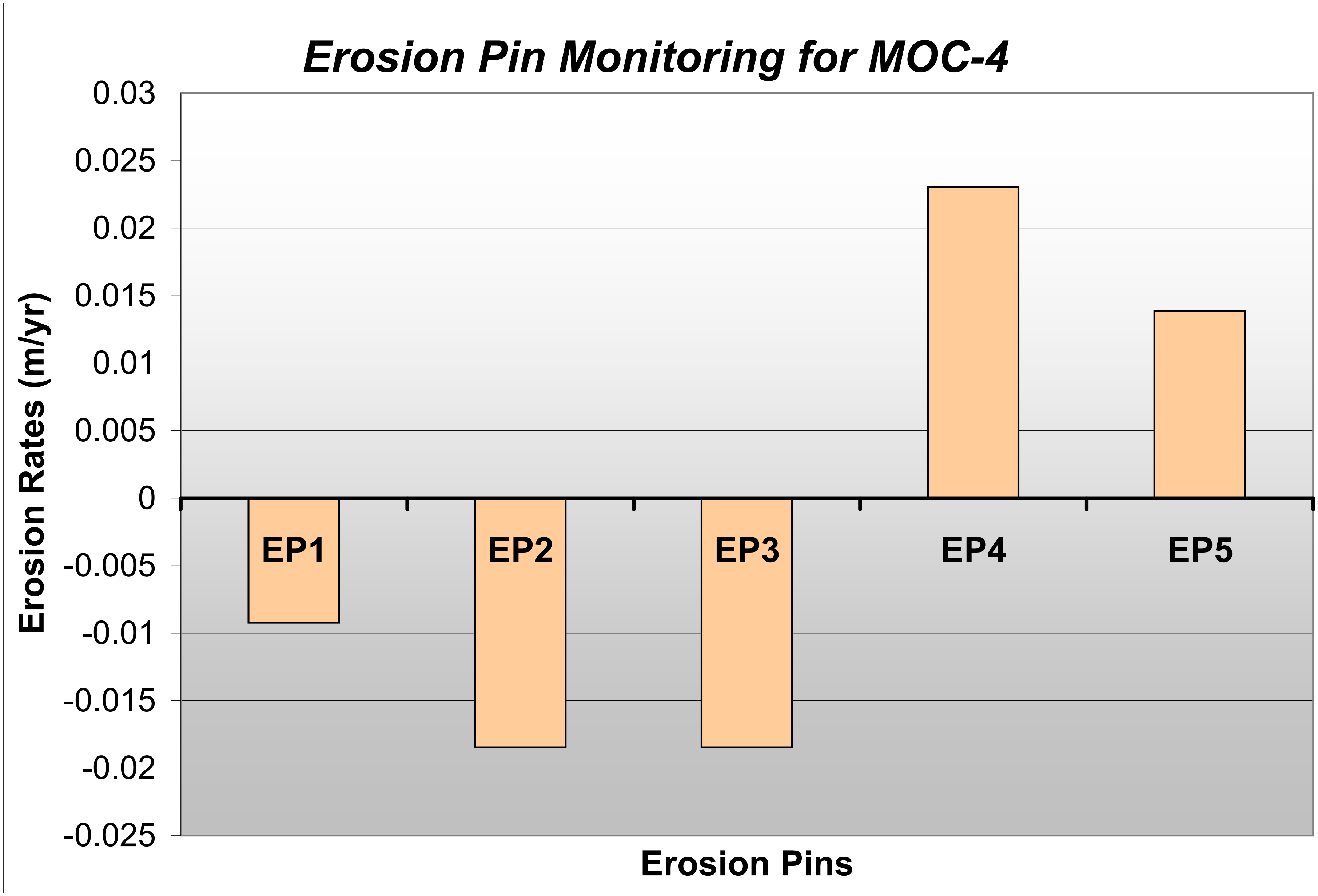


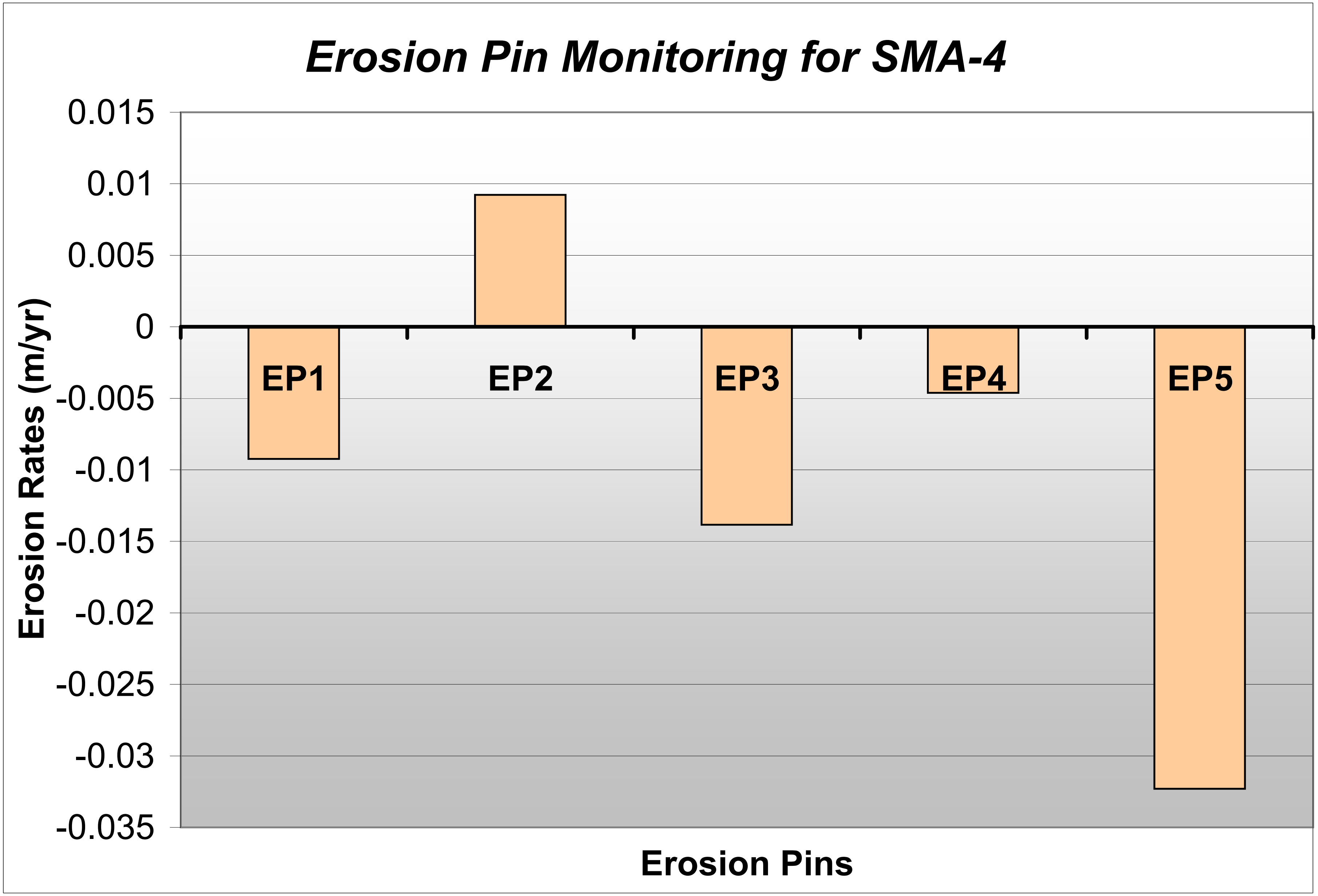

Top of Bank Monitoring Cross-section - 14W-7
Width (cm)
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
Depth (cm)
July 21/03
Nov 20/03

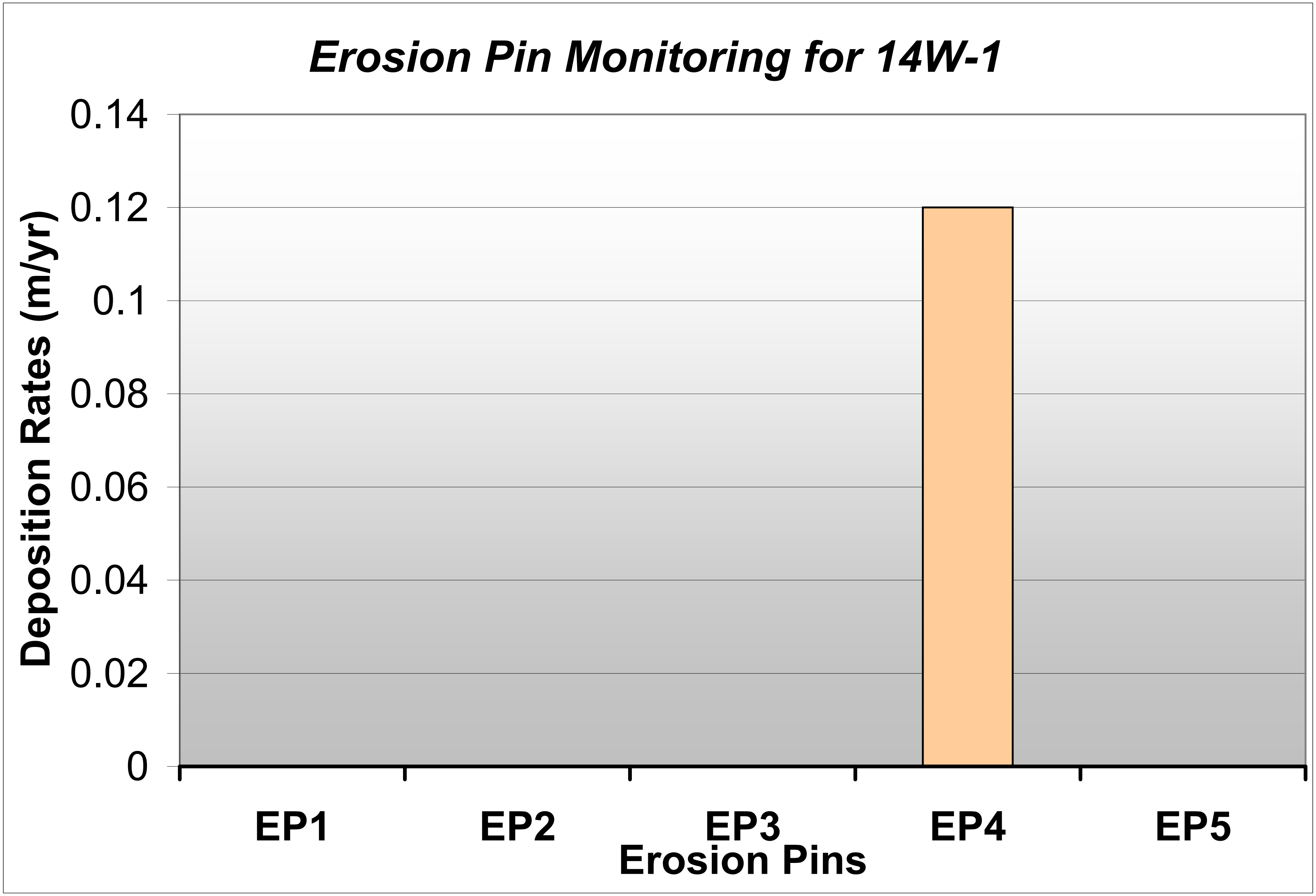

Top of Bank Monitoring Cross-section - GO-1
Width (cm)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Depth (cm)
0
10
20
30
40
50
60
Dec. 5/02
July 21/03
Nov 20/03

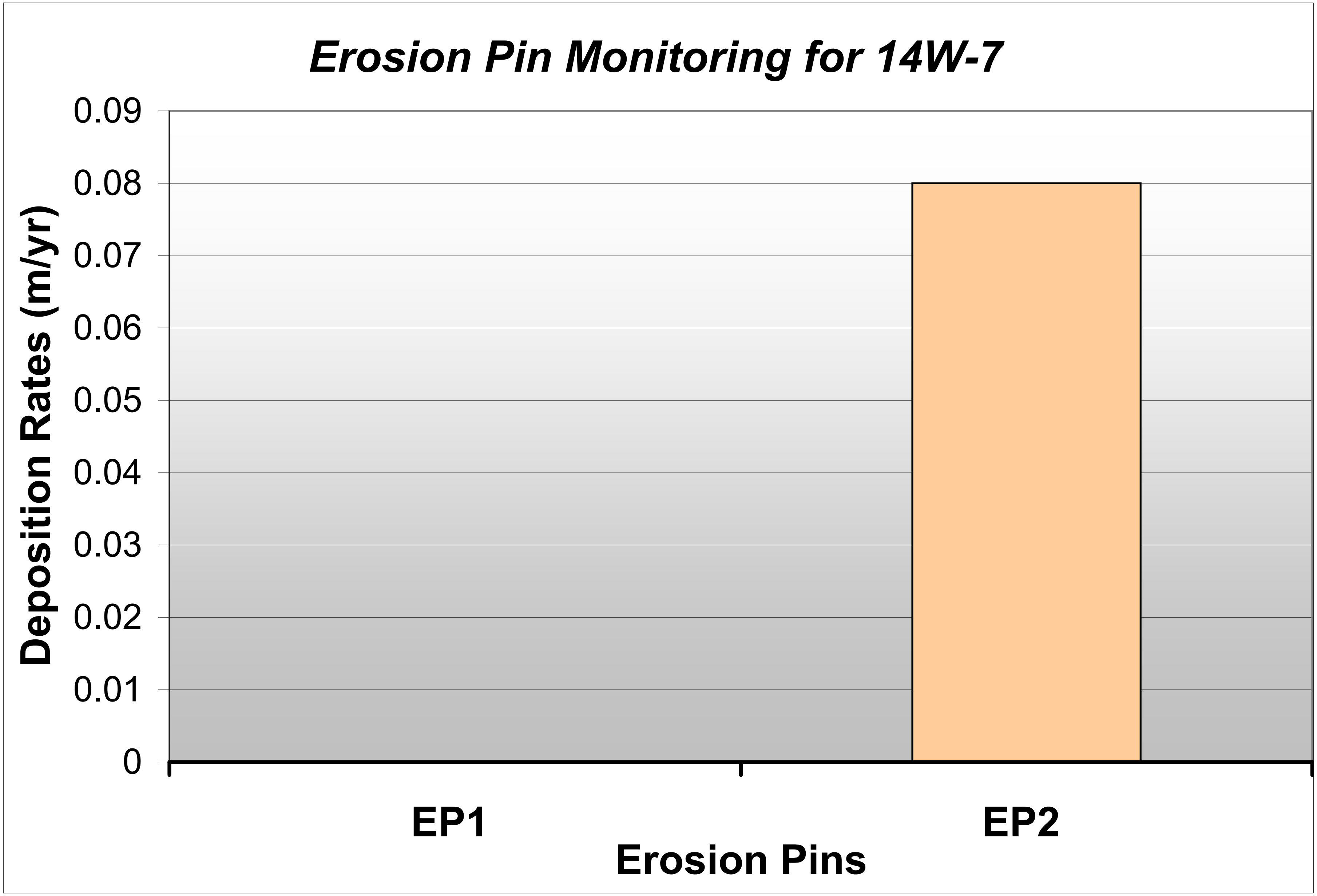

Erosion Pin Monitoring for JC-13
Erosion Rates (m/yr)
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
-0.04
-0.045
EP1
EP2
EP3
EP4
EP5
Erosion Pins

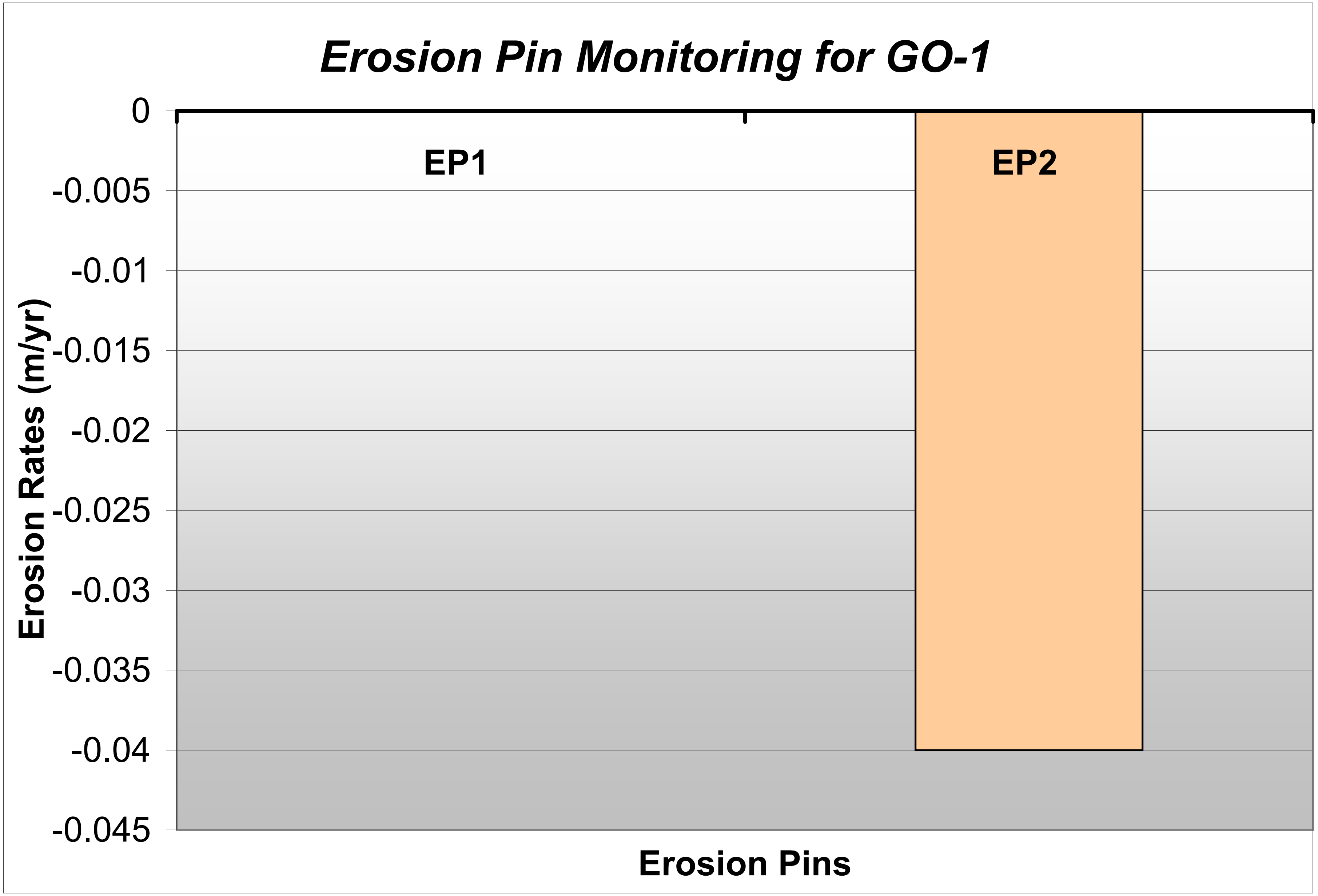

Erosion Pin Monitoring for JC-3
Erosion Rates (m/yr)
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
EP1
EP2
EP3
EP4
Erosion Pins

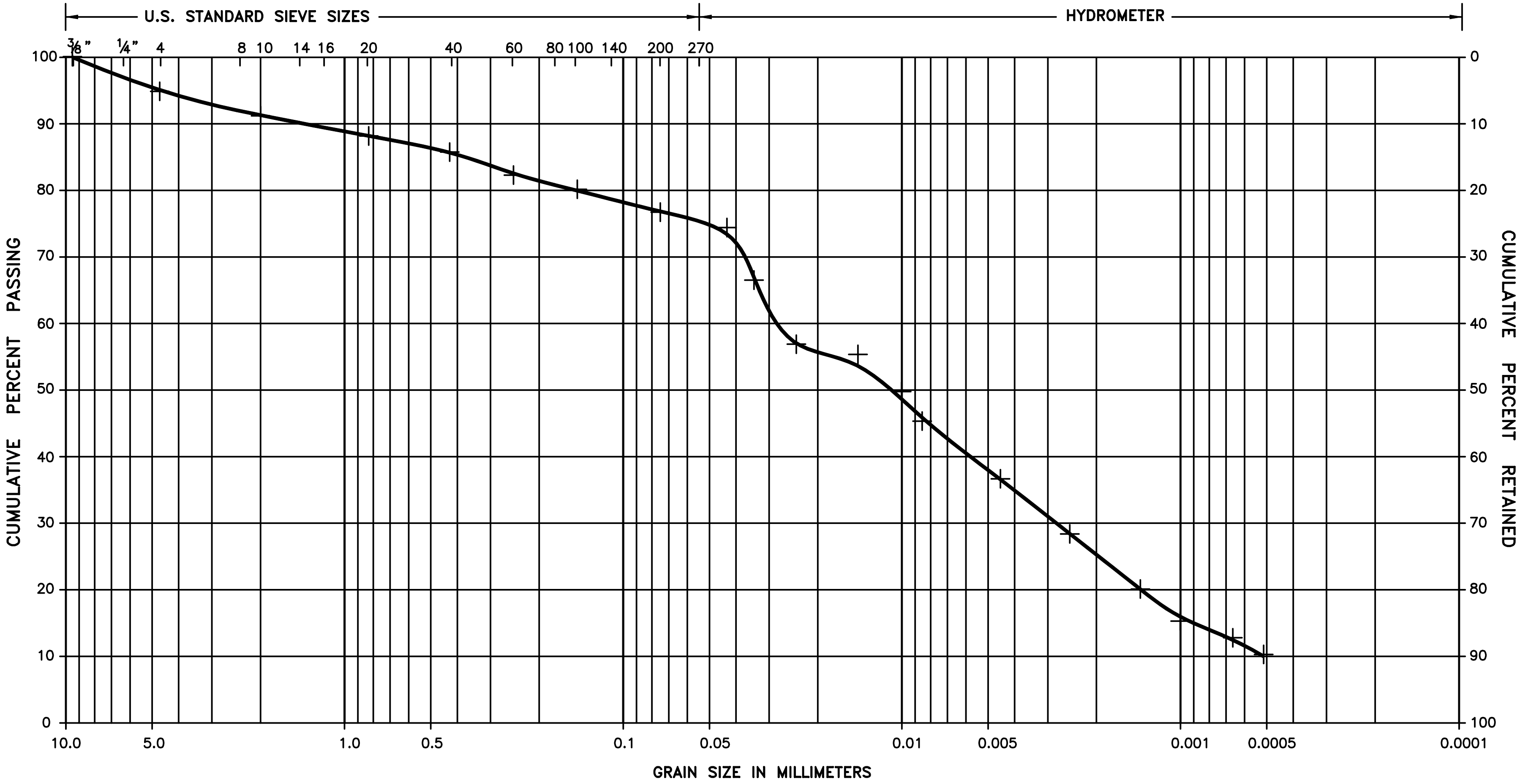

Erosion Pin Monitoring for MOC-4
Erosion Rates (m/yr)
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
EP1
EP2
EP3
EP4
EP5
Erosion Pins


Erosion Pin Monitoring for SMA-4
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
Erosion Rates (m/yr)
EP1
EP2
EP3
EP4
EP5
Erosion Pins


Erosion Pin Monitoring for 14W-1
Deposition Rates (m/yr)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
EP1
EP2
EP3
EP4
EP5
Erosion Pins


Erosion Pin Monitoring for 14W-7
Deposition Rates (m/yr)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
EP1
EP2
Erosion Pins


Erosion Pin Monitoring for GO-1
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
-0.04
-0.045
Erosion Rates (m/yr)
EP1
EP2
Erosion Pins



UNIFIED	Gravel	Sand Coarse	Sand Medium	Sand Fine	Clay & Silt					
M.I.T.	Gravel	Sand Coarse	Sand Medium	Sand Fine	Silt Coarse	Silt Medium	Silt Fine	Clay		
U.S. BUREAU	Gravel	Sand Coarse	Sand Medium	Sand Fine	Sand V.Fine	Silt	Clay			

MW−1
Hole No.

SS−3
Sample Number

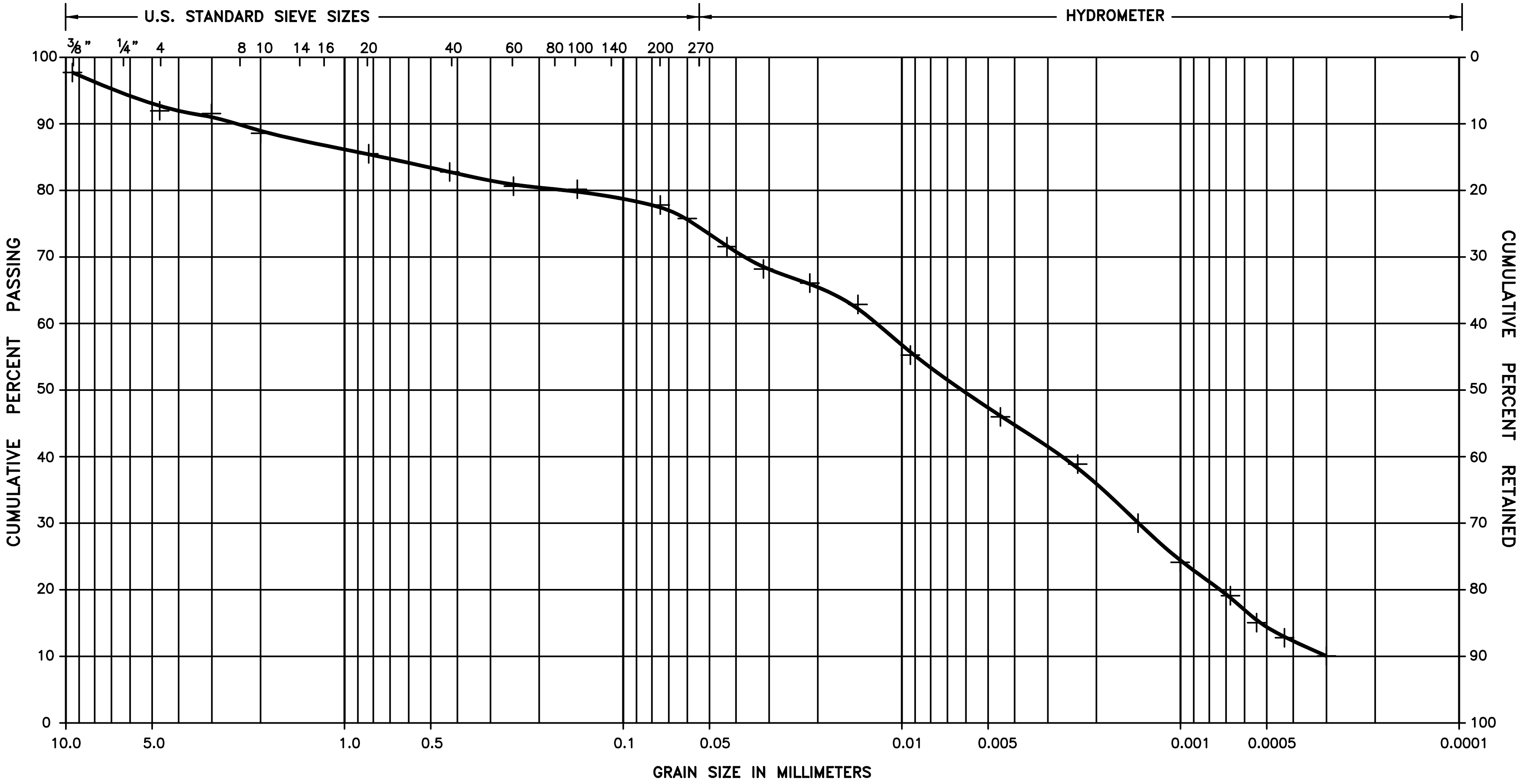
7.5'−9.0'
Depth

Morrison Environmental Limited

North Oakville Subwatershed Study
Oakville, Ontario

GRAIN SIZE CURVE

July 2002 | 208−021 | FIGURE: MEL−34



<table>
<tr><td rowspan="2">UNIFIED</td><td rowspan="2">Gravel</td><td>Coarse</td><td colspan="3">Medium</td><td colspan="4">Fine</td><td colspan="7" rowspan="2">Clay & Silt</td></tr>
<tr><td colspan="8">Sand</td></tr>
<tr><td rowspan="2">M.I.T.</td><td colspan="2" rowspan="2">Gravel</td><td>Coarse</td><td colspan="4">Medium</td><td colspan="3">Fine</td><td colspan="2">Coarse</td><td>Medium</td><td colspan="2">Fine</td><td rowspan="2">Clay</td></tr>
<tr><td colspan="8">Sand</td><td colspan="5">Silt</td></tr>
<tr><td rowspan="2">U.S. BUREAU</td><td colspan="2" rowspan="2">Gravel</td><td colspan="2">Coarse</td><td colspan="2">Medium</td><td colspan="2">Fine</td><td colspan="3">V.Fine</td><td colspan="3" rowspan="2">Silt</td><td colspan="2" rowspan="2">Clay</td></tr>
<tr><td colspan="9">Sand</td></tr>
</table>

MW-1
Hole No.

SS-6
Sample Number

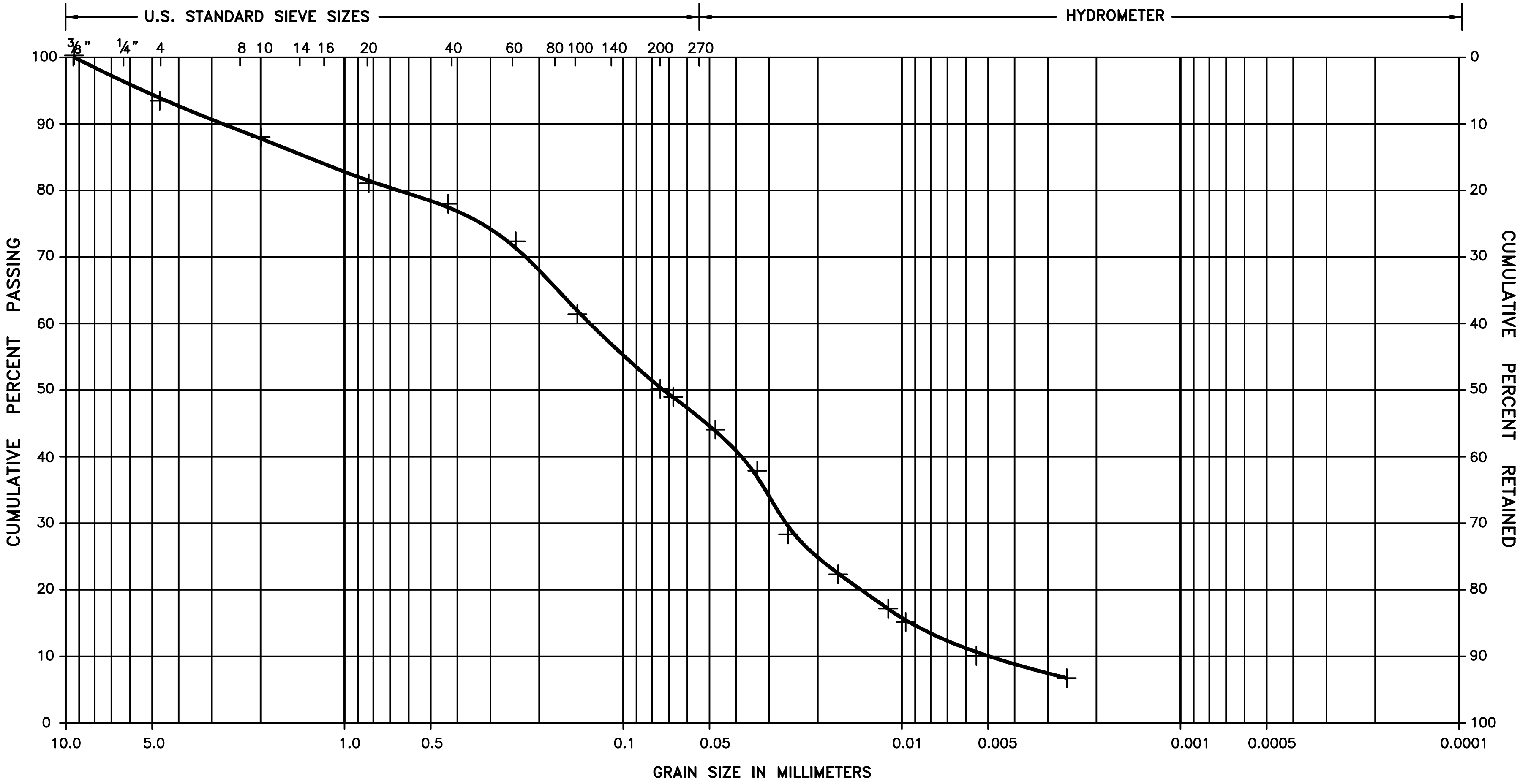
20.0'-21.5'
Depth

Morrison Environmental
Limited

North Oakville Subwatershed Study
Oakville, Ontario

GRAIN SIZE CURVE

July 2002	208-021	FIGURE: MEL-35



UNIFIED	Gravel	Sand Coarse Medium Fine	Clay & Silt	
M.I.T.	Gravel	Sand Coarse Medium Fine	Silt Coarse Medium Fine	Clay
U.S. BUREAU	Gravel	Sand Coarse Medium Fine V.Fine	Silt	Clay

MW-1

Hole No.

SS-11

Sample Number

45.0'-46.5'

Depth

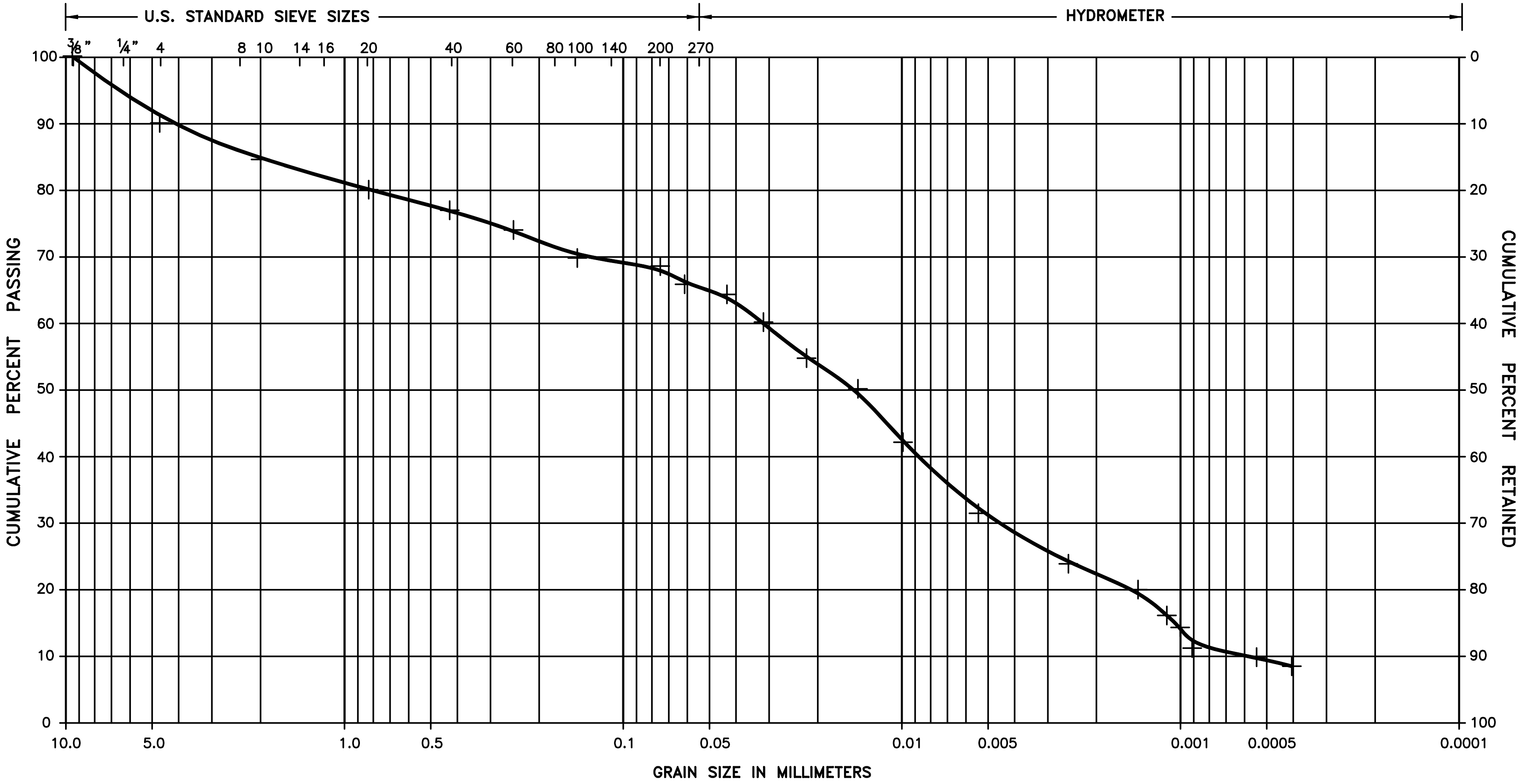
Morrison Environmental Limited

North Oakville Subwatershed Study

Oakville, Ontario

GRAIN SIZE CURVE

July 2002	208-021	FIGURE: MEL-36



<table>
<tr><td rowspan="2">UNIFIED</td><td rowspan="2">Gravel</td><td>Coarse</td><td>Medium</td><td>Fine</td><td rowspan="2" colspan="4">Clay & Silt</td></tr>
<tr><td colspan="3">Sand</td></tr>
<tr><td rowspan="2">M.I.T.</td><td rowspan="2">Gravel</td><td>Coarse</td><td>Medium</td><td>Fine</td><td>Coarse</td><td>Medium</td><td>Fine</td><td rowspan="2">Clay</td></tr>
<tr><td colspan="3">Sand</td><td colspan="3">Silt</td></tr>
<tr><td rowspan="2">U.S. BUREAU</td><td rowspan="2">Gravel</td><td>Coarse</td><td>Medium</td><td>Fine</td><td>V.Fine</td><td rowspan="2">Silt</td><td rowspan="2" colspan="2">Clay</td></tr>
<tr><td colspan="4">Sand</td></tr>
</table>

MW-3
Hole No.

SS-4
Sample Number

10.0'-11.5'
Depth

Morrison Environmental
Limited

North Oakville Subwatershed Study
Oakville, Ontario

GRAIN SIZE CURVE

July 2002	208-021	FIGURE: MEL-37

25-Sep-2002

MORRISON ENVIRONMENTAL LTD.
1087 Meyerside Drive, Unit 1
Mississauga, ON
L5T 1M5

Page: 1
Copy: 2 of 2

Attn: Simon Howell
Project: 208-021
PO #:
Received: 16-Sep-2002 10:50

Job: 2259308
Status: Final

Water Samples

Sample Id	Ag ICAP mg/L	Al ICAP mg/L	As ICAP mg/L	B ICAP mg/L	Ba ICAP mg/L	Be ICAP mg/L	Bi ICAP mg/L	Ca ICAP mg/L
MW-1	<0.005	<0.03	<0.2	0.22	0.038	<0.0005	<0.2	62.9
MW-2	<0.005	<0.03	<0.2	0.34	0.010	<0.0005	<0.2	67.3
MW-3	<0.005	<0.03	<0.2	0.71	0.022	<0.0005	<0.2	153.
MW-4	<0.005	<0.03	<0.2	1.17	0.019	<0.0005	<0.2	133.
M.E.L. 3A (MA)	<0.005	<0.03	<0.2	1.50	0.009	<0.0005	<0.2	89.0
M.E.L. 11 (BAZAR)	<0.005	<0.03	<0.2	1.28	0.020	<0.0005	<0.2	91.3
M.E.L. 45 (RAMPEN)	<0.005	<0.03	<0.2	0.07	0.071	<0.0005	<0.2	185.
M.E.L. 59B (ALDAZ)	<0.005	<0.03	<0.2	1.74	0.025	<0.0005	<0.2	81.0
Sample+Spike (found)	---	---	1.1	---	0.990	0.987	---	---
Sample+Spike (expected)	---	---	1.0	---	1.03	1.00	---	---
Blank	<0.005	<0.03	<0.2	<0.01	<0.005	<0.0005	<0.2	<0.05
QC Standard (found)	0.030	9.63	1.1	0.19	0.951	1.00	1.0	51.1
QC Standard (expected)	0.030	10.0	1.0	0.20	1.00	1.00	1.0	51.0
Repeat MW-1	<0.005	<0.03	<0.2	0.23	0.038	<0.0005	<0.2	63.0

25-Sep-2002

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Attn: Simon Howell
Project: 208-021
PO #:
Received: 16-Sep-2002 10:50

Job: 2259308
Status: Final

Water Samples

Sample Id	Cd ICAP mg/L	Co ICAP mg/L	Cr ICAP mg/L	Cu ICAP mg/L	Fe ICAP mg/L	K ICAP mg/L	Mg ICAP mg/L	Mn ICAP mg/L
MW-1	<0.005	<0.005	<0.005	<0.005	<0.01	6	109.	0.017
MW-2	<0.005	<0.005	<0.005	<0.005	<0.01	8	185.	0.088
MW-3	<0.005	<0.005	<0.005	<0.005	<0.01	26	224.	0.306
MW-4	<0.005	<0.005	<0.005	<0.005	<0.01	19	164.	0.251
M.E.L. 3A (MA)	<0.005	<0.005	<0.005	0.015	<0.01	14	116.	0.030
M.E.L. 11 (BAZAR)	<0.005	<0.005	<0.005	<0.005	<0.01	11	109.	<0.005
M.E.L. 45 (RAMPEN)	<0.005	<0.005	<0.005	0.009	<0.01	2	22.7	<0.005
M.E.L. 59B (ALDAZ)	<0.005	<0.005	<0.005	<0.005	<0.01	15	57.0	0.012
Sample+Spike (found)	0.954	0.942	0.972	0.946	0.94	---	---	0.959
Sample+Spike (expected)	1.00	1.00	1.00	1.00	1.00	---	---	1.01
Blank	<0.005	<0.005	<0.005	<0.005	<0.01	<1	<0.05	<0.005
QC Standard (found)	0.981	0.970	0.987	0.968	0.97	9	10.9	0.967
QC Standard (expected)	1.00	1.00	1.00	1.00	1.00	10	11.0	1.00
Repeat MW-1	<0.005	<0.005	<0.005	<0.005	<0.01	5	109.	0.017

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Attn: Simon Howell
Project: 208-021
PO #:
Received: 16-Sep-2002 10:50

Job: 2259308
Status: Final

Water Samples

Sample Id	Mo ICAP mg/L	Na ICAP mg/L	Ni ICAP mg/L	P ICAP mg/L	Pb ICAP mg/L	S ICAP mg/L	Sb ICAP mg/L	Se ICAP mg/L
MW-1	<0.02	76.7	<0.02	0.2	<0.05	64.2	<0.2	<0.2
MW-2	0.04	87.5	<0.02	0.1	<0.05	130.	<0.2	<0.2
MW-3	0.06	122.	<0.02	<0.1	<0.05	346.	<0.2	<0.2
MW-4	0.05	159.	<0.02	<0.1	<0.05	312.	<0.2	<0.2
M.E.L. 3A (MA)	0.02	121.	<0.02	<0.1	<0.05	194.	<0.2	<0.2
M.E.L. 11 (BAZAR)	0.03	124.	<0.02	0.1	<0.05	163.	<0.2	<0.2
M.E.L. 45 (RAMPEN)	<0.02	129.	<0.02	<0.1	<0.05	20.2	<0.2	<0.2
M.E.L. 59B (ALDAZ)	<0.02	69.9	<0.02	0.8	<0.05	43.7	<0.2	<0.2
Sample+Spike (found)	0.99	---	0.95	---	0.99	---	0.8	1.0
Sample+Spike (expected)	1.00	---	1.00	---	1.00	---	1.0	1.0
Blank	<0.02	<0.1	<0.02	<0.1	<0.05	<0.1	<0.2	<0.2
QC Standard (found)	1.11	47.1	0.98	2.1	0.99	9.9	0.9	1.1
QC Standard (expected)	1.10	50.0	1.00	2.0	1.00	10.0	1.0	1.0
Repeat MW-1	0.04	76.5	<0.02	0.2	<0.05	63.5	<0.2	<0.2

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Job: 2259308
Status: Final

Water Samples

	Si	Sn	Sr	Ti	V	Zn	F-	Cl-
	ICAP	ICAP	ICAP	ICAP	ICAP	ICAP	SM 4500F	SM 4110B
Sample Id	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-1	7.46	<0.05	1.43	<0.005	<0.005	0.013	0.6	28.2
MW-2	6.20	<0.05	2.83	<0.005	<0.005	<0.005	0.3	7.0
MW-3	9.21	<0.05	6.10	<0.005	<0.005	<0.005	0.3	25.6
MW-4	8.34	<0.05	10.3	<0.005	<0.005	<0.005	0.3	32.5
M.E.L. 3A (MA)	5.23	<0.05	7.99	<0.005	<0.005	0.027	0.3	37.1
M.E.L. 11 (BAZAR)	8.52	<0.05	9.82	<0.005	<0.005	<0.005	0.3	130.
M.E.L. 45 (RAMPEN)	4.97	<0.05	0.394	<0.005	<0.005	0.118	0.1	373.
M.E.L. 59B (ALDAZ)	5.93	<0.05	13.9	<0.005	<0.005	<0.005	0.3	120.
Sample+Spike (found)	---	---	---	0.891	0.949	1.01	---	---
Sample+Spike (expected)	---	---	---	1.00	1.00	1.01	---	---
Blank	<0.05	<0.05	<0.001	<0.005	<0.005	<0.005	<0.1	<0.5
QC Standard (found)	2.08	0.96	0.854	0.922	0.965	0.984	5.2	20.5
QC Standard (expected)	2.00	1.00	1.00	1.00	1.00	1.00	5.0	20.0
Repeat MW-1	7.51	<0.05	1.44	<0.005	<0.005	0.012	0.6	27.4

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Water Samples

Sample Id	NO2-N SM 4110B mg/L	PO4-3 SM 4110B mg/L	Br- SM 4110B mg/L	NO3-N SM 4110B mg/L	SO4= SM 4110B mg/L	pH SM 4500B pH Units	Alk 8.3 SM 2320B mg CaCO3/L
MW-1	<0.2	<1	<0.5	0.6	200.	7.63	<1
MW-2	<0.2	<1	<0.5	<0.2	426.	7.38	<1
MW-3	<0.2	<1	<0.5	<0.2	1120.	7.27	<1
MW-4	<0.2	<1	<0.5	<0.2	988.	7.41	<1
M.E.L. 3A (MA)	0.5	<1	<0.5	0.2	630.	7.52	<1
M.E.L. 11 (BAZAR)	<0.2	<1	1.4	0.9	528.	7.58	<1
M.E.L. 45 (RAMPEN)	<0.2	<1	<0.5	6.0	62.6	7.57	<1
M.E.L. 59B (ALDAZ)	<0.2	<1	<0.5	1.2	139.	7.61	<1
Sample+Spike (found)	---	---	---	---	---	---	---
Sample+Spike (expected)	---	---	---	---	---	---	---
Blank	<0.2	<1	<0.5	<0.2	<0.5	---	<1
QC Standard (found)	10.2	47	19.8	10.1	48.8	7.02	<1
QC Standard (expected)	10.0	50	20.0	10.0	50.0	7.00	<1
Repeat MW-1	<0.2	<1	<0.5	0.6	203.	7.66	<1

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Water Samples

Sample Id	Alk 4.2 SM 2320B mg CaCO3/L	NH3-N SM 4500H mg/L	DOC SM 5310C mg/L	pHs Calc. pH Units	CAB Calc. %	Hard(Calc) SM 2340B mg CaCO3/L	CO3= Calc. mg/L
MW-1	574	0.18	4.2	6.94	2.39	609.3	1
MW-2	660	0.21	11.0	6.88	-0.86	931.4	1
MW-3	465	0.36	11.6	6.72	1.86	1308.	1
MW-4	368	0.53	3.4	6.87	2.07	1009.	1
M.E.L. 3A (MA)	347	0.80	0.5	7.04	3.31	703.1	1
M.E.L. 11 (BAZAR)	310	1.01	1.0	7.07	3.78	679.1	1
M.E.L. 45 (RAMPEN)	331	<0.03	0.8	6.72	4.61	557.4	1
M.E.L. 59B (ALDAZ)	356	1.02	0.9	7.03	4.49	437.3	1
Sample+Spike (found)	---	0.69	9.3	nan	nan	nan	nan
Sample+Spike (expected)	---	0.72	9.3	nan	nan	nan	nan
Blank	<5	<0.03	<0.2	11.92	52.5	0.3	nan
QC Standard (found)	248	1.46	10.2	7.36	5.78	172.9	1
QC Standard (expected)	250	1.50	10.0	7.36	4.89	172.6	1
Repeat MW-1	578	0.19	4.5	6.94	2.74	609.9	1

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Water Samples

Sample Id	HCO3- Calc. mg/L	L.I. Calc. None	A.I. Calc. None	R.S.I. Calc. None	Sp. Cond. SM 2510B umhos/cm	Colour SM 2120B TCU	Turb. SM 2130B NTU	TDS SM 2540C mg/L
MW-1	697	0.7	13.17	6.3	1337	6	1.1	916
MW-2	802	0.5	13.17	6.4	1751	65	1.9	1290
MW-3	565	0.5	13.05	6.2	2456	33	4.7	2236
MW-4	446	0.5	12.98	6.3	2244	20	5.4	1982
M.E.L. 3A (MA)	421	0.5	12.91	6.6	1727	<3	0.7	1336
M.E.L. 11 (BAZAR)	376	0.5	12.90	6.6	1762	6	1.0	1334
M.E.L. 45 (RAMPEN)	401	0.8	12.84	5.9	1770	<3	0.2	1190
M.E.L. 59B (ALDAZ)	432	0.6	12.80	6.5	1200	4	0.8	758
Sample+Spike (found)	nan	nan	nan	nan	---	---	---	---
Sample+Spike (expected)	nan	nan	nan	nan	---	---	---	---
Blank	nan	nan	nan	nan	<1	<3	<0.2	<2
QC Standard (found)	300	-0.3	11.65	7.7	720	51	1.8	254
QC Standard (expected)	302	-0.4	11.64	7.7	718	50	1.8	250
Repeat MW-1	702	0.7	13.21	6.2	1336	6	1.2	914

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Status: Final

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: ....

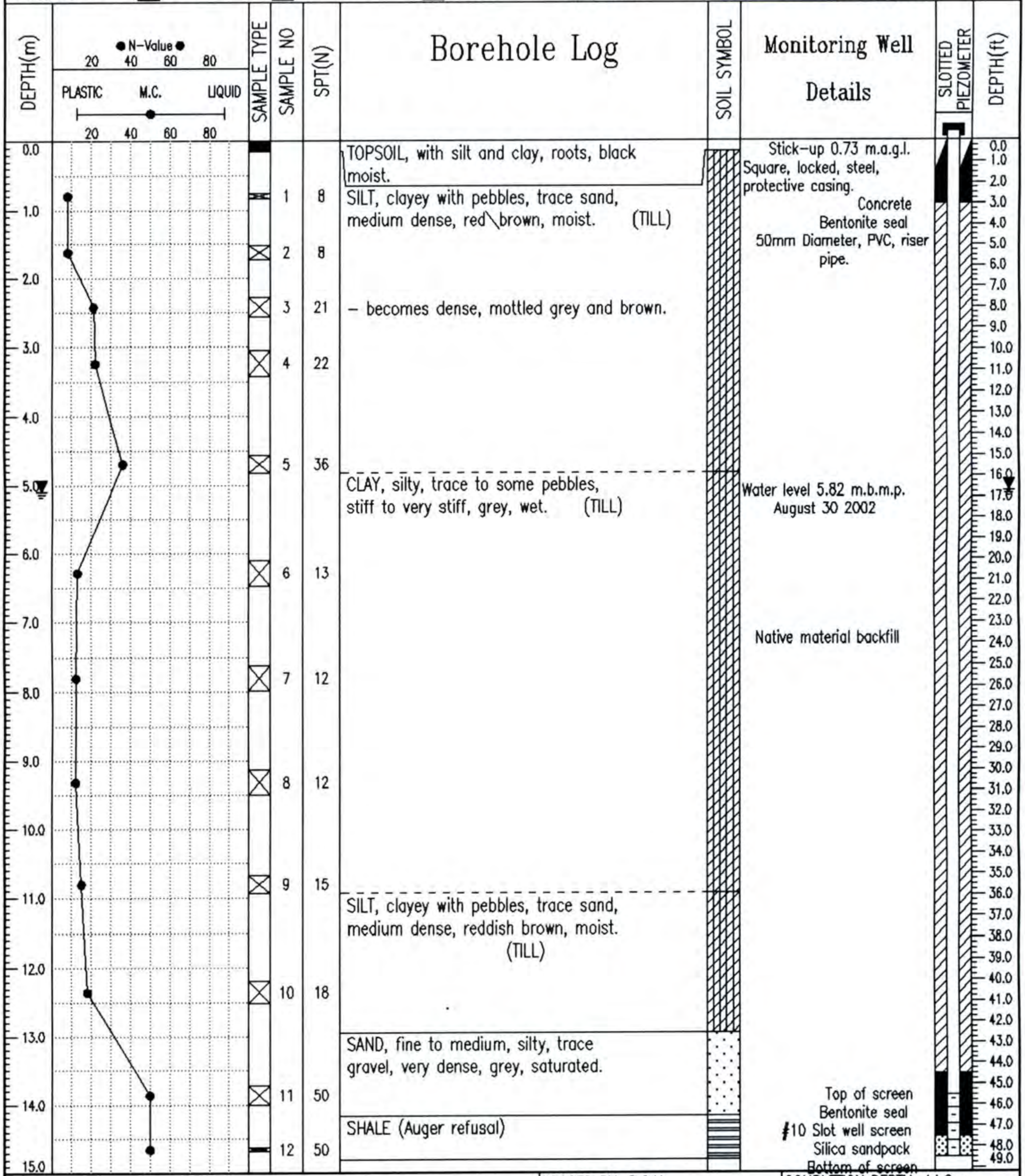
Ralph Siebert, B.Sc.
Section Supervisor, Metals

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW-1
N. Oakville Creeks Subwatershed Study.	Date: May 29 2002	PROJECT NO: 208-021
Moore Reservoir, Oakville, Halton	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ░ SAND

Borehole Log



SAMPLE NO	SPT(N)
1	8
2	8
3	21
4	22
5	36
6	13
7	12
8	12
9	15
10	18
11	50
12	50

TOPSOIL, with silt and clay, roots, black moist.

SILT, clayey with pebbles, trace sand, medium dense, red\brown, moist. (TILL)

– becomes dense, mottled grey and brown.

CLAY, silty, trace to some pebbles, stiff to very stiff, grey, wet. (TILL)

SILT, clayey with pebbles, trace sand, medium dense, reddish brown, moist. (TILL)

SAND, fine to medium, silty, trace gravel, very dense, grey, saturated.

SHALE (Auger refusal)

Stick-up 0.73 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.

Water level 5.82 m.b.m.p.
August 30 2002

Native material backfill

Top of screen
Bentonite seal
#10 Slot well screen
Silica sandpack
Bottom of screen

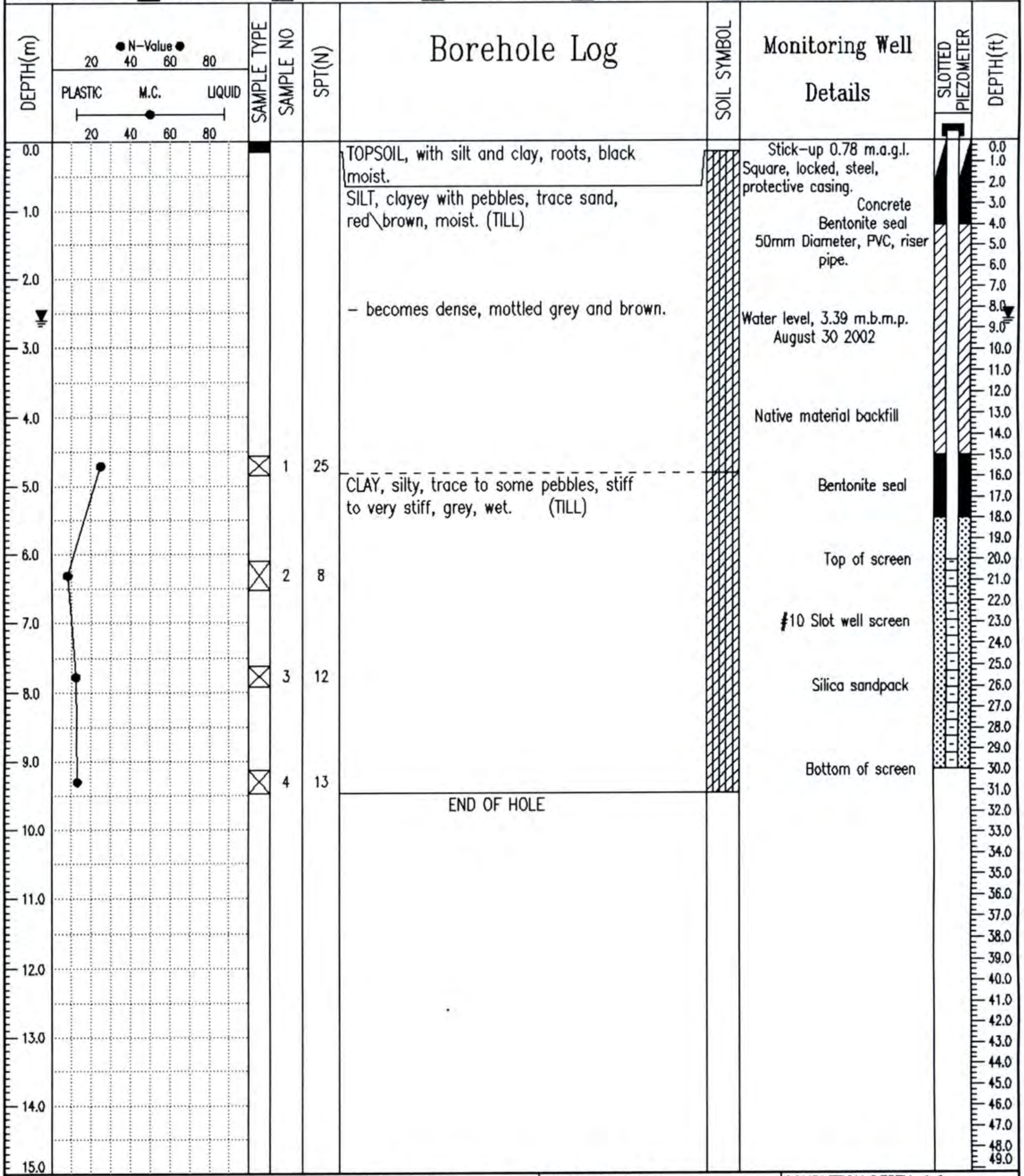
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 14.8 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/29/02
	Fig. No: MEL-1	Page 1 of 1

04/08/08 11:16AM

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW-2
N. Oakville Creeks Subwatershed Study.	Date: May 29 2002	PROJECT NO: 208-021
Moore Reservoir, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND



Borehole Log

TOPSOIL, with silt and clay, roots, black moist.

SILT, clayey with pebbles, trace sand, red\brown, moist. (TILL)

– becomes dense, mottled grey and brown.

CLAY, silty, trace to some pebbles, stiff to very stiff, grey, wet. (TILL)

END OF HOLE

SAMPLE NO	SPT(N)
1	25
2	8
3	12
4	13

Monitoring Well Details

Stick-up 0.78 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.
Water level, 3.39 m.b.m.p. August 30 2002
Native material backfill
Bentonite seal
Top of screen
#10 Slot well screen
Silica sandpack
Bottom of screen

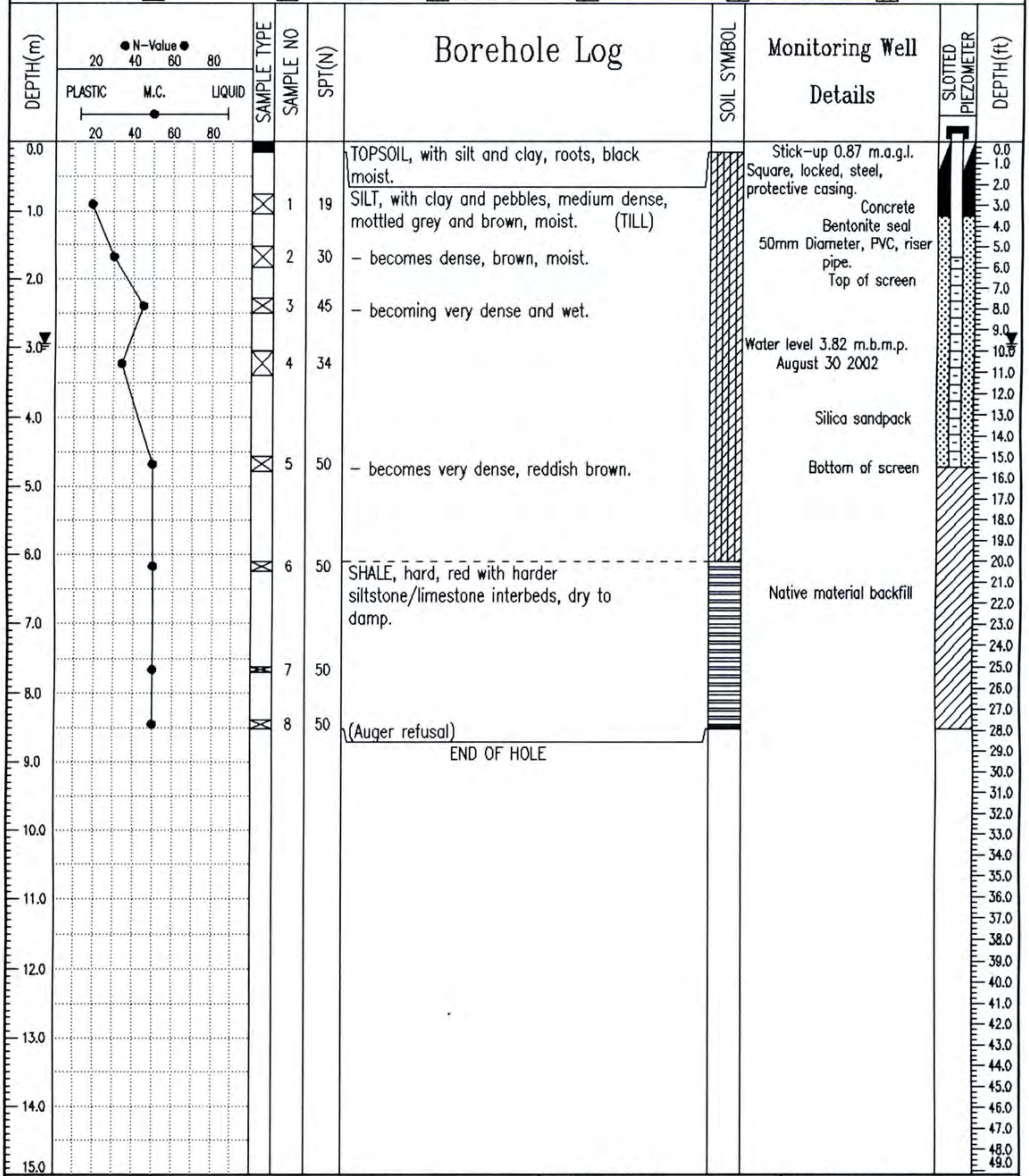
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 9.6 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/29/02
	Fig. No: MEL-2	Page 1 of 1

04/08/06 11:21AM

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW–3
N. Oakville Creeks Subwatershed Study.	Date: May 29/30 2002	PROJECT NO: 208–021
Bazar Property, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE: ■ GRAB; ◺ NO RECOVERY; ☒ SPT; ☰ A-CASING; ▥ SHELBY TUBE; ▮ CORE

BACKFILL TYPE: ■ BENTONITE; ⁚ PEA GRAVEL; ▥ SLOUGH; ⁖ GROUT; ▨ DRILL CUTTINGS; ░ SAND



Borehole Log

Monitoring Well Details

SAMPLE NO	SPT(N)	Borehole Log	Monitoring Well Details
		TOPSOIL, with silt and clay, roots, black moist.	Stick–up 0.87 m.a.g.l. Square, locked, steel, protective casing.
1	19	SILT, with clay and pebbles, medium dense, mottled grey and brown, moist. (TILL)	Concrete Bentonite seal 50mm Diameter, PVC, riser pipe.
2	30	– becomes dense, brown, moist.	Top of screen
3	45	– becoming very dense and wet.	
4	34		Water level 3.82 m.b.m.p. August 30 2002
			Silica sandpack
5	50	– becomes very dense, reddish brown.	Bottom of screen
6	50	SHALE, hard, red with harder siltstone/limestone interbeds, dry to damp.	Native material backfill
7	50		
8	50	(Auger refusal) END OF HOLE	

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 8.5 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/30/02
	Fig. No: MEL–3	Page 1 of 1

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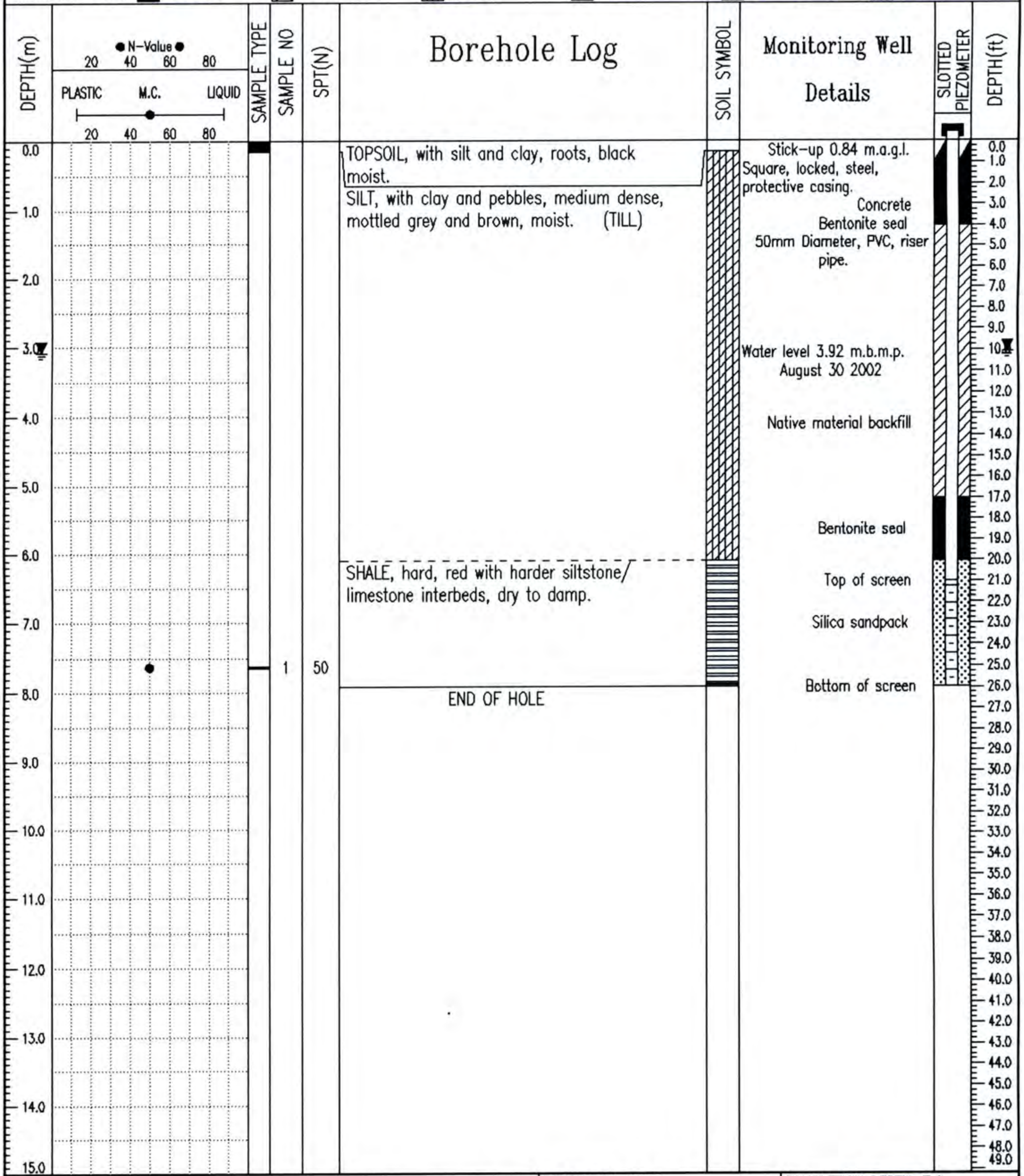
Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW-4
N. Oakville Creeks Subwatershed Study.	Date: May 30 2002	PROJECT NO: 208-021
Bazar Property, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND



Borehole Log

TOPSOIL, with silt and clay, roots, black moist.

SILT, with clay and pebbles, medium dense, mottled grey and brown, moist. (TILL)

SHALE, hard, red with harder siltstone/limestone interbeds, dry to damp.

SAMPLE NO	SPT(N)
1	50

END OF HOLE

Monitoring Well Details

Stick-up 0.84 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.

Water level 3.92 m.b.m.p.
August 30 2002

Native material backfill

Bentonite seal

Top of screen

Silica sandpack

Bottom of screen

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 7.9 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/30/02
	Fig. No: MEL-4	Page 1 of 1

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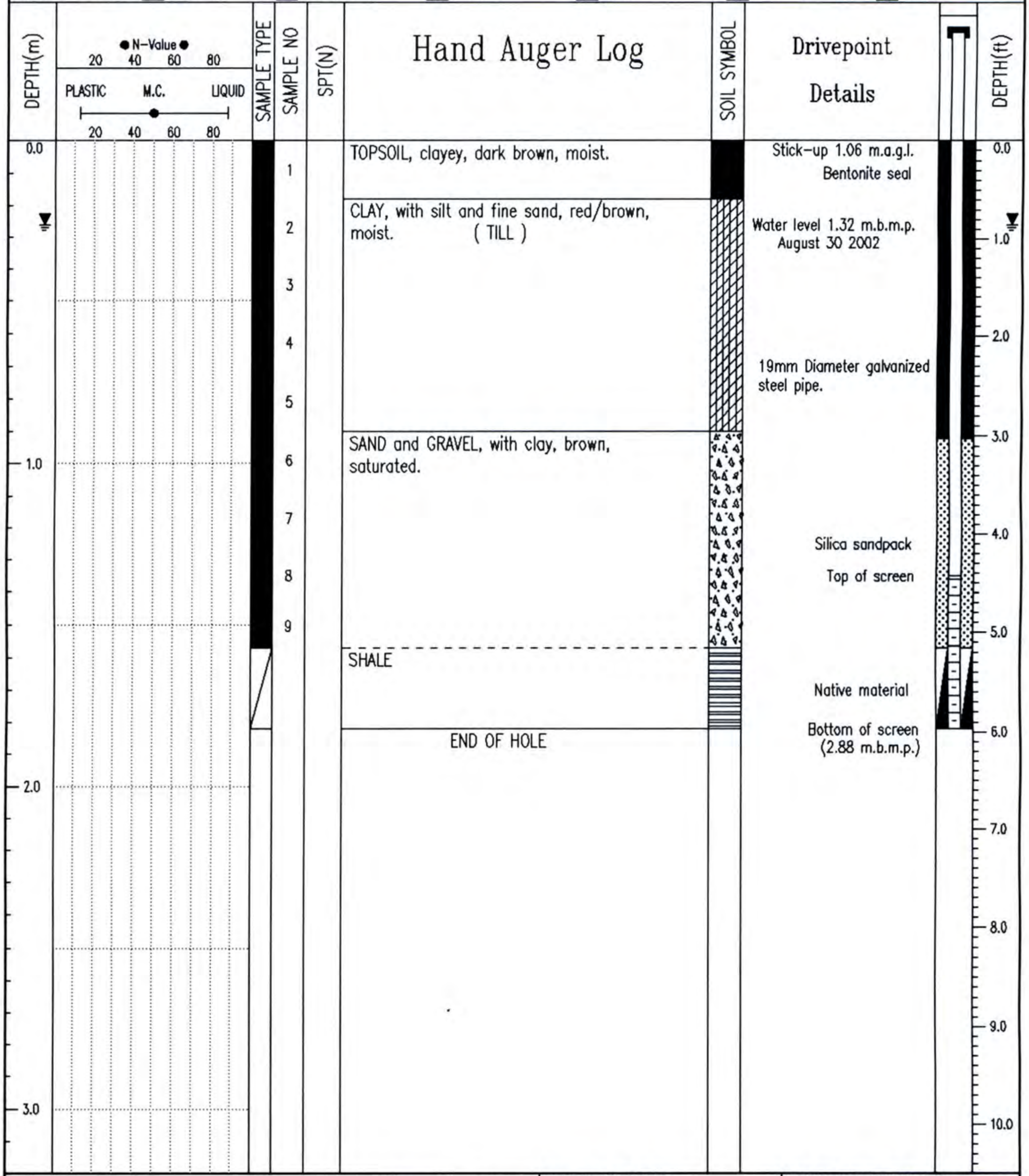
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP1
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208-021
Memorial Gardens, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◸ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁖ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



TOPSOIL, clayey, dark brown, moist.

CLAY, with silt and fine sand, red/brown, moist. (TILL)

SAND and GRAVEL, with clay, brown, saturated.

SHALE

END OF HOLE

Drivepoint Details

Stick-up 1.06 m.a.g.l.

Bentonite seal

Water level 1.32 m.b.m.p.
August 30 2002

19mm Diameter galvanized steel pipe.

Silica sandpack

Top of screen

Native material

Bottom of screen
(2.88 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
	Fig. No: MEL-5	Page 1 of 1

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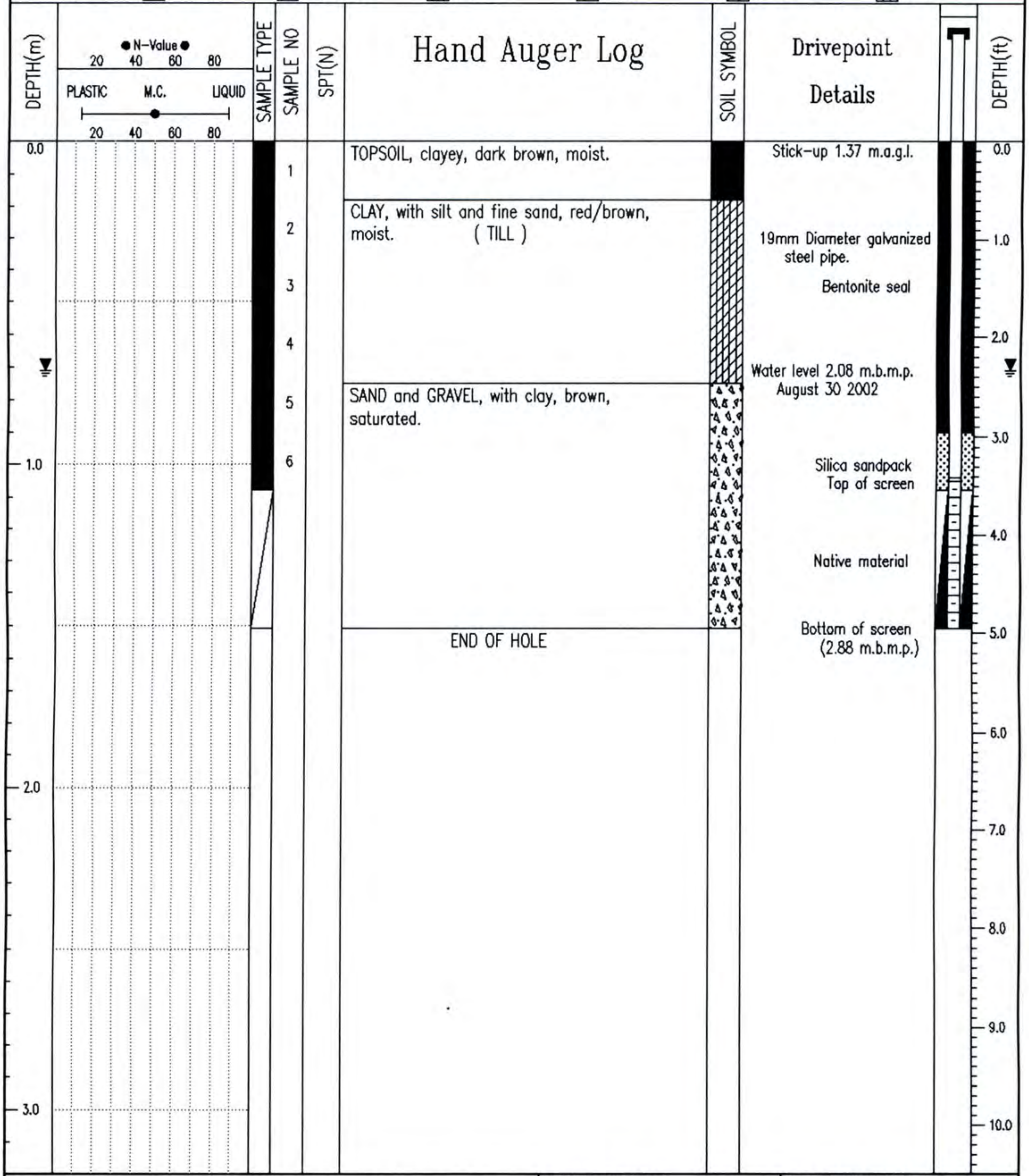
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP2
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208-021
Memorial Gardens, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◪ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▌ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



Depth	Description
	TOPSOIL, clayey, dark brown, moist.
	CLAY, with silt and fine sand, red/brown, moist. (TILL)
	SAND and GRAVEL, with clay, brown, saturated.
	END OF HOLE

Drivepoint Details

Stick-up 1.37 m.a.g.l.

19mm Diameter galvanized steel pipe.

Bentonite seal

Water level 2.08 m.b.m.p. August 30 2002

Silica sandpack

Top of screen

Native material

Bottom of screen (2.88 m.b.m.p.)

Morrison Environmental Limited

Mississauga, Ontario

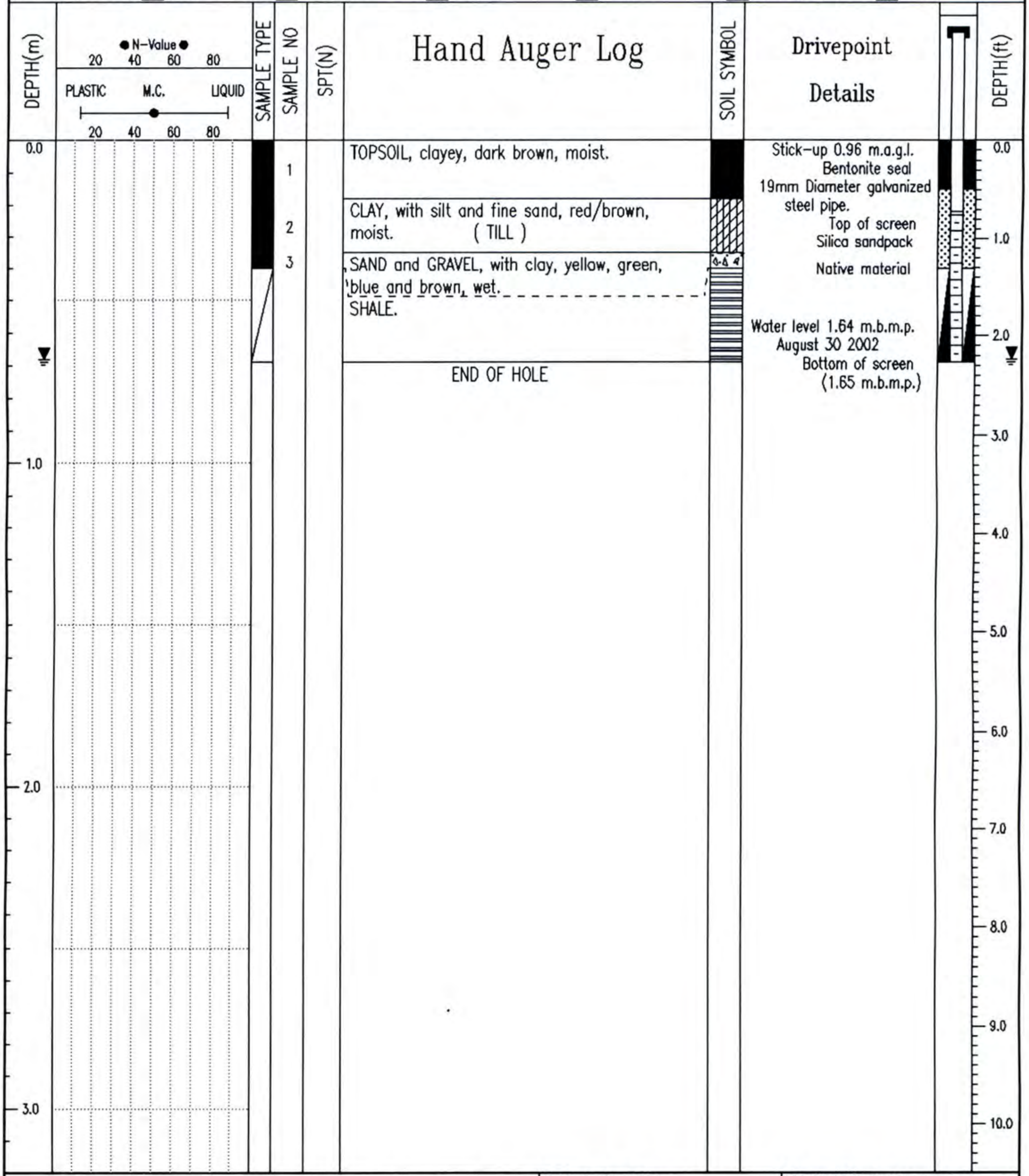
LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
Fig. No: MEL-6	Page 1 of 1

04/08/06 11:27AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP3
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208-021
Accord Reality Limited, Oakville, Halton	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	▤ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ PEA GRAVEL	▥ SLOUGH	⁘ GROUT	▨ DRILL CUTTINGS	⁘ SAND

Hand Auger Log



TOPSOIL, clayey, dark brown, moist.

CLAY, with silt and fine sand, red/brown, moist. (TILL)

SAND and GRAVEL, with clay, yellow, green, blue and brown, wet.

SHALE.

END OF HOLE

Drivepoint Details

Stick-up 0.96 m.a.g.l.
Bentonite seal
19mm Diameter galvanized steel pipe.
Top of screen
Silica sandpack
Native material
Water level 1.64 m.b.m.p.
August 30 2002
Bottom of screen
(1.65 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 0.7 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
	Fig. No: MEL-7	Page 1 of 1

04/08/06 11:27AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP4
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208-021
Accord Reality, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0		■	1		TOPSOIL, clayey, dark brown, moist.	■	Stick-up 1.35 m.a.g.l. 19mm Diameter galvanized steel pipe.	0.0
		■	2 3 4		CLAY, with silt and fine sand, red/brown, moist. (TILL)	▨	Bentonite seal	1.0 2.0
		■	5		SAND and GRAVEL, with clay, yellow, green, blue and brown, wet.	⁙	Silica sand backfill Water level 2.14 m.b.m.p. August 30 2002	
1.0					SHALE.	☰	Top of screen Native material	3.0 4.0
					END OF HOLE		Bottom of screen (2.88 m.b.m.p.)	5.0
2.0								6.0 7.0 8.0
3.0								9.0 10.0

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
Fig. No: MEL-8	Page 1 of 1

Morrison Environmental Limited
Mississauga, Ontario

04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP5
N. Oakville Creeks Subwatershed Study.	Date: August 15 2002	PROJECT NO: 208–021
Lakeport Developement Company, Oakville.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▦ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m) | ● N–Value ● 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | SPT(N) | SOIL SYMBOL | DEPTH(ft)

DEPTH(m)	SAMPLE NO	Hand Auger Log
0.0	1	SILT, clayey, light brown, dry.
	2	SILT, clayey, brown, damp. (TILL)
	3	SILT, clayey, dark brown, moist. (TILL)
1.0	4	SILT, clayey, red, moist.(TILL)
		END OF HOLE
2.0		
3.0		

Drivepoint Details

Stick–up 1.69 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.

Silica sandpack

Top of screen

Native material
Water level dry
August 30 2002
Bottom of screen
(2.94 m.b.m.p.)

DEPTH(ft): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
REVIEWED BY: D.SAWICKI	COMPLETE: 08/15/02
Fig. No: MEL–9	Page 1 of 1

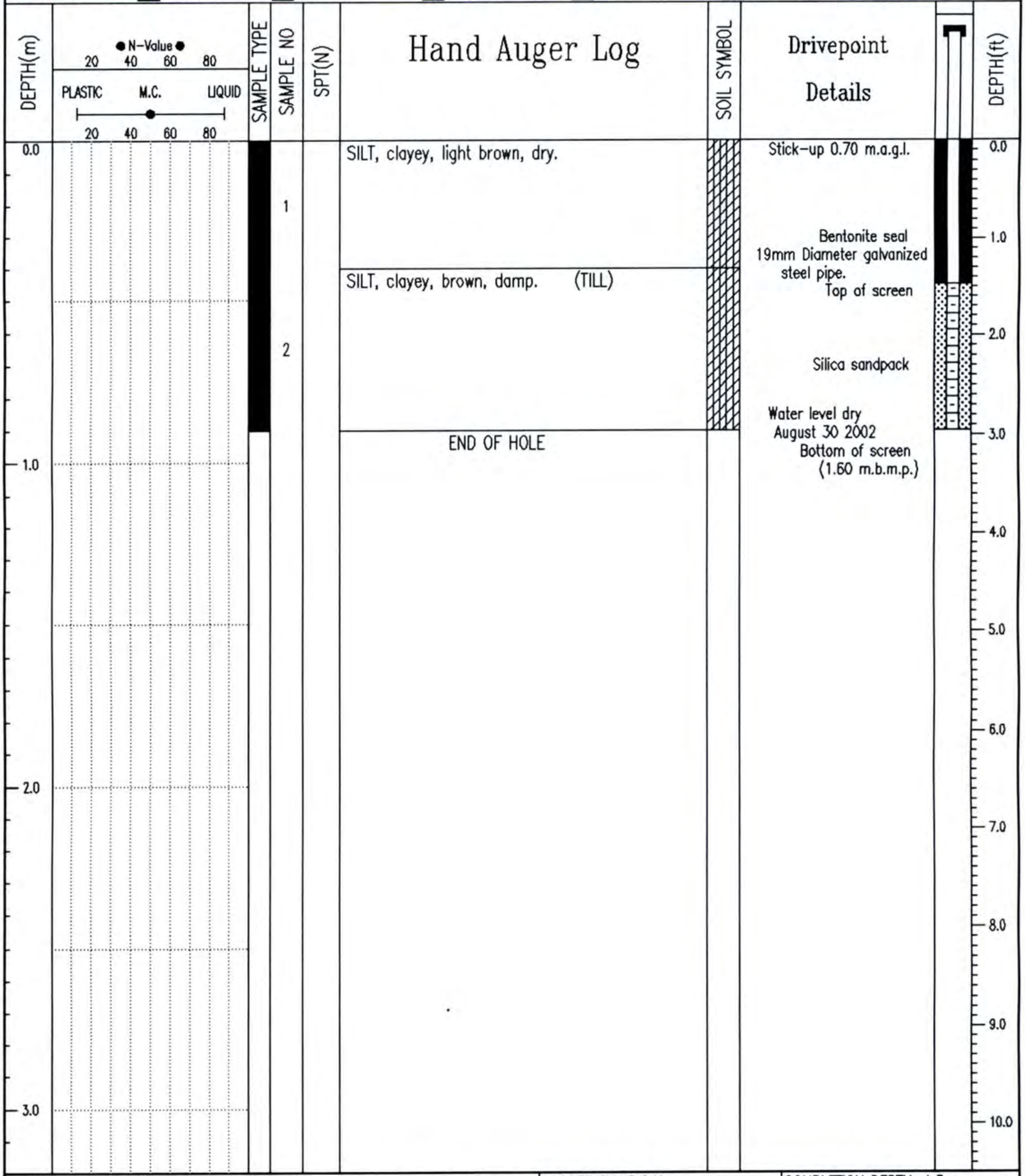
04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP6
N. Oakville Creeks Subwatershed Study.	Date: August 15 2002	PROJECT NO: 208-021
Lakeport Developement Company, Oakville.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◫ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⛶ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



SILT, clayey, light brown, dry.

SILT, clayey, brown, damp. (TILL)

END OF HOLE

Stick-up 0.70 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.
Top of screen

Silica sandpack

Water level dry
August 30 2002
Bottom of screen
(1.60 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 08/15/02
	Fig. No: MEL-10	Page 1 of 1

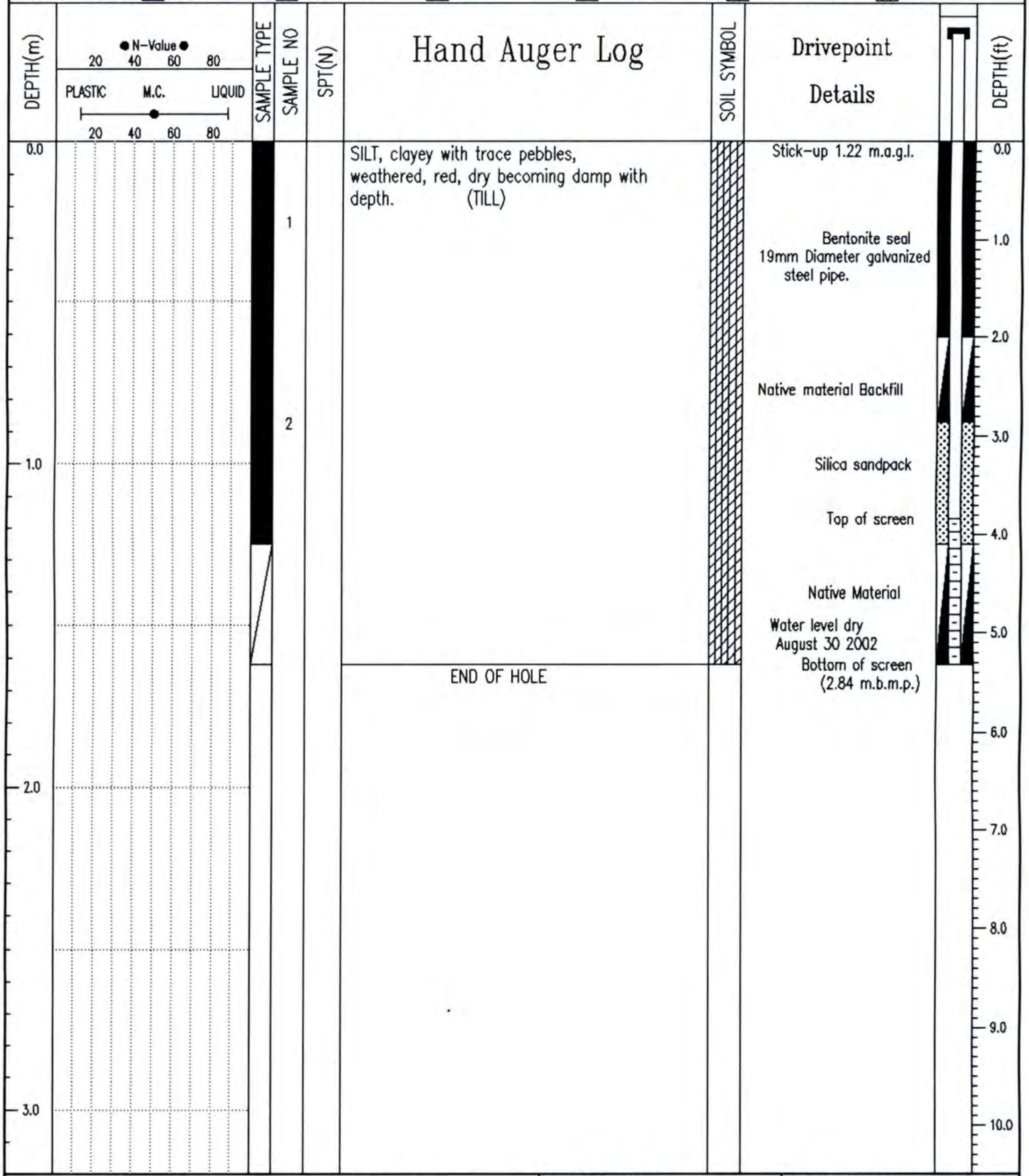
04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP7
N. Oakville Creeks Subwatershed Study.	Date: July 10 2002	PROJECT NO: 208-021
Tribaden Investments Incorporated	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▌ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



SILT, clayey with trace pebbles, weathered, red, dry becoming damp with depth. (TILL)

END OF HOLE

Drivepoint Details

Stick-up 1.22 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.

Native material Backfill

Silica sandpack

Top of screen

Native Material

Water level dry
August 30 2002

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.6 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/10/02
	Fig. No: MEL-11	Page 1 of 1

04/08/06 11:29AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP8
N. Oakville Creeks Subwatershed Study.	Date: July 10 2002	PROJECT NO: 208-021
Tribaden Investments Incorporated	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◪ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0		■	1		SILT, clayey with trace sand and pebbles weathered, red, dry becoming moist with depth. (TILL)	▨	Stick-up 0.99 m.a.g.l. Bentonite seal 19mm Diameter galvanized steel pipe.	0.0 1.0
		■	2			▨	Native material backfill	2.0
		◪				▨	Top of screen Native material	3.0
1.0		◪				▨	Water level dry August 30 2002	
					END OF HOLE		Bottom of screen (2.22 m.b.m.p.)	4.0
								5.0 6.0
2.0								7.0 8.0 9.0
3.0								10.0

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/10/02
	Fig. No: MEL-12	Page 1 of 1

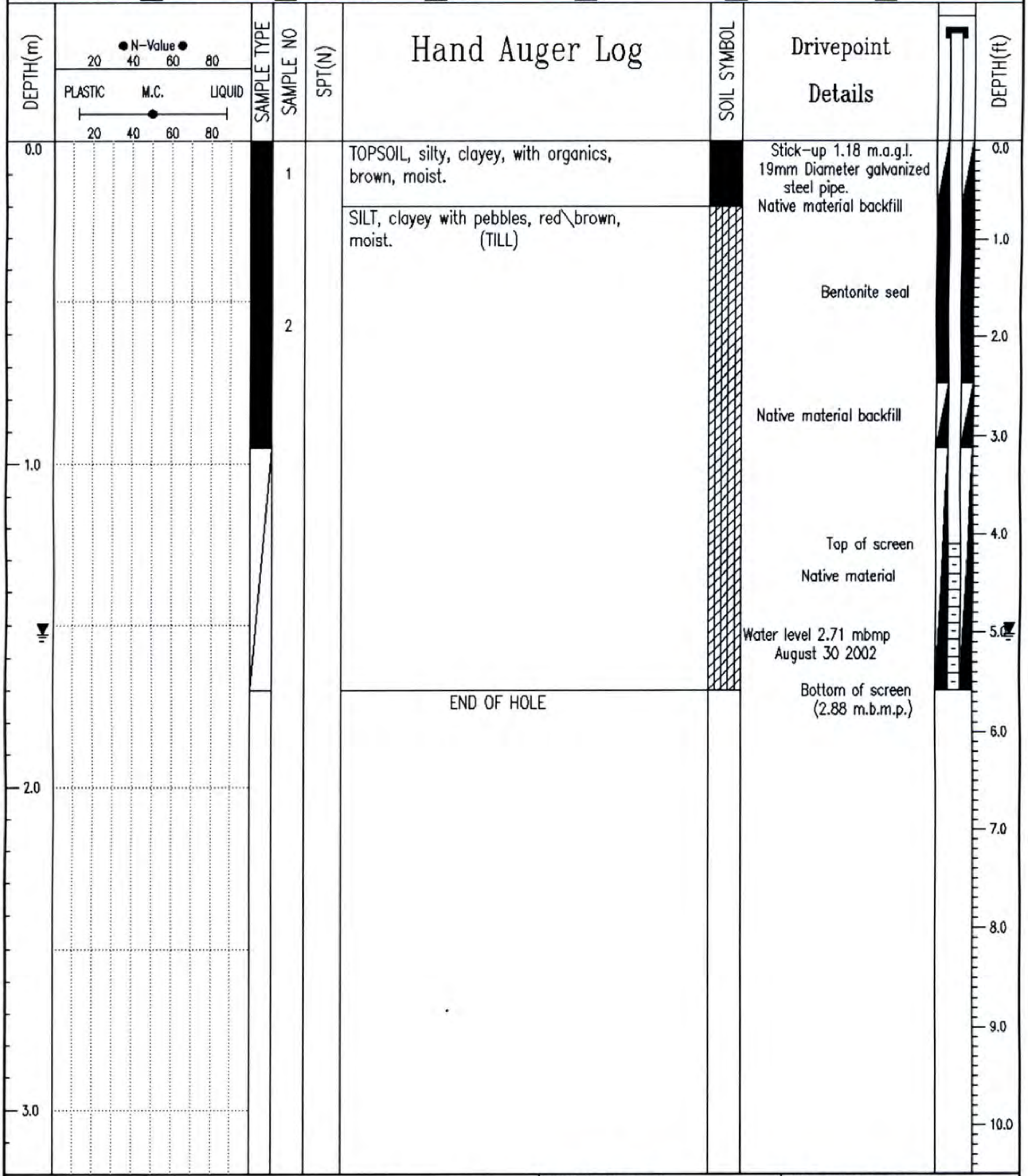
04/08/06 11:29AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP9
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Staroak Developments	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▒ SAND

Hand Auger Log



TOPSOIL, silty, clayey, with organics, brown, moist.

SILT, clayey with pebbles, red\brown, moist. (TILL)

END OF HOLE

Stick-up 1.18 m.a.g.l.
19mm Diameter galvanized steel pipe.
Native material backfill

Bentonite seal

Native material backfill

Top of screen

Native material

Water level 2.71 mbmp
August 30 2002

Bottom of screen
(2.88 m.b.m.p.)

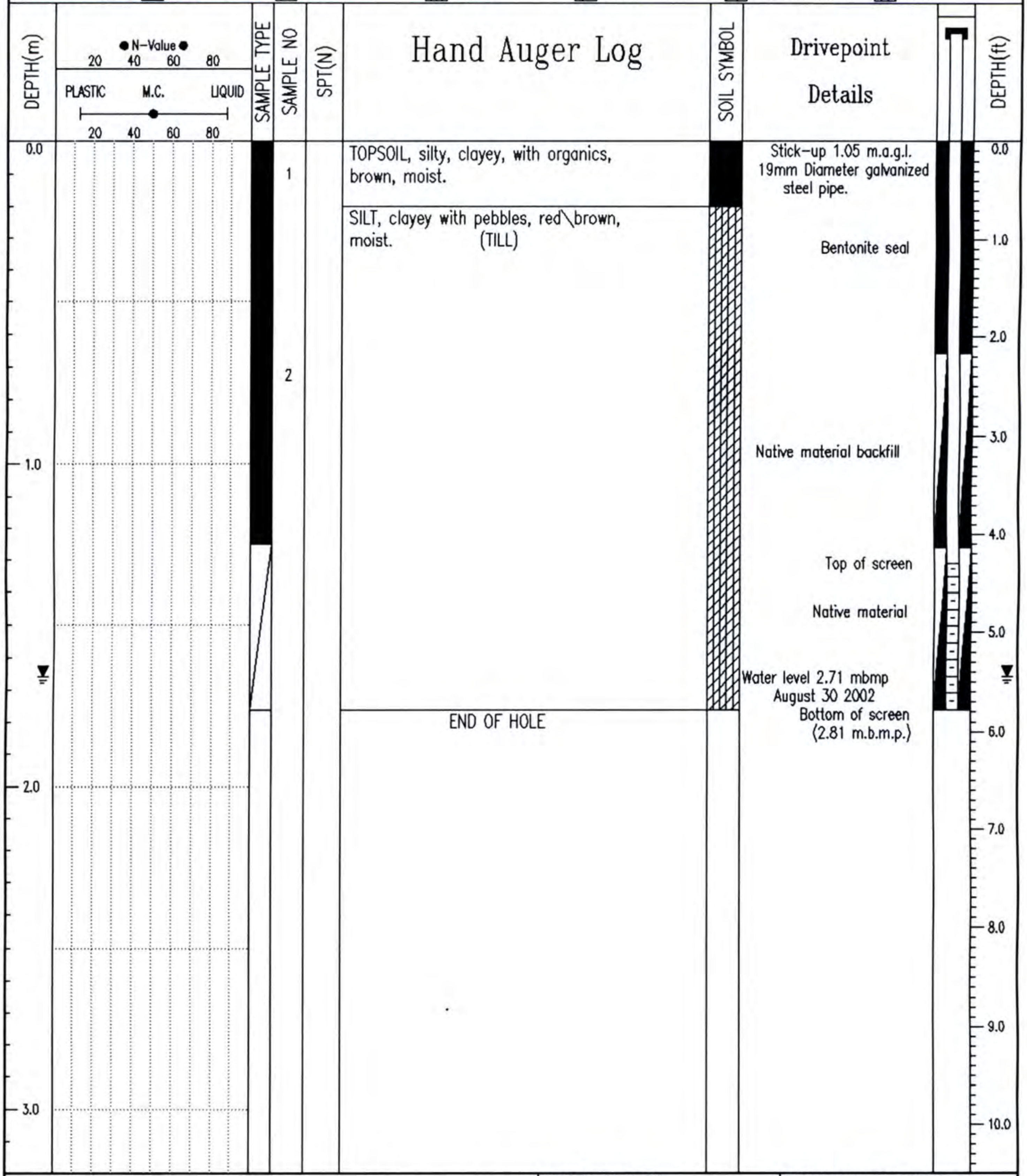
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.7 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
	Fig. No: MEL-13	Page 1 of 1

04/08/08 11:30AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP10
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Staroak Developments	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND



Hand Auger Log

TOPSOIL, silty, clayey, with organics, brown, moist.

SILT, clayey with pebbles, red\brown, moist. (TILL)

END OF HOLE

Drivepoint Details

Stick-up 1.05 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Native material backfill

Top of screen

Native material

Water level 2.71 mbmp
August 30 2002

Bottom of screen
(2.81 m.b.m.p.)

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
Fig. No: MEL-14	Page 1 of 1

04/08/06 11:30AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP11
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Docasa Group Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▦ SAND

DEPTH(m) | ● N-Value ● 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | SPT(N) | SOIL SYMBOL | DEPTH(ft)

Hand Auger Log

0.0

FILL, silty, clayey, red/brown, dry to damp.

CLAY, silty, grey, moist.

SILT, clayey with pebbles, grey, moist. (TILL)

1.0

- becomes saturated .

2.0

END OF HOLE

3.0

Drivepoint Details

Stick-up 0.87 m.a.g.l.
Bentonite seal
19mm Diameter galvanized steel pipe.

Native material

Top of screen

Water level 2.52 mbmp
August 30 2002

Bottom of screen
(2.86 m.b.m.p.)

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 2.0 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
Fig. No: MEL-15	Page 1 of 1

04/08/06 11:31AM

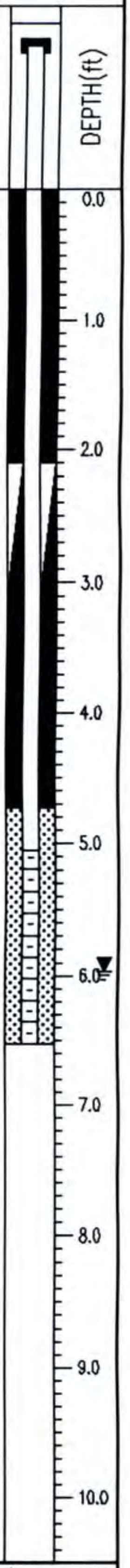
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP12
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Docasa Group Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details
0.0		■	1		FILL, silty, clayey, red/brown, dry to damp.	▩	Stick-up 0.88 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal
		■	2		CLAY, silty, grey, moist.	▨	Native material backfill
1.0		■	3		SILT, clayey with pebbles, grey, moist. (TILL)	▥	Bentonite Seal Top of screen
▼		■	4		- becomes wet.	▥	Silica Sandpack Water level 2.70 mbmp August 30 2002
2.0					END OF HOLE		Bottom of screen (2.87 m.b.m.p.)
3.0							



Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.

REVIEWED BY: D.SAWICKI

Fig. No: MEL-16

COMPLETION DEPTH: 2.0 m

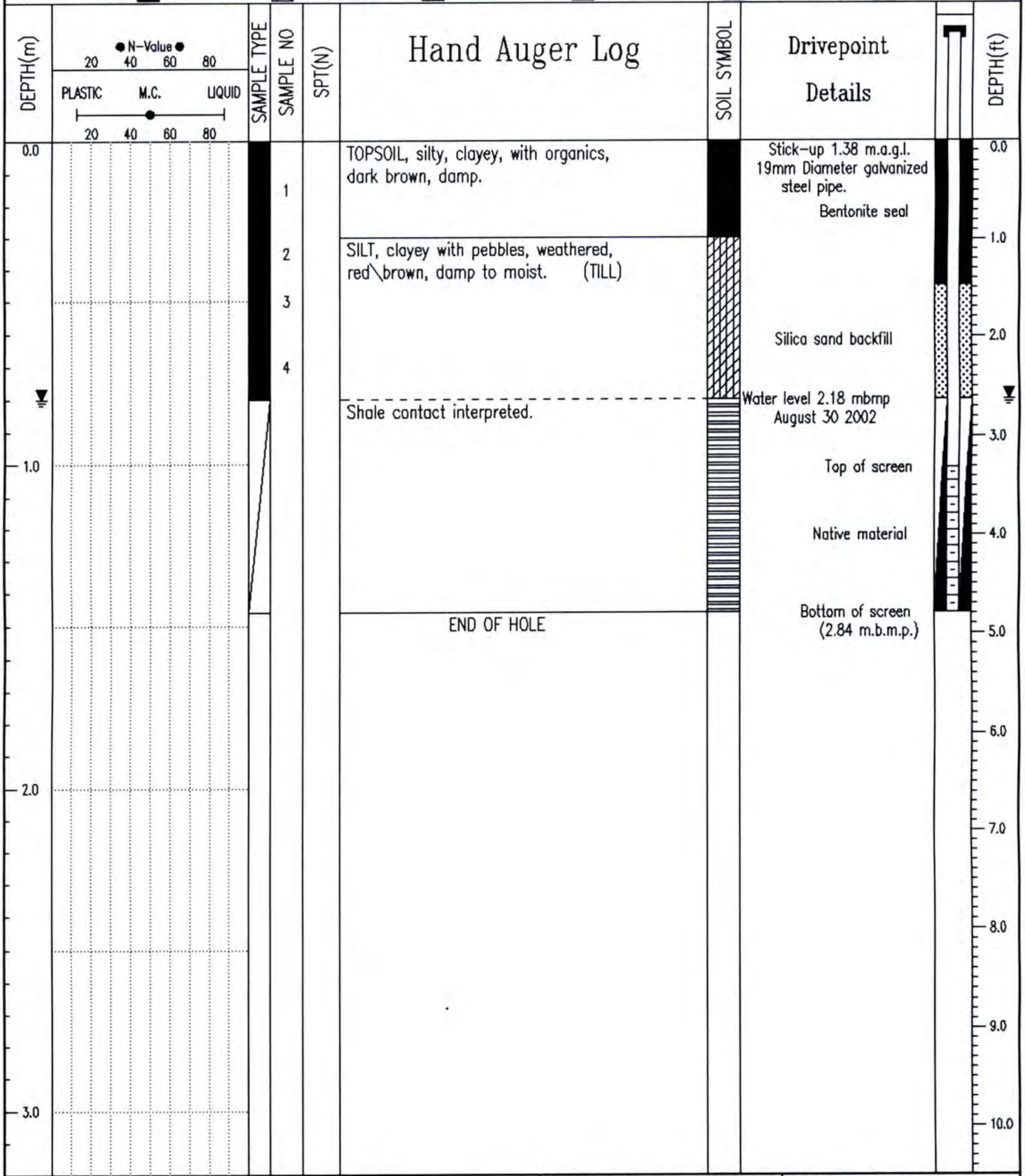
COMPLETE: 07/15/02

04/08/06 11:31AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP13
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Pendent Developments Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▩ SAND



Hand Auger Log

TOPSOIL, silty, clayey, with organics, dark brown, damp.

SILT, clayey with pebbles, weathered, red\brown, damp to moist. (TILL)

Shale contact interpreted.

END OF HOLE

Drivepoint Details

Stick-up 1.38 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill

Water level 2.18 mbmp
August 30 2002

Top of screen

Native material

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited
Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
Fig. No: MEL-17	Page 1 of 1

04/08/06 11:32AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP14
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Pendent Developments Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁝ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0		■	1		TOPSOIL, silty, clayey, with organics, dark brown, damp.	■	Stick-up 1.64 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal	0.0 1.0
		■	2 3 4		SILT, clayey with pebbles, weathered, red\brown, moist. (TILL) – becomes wet.	▨	Silica sandpack Top of screen	2.0
1.0		◿	5		CLAY, sandy, silty, grey, moist. Shale contact interpreted.	☰	Water level 2.56 mbmp August 30 2002 Native material Bottom of screen (2.89 m.b.m.p.)	3.0 4.0
					END OF HOLE			5.0 6.0 7.0
2.0								8.0 9.0
3.0								10.0

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
	Fig. No: MEL-18	Page 1 of 1

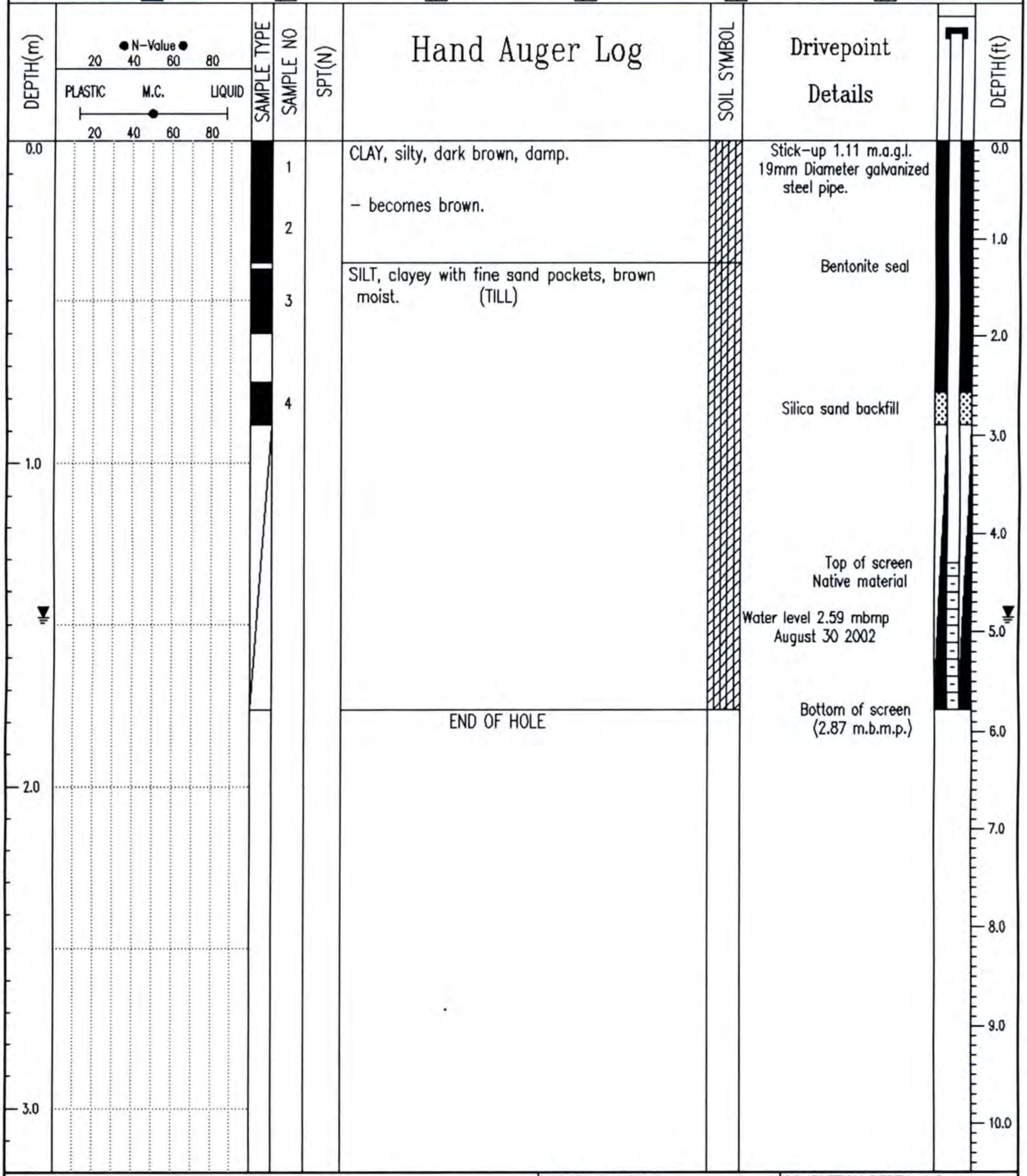
04/08/06 11:32AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP15
N. Oakville Creeks Subwatershed Study.	Date: July 22 2002	PROJECT NO: 208-021
Bazar, Steven, David.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁛ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



CLAY, silty, dark brown, damp.

- becomes brown.

SILT, clayey with fine sand pockets, brown moist. (TILL)

END OF HOLE

Stick-up 1.11 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill

Top of screen
Native material

Water level 2.59 mbmp
August 30 2002

Bottom of screen
(2.87 m.b.m.p.)

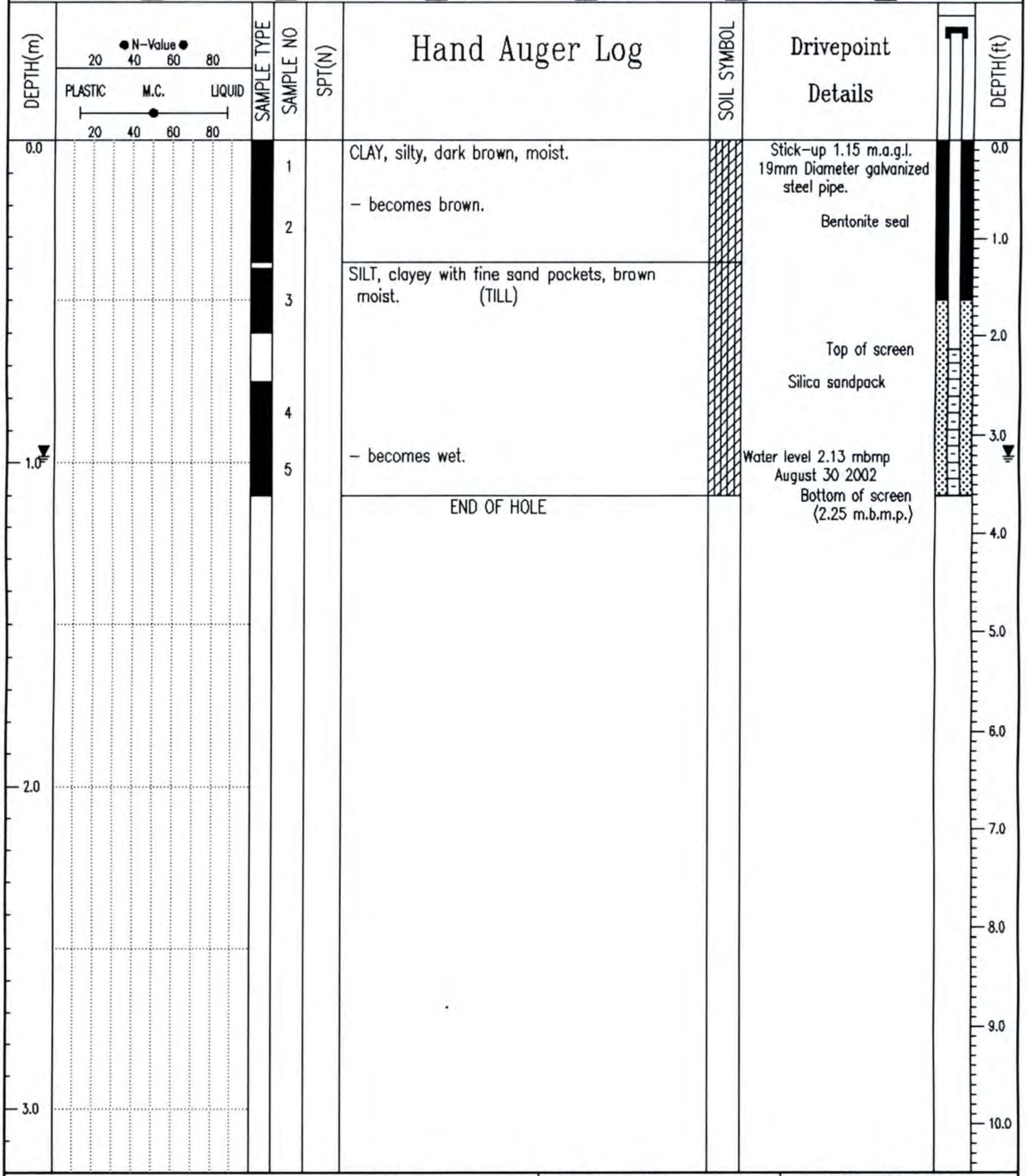
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/22/02
	Fig. No: MEL-19	Page 1 of 1

04/08/06 11:33AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP16
N. Oakville Creeks Subwatershed Study.	Date: July 22 2002	PROJECT NO: 208-021
Bazar, Steven, David.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	☰ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ PEA GRAVEL	▥ SLOUGH	▨ GROUT	▨ DRILL CUTTINGS	⁘ SAND

Hand Auger Log



CLAY, silty, dark brown, moist.

– becomes brown.

SILT, clayey with fine sand pockets, brown moist. (TILL)

– becomes wet.

END OF HOLE

Stick-up 1.15 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Top of screen

Silica sandpack

Water level 2.13 mbmp
August 30 2002

Bottom of screen
(2.25 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/22/02
	Fig. No: MEL-20	Page 1 of 1

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Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP17
N. Oakville Creeks Subwatershed Study.	Date: July 24 2002	PROJECT NO: 208-021
Rampen, Leo.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	☰ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁚ PEA GRAVEL	▥ SLOUGH	◬ GROUT	▨ DRILL CUTTINGS	▩ SAND

Hand Auger Log

● N-Value ●
20 40 60 80

PLASTIC M.C. LIQUID
20 40 60 80

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0	■	1		TOPSOIL, clayey with organics, dark brown, damp.	■	Stick-up 1.09 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal	0.0
	■	2 3		CLAY, silty with some fine sand and trace pebbles, iron staining, brown, moist to wet. – becomes grey.	▨	Water level 1.53 mbmp August 30 2002	1.0 2.0
1.0	■	4		SAND and GRAVEL, silty, brown, saturated.	◬	Top of screen Silica sandpack Bottom of screen (2.23 m.b.m.p.)	3.0
				END OF HOLE			4.0
2.0							5.0 6.0
3.0							7.0 8.0 9.0 10.0

Morrison Environmental Limited
Mississauga, Ontario

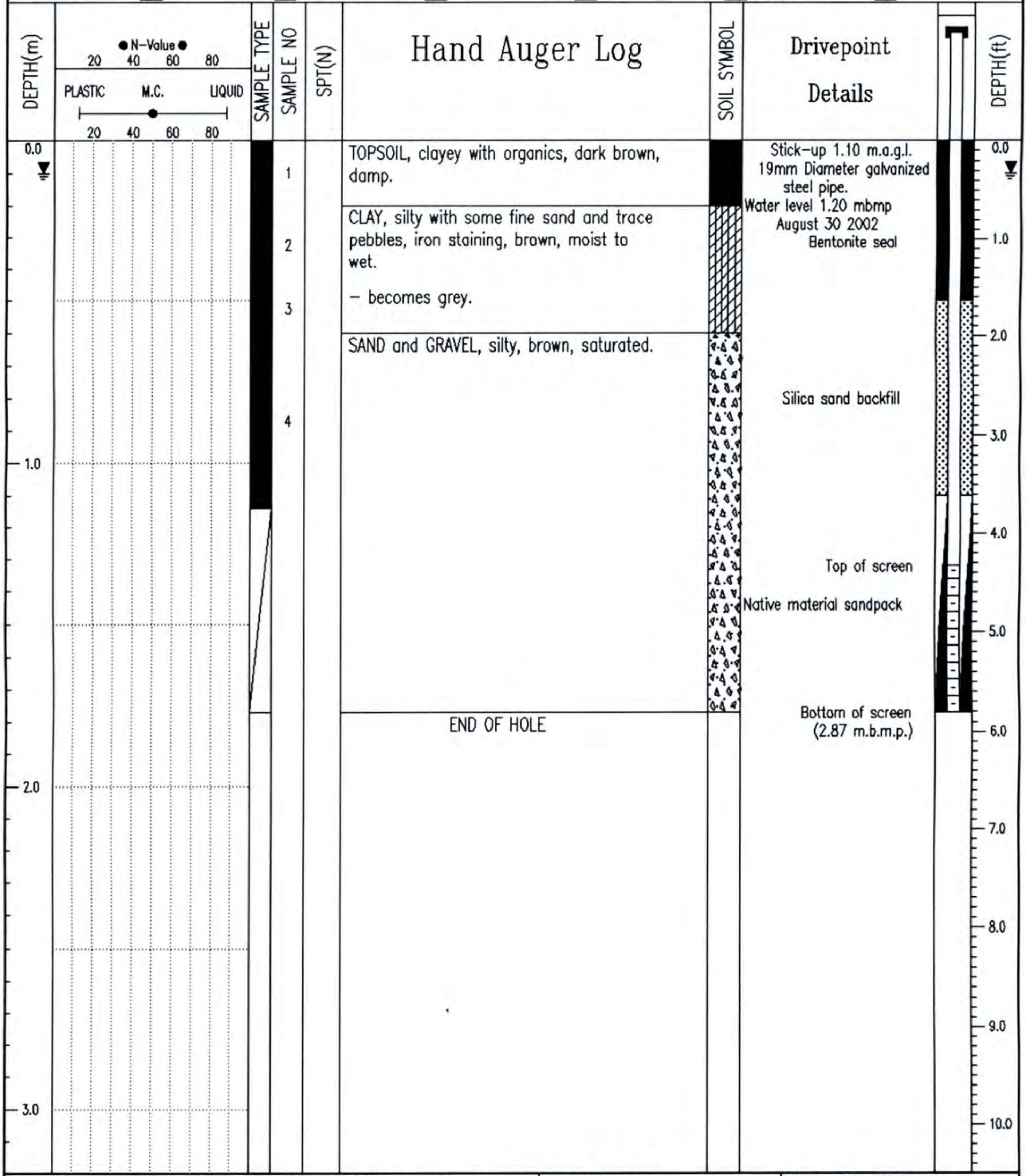
LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/24/02
Fig. No: MEL-21	Page 1 of 1

04/08/06 11:34AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP18
N. Oakville Creeks Subwatershed Study.	Date: July 24 2002	PROJECT NO: 208–021
Rampen, Leo.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁖ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND



Hand Auger Log

TOPSOIL, clayey with organics, dark brown, damp.

CLAY, silty with some fine sand and trace pebbles, iron staining, brown, moist to wet.

– becomes grey.

SAND and GRAVEL, silty, brown, saturated.

END OF HOLE

Drivepoint Details

Stick–up 1.10 m.a.g.l.
19mm Diameter galvanized steel pipe.
Water level 1.20 mbmp
August 30 2002
Bentonite seal

Silica sand backfill

Top of screen

Native material sandpack

Bottom of screen
(2.87 m.b.m.p.)

Morrison Environmental Limited	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
Mississauga, Ontario	REVIEWED BY: D.SAWICKI	COMPLETE: 07/24/02
	Fig. No: MEL–22	Page 1 of 1

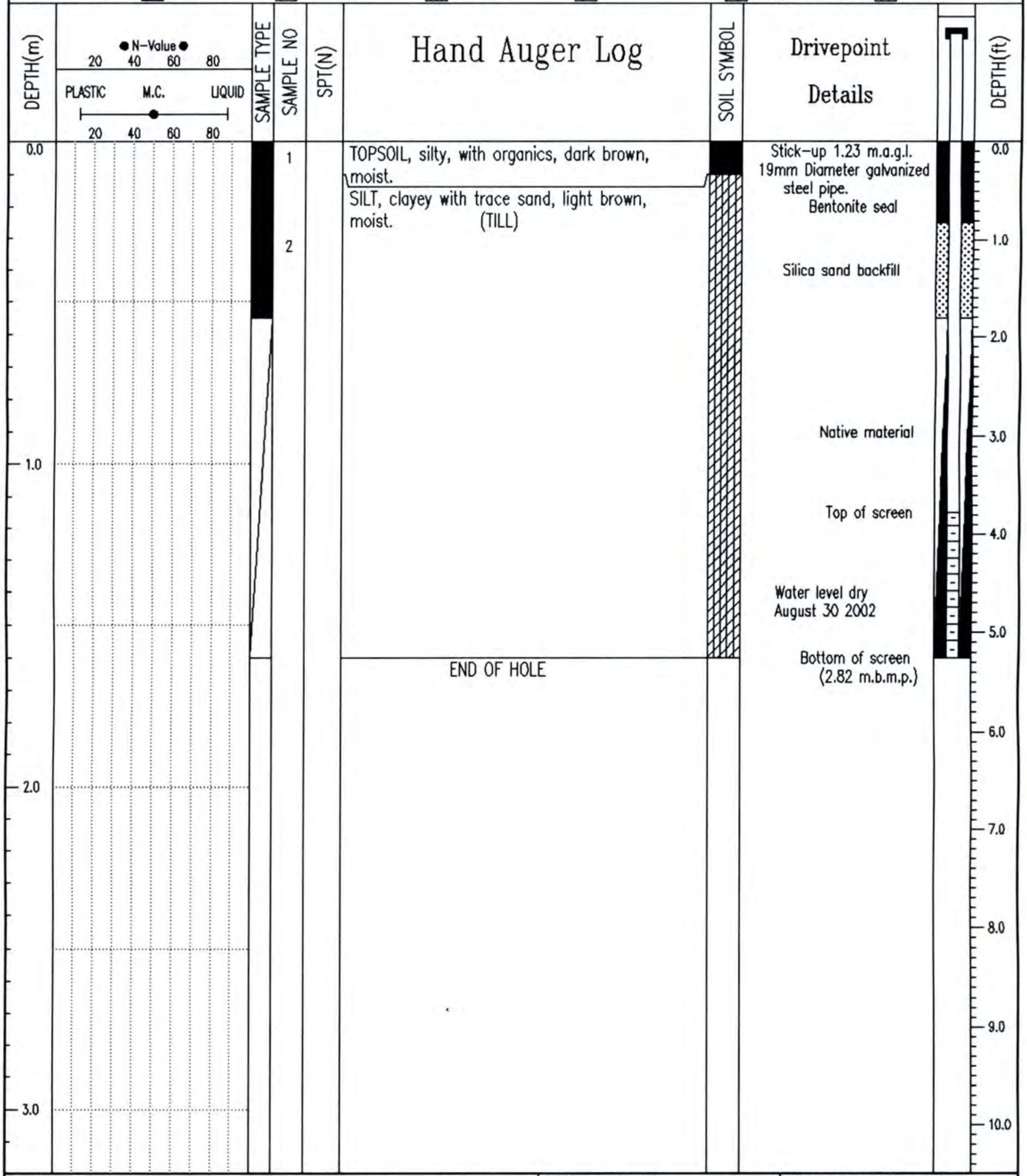
04/08/06 11:35AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP19
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Davis, Minardi Home Corporation.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◺ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▌ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▪ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



TOPSOIL, silty, with organics, dark brown, moist.

SILT, clayey with trace sand, light brown, moist. (TILL)

END OF HOLE

Stick-up 1.23 m.a.g.l.
19mm Diameter galvanized steel pipe.
Bentonite seal

Silica sand backfill

Native material

Top of screen

Water level dry
August 30 2002

Bottom of screen
(2.82 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.6 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
	Fig. No: MEL-23	Page 1 of 1

04/08/06 11:36AM

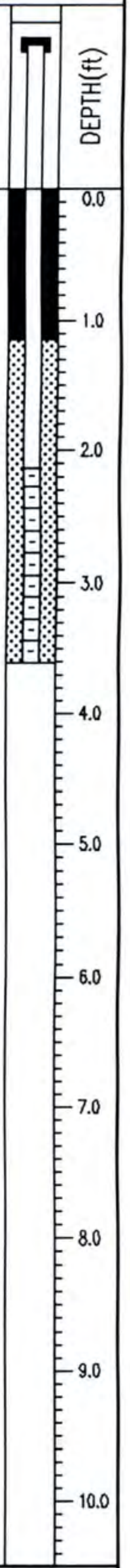
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP20
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Davis, Minardi Home Corporation.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▦ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details
0.0		■	1		TOPSOIL, silty, with organics, dark brown, damp.	■	Stick-up 1.74 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal
		■	2		SILT, clayey with trace sand, light brown, moist. (TILL)	▨	Top of screen Silica sandpack
		■	3			▨	Water level dry August 30 2002
1.0					END OF HOLE		Bottom of screen (2.83 m.b.m.p.)
2.0							
3.0							



Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
	Fig. No: MEL-24	Page 1 of 1

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP21
N. Oakville Creeks Subwatershed Study.	Date: August 14 2002	PROJECT NO: 208-021
Ma, Sylvia	Consultant: Morrison Environmental Ltd.	ELEVATION:

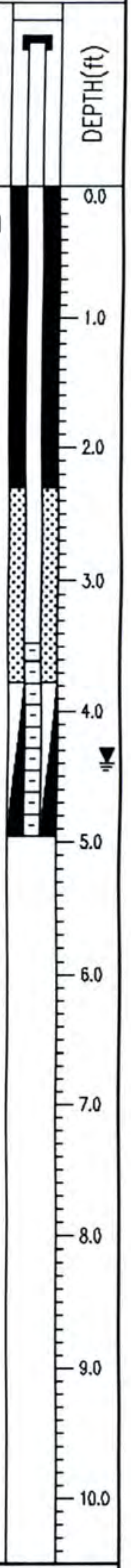
SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁛ PEA GRAVEL ▥ SLOUGH ⁛ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)		SOIL SYMBOL
0.0		■	1		SILT, clayey with trace gravel, brown, moist. (TILL)	▨
		■	2			▨
1.0		■	3			▨
		▨				▨
					END OF HOLE	
2.0						
3.0						

Drivepoint Details



Stick-up 1.33 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sandpack

Top of screen

Native material

Water level 2.67 mbmp
August 30 2002

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited
Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
REVIEWED BY: D.SAWICKI	COMPLETE: 08/14/02
Fig. No: MEL-25	Page 1 of 1

04/08/06 11:37AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP22
N. Oakville Creeks Subwatershed Study.	Date: August 14 2002	PROJECT NO: 208-021
Ma, Sylvia	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◸ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

DEPTH(m) | ● N-Value ● 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | SPT(N)

Hand Auger Log

SOIL SYMBOL

Drivepoint Details

DEPTH(ft)

DEPTH(m)	SAMPLE NO	Hand Auger Log	Drivepoint Details	DEPTH(ft)
0.0	1	SILT, clayey with trace gravel, brown, moist. (TILL)	Stick-up 0.95 m.a.g.l. 19mm Diameter galvanized steel pipe.	0.0
			Bentonite seal	1.0
	2			2.0
				3.0
1.0	3		Silica sand backfill	
				4.0
			Top of screen	5.0
▼			Native material Water level 2.63 mbmp August 30 2002	▼
				6.0
		END OF HOLE	Bottom of screen (2.84 m.b.m.p.)	
2.0				
				7.0
				8.0
				9.0
3.0				10.0

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.9 m
REVIEWED BY: D.SAWICKI	COMPLETE: 08/14/02
Fig. No: MEL-26	Page 1 of 1

04/08/06 11:37AM

Photo 4w.1 Single Piezometer

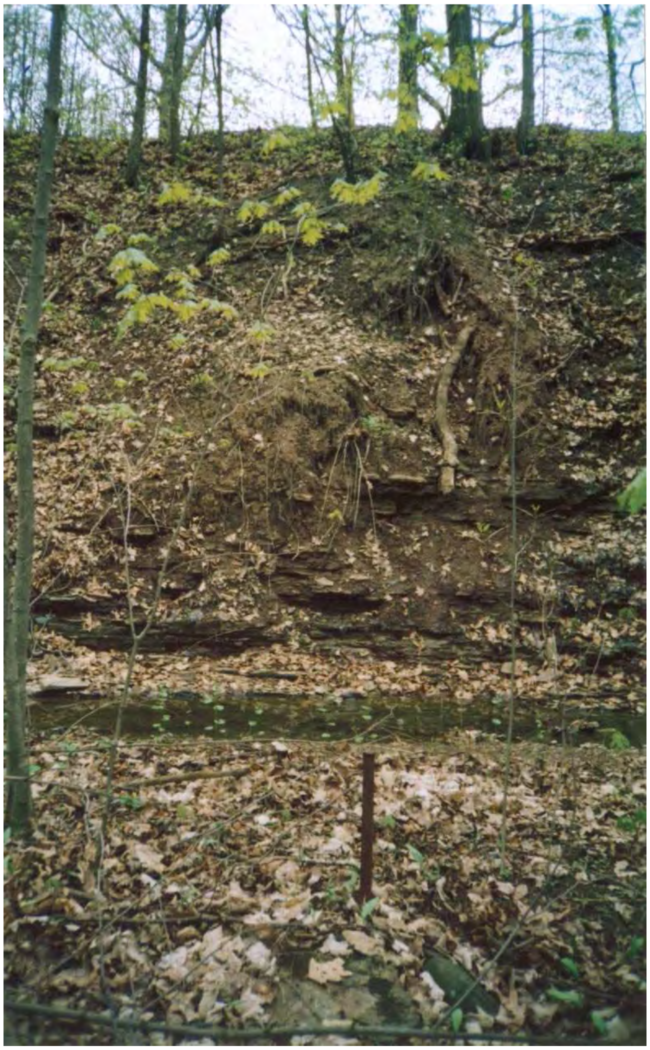


Photo 4.4 Shale Outcrop Along Fourteen Mile Creek. Groundwater was observed discharging to the creek from the base of the outcrop.

Photo 4W.2

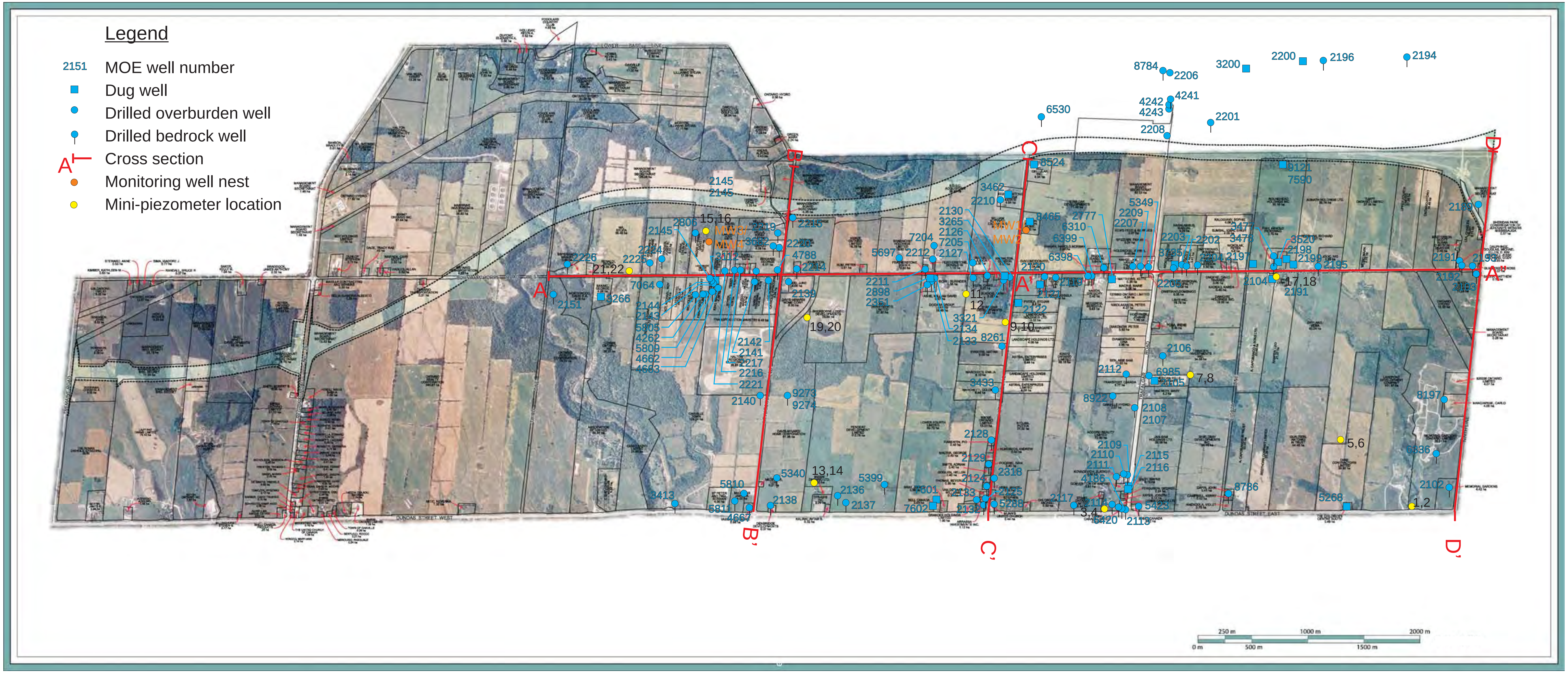
Photo 4.5 Mini-piezometer Nest

Photo E.1 Oblique Photo of much of the study area.
(Note intersection of Tremaine Road and Dundas Street in foreground and gently sloping fluted Till Plain).

Photo E.2 Sixteen Mile Creek Valley Looking South From Highway 407
(Note the exposed horizontally layered red shale of the Queenston Formation)

Photo E.3 Shale Exposed in Fourteen Mile Creek Valley

Photo E.4 Fourteen Mile Creek Valley North of Dundas
Note the alluvium in the stream valley, and the shale pieces indicating the creek bed is on bedrock



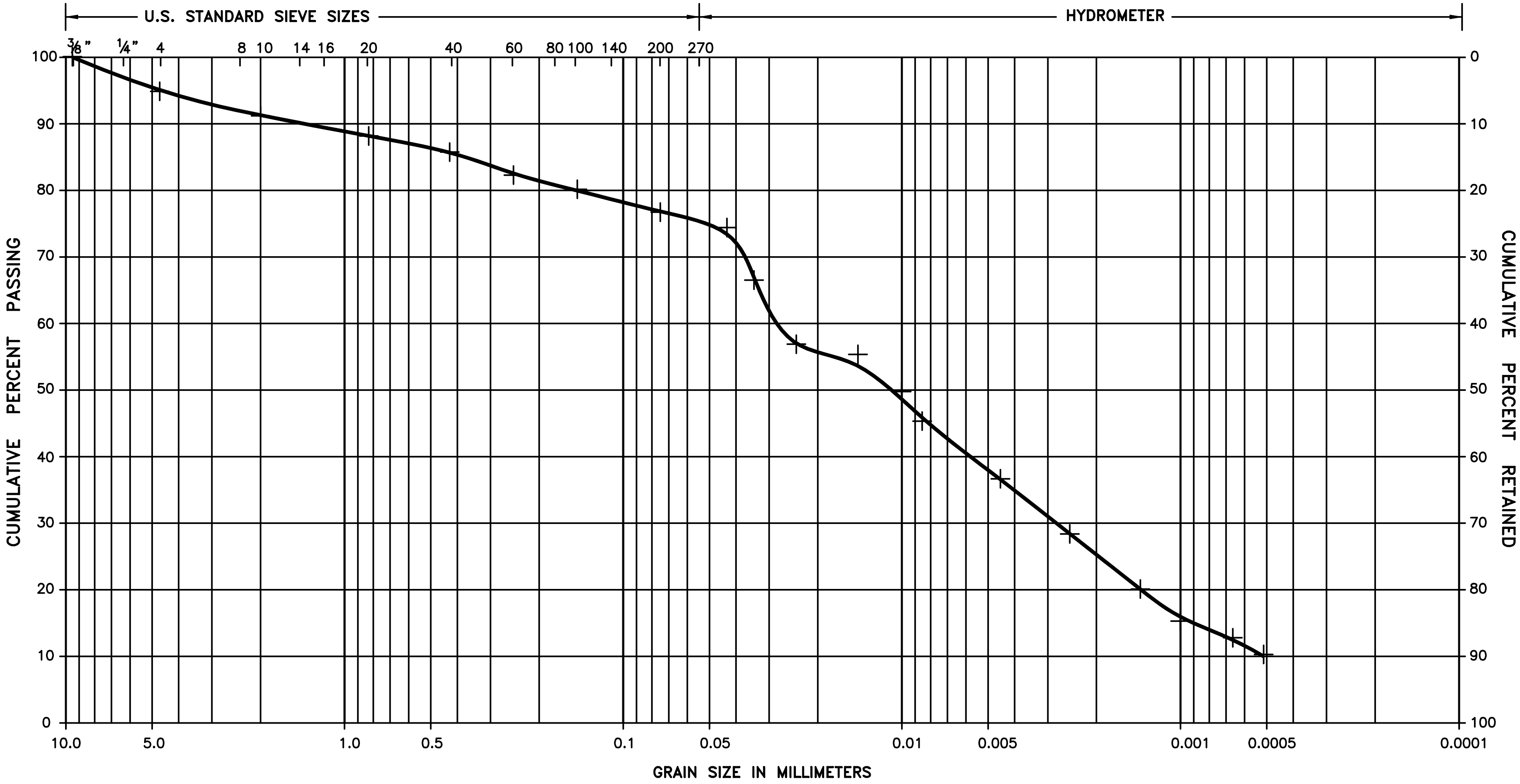
Reference: Planning Services Department, Corporate Drafting & Design Office, Town of Oakville.

208-021/well-loc-plan.cdr

FIGURE E-1E

WELL LOCATION MAP
North Oakville Creeks East of Sixteen Mile Creek
Subwatershed Study
Oakville, Ontario

Morrison Environmental Limited
Groundwater Consultants



<table>
<tr><td rowspan="2">UNIFIED</td><td rowspan="2">Gravel</td><td>Coarse</td><td colspan="3">Medium</td><td colspan="4">Fine</td><td colspan="7" rowspan="2">Clay & Silt</td></tr>
<tr><td colspan="8">Sand</td></tr>
<tr><td rowspan="2">M.I.T.</td><td colspan="2" rowspan="2">Gravel</td><td colspan="2">Coarse</td><td colspan="3">Medium</td><td colspan="3">Fine</td><td colspan="2">Coarse</td><td>Medium</td><td colspan="2">Fine</td><td rowspan="2">Clay</td></tr>
<tr><td colspan="8">Sand</td><td colspan="5">Silt</td></tr>
<tr><td rowspan="2">U.S. BUREAU</td><td colspan="2" rowspan="2">Gravel</td><td colspan="2">Coarse</td><td colspan="2">Medium</td><td colspan="2">Fine</td><td colspan="3">V.Fine</td><td colspan="3" rowspan="2">Silt</td><td colspan="2" rowspan="2">Clay</td></tr>
<tr><td colspan="9">Sand</td></tr>
</table>

MW-1
Hole No.

SS-3
Sample Number

7.5'-9.0'
Depth

Morrison Environmental Limited

North Oakville Subwatershed Study
Oakville, Ontario

GRAIN SIZE CURVE

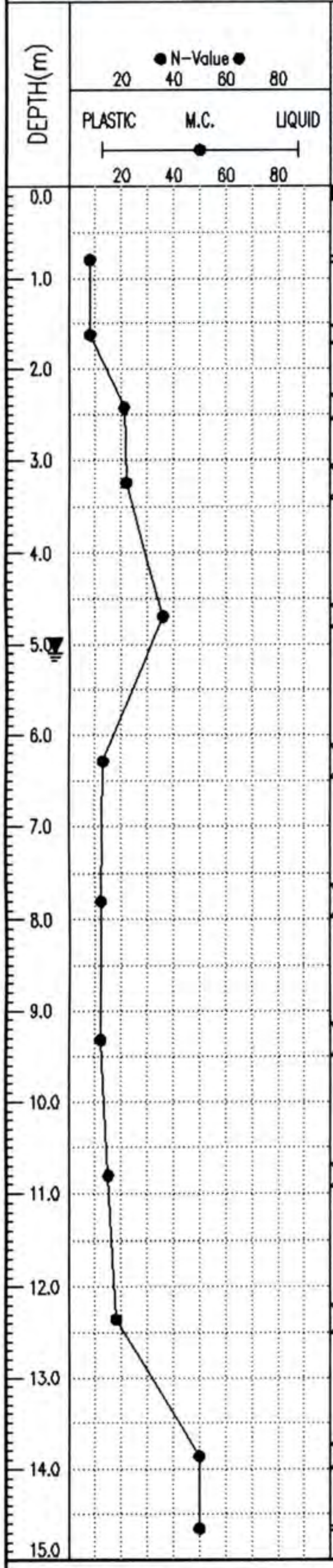
July 2002	208-021	FIGURE: MEL-34

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW-1
N. Oakville Creeks Subwatershed Study.	Date: May 29 2002	PROJECT NO: 208-021
Moore Reservoir, Oakville, Halton	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Borehole Log



SAMPLE NO	SPT(N)	Borehole Log	SOIL SYMBOL
		TOPSOIL, with silt and clay, roots, black moist.	▨
1	8	SILT, clayey with pebbles, trace sand, medium dense, red\brown, moist. (TILL)	▨
2	8		
3	21	– becomes dense, mottled grey and brown.	
4	22		
5	36		
		CLAY, silty, trace to some pebbles, stiff to very stiff, grey, wet. (TILL)	▨
6	13		
7	12		
8	12		
9	15		
		SILT, clayey with pebbles, trace sand, medium dense, reddish brown, moist. (TILL)	▨
10	18		
		SAND, fine to medium, silty, trace gravel, very dense, grey, saturated.	⁚
11	50		
		SHALE (Auger refusal)	☰
12	50		

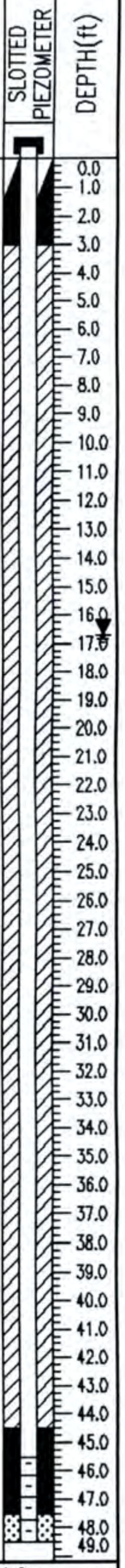
Monitoring Well Details

Stick-up 0.73 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.

Water level 5.82 m.b.m.p.
August 30 2002

Native material backfill

Top of screen
Bentonite seal
#10 Slot well screen
Silica sandpack
Bottom of screen



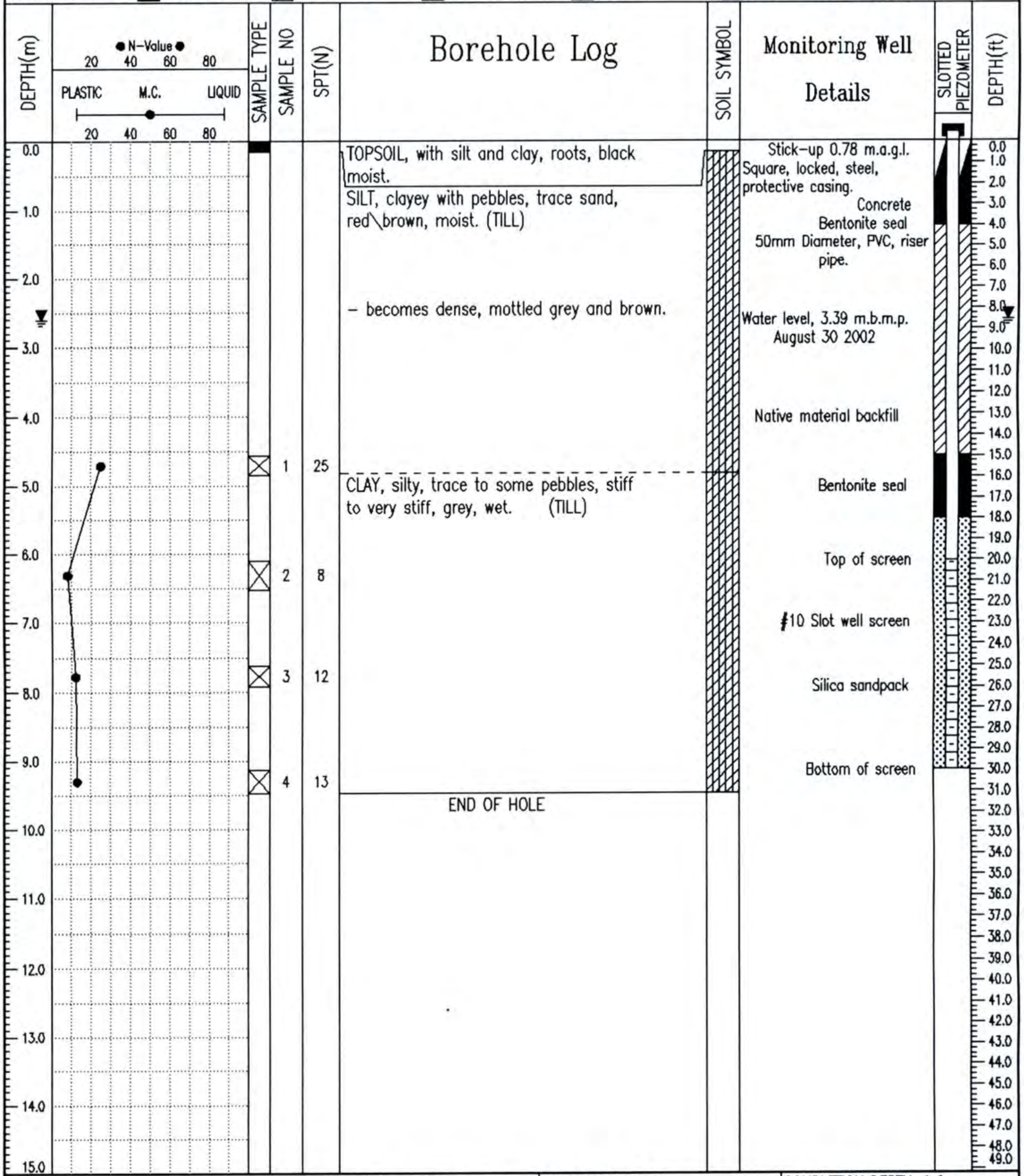
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 14.8 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/29/02
	Fig. No: MEL-1	Page 1 of 1

04/08/06 11:16AM

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW-2
N. Oakville Creeks Subwatershed Study.	Date: May 29 2002	PROJECT NO: 208-021
Moore Reservoir, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▱ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND



SAMPLE NO	SPT(N)
1	25
2	8
3	12
4	13

TOPSOIL, with silt and clay, roots, black moist.

SILT, clayey with pebbles, trace sand, red\brown, moist. (TILL)

– becomes dense, mottled grey and brown.

CLAY, silty, trace to some pebbles, stiff to very stiff, grey, wet. (TILL)

END OF HOLE

Stick-up 0.78 m.a.g.l. Square, locked, steel, protective casing.

Concrete

Bentonite seal

50mm Diameter, PVC, riser pipe.

Water level, 3.39 m.b.m.p. August 30 2002

Native material backfill

Bentonite seal

Top of screen

#10 Slot well screen

Silica sandpack

Bottom of screen

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 9.6 m
REVIEWED BY: D.SAWICKI	COMPLETE: 05/29/02
Fig. No: MEL-2	Page 1 of 1

04/08/06 11:21AM

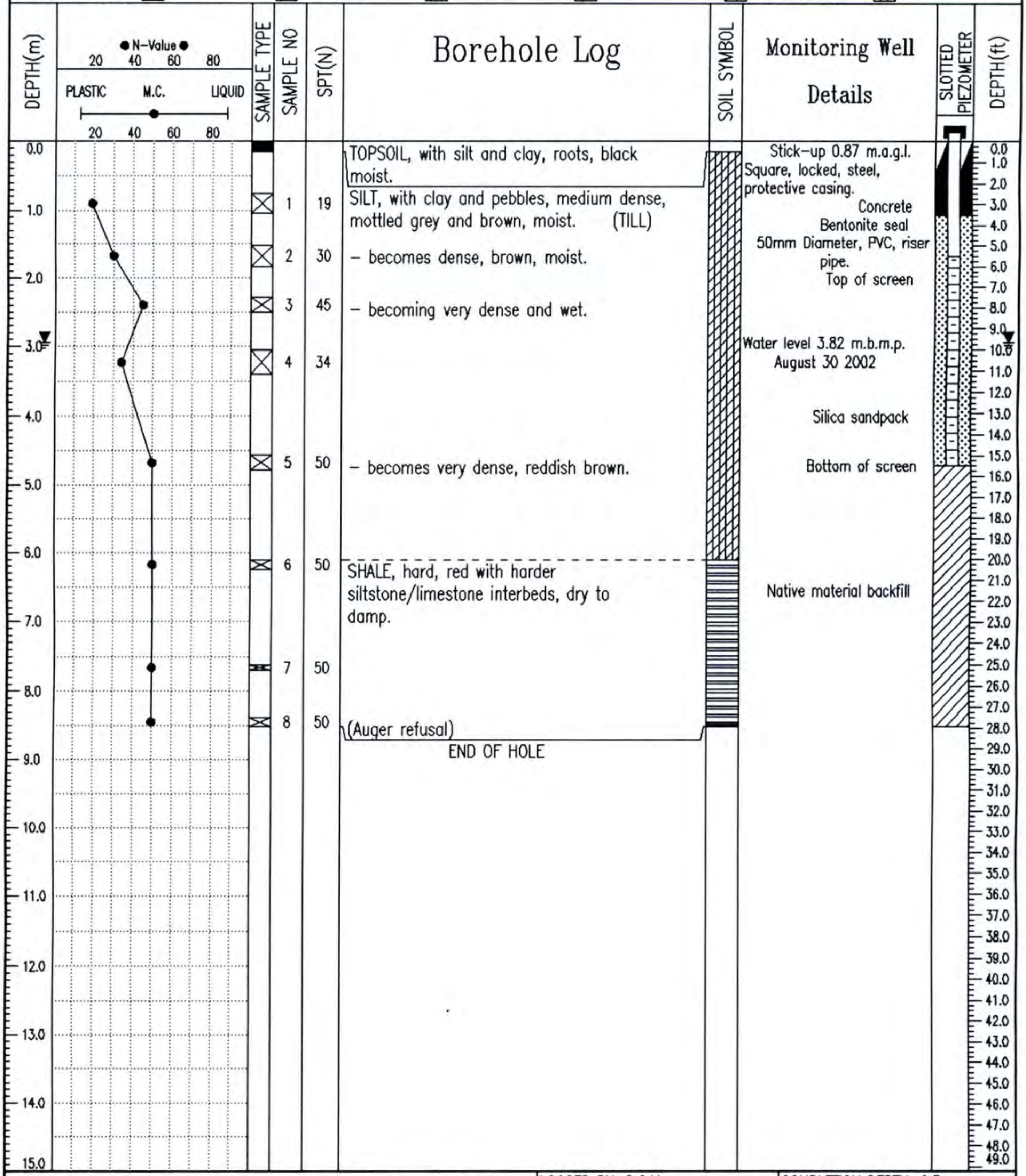
Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW–3
N. Oakville Creeks Subwatershed Study.	Date: May 29/30 2002	PROJECT NO: 208–021
Bazar Property, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND

Borehole Log

Monitoring Well Details



SAMPLE NO	SPT(N)	Borehole Log
		TOPSOIL, with silt and clay, roots, black moist.
1	19	SILT, with clay and pebbles, medium dense, mottled grey and brown, moist. (TILL)
2	30	– becomes dense, brown, moist.
3	45	– becoming very dense and wet.
4	34	
5	50	– becomes very dense, reddish brown.
6	50	SHALE, hard, red with harder siltstone/limestone interbeds, dry to damp.
7	50	
8	50	(Auger refusal)

END OF HOLE

Stick–up 0.87 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.
Top of screen
Water level 3.82 m.b.m.p.
August 30 2002
Silica sandpack
Bottom of screen
Native material backfill

Morrison Environmental Limited
Mississauga, Ontario

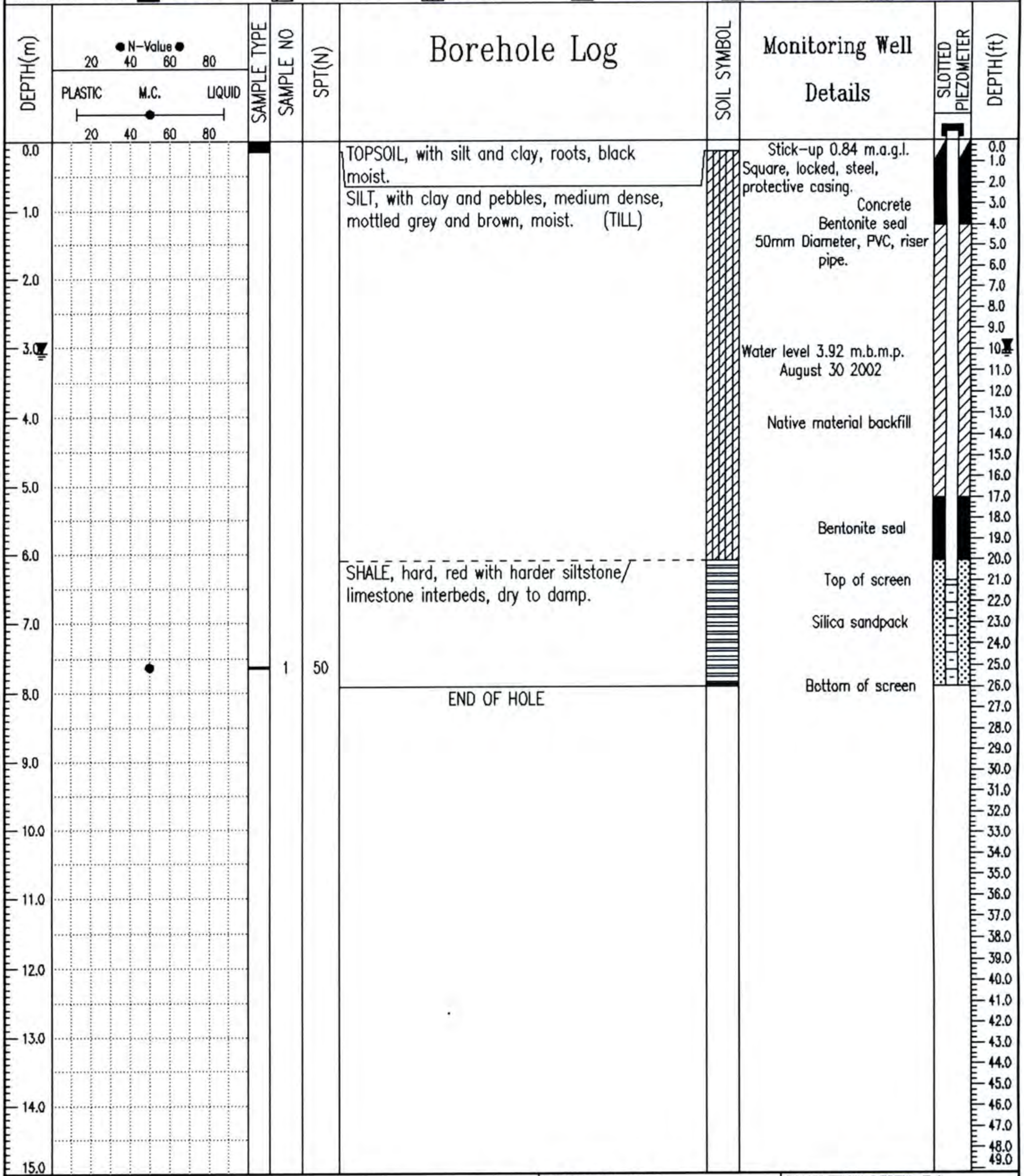
LOGGED BY: S.G.H.	COMPLETION DEPTH: 8.5 m
REVIEWED BY: D.SAWICKI	COMPLETE: 05/30/02
Fig. No: MEL–3	Page 1 of 1

04/08/06 11:23AM

Totten Sims Hubicki	Method: Solid Stem Auger	BOREHOLE NO: MW–4
N. Oakville Creeks Subwatershed Study.	Date: May 30 2002	PROJECT NO: 208–021
Bazar Property, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND



Borehole Log

TOPSOIL, with silt and clay, roots, black moist.

SILT, with clay and pebbles, medium dense, mottled grey and brown, moist. (TILL)

SHALE, hard, red with harder siltstone/ limestone interbeds, dry to damp.

END OF HOLE

Monitoring Well Details

Stick–up 0.84 m.a.g.l.
Square, locked, steel, protective casing.
Concrete
Bentonite seal
50mm Diameter, PVC, riser pipe.

Water level 3.92 m.b.m.p.
August 30 2002

Native material backfill

Bentonite seal

Top of screen

Silica sandpack

Bottom of screen

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 7.9 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 05/30/02
	Fig. No: MEL–4	Page 1 of 1

04/08/06 11:24AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP1
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208–021
Memorial Gardens, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁙ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

● N-Value ● 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0	■	1		TOPSOIL, clayey, dark brown, moist.	■	Stick-up 1.06 m.a.g.l. Bentonite seal	0.0
	■	2 3 4 5		CLAY, with silt and fine sand, red/brown, moist. (TILL)	▨	Water level 1.32 m.b.m.p. August 30 2002 19mm Diameter galvanized steel pipe.	1.0 2.0
1.0	■	6 7 8 9		SAND and GRAVEL, with clay, brown, saturated.	⁘	Silica sandpack Top of screen	3.0 4.0 5.0
	▨			SHALE	☰	Native material	
				END OF HOLE		Bottom of screen (2.88 m.b.m.p.)	6.0
2.0							7.0 8.0 9.0
3.0							10.0

Morrison Environmental Limited
Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
Fig. No: MEL–5	Page 1 of 1

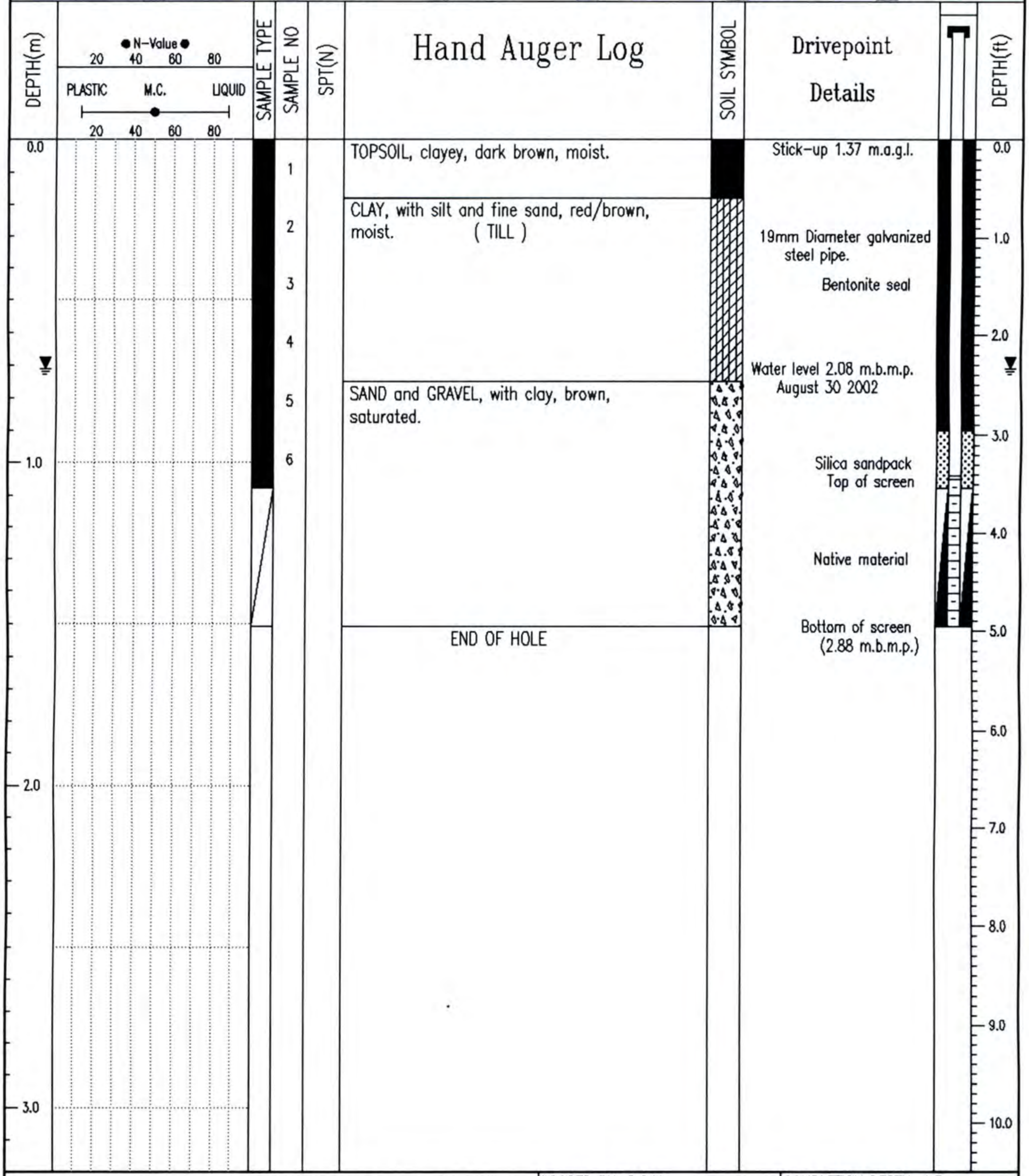
04/08/06 11:26AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP2
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208–021
Memorial Gardens, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▦ SAND

Hand Auger Log



TOPSOIL, clayey, dark brown, moist.

CLAY, with silt and fine sand, red/brown, moist. (TILL)

SAND and GRAVEL, with clay, brown, saturated.

END OF HOLE

Stick–up 1.37 m.a.g.l.

19mm Diameter galvanized steel pipe.

Bentonite seal

Water level 2.08 m.b.m.p.
August 30 2002

Silica sandpack
Top of screen

Native material

Bottom of screen
(2.88 m.b.m.p.)

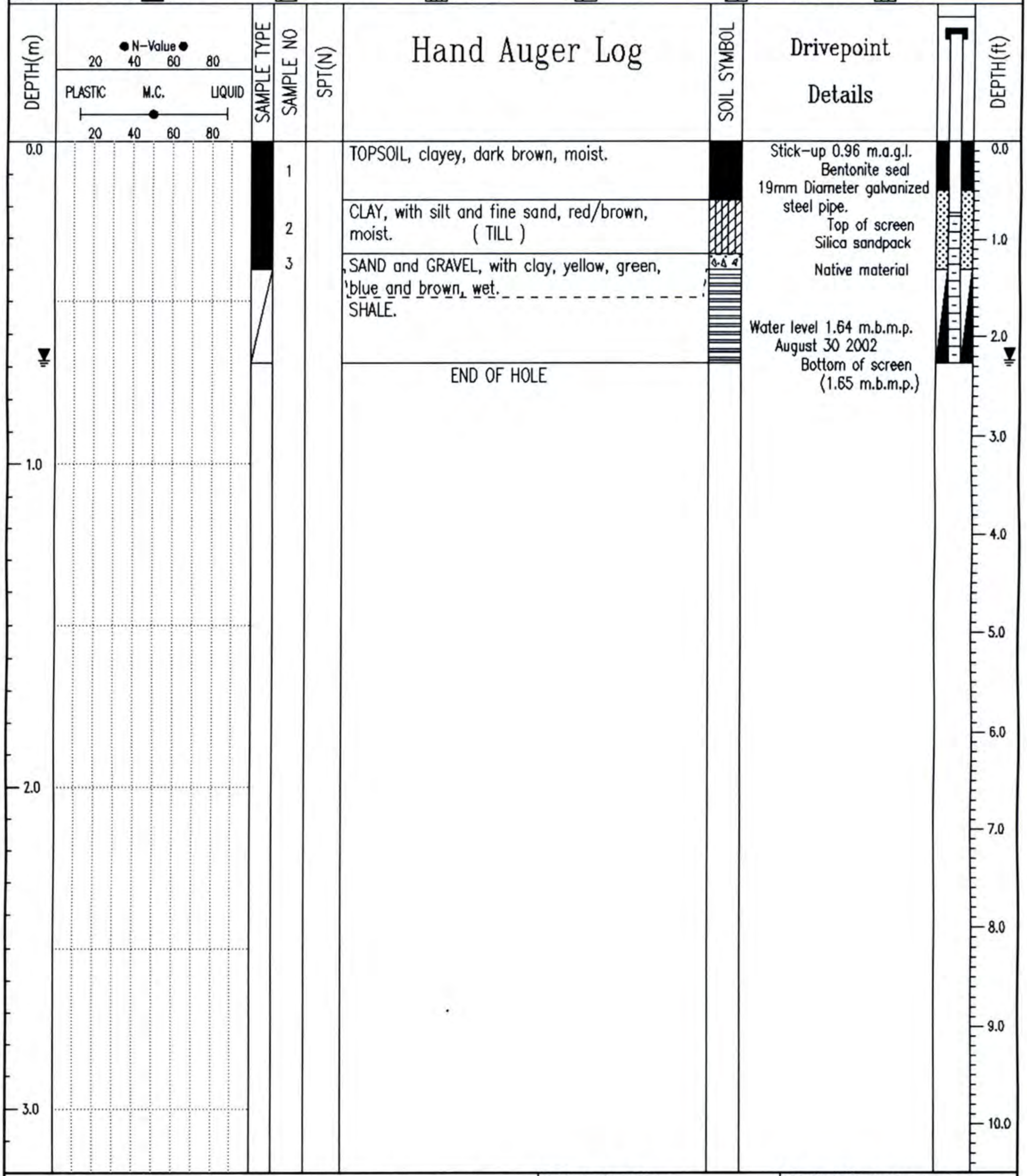
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
	Fig. No: MEL–6	Page 1 of 1

04/08/06 11:27AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP3
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208–021
Accord Reality Limited, Oakville, Halton	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	☰ A–CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ PEA GRAVEL	▥ SLOUGH	⁘ GROUT	▨ DRILL CUTTINGS	▩ SAND

Hand Auger Log



TOPSOIL, clayey, dark brown, moist.

CLAY, with silt and fine sand, red/brown, moist. (TILL)

SAND and GRAVEL, with clay, yellow, green, blue and brown, wet.

SHALE.

END OF HOLE

Stick–up 0.96 m.a.g.l.
Bentonite seal
19mm Diameter galvanized steel pipe.
Top of screen
Silica sandpack
Native material

Water level 1.64 m.b.m.p.
August 30 2002
Bottom of screen
(1.65 m.b.m.p.)

Morrison Environmental Limited	LOGGED BY: S.G.H.	COMPLETION DEPTH: 0.7 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
Mississauga, Ontario	Fig. No: MEL–7	Page 1 of 1

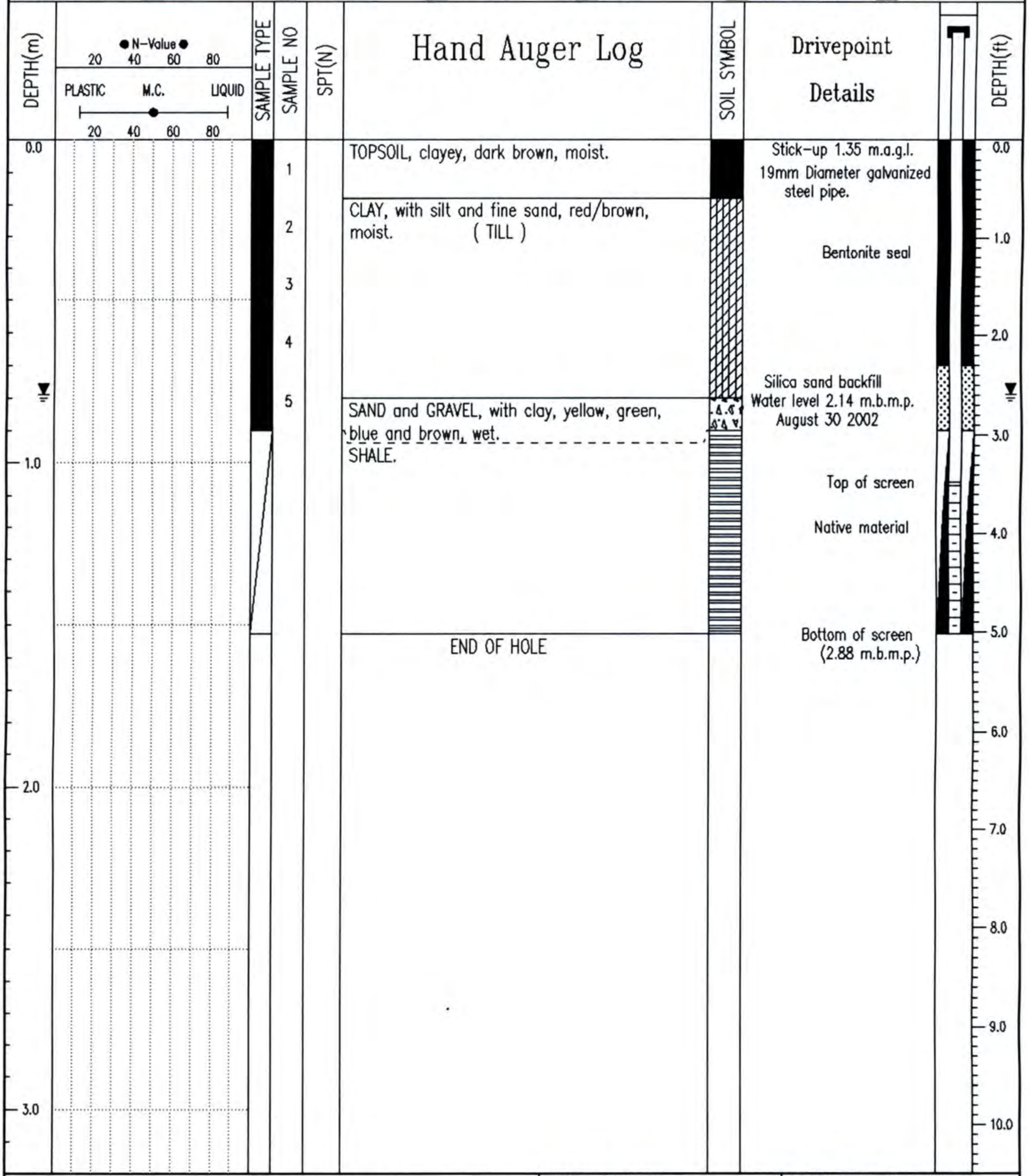
04/08/06 11:27AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP4
N. Oakville Creeks Subwatershed Study.	Date: April 22 2002	PROJECT NO: 208-021
Accord Reality, Oakville, Halton.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



TOPSOIL, clayey, dark brown, moist.

CLAY, with silt and fine sand, red/brown, moist. (TILL)

SAND and GRAVEL, with clay, yellow, green, blue and brown, wet.

SHALE.

END OF HOLE

Stick-up 1.35 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill
Water level 2.14 m.b.m.p.
August 30 2002

Top of screen

Native material

Bottom of screen
(2.88 m.b.m.p.)

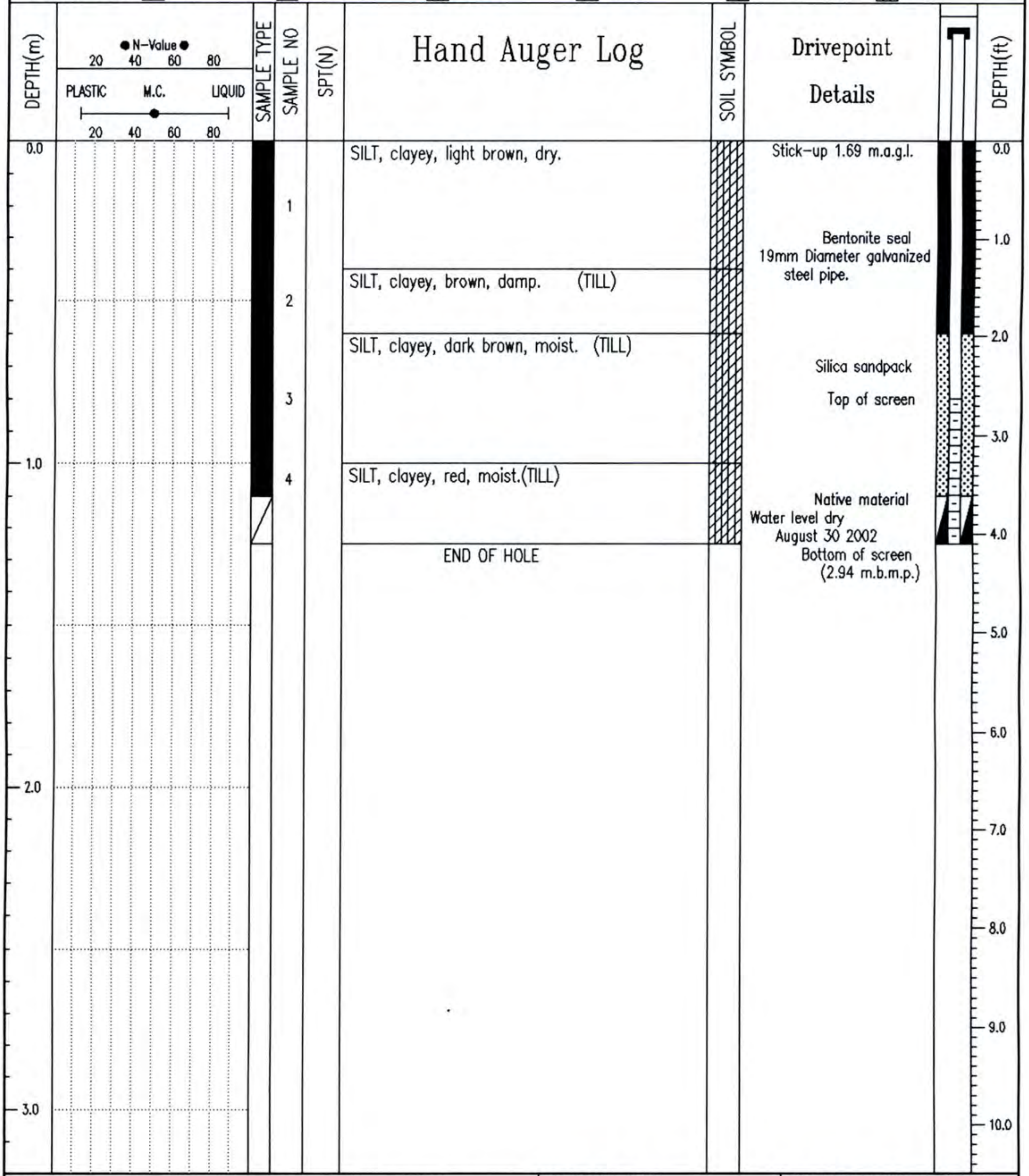
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 04/22/02
	Fig. No: MEL-8	Page 1 of 1

04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP5
N. Oakville Creeks Subwatershed Study.	Date: August 15 2002	PROJECT NO: 208-021
Lakeport Developement Company, Oakville.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	◿ NO RECOVERY	☒ SPT	☰ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ PEA GRAVEL	▥ SLOUGH	▨ GROUT	▨ DRILL CUTTINGS	▒ SAND

Hand Auger Log



SILT, clayey, light brown, dry.

SILT, clayey, brown, damp. (TILL)

SILT, clayey, dark brown, moist. (TILL)

SILT, clayey, red, moist.(TILL)

END OF HOLE

Stick-up 1.69 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.

Silica sandpack

Top of screen

Native material
Water level dry
August 30 2002
Bottom of screen
(2.94 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 08/15/02
	Fig. No: MEL-9	Page 1 of 1

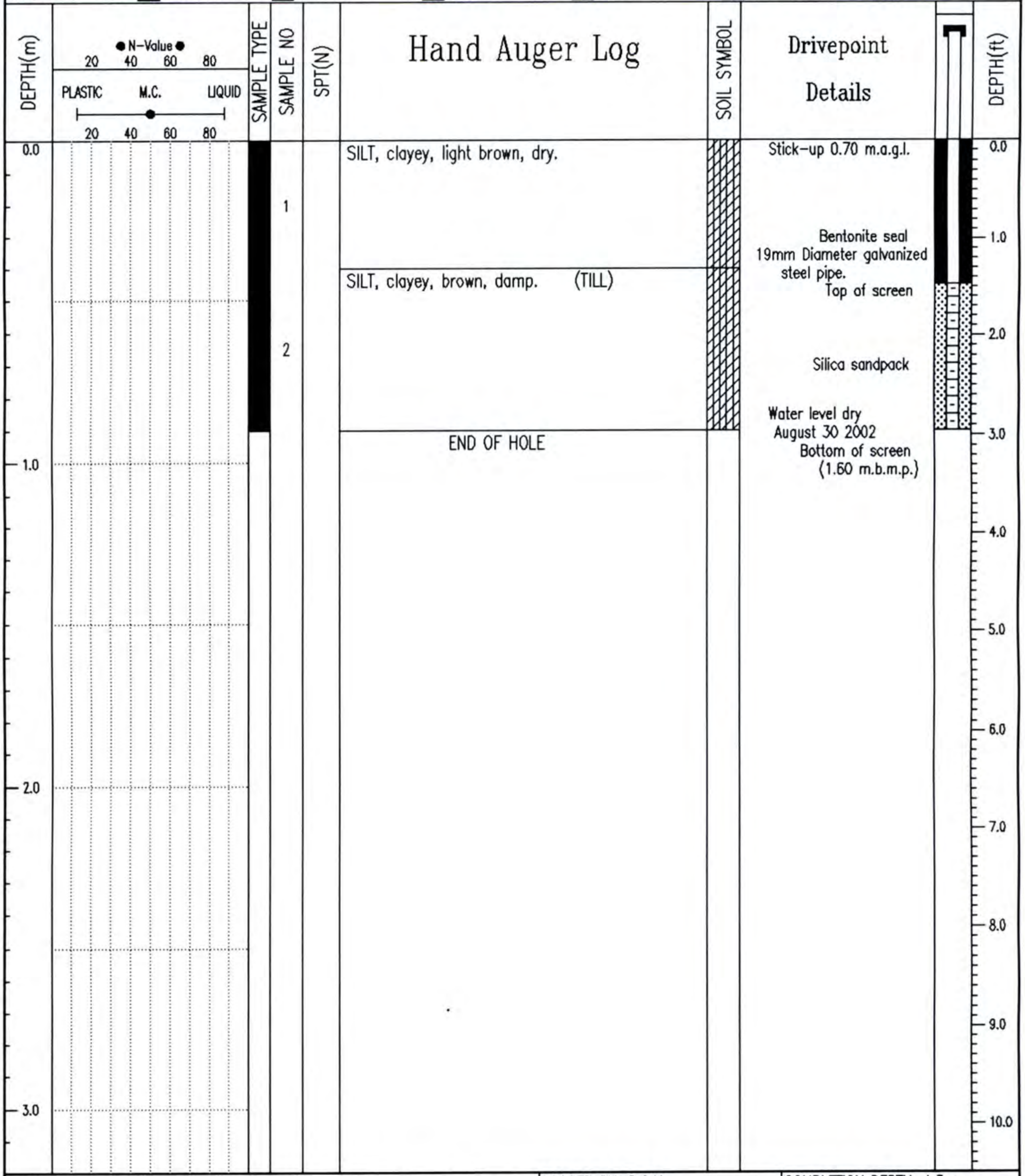
04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP6
N. Oakville Creeks Subwatershed Study.	Date: August 15 2002	PROJECT NO: 208-021
Lakeport Developement Company, Oakville.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◪ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ◧ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



SILT, clayey, light brown, dry.

SILT, clayey, brown, damp. (TILL)

END OF HOLE

Stick-up 0.70 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.
Top of screen

Silica sandpack

Water level dry
August 30 2002
Bottom of screen
(1.60 m.b.m.p.)

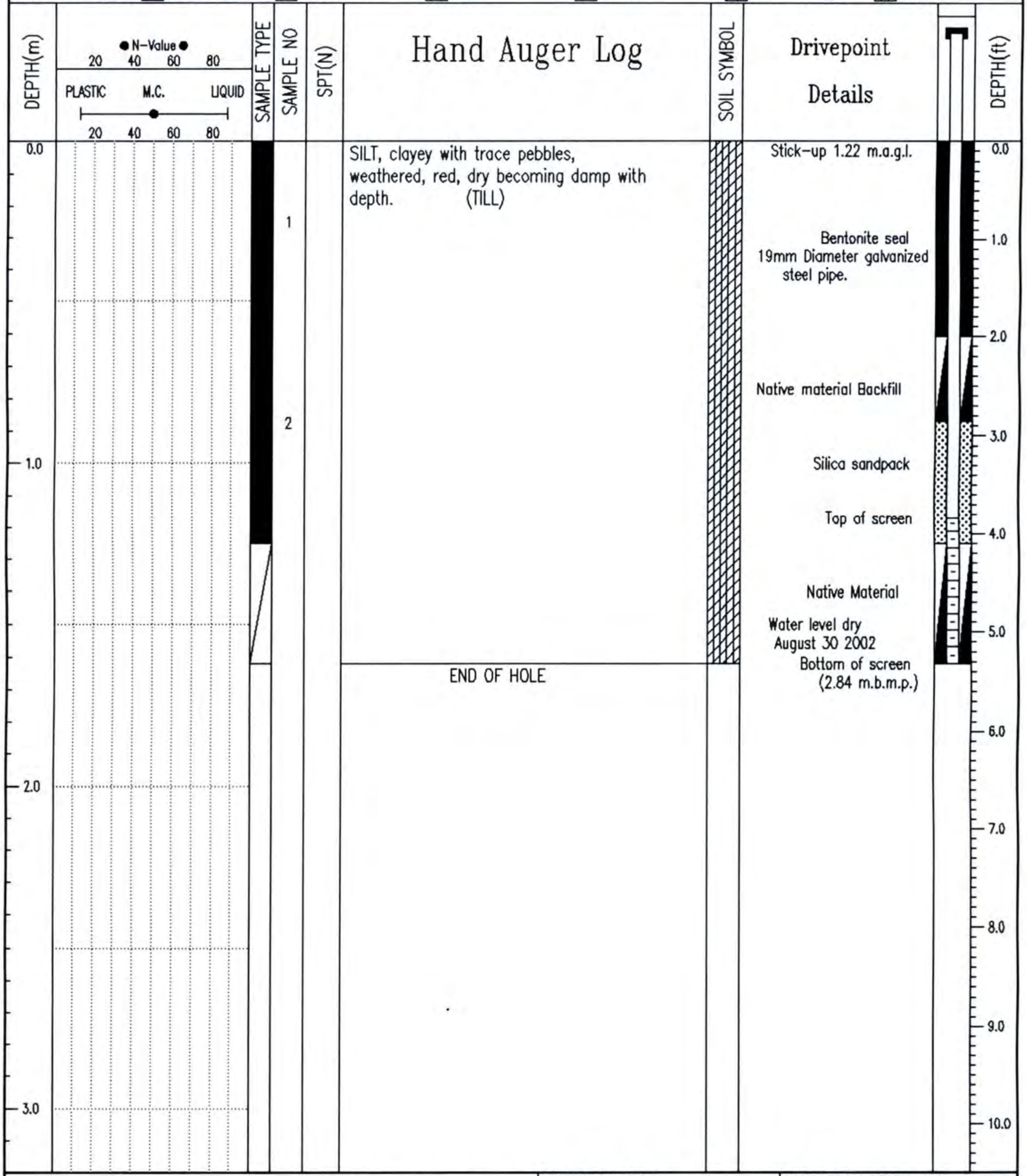
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 08/15/02
	Fig. No: MEL-10	Page 1 of 1

04/08/06 11:28AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP7
N. Oakville Creeks Subwatershed Study.	Date: July 10 2002	PROJECT NO: 208-021
Tribaden Investments Incorporated	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	☰ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁖ PEA GRAVEL	▥ SLOUGH	⁖ GROUT	▨ DRILL CUTTINGS	▩ SAND

Hand Auger Log



SILT, clayey with trace pebbles, weathered, red, dry becoming damp with depth. (TILL)

END OF HOLE

Stick-up 1.22 m.a.g.l.

Bentonite seal
19mm Diameter galvanized steel pipe.

Native material Backfill

Silica sandpack

Top of screen

Native Material

Water level dry
August 30 2002

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.6 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/10/02
	Fig. No: MEL-11	Page 1 of 1

04/08/06 11:29AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP8
N. Oakville Creeks Subwatershed Study.	Date: July 10 2002	PROJECT NO: 208-021
Triboden Investments Incorporated	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	◪ NO RECOVERY	☒ SPT	☰ A-CASING	◫ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⁘ PEA GRAVEL	▥ SLOUGH	▨ GROUT	▧ DRILL CUTTINGS	▩ SAND

Hand Auger Log

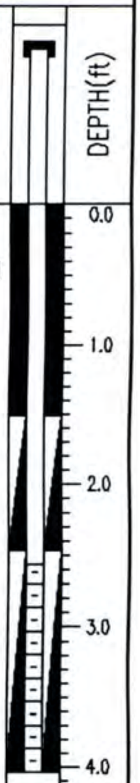
DEPTH(m) | ● N-Value ● 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | SPT(N) | SOIL SYMBOL | DEPTH(ft)

0.0 — SILT, clayey with trace sand and pebbles weathered, red, dry becoming moist with depth. (TILL)

Sample No: 1, 2

END OF HOLE

Drivepoint Details



Stick-up 0.99 m.a.g.l.
Bentonite seal
19mm Diameter galvanized steel pipe.

Native material backfill

Top of screen

Native material

Water level dry
August 30 2002

Bottom of screen
(2.22 m.b.m.p.)

DEPTH(m): 0.0, 1.0, 2.0, 3.0

DEPTH(ft): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/10/02
	Fig. No: MEL-12	Page 1 of 1

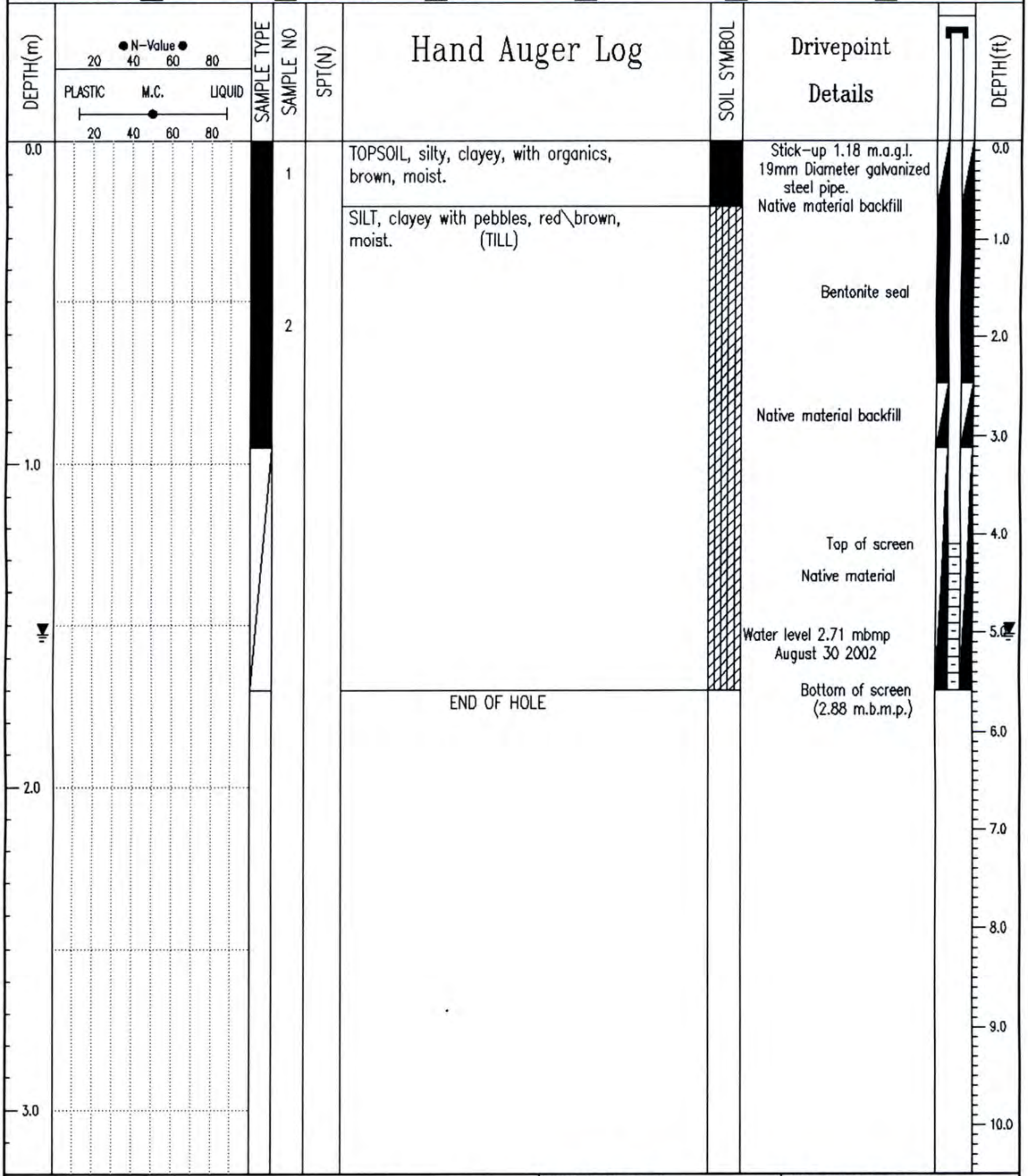
04/08/06 11:29AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP9
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Staroak Developments	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▧ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



TOPSOIL, silty, clayey, with organics, brown, moist.

SILT, clayey with pebbles, red\brown, moist. (TILL)

END OF HOLE

Stick-up 1.18 m.a.g.l.
19mm Diameter galvanized steel pipe.
Native material backfill

Bentonite seal

Native material backfill

Top of screen

Native material

Water level 2.71 mbmp
August 30 2002

Bottom of screen
(2.88 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.7 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
	Fig. No: MEL-13	Page 1 of 1

04/08/08 11:30AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP10
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Staroak Developments	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◪ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

DEPTH(m) | ● N-Value ● 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | SPT(N)

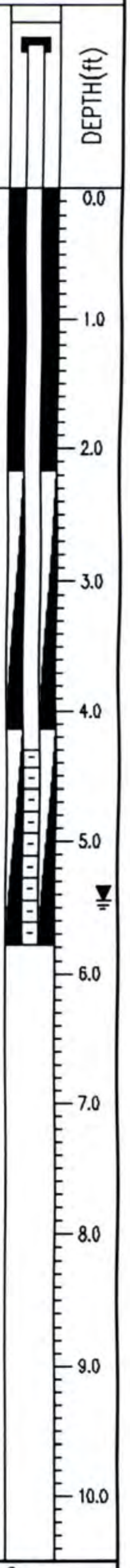
Hand Auger Log

SOIL SYMBOL

Drivepoint Details

DEPTH(ft)

DEPTH(m)	SAMPLE NO	Description	Drivepoint Details
0.0	1	TOPSOIL, silty, clayey, with organics, brown, moist.	Stick-up 1.05 m.a.g.l. 19mm Diameter galvanized steel pipe.
	2	SILT, clayey with pebbles, red\brown, moist. (TILL)	Bentonite seal Native material backfill Top of screen Native material Water level 2.71 mbmp August 30 2002 Bottom of screen (2.81 m.b.m.p.)
		END OF HOLE	



DEPTH(m): 0.0, 1.0, 2.0, 3.0

Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
Fig. No: MEL-14	Page 1 of 1

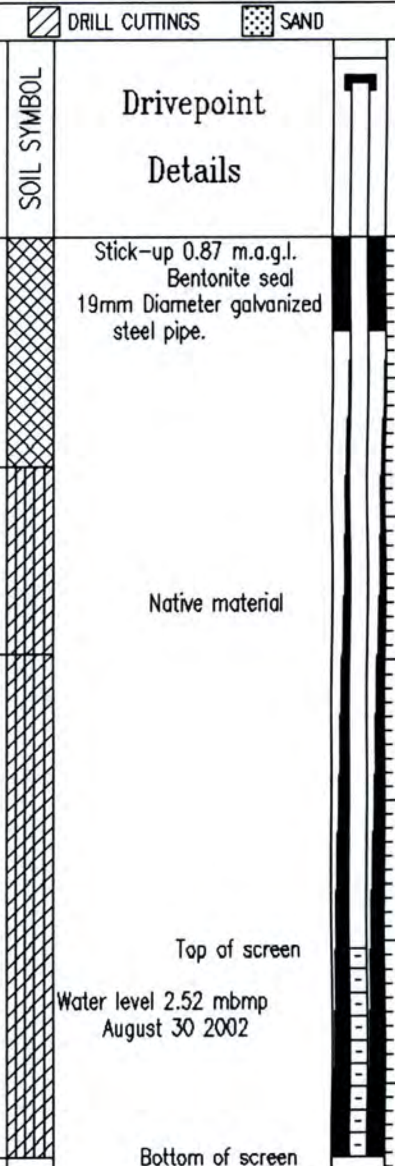
04/08/06 11:30AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP11
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Docasa Group Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND

DEPTH(m)	● N-Value ● 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0					FILL, silty, clayey, red/brown, dry to damp.		Stick-up 0.87 m.a.g.l. Bentonite seal 19mm Diameter galvanized steel pipe.	0.0
					CLAY, silty, grey, moist.		Native material	1.0 2.0
1.0					SILT, clayey with pebbles, grey, moist. (TILL)			3.0 4.0
					- becomes saturated .		Top of screen Water level 2.52 mbmp August 30 2002	5.0 6.0
2.0					END OF HOLE		Bottom of screen (2.86 m.b.m.p.)	7.0 8.0 9.0
3.0								10.0



Morrison Environmental Limited

Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 2.0 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
Fig. No: MEL-15	Page 1 of 1

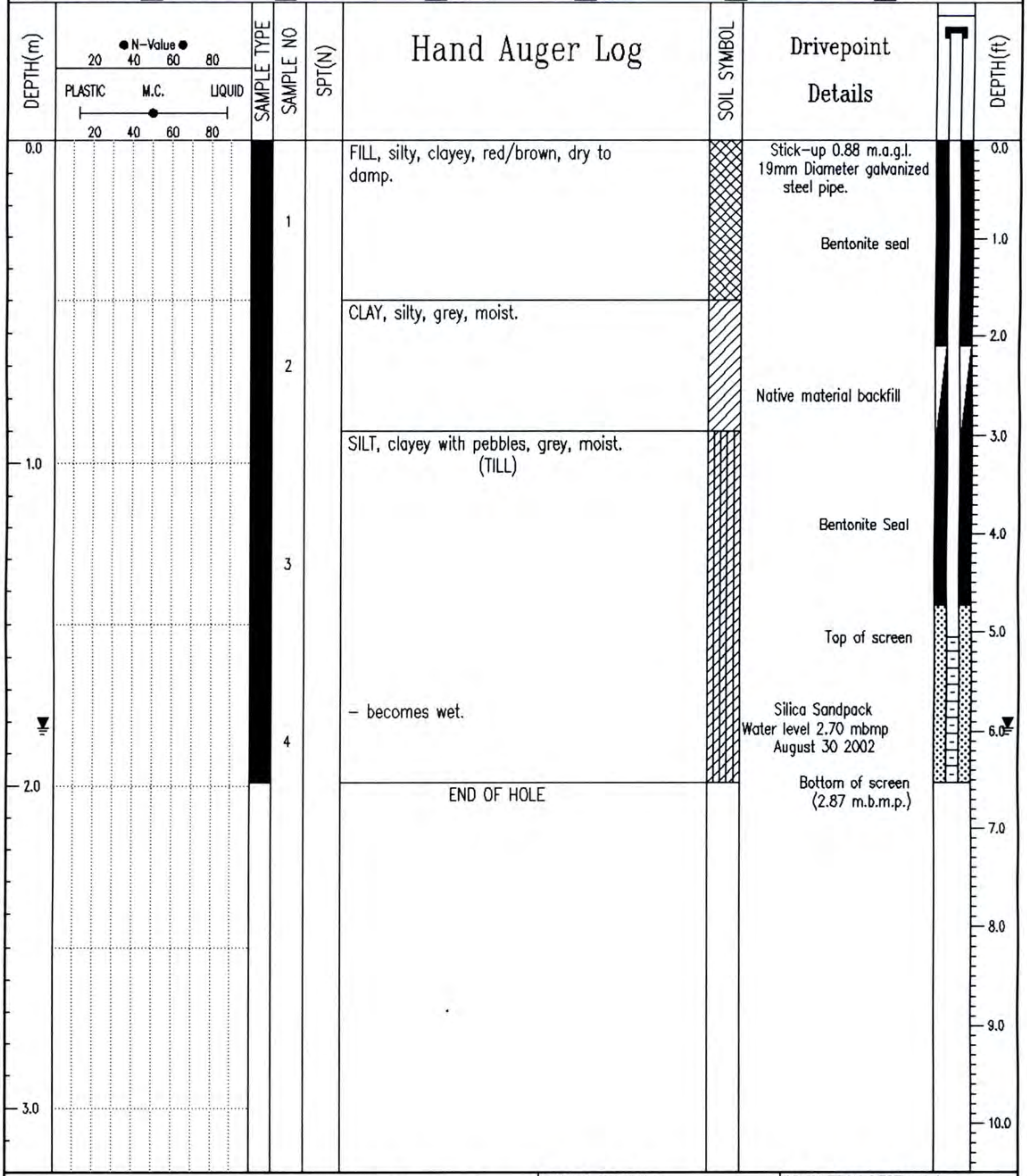
04/08/06 11:31AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP12
N. Oakville Creeks Subwatershed Study.	Date: July 15 2002	PROJECT NO: 208-021
Docasa Group Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ▤ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



FILL, silty, clayey, red/brown, dry to damp.

CLAY, silty, grey, moist.

SILT, clayey with pebbles, grey, moist. (TILL)

- becomes wet.

END OF HOLE

Stick-up 0.88 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Native material backfill

Bentonite Seal

Top of screen

Silica Sandpack
Water level 2.70 mbmp
August 30 2002

Bottom of screen
(2.87 m.b.m.p.)

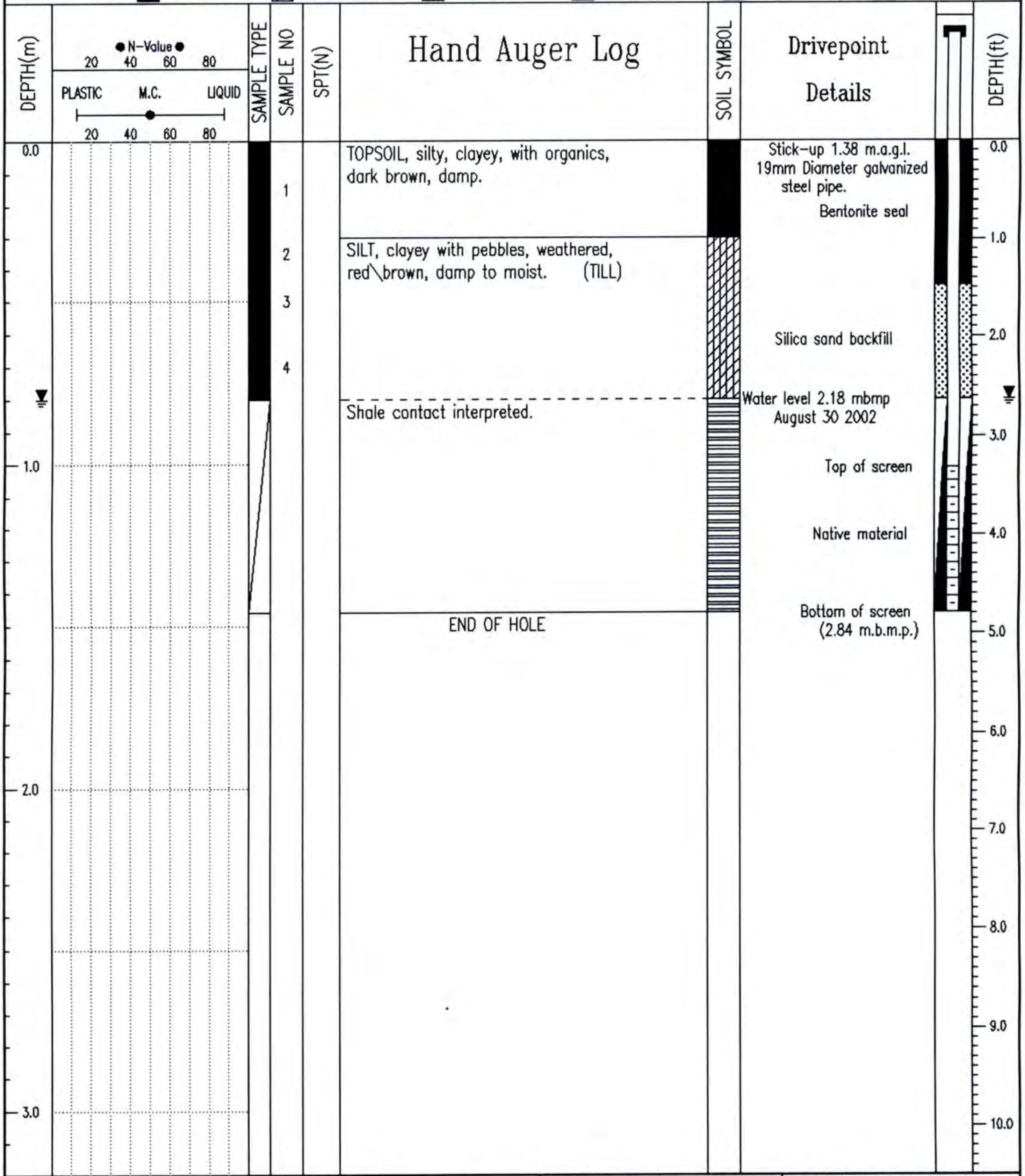
Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 2.0 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/15/02
	Fig. No: MEL-16	Page 1 of 1

04/08/06 11:31AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP13
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Pendent Developments Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE	■ GRAB	▨ NO RECOVERY	☒ SPT	☰ A-CASING	▥ SHELBY TUBE	▮ CORE
BACKFILL TYPE	■ BENTONITE	⛶ PEA GRAVEL	▥ SLOUGH	▩ GROUT	▨ DRILL CUTTINGS	░ SAND

Hand Auger Log



TOPSOIL, silty, clayey, with organics, dark brown, damp.

SILT, clayey with pebbles, weathered, red\brown, damp to moist. (TILL)

Shale contact interpreted.

END OF HOLE

Drivepoint Details

Stick-up 1.38 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill

Water level 2.18 mbmp
August 30 2002

Top of screen

Native material

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
	Fig. No: MEL-17	Page 1 of 1

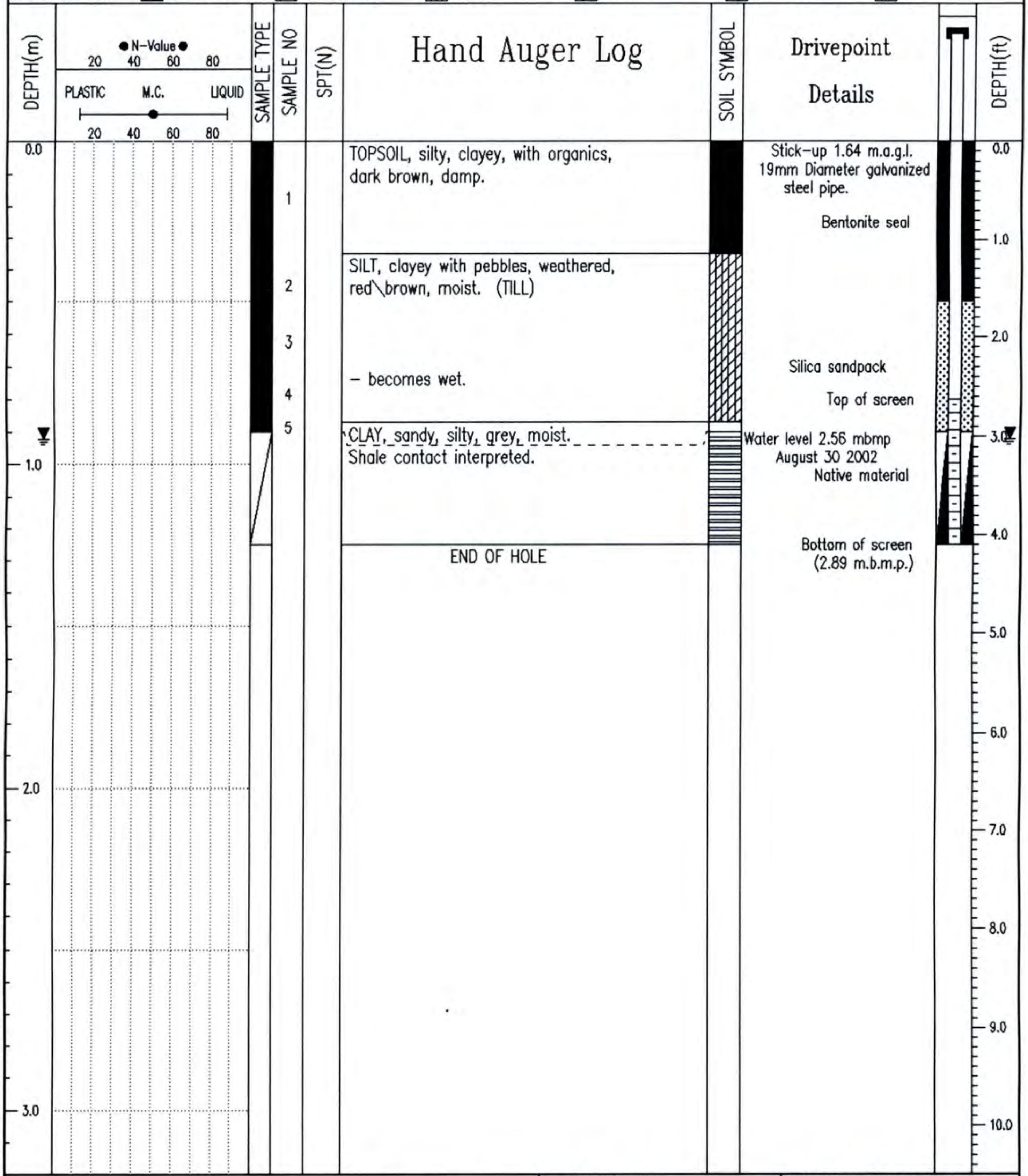
04/08/06 11:32AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP14
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Pendent Developments Limited	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



TOPSOIL, silty, clayey, with organics, dark brown, damp.

SILT, clayey with pebbles, weathered, red\brown, moist. (TILL)

– becomes wet.

CLAY, sandy, silty, grey, moist.
Shale contact interpreted.

END OF HOLE

Stick-up 1.64 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sandpack

Top of screen

Water level 2.56 mbmp
August 30 2002

Native material

Bottom of screen
(2.89 m.b.m.p.)

Morrison Environmental Limited
Mississauga, Ontario

LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.3 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
Fig. No: MEL-18	Page 1 of 1

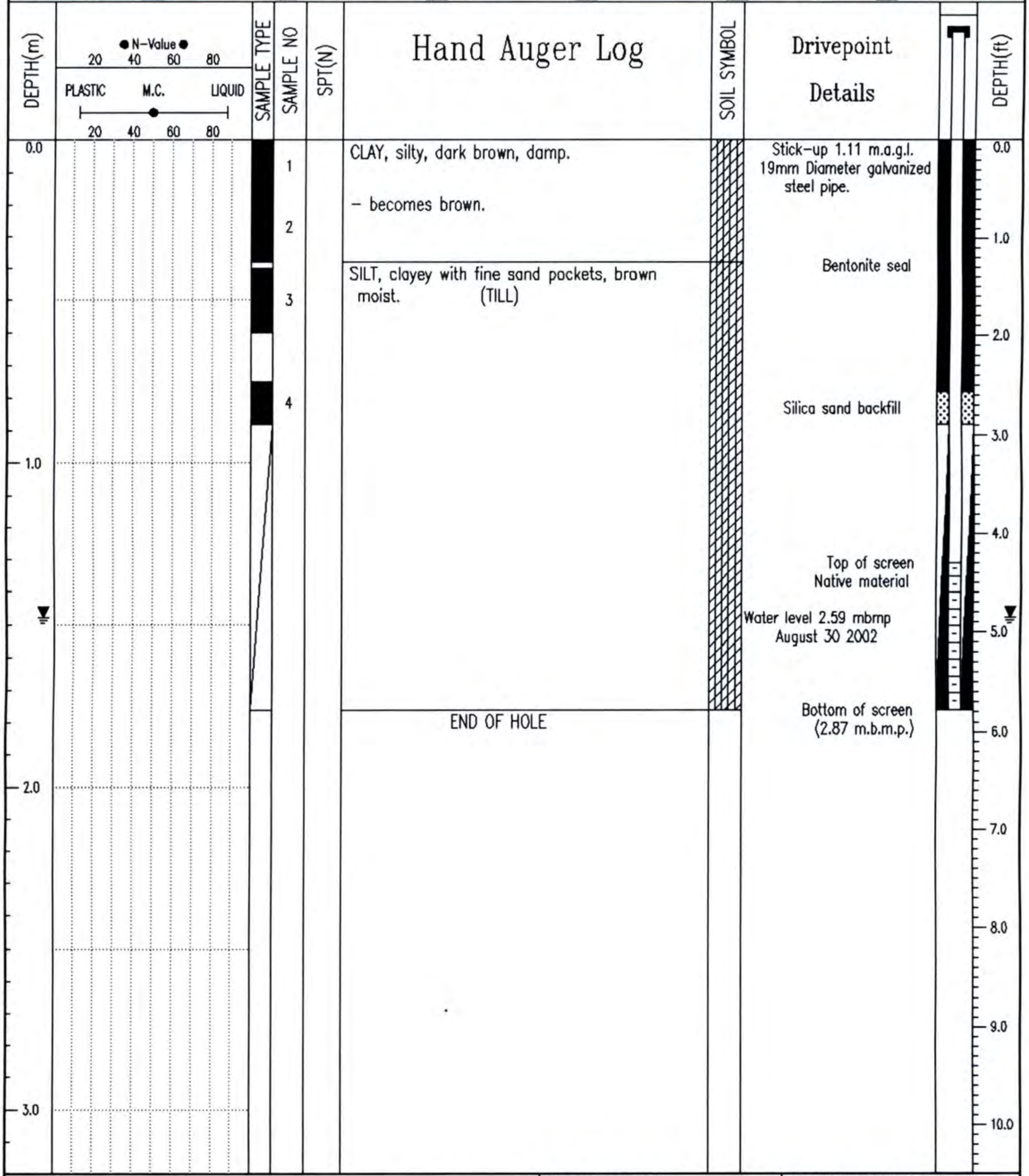
04/08/06 11:32AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP15
N. Oakville Creeks Subwatershed Study.	Date: July 22 2002	PROJECT NO: 208-021
Bazar, Steven, David.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log



CLAY, silty, dark brown, damp.

– becomes brown.

SILT, clayey with fine sand pockets, brown moist. (TILL)

END OF HOLE

Stick-up 1.11 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill

Top of screen
Native material

Water level 2.59 mbmp
August 30 2002

Bottom of screen
(2.87 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/22/02
	Fig. No: MEL-19	Page 1 of 1

04/08/06 11:33AM

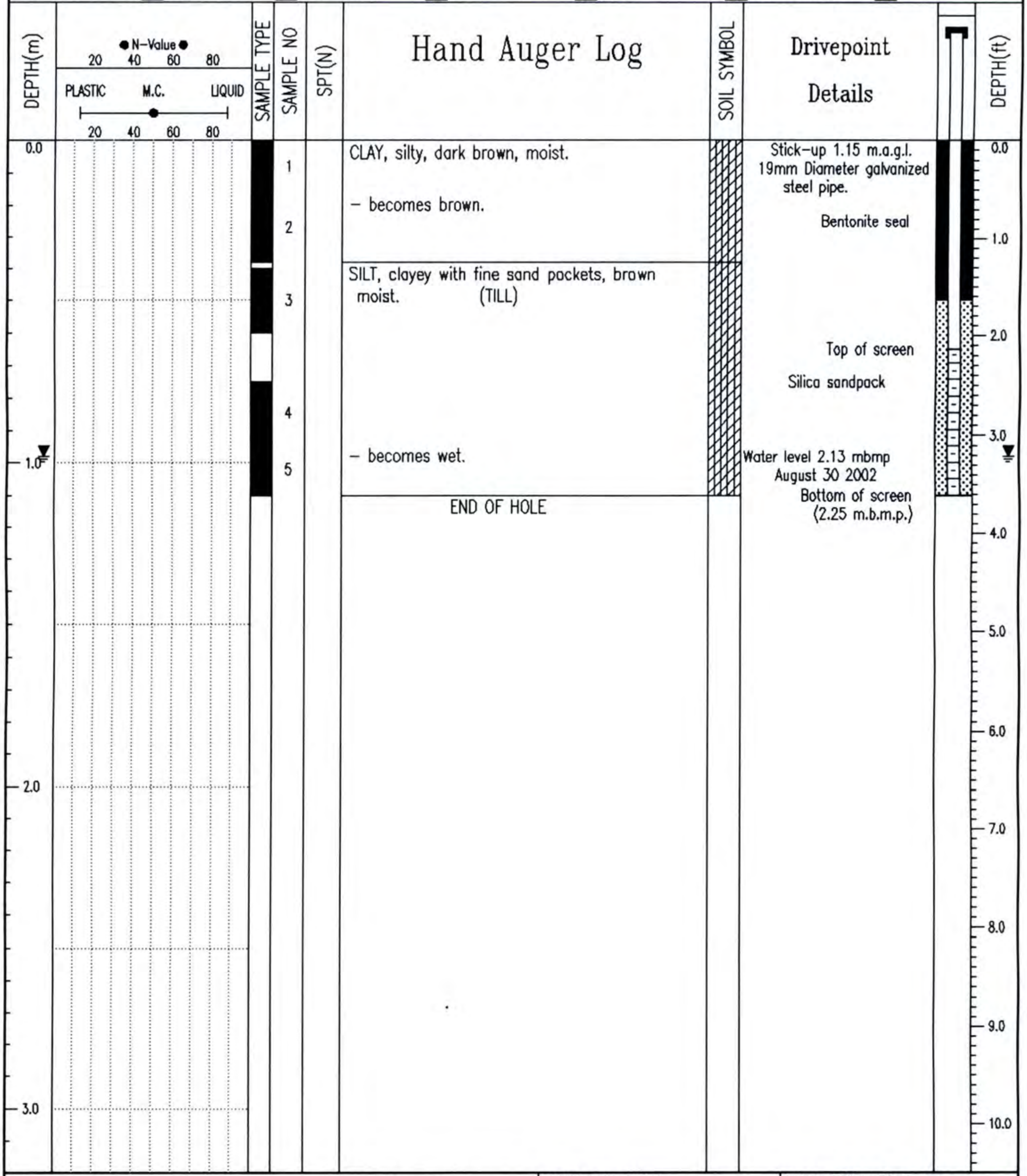
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP16
N. Oakville Creeks Subwatershed Study.	Date: July 22 2002	PROJECT NO: 208-021
Bazar, Steven, David.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◪ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

Drivepoint Details



CLAY, silty, dark brown, moist.

– becomes brown.

SILT, clayey with fine sand pockets, brown moist. (TILL)

– becomes wet.

END OF HOLE

Stick-up 1.15 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Top of screen

Silica sandpack

Water level 2.13 mbmp
August 30 2002

Bottom of screen
(2.25 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/22/02
	Fig. No: MEL-20	Page 1 of 1

04/08/06 11:34AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP17
N. Oakville Creeks Subwatershed Study.	Date: July 24 2002	PROJECT NO: 208-021
Rampen, Leo.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND

Hand Auger Log

DEPTH(m)	● N-Value ● 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0		■	1		TOPSOIL, clayey with organics, dark brown, damp.	■	Stick-up 1.09 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal	0.0
		■	2 3		CLAY, silty with some fine sand and trace pebbles, iron staining, brown, moist to wet. – becomes grey.	▨	Water level 1.53 mbmp August 30 2002	1.0
		■	4		SAND and GRAVEL, silty, brown, saturated.		Top of screen Silica sandpack	2.0 3.0
1.0					END OF HOLE		Bottom of screen (2.23 m.b.m.p.)	4.0
2.0								5.0 6.0 7.0 8.0
3.0								9.0 10.0

Morrison Environmental Limited

Mississauga, Ontario

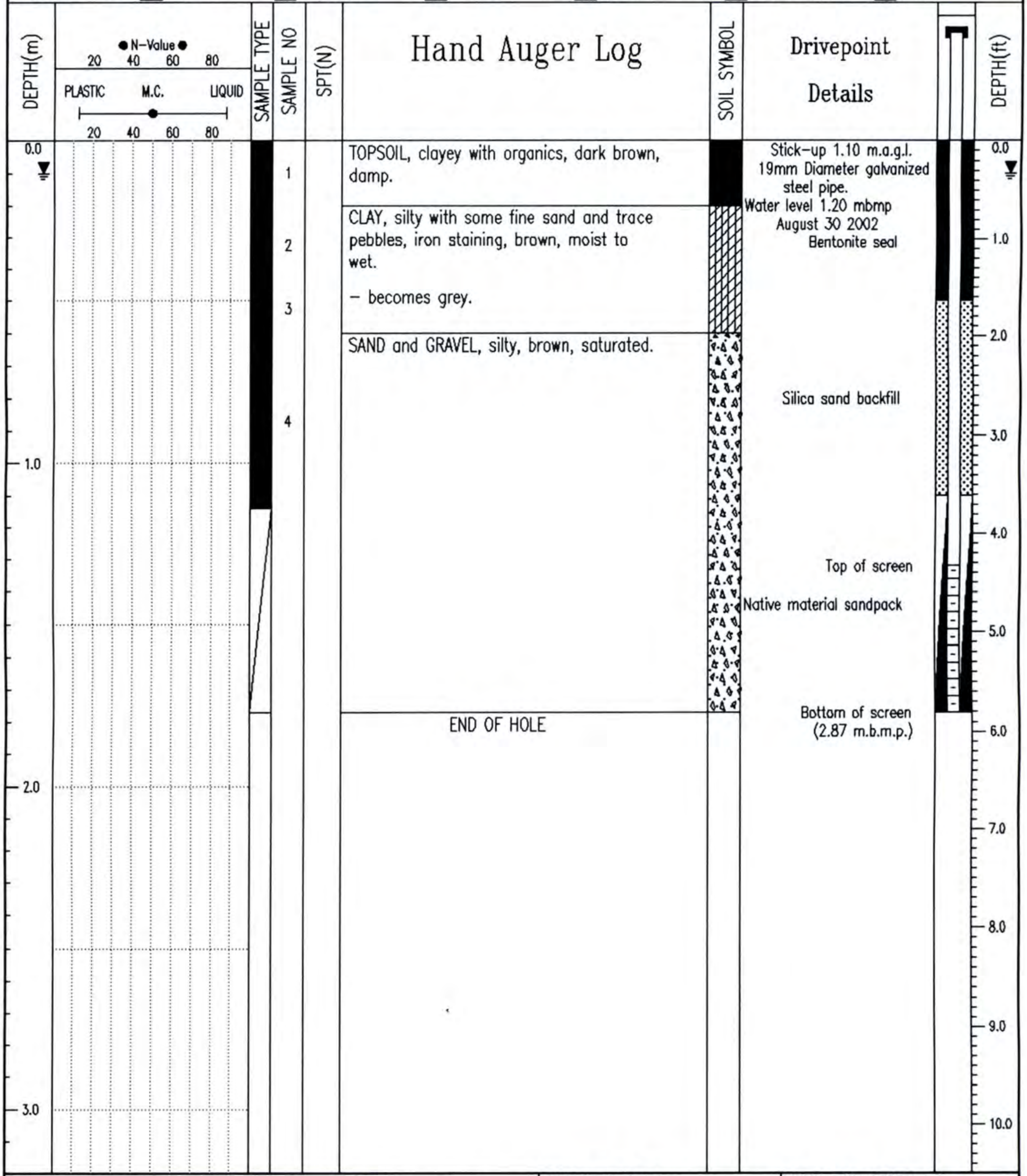
LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/24/02
Fig. No: MEL-21	Page 1 of 1

04/08/06 11:34AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP18
N. Oakville Creeks Subwatershed Study.	Date: July 24 2002	PROJECT NO: 208-021
Rampen, Leo.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ◫ SHELBY TUBE ◨ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND



Hand Auger Log

TOPSOIL, clayey with organics, dark brown, damp.

CLAY, silty with some fine sand and trace pebbles, iron staining, brown, moist to wet.

– becomes grey.

SAND and GRAVEL, silty, brown, saturated.

END OF HOLE

Drivepoint Details

Stick-up 1.10 m.a.g.l.
19mm Diameter galvanized steel pipe.
Water level 1.20 mbmp
August 30 2002
Bentonite seal

Silica sand backfill

Top of screen

Native material sandpack

Bottom of screen
(2.87 m.b.m.p.)

Morrison Environmental Limited	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.8 m
Mississauga, Ontario	REVIEWED BY: D.SAWICKI	COMPLETE: 07/24/02
	Fig. No: MEL-22	Page 1 of 1

04/08/06 11:35AM

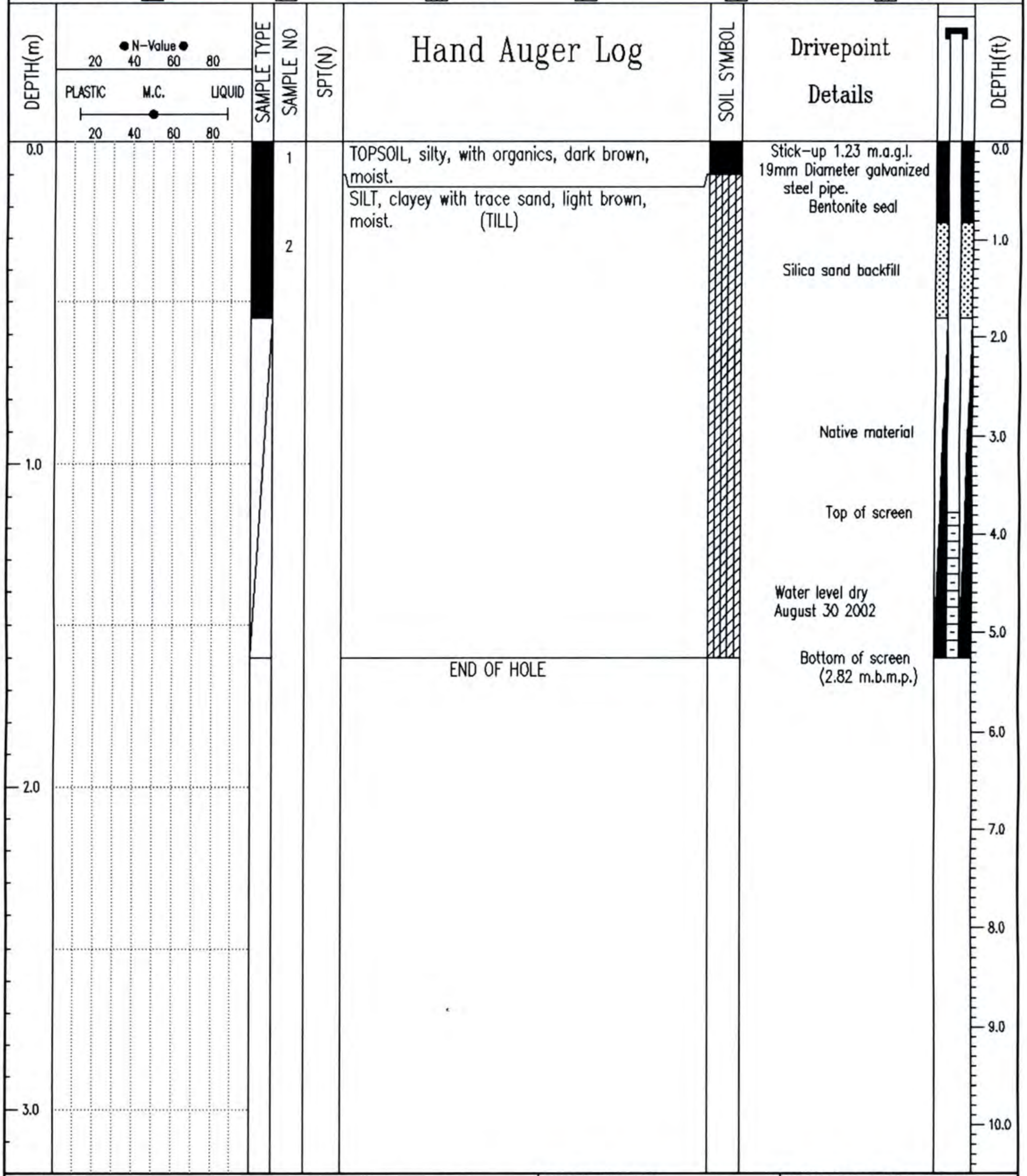
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP19
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Davis, Minardi Home Corporation.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◸ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

Drivepoint Details



TOPSOIL, silty, with organics, dark brown, moist.

SILT, clayey with trace sand, light brown, moist. (TILL)

END OF HOLE

Stick-up 1.23 m.a.g.l.
19mm Diameter galvanized steel pipe.
Bentonite seal

Silica sand backfill

Native material

Top of screen

Water level dry
August 30 2002

Bottom of screen
(2.82 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.6 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
	Fig. No: MEL-23	Page 1 of 1

04/08/06 11:36AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP20
N. Oakville Creeks Subwatershed Study.	Date: July 26 2002	PROJECT NO: 208-021
Davis, Minardi Home Corporation.	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A-CASING ◫ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁛ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

DEPTH(m)	SAMPLE TYPE	SAMPLE NO	SPT(N)	Hand Auger Log	SOIL SYMBOL	Drivepoint Details	DEPTH(ft)
0.0	■	1		TOPSOIL, silty, with organics, dark brown, damp.	■	Stick-up 1.74 m.a.g.l. 19mm Diameter galvanized steel pipe. Bentonite seal	0.0
	■	2		SILT, clayey with trace sand, light brown, moist. (TILL)	▨		1.0
	■				▨	Top of screen Silica sandpack	2.0
	■	3			▨		3.0
1.0	■				▨	Water level dry August 30 2002	
				END OF HOLE		Bottom of screen (2.83 m.b.m.p.)	4.0
							5.0
							6.0
2.0							7.0
							8.0
							9.0
3.0							10.0

N-Value: 20 40 60 80
PLASTIC M.C. LIQUID: 20 40 60 80

Morrison Environmental Limited

Mississauga, Ontario

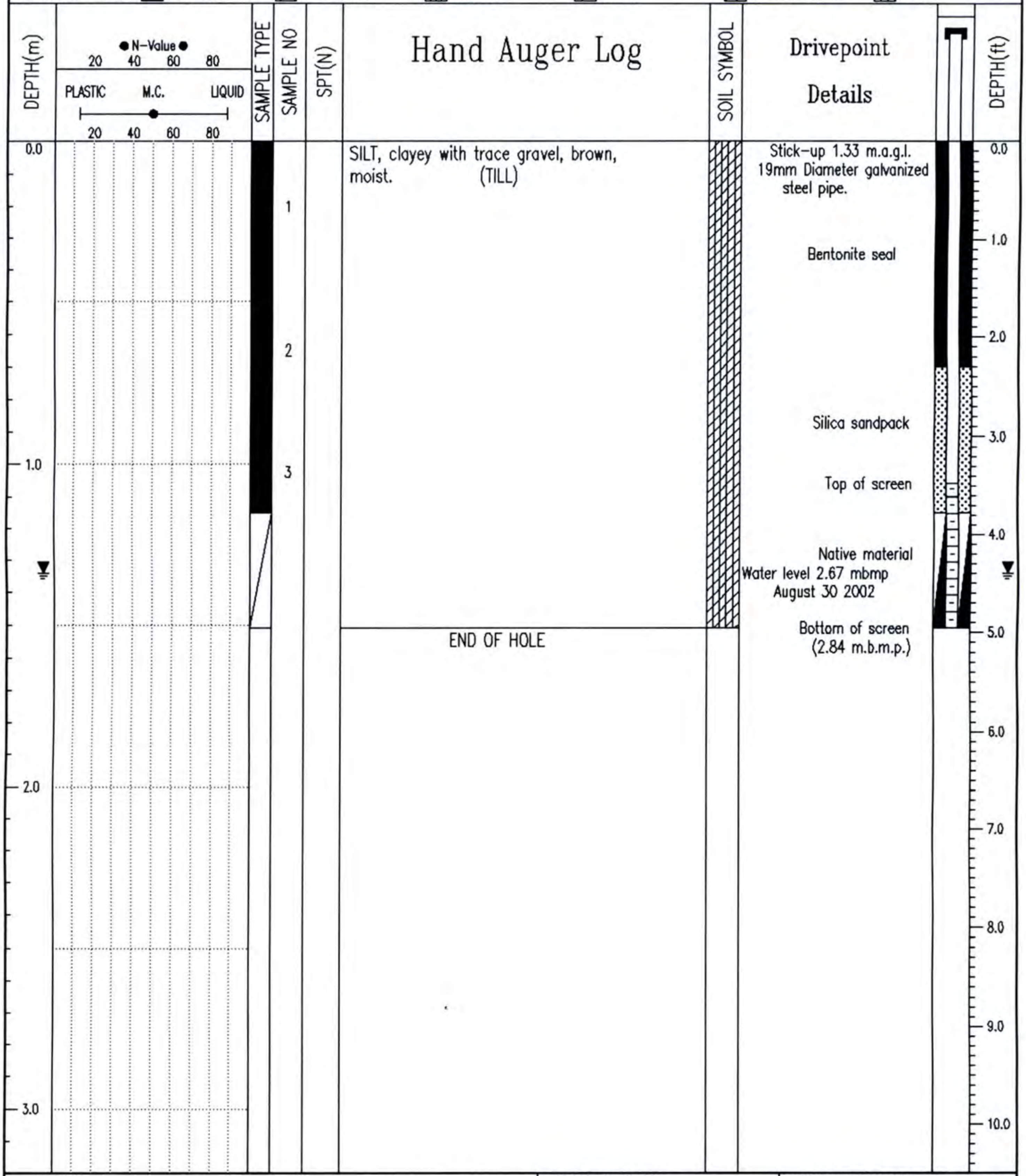
LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.1 m
REVIEWED BY: D.SAWICKI	COMPLETE: 07/26/02
Fig. No: MEL-24	Page 1 of 1

04/08/06 11:36AM

Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP21
N. Oakville Creeks Subwatershed Study.	Date: August 14 2002	PROJECT NO: 208-021
Ma, Sylvia	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ◿ NO RECOVERY ☒ SPT ☰ A-CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND



Hand Auger Log

SILT, clayey with trace gravel, brown, moist. (TILL)

END OF HOLE

Drivepoint Details

Stick-up 1.33 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sandpack

Top of screen

Native material

Water level 2.67 mbmp
August 30 2002

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.5 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 08/14/02
	Fig. No: MEL-25	Page 1 of 1

04/08/06 11:37AM

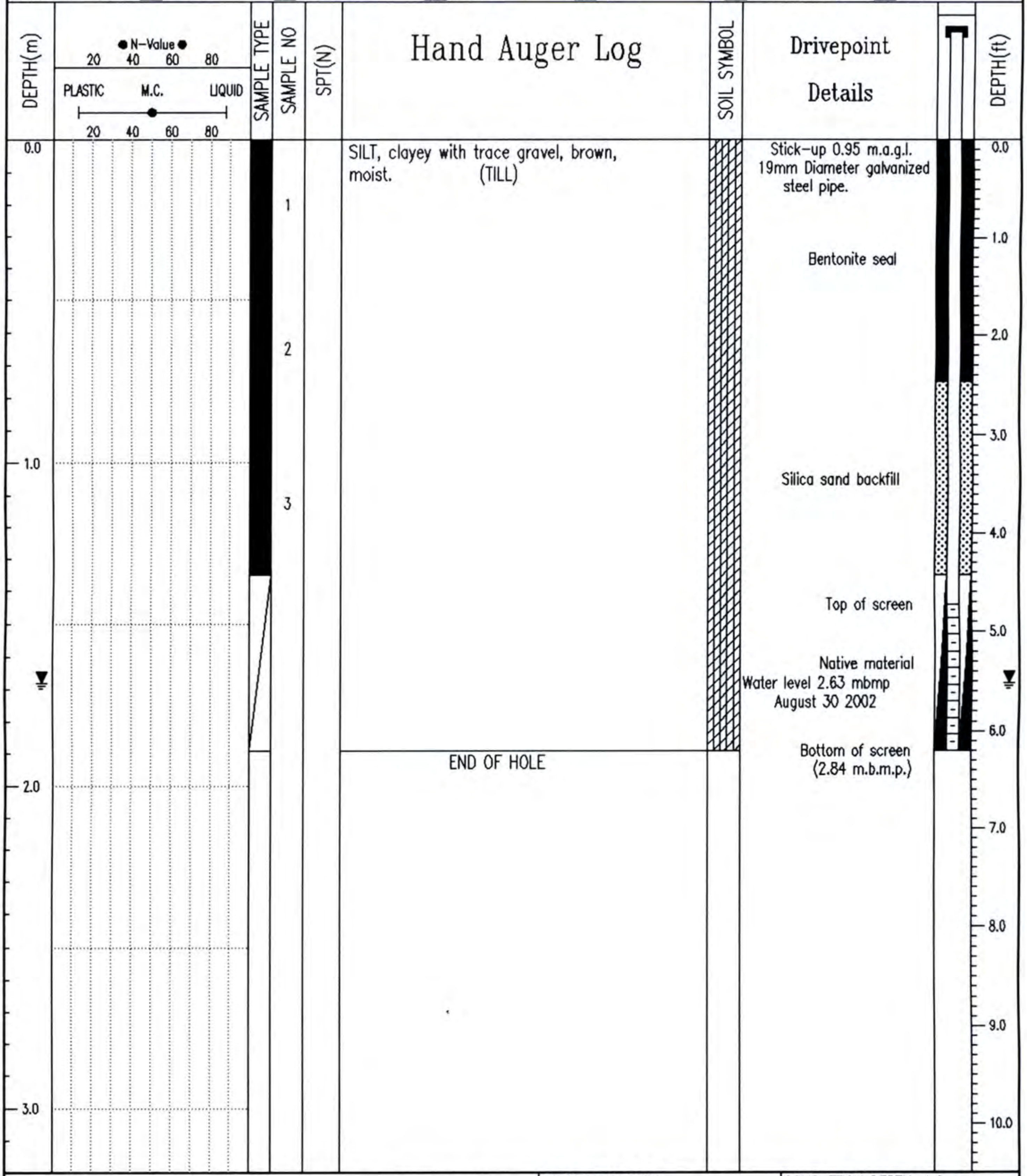
Totten Sims Hubicki	Method: Hand Auger	AUGER HOLE NO: DP22
N. Oakville Creeks Subwatershed Study.	Date: August 14 2002	PROJECT NO: 208–021
Ma, Sylvia	Consultant: Morrison Environmental Ltd.	ELEVATION:

SAMPLE TYPE ■ GRAB ▨ NO RECOVERY ☒ SPT ☰ A–CASING ▥ SHELBY TUBE ▮ CORE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ▩ SAND

Hand Auger Log

Drivepoint Details



SILT, clayey with trace gravel, brown, moist. (TILL)

END OF HOLE

Stick–up 0.95 m.a.g.l.
19mm Diameter galvanized steel pipe.

Bentonite seal

Silica sand backfill

Top of screen

Native material

Water level 2.63 mbmp
August 30 2002

Bottom of screen
(2.84 m.b.m.p.)

Morrison Environmental Limited Mississauga, Ontario	LOGGED BY: S.G.H.	COMPLETION DEPTH: 1.9 m
	REVIEWED BY: D.SAWICKI	COMPLETE: 08/14/02
	Fig. No: MEL–26	Page 1 of 1

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