4.0 TMDL APPLICATIONS

The feasibility of using the IC Method for TMDL development was tested by applying it to complete TMDL applications for the following seven impaired watersheds nominated by five of the New England states.

- Beaver Brook, New Hampshire
- Goodwives River, Connecticut
- Peters River, Massachusetts
- Three Ponds Brook, Rhode Island
- Cohas Brook, New Hampshire
- Artic Brook, Maine
- Tributary to Bond Brook, Maine

The watersheds assessed in Chapter 4 do not all match our selection criteria for using the IC method, nor do they all have impervious cover greater than 9%, which is generally our suggested initial TMDL target and screen for applying this method (unless a state has more site-specific information that indicates a different target is appropriate). For each example watershed, we note what worked and what didn't work in the analysis, and discuss whether the watershed is an appropriate selection for this approach.

The IC Method is very useful for developing TMDLs for aquatic life impairments caused by stormwater runoff. It is particularly helpful for developing stormwater TMDLs where no specific pollutant can be identified as the cause of the impairment. If a water body is 303(d)-listed for both an aquatic life impairment caused by stormwater and specific pollutants, the IC Method may be used to address the aquatic life impairment. Specific TMDL targets for the listed pollutants should also be developed. Where any specific 303(d)-listed pollutants are primarily related to stormwater runoff, the techniques outlined in this report may be appropriate. If the specific listed pollutants causing the impairment are related to sources other than stormwater volume, then other more appropriate techniques should be used to develop these TMDL targets. In the seven pilot TMDL applications which follow, we present calculations of stormwater runoff volume and individual pollutant loads for illustrative purposes only, using expanded applications of the basic, recommended IC method procedure.

Use of the IC method to complete TMDLs for each of these watersheds is described below. Key elements to screen a watershed for IC applicability (listed impairment(s), size of watershed and

%IC, along with a discussion of the ease of application and applicability of the IC method to the example) are provided in a summary after each example.

4.1 Beaver Brook

An IC method analysis for New Hampshire's Beaver Brook watershed was performed to complete a TMDL allocation. The IC method was applied to estimate existing and target % IC in the overall watershed and in each sub-watershed.

4.1.1 Watershed Description

The watershed for the Beaver Brook is located within Pelham, Salem, Hudson, Londonderry, Auburn, Derry, and Chester town boundaries and is shown on Figure 4-1. The watershed is characterized by forest, cleared land, roads, and residential development, as tabulated in Table 4-1. The drainage area is 46,735 acres (73.02 sq. miles). Beaver Brook has a hydrologic unit code is 01070002-240 (NHDES, 2004) and is a part of the Merrimack River Basin. Beaver Brook begins at the juncture of Golden Brook in Pelham, NH and drains into the Merrimack River in Lowell, MA. The Merrimack River Basin covers 5,010 square miles in south-central New Hampshire, extending into Massachusetts.

Beaver Brook has been placed on the Clean Water Act 303(d) list for several parameters including pH, benthic-marcoinvertebrates, mercury, and *Escherichia coli* (State of New Hampshire 305(b) and 303(d), 2004). Under the 2004 New Hampshire Consolidated Assessment and Listing Methodology, impairment is listed for pH by having a pH less than 6.5 or greater than 8.0. Benthic-Macroinvertebrate Bioassessments protocol lists impaired due to a benthic index of biologic integrity score less than 45. Mercury is listed based on results falling between 0.77ug/L to 1.40ug/L (based on dissolved metal results). According to the State of New Hampshire Section 305(b) and 303(d), Beaver Brook does not support aquatic life, fish consumption and primary contact recreation (NHDES, 2004).

Table 4-1 Beaver Brook: Major Landuse Distribution

Landuse	Percentage of Watershed
Mixed forest	23%
Cleared/other open Tundra	18%
Beech/oak	13%
Transportation Active agricultural land	10%
Other hardwoods	8%
White/red pine	7%
Hay/rotation/permanent pasture	4%
Open water Wetlands	4%
Other	12%

4.1.2 Available Data

The New Hampshire Department of Environmental Services (NHDES), provided GIS coverage data for the Beaver Brook's watershed. The other GIS coverages required for the analysis, including Landcover, were acquired from the NH GRANIT website. The 2001 New Hampshire Land Cover Assessment categorizes land cover and land use into 23 classes.

Figure 4-2 provides a landuse map for the Beaver Brook watershed. The coverage was created for to provide a multi-purpose data set to support regional analysis, with as much detail as possible in the forested and agricultural classes. The landcover dataset was based on LandSat TM Satellite Imagery.

The New Hampshire landcover dataset was problematic for the IC Method and required significant additional analysis to yield useful coverage information. Specifically, The NH landcover categories were focused on forest and agricultural classes and lumped all non-transportation development categories together (i.e., commercial, industrial, high density residential, medium density residential, and low density residential were considered the same category). This is problematic because the different development-related landuses have significantly different impervious cover characteristics. To refine the dataset to be more useful for impervious cover determination, we manually split the development class into five sub classes; commercial, industrial, high density residential, medium density residential, and low density residential. This was accomplished by comparing the development class to the Digital Ortho Quarter Quadrangles, and modifying it to one of the sub classes. The Beaver Brook watershed was fairly large for this approach. Thus, the watershed layer was also split into twenty-four sub-basins.

4.1.3 Impervious Cover and Pollutant Load Calculation

To calculate watershed impervious cover, the Beaver Brook's sub-basins were digitally intersected with the revised NH landcover assessment, and the area of each landuse category in each sub-basin calculated. Sub-basin impervious percentages were then calculated based on the assumed impervious percentages for each landuse as shown in Table 4-2. The assumed percentage of impervious cover for each landuse was derived using recommended percentages in TR-55, Urban Hydrology for Small watersheds (USDA, 1986). The results of this analysis indicate the Beaver Brook watershed is 12 percent impervious, with one sub-basin with 29 percent impervious cover.

Figure 4-3 shows the impervious cover estimate for each Beaver Brook sub-basin. Table 4-3 provides the percent impervious cover for each sub-basin in a tabular form. The Impervious Cover Model predicts impacted stream quality for greater than 10 percent impervious cover and severe degradation of stream quality for greater than 25 percent impervious cover. Thus, the impervious cover model predicts that the Beaver Brook watershed has impacted water quality with severe water quality degradation in some sub-basins within the watershed.

Table 4-2 Beaver Brook: Estimated Percent Impervious Cover by Landcover

Landuse	Estimated Percent Impervious Cover
Commercial	85%
High Density Residential (smaller than 1/4 acre lots)	65%
Industrial	72%
Low Density Residential (greater than 1/2 acre lots)	16%
Medium Density Residential (1/4 to 1/2 acre lots)	31%
Transportation Active agricultural land	100%
Other	0%

Table 4-4 provides estimated existing % IC and target % IC values for the Beaver Brook watershed. For illustrative purposes, estimated annual stormwater runoff volume and estimated annual pollutant loads for selected parameters are also provided, using annual rainfall and estimated event mean concentration of pollutants from (Schueler, 2003). For this watershed, an annual rainfall of 36.4 inches (Concord, NOAA.com) and a fraction of annual rainfall events that produced runoff of 0.9 (Schueler, 2003) were used.

Table 4-3 Beaver Brook: Sub-basin Estimated Impervious Cover

Sub-basin	Estimated Percent Impervious Cover
1	12.0%
2	16.5%
3	7.6%
4	14.8%
5	15.1%
6	12.9%
7	14.4%
8	18.3%
9	20.6%
10	28.7%
11	10.0%
12	8.1%
13	18.1%
14	1.1%
15	10.2%
16	6.9%
17	6.1%
18	12.5%
19	8.8%
20	5.2%
21	11.3%
22	10.0%
23	7.6%
24	12.6%

Table 4-4 Beaver Brook: Estimated Existing and Target TMDL Values for Key Parameters

Parameter	Estimated Conditions	
	Existing	TMDL Target
Impervious Cover	12%	9%
Optional:		
Annual Runoff Volume	20,700. acre-ft	16,700 acre-ft
Total Suspended Solids	4,400,000 lbs	3,600,000 lbs
Total P	18,000 lbs	14,000 lbs
Soluable P	7,300 lbs	5,900 lbs
Total N	130,000 lbs	110,000 lbs
TKN	97,000 lbs	78,000 lbs
Nitrate & Nitrite	37,000 lbs	30,000 lbs
Copper	750 lbs	610 lbs
Lead	3,800 lbs	3,100 lbs
Zinc	9,100 lbs	7,300 lbs

4.1.4 Summary and Conclusions

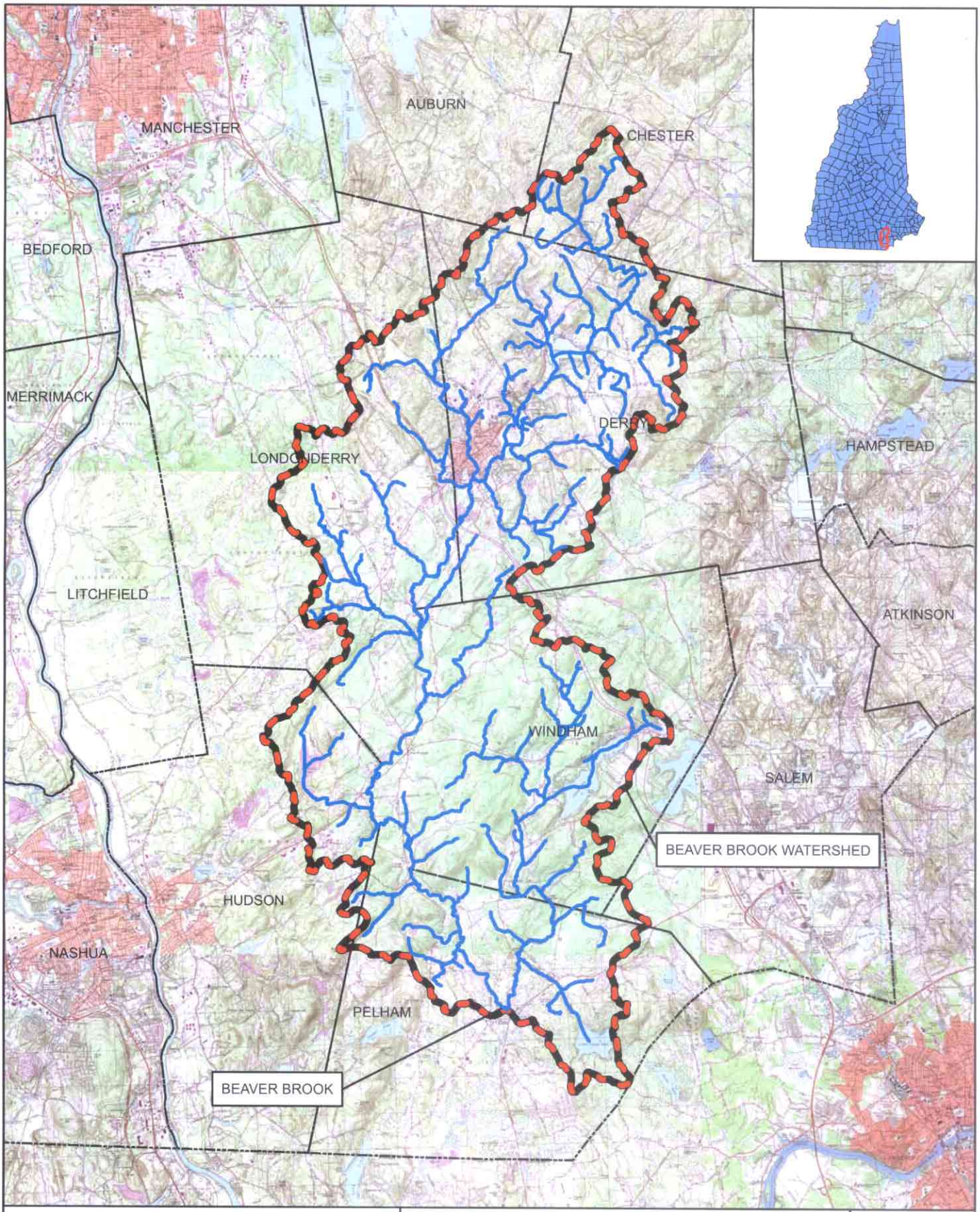
Beaver Brook, New Hampshire

Section 303(d) listed impairments:	Aquatic life support
	Fish consumption (mercury)
	Primary contact recreation (e-coli bacteria)
Size of watershed:	73 square miles
Percent of IC in watershed:	12% (sub-basin range = 1 – 29%)

Applicability of IC method to this watershed

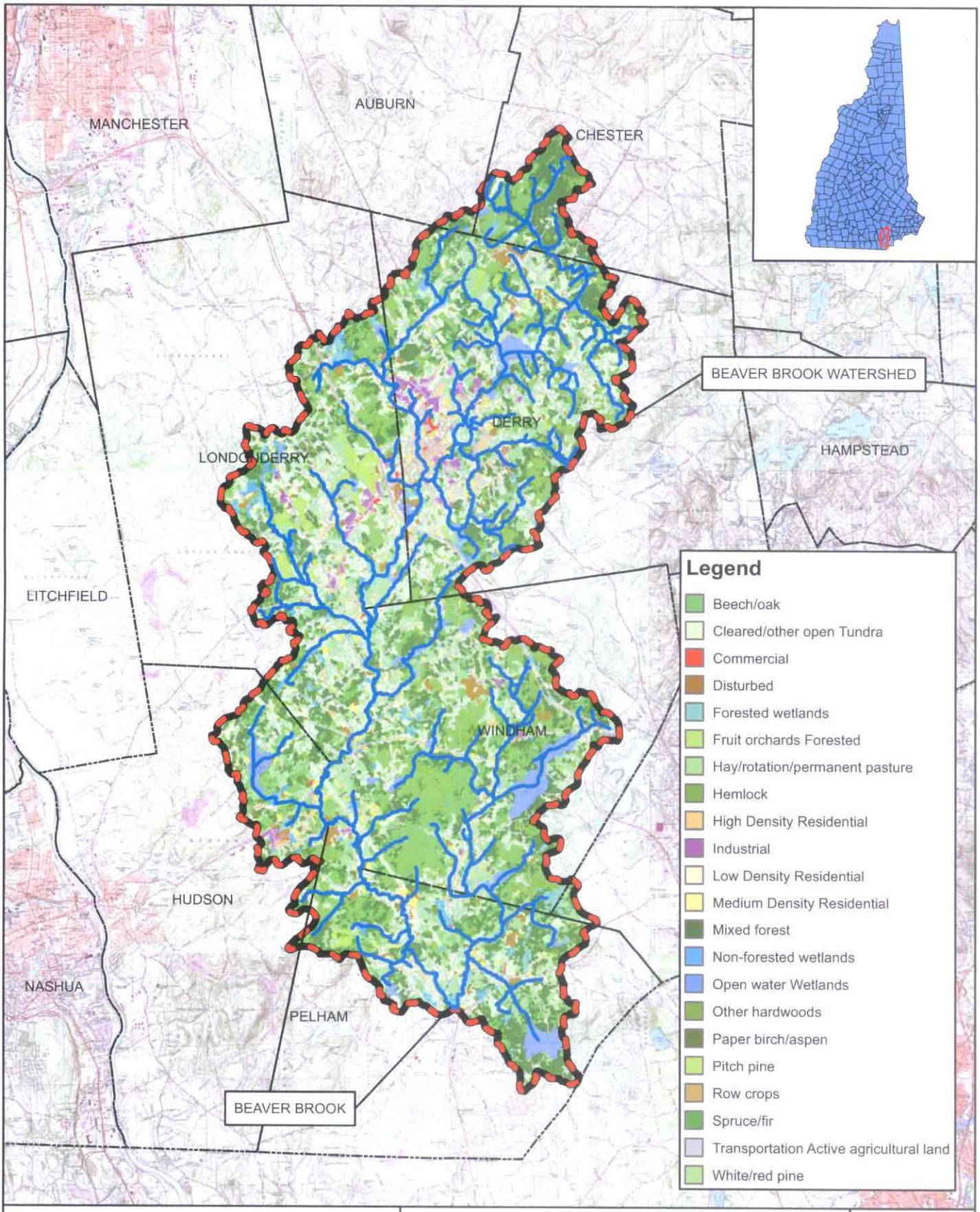
As noted in the case study, the NH dataset proved problematic for the analysis, and required a lot of manipulation to generate the land use detail needed. Also, the watershed was large and required breaking into 24 sub-basins, which were then analyzed for their percent IC. The resulting analysis showed that a number of sub-basins had IC levels substantially higher than the target. This finding allows resource professionals to target TMDL development and implementation efforts at those sub-basins which have the worst conditions, thereby addressing the worst problems and perhaps more quickly reaching restored conditions for the watershed as a whole.

Consequently, the IC method appears to be a good approach for the aquatic life support impairment in this watershed, although EPA would expect additional specific TMDLs to be developed for the other 303(d)-listed impairments.



BEAVER BROOK WITH
WATERSHED BOUNDARY INDICATED
PELHAM, NEW HAMPSHIRE

FIGURE
4-1



N

0 6,000 12,000 24,000 Feet

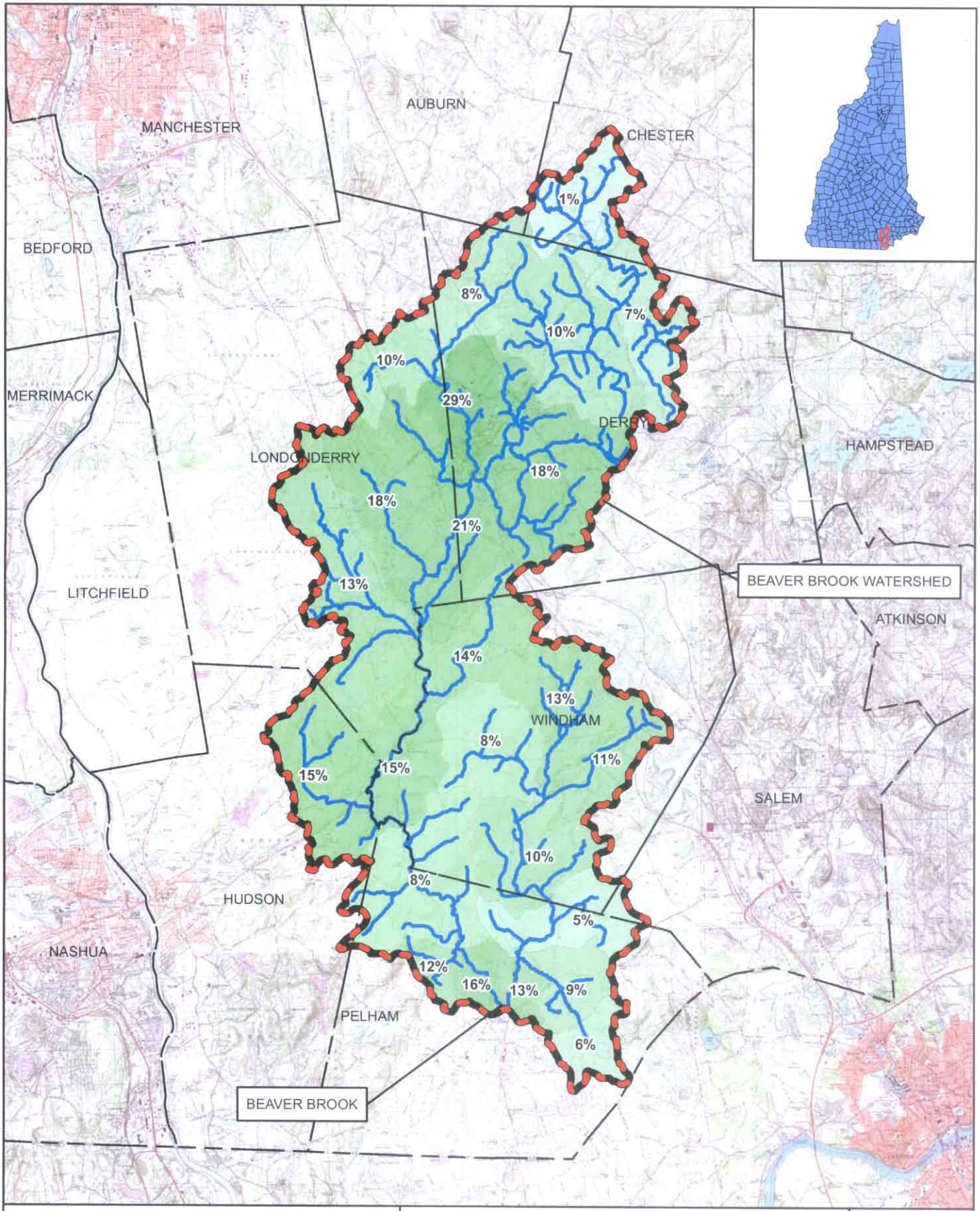
1 inch equals 11,999.061536 feet

BEAVER BROOK LANDUSE MAP

PELHAM, NEW HAMPSHIRE

FIGURE

4-2



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0 6,000 12,000 24,000 Feet

1 inch equals 12,002.394323 feet

BEAVER BROOK SUB WATERSHED
IMPERVIOUS COVER MAP
PELHAM, NEW HAMPSHIRE

FIGURE
4-3