APPENDIX A

Connecticut Surface Water Classifications

Appendix A
Connecticut Surface Water Classifications (1997)

Class	Designated Use	Compatible Discharges
AA	Existing or proposed public drinking water supply impoundments and tributary surface waters	Treated backwash from drinking water treatment facilities; minor cooling water; clean water
A or SA*	May be suitable for drinking water supply (Class A), may be suitable for all other water uses including swimming, shellfish resource; character uniformly excellent; may be subject to absolute restrictions on the discharge of pollutants	Treated backwash from drinking water treatment facilities; minor cooling water; clean water
B or SB	Suitable for swimming, other recreational purposes, agricultural uses, certain industrial processes, and cooling; excellent fish and wildlife habitat; good aesthetic value	Those allowed in Class AA, A; major and minor discharges from municipal and industrial wastewater treatment
C or SC*	May have limited suitability for certain fish and wildlife, recreational boating, certain industrial processes, and cooling; good aesthetic value; not suitable for swimming. Quality considered unacceptable; goal is B or SB	Same as B or SB
D or SD*	May be suitable for swimming or other recreational purposes; certain fish and wildlife habitat, certain industrial processes, and cooling; may have good aesthetic value. Present conditions, however, severely inhibit or preclude one or more of the above resource values. Quality considered unacceptable; goal is B or SB	Same as B or SB

*Designates salt or brackish water

APPENDIX B

Assumptions for Development Potential Calculations

Assumptions for Residential Development Potential

1. Contiguous vacant residential parcels within the same zoning district were grouped together into 'planning areas' for the purpose of facilitating calculation of the gross developable acreage potential.

2. Wetlands and steep slopes (greater than 15%) were then subtracted from each of the 'planning areas' to determine the developable land area.

   This assumption may create an understatement of potential dwelling units since the area of wetlands and slopes may be counted toward total lot area to meet the minimum lot size requirement, with the structure being placed on the non-wetland or steep slope portion of the parcel. Also, wetlands and steep slope areas may be built upon by special permit. However, this understatement will be assumed to be offset by an overstatement created by the application of the zoning minimum lot size to the 'planning area' (see #4).

3. Accounting for new road construction within the potentially developable vacant residential areas was accomplished by subtracting 10% of the land area from each of the 'planning areas'. The remaining land area in each of the 'planning areas' is considered to be the net developable land area.

4. The minimum lot size, as dictated by the underlying zoning regulations within each of the planning areas, was then applied to determine the potential number of single family residences that could be constructed within the planning area.

   An overstatement of the number of dwelling units may be created by the application of the zoning minimum lot size to the 'planning area' since the 'planning area' is a aggregation of the underlying individual parcels. If the zoning regulation minimum lot size were applied to the individual parcels there would be land that remains in each parcel that is too small to equal another lot at the minimum required size. These remainders are added together by using a 'planning area' comprised of individual lots. The combined remainders thereby allowed for more lots, and in turn more dwelling units than actually possible. However, this overstatement may be offset by the understatement of dwelling units created by the wetlands and steep slopes assumption discussed at #2.

5. For those planning areas within the "Planned Residential Development" the number of dwelling units possible was based on the following calculations using the applicable values for the district as dictated by the zoning regulations.

Land area required:

3 bedroom	7,500 sq. ft. of land required per unit
2 bedroom	5,500 sq. ft. of land required per unit
1 bedroom	3,500 sq. ft. of land required per unit

(Assuming that units are not higher than 2 stories as the land requirements lessen for units on a 3rd story or higher.)

Open space required:

Two times the residential floor area.

Minimum floor area:

550 sq. ft. for 1 bedroom, plus 125 sq, ft. per each additional bedroom.

Open space requirement at minimum floor area:

3 bedroom	1,600 sq. ft. open space per unit
(550 sq. ft. + 250) × 2	
2 bedroom	1,350 sq. ft. open space per unit
(550 sq. ft. + 125) × 2	
1 bedroom	1,100 sq. ft. open space per unit
(550 sq. ft.) × 2	

Total area required per unit: (combination of required land area and open space)

3 bedroom	9,100 sq. ft. total area required
(7,500 + 1,600)	
2 bedroom	6,850 sq. ft. total area required
(5,500 + 1,350)	
1 bedroom	4,600 sq. ft. total area required
(3,500 + 1,100)	

Possible number of units per acre:

3 bedroom	4.8 units per acre
(43,560 ÷ 9,100)	
2 bedroom	6.4 units per acre
(43,560 ÷ 6,850)	
1 bedroom	9.5 units per acre
(43,560 ÷ 1,100)	

An average number of units per acre was then assumed based on the above figures for each type of unit. This figure of 8.0 units per acre was applied to the net developable acreage for the planning areas in the "Planned Residential Development" zone to determine the possible number of dwelling units at maximum build-out.

6. Outside of the "Planned Residential Developments" it was assumed that all the dwellings to be built would be single-family structures.

Assumptions for Non-residential Development Potential

1. All parcels developed as a single unit with one structure. This produces the maximum amount of building square footage. Subdividing the parcels lessens the amount of building square footage by increasing the area reserved for setbacks, buffers, roads, etc.

2. All buildings constructed as a single story. This is most common for industrial and retail/commercial uses and is consistent with the type of development currently found within the study area.

3. Parking requirements are based on common requirements for commercial and industrial uses as well as Town of Vernon, CT Zoning Regulations, §12.
   These requirements include:
   a. 2 spaces per 1000 square feet of buildings in industrial zones.
   b. 4 spaces per 1000 square feet of buildings in commercial and planned commercial zones.
   c. 3 spaces per 1000 square feet of buildings in special – economic development zones.
   d. 1 parking space is equal to 300 square feet. This figure includes the actual parking space as well as the associated roads and landscaping/curbing. This figure is based on an industry standard assumption.

4. The maximum lot coverage allowed in a zone is based on the coverage allowed without requiring a special permit.
   These requirements include:

a.	Commercial zone	60% coverage
b.	Industrial zone	40% coverage
c.	Planed Commercial zone	55% coverage
d.	Special – Economic Development zone	65% coverage

   The maximum coverage includes all impervious surfaces (i.e. buildings and parking areas).

5. Wetlands, as defined by the official Inland Wetland and Water Course Map, and slopes of greater than 15%, as defined by USGS Topographical Maps, were not included as land that could be built upon, but were included in the total lot size. Therefore, the total buildable area of a parcel was the lesser of maximum lot coverage (determined by multiplying the maximum coverage percentage for the zone by the parcel size) and the area not constrained by slopes and wetlands (determined by subtracting the area in wetlands and steep slopes from the total parcel size).

6. Parcels that were covered with wetlands and steep slopes that made building construction impractical were discounted from the build-out calculation.

7. All lots included in the analysis meet the requirements of the Vernon, CT Zoning Regulations for frontage and minimum lot width.

8. Required setbacks and buffers were assumed to fall in the areas outside developable building area.

9. Assumptions regarding data sources include:
   a. Wetland, zoning and parcel boundaries provided by the Town Engineer are geographically coordinated.
   b. Tax maps provided by Town Assessor are the most accurate representation of parcel boundaries
   c. Acreage provided on the tax maps is the most accurate representation of parcel area
   d. Zoning boundaries as identified on the map titled Town of Vernon Zoning Map is the most accurate representation of zoning boundaries

10. On parcels were a use is present, but only occupying a small percentage of the parcel the parcel was included in the build-out analysis.

Parking / Building Relation Formulas:

- **Commercial and Planned Commercial**

  Assume: 4 spaces per 1,000 square feet of building area
  1 parking space = 300 square feet
  1 story building

x = parking area (sq. ft.)
d = developable acreage (sq. ft.) -- Given
b = building size

Ratio of building size to parking area: 1000 square feet building per 1200 square feet parking.

1000/1200 = 10/12 = 5/6

1. $x + 5/6x = d$
   $x(1 + 5/6) = d$
   $1.83333x = d$
   $x = d/1.83333$

2. $d - x = b$

- **Industrial**
  Assume: 2 spaces per 1,000 square feet of building area
  1 parking space = 300 square feet
  1 story building

x = parking area (sq. ft.)
d = developable acreage (sq. ft.) -- Given
b = building size

Ratio of building size to parking area: 1000 square feet building per 600 square feet parking.

1000/600 = 10/6 = 5/3

1. $x + 5/3x = d$
   $x(1 + 5/3) = d$
   $2.66667x = d$
   $x = d/2.66667$

   e. $d - x = b$

- **Special – Economic Development**
  Assume: 3 spaces per 1,000 square feet of building area
  1 parking space = 300 square feet
  1 story building

x = parking area (sq. ft.)
d = developable acreage (sq. ft.) -- Given
b = building size

Ratio of building size to parking area: 1000 square feet building per 600 square feet parking.

1000/900 = 10/9

1. $x + 10/9x = d$
   $x(1 + 10/9) = d$
   $2.11111x = d$
   $x = d/2.11111$

   f. $d - x = b$

APPENDIX C

Inventory of Privately Owned Undeveloped Land

JOIN_MBL	ID_	MAP	BLK	PARC	ACRE	ADDRESS	OWNER	USE	EC	ZONE
02-0011-00018	38	2	11	18	6	10 PITKIN RD.	VERNON CIRCLE ACQUISITION CORP			
02-0156-00008	81	2	156	8	32	MAIN ST (TALC)	TALCOTT, JOHN - TRUSTEE	6-2	4	R-27
03-0004-00009	115	3	4	9	88	243 TALCOTTVILLE RD	LYMAN, FAITH	6-1		IP
04-0004-00001	33	4	4	1	104	606 DART HILL RD	GERBER, EDWIN	6-1		SED
04-0004-0008A	112	4	4	8A	83	TALCOTTVILLE RD	CHAPMAN, GARDNER	6-1	2	IP
06-0002-0001A	145	6	2	1A	6	WINDSORVILLE RD	CAMPELLI, PIETRO & RUTH	5-1	4	GI
06-0002-0007C	144	6	2	70	3	WINDSORVILLE RD	HOERLE, CHRISTIAN	5-1	4	R-22
07-02AA-00001	143	7	2AA	1	5	WINDSORVILLE RD	FAMILY STATIONS INC	5-1	4	R-22
07-02AB-00001	142	7	2AB	1	28	WINDSORVILLE RD	FAMILY STATIONS INC	5-1	4	R-22
08-0002-0016A	111	8	2	16A	5	529 TALCOTTVILLE RD	D.F.&D. REALTY TRUST	2-1	1	CAX
08-0024-00005	92	8	24	5	3	REGAN RD	KACZMARCZYK, WALTER	5-2	3	C-20
09-015H-0026A	107	9	15H	26A	3	380 TALCOTTVILLE RD	JARVIS, ALICE	2-1	1	CAX
09-015H-0026D	109	9	15H	26D	4	360 TALCOTTVILLE RD	JARVIS, ALICE	2-1	2	CAX
09-015H-0026E	108	9	15H	26E	2	370 TALCOTTVILLE RD	JARVIS, ALICE	2-1	3	CAX
10-015R-00037	113	10	15R	37	7	206 TALCOTTVILLE RD	LUDWIG, ROBERT	5-2	2	C-20
11-0011-00003	37	11	11	3	4	51 DOBSON RD	ARK REALTY CO.	1-1		R-22
11-0015-17-1A	41	11	15	17-1A	6	ELEANOR ST	TALARSKI, EDWARD - TRUSTEE	1-1	3	C-20
11-0155-09A10	133	11	155	9A10	14	133 WASHINGTON ST	CHARBONNEAU, ANDRE	5-1	4	R-27
12-0155-0002C	163	12	155	20	13	253 PHOENIX ST	STEELE, GLADYS	6-3		
12-0155-00031	155	12	155	31	8	174 ELM HILL RD	WINTRESS, KAREN & JAMES	6-3		
12-0155-00033	47	12	155	33	7	140 ELM HILL RD	YEDZINIAK, LENA	6-3	2	R-27
12-0155-00034	44	12	155	34	46	ELM HILL RD	TALCOTT, JOHN -TRUSTEE	6-2	3	R-27
12-0155-0031B	43	12	155	31B	10	ELM HILL RD	HAYES, CAROLYN	6-3	2	R-27
12-0155-0033A	42	12	155	33A	17	ELM HILL RD	HAYES, CAROLYN	6-3	3	R-27
12-0156-0008A	46	12	156	8A	5	48 ELM HILL RD	TALCOTT, JOHN -TRUSTEE	6-2	1	R-27
12-0162-00001	45	12	162	1	32	ELM HILL RD	TALCOTT, JOHN	6-2	3	R-27
13-0153-0016A	77	13	153	16A	10	60 LAKE ST	PLATT, CHARLES & NATALIE	5-1	3	R-27
13-0153-0023A	164	13	153	23A	4	PHOENIX ST	PAQUETTE, ROBERT	6-3		
13-0153-0023B	161	13	153	23B	4	144 PHOENIX ST	MERZ, JEAN	6-3		
13-0165-0069C	162	13	165	69C	6	228 PHOENIX ST	LAM, MICHELLE	6-3		
14-0142-00111	165	14	142	111	7	19 ROSEWOOD DR	YAMARIK, GEORGE & SANDRA	6-3		
14-0142-00121	102	14	142	121	6	41 ROSEWOOD DRIVE	STILLBACH, CHRISTOPHER		3	
14-0143-0038C	DEL	14	143	38C	2	LAKE ST	STAVENS, ROBERT	6-3		
14-0143-0039C	160	14	143	39C	19	310 LAKE ST	STAVENS, ROBERT	6-3		
14-0166-00013	76	14	166	13	11	271 LAKE ST	GOTTIER, ARTHUR	5-1	2	R-27
16-0142-00155	22	16	142	155	171	BOX MOUNTAIN RD	PETRIN, ROGER	6-2	4	R-27
16-0142-0168A	21	16	142	168A	5	BOX MOUNTAIN RD	ENGLAND, WILLIARD		4	R-27
16-0142-0169A	146	16	142	169A	18	BOX MOUNTAIN DR	FISH, DONALD & SHARON	1-2		R-27
19-0016-0007A	60	19	16	7A	1	HARTFORD TPKE	JOHNSON, THOMAS	1-1	1	R-27
20-0018-00042	30	20	18	42		243 CENTER RD	VERNON, DELETE <2 AC.	1-1	4	R-27
20-0018-0004V	71	20	18	4V	16	JONATHON DRIVE	RUPNER, ILMAR		3	R-27
20-0021-00049	32	20	21	49		24 CRESTRIDGE DR	BENEVIDES, GARRY & LYNN	1-1	4	R-27
21-021F-0002A	137	21	21F	2A	10	152 WEST ST	LEE, RICHARD	1-3	4	R-22
22-0039-00003	140	22	39	3	2	WINDERMERE AVE	LUGINBUHL, EDWARD & ALMA	6-1	4	PRD

22-0061-0026A	86	22	61	26A	2 MORRISON ST	LEE, RICHARD		2	R-10
23-091A-00006	51	23	91A	6	3 GRAND AVE	DROST, BARBARA	1-1	4	R-10
24-0062-00008	158	24	62	8	7 28 HIGHLAND AVE	CAMPELLI, ANTONIO & ELLEN	6-3		
25-0021-0003A	135	25	21	3A	40 WEST ST	DOHERTY, DONALD ETAL	6-1	3	R-27
25-0065-00034	136	25	65	34	18 WEST ST	STRONG, NORMAN	6-1	4	R-27
26-0068-0010A	3	26	68	10A	4 BAMFORTH RD	BAMFORTH COURT DEV CORP		4	R-27
26-0072-00031	59	26	72	31	8 933 HARTFORD TPKE	KANIA, WILLIAM & HELEN		3	C
26-065B-00027	128	26	65B	27	1 276 VERNON AVE	STOLARONEK, AMELIA	1-1	2	R-22
26-065B-0030C	130	26	65B	30C	2 290 VERNON AVE	KARAHALIOS, KONSTANTIA	1-3	2	R-22
27-0017-0009C	171	27	17	9C	10 WHITNEY FERGUSON RD	BRAY, STANLEY & KUNZLI....	5-3		
27-0019-00004	170	27	19	4	7 274 WEST ST	STRONG, NORMAN & GERALDINE	6-1		
27-0021-00008	139	27	21	8	2 WEST ST	MCCOY, FRANK & JEANETTE	1-1	1	R-27
27-0066-00018A	29	27	66	18A	4 25 CEMETARY RD	BROWN, MILTON & MARION TRUSTEE	6-3	1	R-27
28-0066-00029	57	28	66	29	33 HARTFORD TPKE	STRONG, NORMAN	6-1		R-27
28-0133-00006	6	28	133	6	3 120 BOLTON RD	SERRAMBANA, VICTOR		1	IP
28-0133-0005K	70	28	133	5K	8 55 INDUSTRIAL PARK AVE	PRIMUS FAMILY TRUST	6-2	1	IP
28-0133-0005N	DEL	28	133	5N	2 31 INDUSTRIAL PARK AV	PRIMUS FAMILY TRUST	6-2		
29-0134-00001	105	29	134	1	38 60 SOUTH FRONTAGE RD	SOUTH FRONTAGE VERNON LLC	5-3	4	C-20
29-0135-00001	169	29	135	1	6 250 TUNNEL RD	ROSENBERGER, JOAN	6-3		
30-0133-0001J	149	30	133	1J	7 255 BAMFORTH RD	TRIGGS, ROBERT & ANN	6-3		
30-0133-0005E	150	30	133	5E	2 186 BOLTON RD	PRIMUS FAMILY TRUST	6-1		
30-0134-00008	124	30	134	8	24 95 VALLEY FALLS RD	CLARK, EDWARD	6-1	4	R-27
31-0142-0221A	40	31	142	221A	10 ECHO RIDGE DR	SANTA FE TRUST	1-1	4	R-27
32-0142-00223	39	32	142	223	30 ECHO DRIVE	OLSON, PATRICIA A.	5-1	3	R-27
33-0135-00025	17	33	135	25	3 BOLTON RD	LAKEVIEW PARTNERS	6-3	4	R-40
33-0135-00027	13	33	135	27	43 BOLTON RD	HATHAWAY, MILTON	6-2	3	R-40
33-0135-00029	14	33	135	29	10 BOLTON RD	HATHAWAY, MILTON	6-2	4	R-40
33-0135-0023A	7	33	135	23A	38 729 BOLTON RD	MAFFESSOLI, SALVATORE	6-2	3	R-40
33-0135-0024-1	11	33	135	24-1	74 BOLTON RD	ROBERTS, ROSS & D. JAMES&	6-2	3	R-40
33-0135-0026A	12	33	135	26A	5 BOLTON RD	MALONE, JOANNE M.	6-3	2	R-40
35-0143-0003C	122	35	143	3C	30 VALLEY FALLS RD	KNAPP, ANNE WEBSTER	6-2	4	R-27
36-0137-0004S	159	36	137	4S	5 79 INDIAN TRAIL	ROMEO, ELAINE	6-3		
37-0068-00012	157	37	68	12	40 942 HARTFORD TPKE	NICOTERA, JOSEPH & FRANCES	6-2		
37-0132-00001	2	37	132	1	53 RESERVOIR RD	TANCANHOOSEN LLC	6-2	3	R-27
37-0139-0004A	97	37	130	4A	118 RESERVOIR RD	TANCANHOOSEN LLC	6-2	3	R-27
38-0068-00023	54	38	68	23	20 HARTFORD TPKE	SANTINI, EVANDRO	5-2	2	IP
38-0068-0021A	58	38	68	21A	6 HARTFORD TPKE	SANTINI, EVANDRO	2-1	1	IP
39-062C-00045	131	39	62C	45	5 VERNON AVE	MAIN RIDGE APART. ASSOC.	1-1	3	R-22
39-062C-0042A	129	39	62C	42A	8 VERNON AVE	CAMPELLI, PIETRO & RUTH	6-3	2	R-22
40-0109-00031	50	40	109	31	8 46 GAYNOR PLACE	MCKEOWN, JOHN & GERALD	1-2	4	PRD
40-0109-00046	31	40	109	46	24 CHESTNUT ST	ERCOLINI, ROBYN	1-1	4	PND
41-0114-9994A	80	41	114	4A	2 LAWRENCE ST	KAMIENSKI, BEVERLY	5-1	4	R-10
41-0115-00005	167	41	115	5	7 33 SNIPSIC ST	KALINA, MARK	6-3		
41-0115-00007	166	41	115	7	7 25 SNIPSIC ST	GRABOWSKI, CHESTER &	6-3		
42-0122-00026		42	122	26	HALE ST	COLOR IT RED	5-2		R-10

43-0130-00003	99	43	130	3	2	RESERVOIR RD	TANCANHOOSEN LLC	5-1	4	R-27
44-0129-0002B	98	44	129	2B	70	RESERVOIR RD	TANCANHOOSEN LLC	6-2	4	R-27
44-0131-00002	100	44	131	2	226	RESERVOIR RD	TANCANHOOSEN LLC	6-2	4	R-27
46-0068-00061	94	46	68	61	45	75 RESERVOIR RD	LEE & LAMONT	5-3	3	CAX
46-0071-00019	67	46	71	19	36	HYDE AVE	HAYES/CONYER PARTNERSHIP	5-2	2	CAX
46-0071-0021A	68	46	71	21A	5	HYDE AVE	GUNTHER FAMILY PARTNERSHIP	1-1	1	IP
47-0127-00001	84	47	127	1	11	MILE HILL RD	BRAY, WILLIAM & MERLENE ANNE	1-1	2	R-27
47-0129-00001	85	47	129	1	47	MILE HILL RD	BRAY, WILLIAM & WAYNE	6-2	3	R-40
48-0129-00003	49	48	129	3	19	FISH & GAME RD	ROCKVILLE FISH & GAME	6-2		R-40
48-0129-00003	49	48	129	3	20	FISH & GAME RD	ROCKVILLE FISH & GAME	6-3		R-40
48-0131-00001	156	48	131	1	32	FISH & GAME RD	ROCKVILLE FISH & GAME CLUB	6-2		
49-0131-00003	152	49	131	3	14	178 BRANDY HILL RD	ROBINSON, KENNETH	6-3		
49-0131-0003A	24	49	131	3A	20	BRANDY HILL RD	ROBINSON, KENNETH	6-3	4	R-40
49-0131-0003B	168	49	131	3B	44	SUTTON DR	PAW INDUSTRIES LLC	6-2		
51-0131-0006B	64	51	131	6B	29	HATCH HILL RD	PASSARETTI, PAULA		3	R-40
51-0131-006B4	63	51	131	6B4	7	147 HATCH HILL RD	PASSARETTI, PAULA		3	1-40
51-0138-00003	66	51	138	3	63	HATCH HILL RD	O'MALLEY, VIRGINIA - TRUSTEE	6-2	2	R-40
51-0139-00082	65	51	139	82	5	70 HATCH HILL RD	SCRANTON, THOMAS & NOLENE		4	R-40
51-0139-00086	62	51	139	86	23	200 HATCH HILL RD	FINCH, FRANCES	6-3	4	R-40
51-0139-082-6	61	51	139	82-6	6	132 HATCH HILL RD	GRISWOLD, THOMAS & KIM	1-3	3	R-40
51-0139-083-13	91	51	139	83-13	6	90 RAVENSCROFT	CRAIG, GREGORY & PATRICIA		3	R-40
52-0140-00042	53	52	140	42	61	GRIER RD	COMM'L SERVICE OF PERRY INC	1-1	3	R-40
53-0141-0004-1	10	53	141	4-1	28	BOLTON RD	ROBERTS, ROSS & D. JAMES&	6-2	3	R-40
53-0141-0006A	16	53	141	6A		836 BOLTON RD	HAYES, RICHARD	1-1	2	R-40
54-0135-00019	9	54	135	19	9	679 BOLTON RD	FOLEY, GRACE R.		3	R-40
54-0135-0018B	15	54	135	18B	11	BOLTON RD	MARTINELLI, JOSEPHINE	1-1	4	R-40
54-0135-016A1	5	54	135	16A1	5	BOLTON RD	CARUOLO, ANTONIO & DOROTHY		4	R-40
55-0131-00004	25	55	131	4	45	BRANDY HILL RD	PRIDDY, ROBERT & BETTY	6-2	3	R-40
55-0131-00005	153	55	131	5	29	212 BRANDY HILL RD	SILHAVY, LOUIS & RUTH	6-2		
55-0139-0085A	151	55	139	85A	4	478 BOLTON RD	DARICO, WILLIAM & OLGA	6-3		
55-O131-00006	23	55	131	6	35	BRANDY HILL RD	STEVENSON, MARIANNE		3	R-40
Total Private Non-developed Land:					**2453**	**Acres**				

APPENDIX D

Preservation and Acquisition Methods

PRESERVATION AND ACQUISITION METHODS

Fee Simple Acquisition

- Outright purchase by Town.

- Life estates - Town purchases land with provision for owner to continue living on the land until his death, after which Town acquires all rights. Usually less expensive to purchase since it allows continual use of property by owners, and the costs may be spread over a period of years.

- Gift - either directly to Town or through a land trust.

- Lease - may be useful if length of lease is at least equal to the expected life of contemplated development (buildings and other facilities). A problem with this arrangement is that the site may be prohibitively expensive to purchase after expiration of the lease. If purchase option is included this flaw may be avoided.

- Condemnation - the legal right of a government to take private land for public purposes with just compensation to owner. Rarely used except in extreme problem cases.

- Mandatory dedications - Vernon currently requires that up to 20 percent of a subdivision be dedicated to Town for open space.

- Purchase and leaseback - Town acquires property and leases land back to owner or another party for a certain use or development.

- Impact fees or in lieu fees (in place of land dedication) to buy land.

- Transfer of land among levels of government.

Less Than Fee Simple

In lieu of having to acquire all the rights to ownership, preservation of land and resources may also be achieved by restricting the rights of the owner. These restricted rights are defined in a legal agreement called a conservation agreement.

Conservation easements may be categorized or named according to the resource which they protect, such as:

- Land Conservation Easements: preserve significant values of a particular land parcel.

- Historic Preservation Easements: preserve the facade and surroundings of historic structures or sites.

- Agricultural Preservation Easements: preserve an agricultural operation.

- Scenic Easements: preserve a particularly scenic area.

The restrictions of each easement may be tailored to the particular property and to the interests of the individual owner. For example,

- The easement may or may not allow public access to the parcel.
- The restrictions may be temporary or permanent.
- The easement may be limited to a small hiking trail on a parcel, or it may apply to an entire parcel.

The property owner retains private ownership of the land or resource but conveys the right to enforce the easement's restrictions to a qualified conservation recipient. The recipient may be a public agency, such as the Town of Vernon itself, or it may be a privately incorporated non-profit group such as the Audubon Society, the Nature Conservancy or a local land conservation trust, described below:

Land Conservation Trust

A Land Conservation Trust is a private non-profit organization incorporated for purposes of preservation of locally significant parcels of natural areas and open space. A voluntary board of directors runs the trust and its membership is open to the public. It may receive properties through any one of the acquisition methods described above. A land trust may be organized to serve on town or it may encompass several towns.

In Vernon, the Northern Ct Land Trust was organized and incorporated in 1988. Its goal is to preserve significant natural areas located primarily within the Town of Vernon. As a private, non-profit organization it can receive gifts and donations of land; tax benefits are thus allowed to the donator according to the IRS charitable donation regulations.

Purchase of Development Rights

Land owner retains ownership of property and remains on tax rolls yet on a lower rate because of restricted use. This is a common method used for farm preservation.

APPENDIX E

American Planning Association PAS Memorandum

And

Connecticut River Joint Commission's Memoranda

PAS Memo
PLANNING ASSOCIATION
AUGUST 2000

Urban Stream Buffer Architecture

By Tom Schueler

Headwater streams make up as much as 75 percent of the total stream and river mileage in the contiguous United States. These critical headwater streams are often severely degraded by urbanization. As a consequence, many communities have adopted stream buffer requirements as part of an overall urban watershed protection strategy.

In the past, buffer requirements have been relatively simplistic—the "design" of a stream buffer often consisted of just drawing a line of uniform width on a site plan. Buffers designed this way often are invisible to contractors, property owners, and even local governments. As a result, many stream buffers fail to perform their intended function and are subject to disturbance and encroachment.

In addition, while communities frequently cite pollutant removal as the key benefit when justifying the establishment of stream buffers in urbanizing areas, the ability of buffers to remove pollutants in urban stormwater is fairly limited. Much of the pollutant removal by rural and agricultural buffers appears to be due to relatively slow transport of pollutants across the buffer or under it in shallow groundwater. This relatively slow movement promotes greater pollutant removal by soils, roots, and microbes.

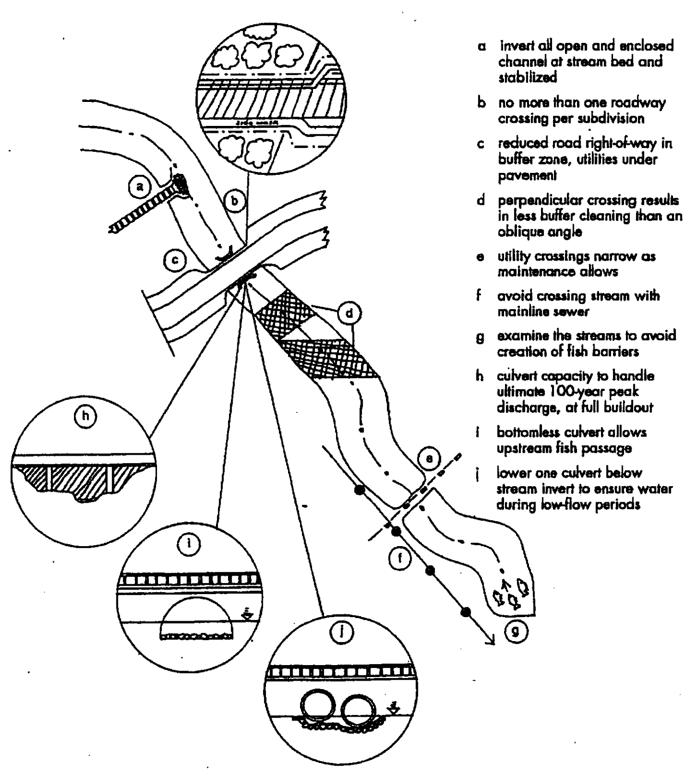
These conditions are rarely encountered in urban watersheds, where rainfall is rapidly converted into concentrated flow. Once flow concentrates, it forms a channel that effectively short-circuits the buffer. In urban areas, stormwater flows quickly concentrate within a short distance. Consequently, as much as 90 percent of the surface runoff generated in an urban watershed will become concentrated before it reaches the buffer, and ultimately will cross it in an open channel or an enclosed storm drain pipe. As a result, some kind of structural best management practice (BMP) is often needed in addition to the buffer to remove pollutants from runoff before it enters the stream.

The ability of a particular buffer to actually realize its many benefits depends to a large extent on how well the buffer is planned or designed. This *PAS Memo* presents a scheme for stream buffer design, drawn from field research and local experience across the country. The suggested urban stream buffer design is based on 10 practical performance criteria that govern how a buffer will be sized, delineated, managed, and crossed, and how it will handle stormwater. In addition, the buffer design contains several provisions to respect the property rights of adjacent landowners.

Minimum Total Buffer Width

Most local buffer criteria are composed of a single requirement, that the buffer be a fixed and uniform width from the stream channel. Urban stream buffers range from 20 to 200 feet in width on each side of the stream, according to a national survey of 36 local buffer programs, with an average of 100 feet. Most jurisdictions arrive at their buffer width requirement by adopting other state and local criteria, from local experience, and/or through political compromise during the buffer adoption process. Most communities require that the buffer include all land within the 100-year floodplain. Others may extend the buffer to pick up adjacent wetlands, steep slopes, or critical habitat areas. In general, a minimum base width of at least 100 feet is recommended to provide adequate stream protection. In most regions of the country, this requirement translates to a buffer that is perhaps three to five mature trees wide on each side of the channel.

Figure 1: Crossing the Stream Buffer



Three-Zone Buffer System

Effective urban stream buffers divide the total buffer width into three zones: streamside, middle core, and outer zone. Each zone performs a different function and has a different width, vegetative target, and management scheme.

The streamside zone protects the physical and ecological integrity of the stream ecosystem. The vegetative target is mature riparian forest that can provide shade, leaf litter, woody debris, and erosion protection to the stream. The minimum width is 25 feet from each stream bank—about the distance of one or two mature trees from the streambank. Land use is highly restricted, limited to stormwater channels, footpaths, and a few utility or roadway crossings.

The middle core zone extends from the outward boundary of the streamside zone and varies in width depending on stream order, the extent of the 100-year floodplain, any adjacent steep slopes, and protected wetland areas. Its functions are to protect key stream components and provide further distance between upland development and the stream. The vegetative target for this zone is also mature forest, but some clearing may be allowed for stormwater management, access, and recreational uses. A wider range of activities and uses are allowed within this zone, such as bike paths and stormwater BMPs. The minimum width of the middle core is about 50 feet, but it is often expanded based on stream order, slope, or the presence of critical habitats (see Buffer Expansion and Contraction).

The outer zone is the buffer's buffer, an additional 25-foot setback from the outward edge of the middle core zone to the nearest permanent structure. In many instances, this zone is within a residential backyard. The vegetative target for the outer zone is usually turf or lawn, although the property owner is encouraged to plant trees and shrubs. Few uses are restricted in this zone. Gardening, compost piles, yard wastes, and other common residential activities are promoted within the zone. The only major restrictions are no septic systems and no new permanent structures.

Predevelopment Vegetative Target

The ultimate vegetative target for the streamside and middle zones of most urban stream buffers should be the plant community present before development, which is usually mature forest. Notable exceptions include the prairie streams of the Midwest and arroyos of the arid West that may have a grass or shrub cover.

A vegetative target has several management implications. First, if the streamside zone does not currently meet its vegetative target, it should be managed to ultimately achieve it. For example, a grassy area should be allowed to grow into a forest over time. In some cases, active reforestation may be necessary to speed up succession. Second, a vegetative target implies the buffer will contain mostly native species adapted to the floodplain. Non-native or invasive tree, shrub, and vine species should be avoided and removal of exotic shrubs and vines, like multiflora rose or honeysuckle, should be encouraged.

Buffer Expansion and Contraction

Many communities require that the minimum buffer width be expanded under certain conditions. Thus, while the streamside and outer zones of the buffer are fixed, the width of the middle zone may expand to include the entire 100-year floodplain; all undevelopable steep slopes (greater than 25 percent); steep slopes from five to 25 percent slope (adding four additional feet of buffer for every one percent increment of slope above 5 percent); and adjacent delineated wetlands or critical habitats.

The middle zone can also expand to protect streams of higher order or quality. For example, the middle zone may increase from 75 feet for first- and second-order streams to 100 feet for third- and fourth-order streams, and as much as 125 feet for fifth- or higher order streams and rivers. The buffer width can also be contracted in some circumstances, to accommodate unusual or historical development patterns, shallow lots, stream crossings, or stormwater ponds (see Buffer Flexibility).

Buffer Delineation

Three key decisions must be made when delineating the buffer boundaries: the mapping scale at which the streams will be defined, the place where the stream begins and the buffer ends, and the point from which the inner edge of the buffer should be measured.

Table 1. Example of the Use of Density Credits
(to compensate developers for excessive land consumption by buffers)

Percentage of site lost to buffers	Density* credit
1 to 10%	1.0
11 to 20%	1.1
21 to 30%	1.2
31 to 40%	1.3
41 to 50%	1.4
51 to 60%**	1.5
61 to 70%**	1.6
71 to 80%**	1.7
81 to 90%**	1.8
91 to 99%**	1.9

Adapted from Burns, 1992.
*Additional dwelling units allowed over base density (1.0)
**Credit may be transferred to a different parcel

Mapping scale. The traditional mapping scale used to define stream networks are the U.S. Geological Survey 7.5 minute quadrangle maps (1 inch = 1,000 feet), which denote streams with blue lines. It should be kept in mind that these blue lines are only a first approximation for delineating streams. This scale does not always fully reveal all first-order perennial streams or intermittent channels in the landscape, or precisely mark the transition between the two. Consequently, the actual location of the stream channel should be confirmed in the field.

Stream origin. The origin of a first-order stream is always a matter of contention. As a practical rule, it can be defined as the point where an intermittent stream forms a distinct channel, indicated by the presence of an unvegetated streambed and high water marks. Other regions define the stream origin as the upper limit of running water during the wettest season of the year. Identification problems have frequently been reported where the stream network has been extensively modified by prior agricultural drainage practices.

Buffer measurement. The inner edge of the buffer can be defined from the centerline of small first- or second-order streams. The accuracy of this method is questionable in higher order streams with wider channels. Thus, for third and higher order streams, the inner edge of the buffer is measured from the top of each streambank.

Buffer Crossings

Two major goals of a stream buffer network are to maintain an unbroken corridor of riparian forest and the upstream and downstream passage of fish in the stream channel. It is not always possible to meet both goals everywhere along the stream buffer network. Some provision must be made for linear forms of development that must cross the stream or the buffer, such as roads, bridges, fairways, underground utilities, enclosed storm drains, or outfall channels.

However, it is possible to minimize the impact to the continuity of the buffer network and fish passage (see Figure 1). Performance criteria should specifically describe the conditions under which the stream or its buffers can be crossed. Some performance criteria could include:

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- Crossing width: define a minimum width for maintenance access.
- Crossing angle: direct right angles are preferred, because they require less buffer clearing than oblique crossing angles.
- Crossing frequency: allow only one road crossing within each subdivision, and permit no more than one fairway crossing for every 1,000 feet of buffer.
- Crossing elevation: have all direct outfall channels (the places where effluent is discharged into receiving waters) discharge at the invert elevation, or the lowest point of the stream channel.

Underground utility and pipe crossings should be located at least three feet below the stream invert elevation, so that future channel erosion does not expose them, creating unintentional fish barriers. All roadway crossings and culverts should be capable of passing the ultimate 100-year flood event. Bridges should be used in lieu of culverts when crossings require a 72 inch or greater diameter pipe. The use of corrugated metal pipe for small stream crossings should be avoided, as these often tend to create fish barriers. The use of slab, arch, or box culverts are much better alternatives. Where possible, the culvert should be "bottomless" (i.e., the natural channel bottom should not be hardened or otherwise encased), to ensure passage of water during dry weather periods.

Stormwater Runoff

Buffers can be an important component of a stormwater treatment system. They cannot, however, treat all the stormwater runoff generated within a watershed (generally, a buffer system can only treat runoff from less than 10 percent of the contributing watershed to the stream). Therefore, some kind of structural BMP must be installed to treat the stormwater runoff from the remaining 90 percent of the watershed. Often the most desirable location for BMPs is within or adjacent to the stream buffer.

Using buffers for stormwater treatment. The outer and middle zone of the stream buffer may be used as a grass/forest filter strip under limited circumstances. For example, the buffer cannot treat more than 75 feet of overland flow from impervious areas and 150 feet from pervious areas, such as backyards or rooftops. The designer should compute the maximum runoff velocity for both the six-month and two-year storms from each overland flow path, based on the slope, soil, and vegetative cover. If the calculations indicate that velocities will be erosive under either condition (greater than three feet per second (fps) for a six-month storm, five fps for a two-year storm), the allowable length of contributing flow should be reduced.

When the buffer receives flow directly from an impervious area, the designer should include curb cuts or spacers so that runoff can spread evenly over the filter strip. The filter strip should be located three to six inches below the pavement surface to prevent sediment deposits from blocking inflow to the filter strip. A narrow stone layer at the pavement edge often works well. The stream buffer can be accepted as a stormwater filtering system if basic maintenance can be assured, such as routine mowing of the grass filter and annual removal of accumulated sediments at the edge of the impervious areas and the grass filter. The existence of an enforceable maintenance agreement that allows for public maintenance inspection is also helpful.

Location of stormwater ponds and wetlands within buffer. A particularly difficult management issue involves locating stormwater ponds and wetlands in relation to the buffer. Should they be located inside or outside of the buffer? And if they are allowed within the buffer, where exactly should they be placed?

Several arguments can be made for locating ponds and wetlands within the buffer or on the stream itself. Constructing ponds on or near the stream allows the greatest possible drainage area to be treated at one topographic point. Also, ponds and wetlands require the dry weather flow of a stream to maintain water levels and prevent nuisance conditions. Lastly, ponds and wetlands add a greater diversity of habitat types and structure and can add to the total buffer width in some cases. On the other hand, placing a pond or wetland in the buffer can create environmental problems, including localized clearing of trees, sacrifice of stream channels above the BMP, creation of a fish migration barrier, modification of existing wetlands, and stream warming.

Locating ponds and wetlands in buffers will always be a balancing act. Given the effectiveness of stormwater ponds and wetlands in removing pollutants, one should not completely prohibit their use within the buffer. When choosing pond and wetland sites, employ performance criteria that will restrict the use of ponds or wetlands, such as defining a maximum size (e.g. 100 acres), placing them only within the first 500 feet of a stream channel, clearing the streamside buffer zone only for the pond or wetland's outflow channel (if the pond is discharging from the middle zone into the stream), putting them within the middle or outer zone of the buffer, or using ponds only to manage stormwater quantity within the buffer.

Plan Review and Construction

The limits and uses of stream buffer systems should be well defined during each stage of the development process, from initial plan review through construction. The following steps are helpful during the planning stage:

- Require that the buffer be delineated on preliminary and final concept plans;
- Verify the stream delineation in the field;
- Check that buffer expansions are computed and mapped properly;
- Check suitability of use of buffer for stormwater treatment;
- Ensure other BMPs are properly integrated in the buffer; and
- Examine any buffer crossings for problems.

Stream buffers are vulnerable to disturbance during construction. Steps to prevent encroachment include:

- marking buffer limits on all plans used during construction;
- conducting a preconstruction stakeout of buffers to define limit of disturbance;
- marking the limit of disturbance with silt or snow fence barriers and signs to prevent the entry of construction equipment and stockpiling; and
- familiarizing contractors with the limit of disturbance during a preconstruction walk-through.

Buffer Education and Enforcement

Protecting the future integrity of the buffer system requires a strong education and enforcement program. This can be supported by encouraging greater buffer awareness and stewardship among adjacent residents and the community. Several simple steps can accomplish this:

Burns, D. 1992. *Environmental Protection and Resource Conservation Plan.* City of Lacey, Wash.

Desbonnet, A., P. Pogue, V. Lee, and N. Wolff. 1994. *Vegetated Buffers in the Coastal Zone: A Summary Review and Bibliography.* Coastal Resources Center. University of Rhode Island.

Heraty, M. 1993. *Riparian Buffer Programs: A Guide to Developing and Implementing a Riparian Buffer Program as an Urban Stormwater Best Management Practice.* Metropolitan Washington Council of Governments. U.S. EPA Office of Oceans, Wetlands and Watersheds.

Leopold et al., 1964. *Fluvial Processes in Geomorphology.* W.H. Freeman. San Francisco.

Model Buffer Ordinance. Available at www.cwp.org/Model%20Ordinances/buffer_model_ordinance.htm

Schueler, Tom. 1995 "The importance of imperviousness." *Watershed Protection Techniques.* Vol. 1, No. 3.

__________. *Site Planning for Urban Stream Protection.* Center for Watershed Protection. Silver Spring, Maryland.

__________. 1994. *The Stream Protection Approach.* Center for Watershed Protection. Terrene Institute, Washington, D.C.

- Mark the buffer boundaries with permanent signs that describe allowable uses;
- Educate buffer owners about the benefits and uses of the buffer with pamphlets, streamwalks, and meetings with homeowners associations;
- Ensure that new owners are fully informed about buffer limits/uses when property is sold or transferred;
- Engage residents in a stewardship program that includes reforestation and backyard "bufferscaping" programs;
- Conduct annual bufferwalks to check on encroachment.

Most encroachment problems reflect ignorance rather than contempt for the buffer system. Awareness and education measures can increase buffer recognition within the community. Not all residents, however, will respond to this effort. A limited enforcement program may be necessary. This usually involves correction notices and site visits, with civil fines used as a last resort if compliance is not forthcoming. Some buffer ordinances allow the full cost of buffer restoration to be charged as a property lien. A fair and full appeals process should accompany any enforcement action.

Buffer Flexibility

In most regions of the country, a 100-foot buffer will take about five percent of the total land area in any given watershed out of production. While this constitutes a relatively modest land reserve at the watershed scale, it can be a significant hardship for a landowner whose property is adjacent to a stream. Many communities are legitimately concerned that stream buffer requirements could represent an uncompensated taking of private property. These concerns can be reduced if a community incorporates several simple measures to ensure fairness and flexibility when administering its buffer program.

Buffer ordinances that retain property in private ownership generally are considered by the courts to avoid the takings issue, as buffers provide compelling public safety, welfare, and environmental benefits to the community that justify partial restrictions on land use. Most buffer programs meet the "rough proportionality" test advanced by the U.S. Supreme Court. Indeed, stream buffers are generally perceived to have either a neutral or positive impact on adjacent property value. The key point is that the buffer reservation cannot take away all economically beneficial use of the property. Buffer averaging, density compensation, conservation easements, and variances can help protect property owners from this negative impact.

Buffer averaging. Here a community provides some flexibility in the buffer width, permitting the buffer to become narrower at some points along the stream as long as the average width meets the minimum requirement. In general, allowing the buffer to be narrower in places is permitted sparingly, to ensure that the streamside zone is not disturbed and that no new structures are allowed within the 100-year floodplain (if this is a greater distance than the buffer width).

Density compensation. This scheme grants a developer credit for additional density elsewhere on the site to compensate for developable land lost to the buffer. Developable land is defined as the buffer area remaining after the 100-year floodplain, wetland, and steep slope areas have been subtracted. Credits are granted when more than five percent of developable land is consumed, using the approach shown in Table 1. The density credit is accommodated by allowing greater flexibility in setbacks, frontage distances, or minimum lot sizes. Cluster development also allows the developer to recover lots that are taken out of production due to buffers and other requirements.

Conservation easements. Landowners should be afforded the option of protecting lands within the buffer with a perpetual conservation easement. The easement puts conditions on the use of the buffer and can be donated to a land trust as a charitable contribution, reducing an owner's income tax burden. Alternately, the conservation easement can be donated to a local government in exchange for a reduction or elimination of property tax on the parcel.

Variances. The buffer ordinance should have provisions that enable an existing property owner to be granted a variance, if the owner can demonstrate severe economic hardship or unique circumstances make it impossible to meet some or all buffer requirements. The owner should also have access to an appeals process should the request for a variance be denied.

Conclusion

Urban stream buffers are an integral element of any local stream protection program. By adopting some of these rather simple performance criteria, communities can make their stream buffers more than just a line on a map. Better design and planning also ensure that communities realize the full environmental and social benefits of stream buffers.

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RIVER BANKS & BUFFERS

No. 1

Introduction to Riparian Buffers

for the Connecticut River Watershed

Riparian buffers are the single most effective protection for our water resources in Vermont and New Hampshire. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff and provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter.

Natural riparian buffers have been lost in many places over the years. Restoring them will be an important step forward for water quality, riverbank stability, wildlife, and aesthetics in the Connecticut River Valley. Landowners, town road agents, local governments, farmers, and conservation organizations can all help restore and protect the riparian buffers which in turn restore and protect the quality of our streams.

HOW BUFFERS GO TO WORK

For water quality

Sediment Filter

Riparian buffers help catch and filter out sediment and debris from surface runoff. Depending upon the width and complexity of the buffer, 50–100% of the sediments and the nutrients attached to them can settle out and be absorbed as buffer plants slow sediment-laden runoff waters. Wider, forested buffers are even more effective than narrow, grassy buffers.

Pollution Filter, Transformer, and Sink

The riparian buffer traps pollutants that could otherwise wash into surface and groundwater. Phosphorus and nitrogen from fertilizer and animal waste can become pollutants if more is applied to the land than plants can use. Because excess phosphorus bonds to soil particles, 80–85% can be captured when sediment is filtered out of surface water runoff by passing through the buffer. Chemical and biological activity in the soil, particularly of streamside forests, can capture and transform nitrogen and other pollutants into less harmful forms. These buffers also act as a sink when nutrients and excess water are taken up by root systems and stored in the biomass of trees.

Stream Flow Regulator

By slowing the velocity of runoff, the riparian buffer allows water to infiltrate the soil and recharge the groundwater supply. Groundwater will reach a stream or river at a much slower rate, and over a longer period of time, than if it had entered the river as surface runoff. This helps control flooding and maintain stream flow during the driest time of the year.

For bank stability

Bank Stabilizer

Riparian buffer vegetation helps to stabilize streambanks and reduce erosion. Roots hold bank soil together, and stems protect banks by deflecting the cutting action of waves, ice, boat wakes, and storm runoff.

Bed Stabilizer

Riparian buffers can also reduce the amount of streambed scour by absorbing surface water runoff and slowing water velocity. When plant cover is removed, more surface water reaches the stream, causing the water to crest higher during storms or snowmelt. Stronger flow can scour streambeds, and can disturb aquatic life.

For fish and wildlife

Wildlife Habitat

The distinctive habitat offered by riparian buffers is home to a multitude of plant and animal species, including those rarely found outside this narrow band of land influenced by the river. Continuous stretches of riparian buffer also serve as wildlife travel corridors.

Aquatic Habitat

Forested riparian buffers benefit aquatic habitat by improving the quality of nearby waters through shading, filtering, and moderating stream flow. Shade in summer maintains cooler, more even temperatures, especially on small streams. Cooler water holds more oxygen and reduces stress on fish and other aquatic creatures. A few degrees difference in temperature can have a major effect on their survival. Woody debris feeds the aquatic food web. It also can create stepped pools, providing cover for fish and their food supply while reducing erosion by slowing flow.

Recreation and Aesthetics

Forested buffers are especially valuable in providing a green screen along waterways, blocking views of nearby development, and allowing privacy for riverfront landowners. Buffers can also provide such recreational opportunities as hiking trails and camping.

THE BETTER BUFFER

For every buffer there is a reason. Whether it is pollution filtration, erosion control, wildlife habitat, or visual screening, the size and vegetation of the buffer should match the land use and topography of the site.

Topography

A buffer is more important for water quality in areas that collect runoff and deliver it to streams, and less critical on land that tips away from the water. Steeper slopes call for a wider riparian buffer below them to allow more opportunity for the buffer to capture pollutants from faster moving runoff. This is also true at both ends of a flood chute, or the path a river takes across a meander at high water.

Hydrology and Soil

The ability of the soil to remove pollutants and nutrients from surface and ground water also depends upon the type of soil, its depth, and relation to the water table. On a wetter soil, a wider buffer is needed to get the same effect.

Vegetation

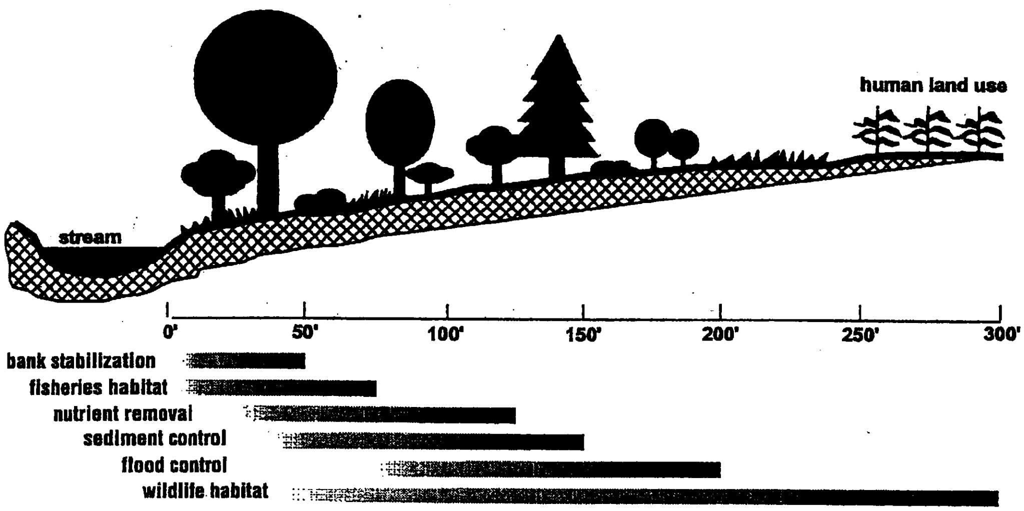
The purpose(s) of the buffer will influence the kind of vegetation to plant or encourage. In urban and residential areas, trees and shrubs do a better job at capturing pollutants from parking lots and lawn runoff and providing visual screening and wildlife habitat.

Between cropland and waterways, a buffer of shrubs and grasses can provide many of the benefits of a forested buffer without shading crops, and trees can be used on the north side of fields.

Trees have several advantages over other plants in improving water quality and offering habitat. Trees are not easily smothered by sediment and have greater root mass to resist erosion. Above ground, they provide better cover for birds and other wildlife using waterways as migratory routes. Trees can especially benefit aquatic habitat on smaller streams. Native vegetation is preferable to non-native plants.

BUFFER WIDTH

How big should a buffer be? One size doesn't fit all. It depends on what you want the buffer to do. There isn't one generic buffer which will keep the water clean, stabilize the bank, protect fish and wildlife, and satisfy human demands on the land. The minimum acceptable width is one that provides acceptable levels of all needed benefits at an acceptable cost. **The basic bare-bones buffer is 50' from the top of the bank. You get more with every foot.**



To Stabilize Eroding Banks

On smaller streams, good erosion control may require only covering the bank with shrubs and trees, and a 35' managed grass buffer. If there is active bank erosion, or on larger streams, going beyond the bank at least 50' is necessary. Severe bank erosion on larger streams requires engineering to stabilize and protect the bank - but this engineering can be done with plants. For better stabilization, put more of the buffer in shrubs and trees.

To Filter Sediment and Attached Contaminants from Runoff

For slopes gentler than 15%, most sediment settling occurs within a 35' wide buffer of grass. Greater width is needed on steeper slopes, for shrubs and trees, or where sediment loads are particularly high.

To Filter Dissolved Nutrients and Pesticides from Runoff

A width up to 100' or more may be necessary on steeper slopes and less permeable soils to allow runoff to soak in sufficiently, and for vegetation and microbes to work on nutrients and pesticides. Most pollutants are removed within 100', although in clay soils, this may not happen within 500'.

To Protect Fisheries

Buffer width depends on the fish community. For cold water fisheries, the stream channel should be shaded completely. Unless there are problems with algae blooms, warm water fisheries do not require as wide a buffer or as much shade, but they still benefit from water cleaned by a buffer's filtering action. Studies show that at least up to 100', the wider the buffer, the healthier the aquatic food web.

To Protect Wildlife Habitat

Buffer width depends upon desired species: 300' is a generally accepted minimum. Much larger streamside forest buffer widths are needed for wildlife habitat purposes than for water quality purposes. The larger the buffer zone, the more valuable it is. Larger animals and interior forest species generally require more room. Some use so much habitat that it would be nearly impossible to protect the size buffers they require. A narrow width may be acceptable for a travel corridor to connect larger areas of habitat. Continuity is important — even small patches of trees are better than none at all when it comes to migrating birds.

To Protect Against Flood Damage

Smaller streams may require only a narrow width of trees or shrubs; a larger stream or river may require a buffer that covers a substantial portion of its flood plain. This is why it is not a good idea to build a permanent structure where a river can get at it.

To Grow Valuable Products

Buffer width depends upon the desired crop and its management. Don't forget to consider tax incentives and cost-share programs when looking at the economic return from a riparian buffer.

DECIDING ON THE RIGHT WIDTH FOR YOUR PROPERTY

From the top of the streambank, turn back and take 15 long paces. This should carry you 50' from the bank. This area should be covered with native vegetation. Another 15 paces brings you about 100' from the bank. The ability of a buffer to remove pollutants is uncertain if it is narrower than this. A 100' buffer will generally remove 60% or more of pollutants, depending on local conditions. It will also provide food, cover and breeding habitat for many kinds of wildlife but only fulfill a few needs for others, such as travel cover.

Remember, a bigger buffer is needed to do the job if:

- the riverside land is sloped and runoff is directed here
- the land above is sloped (the steeper the slope, the wider a buffer should be)
- land use is intensive (crops, construction, development)
- soils are erodible
- the land is floodplain
- the stream naturally meanders
- the land drains a large area (ratio of drainage area to buffer area is more than 60:1; based on the soil loss factor in the Connecticut River Valley)
- more privacy is desired

Fact sheets in the series *Riparian Buffers for the Connecticut River Watershed*

No. 1 Introduction to Riparian Buffers
No. 2 Backyard Buffers
No. 3 Forestland Buffers
No. 4 Buffers for Habitat
No. 5 Buffers for Agricultural Land
No. 6 Urban Buffers
No. 7 Guidance for Communities
No. 8 Planting Riparian Buffers (& plant list)
No. 9 Field Assessment
No. 10 Sources of Assistance

See also the companion series for land owners:
The Challenge of Erosion in the Connecticut River Valley, Connecticut River Joint Commissions, 1998.

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RIVER BANKS & BUFFERS

Guidance for Communities

No. 7

in the Connecticut River Watershed

Our most fertile soils, our most valuable fish and wildlife habitat, and some of our most expensive real estate are found along rivers and streams. Add to that the power of flooding waterways to destroy private property, and here is a situation which begs for sensible town policy.

THE CHALLENGE

The high quality of life offered in the beautiful valley of the Upper Connecticut River, with waters clean and attractive once again, brings with it both the promise of growth and the threat of losing a landscape our children will recognize in the years ahead.

Our region has a long tradition of respect for the rights of individual property owners. This understanding must include concern for the rights of neighbors and, along rivers, for those downstream who can be directly affected by the actions of a single landowner. In the tug of war between unlimited freedom in the use of private property, and the need to protect both private property and the public good from harm, many town decision-makers are recognizing that it is in their own economic and environmental self-interest to guide development near moving water. Allowing development too close to a waterway has too often led to damage or loss of roads and buildings, and pollution of the river, not to mention a growing threat to the rural character which is the signature of the Connecticut River Valley.

Riparian buffers are a river's right-of-way.

The flood and erosion "insurance" provided by a riparian buffer is all the more important now that weather patterns are taking a turn. Whether global climate warming is natural or human-induced, New England is seeing a definite shift toward heavy storms that deliver several inches of rain in a single day. Sturdy buffers are the best protection for private property. Smaller tributaries are just as important as the larger streams they supply. If land adjacent to small streams is altered to reduce its flood control function, the cumulative impact will result in worse flooding in the mainstem, even if mainstem flood plains are safeguarded against further development.

Development pressure inevitably means pressure on aquifers. Nature's own water treatment facilities, riparian buffers help cleanse and recharge wells and groundwater supplies. They are a real bargain compared to a multi-million dollar piece of infrastructure.

Small streams need buffers, too.

Land conversion also brings traffic closer to waterways. In the upper Connecticut River Valley, roads and railroads often closely follow rivers and streams, pinching the riparian zone. These may have longer lasting impacts on riparian land than any other type of human land use.

Local officials can help by utilizing town wetland and zoning regulations to protect stream buffers in areas that have not yet been developed, and by encouraging buffer restoration in developed areas. Developers and property owners can help by maintaining or restoring adequate stream buffers before, during, and after construction.

Rewards of Riparian Buffers

Economic services

- protect citizens against property loss through flood damage and erosion
- recharge aquifers
- protect quality of public drinking water supplies
- support the recreation and tourism industry
- support sustainable yields of timber

Social services

- protect clean surface water for public recreation
- protect prime agricultural soils from permanent loss through development
- provide natural fences, visual screens, and noise control
- provide outdoor laboratories for teaching and research
- offer places for camping, nature study, hunting and fishing
- improve air quality
- recycle nutrients
- trap heavy metals and toxins
- store excess sediments
- trap excess carbon dioxide

Biological services

- support predators of rodent and insect pests
- protect fish and wildlife habitat
- provide corridor for movement of wildlife

FIRST STEPS

Build public support and awareness by assembling citizens interested in their town's future who can offer experience in engineering, home building, and conservation issues. Look at existing local policy with both small streams and large rivers in mind: master plan, zoning ordinance, subdivision regulations, and site plan review. Consult your regional planning commission for expert advice, model ordinances, or an evaluation of how well streams and riparian buffers fare under your town's current zoning provisions.

Your regional planning commission can perform a build-out analysis to show the density and pattern of development that could occur under current zoning. This jump into the future can identify where adjustments should be made today to avoid an unwelcome tomorrow.

Develop guidelines that remain flexible to site-specific needs. There is no one-size-fits-all buffer width adequate to protect water quality, habitat, and human interests. These policies should establish a clear link between water quality protection and riparian buffers.

THE TOWN PLANNER'S TOOL BOX

MASTER OR TOWN PLAN

The entire community and its waterways will benefit from a natural resources inventory that includes streams, their flood ways, and flood plains, as well as the town's stated resource protection goals and objectives. Refer to the *Connecticut River Corridor Management Plan* for information. In Connecticut river front towns, this plan can be adopted as an adjunct to the master plan following a public hearing, in New Hampshire by vote of the planning board, and in Vermont by vote of the selectmen. This provides the footing for a zoning ordinance that will help the town protect its waterways, and can also help the town foster connections among conservation lands.

Stating the town's support of riparian buffers in the master plan, however, is only window dressing if the zoning ordinance does not back it up. Towns can also employ a number of non-regulatory tools for promoting buffers.

ZONING ORDINANCE

Shoreland conservation zoning is not a "taking"—because it doesn't reduce density.

Don't prohibit development—guide its location. Apply shoreland and buffer guidelines on small streams as well as on larger rivers. Small streams are most vulnerable because they respond most dramatically to changes in adjacent land uses, tend to be located on the steepest sloping and erosion-prone lands, and often have the highest quality remaining habitat. The zoning ordinance can apply a shoreland protection overlay district to all year-round streams within its borders, with the guidelines that follow. To encourage use of the various shoreland conservation techniques presented below, allow them by right, rather than by special exception.

Suggested allowable uses
Encourage agriculture and forestry, provided they use best management practices established by NH and acceptable management practices established by VT; parks, recreation areas with minimal structural development; non-motorized trails; utility transmission lines. Encourage passive use of land for recreation and nature appreciation. Maintain wetlands, flood plains, seeps, and bogs in their natural condition. Allow harvest of timber for firewood or commercial use, consistent with state forestry harvesting guidelines.

Suggested prohibited uses
All uses that present a higher potential for pollution: filling stations, car washes, junkyards, bulk fuel storage, truck terminals, any facilities handling hazardous material. Campgrounds other than dispersed forested tenting sites should be excluded because of their tendency toward deforestation and soil compaction. Towns may wish to guide use of ATVs and mountain biking to less sensitive locations since these higher impact uses can contribute to vegetation loss and erosion. Buildings that do not depend on proximity to water should be sited outside a riparian buffer.

Lot coverage
Discourage impervious surfaces. The quality of life in a stream goes distinctly downhill when its watershed reaches 10-15% of impervious cover. A stream whose watershed is more than 25% impervious can no longer support aquatic life. Encourage developers to use alternatives that allow rain and snowmelt to soak in rather than run off, including retention of open space. Reducing the overall area of impervious surfaces and suburban lawns by encouraging conservation zoning, which minimizes site disturbance, will result in a lower total volume of stormwater runoff. Manicured lawns might as well be green asphalt, since they shed most of the water that falls on them. Encourage developers to retain natural vegetation already at work protecting the town's waterways.

Lot size and density
Some communities have actually done away with minimum lot sizes in order to guide development away from a stream buffer or other sensitive land. Allow flexibility so that developers can establish the same number of lots on the parcel outside the riparian buffer as they would in a conventional cookie-cutter layout, considering the total amount of land that is high, dry, and flood-free. A community can even give density bonuses for land-conserving design, and density *dis*incentives to actively discourage land-consuming layouts. Experience shows that the added value of open space for views and for passive and active recreation can balance and even outweigh the conventionally perceived lower value of smaller lots.

Minimum frontage and road setbacks
The larger these are, the more they tend to intrude on the riparian buffer. A flexible design should be allowed, even on small properties, when there is a possibility of increasing a riparian buffer. It is better to site a building closer to a road than to a stream.

Open space/cluster development
Cluster development concentrates construction on land with less conservation value, and allows owners of house lots in the development to share undivided ownership and enjoyment of the portion of the property remaining in a scenic and natural condition. This usually decreases the developer's costs for road and utility construction, and increases both the initial and the resale value of each lot, resulting in economic incentives for the developer and attraction to the buyer. The land can be managed by a homeowner's association, land trust, or the town.

Building on the 100-year flood plain is inherently unsafe.

Stream setback
The town can establish a riparian buffer similar to a utility right-of-way, whose width is determined before construction begins. Buffer averaging allows flexibility to account for the 100-year flood plain, steepness of slopes, adjacent wetlands, limited lot size, stormwater ponds, and pre-existing structures. The town can adopt the provisions of the NH Comprehensive Shoreland Protection Act for those waters not covered under the Act. On the mainstem of the Connecticut and its larger tributaries, towns should consider enacting stronger local protection that better reflects the flood and erosion potential of

these larger rivers. It is best to deter building on the 100-year flood plain; construction here is inherently unsafe.

Buffer Width Options

See *Introduction to Riparian Buffers*, No. 1 in this series, for more on buffer widths for various functions.

Fixed width — select a distance to protect most desired functions: for example, a 75' buffer for 1st and 2nd order (small) streams, 100' for 3rd and 4th order (medium-sized) streams, and 150' for large rivers, 5th order and higher. This is simplest to administer but will be more than adequate in some situations and inadequate in others.

Variable width — based on site-specific conditions such as slope and intensity of land use. Since every stream, parcel, and land use is different, buffers are better tailored to the land rather than to a cookie-cutter approach. While more science-based, this requires more site evaluation and is more difficult to administer.

Combination of the above — determine a standard width, and specify criteria for expanding or contracting, such as to include the 100-year flood plain, undevelopable steep slopes, and/or adjacent wetlands or critical habitats. For example, Weathersfield VT requires a 50' minimum buffer for land with 0-10% slope next to streams wider than 10', and adds 20' in buffer width for each 10% increase in slope.

Protected slope areas

Address slope gradient, soil erodability, and proximity to stream channels, since increasing slope results in a need for an increase in buffer width.

SUBDIVISION REGULATIONS

Map of existing resources & site analysis

The single most important document is a map prepared at the outset, showing

- streams, wetlands, and their buffers
- 100-year flood plains
- soil types and contours with areas of slopes over 15% indicated
- other valued natural resources such as farmland, aquifers and public water supply protection areas, woodlands, & significant wildlife habitat
- cultural resources such as historic/archeological features, and also views into and out of the site.

Information for this map is readily available, requires little or no cost or engineering except for the slopes and soils, and will form the basis for all the major design decisions. Much information can be gained from aerial photographs available from the county Natural Resources Conservation Service office.

Urge developers to retain natural riparian vegetation.

Encourage a pre-application meeting and schedule a site visit early in the review process in order to discuss the conservation potential of the property and to help the developer save time and expense designing around it. This is a good opportunity to discuss the value of a riparian buffer and the reasons to keep existing vegetation.

Applicants should be asked to submit a lightly engineered sketch showing the maximum number of lots they could reasonably expect to gain under a conventional layout after discounting unbuildable land. This better reflects the development capacity of the property, and gives the developer and the town time to work together before investing in an engineered "preliminary plan."

Then use the approach used by successful designers of golf course developments: locate house sites around the most valuable natural features just as one might around a fairway or putting green, keeping structures as far away from the stream as possible. Finally, align streets and trails, and draw in lot lines.

Wastewater management specifications

Include erosion and sedimentation control, stormwater management, landscaping, and provisions for special investigative studies. It is appropriate to incorporate the NH Comprehensive Shoreland Protection Act criteria here.

Road design specifications

Flexible road width dimensions will help make room for greater setbacks from streams.

Drainage design specifications
Providing buffers should reduce the cost and size of stormwater detention basins needed on the site, freeing land and funds for other uses. Promote forested buffers as part of stormwater management planning and allow the pollution removal effectiveness of buffers to be credited in stormwater plans and calculations, but ensure that the size of the proposed buffer is adequate to handle the job. Criteria of state regulations such as NH RSA 483-B can be added as written after reviewing them for consistency with locally adopted language. Include sections on erosion and sedimentation control.

Innovative land use controls
The town can allow transfer of development rights from riverfront lands to other parts of town designated for more intensive development. This protects the property value of the riverfront land while keeping it on the job protecting the river.

A WORD ABOUT ARCHEOLOGICAL RESOURCES
Since stream corridors have been powerful magnets for human settlement throughout history, it is not uncommon for historic and prehistoric resources to be buried by sediment or obscured by vegetation along stream corridors. Contact the State Historic Preservation Office to identify any potential cultural resources before beginning work. If a site is uncovered unexpectedly, all activity that might adversely affect it must cease. The SHPO will determine the significance of the site and advise on how to proceed to avoid delay.

NON-REGULATORY OPTIONS FOR PROTECTING RIPARIAN BUFFERS

Encourage road agents to avoid mowing vegetation in riparian buffers where roads are close to streams. The often-too-small strip of grass, ferns, and other volunteer plants has a big job to do to keep trash, road pollutants, and sand out of the water.

Encourage the local conservation commission to educate townspeople about the value of buffers and the ways in which personal choices can have lasting effects, both good and bad, on the region's water resources. Let them know how unintentional encroachment such as dumping, understory removal, or altering drainage can reduce buffer function. Contact your county conservation district office to visit a riparian buffer demonstration site. Recognize landowners who do maintain buffers: designate "watershed friendly farms," make an annual award from the conservation district or conservation commission, and provide publicity.

Work with a local land trust to acquire development rights through purchased or donated conservation easements. The landowner continues to use and enjoy the land within the limits of the easement. An easement should include both the streambank and a buffer around it. Guidance on timber harvesting, land conversion, construction, or road building within the buffer can be written into the easement. This will run with the land forever, providing for continuity of management as owners change. A conservation easement need not require the landowner to provide public access, and it can offer significant tax advantages.

The town can also consider providing property tax incentives for landowners who set aside buffers, and can acquire especially sensitive waterfront lands for public space, perhaps using funds from the Land Use Change Tax.

EXISTING STATE & LOCAL REGULATIONS

Since riparian buffers are among the very best ways to protect both private property and the quality of rivers and streams, state and many local authorities have taken steps to protect them. In both Vermont and New Hampshire, septic systems must be set back 75' from rivers and streams, and many municipalities also have setbacks for structures. Some require vegetated buffers of a standard width, while others prescribe a range and assign a width appropriate to the site, often based on slope.

New Hampshire: The Comprehensive Shoreland Protection Act (RSA 483-B) protects existing natural woodland buffers within 150' of the public boundary line on 4th order streams, including lower portions of the Ashuelot, Ammonoosuc, Cold, Gale, Israel, Mascoma, Mohawk, Sugar, Little Sugar, and Upper Ammonoosuc Rivers, and the lower parts of Mink, Partridge, and Stocker Brooks. On these waterways, not more than 50% of the basal area of trees and a maximum of 50% of the total number of saplings can be removed in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs, and ground covers and their living, undamaged root systems must be left in place. RSA 483-B does not protect smaller streams. While the Connecticut River mainstem was also exempt from this law at the time of printing, its provisions may apply in the future.

While forestry is exempt from RSA 483-B, the Basal Area Law (RSA 227-J:9) requires that within 150' of 4th order streams and great ponds, 50% of the pre-harvest basal area must be maintained, and that 50% of the preharvest basal area must be maintained within 50' of all perennial streams, rivers, and brooks.

Vermont: *There is no shoreland protection law in Vermont as of this writing.* The Agency of Natural Resources has adopted a Buffer Procedure pursuant to 3 V.S.A. § 835 which is not a rule or regulation, but may be used as guidance in conditioning permits. *The Manual of Acceptable Management Practices* for forestry specifies that except for stream crossings, a protective strip shall be left along streams in which only light thinning or selection harvesting can occur, so that breaks made in the canopy are minimal and a continuous cover is maintained. Log transport machinery must remain outside a 25' margin along the stream. Including this 25' margin, the width of the protective strip shall be 50' for land sloping 1-10%, adding another 20' for each additional 10% increase in grade.

FURTHER READING

The Connecticut River Corridor Management Plan, Connecticut River Joint Commissions, 1997. Copies of this plan were provided to each member of the board of selectmen, planning board/commission, and conservation commission of the 53 NH & VT riverfront towns, and to each town's library, school, and historical society. It is also available on the Web (www.crjc.org).

Buffers for Wetlands and Surface Waters: A Guidebook for NH Municipalities, Chase, Deming, & Latawiec. Audubon Society of NH, NH Office of State Planning, NRCS, UNH Cooperative Extension, 1997

A Guide to Developing and Re-Developing Shoreland Property in New Hampshire, North Country Resource Conservation & Development Area, 1999.

Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in NH. NH Department of Environmental Services, 1992.

Growing Greener — Putting Conservation into Local Plans and Ordinances, Randall Arendt. Island Press, Washington DC, 1999.

Dealing with Change in the Connecticut River Valley: A Design Manual for Conservation and Development, Center for Rural Massachusetts. Lincoln Institute of Land Policy & the Environmental Law Foundation, 1988.

Natural Resources: An Inventory Guide for New Hampshire Communities, Upper Valley Land Trust & UNH Cooperative Extension Service, 1992.

Watershed Guide to Cleaner Rivers, Lakes & Streams, Brian Kent. Connecticut River Joint Commissions, 1995

Wildlife illustrations by New Hampshire naturalist David M. Carroll

Fact sheets in the series *Riparian Buffers for the Connecticut River Watershed*

No. 1 Introduction to Riparian Buffers
No. 2 Backyard Buffers
No. 3 Forestland Buffers
No. 4 Buffers for Habitat
No. 5 Buffers for Agricultural Land
No. 6 Urban Buffers
No. 7 Guidance for Communities
No. 8 Planting Riparian Buffers (& plant list)
No. 9 Field Assessment
No. 10 Sources of Assistance

See also the companion series for land owners:
The Challenge of Erosion in the Connecticut River Valley, Connecticut River Joint Commissions, 1998.

Part of the ***Living with the River*** series. May be reprinted without permission.
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