

WELLS CREEK WATERSHED PARTNERSHIP ROSGEN STREAM CLASSIFICATION ANALYSIS

Scot Johnson
DNR Waters
Mississippi River Hydrologist

November 15, 1999

INTRODUCTION

The Rosgen Stream Classification System uses channel dimensions and other physical characteristics to categorize stream reaches (Rosgen, 1996). Once categorized, the classification system can provide insight into the stability of the stream reach and assist with the design of stream restoration or remediation projects. The Rosgen system has not been used extensively in Minnesota but is being examined by a number of state agencies for its applicability in this part of the United States. River scientists in Minnesota are developing regional curves from the Rosgen measurements (Thompson and Hanson, 1999). The recent Whitewater River Restoration Project in southeast Minnesota used Rosgen measurements, in part, to design the channel dimensions and sinuosity necessary to restore 3 miles of trout stream.

METHODS

Rosgen stream classification parameters were measured for Wells Creek and four major tributaries at 17 locations. Department of Natural Resources - Bureau of Engineering total station surveys and other field data were collected during the 1997 field season. At each of the 17 locations, transects were surveyed across the entire floodplain. Measurements included stream channel dimensions and bank full elevations. Stream channel measurements were compiled for all reaches (attachment 1). The transect locations and their associated Rosgen stream classifications were mapped (attachment 2). In addition, a table was compiled to better interpret the stream classifications in light of the physical setting and nearby landuse (attachment 3). A typical channel cross-section was constructed to illustrate Rosgen channel measurements (appendix 4).

FINDINGS

A total of six different stream classifications were identified in the analysis. By far, the most prevalent stream classification category on both main stem and tributary reaches was B5c (9 out of 17 locations). C5 classifications were found along 3 reaches with, E5 classifications at 2 reaches and individual C5c, F5 and G5c classifications rounding out the rest of the sites. Stream classification characteristics were summarized graphically (Rosgen, 1996) (appendix 5).

Wells Creek Mainstem Classifications

The mainstem of Wells Creek is generally a B5c stream. Transects 3, 5, 6, 9, and 10 are all classified as B5c stream reaches. "B" streams are generally found on stable, well vegetated soils and tend to be stable streams when riparian vegetation is present. B5 streams are characterized by moderate entrenchment, width/depth ratio and sinuosity. B5c streams have a slightly gentler gradient than B5 streams (Rosgen, 1996). B type streams are capable of providing good fisheries habitat if riparian vegetation and large woody debris are present (Thompson and Hanson, 1999).

C5, F5 and C5c classifications were also present along the mainstem. These transect classifications may be highly influenced by their physical setting and nearby land use as described below:

Site 1

The Site 1 stream reach was best classified as a C5 stream reach. Type C streams are considered slightly entrenched, with moderate to high width/depth ratios, and high sinuosity values. These streams have varying sediment supply loads from very low, to high in river systems which are eroding their banks, or in systems with little riparian vegetation. Some C streams tend to shift laterally and vertically as the instability of the contributing watershed causes changes in flow or the amount of sediment entering the system.

The Site 1 stream reach is located within the Wells Creek delta just off the Sand Pont Trail within Frontenac State Park. The Wells Creek delta formed within Lake Pepin; a unique, natural lake within the Mississippi River. While Lake Pepin was formed naturally when the Chippewa River delta blocked and backed up Mississippi River water, Lock and Dam 4 of the 9-Foot Channel Project has raised water levels in the lake thereby raising Wells Creek's base level.

Wells Creek has been observed to shift channels quite often in this area. Stream migration occurs when sand size bed sediments slowly fill the active channel until it is higher than the surrounding land and a new lower distributary channel captures the flow and sends it off in a new direction. Sinuosity is low for this "C" stream reach. This mainstem stream reach is less stable than the B5 stream reaches upstream.

Site 2

The Site 2 stream reach was classified as a F5 stream. "F" streams are considered to be highly entrenched, with moderate to high width/depth ratios, and moderate sinuosities. These streams have a high sediment load with highly erodible banks because they are nearly vertical. This an area of transition as Wells Creek cuts through the Pleistocene river terraces on its way to the Mississippi River. The creek is actively working a 50 foot high sand and gravel terrace which overloads the stream with sediments. Abandoned channels and other evidence points to this area as one that was highly disturbed in the past by large floods that conveyed heavy bed loads. This area appears to be on the mend but with the continued sediment load from the river terrace may require a long time for recovery from an "F" to a "B" stream.

Site 4

The Site 3 stream reach is a C5 site along a high bank. Downstream of the transect the bank is very steep and actively eroding. There is evidence that the transect location was once heavily grazed. The large amount of woody debris in the stream suggests stream instability in the past. Current land use includes light grazing and recreational activity. The area appears to be stable now, is very well vegetated and the abundant woody debris provides good fish cover and structure.

Site 8

The Site 8 stream reach is classified as a "C5c" stream reach. C5c reaches have a lower gradient than C5 streams (Rosgen, 1996). This stream reach was partially moved and reconstructed to accommodate the rebuilding of County Highway 2 and has a very gently gradient. No longer pastured, vegetation along this reach is now lush. Recent bioengineering efforts using tree revetments and willow stakes have stabilized the outside meander bends that were eroding. This stream reach may eventually recover to a B5c classification.

Tributary Classifications

Clear Creek (B1 -B2)

In its upper reach, Clear Creek is an E5 stream while the lower reach is classified B5c. Type E streams are slightly entrenched, with very low width/depth ratios, and very high sinuosities which result in the highest meander width ratio values of all stream types. E stream types are considered to be highly stable streams, provided the floodplain and low width/depth ratios are maintained. The E streams can be very sensitive to disturbance (Thompson and Hanson, 1999). It is theorized that the type B lower reach of Clear Creek, with its greater entrenchment, higher width/depth ratios and less sinuosity has transitioned into a morphology more like the mainstem channel.

Unnamed Tributary near the intersection of Highway 2 and Highway 5 (D1 - D2)

Like Clear Creek, this tributary is a type E5 in the upstream reach while it is classified as a B5c in its lower reach. Sandwiched in between the two measured reaches is a channelized and leveed reach. This tributary had a much larger drainage area many years ago until Hay Creek pirated away part of the watershed. It is suspected that additional Rosgen classification types would be found along other reaches of this tributary if measurements were completed.

Rock Creek (A1 - A2)

Like the Wells Creek mainstem, Rock Creek transects A1 and A2 represent type B5c stream reaches. Type B5c streams are relatively stable streams when riparian vegetation is present. It is speculated that the B5c upper reach classification may represent slightly degraded channel conditions with its greater entrenchment, larger width/depth ratios and lower sinuosity compared to the E5 classifications found in the upper reaches of Clear Creek and Unnamed Creek near Hwy 2 and 5. Highway 45 comes very close to the creek in this narrow valley which may have contributed to the possible degradation in stream quality.

Unnamed Tributary near Highway 3 (C1 -C2)

This tributary was best classified as C5 in the upper reach, G5c in the lower reach and has a very gentle gradient. G type streams are highly entrenched, exhibit moderate sinuosity and low width/depth ratios. G5 streams are generally in a degradation mode derived from near continuous channel adjustments due to excessive bank erosion. G5c have less gradient than other G type reaches. The lower gradient G5c reaches are generally observed developing within a previously meandering, low gradient system with floodplains such a C5 situated in a wide valley. These streams are very sensitive to disturbance and tend to make significant adverse channel adjustments to changes in flow regime and sediment supply from the watershed (Rosgen, 1996). Field observations, such as the large deposits of loose, flocculent silts within the channel suggest that the lower end of this tributary is the most degraded of all tributary reaches classified.

WELLS CREEK DATA APPLIED TO SE MINNESOTA REGIONAL CURVES

Wells Creek mainstem and tributary data points were plotted on three Southeast Minnesota regional curves (attachment 6, 7, and 8). A table comparing values from Wells Creek to other regional streams was compiled (Hanson, unpublished)(attachment 9). Drainage area was used as the independent variable on the x-axis and plotted against bankfull depth, cross-sectional area and bankfull width on the y-axes. Wells Creek data points plotted in good agreement with the best fit regression line for each graph. Two C5 streams plotted consistently on the low side of the best fit regression line.

OBSERVATIONS

Overall, sinuosity values and slopes were on the very low end of the classification ranges (out of range at 3 locations for sinuosity). Bank full was difficult to determine in the field and some sensitivity analysis should be completed to see how this affects classification. There may be future opportunities to apply Rosgen measurements to the restoration of two mainstem locations experiencing excessive sediment loading from high, actively eroding banks. The first location is at Site 2 where a Pleistocene river terrace is being worked by the stream. The second location is on or near State Forest Land just downstream of Site 4 where the stream is eroding into a glacial outwash deposit. Based on Rosgen classifications, the unnamed tributary near Highway 3 is degraded and may warrant additional watershed management efforts.

REFERENCES

Hanson, C., 1999, unpublished graphs and tables.

Rosgen, D.L., 1996, Applied River Morphology, Wildland Hydrology Consultants, Pagosa Springs, CO.

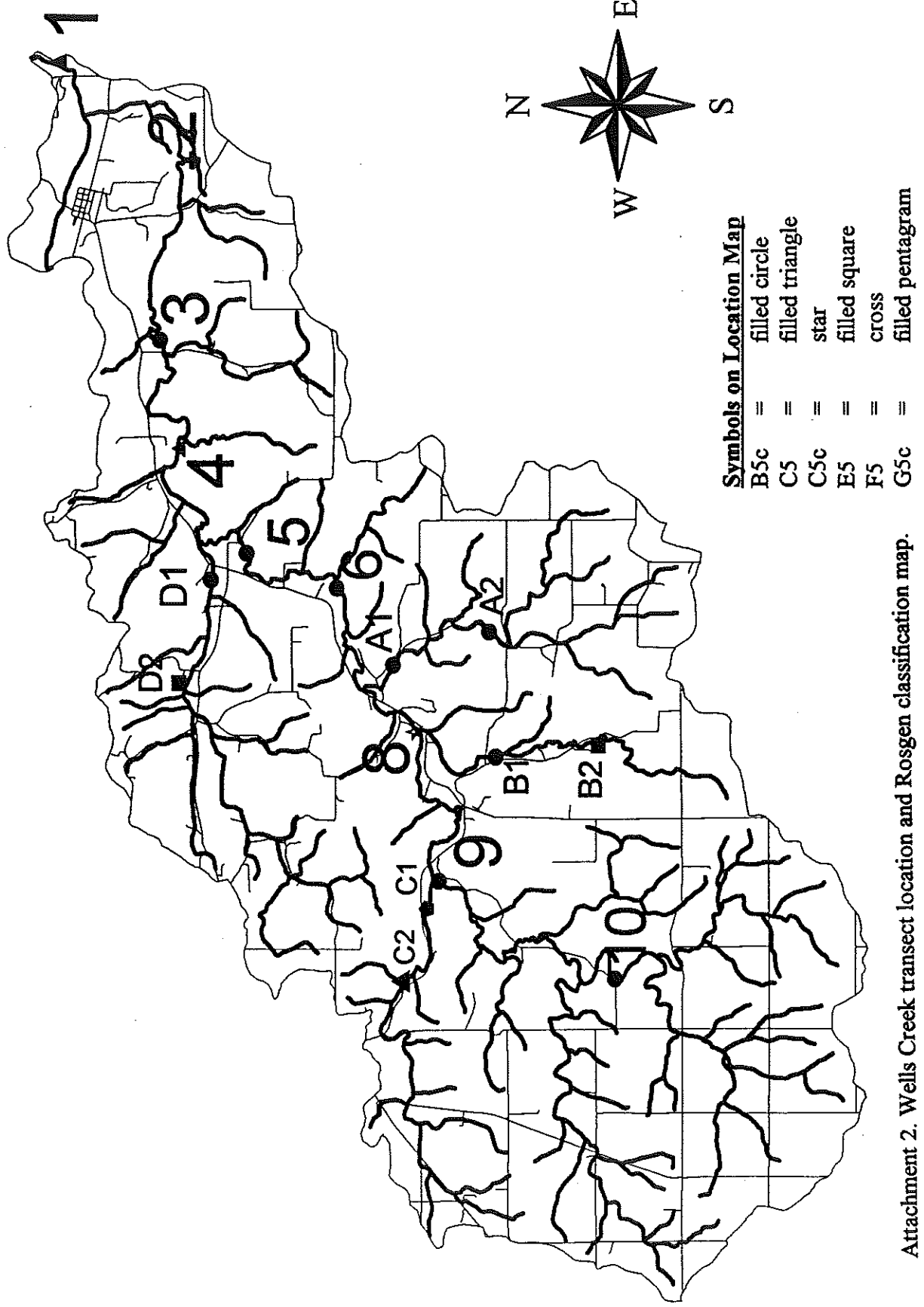
Thompson, W. and C. Hanson, 1999, MNDNR Region 5 - Southeast Minnesota Evaluation of Geomorphology Based on Stream Classification System - 1998, 9 pages.

Wells Creek Rosgen Classification Analysis January 1999

SITE	X-SEC	BANK FULL WIDTH	X-SEC AREA	MEAN DEPTH	W/D RATIO	MAX DEPTH	2X MAX DEPTH	FLOODPRONE AREA WIDTH	ENTR RATIO	REACH LENGTH	WL ELEV. DIFF	SLOPE	SINUOSITY	ROSGEN CLASSIFICATION
1	E	17	24.5	1.4	11.8	2.34	4.64	220+	12.9+	830	3.29	0.004	1.1	C5 (sinuosity too low)
2	D	29	37.8	1.3	22.3	1.88	3.76	34.0	1.2	1382	1.97	0.001	1.4	F5
3	B	25	54.7	2.2	11.4	2.52	5.04	44.0	1.8	690	2.01	0.003	1.1	B5c
4	D	16	22.5	1.4	11.4	2.14	4.28	60.0	3.8	798	2.11	0.003	1.4	C5
5	C	29	63.4	2.2	13.2	2.58	5.16	46.0	1.6	941	0.25	0.000	1.3	B5c
6	D	30	54.7	1.8	16.6	2.52	5.04	44.0	1.5	683	2.05	0.003	1.1	B5c
8	B	23	43.1	1.9	12.3	2.78	5.56	68.5	3.0	1193	1	<0.001	1.2	C5c
9	D	32	53	1.8	18.8	2.18	4.36	49.0	1.5	2001	4.93	0.002	1.5	B5c
10	B	30	57.8	1.9	15.5	2.85	5.7	65.0	2.2	1259	4.97	0.004	1.4	B5c
A1	A	18	16	0.9	20.2	1.58	3.16	32.0	1.8	969	4.97	0.005	1.0	B5c
A2	A	15	8.8	0.6	25.4	1.12	2.24	24.0	1.6	975	4.97	0.005	1.0	B5c
B1	C	26	57.2	2.2	11.8	2.9	5.8	45.0	1.7	693	2.01	0.003	1.1	B5c
B2	C	14	13.4	1.0	13.6	1.92	3.84	65.5	4.9	753	5.38	0.007	1.5	E5
C1	D	6	9.1	1.5	4	1.77	3.54	9.0	1.5	442	2.94	0.007	1.1	G5c
C2	D	15	19.6	1.3	11.5	2.53	5.06	48.0	3.2	595	5.79	0.010	1.1	C5 (sinuosity too low)
D1	C	21	9.8	0.5	44.6	97	1.94	44.0	2.1	949	3.61	0.004	1.0	B5c
D2	B	19	36.8	1.9	9.8	2.7	5.4	63.0	3.3	787	3.61	0.005	1.0	E5 (sinuosity too low)

Attachment 1. Wells Creek Rosgen Stream Classification measurements.

Wells Creek Transect Locations



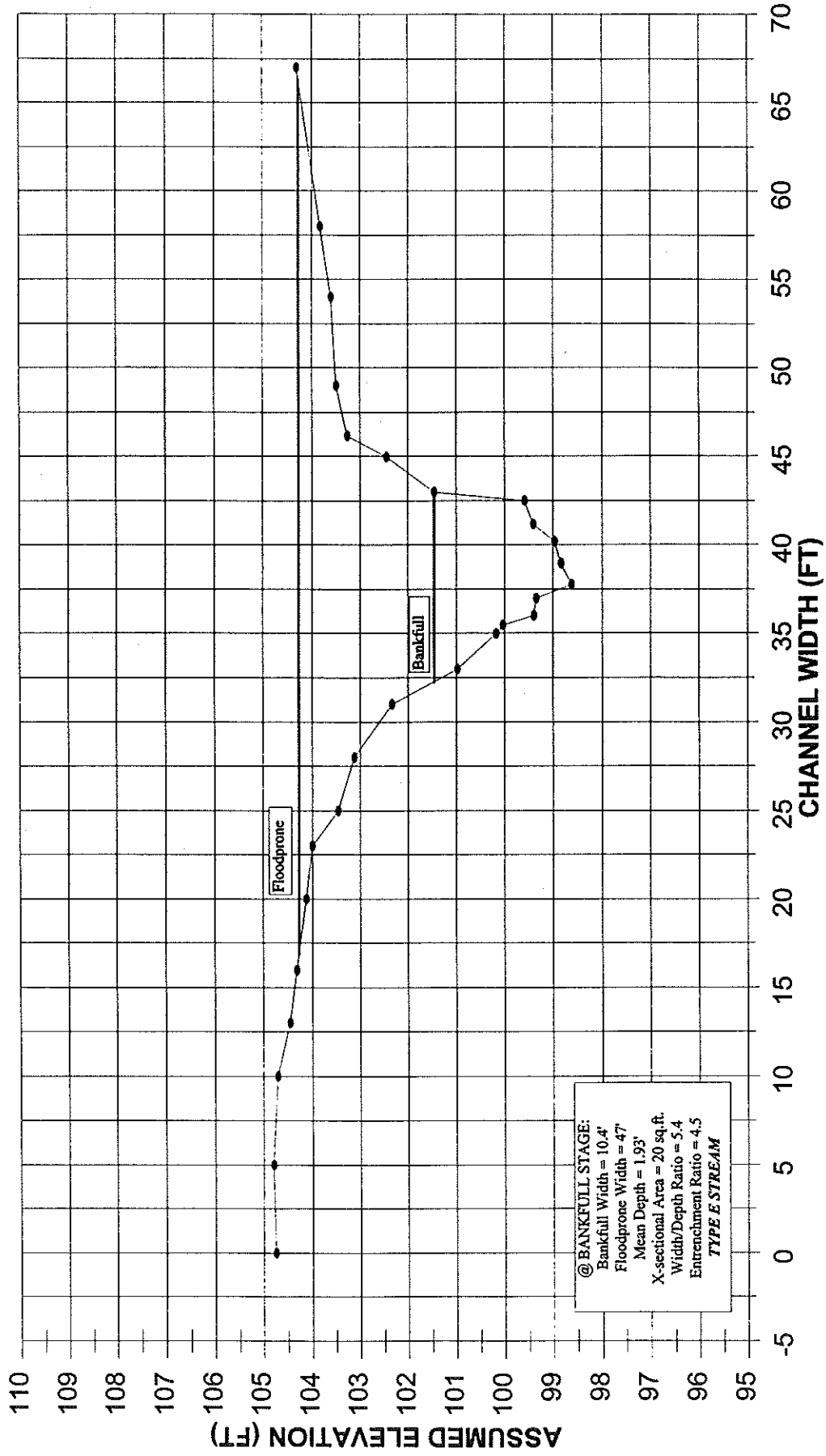
Attachment 2. Wells Creek transect location and Rosgen classification map.

Wells Creek Watershed Partnership
Rosgen Classification and Landuse

Site Number	Rosgen Classification	Stream	Land Cover Description Spring 1997
1	C5	Wells Creek	Floodplain Forest on Wells Creek Delta
2	F5	Wells Creek	Pasture on Pleistocene River Terrace
3	B5c	Wells Creek	Pasture
4	C5	Wells Creek	Pasture near high bank
5	B5c	Wells Creek	Hay Field
6	B5c	Wells Creek	Pasture
8	C5c	Wells Creek	Pasture (moved for Highway)
9	B5c	Wells Creek	Row Crops
10	B5c	Wells Creek	Pasture
A1	B5c	Rock Creek	Pasture
A2	B5c	Rock Creek	Pasture
B1	B5c	Clear Creek	Row Crop
B2	E5	Clear Creek	Pasture
C1	G5c	Unnamed (Hwy 3)	Row Crop
C2	C5	Unnamed (Hwy 3)	Row Crop
D1	B5c	Unnamed (2&5)	Pastured Corridor within Row Crop
D2	E5	Unnamed (2&5)	Row Crop

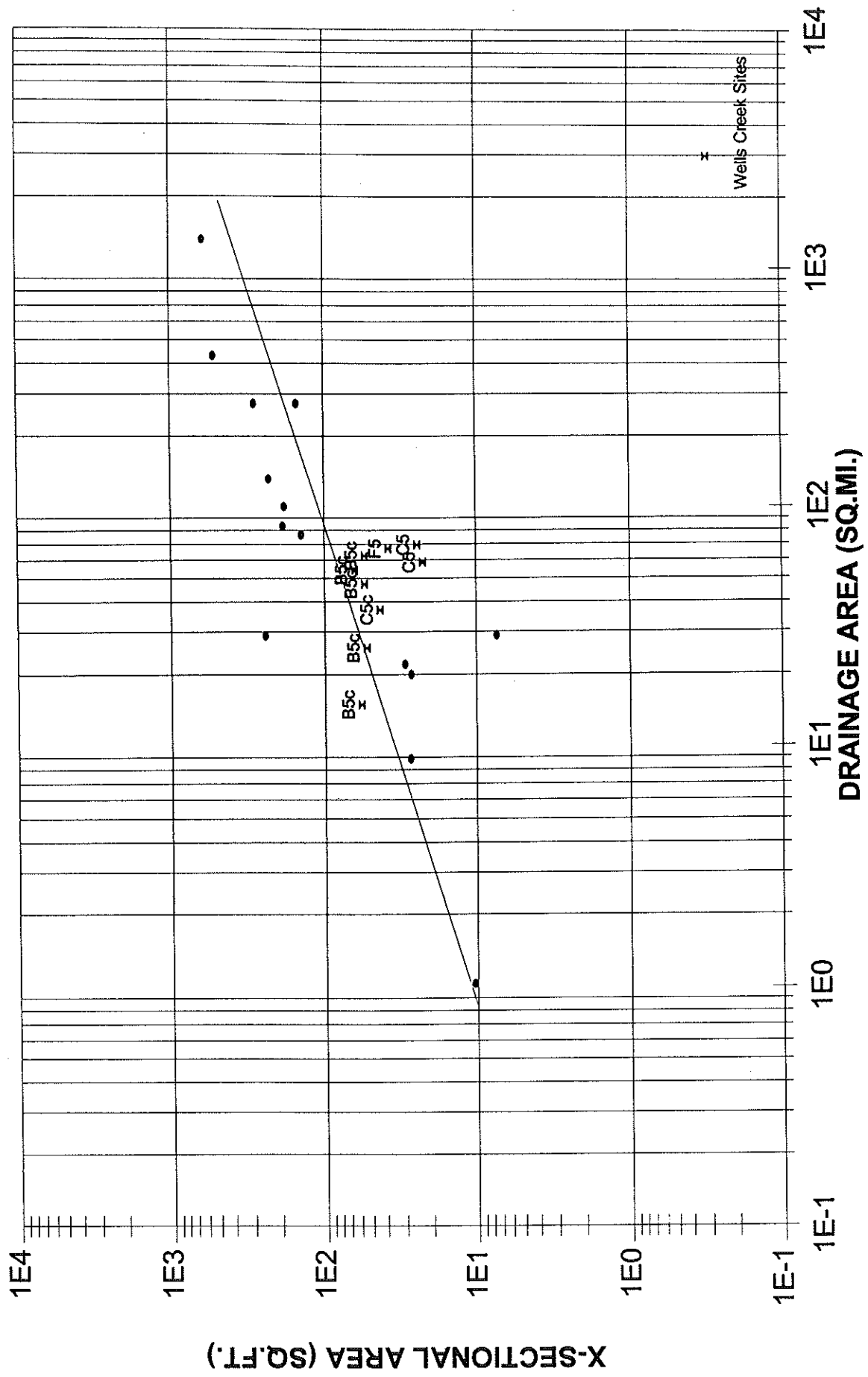
Attachment 3. Wells Creek transect classification and landuse table.

TYPICAL ROSGEN CLASSIFICATION
CHANNEL X-SECTION



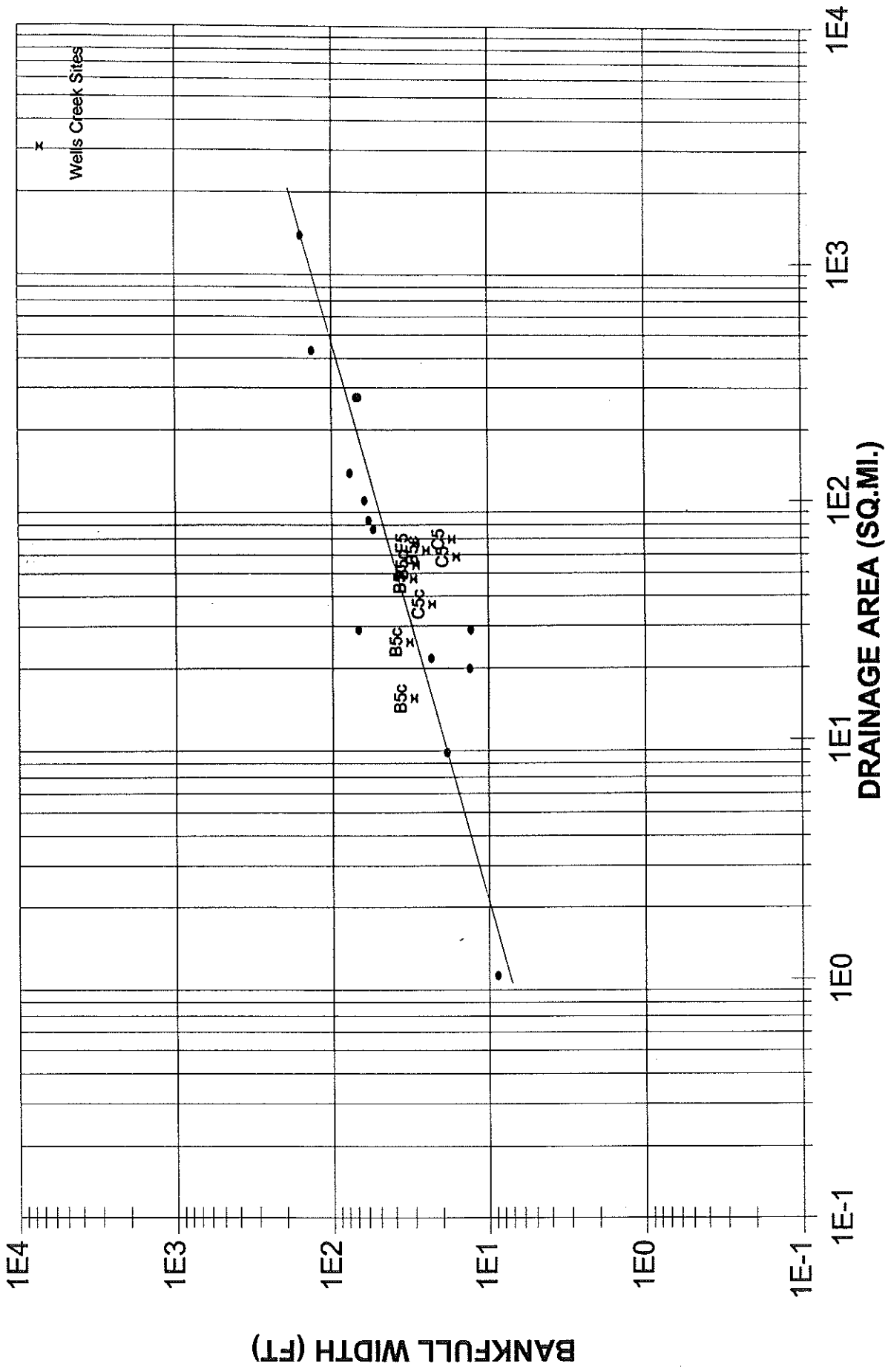
Attachment 4. Typical stream channel and floodplain cross-section with Rosgen measurements.

**DRAINAGE AREA VS.
X-SECTIONAL AREA**



Attachment 6. Southeast Minnesota Streams - Cross-Sectional Area/Drainage Area Regional Curve with Wells Creek sites identified.

DRAINAGE AREA VS. BANKFULL WIDTH



Attachment 7. Southeast Minnesota Streams - Bankfull Width/Drainage Area Regional Curve

S.E. MINNESOTA REGIONAL CURVE VALUES:

STREAM	USGS #	DRAINAGE AREA	B.F. X-SEC.	B.F. WIDTH	B.F. MEAN DEPTH	Stream Type
Gilmore Creek	5379000	8.95	27.4	18.5	1.5	C
S.Fork Whitewater	5385500	76.8	141.2	54.5	2.6	B
N.Fork Whitewater	5376000	101	182.9	61.8	3.0	B
S.Fork Root River	5376500	275	150.5	67.5	2.2	F
Cannon River	5355200	1320	601.3	156.6	3.8	F
Straight River	5353800	435	515.9	134.0	3.9	C
Rush Creek	5384500	132	230.2	77.0	3.0	B
Whitewater Beaver	5376800	276	284.2	70.0	4.1	C
Cascade Creek	ungaged	20.12	26.9	13.2	2.0	E
Milliken Creek	ungaged	22.1	29.7	23.4	1.3	C
Rocky Creek	ungaged	1.04	10.6	8.8	1.2	E
Garvin Brook	ungaged	29.2	7.4	13.0	0.6	B
Garvin #2	ungaged	29.2	243.1	68.3	3.6	B
S.Fork Zumbro	ungaged	84	186.0	58.3	3.2	C
Wells Creek - #10	ungaged	15	57.8	30.0	1.9	B5c
Wells Creek - #9	ungaged	25.8	53.0	32.0	1.8	B5c
Wells Creek - #8	ungaged	37.2	43.1	23.0	1.9	C5c
Wells Creek - #6	ungaged	47.6	54.7	30.0	1.8	B5c
Wells Creek - #5	ungaged	54.4	63.4	29.0	2.2	B5c
Wells Creek - #4	ungaged	58.9	22.5	16.0	1.4	C5
Wells Creek - #3	ungaged	63	54.7	25.0	2.2	B5c
Wells Creek - #2	ungaged	67.3	37.8	29.0	1.3	F5
Wells Creek - #1	ungaged	70	24.5	17.0	1.4	C5

Attachment 9. Southeast Minnesota Streams - Regional Curve values.

