Watershed Delineation & Runoff Calculations

Two streams were evaluated on the property, one perennial and one intermittent. The road crossings at the southern end of the property were identified as outlet points for the streams and used for delineating each stream's watershed, calculating watershed area, and determining run-off volume for the 2-year and 50-year 24-hour storm events. Watershed area for each stream was delineated using USGS topographic maps and digital elevation models acquired from NH Granit (NH's Statewide GIS Clearinghouse, www.granit.unh.edu). The Soil Conservation Service's TR-55 method[1] was then utilized to determine runoff volumes in each watershed for the 2-year and 50-year 24-hour storm events (tables 1 and 2).

Table 1: Stream 1, Watershed Area = 80 Acres

	Land Use	Hydrologic Condition	Soil Hydro Group	CN	Rainfall	Runoff (in)	Runoff (feet)	Area (Acres)	Runoff (Acre-Ft)	Runoff (Gallons)
2-yr 24-hr storm event	Forest	Good	C	70	2.8"	0.6	.05	80	**4.0**	**1,316,501**
50-yr 24-hr storm event	Forest	Good	C	70	5.6"	2.5	.21	80	**16.6**	**5,412,387**

Table 2: Stream 2, Watershed Area = 33 Acres

	Land Use	Hydrologic Condition	Soil Hydro Group	CN	Rainfall	Runoff (in)	Runoff (feet)	Area (Acres)	Runoff (Acre-Ft)	Runoff (Gallons)
2-yr 24-hr storm event	Forest	Good	C	70	2.8"	0.6	.05	33	**1.7**	**543,057**
50-yr 24-hr storm event	Forest	Good	C	70	5.6"	2.5	.21	33	**6.9**	**2,232,610**

[1] National Soil Conservation Service. (1986) Technical Release 55. Second Ed. United States Department of Agriculture 210-VI-TR-55.

Stream Classification Methodology

For the purposes of determining Rosgen Tier II Stream Classification, two cross-sections were surveyed on each stream, with one located above and one below each road crossing. The cross-section surveys were conducted by Jennifer Holton and her field assistant on May 12, 2009, using surveyor's level and rod and 165' Keson measuring tape. Survey points collected include the following: top of bank, change in soils or vegetation type, breaks in slope, channel bottom, changes in streambed slope, left and right edge of water, bankfull indicators, and the intersect of 2-times maximum depth at bankfull elevation. Bankfull indicators at each cross-section are noted within the labels of the associated photographs (included separately), and flow stage, bankfull stage, and flood prone stage are labeled on each cross-section profile.

Pebble counts and channel slope measurements were also conducted at each cross-section. Stream morphology variables (table 3), as calculated from the cross-section measurements, were then used to determine stream types based on the Rosgen Stream Classification system[2] (key attached). The variables necessary to determine stream classification are explained below:

- Entrenchment Ratio: this value, which is computed by dividing the flood-prone area width by the bankfull width, describes the degree of vertical containment of the stream's channel.
- Width/Depth Ratio: This is a measurement that describes the shape of the channel in respect to its width and average depth. This ratio is computed by dividing the bankfull width by the bankfull mean depth.
- Sinuosity: As measured on a map, the sinuosity is determined by dividing the stream length by the valley length or the valley slope by the channel slope. As these were very small, 1st order streams, one of which is intermittent and does not appear on the USGS topographic map, the sinuosity was visually estimated in the field, but not calculated in the office.
- Slope: Channel slope was measured in the field over a distance of 20-times bankfull width using a clinometer. Since clinometers tend to over-estimate channel slope on lower gradient reaches, measurements were verified in the office using USGS topographic maps. The streams surveyed for this study are higher gradient, 1st order streams, and as such, the clinometer readings were found to be accurate when compared with map measurement.
- Channel Materials: Channel materials were determined using a channel material size distribution analysis (pebble count). Typically the minimum sample size for a pebble count should be 100; however, since these are very small, 1st order streams, we deemed it unnecessary to go to such lengths. Our pebble counts were based on 20 "first blind touch" samples, and the D50 index (50 percent of the sampled population is equal to or finer than the representative particle diameter) was used.

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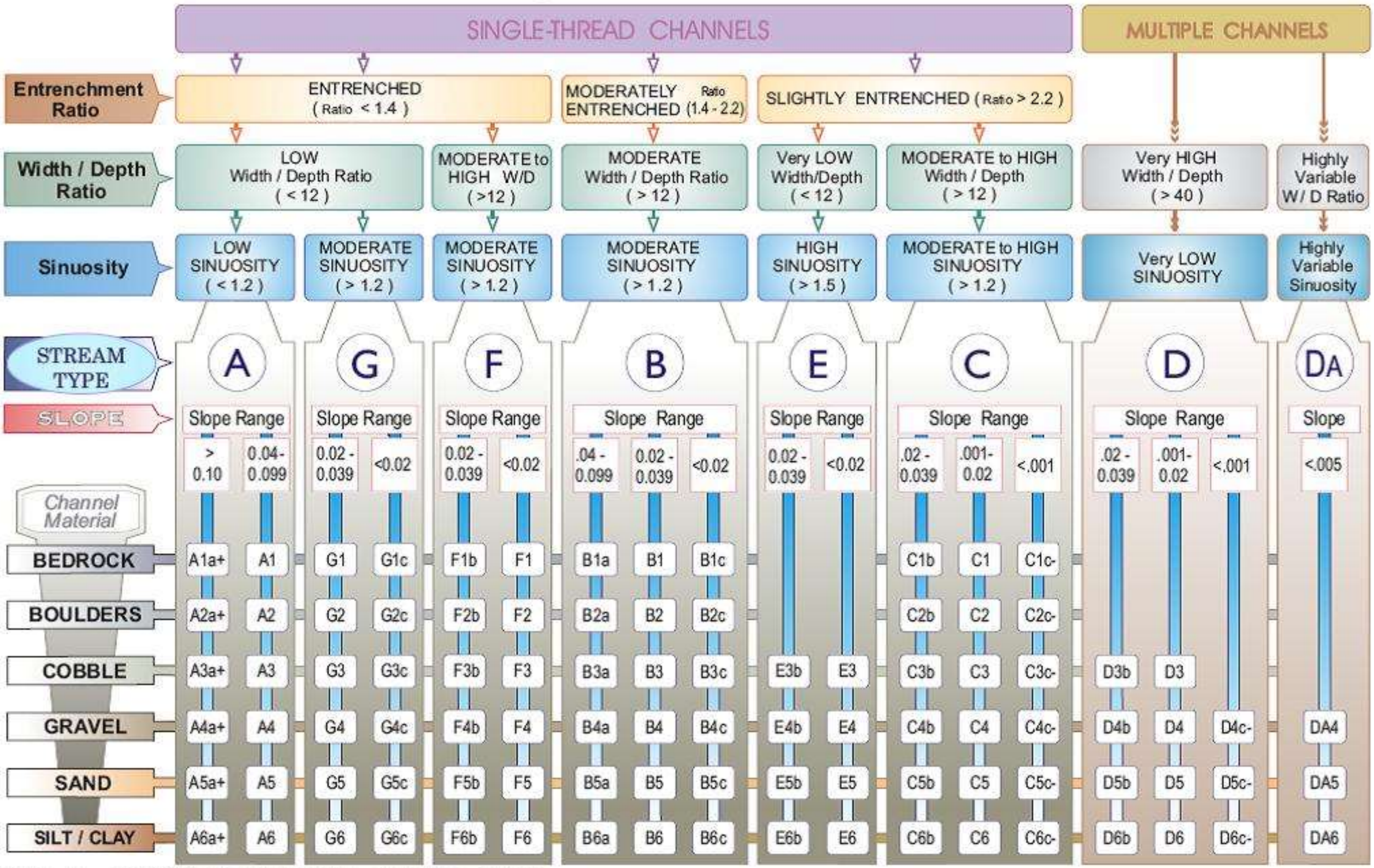
[2] Rosgen, D.L. 1994. *A Classification of Natural Rivers,* Catena, Vol 22, 169-199, Elsevier Science, B.C. Amsterdam.

Table 3: Stream Morphology Variables

Cross-Section	Bankfull Width (ft)	Width/Depth Ratio	Entrenchment Ratio	Channel Material	Slope[3] (%)	Stream Type
Stream 1, Above Crossing	7.8	15.6	1.8	Gravel	9	B4a
Stream 1, Below Crossing	7.3	14.6	5.2	Gravel	7	C4
Stream 2, Above Crossing	6.7	18.1	3.1	Gravel	8	C4
Stream 2, Below Crossing	1.1	3.7	10.3	Sand	9	E5

[3] Note that all cross-sections except for the first in this table have slopes outside of the typical range for that stream type. Generally C and E stream types are low gradient streams with a slope of less than 2 percent.

The Key to the Rosgen Classification of Natural Rivers



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.