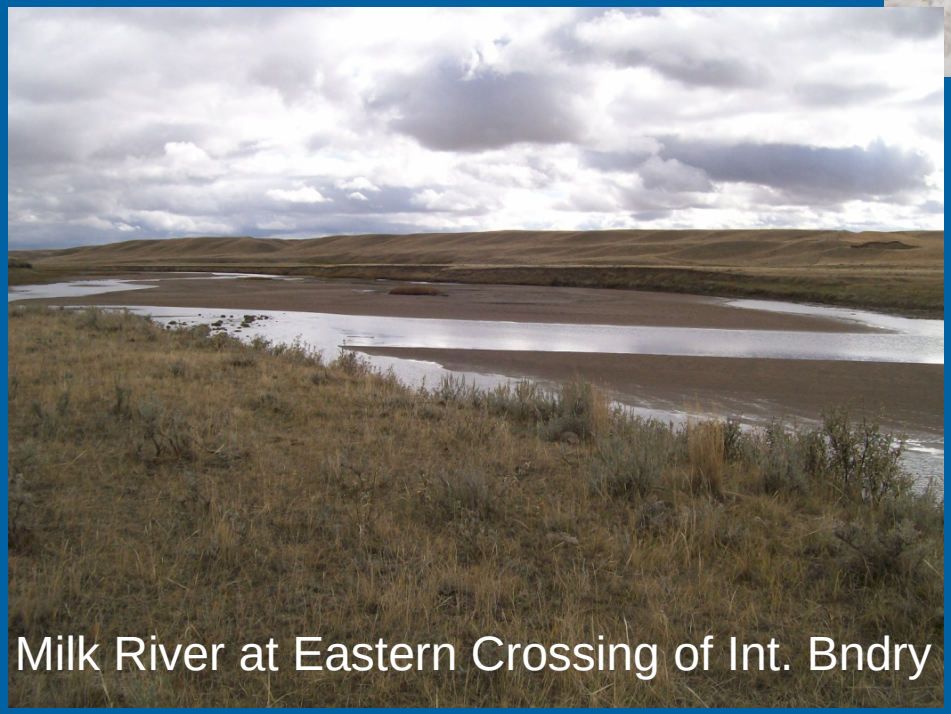
StreamStats-

Approaches for Estimating Basin and Streamflow Characteristics for Montana

Swiftcurrent Creek at Many Glacier, MT-2006


Milk River at Eastern Crossing of Int. Bndry

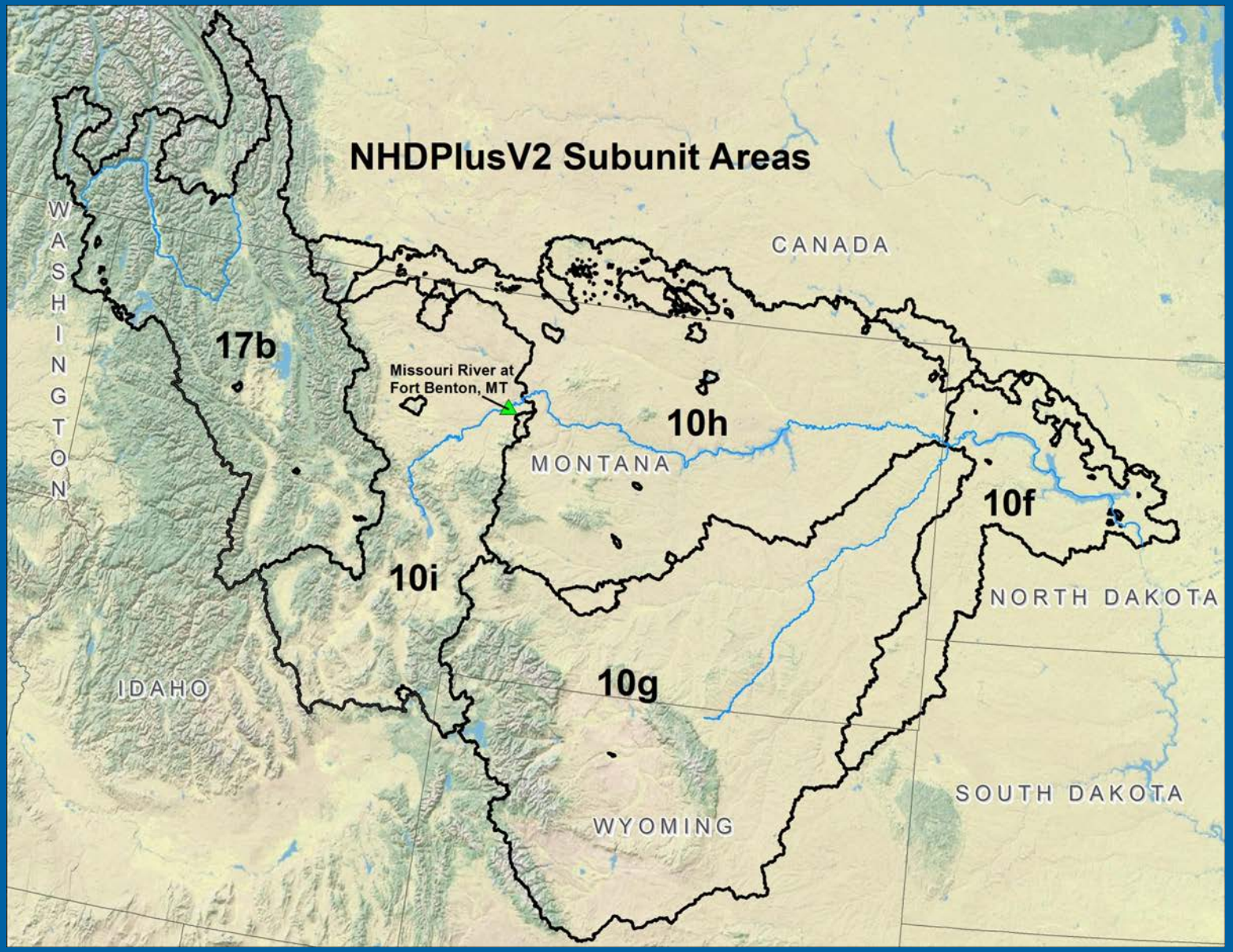
In cooperation with
Montana Department of Natural Resources and Conservation, Montana Department of Transportation, and Montana Department of Environmental Quality

StreamStats - Web Application

- Nationally standardized web tool developed by USGS Office of Surface Water
- For *gaged* sites: provides published streamflow statistics and basin characteristics
- For *ungaged* sites: solves previously published regression equations to estimate streamflow statistics using basin characteristic data
- User access via an interactive map

USGS

StreamStats Coverage for MT



What are Streamflow Characteristics and why are they important?

- Ways to summarize streamflow data
  - Basic summary statistics
    - Range (e.g. max, min)
    - Mean (e.g. daily, monthly)
  - Flow-duration analyses (e.g. exceedance flows)
  - Frequency analyses (e.g. 100-year flood)
- Intended use determines type of analyses and data period

100-year flood

30Q2

90% exceedance flow

7Q10

mean monthly flow

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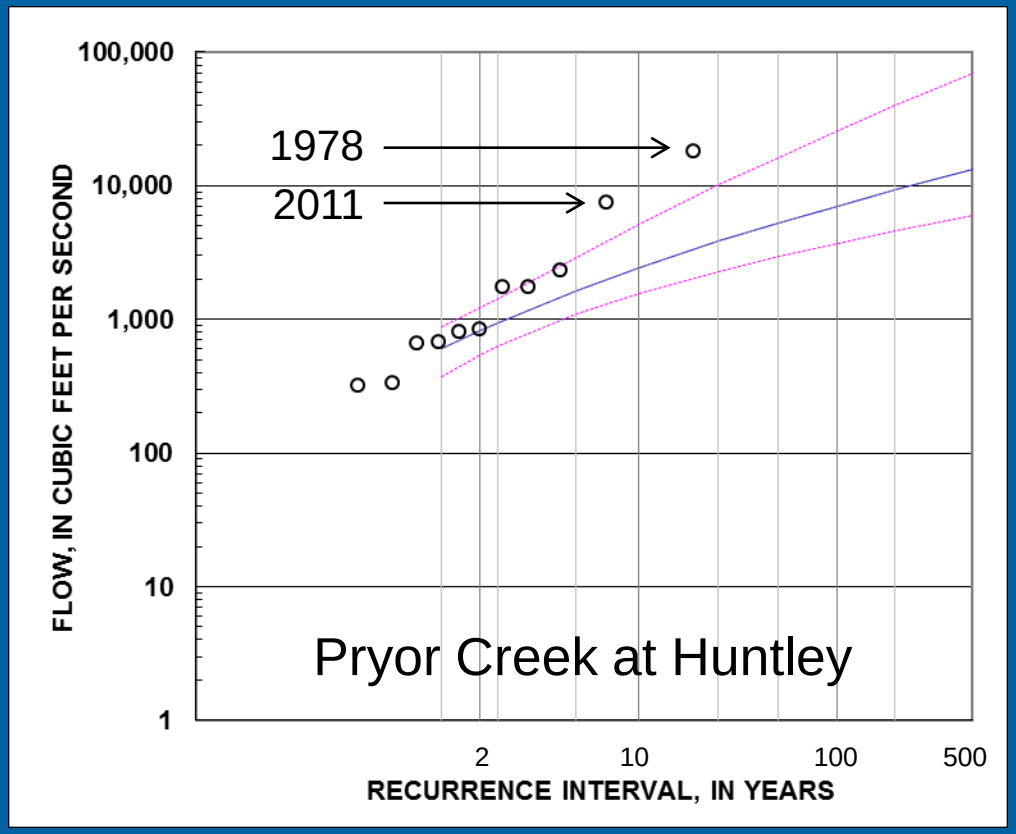
Steps for developing StreamStats

1. Compute streamflow characteristics for discontinued and active gages in Montana and surrounding areas.

- Compute flood frequencies
- Compute low flow and median flow characteristics



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Low Flow Statistics

05014500 Swiftcurrent Creek at Many Glacier
[Alternative text]
Site number [XX]
Period of record 1912–2009

[UCI, upper 95-percent confidence interval; LCI, lower 95-percent confidence interval; ft³/s, cubic feet per second; %, percent; --, length of record is not sufficient to estimate values for given recurrence interval]

Period of consecutive days	Flow and 95-percent confidence intervals (UCI, LCI), in ft³/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent											
	2		5		10		20		50		100	
	50%		20%		10%		5%		2%		1%	
	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI
Magnitude of annual low flow based on 53 years of record												
1	12	13 11	8.6	9.3 7.7	7.0	7.8 6.2	5.8	6.5 5.0	3.3	4.0 2.6	0.00	0.00 .00
3	12	13 12	9.1	9.9 8.3	7.5	8.3 6.6	6.2	7.0 5.3	3.6	4.3 2.8	.00	.00 .00
7	13	13 12	9.7	11 8.8	8.1	8.9 7.1	6.8	7.6 5.8	3.5	4.4 2.6	4.8	3.6 3.9
14	15	16 14	11	12 9.9	9.4	10 8.3	8.2	9.1 7.1	7.0	7.9 5.9	6.3	7.2 5.3
30	16	17 14	12	13 11	10	11 8.9	8.8	9.8 7.8	7.6	8.6 6.4	6.8	7.8 5.7
60	17	19 16	13	14 12	11	12 9.7	9.6	11 8.4	8.3	9.4 7.1	7.6	8.6 6.5
90	22	23 20	16	18 14	14	15 12	13	13 10	10	12 8.5	9.2	11 7.6
120	27	30 23	19	21 17	16	18 14	14	16 12	12	14 10	11	13 9.0
183	35	39 31	24	27 21	20	23 17	18	21 15	16	18 13	14	17 11
365	50	55 46	37	41 33	32	35 28	28	31 24	24	28 21	22	26 19
Magnitude of seasonal low flow for March-June based on 65 seasons of record												
1	15	17 14	11	12 9.6	9.0	10 7.9	7.8	8.9 6.8	6.7	7.9 5.7	6.1	7.1 5.1
3	16	17 14	11	12 9.9	9.4	10 8.2	8.2	9.3 7.1	7.1	8.1 6.0	6.8	7.8 5.4
7	17	19 16	12	13 11	10	11 8.9	8.9	10 7.7	7.8	8.9 6.8	7.1	8.2 5.9
14	19	21 17	13	15 12	11	13 9.6	9.8	11 8.3	8.5	9.8 7.1	7.8	9.1 6.4
30	21	23 19	14	16 12	12	13 10	10	12 8.7	9.1	11 7.8	8.4	9.8 6.8
60	24	27 22	16	18 14	14	15 12	12	14 10	10	12 8.8	9.4	11 7.7
Magnitude of seasonal low flow for July-October based on 65 seasons of record												
[1] 1	35	38 33	24	26 22	20	22 18	17	18 14	14	15 12	12	14 10
[1] 3	37	40 34	25	28 23	21	23 18	18	19 15	14	16 12	13	14 11
[1] 7	40	43 37	27	30 25	22	25 20	19	21 17	15	17 13	14	15 12
[1] 14	44	47 40	30	33 27	25	27 22	21	23 18	17	19 15	15	17 13
[1] 30	47	51 43	32	35 29	26	29 24	22	25 20	19	21 16	17	19 14
[1] 60	52	57 46	36	39 33	30	33 27	25	28 22	21	24 18	19	22 16
Magnitude of seasonal low flow for November-February based on 34 seasons of record												
1	13	14 12	9.4	10 8.5	7.9	8.8 6.9	6.7	7.6 5.7	4.4	5.3 3.6	0.00	0.00 .00
3	14	15 13	10	11 9.0	8.4	9.3 7.3	7.1	8.0 6.1	4.7	5.6 3.8	.00	.00 .00
7	15	17 14	11	12 9.6	8.8	9.8 7.8	7.4	8.4 6.3	6.0	7.0 4.9	5.2	6.1 4.3
14	17	18 15	12	13 11	10	11 9.0	8.9	10 7.7	7.6	8.7 6.4	6.8	7.9 5.6
30	18	19 16	13	14 12	11	12 9.6	9.4	11 8.1	8.0	9.1 6.7	7.1	8.2 5.9
60	20	21 18	14	15 13	12	13 10	10	12 8.8	8.6	9.9 7.2	7.7	8.9 6.3

[1] Kendall's Tau trend test indicates a trend exists and the frequency curve for indicated n-day period may not fit the data.
[2] Absolute value of computed skew for indicated n-day period is greater than 3.3; therefore, the frequency curve cannot be computed.

05014500 Swiftcurrent Creek at Many Glacier
[Alternative text]
Site number XX—Continued
Period of record 1912–2009

[UCI, upper 95-percent confidence interval; LCI, lower 95-percent confidence interval; ft³/s, cubic feet per second; %, percent; --, length of record is not sufficient to estimate values for given recurrence interval]

Period of consecutive days	Flow and 95-percent confidence intervals (UCI, LCI), in ft³/s, for indicated recurrence interval, in years, and exceedance probability, in percent											
	2		5		10		25		50		100	
	50%		20%		10%		4%		2%		1%	
	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI	Flow	UCI LCI
Magnitude of annual high flow based on 53 years of record												
1	925	1,010 844	1,320	1,460 1,200	1,680	1,930 1,510	2,310	2,770 2,010	2,910	3,630 2,440	3,480	4,700 2,610
3	856	937 779	1,110	1,230 1,050	1,330	1,490 1,220	1,670	1,930 1,500	1,960	2,320 1,720	2,250	2,780 1,870
7	726	770 685	965	974 951	1,020	1,120 922	1,170	1,300 1,080	1,280	1,430 1,140	1,390	1,590 1,250
15	625	659 592	760	814 718	841	915 769	936	1,030 849	1,000	1,120 922	1,070	1,200 977
[1] 20	592	624 562	713	763 674	782	846 734	859	942 798	911	1,010 842	959	1,070 881
[1] 30	547	575 520	650	694 616	706	761 665	765	835 716	804	884 746	838	925 777
[1] 60	400	412 391	329	361 305	374	415 344	424	477 387	457	519 405	488	559 441
[1] 90	374	391 359	403	457 414	463	494 442	496	535 470	518	561 488	537	583 504

[1] Kendall's Tau trend test indicates a trend exists and the frequency curve for indicated n-day period may not fit the data.
[2] Absolute value of computed skew for indicated n-day period is greater than 3.3; therefore, the frequency curve cannot be computed.

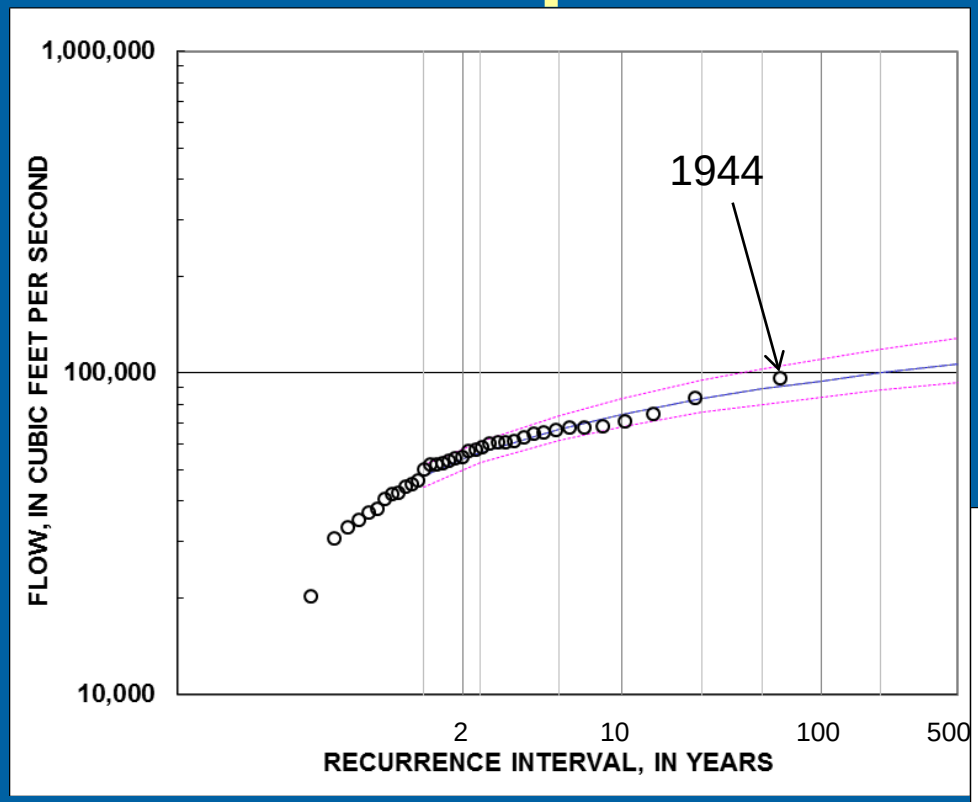
Monthly and annual mean flows

Month	Maximum of the mean flow (ft³/s)	Minimum of the mean flow (ft³/s)	Mean flow (ft³/s)	Standard deviation of mean flow (ft³/s)	Mean of the minimum mean flow (ft³/s)	Standard deviation of the mean minimum flow (ft³/s)	Years of record
October	143	20	84	34	42	20	93
November	320	13	74	38	30	16	60
December	100	14	37	20	22	9.8	36
January	177	10	33	28	17	8.3	33
February	68	6.9	27	14	16	6.9	34
March	144	9.7	32	22	17	8.3	66
April	340	17	104	82	32	18	74
May	636	208	373	84	128	60	93
June	822	193	483	137	239	73	98
July	319	114	207	92	140	47	97
August	207	30	113	34	73	34	97
September	236	30	84	44	30	21	97
Annual	184	86	140	22	13	6.1	53

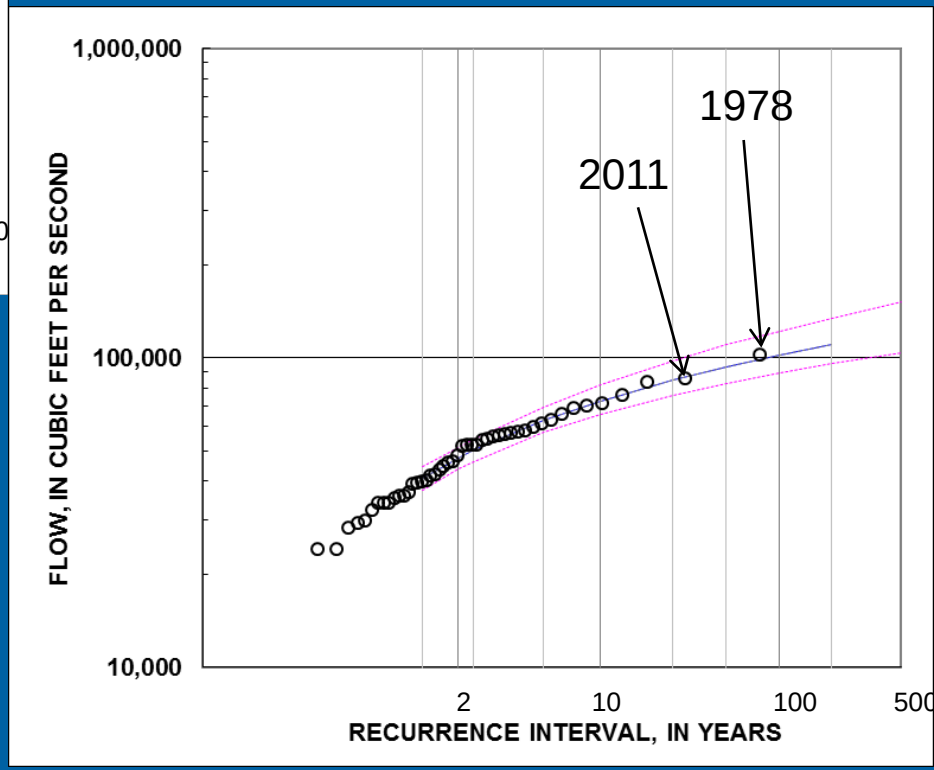
Duration of daily mean flows based on entire period of record

Flow, in ft³/s, which was equaled or exceeded for indicated percent of time							
99%	98%	95%	90%	80%	70%	60%	50%
11	13	16	21	31	43	62	84
40%	30%	20%	10%	10%	5%	2%	1%
121	177	270	348	442	592	764	832

Flood Frequencies



Yellowstone River at Miles City
Pre-regulation 1923-1964
Post-regulation 1965-2011



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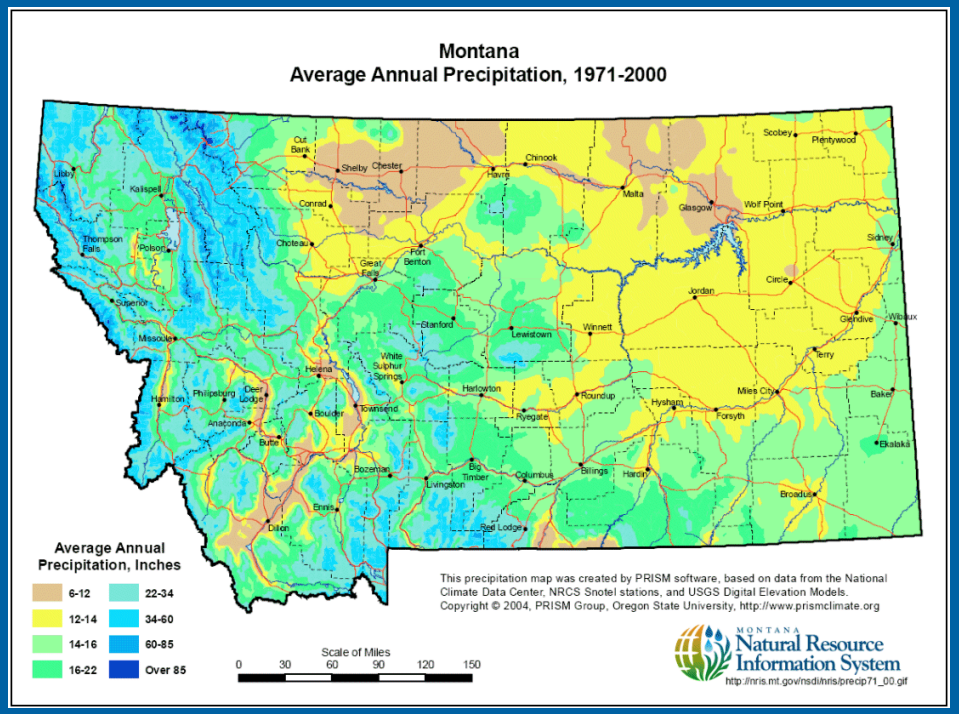
Steps for developing StreamStats

2. Prepare GIS data for computing basin characteristics (BCs)
   - Drainage area
   - Slope
   - Elevation
   - Shape
   - Climatic characteristics, e.g. precipitation, evaporation, air temperature
   - Land-cover/use
   - Soils/geology



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Basin Characteristics

Green- currently avail.
Grey- most will be avail.
Blue-data covering MT only
Red-data covering US only

Basin Characteristics Report

STUDY AREA
MT-ID-WY ONLY
MT ONLY

Site Idenification Number: 06090800
Station Name: Missouri River at Fort Benton, MT

Name	Parameter	Value
CONTDA	Area that contributes flow to a point on a stream, in square miles.	24297.24
PERIMMI	Basin perimeter, in miles.	1781.47
COMPRAT	A measure of basin shape related to basin perimeter and drainage area.	3.22
ELEV	Mean Basin Elevation in feet.	6000.44
ELEVMAX	Maximum basin elevation in feet.	11267.74
MINBELEV	Minimum basin elevation in feet.	2616.76
RELIEF	Maximum - minimum elevations, in feet.	8650.98
EL5000	Percent of basin above 5,000 feet elevation.	70.58
EL5500	Percent of basin above 5,500 feet elevation.	60.07
EL6000	Percent of basin above 6,000 feet elevation.	49.94
EL6500	Percent of basin above 6,500 feet elevation.	39.21
EL7000	Percent of basin above 7,000 feet elevation.	27.77
BSLDEM30	Mean basin slope computed from 30 m DEM, in percent.	19.62
SLOP30_30M	Percent area with slopes greater than or equal to 30 percent from 30-meter DEM.	24.14
NFSL30_30M	Percent area with north-facing slopes greater than or equal to 30 percent from 30-meter DEM.	7.90
SLOP50_30M	Percent area with slopes greater than or equal to 50 percent from 30-meter DEM.	7.43
FOREST	Percent of basin covered by forest.	33.69
URBAN	Percent of urban land cover determined from NLCD 2001 & CIRCA 2000 land cover dataset.	1.64
WETLAND	Percent of wetland land cover determined from NLCD 2001 & CIRCA 2000 land cover dataset.	1.02
PCTDADAMS	Percentage of drainage area upstream of NID dataset.	100.00
LAKEAREA	Percent of basin in lakes, ponds, and reservoirs.	0.62
AG_OF_DA	Percent of agricultural land cover determined from NLCD 2001 & CIRCA 2000 land cover dataset.	9.40
IRRIGATED	Percent of basin under some irrigation regime.	3.54
PRECIP	Mean Annual Precipitation, in inches.	20.71
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years, in inches - Equivalent to precitation intensity index.	2.45
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years, in inches.	5.10
MAXTEMP	Mean annual maximum temperature in degrees Celsius.	78.20
MINTEMP	Mean annual minimum temperature in degrees Celcius.	-25.00
MARMAXTMP	Mean maximum March temperature in degrees Celsius.	26.00
MARAVTMP	Mean March temperature in degrees Celsius.	-11.34
SPRINGAVET	Spring mean evapotranspiration March - June (2001 - 2011), in average inches per month.	1.48
SUMMERAVET	Summer mean evapotranspiration July - October (2001 - 2011), in average inches per month.	1.16

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Steps for developing StreamStats

3. Develop regional regression equations using computed streamflow characteristics and BCs.

- Regression equations might take the form:

$$Q_{100} = 0.352*CA^{0.960}*S^{1.25}$$

or

$$Q_{100} = 362*CA^{0.521}*PII^{4.47}$$

where:

Q_{100}	is the 100-year flood
CA	is contributing drainage area, in square miles
S	is main-channel slope, in feet per mile
PII	is precipitation intensity index, in inches

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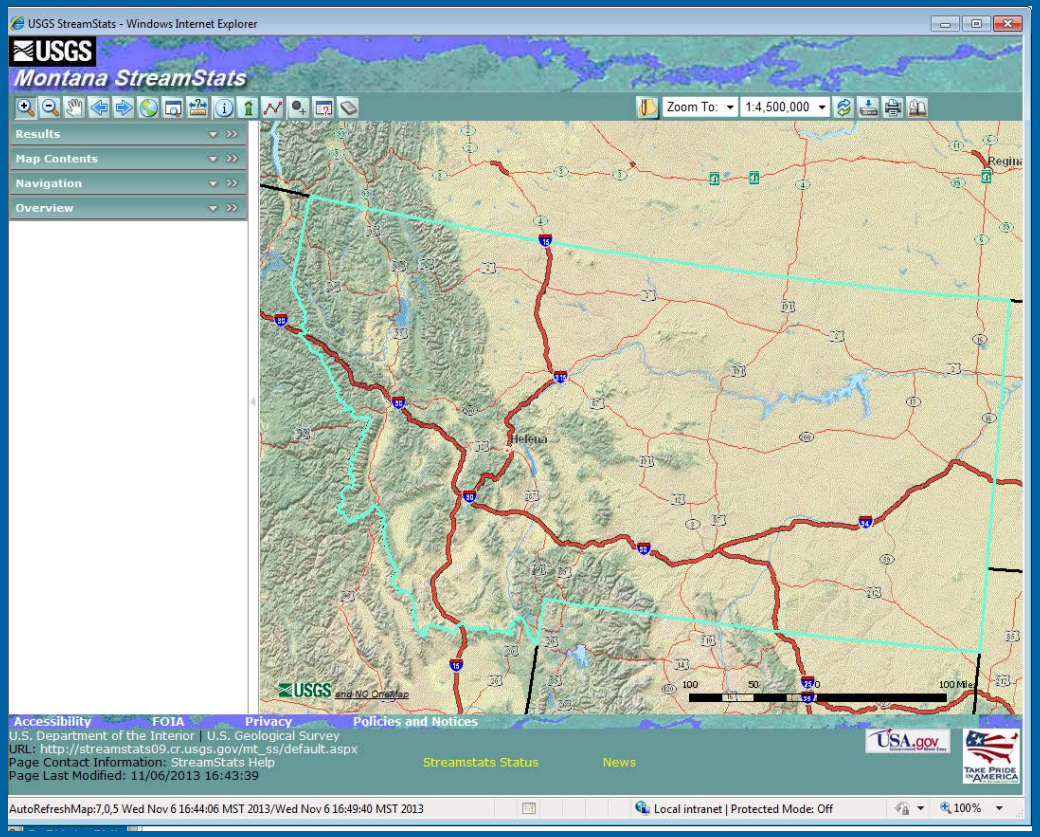
Regression Equations

- Flood Frequency Data
- Low Flow Data

Steps for developing StreamStats

4. Deploy StreamStats with GIS data and regression equations.

- National StreamStats page: http://water.usgs.gov/osw/streamstats/index.html
- http://streamstats09.cr.usgs.gov/mt_ss/index.htm



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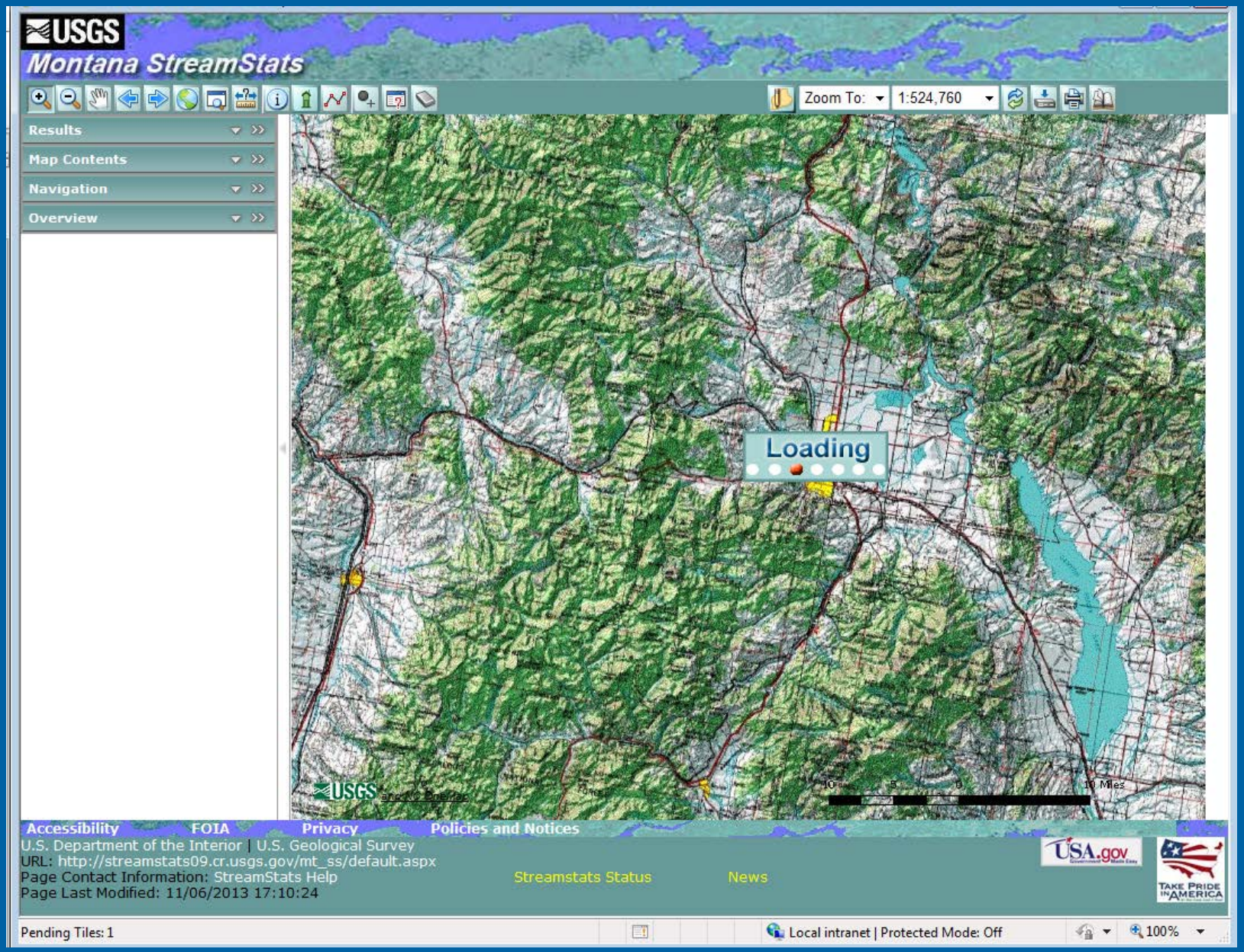
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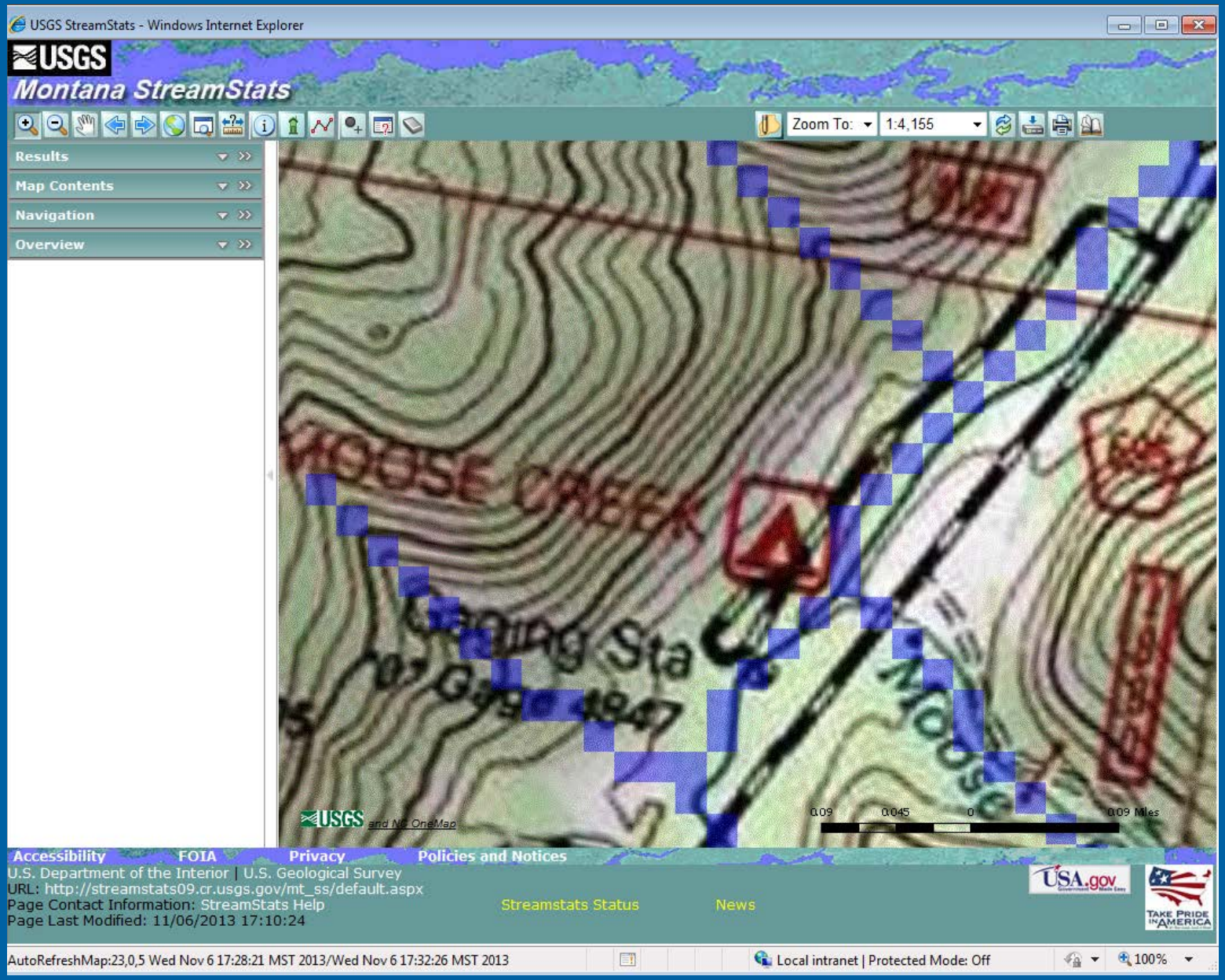
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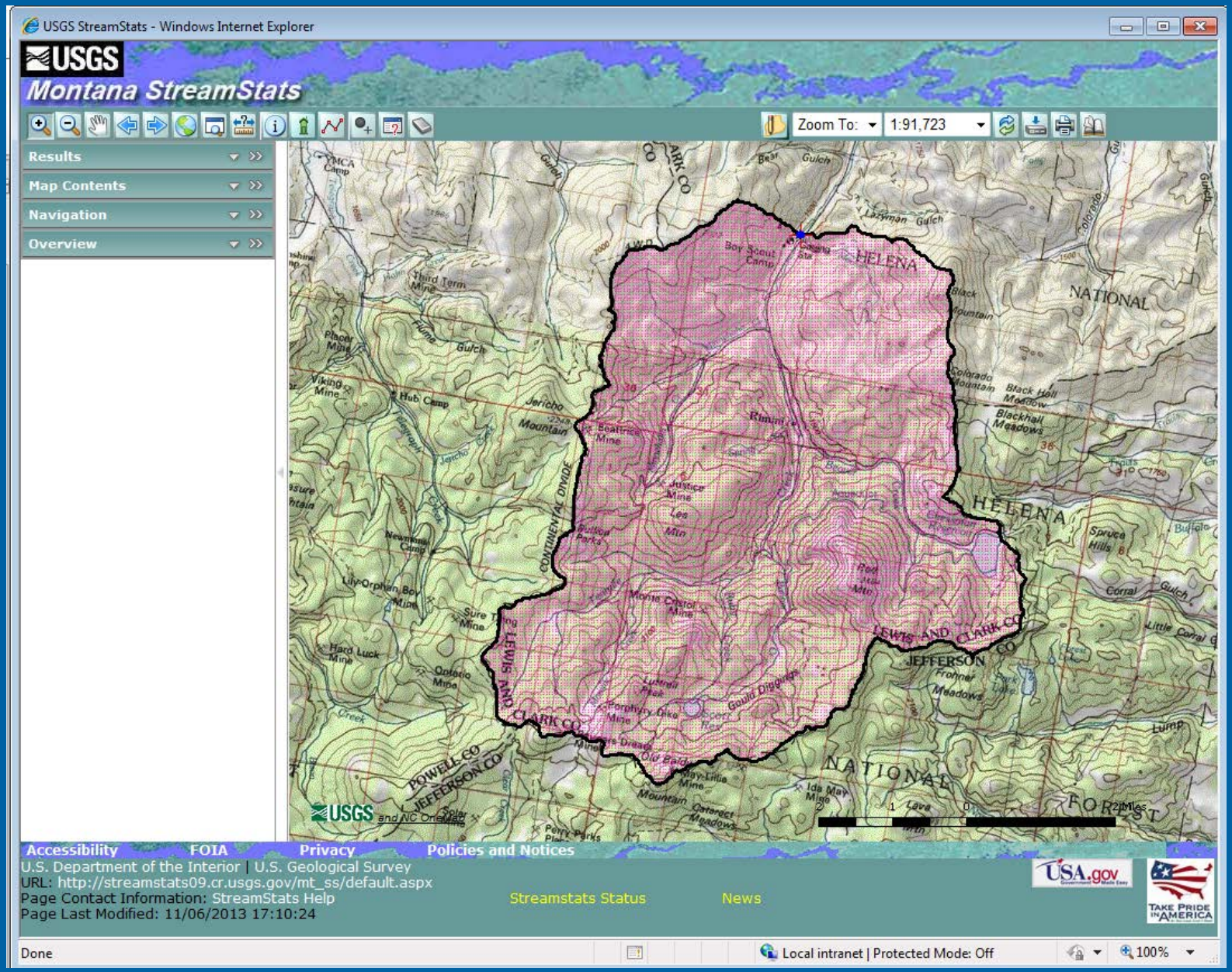
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Basin Characteristics Report - Windows Internet Explorer

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USGS

Montana StreamStats

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Basin Characteristics Report

Date: Wed Nov 6 2013 17:43:38 Mountain Standard Time
NAD27 Latitude: 46.5255 (46 31 32)
NAD27 Longitude: -112.2547 (-112 15 17)
NAD83 Latitude: 46.5254 (46 31 32)
NAD83 Longitude: -112.2555 (-112 15 20)

Parameter	Value
Contributing drainage area, in square miles	35.9
Mean Basin Elevation in feet	6490
Minimum Basin Elevation in feet	4850
Maximum Basin Elevation in feet	8230
Maximum - minimum elevation, in feet	3380
High Elevation Index - Percent of area above 6000 feet	77
Mean basin slope computed from 30 m DEM, in percent	27.4
Percent of area having slope greater than or equal to 30 percent, computed from 30-m DEM	39
Percent of area having North-facing slopes greater than or equal to 30 percent, computed from 30-m DEM	15
Percent of area having slope greater than or equal to 50 percent, computed from 30-m DEM	8
Percent of area covered by forest	93
Mean annual precipitation, in inches	24.5
Mean Spring (March - June) Evapotranspiration (2001-2011), in average inches per month	1.5
Mean Summer (July - October) Evapotranspiration (2001-2011), in average inches per month	1.47

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Coming soon to Streamstats

- Streamgages
  - Parrett WRIR 03-4308
  - McCarthy SIR 2004-5266
- Dams
- Additional basin characteristics

Prickly Pear Creek nr. Clancy, MT-1981

USGS

Coming next fall to Streamstats

- New flood frequencies
- New low flow stats
- New regression equations

Gibson Dam on the Sun River
June, 1964 – crest length 960 feet

Photograph taken by George F. Roskie, Lewis and Clark National Forest

USGS