Progress Report

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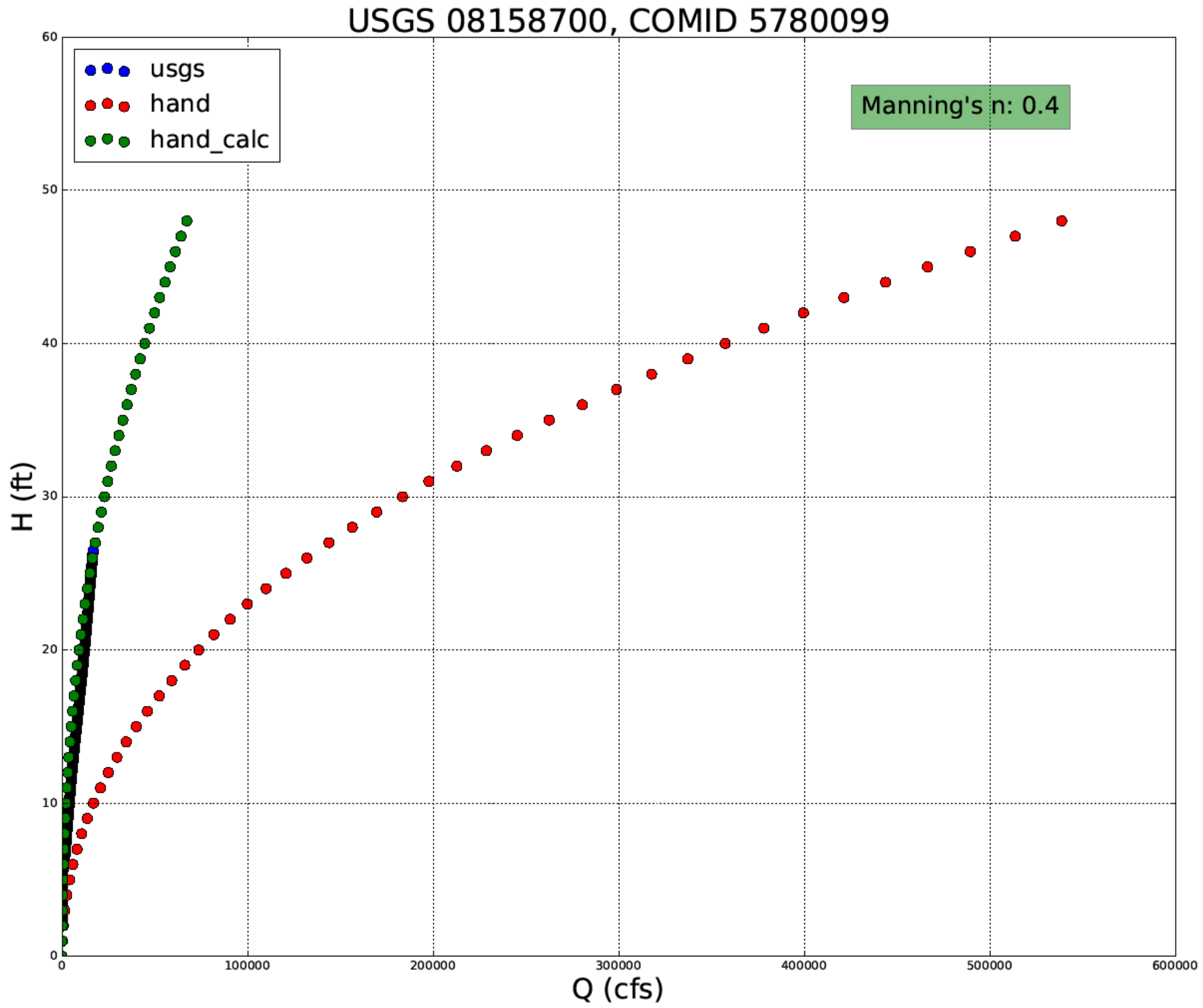
Progress Made

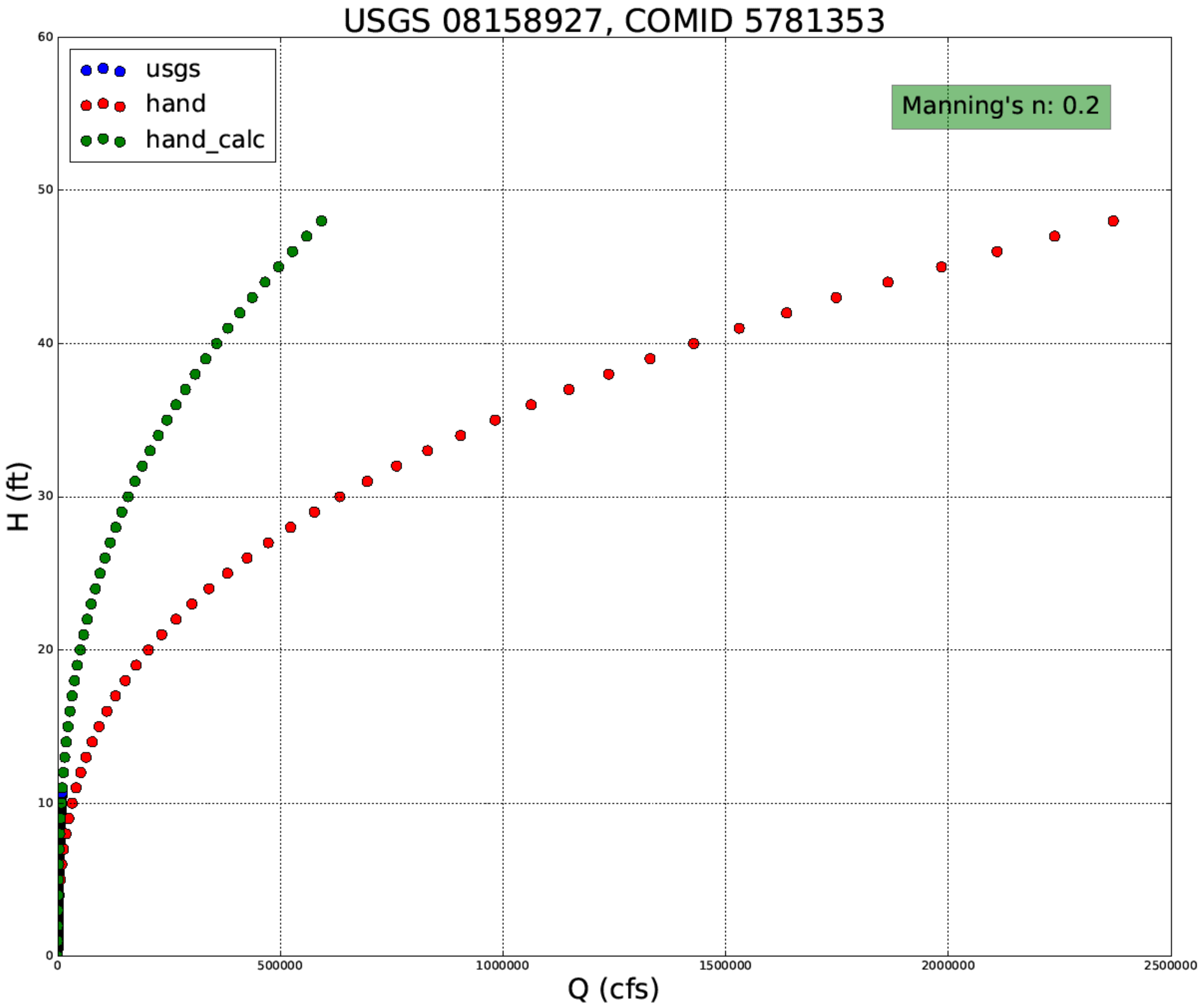
- USGS rating curves from URL

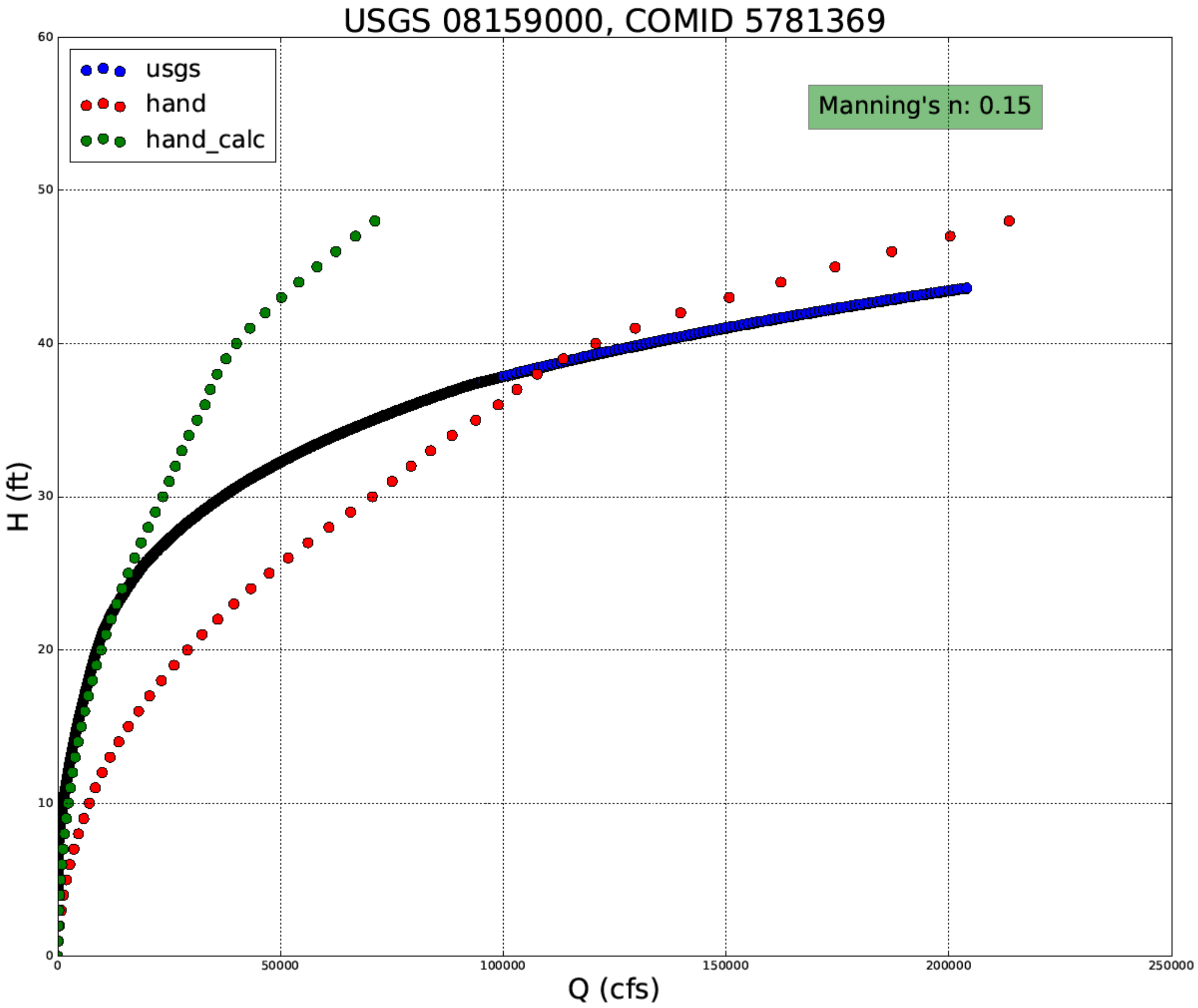
http://waterdata.usgs.gov/nwisweb/get_ratings?file_type=exsa&site_no={0}

- HAND rating curves from netCDF file (from Xing)
- Calculated HAND rating curves from netCDF file (from Xing)
  - Using WetArea, HydraulicRadius, and Slope parameters with a fixed n
  - Tested with n = 0.05 and is nearly identical to Xing's rating curves
- Manually approximated n-value to match HAND to USGS rating curves

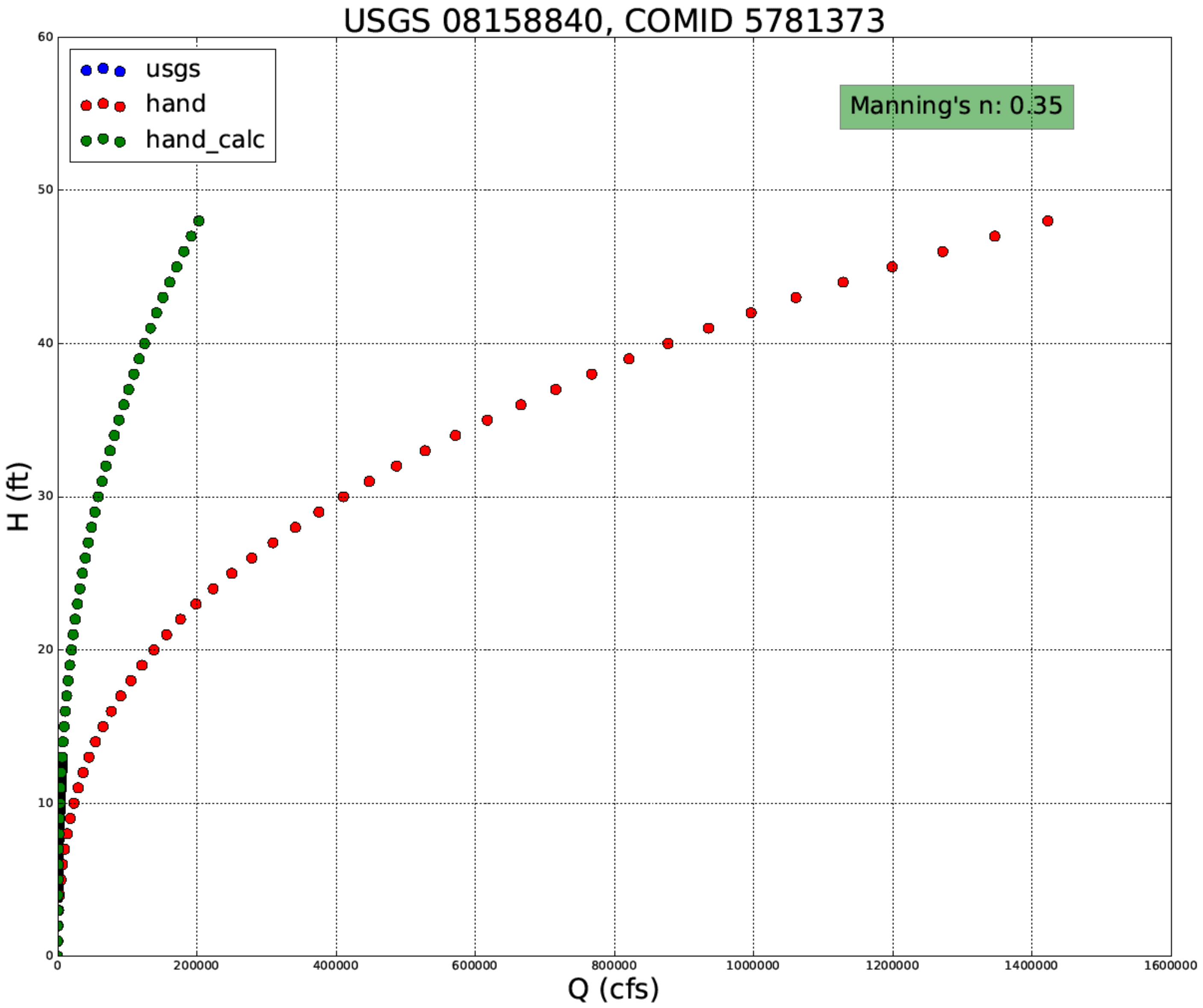


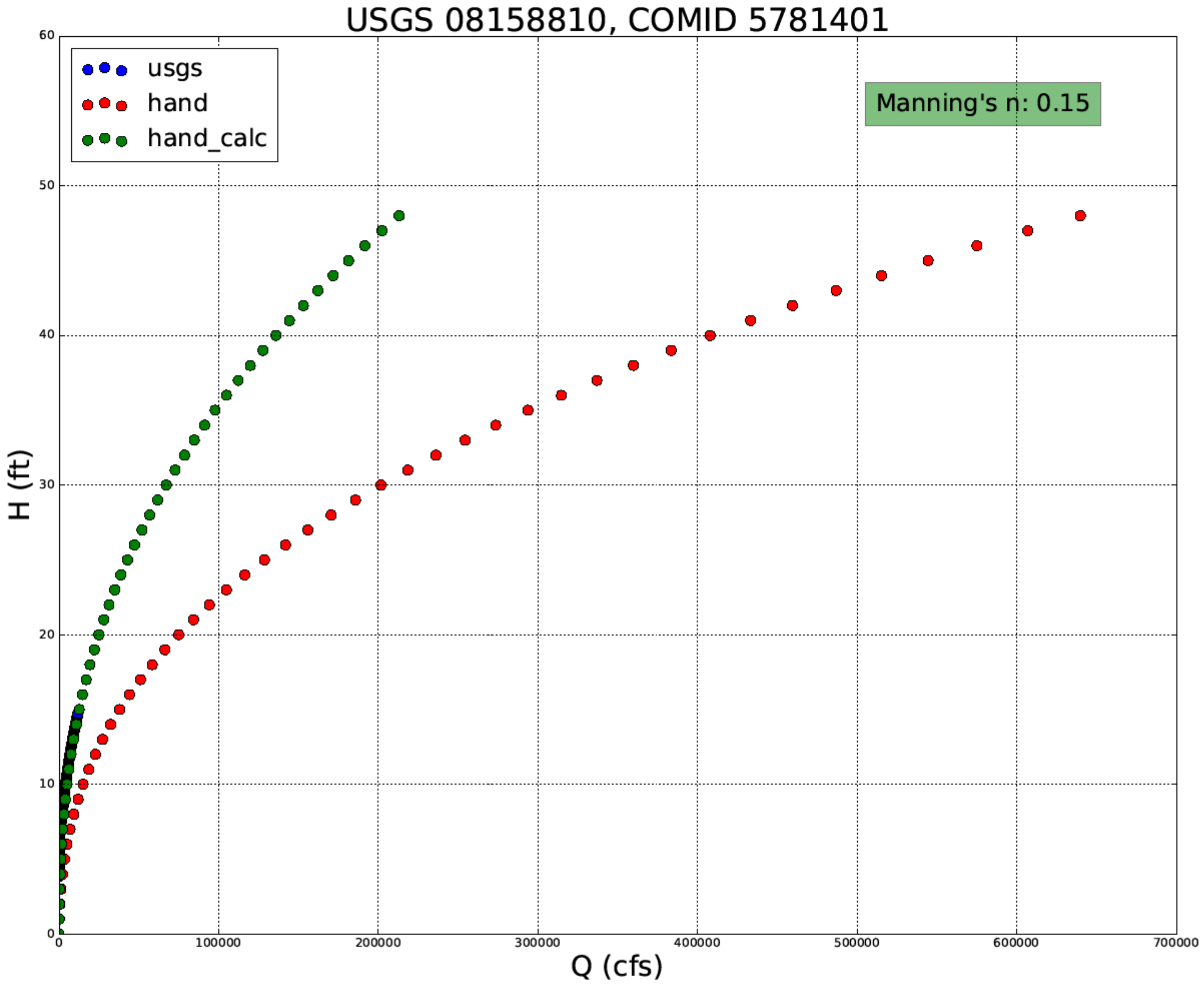
USGS 08158700, COMID 5780099
usgs
hand
hand_calc
Manning's n: 0.4
H (ft)
Q (cfs)
0
10
20
30
40
50
60
100000
200000
300000
400000
500000
600000


USGS 08158927, COMID 5781353
usgs
hand
hand_calc
Manning's n: 0.2
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
500000
1000000
1500000
2000000
2500000

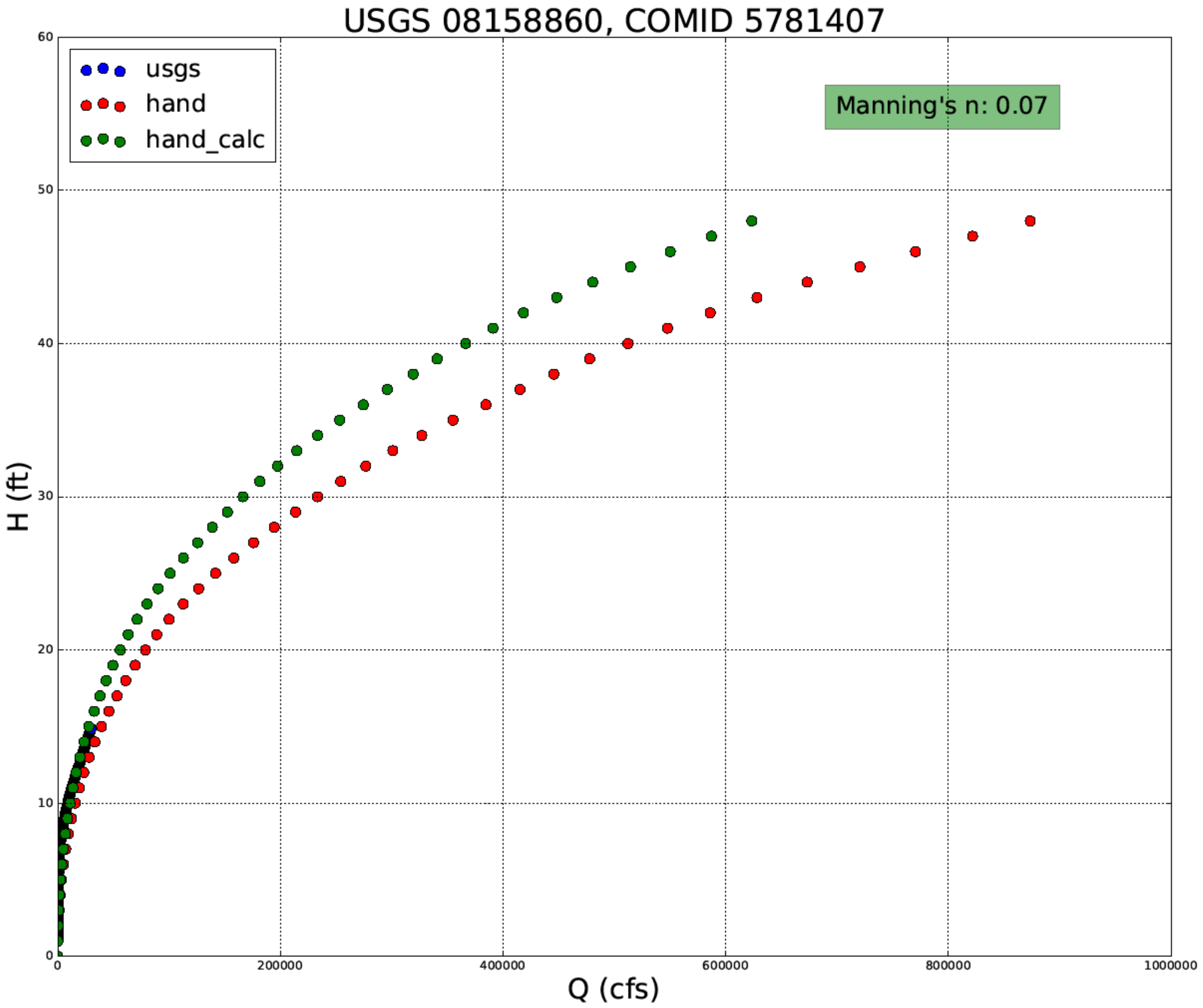


USGS 08159000, COMID 5781369
usgs
hand
hand_calc
Manning's n: 0.15
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
50000
100000
150000
200000
250000

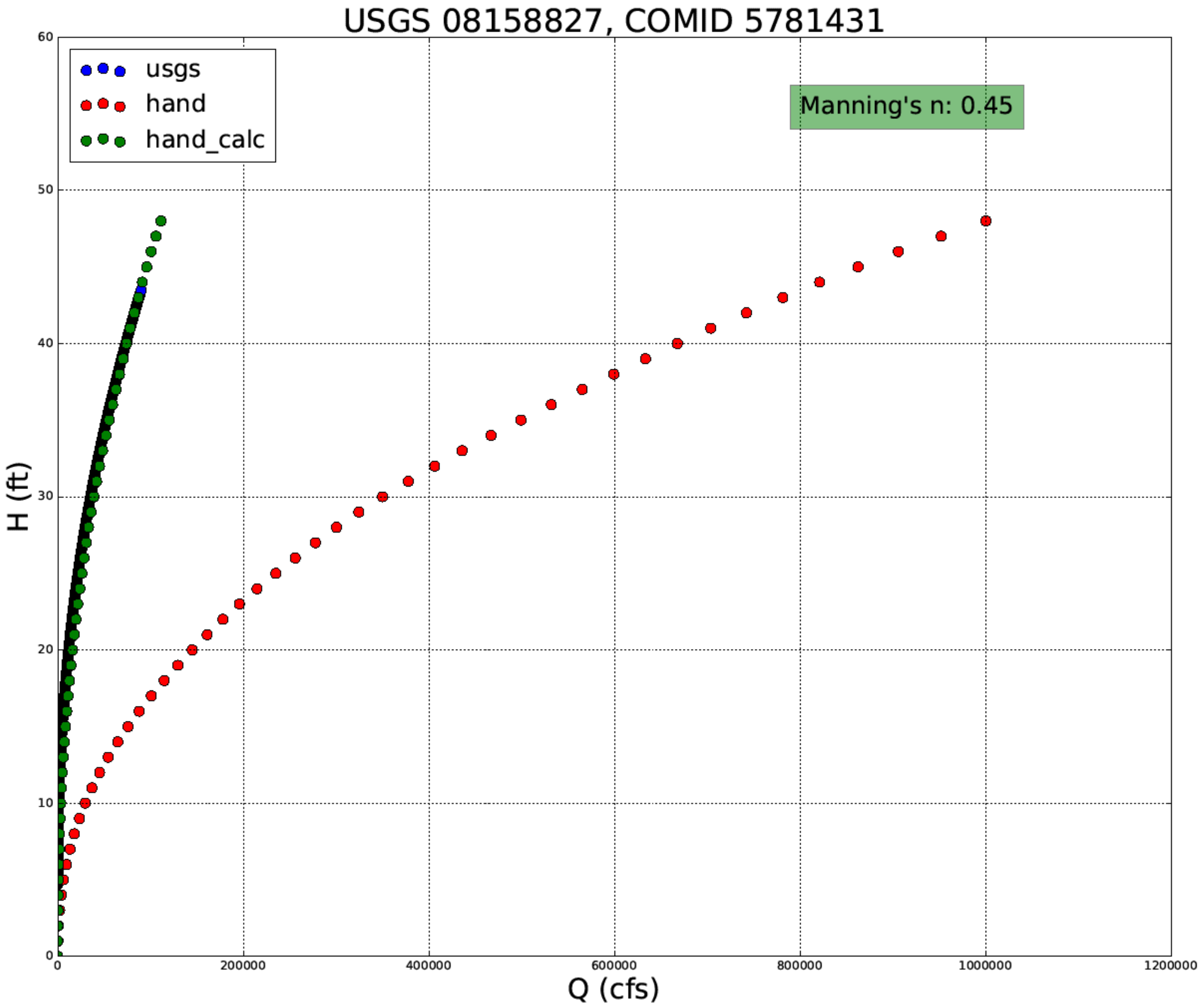

USGS 08158840, COMID 5781373
usgs
hand
hand_calc
Manning's n: 0.35
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
200000
400000
600000
800000
1000000
1200000
1400000
1600000



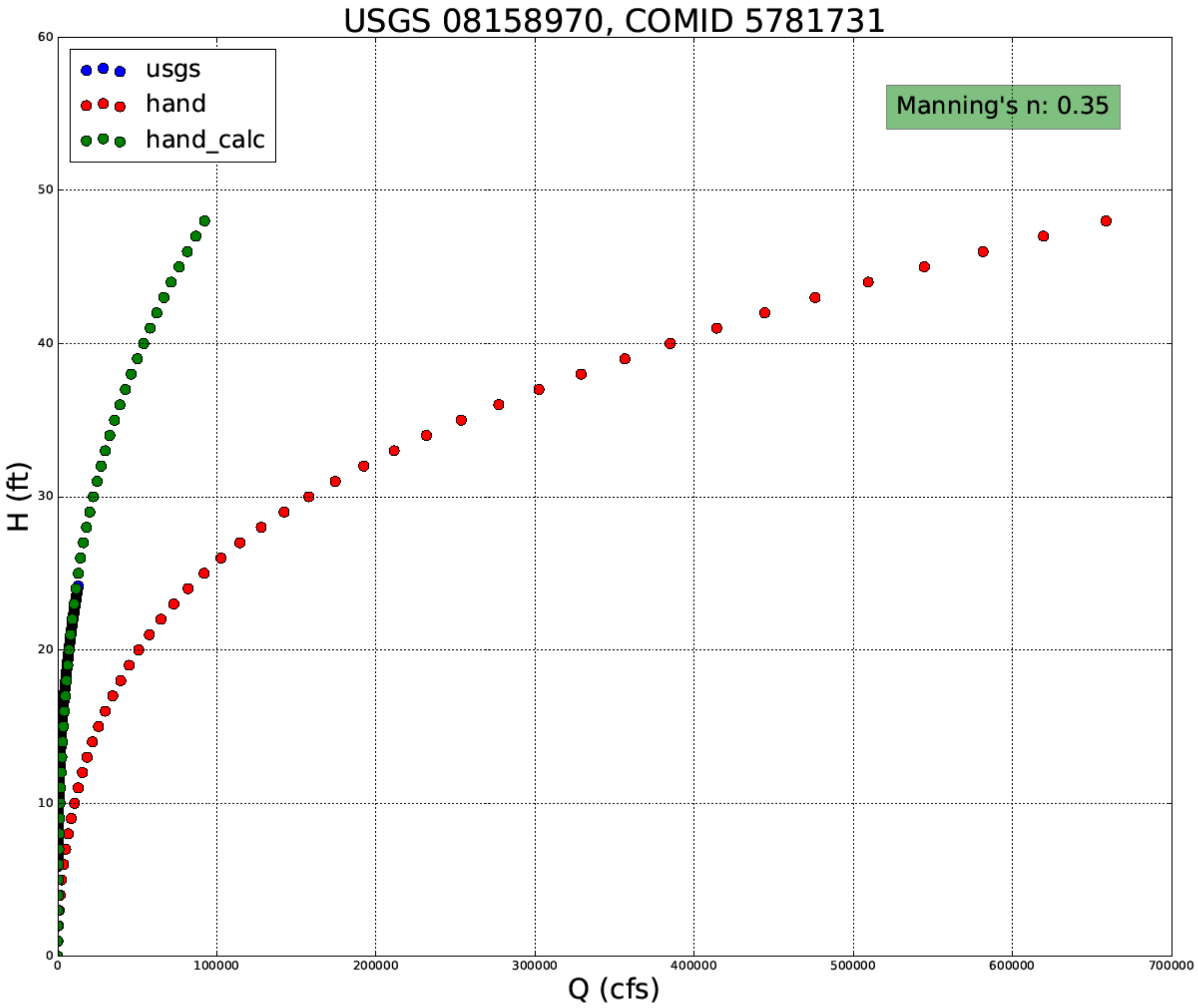
USGS 08158810, COMID 5781401
usgs
hand
hand_calc
Manning's n: 0.15
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
100000
200000
300000
400000
500000
600000
700000



USGS 08158860, COMID 5781407
usgs
hand
hand_calc
Manning's n: 0.07
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
200000
400000
600000
800000
1000000



USGS 08158827, COMID 5781431
usgs
hand
hand_calc
Manning's n: 0.45
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
200000
400000
600000
800000
1000000
1200000


USGS 08158970, COMID 5781731
usgs
hand
hand_calc
Manning's n: 0.35
H (ft)
Q (cfs)
0
10
20
30
40
50
60
0
100000
200000
300000
400000
500000
600000
700000

Summary of Results

COMID	roughness
5780099	0.4
5781353	0.2
5781369	0.15
5781373	0.35
5781401	0.15
5781407	0.07
5781431	0.45
5781731	0.35

Average n: 0.265

Next Steps

- Automate determination of manning’s roughness for each COMID, given USGS rating curve data.
- Compare automated to manual results and adjust accordingly.
- Iterate until automation is relatively correct.

waterdata.usgs.gov/nwisweb/get_ratings?file_type=exsa&site_no=08158700

```
# //UNITED STATES GEOLOGICAL SURVEY       http://water.usgs.gov/
# //NATIONAL WATER INFORMATION SYSTEM     http://water.usgs.gov/data.html
# //DATA ARE PROVISIONAL AND SUBJECT TO CHANGE UNTIL PUBLISHED BY USGS
# //RETRIEVED: 2016-08-19 20:51:32
# //WARNING
# //WARNING The stage-discharge rating provided in this file should be
# //WARNING considered provisional and subject to change. Stage-discharge
# //WARNING ratings change over time as the channel features that control
# //WARNING the relation between stage and discharge vary. Users are
# //WARNING cautioned to consider carefully the applicability of this
# //WARNING rating before using it for decisions that concern personal or
# //WARNING public safety or operational consequences.
# //WARNING
# //FILE TYPE="NWIS RATING"
# //DATABASE NUMBER=01 DESCRIPTION=" Standard data base for this site."
# //STATION AGENCY="USGS " NUMBER="08158700       " TIME_ZONE="CST" DST_FLAG=Y
# //STATION NAME="Onion Ck nr Driftwood, TX"
# //DD NUMBER="   5" LABEL="Discharge FROM DCP (ft3/s)"
# //PARAMETER CODE="00060"
# //RATING SHIFTED="20160819200000 CDT"
# //RATING ID=" 7.3" TYPE="STGQ" NAME="stage-discharge" AGING=A
# //RATING REMARKS="Straight line extension R#7.2 to cover 10/30/2015 peak"
# //RATING EXPANSION="logarithmic"
# //RATING OFFSET1=1.65
# //RATING_INDEP ROUNDING="2223456782" PARAMETER="Gage height (ft)"
# //RATING_DEP ROUNDING="2222233332" PARAMETER="Discharge (ft3/s)"
# //RATING_DATETIME BEGIN=20151030000000 BZONE=CDT END=20160426235959 EZONE=CDT AGING=A
# //RATING_DATETIME COMMENT="Start on 10/30/2015 to cover peak this day"
# //RATING_DATETIME BEGIN=20160427000000 BZONE=CDT END=20160622235959 EZONE=CDT AGING=R
# //RATING_DATETIME COMMENT="Start on 10/30/2015 to cover peak this day"
# //RATING_DATETIME BEGIN=20160623000000 BZONE=CDT END=23821230120000 EZONE=CST AGING=W
# //RATING_DATETIME COMMENT="Start on 10/30/2015 to cover peak this day"
# //SHIFT_PREV BEGIN="20160819121500" BZONE="CDT" END="--------------" EZONE="---"
# //SHIFT_PREV STAGE1="3.05" SHIFT1="-0.30" STAGE2="3.97" SHIFT2="-0.22" STAGE3="6.50" SHIFT3="0.00"
# //SHIFT_PREV COMMENT="Similar shift still observed. Fill continues from gravel deposited on control."
# //SHIFT_NEXT BEGIN="--------------" BZONE="---" END="--------------" EZONE="---"
# //SHIFT_NEXT STAGE1="---" SHIFT1="---" STAGE2="---" SHIFT2="---" STAGE3="---" SHIFT3="---"
# //SHIFT_NEXT COMMENT=" "
INDEP   SHIFT   DEP     STOR
16N     16N     16N     1S
1.95    -0.30   0.00    *
1.96    -0.30   0.10
1.97    -0.30   0.19
1.98    -0.30   0.29
1.99    -0.30   0.38
2.00    -0.30   0.48    *
2.01    -0.30   0.59
2.02    -0.30   0.69
2.03    -0.30   0.80
2.04    -0.30   0.91
2.05    -0.30   1.0
2.06    -0.30   1.1
```

“INDEP” = Height (ft)

“SHIFT” = displacement from actual bottom
(subtract from INDEP to get actual)

“DEP” = Discharge(cfs)

INDEP	SHIFT	DEP	STOR
16N	16N	16N	1S
0.99	-0.14	0.00	*
1.00	-0.14	0.00	
1.01	-0.14	0.01	
1.02	-0.14	0.01	
1.03	-0.14	0.01	
1.04	-0.14	0.02	
1.05	-0.14	0.03	
1.06	-0.14	0.04	
1.07	-0.14	0.05	
1.08	-0.14	0.07	
1.09	-0.14	0.09	
1.10	-0.14	0.11	
1.11	-0.14	0.14	
1.12	-0.14	0.17	
1.13	-0.14	0.20	
1.14	-0.14	0.23	
1.15	-0.14	0.26	
1.16	-0.14	0.30	
1.17	-0.14	0.34	
1.18	-0.14	0.38	
1.19	-0.14	0.43	
1.20	-0.14	0.50	
1.21	-0.14	0.57	
1.22	-0.14	0.63	
1.23	-0.14	0.70	
1.24	-0.14	0.77	*
1.25	-0.14	0.85	
1.26	-0.14	0.93	
1.27	-0.14	1.0	
1.28	-0.14	1.1	*
1.29	-0.15	1.1	*
1.30	-0.15	1.2	
1.31	-0.15	1.3	
1.32	-0.15	1.4	
1.33	-0.15	1.6	
1.34	-0.15	1.7	*

"INDEP" = Height (ft)

- For each COMID:
  - For each height (ft) in HAND netCDF file (0, 1, 2, … 48)
    - Pull corresponding WetArea, HydraulicRadius, and Slope
    - Pull corresponding USGS discharge (use USGS rating curve)
    - Calculate manning's roughness
  - Average all roughness values together
- Return average manning's roughness for each COMID

$$n = \frac{1.49}{Q} A R^{2/3} S_o^{1/2}$$

At-a-station Hydraulic-Geometry (AHG)

- Use river geometry to determine stream velocity

$$\boxed{U = K \cdot Y^{p} \cdot S^{q}}$$

- U = velocity
- K = 1 / n , n = manning roughness
- Y = average channel depth
- S = slope
- P = 0.667 (Dingman, 2007)
- Q = 0.500 (Dingman, 2007)

Analytical derivation of at-a-station hydraulic–geometry relations

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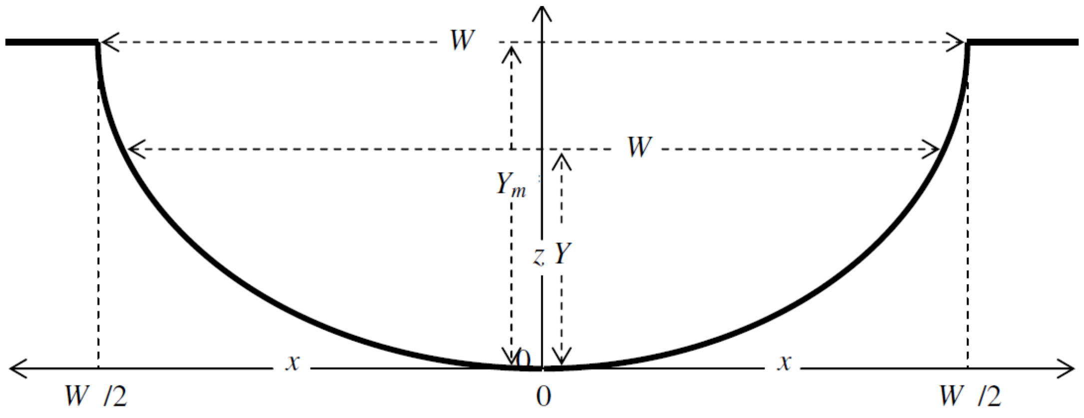
Department of Earth Sciences, University of New Hampshire, Durham, NH, USA

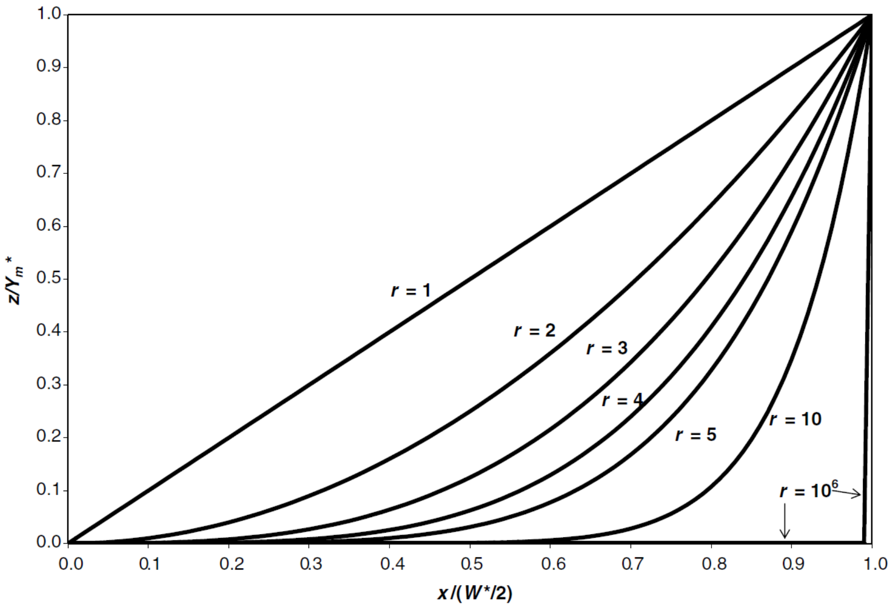
Received 9 May 2006; received in revised form 26 August 2006; accepted 28 September 2006



AHG continued

- Y = average depth
- Ym = maximum depth
- r = shape of channel (2 for parabolic)
- Given Ym, can compute Y given r

$$\boxed{Y = \left(\frac{r}{r+1}\right) \cdot Y_m}$$



AHG continued

- Can then use following relationships to calculate a, b, c, f, k, m

$$\boxed{Y = c \cdot Q^f} \qquad \boxed{W = a \cdot Q^b} \qquad \boxed{U = k \cdot Q^m}$$

- Finally, plug Q into manning's equation using HAND WetArea, HydraulicRadius, and Slope, and back-calculate roughness.

$$\boxed{\boldsymbol{n = \frac{1.49}{Q} A R^{2/3} S_o^{1/2}}}$$

Final Plan

- Define machine-learning algorithm to compute manning’s roughness using a fraction of available USGS rating curve data (ie. 90%)
- Manually assign roughness to test fraction (ie. 10%)
- Apply algorithm to test fraction (ie. 10%)
- Validate/verify correctness of algorithm on test fraction (ie. 10%)
- Compare automated to manual results and adjust accordingly.
- Implement algorithm on remaining 2.7 million reaches