APPENDIX A:

UNDERSTANDING VULNERABILITY DATA (ISI)

APPENDIX A

MOE GWISI description for public, non-technical audiences

Generally it is well accepted that the thicker the geological material, the longer water will take to move through it and into the groundwater system. However the characteristics of the geological material and how they are described in boreholes or as they appear in outcrops exposed to the surface is important. Often the characteristics that actually control the movement of water into the subsurface and perhaps on to wells, streams and aquifers are secondary in nature. For example clays are considered impermeable for all practical purposes, however in Ontario we find root holes, fractures and desiccation cracks to depths not normally expected.

Therefore the MOE and consultant and agency representatives built a consensus that any mapping of vulnerability of ground water to contamination would be based on actual borehole and site specific observations in the field. From that information an "effective thickness" is calculated using the sum of each layer of geological materials which was multiplied by a "K factor". This allows the geoscientists to interpret the local geology instead of relying on general soil or map information. The MOE Groundwater Intrinsic Susceptibility Index (GWISI) number is then used to classify the vulnerability into High, Medium & Low. The higher vulnerability areas have less protective covering and the lower vulnerability areas have more protective covering.

The individual points used in the making of the GWISI map are labeled and the boreholes or outcrops where geological information is of good quality. The map contouring software is used to automate the isolation of coloured areas on the map using the High, Medium and Low classifications based on the "effective thickness".

In this calculation the horizontal travel in meters/day is represented in the "K Factor". The GWISI is applies to the shallow water table, the top of the aquifer or to a depth of 15m. The vertical rate of travel could be 10X faster than indicated by the "K Factor" or the "K Factor" could be replaced based on actual field testing values.
In addition, bedrock geology, quaternary geology, overburden thickness, sand and gravel thickness and water table maps and local information is used to created vulnerability maps.

In addition, bedrock geology, quaternary geology, overburden thickness, sand and gravel thickness and water table maps and local information is used to created vulnerability maps.

APPENDIX B:

UNDERSTANDING VULNERABILITY DATA (ISI)

Appendix B – Development of SSI and Runoff Indices

It should be noted that the strategies used to create these vulnerability layers were undertaken to fill the specific needs of this project and its target audiences. These indices were developed independently by the technical team to communicate vulnerability information to the public and have not been extensively peer reviewed by geoscience and technical experts. The following approach has been developed specifically for this project and may not be suitable for other applications or analysis.

Shallow Susceptibility Index

Due to local conditions of shallow groundwater and a large Old Order Mennonite population serviced by shallow wells, it was determined that the ISI layer underestimated the vulnerability of this region due to a lack of data points in the water well database. The regions of particular concern are Howick Township and the former Townships of Turnberry, Kinloss, Culross and West Wawanosh. As a backup to areas with limited well information, another vulnerability layer was developed to give landowners an alternative to ISI.

The Surficial Susceptibility Index (SSI) is a method for estimating the security of potential shallow aquifer based on the permeability of the soils and the first subsoil layer (Quaternary geology) **-** the higher the permeability, the higher the susceptibility.

The susceptibility of these shallow aquifers can be estimated by comparing the permeability of the soils with the quaternary geology. In order to do this, the soils layer and quaternary geology layer were overlain and values given to each type of soil and geological unit. The combination of different soils and subsoil types were given values based on their estimated rate of infiltration in order to approximate the susceptibility of a given area.

Matrix for determining Shallow Groundwater Susceptibility values based on Hydrologic soil grouping and permeability of quaternary geology:

	Soils		
Geology	D	B/C	A
Low permeability	1	3	5
High permeability	2	4	6

In SSI, values from 1 to 3 are considered low susceptibility, 4 and 5 considered moderately susceptible and 6 is considered highly susceptible to contamination. Refer to Appendix C for the classification of soil and geology units.

Surface Water Vulnerability – Runoff Index

The goal of developing this layer is to be a guide for landowners about the risk of runoff from their property, where a higher risk for runoff has a greater potential for contaminating surface water with sediment, nutrients and/or bacteria. The chosen methodology is more suited to an agricultural watershed.

Given the communications focus of this project and limited timeframe and budget for implementation, no existing surface water data models at the watershed scale were appropriate for incorporation into the mapping application. Therefore the technical team considered a number of options for developing a local surface water susceptibility methodology for this project. Several existing methodologies were considered: a modified USLE or RUSLE equation with an added transport variable, the Time of Travel approach being used by the Ontario Ministry of Natural Resources (WRIP), and running a hydrograph equation on the landscape. These options were evaluated using the same criteria as groundwater data (accurate, applicable, scale appropriate, understandable). After some deliberation, the technical team decided that all the proposed approaches could meet these criteria. It was decided the best option would be to employ a variant of the Time of Travel approach, which could incorporate actual runoff hydrographs in the calculation. Considering the feasibility of developing the data within the time constraints of the project and with the geospatial tools available, it was instead decided to calculate runoff from the landscape using a unit hydrograph approach.

A modified unit hydrograph approach was used to calculate the runoff proportion. The main modification is that the runoff proportion is calculated from the soil and slope characteristics for each pixel in the watershed versus an area weighted single value for an entire catchment. The major variables for the calculation were:

1) The curve number (CN) for each pixel was assigned based on the soil hydrologic group and percent slope. The initial CN value range was based on a row crop scenario. This will overestimate runoff of permanent pasture and hay and grain systems. See table Appendix C for a listing of soil types and hydrologic soil groups. In selecting the CN value, the higher end of the range was selected since the watershed condition was assumed to be saturated, or condition III. This is to highlight the times of the year when soil is more likely to be bare. Once again, this will overestimate the amount of runoff that would occur when the soil is drier.
2) Deep percolation (FC) was determined by soil type. See Appendix C for a listing of soil types and FC values.
3) Based on water quality information in response to rainfall, and based on rainfall patterns, an Atmospheric Environment Service (AES) 50mm 8 hour storm with 30% distribution was selected. Refer to table B1 and figure B1

Table B1: AES 12 Hour Design Storm Distributions

	10%		30%		50%		70%		90%	
Elapsed Time [Hours]	Cumul. %	Incr. %	Cumul. %	Incr. %	Cumul. %	Incr. %	Cumul. %	Incr. %	Cumul. %	Incr. %
1	45	45	13	13	4	4	3	3	1	1
2	85	40	39	26	18	14	8	5	3	2
3	98	13	59	20	30	12	14	6	4	1
4	100	2	74	15	42	12	24	10	10	6
5	100	0	88	14	60	18	39	15	14	4
6	100	0	96	8	75	15	50	11	27	13
7	100	0	99	3	84	9	60	10	36	9
8	100	0	100	1	91	7	72	12	44	8
9	100	0	100	0	96	5	84	12	58	14
10	100	0	100	0	100	4	92	8	61	3
11	100	0	100	0	100	0	96	4	92	31
12	100	0	100	0	100	0	100	4	100	8

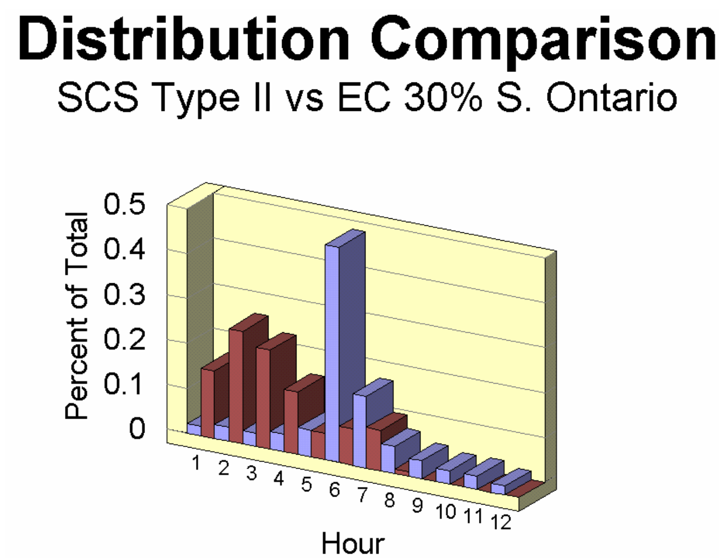


Figure B1: Rainfall Distribution Comparison between Environment Canada 30% distribution in Southern Ontario (red) and the Soil Conservation Service (blue)

A major consideration is that the estimation of runoff is very conservative and is based on a worst case scenario. The reason for this is that it is better to move from a high rating to a lower rating through refinement, then to have a landowner see the rating go up after refinement.

For defining levels of runoff potential, the following categories were developed based on the percentage of the rainfall (50mm) that would run off over the 8 hours:
Low – 0- 15% of the rainfall amount ran off
Medium – more than 15% to 30% of the rainfall amount ran off
High – greater than 30% of the rainfall amount ran off

These estimates are for each pixel and do not take into account runoff water that may be coming from upslope. Also, this methodology does not indicate areas that are contaminating surface water since no transport function is included. A steep slope may produce runoff, but if it infiltrates on more level ground before reaching a watercourse, it may have no impact on water quality.

The output was tested by substituting the proportions of high, medium and low runoff index for area weighted values of CN and FC in the watershed upstream of Listowel, Ontario. When compared to the actual hydrograph of a storm event, the fit was significant.

The following program was used to calculate the percentage of the total rainfall that ran off the land

```
    ROUTINE FOR CALCULATION OF RUNOFF TOTALS
    very roughly translated from HYDROPAK (Jack MacPherson)
    rtot = total rainfall : rem [50mm] our case
     E array IS INCREMENTAL RAINFALL FRACTONS
     G array IS ACCUMULATED RAINFALL
     H array IS ACCUMULATED RUNOFF
     THESE VALUES ARE FOR THE UNIT HYDROGRAPH DEVELOPMENT PROCESS
     SINCE WE ONLY NEED RATIO AND NOT TOTAL PEAKS WE DO NOT NEED TO DEVELOP
THE UNITGRAPHS


4380        RESTORE 4380: REM AES 30% SOUTH ONT. 8 Hour STORM
       DATA .13,.26,.20,.15,.14,.08,.03,.01,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,8,1.0
            S$ = "AES 30% Southern Ontario"
     READ IN E ARRAY  [this sample is in 1 hour increments]
     acumrain = 0
   rem must zero arrays for G & H
   FOR I = 1 TO stormduration [8] storm duration in hours
      RV(2) = E(I) * rtot
      acumrain = acumrain + RV(2)
      G(I) = acumrain
   NEXT I
      soilstorage = 25400 / CN - 254
      SLOSS = deepercrate [considered minimum infiltration rate] holtans Fc
    FOR I = 1 TO stormduration [8]
      potruno = G(I) - .2 * soilstorage
   IF potruno < 0 THEN potruno = 0 [remove negs]
    H(I) = potruno ^ 2 / (G(I) + .8 * soilstorage
   IF I = 1 THEN GOTO 5410
      incrrain = G(I) - G(I - 1)
      incrunoff = H(I) - H(I - 1)
      incremloss = incrain - incrunoff
   IF incremloss < SLOSS THEN H(I) = GIN - SLOSS + H(I - 1)
      IF H(I) < H(I - 1) THEN H(I) = H(I - 1)
      incrunoff = H(I) - H(I - 1)
      acumrunoff = H(I)
5410    NEXT I
    RUNOFF RATIO = acumrunoff / acumrain [this is the used value]
```

APPENDIX C:

SOIL AND GEOLOGY VALUES FOR SSI AND RUNOFF INDICIES

Appendix C – Soil and Geology Values for SSI and Runoff Indices

i)The classes for estimating the permeability of the Quaternary Geology Units for the Maitland Valley CA watershed are listed below. The classes were developed by Brian Luinstra, PH D P.Geo, MVCA. Relative classifications were developed specifically for this project and may not be suitable for use in other applications or analysis.

Permeability Rating for SSI	Standard Code Unit Name from ABCA, MVCA and UTRCA Quaternary Geology Digitizing Project
Low	Catfish Creek Till: stony, clayey silt to silty sand matrix
Low	Cultural features: fill; man-made deposits
Low	Dunkeld Till (Huron-Georgian Bay lobe): silt matrix
Low	Elma Till (Huron-Georgian Bay lobe): stony, silt to sandy silt matrix
Low	Glaciolacustrine Deep Water deposits: clay, silt, silty and very fine sand;
Low	Maryhill Till (Erie lobe): clay matrix
Low	Modern Fluvial deposits: clay, silt, sand, gravel, muck; alluvial and stream deposits, deposited on modern flood plains
Low	Mornington Till (Huron-Georgian Bay lobe): silty clay matrix
Low	Organic deposits: muck, peat, marl; bog and swamp deposits
Low	Port Stanley Till (Erie lobe): silty clay to sandy silt matrix
Low	Rannoch Till (Huron lobe): silty clay to sandy silt matrix
Low	St. Joseph Till (Huron lobe): silt to silty clay matrix
Low	Stratford Till (Huron-Georgian Bay lobe): sandy silt matrix
Low	Tavistock Till (Huron-Georgian Bay lobe): silty clay to sandy silt matrix
Low	Wartburg Till (Huron-Georgian Bay lobe): clay matrix
Low	Wildwood Silts (Huron lobe): silt; lacustrine deposits
High	Bass Island Formation: dolostone
High	Bedrock: Undifferentiated
High	Bois Blanc Formation: limestone with chert
High	Detroit River Group: limestone, dolostone
High	Dundee Formation: limestone
High	Eolian deposits: fine sand, silt; dunes and sand plains
High	Eolian deposits: fine to medium sand; dunes and sand plains
High	Fluvial deposits: gravel, sand, silt; alluvial deposits
High	Glaciofluvial Ice-contact deposits: gravel; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
High	Glaciofluvial Ice-contact deposits: sand, silt; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
High	Glaciofluvial Ice-contact deposits: undifferentiated sand, gravel, silt and till; esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
High	Glaciofluvial Outwash deposits: gravel, gravelly sand; proglacial river and deltaic deposits
High	Glaciofluvial Outwash deposits: sand; proglacial river and deltaic deposits
High	Glaciolacustrine Beach and Shoreline deposits: coarse sand, gravel; beach, bar, deltaic, shallow water and nearshore deposits
High	Glaciolacustrine Shallow Water deposits: fine to medium sand; deltaic and nearshore deposits
High	Hamilton Group: shale, limestone
High	Lacustrine Shoreline deposits: sand, gravel; nearshore and beach deposits
High	Older Fluvial deposits: sand, gravel; alluvial deposits
High	Salina Formation: shale, dolostone, evaporites

ii)The classes for estimating the permeability of the Quaternary Geology Units for the Saugeen Valley CA watershed are listed below. The classes were developed by Brian Luinstra, PhD P.Geo, MVCA. Relative classifications were developed specifically for this project and may not be suitable for use in other applications or analysis.

Permeability Rating for SSI	Primary Material Attribute Provincial Quaternary Geology Layer from OGDE
Low	Clay, silt
Low	Clay, silt, sand, gravel
Low	Diamicton
Low	Organic Deposits
High	Gravel
High	Paleozoic Bedrock
High	Sand
High	Sand, Gravel
High	Silt, sand
High	Silt, Sand, Gravel

iii)The values for the runoff index for soil hydrologic characteristics are listed below.
Values were used for this project that may not be suitable for other applications or analysis

Basin Runoff Forecast Unit Calibration of the Saugeen and Maitland Watersheds by Jack MacPherson 1978-1982.

		County	Class	A Horizon (cm)	S %	Fc mm/hr
Berrien Sandy Loam	Bes	Bruce Grey Wellington	B-A	22.86	31.0	7.0
	Bes	Huron	B-A	25.40	30.9	7.4
Bookton Sandy Loam	Bos	Bruce Grey Wellington	B-A	20.32	31.0	7.0
	Bos	Huron	B-A	12.70	30.9	7.0
Bottom Land	BL	Bruce	B	30.48	31.3	6.1
	BL	Grey	B	30.48	31.3	6.1
	BL	Wellington	B	30.48	31.3	6.1
Brady Sandy Loam	Bsl	Bruce	B-A	33.02	31.0	7.5
	Bsl	Grey	B-A	30.48	31.0	7.0
	Bs	Wellington	B-A	20.32	31.0	7.6
	Brs	Huron	A-B	20.30	33.0	8.9
Breypen	Bp	Bruce	B-D	2.54	26.0	3.0
	Bp	Grey Wellington	B-D		26.0	3.0
Bridgman Sand	Bis	Bruce Grey Wellington	B	15.24	24.4	6.3
Brighton Sand	Brs	Bruce Grey Wellington	B	30.48	32.3	6.8
Brisbane Loam	Brl	Bruce	B	25.40	30.0	5.0
	Brl	Grey	B	25.40	30.0	6.0
	Bl	Wellington	B	17.78	30.0	6.0
	Brl	Huron	B	27.90	30.0	5.8
Brookston Clay Loam	Bc	Perth	B-C	17.78	25.7	3.5
	Bc	Bruce	B-C	17.78	25.7	3.5
	Bc	Grey	B-C	17.78	25.7	3.5
	Bnc	Wellington	B-C	15.24	25.7	3.8
	Bc	Huron	B-C	20.30	25.7	3.9
Brookston Loam	Bnl	Bruce Grey Wellington	B	15.24	30.0	7.6
Brookston Silt Loam	Bs	Perth	B	17.78	31.3	3.8
	Bs	Bruce	B	17.78	31.3	3.8
	Bns	Grey Wellington	B-C	15.24	25.7	3.8
	Bs	Huron	B	20.30	31.3	4.0
Brookston Silty Clay Loam	Bsc	Huron	C-B	20.30	23.3	3.8
Burford Loam	Bg	Perth	B	48.30	30.0	4.0
	Bg	Bruce	B	40.64	30.0	6.1
	Bg	Grey	B	25.40	30.0	5.5
	Bg	Wellington	B	30.48	30.0	5.0
	Bg	Huron	B	40.60	30.0	5.9
Chesley Clay Loam	Cc	Bruce	B-C	12.70	25.7	3.5

		Grey				
		Wellington				
Chesley Silt Loam	Cs	Bruce	B	12.70	31.3	4.5
		Grey				
		Wellington				
Chesley Silty Clay Loam	Csc	Bruce	C-B	12.70	23.3	3.5
	Csc	Grey	C-B	12.70	23.3	3.5
		Wellington				
Colwood Silt Loam		Bruce				
		Grey				
	Cos	Wellington	A-B	15.24	36.3	8.4
Donnybrook Sandy Loam	Dsl	Perth	B-A	58.40	31.0	7.0
	Dos	Bruce	B-A	43.18	31.0	7.6
	Dos	Grey	B-A	40.64	31.0	7.6
	Db	Wellington	B-A	25.40	31.0	7.0
	Dos	Huron	B-A	61.00	31.0	7.6
Dumfries Loam	Dl	Bruce	B	35.56	30.0	5.8
		Grey				
	Dl	Wellington	B	30.48	30.0	4.0
	Dl	Huron	B	27.90	30.0	6.0
Dumfries Sandy Loam	Ds	Huron	B-A	27.90	30.9	7.6
Dumfries-Hillsburgh		Bruce				
		Grey				
	Dl-Hif	Wellington	B	35.56	30.0	7.6
Eastport Gravel	Eg	Bruce	B	91.44	24.4	6.4
		Grey				
		Wellington				
Eastport Sand	Es	Bruce	B	15.24	24.4	6.3
		Grey				
		Wellington				
Elderslie Clay Loam	Ecl	Bruce	B-C	17.78	25.7	3.5
		Grey				
		Wellington				
Elderslie Silt Loam	Esl	Bruce	B	17.78	31.3	4.5
		Grey				
		Wellington				
Elderslie Silty Clay Loam	Esc	Bruce	C-B	17.78	23.3	3.5
	Esc	Grey	C-B	10.16	23.3	3.5
		Wellington				
	Psc	Huron	C-B	20.30	23.3	3.9
Farmington Loam		Bruce				
	Fl	Grey	B-A	12.70	30.9	6.1
	Fl	Wellington	B-A	12.70	30.9	6.1
Fox Sandy Loam	Fsl	Bruce	B-A	66.04	31.0	7.6
	Fsl	Grey	B-A	58.42	31.0	7.6
	Fs	Wellington	B-A	60.96	31.0	7.6
	Fs	Huron	A	56.00	32.7	8.9
Gilford Loam	Gil	Perth	B	17.80	30.0	6.1
	Gil	Bruce	B	15.24	30.0	6.1
	Gil	Grey	B	15.24	30.0	6.1
	Gil	Wellington	B	20.32	30.0	6.1
	Gil	Huron	B	17.80	30.0	6.1
Granby Sand	Gs	Bruce	B	17.78	32.3	6.9
	Gs	Grey	B	20.32	32.0	6.9
	Gs	Wellington	B-A	17.78	31.0	7.6
Granby Sandy Loam	Gsl	Bruce	B-A	17.78	31.0	7.5
		Grey				

	Grs	Wellington	B-A	17.78	31.0	7.5
	Gs	Huron	B-A	20.30	30.9	7.6
Guelph Loam	Gl	Perth	B	33.60	30.0	4.0
Guerin Loam	Gul	Huron	B	22.90	30.0	6.1
Harkaway Loam	Hal	Bruce	B	12.70	30.0	6.0
	Hal	Grey	B	10.16	30.0	6.0
Harkaway Silt Loam	Has	Bruce	B	12.70	31.3	6.1
	Has	Grey	B	10.16	31.3	6.1
		Wellington				
Harriston Loam	Hl	Bruce	B	45.72	30.0	5.8
	Hl	Grey	B	45.72	30.0	5.8
	Hl	Wellington	B	48.26	30.0	5.8
	Hl	Huron	B	48.30	30.0	5.0
Harriston Silt Loam	Hsi	Perth	B	50.80	31.3	4.0
	Hs	Bruce	B	50.80	31.3	5.8
	Hs	Grey	B	45.72	31.3	5.5
	Hs	Wellington	B	48.26	31.3	6.1
	Hs	Huron	B	48.30	31.3	5.0
Huron Clay Loam	Huc	Perth	B-C	25.40	25.7	3.5
	Huc	Bruce	B-C	27.94	25.7	3.5
		Grey				
	Huc	Wellington	B-C	43.18	25.7	3.8
	Huc	Huron	B-C	25.40	25.7	3.5
Huron Loam	Hul	Bruce	B-C	27.94	25.7	3.8
		Grey				
	Hul	Wellington	B-C	43.18	25.7	3.8
Huron Silt Loam	Hus	Perth	B	25.40	31.3	3.3
	Hus	Bruce	B	27.94	31.3	4.5
		Grey				
	Hus	Wellington	B	43.18	31.3	4.0
	Hus	Huron	B	25.40	31.3	3.5
Killean Loam	Kl	Bruce	B	30.48	30.0	6.5
		Grey				
		Wellington				
Lily Loam		Bruce				
	Lyl	Grey	B	15.24	30.0	5.8
	Lyl	Wellington	B-A	17.78	31.0	7.6
Listowel Loam	Ll	Bruce	B	30.48	30.0	5.0
	Ll	Grey	B	25.40	30.0	5.0
	Ll	Wellington	B	30.48	30.0	6.0
	Ll	Huron	B	33.00	30.0	6.0
Listowel Silt Loam	Lsi	Perth	B	35.60	31.3	4.5
	Ls	Bruce	B	30.48	31.3	4.5
	Ls	Grey	B	25.40	31.3	4.5
	Lis	Wellington	B	30.48	31.3	6.1
	Ls	Huron	B	17.80	31.3	6.1
London Loam	Li	Perth	B	22.90	30.0	4.0
Lyons Loam	Lyl	Huron	B-A	20.30	30.0	7.6
Muck	M	Bruce	D	0.00	27.0	3.5
	M	Grey	D	0.00	27.0	3.5
	M	Wellington	D	0.00	27.0	3.5
	M	Huron	D	0.00	27.0	3.5
Osprey Loam	Ol	Bruce	B	7.62	30.0	5.2
	Ol	Grey	B	5.08	30.0	5.0
		Wellington				
Parkhill Loam	Pl	Perth	B	15.24	30.0	5.8
	Pal	Bruce	B	15.24	30.0	5.8

	Pal	Grey	B	15.24	30.0	5.0
	Pal	Wellington	B	17.78	30.0	5.8
	Pal	Huron	B	17.80	30.0	5.8
Parkhill Silt Loam	Pas	Bruce	B	17.78	30.0	5.8
	Pas	Grey	B	15.24	31.3	6.0
	Pas	Wellington	B	17.78	31.3	6.0
	Pas	Huron	B	17.80	31.3	6.1
Peat	P	Bruce	D	0.00	27.0	3.8
	P	Grey	D	0.00	27.0	3.8
	P	Wellington	D	0.00	27.0	3.8
Perth Clay Loam	Pc	Perth	B-C	25.40	25.7	3.5
	Pc	Bruce	B-C	33.02	25.7	3.5
		Grey				
	Pc	Wellington	B-C	17.78	25.7	3.8
	Pc	Huron	B-C	20.30	25.7	3.8
Perth Loam		Bruce				
		Grey				
	Pl	Wellington	B-C	17.78	25.7	3.8
Perth Silt Loam	Ps	Perth	B	25.40	31.3	3.3
	Ps	Bruce	B	33.02	31.3	4.0
		Grey				
	Ps	Wellington	B	17.78	31.3	4.5
	Ps	Huron	B	20.30	31.3	3.9
Perth Silty Clay Loam	Psc	Huron	C-B	20.30	23.3	3.9
Pike Lake Loam		Bruce				
	PLl	Grey	B-A	27.94	31.0	7.5
		Wellington				
Plainfield Sand	Pls	Bruce	B-A	7.62+	31.0	7.6
		Grey				
		Wellington				
Sargent Loam	Sg	Bruce	B	7.62	30.0	5.0
	Sg	Grey	B	7.62	30.0	4.5
		Wellington				
Saugeen Clay Loam	Sc	Bruce	B-C	17.78	25.7	3.5
		Grey				
		Wellington				
Saugeen Silt Loam	Ss	Bruce	B	10.16	31.3	4.2
		Grey				
		Waterloo				
Saugeen Silty Clay Loam	Ssc	Bruce	C-B	17.78	23.3	3.5
	Ssc	Grey	C-B	15.24	23.3	3.8
		Wellington				
Sullivan Sand	Sus	Bruce	B	7.62	32.3	6.9
	Sus	Grey	B	7.62	32.3	6.9
		Wellington				
Tecumseth Sand		Bruce				
	Ts	Grey	B	20.32	32.3	6.9
		Wellington				
Teeswater Silt Loam	Tes	Bruce	B	48.26	31.3	4.2
		Grey				
	Tes	Wellington	B	60.96	31.3	4.2
	Tes	Huron	B	45.70	31.3	5.5
Toledo Clay Loam	Tc	Bruce	B-C	15.24	25.7	3.5
	Tc	Grey	B-C	15.24	25.7	3.4
	Tc	Wellington	B-C	15.24	25.7	3.5
	Tc	Huron	B-C	17.80	25.7	3.8
Toledo Silt Loam	Ts	Bruce	B	15.24	31.3	3.0

		Grey				
		Wellington				
	Ts	Huron	B	17.80	31.3	5.5
Vincent Silty Clay Loam	Vsc	Bruce	C-B	7.62	23.3	3.8
	Vsc	Grey	C-B	10.16	23.3	3.5
		Wellington				
Waterloo Sandy Loam	Wsl	Perth	B-A	40.60	31.0	7.0
	Wsl	Bruce	B-A	43.18	31.0	7.0
	Wsl	Grey	B-A	35.56	31.0	7.0
		Wellington				
Wauseon Sandy Loam	Was	Bruce	B-A	20.32	31.0	4.5
		Grey				
		Wellington				
	Was	Huron	B-A	22.90	30.9	7.2
Wiarton Loam	Wl	Bruce	B	15.24	30.0	5.8
		Grey				
		Wellington				
Wiarton Silt Loam	Ws	Bruce	B	15.24	31.3	5.9
	Ws	Grey	B	17.78	31.3	5.9
		Wellington				

APPENDIX D:

WEBSITE FORMS

Contact :

Project Feedback

A project feedback form has also been developed. Please take a moment to fill it out so we can identify ways to improve the site and better meet the needs of users. This form can be sent anonymously.

1. Was it easy to find your property in the mapping section?

Yes No

Comments (optional)

2a. Is the information presented with the maps clear?

Yes No

Comments (optional)

2b.Do you have questions that were not answered?

Yes No

Comments (optional)

---

3. Does the information reflect what you know about your property? Does it seem accurate?

Yes No

Comments (optional)

---

4. Is the information useful?

Yes No

Comments (optional)

---

5. Would you like a Conservation Authority staff member to contact or visit you to discuss the information presented?

☐ Yes ☐ No

If so, please provide contact information

---

6. Was the speed or performance of the site satisfactory? (That is, did information like the map appear on your screen in a reasonable amount of time?)

☐ Yes ☐ No

Comments (optional)

---

7. What type of internet connection are you using?

☐ High speed connection (such as cable or DSL) ☐ Dial up service

Comments (optional)

---

8. What category best describes you?

☐ Farmer ☐ Rural landowner ☐ Agricultural consultant ☐ Municipal Staff or councillor ☐ Other

---

9. The My Land, Our Water project is testing the delivery of water information to users in three ways. How would you prefer to receive this information?

☐ Web Site ☐ Computer stations at the SVCA and MVCA offices ☐ Conservation Authority staff visiting a landowner

Comments (optional)

---

10. Will you recommend the site to others?

☐ Yes ☐ No

Comments (optional)

Send Comment

Data Feedback

We recognize that the MOE Water Well Record Database contains inaccurate and missing records. We are currently gathering missing information from the database. This information will be passed on to the MOE to assist their efforts to update the database.

If you have a well that is not in the database, or know of a well that is not located in the right spot, please complete this form. A Conservation Authority staff member will contact you to discuss the problem.

Name

Phone

Email

Comments (optional)

Submit

APPENDIX E:

LANDOWNER INFORMATION PACKAGE - EXTENSION

My Land, Our Water - Providing Access to Source Protection Information for the Rural Community

November 8, 2004

Project Purpose

1. To improve access to information on source protection for rural and agricultural landowners and municipalities in the Maitland and Saugeen watersheds.
2. To encourage the protection of both surface and groundwater.

Outcomes

1. Mapping the vulnerability of land to surface and groundwater contamination.
2. Evaluation of three methods of delivering this information to the community:
   - over the internet
   - at designated terminals located in the MVCA and SVCA offices
   - an extension staff person available to visit farm operations

Need for the Project

The MVCA and SVCA watersheds are primarily agricultural and the majority of the land is privately owned. Large areas in both watersheds are not part of a municipal well capture zone. Most of the rural population obtain their water from private wells.

What We Know

- Surveys conducted by the MVCA in 2000 indicated that landowners want financial and technical assistance in order to select appropriate best management practices for protecting water quality.
- Actions to protect water need to occur at the individual farm level. We know that landowners are interested in information about their own property and their local community.
- We know what information landowners, crop consultants, and municipalities need in order to make choices that will protect water. This information includes: aerial photography, soil, slope and geology information, groundwater characteristics, and risk assessments for surface and groundwater.

Benefits of the Project

- This project will place consistent, credible and well interpreted information into the hands of land managers.
- Landowners need this source protection information to develop farm water protection plans and nutrient management plans.
- The methodology of how risk is calculated and mapped can be transferred to surrounding watersheds with similar physical characteristics and land management issues. Four of the ten highest manure producing watersheds border the Maitland and Saugeen watersheds.
- Prevention is better than treatment; the project will assist landowners to take proactive steps to protect surface and groundwater.
- Municipalities will be able to incorporate risk information into their decision making processes.
- Learn how landowners respond to the three methods of data delivery.
- Learn how landowners respond to discovering that their surface and/or groundwater is at high risk for contamination.

My Land, Our Water - on the web

My Land, Our Water can soon be viewed at http://myland.mvca.on.ca or by visiting the MVCA and SVCA offices. Please call ahead to ensure a staff member is available to assist you.

The *My Land, Our Water* project is still under construction and we would appreciate your comments and suggestions. If you visit the website please take a moment to complete the feedback form or call Jayne Thompson at 335-3557 with your comments.

Partners

Maitland Watershed Partnerships Water Action Team Members

B.M. Ross and Associates Ltd.
County of Huron
Ducks Unlimited
Fisheries and Oceans Canada
Huron Farm Environmental Coalition
Huron Stewardship Council
Maitland Engineering Services Ltd.
Maitland Valley Conservation Authority
Ministry of the Environment
Ontario Ministry of Agriculture and Food
Ontario Ministry of Natural Resources
Town of North Perth
Wellington Stewardship Council
Wescast Industries Inc.

SVCA Water Team

Bruce County Federation of Agriculture
Campground Operator
Golf Course Owner
Grey County Federation of Agriculture
Interforest
Micro-Hydro Producer
Ministry of the Environment
Ontario Clean Water Agency
Ontario Ministry of Agriculture and Food
Ontario Ministry of Natural Resources
Rural Municipality
Saugeen Field Naturalists
Saugeen Valley Conservation Authority
Urban Municipality
Water Bottling Company

Resource Experts

John FitzGibbon - School of Rural Planning and Landscape Architecture, University of Guelph

John FitzSimons - School of Rural Planning and Landscape Architecture, University of Guelph

Jack MacPherson - Hydrology Consultant

Jennifer McLellan - Hydrogeology Consultant

SAUGEEN CONSERVATION

Maitland Valley Conservation Authority
Working for a Healthy Environment!

Groundwater - an introduction

My Land, Our Water

What is it?

Groundwater is any water found underground. It moves through the spaces between the soil particles, or through cracks and channels in bedrock.

How does it get there?

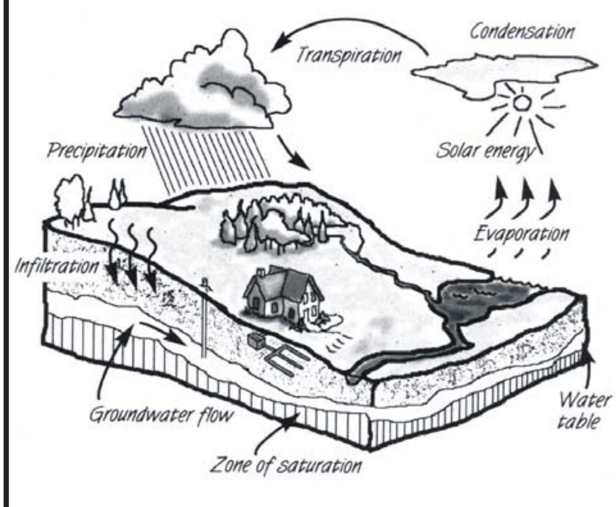
Groundwater is recharged when rain falls or snow melts. Water that doesn't run off to rivers and ponds, or evaporate back to the air, seeps into the ground. It moves down through the spaces between the soil particles (pore spaces) until it reaches the water table. Above the water table, the pore spaces are filled with air, or air and water. Below the water table all pore spaces are filled with water and the soil is saturated.

The amount of groundwater recharge depends on the ground cover (pavement, lawn or wood lot), the ground slope, and the soil type. The quality of the recharge water depends on human activities and presence of contaminants on the ground surface.

Where does it go?

Water is always moving. Below the water table, the groundwater continues to travel through the soil or rock. It may only be underground a few weeks, remaining close to the ground surface and discharging into a nearby creek; or it can move deeper, travelling many kilometres over hundreds of years, possibly discharging into a major river or large lake.

If the water is travelling through an aquifer it may be pulled into a well. It's then pumped out of the ground for our use and discharged onto the surface as waste water.



The Healthy Home Guidebook, Dundas Environmental Awareness Group, 2002

What is an aquifer?

The soil below the ground is often layered. These layers can be sand, silt or clay, or a mixture. In the same way, the solid bedrock below the soil may be layers of different rock types. Some layers are permeable, meaning water can move through them easily. If a permeable layer is saturated and can supply water to a well it's called an aquifer. Typical aquifers consist of sand and gravel, or limestone rock that has many interconnecting channels.

Less permeable soils, such as silt and clay, restrict water movement. The presence of a low permeable layer (called an aquitard) above an aquifer helps protect the aquifer from contamination.

Did you know...

The water you are drinking today has been used many times. It may even have been drinking water for a dinosaur!

Protecting Groundwater

The costs of preventing groundwater contamination are much less then those associated with trying to clean up contamination. What we do on our land can directly impact the quality and quantity of water available for use. In order to protect groundwater in highly susceptible areas the following Best Management Practices could be used:

1. Reduce nutrient input - Nutrients, particularly Nitrogen, are soluble in water and can quickly infiltrate to aquifers and wells. Limit the application of Nitrogen to the recommended amounts in a Nutrient Management Plan.

2. Change the timing and frequency of application Nitrogen applied in the fall is more likely to leach through the soil layers and into nearby aquifers through the winter. Consider applying nitrogen in the spring to maximize nutrient uptake by crops. More frequent, split applications also maximize crop uptake of nutrients and reduce the amount of nitrogen leached to aquifers.

3. Plant crops that require less nutrients - Different crops require less nutrients than other and don't "shed" or leach as much nutrient as others. In areas of high susceptibility, avoid planting row crops that require high doses of nitrogen, such as corn. If possible, consider planting other crops that fix nitrogen from the atmosphere such as beans.

4. Decommission out-of-service wells - Wells that are out of service provide contaminants with a direct route to the aquifer, 'short-circuiting' the subsurface materials that act as a filter for infiltrating water. A licensed well contractor should decommission old wells.

Protecting Your Well

The best and most economical way to protect your well is by implementing BMPs around the wellhead.

1. Well location - Locate wells on high ground where they won't be flooded by surface water. If your well is located in a depression, build up the soil around the well to divert water away. Drilled wells should be located at least 15 metres from septic systems or manure storages, shallow wells 30 metres.

2. Well installation - Well casings should extend a minimum of 18 inches above the ground and have a sealed vermin proof cap. Casings should be water-tight with water-tight joints. Drilled wells should have pitless adaptors. Make sure that there are no large gaps between the outside of the casing and the ground around it where surface water can run directly into into the ground.

3. Maintain your wellhead - Wellheads should be accessible at all times of the year for maintenance and inspection. Do not plant gardens around or on top of your well. Avoid spreading fertilizers or pesticides around the well. Make sure that all livestock are fenced away from the well.

4. Test your water regularly - Testing your water is the only way to ensure that the water you are drinking is safe. Test your water seasonally (4 times a year) or after major rainfall and snowmelt events for bacteriological contamination. You should also test your water annually for nitrates and fluoride; parameters that have no taste or smell but can have long-term health effects on you and your family.

Why protect groundwater?

- It provides our drinking water.
- It feeds water to creeks and rivers.

For more information on groundwater in your area please contact:

Maitland Valley Conservation Authority
Box 127, Wroxeter ON N0G 2X0
(519) 335-3557
maitland@mvca.on.ca

Visit the *My Land, Our Water* website at:
http://myland.mvca.on.ca

Why Healthy Water?

My Land, Our Water

Background

A safe and secure long-term water supply is crucial for the quality of life of all watershed residents. It is a key factor in ensuring economic prosperity and healthy communities. A healthy watershed means clean drinking water, habitat for wildlife, an adequate water supply for agriculture and business, and recreational opportunities such as canoeing, fishing and hiking.

Our watersheds are really a series of interconnected ecosystems including, wetlands, streams, forests, lakes and rivers. The links between these areas means that what happens upstream will affect the environment downstream. It takes about 3 days for a drop of water to travel from the headwaters of the Maitland River to Lake Huron. The amount of water in our watersheds is finite because what we have available is continually recycled through the hydrological cycle.

Our actions can have a direct impact on the health of our water resources. Both surface water and groundwater can be easily contaminated and even if the quantity of pollutants at one source is small, the combined impact of sources across a watershed can be significant.

Water resources are truly a community resource. With careful use and protection of our water supplies we will continue to have enough clean water in the future.

For more information on water quality in your area please contact:

Maitland Valley Conservation Authority
Box 127, Wroxeter ON N0G 2X0
(519) 335-3557
maitland@mvca.on.ca

Visit the *My Land, Our Water* website at:
http://myland.mvca.on.ca

November 8, 2004

Surface Water - an introduction

Surface water refers to all the water found on the surface of the earth, including rivers and streams, lakes and ponds, and human-made drains and reservoirs. Surface water is extremely important as it is a primary source of water for drinking and irrigation as well as being used extensively for recreation. Healthy surface waters are essential to maintain healthy ecosystems and sustain our natural heritage.

Surface water is derived from two main sources – groundwater discharge and runoff from precipitation. Groundwater discharge feeds water to streams from underground aquifers and is responsible for most “baseflow” – the amount of water that is constantly flowing in a river, even during dry periods. Streams with lots of baseflow are often found in areas where there are high permeability sand and gravel soils from which groundwater can move quickly.

When water hits the ground in the form of rain, a portion of it infiltrates to the ground, eventually becoming part of underground aquifers. Another portion of water is used up by growing plants or evaporates back into the atmosphere while the remaining portion of water “runs off” the land and into surface water systems. The amount of runoff from rainfall is dependant on several factors including temperature, vegetation, soils and the slope of the land it falls on.

Surface Water Quality

Surface water can become contaminated by a number of chemical compounds and biological organisms. For the most part, these contaminants adhere, or stick, to soil particles. Since the contaminants adhere to soil, preventing erosion of soils can protect surface water quality.

How likely erosion is to occur on a property is dependant on any number of factors, the most important being the amount and speed of water flowing over the land, and the soils, slopes and vegetation of the land. For example, areas with higher slopes are more likely to have erosion problems than flat areas.

Healthy Streams, Rivers and Lakes

Healthy streams, rivers and lakes are essential to provide habitat to fish and wildlife as well as for human needs. In healthy surface waters a balance, or equilibrium, has been achieved between the water, the organisms that use the water and the land around it. Since every surface water system is different, it is necessary to evaluate the health of every system separately.

APPENDIX F:

EXTENSION EVALUATION FORMS

Appendix F – Extension Evaluation Forms

My Land, Our Water Extension Visits

Landowner Comments

Date: ______________________________

Location: ______________________________

Staff: ______________________________

A) Natural Characteristics Information

1. Are you having problems with any of the maps? (Difficult to understand? Hard to read? Too small?)

   Air photo

   Soil

   Geology

   Wells

   Slope

2. Does the information on the maps match what you know about your property?

3. Is the well information for your property correct?

   Yes No

   If not, would you like a CA staff member to contact you about correcting the information?

   Yes No

4. Is the information I presented with the maps clear?

5. What one thing did you like the most about the maps?

What one thing did you like the least?

B) ISI and SSI Information

1. Do you have concerns or questions about the ISI/SSI mapping?

2. Did you find the ISI/SSI information useful? For example, having seen this information do you think you will make changes to the way your property is managed?

3. We recognize that ISI and SSI can be difficult concepts to explain. Can you suggest ways that we might be able to improve our explanation?

C) General

1. Do you have questions that haven't been answered?

2. In general how do you prefer to get agriculture/conservation information?

Radio	Neighbors
Farm publications	Commodity group meetings
Internet	Television
Other	

3) What are the advantages of having a staff member review this information with you?

Disadvantages?

4) Are you an internet user? Yes No

If yes - do you see advantages to receiving this information through a website?

Disadvantages?

Would you be interested in reviewing the *My Land, Our Water* website and providing us with some feedback? Yes No

5) Do you have any advice for us as we introduce this project in the Maitland watershed?

My Land, Our Water Extension Visits

Staff Summary

Date of Visit: ______________________________

Property Location: ______________________________

Staff Member: ______________________________

Length of Visit: ______________________________

1. General landowner response to the visit (Did they seem engaged? Were they asking lots of questions? Positive or negative atmosphere?).

2. How did the landowner respond to the content of the visit? Did they appear to understand the information that was presented?

3. Describe how the landowner reacted to the ISI and SSI information? For example, if their property had a high ISI or SSI result did they appear upset, angry, concerned?

4. Did the landowner have difficulty understanding any specific part of the presentation?

5. Was there any information or topic that the landowner seemed particularly interested in?

6. Did the landowner express any concerns about the credibility or accuracy of the information presented?

7. Your general impressions of the visit.

8. Is follow-up required for this landowner? If so, what information have they requested?

9. Suggestions for content to add or delete.

10. Suggestions for questions to add or delete.