Land Use and STEPL Methodology

Comparison of Land Use / Land Cover: 2000 & 2009

Data notes:

This table compares land use/land cover data developed in 2000 and 2009 by Lakes Region Planning Commission. The year 2000 classification was primarily based on 1998 black & white aerial photography, while the year 2009 classification was primarily based on 2006 color photography. The earlier project used a simpler classification scheme of only 14 classes, while the 2009 project used a classification scheme of 58 classes. To help with the comparison of these somewhat different data sets, some intermediate subtotals have been calculated (e.g., Residential Sum, Commercial Sum).

Land use data were developed based on town boundaries; as a result, a watershed-based analysis like this contains data sets developed at different times. In this case, data sources include:

2009 Land Use/Land Cover

Town	**Date of data development**	**Data Sources**
Meredith	2009	2006 color photos, 2008 color photos, town parcel data, zoning, sewers, local knowledge
Laconia	2009	2006 color photos, 2008 color photos, town parcel data, zoning, local knowledge
Gilford	2009	2006 color photos, 2008 color photos, town parcel data, zoning, sewers, local knowledge
Center Harbor	2009	2006 color photos, 2008 color photos, parcel data (where available), zoning, local knowledge
Holderness	2006	2003 color photos, local knowledge
Ashland	2000	1998 black and white photos
New Hampton	2000	1998 black and white photos

2000 Land Use/Land Cover

Town	Date of data development	Data Sources
Meredith	2000	1998 black and white photos
Laconia	2000	1998 black and white photos
Gilford	2000	1998 black and white photos
Center Harbor	2000	1998 black and white photos
Holderness	2000	1998 black and white photos
Ashland	2000	1998 black and white photos
New Hampton	2000	1998 black and white photos

Data Limitations

In some places, the differences between 2000 & 2009 classifications are the result of land use conversion (for example, a new residential development in what had been forest or agricultural land). However, a different methodology was also used to develop the 2000 classification: at that time, building footprints were digitized, whereas now, the entire visual extent of a land use is digitized. An effect of this change is to greatly increase the estimated acreage in some of the developed categories. For example, in the past a single house on an acre of mown lawn might have been calculated as 0.05 acres of residential; today, the entire acre of lawn would be digitized and calculated as 1.0 acre of residential land use. Finally, the 1998 black and white aerial photography used as the basis for the 2000 classification has much lower resolution than the 2006 1-foot color photography used for most of the 2009 data. As a result, the analyst developing the 2009 data was more likely to be able to see and capture scattered residential development such as individual houses.

Models for phosphorus loading

Dillon-Rigler Model – an empirical model that predicts average summer chlorophyll-*a* concentrations in temperate lakes from total phosphorus concentrations at spring overturn (phosphorus concentrations are near-constant from surface to bottom during spring mixing). In general, average summer chlorophyll-*a* concentrations in temperate lakes increases with increasing spring overturn phosphorus concentration. The model has been well documented and widely used by lake managers, limnologists and researchers to set phosphorus loading guidelines for lakes and to set lake restoration objectives.

Vollenweider Model – examines phosphorus load and response characteristics for the relative general acceptability of the water for recreational use (Vollenweider, 1975). The model was developed by Vollenweider, working on the Organization for Economic Cooperation and Development (OECD) Eutrophication Study. Vollenweider found that when the annual phosphorus load to a lake is plotted as a function of the quotient of the mean depth and hydraulic residence time, lakes which were eutrophic tended to cluster in one area and oligotrophic lakes in another. Vollenweider developed a statistical relationship between areal annual phosphorus loading to a lake normalized by mean depth and hydraulic residence time, to predict lake phosphorus concentration. More information on the model can be found in: Vollenweider, R.A. 976, Advances in defining critical loading levels for phosphorus in lake eutrophication. Mem. Ist. Ital. Idrobiol., 33: 53-83.

Spreadsheet Tool for Estimating Pollutant Load (STEPL) – "Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices" (STEPL 4.0 User's Guide, 2006). STEPL Version 4.1, 12/13/07, developed by Tetra Tech, Inc. for the Grants Reporting and Tracking System of the U.S. Environmental Protection Agency (EPA).

STEPL Methodology

I. Input Worksheet

Table 1. Input Watershed land use and precipitation information

A. Individual STEPL spreadsheets were created for each subwatershed
B. Subwatersheds were not treated as all part of a single subwatershed
C. Groundwater load calculations were included
D. Precipitation and Rain correction factors were based on the Bristol weather station

Table 2. Input Agricultural Animals

Information on agriculture was obtained from the NH Department of Agriculture and the Belknap County Conservation District. Figures are estimates for the community, and not necessarily specific to the watershed.

Livestock										
	Cattle	Pig farm	Sheep farm	Horse	Chicken farm	Turkey	Duck	Camelid farm	Goat farm	Game bird farm
Gilford	236	1	1					1		
Laconia	24	1	1						1	
Meredith	12	2			2			1		1
Total	**272**			**20**						
Total, assuming 10 animals/farm		**40**	**20**	**0**	**20**	**0**	**0**	**20**	**10**	**10**

Source: NH Dept. Ag.

Figures are by community, not watershed. Number of cattle were available, all others were by farm.

Assumed 10 animals per farm and assumed that all farms are within the watersheds and that they are equally distributed.

Added specifics depending on some familiarity with watersheds - i.e. bison farm in Gilford

Table 3. Input Septic Systems and illegal wastewater discharge

Estimated count of septic systems within 250' of shoreline in the Meredith Bay, Paugus Bay, Saunders Bay, and Waukewan subwatersheds:

	Subwatershed					
Town	**Lake Waukewan**	**Meredith Bay**	**Paugus Bay**	**Saunders Bay-North**	**Saunders Bay-South**	**Grand Total**
Ashland	1					1
Center Harbor	65	8				73
Gilford		36	6	125	147	314
Laconia		2	31		1	34
Meredith	113	392	9	352		866
New Hampton	132					132
Grand Total	311	438	46	477	148	1420

Methodology:

First, a 250' buffer was applied to the shoreline of all waterbodies in the NH Hydrography Dataset – lakes, ponds, and streams, but not wetlands – within the 4-subwatershed study area ("BufferArea_Septic"). A point shapefile was created to represent estimated septic locations within this buffer ("Septic_points_250buf"). The points were developed differently for each town, depending on the presence of town sewer, parcel data, etc.

Ashland: Points were manually located by examining 2006 1-foot aerial photography.

Center Harbor: Points were manually located by examining 2006 1-foot aerial photography.

Gilford: To try to identify which parcels are not served by town sewer, sewer lines were buffered by 250', and any parcels that did not intersect with the buffer were considered septic parcels. Parcels that had text PID values ("ROAD", "ROW", or "CEMETERY") were excluded. A point shapefile representing the centroid of each septic parcel polygon was created, and any points that fell within BufferArea_Septic were appended to Septic_points_250buf.

Laconia: To try to identify which parcels are not served by town sewer, sewer lines were buffered by 250', and any parcels that did not intersect with the buffer were considered septic parcels. Parcels with a STYLE_DESC of “Vacant Land” were excluded. A point shapefile representing the centroid of each septic parcel polygon was created, and any points that fell within BufferArea_Septic were appended to Septic_points_250buf.

Meredith: Parcels were considered septic users if their UTIL_DESC did not include the word “Sewer” and if their USE_DESC did not include the word “VACANT.” A point shapefile representing the centroid of each septic parcel polygon was created, and any points that fell within BufferArea_Septic were appended to Septic_points_250buf.

New Hampton: A point shapefile representing the centroid of each septic parcel polygon was created. Points representing roads were removed, and any remaining points that fell within BufferArea_Septic were appended to Septic_points_250buf. Because the original parcel shapefile did not align well with the boundaries of waterbodies from aerial photographs and the NH Hydrography Dataset, some points were manually adjusted (i.e., if their source parcel was within 250’ of the waterbody as drawn in the parcel layer itself, its associated point was added or moved to fall within BufferArea_Septic.)

Table 4. USLE Parameters

NAME	STATE_NAME	FIPS	LAND USE	Ravg	Kavg	LSavg	Cavg	Pavg
Belknap	New Hampshire	33001	Cropland-cultivated	110.00	0.20	0.338	0.02	1.00
Belknap	New Hampshire	33001	Cropland-noncultivated	110.00	0.26	0.895	0.03	0.92
Belknap	New Hampshire	33001	Pastureland	110.00	0.23	0.828	0.01	1.00
Belknap	New Hampshire	33001	Forest land	110.00	0.21			

Table 5. Soil Hydrologic Group (SHG)

SHG “C” chosen as representative for Belknap County based on NRCS data from web soil survey. This is the dominant group based on

Soil N concentration % set at 0.10
Soil P concentration % set at 0.044

Table 6. Reference Runoff Curve numbers

SHG	A	B	C	D
Urban	83	89	98	93
Cropland	67	78	85	89
Pastureland	49	69	74	84
Forest	39	60	70	79

"CN values are commonly used parameters to determine how much rainfall will become runoff. They are based on land use cover and soil type, with higher CN values corresponding to poorly drained soils and more impervious area, resulting in increased runoff" (NH DES Stormwater Manual, Ch. 5 Antidegradation p. 41). CN values for Pastureland changed to "74" and Forest changed to "70" based upon recommended Curve Numbers from the NH DES Stormwater Manual, Ch. 5 Antidegradation (p. 41).

II. Land & Rain Worksheet

Table 1. Rainfall Initial Abstraction Factor

STEPL provides rainfall correction factors for the weather stations listed for each state in a separate excel spreadsheet "RainCoFactor.xls". It also allows for a "rainfall initial abstraction factor" to be input in this table.

"Rainfall Initial Abstraction Factor: A factor that determines initial rainfall retention on the land surface ranges from 0 to 0.2."

The default for this cell is "0". Changing this default value significantly impacts the estimated pollutant loads by land use.

The method used to determine the appropriate Ia factor to use was based on the Natural Resource Conservation Service (NRCS), formerly the SCS (Soil Conservation Service), Curve Number runoff method:

$$Ia = 0.2S$$

$$Q = (P-0.2S)^2 / (P+0.8S)$$
$$S = (1000/CN) - 10$$

A spreadsheet was developed by NH DES, "SCS Runoff, Initial Abstraction Assessment", to calculate the Ia factor to use based on CN. CN values are published by NRCS TR-55. The major factors determining CN are hydrologic condition, soil type, cover type, and antecedent runoff condition.

A weighted CN value was determined for each subwatershed by multiplying the CN value for each land use by the acreage of that land use. The total of the (CN* LUacreage) were then divided by the total LU acreage to arrive at the weighted CN for that subwatershed.

Land & Rain Worksheet

Watershed	Land use	Acres	CN	Weighted	Weighted CN	Ia Factor
Waukewan	Urban	950.4	98	93139.2		
	Crop	9.8	85	833		
	Pasture	186.5	74	13801		
	Forest	6015	70	421050		
Total		7161.7		528823.2	74	0.143
Meredith	Urban	1771	98	173558		
	Crop	10.2	85	867		
	Pasture	194.5	74	14393		
	Forest	4180	70	292600		
Total		6155.7		481418	78	0.129

Watershed	Land use	Acres	CN	Weighted	Weighted CN	Ia Factor
Paugus	Urban	1806.7	98	177056.6		
	Crop	13.8	85	1173		
	Pasture	263.1	74	19469.4		
	Forest	4096.5	70	286755		
Total		6180.1		484454	78	0.129
Sanders	Urban	2753	98	269794		
	Crop	26.4	85	2244		
	Pasture	500.7	74	37051.8		
	Forest	9462	70	662340		
Total		12742.1		971429.8	76	0.137
Sanders S	Urban	2229	98	218442		
	Crop	23.8	85	2023		
	Pasture	452.1	74	33455.4		
	Forest	7031	70	492170		
Total		9735.9		746090.4	77	0.133
Sanders N	Urban	524	98	51352		
	Crop	2.6	85	221		
	Pasture	48.6	74	3596.4		
	Forest	2431	70	170170		
Total		3006.2		225339.4	75	0.14