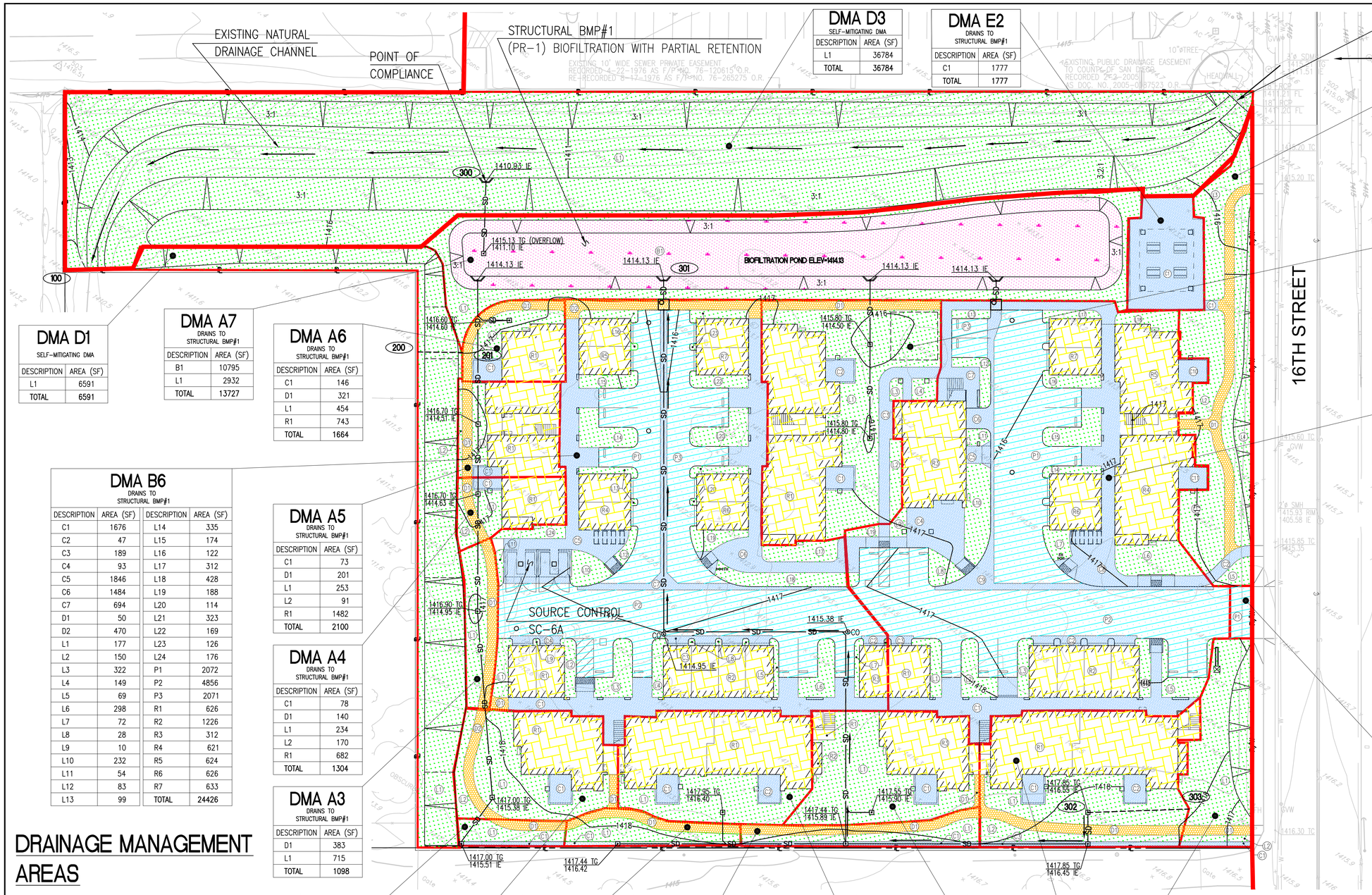


DMA D1
SELF-MITIGATING DMA

DESCRIPTION	AREA (SF)
L1	6591
TOTAL	6591

DMA A7
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
B1	10795
L1	2932
TOTAL	13727

DMA A6
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	146
D1	321
L1	454
R1	743
TOTAL	1664

DMA B6
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)	DESCRIPTION	AREA (SF)
C1	1676	L14	335
C2	47	L15	174
C3	189	L16	122
C4	93	L17	312
C5	1846	L18	428
C6	1484	L19	188
C7	694	L20	114
D1	50	L21	323
D2	470	L22	169
L1	177	L23	126
L2	150	L24	176
L3	322	P1	2072
L4	149	P2	4856
L5	69	P3	2071
L6	298	R1	626
L7	72	R2	1226
L8	28	R3	312
L9	10	R4	621
L10	232	R5	624
L11	54	R6	626
L12	83	R7	633
L13	99	TOTAL	24426

DMA A5
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	73
D1	201
L1	253
L2	91
R1	1482
TOTAL	2100

DMA A4
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	78
D1	140
L1	234
L2	170
R1	682
TOTAL	1304

DMA A3
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
D1	383
L1	715
TOTAL	1098

DMA D3
SELF-MITIGATING DMA

DESCRIPTION	AREA (SF)
L1	36784
TOTAL	36784

DMA E2
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	1777
TOTAL	1777

DMA D2
SELF-MITIGATING DMA

DESCRIPTION	AREA (SF)
C1	28
C2	126
D1	885
L1	978
L2	748
L3	886
L4	1518
L5	165
TOTAL	5334

DMA E1
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	150
C2	151
C3	543
D1	366
L1	3034
L2	206
L3	63
L4	123
R1	3048
TOTAL	7684

DMA C1
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)	DESCRIPTION	AREA (SF)
C1	1446	L11	83
C2	217	L12	174
C3	47	L13	72
C4	889	L14	104
C5	99	L15	324
C6	110	L16	239
C7	457	L17	110
C8	2001	L18	251
C9	677	L19	104
C10	143	P1	3571
C11	130	P2	5148
L1	171	P3	297
L2	298	R1	472
L3	151	R2	1224
L4	148	R3	1482
L5	232	R4	1547
L6	541	R5	1507
L7	159	R6	624
L8	185	R7	627
L9	85	TOTAL	26652
L10	506		

DMA D4
DE MINIMIS

DESCRIPTION	AREA (SF)
P1	249
TOTAL	249

DMA A1
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	101
D1	153
L1	349
TOTAL	603

DMA A2
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	151
D1	63
D2	255
L1	1431
L2	289
R1	1343
TOTAL	3532

DMA B1
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	156
D1	374
L1	551
TOTAL	1081

DMA B2
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	218
D1	503
L1	537
TOTAL	1258

DMA B3
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	151
C2	145
L1	1339
R1	2717
TOTAL	4352

DMA B4
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	151
D1	38
L1	2225
R1	145
R2	65
R3	1309
TOTAL	3933

DMA B5
DRAINS TO STRUCTURAL BMP#1

DESCRIPTION	AREA (SF)
C1	151
C2	146
C3	210
D1	461
L1	1512
L2	477
R1	2972
TOTAL	5929

DMA D5
SELF-MITIGATING DMA

DESCRIPTION	AREA (SF)
C1	78
D1	142
L1	2264
L2	102
TOTAL	2586

DRAINAGE MANAGEMENT AREAS

LEGEND

ALL EXISTING ITEMS ARE SCREENED

- EXISTING CONTOURS — 520
- PROPERTY LINE — ℄
- RIGHT-OF-WAY — R/W
- NEW CONTOURS — 520
- CATCH BASIN
- DRAINAGE DIRECTION
- STORM DRAIN — SD
- NEW BUILDING (IMPERVIOUS)
- DMA BOUNDARY
- (R1) BIO-FILTRATION
- (C1) CONCRETE PAVEMENT
- (D1) DECOMPOSED GRANITE
- (L1) LANDSCAPE
- (P1) ASPHALT PAVEMENT
- (R1) ROOFS

SCALE 1"=40'

GRAPHIC SCALE

0 5'10' 20' 40' 60'

SCALE: 1" = 20'

STRUCTURAL BMP#1 DMA SUMMARY (A, B, C, E)

DESCRIPTION	TOTAL AREA (SF)	NOTE
BIO-FILTRATION (B)	10795	PERVIOUS
CONCRETE (C)	14756	IMPERVIOUS
DECOMPOSED GRANITE (D)	3778	SEMI-PERVIOUS
LANDSCAPE (L)	24956	ENGINEERED PERVIOUS
AC PAVEMENT (P)	18015	IMPERVIOUS
ROOFS (R)	26657	IMPERVIOUS
TOTAL	98957	

SITE INFORMATION:

HYDROLOGIC SOIL GROUP: C

GROUND WATER DEPTH: 10-20 FEET

CRITICAL COARSE SEDIMENT YIELD AREAS: NO CCSYAs ON SITE OR UPSTREAM OF SITE PER WMAA PCCSYA MAPS

1 H2-2 ENLARGEMENT

BDS Engineering, Inc.
Civil Engineering
Land Surveying
5575 Lake Park Way, Suite 114
La Mesa, California 91942
(619) 582-4932 FAX (619) 582-7428

VILLAGE PLACE APARTMENTS

521 16TH STREET, RAMONA, CA 92065

Revisions:

Sheet Title: DRAINAGE MANAGEMENT AREA EXHIBIT

Date: 11-10-17

Project No.: 14-18

Sheet No.:

H2-2:- POST-DEVELOPMENT DRAINAGE

DWG. FILE: L:\PROJECTS\1418\Admin\04 Hydro\02 MAPS\H2.dwg
PLOT DATE: Nov 21, 2017- 3:53pm
L:\PROJECTS\1418\Admin\04 Hydro\02 MAPS\H2.dwg, 11/21/2017 3:53:09 PM, Imagine, 1:1

BDS Engineering, Inc.
CIVIL ENGINEERS

PROJECT: VILLAGE PLACE APARTMENTS — PROJECT NO.: 14-18

ENGINEER: Tara Mugane — DATE: NOV 2017

Year Storm	P_6	P_{24}	P_6 / P_{24}	a*	n*
1	1.02	1.82	56.0%	7.59	0.65
2	1.30	2.33	55.8%	9.67	0.65
10	1.99	3.60	55.3%	14.81	0.65
50	2.81	5.08	55.3%	20.91	0.65
100	3.19	5.78	55.2%	23.73	0.65

Note: Initial and Travel Times are calculated based on Fig 3-3 and 3-4 of the County Hydrology Manual, *StormCad Software Variables

$T_{c,\ MINIMUM}$ = 5 minutes

DRAINAGE AREA NO.	UPSTREAM NODE	DOWNSTREAM NODE	AREA (SF)	AREA (AC.)	IMPERVIOUS AREA (SF)	LENGTH OF FLOW (FT.)	SLOPE (%)	% IMPER-VIOUS	C	ΣCA	Initial Li	Initial Ti	Travel Lt	Travel Tt	ΣTc (min)	I (per att. chart) 1	2	10	50	100	ΣQ (CFS) 1	2	10	50	100
PRE - DEVELOPMENT																									
SYSTEM EX-1																									
	105	104	11552	0.27	9704	150	100.5%	84.00%	0.81	0.22	60	0.9			5.0	2.69	3.43	5.24	7.40	8.40	0.58	0.74	1.13	1.59	1.81
	104	103	934838	21.46	546880	1509	0.7%	58.50%	0.65	14.16					12.2	1.51	1.93	2.95	4.16	4.73	21.41	27.29	41.78	58.99	66.97
	103	102	428380	9.83	278447	557	0.7%	65.00%	0.69	20.95					13.3	1.43	1.82	2.79	3.94	4.47	29.96	38.18	58.44	82.53	93.69
	102	101A	422215	9.69	282884	560	0.3%	67.00%	0.70	27.74					18.7	1.15	1.46	2.24	3.16	3.59	31.83	40.57	62.10	87.70	99.55
	101A	100	442302	10.15	327303	641	10.0%	74.00%	0.74	35.25					28.0	0.88	1.13	1.73	2.44	2.77	31.18	39.74	60.84	85.90	97.52
			Total Area	**51.41**				**Avg C**	**0.69**					**ΣTc**	**28.0**									Q_{100}	**97.52**
SYSTEM EX-2																									
	201	200	113743	2.61	0	478	1.0%	0.00%	0.30	0.78	70	12.5	408	4.5	17.0	1.22	1.56	2.38	3.36	3.82	0.96	1.22	1.87	2.63	2.99
			Total Area	**2.61**				**Avg C**	**0.30**					**ΣTc**	**17.0**									Q_{100}	**2.99**
POST - DEVELOPMENT																									
SYSTEM 1																									
	105	104	11552	0.27	9704	150	100.5%	84.00%	0.81	0.22	60	0.9			5.0	2.69	3.43	5.24	7.40	8.40	0.58	0.74	1.13	1.59	1.81
	104	103	934838	21.46	546880	1509	0.7%	58.50%	0.65	14.16					12.2	1.51	1.93	2.95	4.16	4.73	21.41	27.29	41.78	58.99	66.97
	103	102	428380	9.83	278447	557	0.7%	65.00%	0.69	20.95					13.3	1.43	1.82	2.79	3.94	4.47	29.96	38.18	58.44	82.53	93.69
	102	101A	422215	9.69	282884	560	0.3%	67.00%	0.70	27.74					18.7	1.15	1.46	2.24	3.16	3.59	31.83	40.57	62.10	87.70	99.55
	101A	100	487255	11.19	341079	641	0.2%	70.00%	0.74	36.01					25.3	0.94	1.20	1.84	2.60	2.95	34.01	43.35	66.35	93.70	106.37
			Total Area	**52.44**				**Avg C**	**0.69**					**ΣTc**	**25.3**									Q_{100}	**106.37**
SYSTEM 3																									
	303	302	5929	0.14	3479	46	1.5%	58.68%	0.67	0.09	46	4.6			5.0	2.69	3.43	5.24	7.40	8.40	0.25	0.31	0.48	0.68	0.77
	302	301	98957	2.27	59428	473	0.5%	60.05%	0.66	1.59					6.4	2.29	2.92	4.47	6.31	7.17	3.65	4.65	7.11	10.04	11.40
	301	300	104886	2.41	62907	N/A	N/A	N/A	N/A						19.2	1.13	1.44	2.20	3.11	3.53	1.80	2.29	3.50	4.95	5.61
			Total Area	**2.41**				**Avg C**	**0.66**					**ΣTc**	**19.2**									Q_{100}	**5.61**
JUNCTION SYSTEM 1&3[1]			**Total Area**	**54.85**				**Avg C**	**0.69**					**ΣTc**	**25.3**									Q_{100}	**111.10**
SYSTEM 2	201	202	6591	0.15	0	21	50.0%	0.00%	0.30		21	1.8			5.0	2.69	3.43	5.24	7.40	8.40	0.12	0.16	0.24	0.34	0.38
			Total Area	**0.15**				**Avg C**	**0.30**					**ΣTc**	**5.0**									Q_{100}	**0.38**

[1] Junction Analysis based on San Diego County Hydrology Manual Section 3.4.2. Calculations are attached.

PRE-DEVELOPMENT: Q_{100} ANALYSIS

EX - 1

105 → 104

$A = 11552\ SF = 0.27\ ACRE$ $\quad \Delta ELEV = 1429 - 1428 = 1'$

$L_{OVERLAND} = 150' \Rightarrow L_M = 60'^{*}$ $\quad S = 0.7\%$

$C_{GEN.COM} = 0.81$ $\quad T_c = 5 min$ (minimum)

* BASED ON SAN DIEGO COUNTY HYDROLOGY MANUAL TABLE 3-2

104 → 103

$A = 934838\ SF = 21.46\ ACRE$ $\quad \Delta ELEV = 1428 - 1418 = 10'$

$L = 1,509\ LF$ $\quad S = 0.7\%$

C:

MDR (4.30u/A)	$= 450193\ SF$	$\times\ 0.48$	$=$	216093
G. COMM	$= 484645\ SF$	$\times\ 0.81$	$=$	392562

$C_{AVG} = 0.65$

%IMP

450193×0.30	$=$	135058
484645×0.85	$=$	411948

%IMP = 58.5%

STREET FLOW:

$Q_{AVG} = Q_{104} + q_{avg}(A_{104-103}/2)$

1st ASSUMPTION: $q_{avg} = 2.0\ cfs/acre$

$Q_{AVG} = 1.81\ cfs + (2)(21.46/2) = 22.97\ cfs$

PER FIG. 3-6 $\quad V = 3.1\ fps$

$$T_t = \frac{1509\ LF}{3.1\ FPS} \cdot \frac{1}{60} = 8.11\ min$$

$T_{103} = 5 + 8.11 = 13.11 \text{ min} \Rightarrow I = 4.51$

$Q_{103} = \Sigma(CA)I = 14.16 \cdot 4.51 = 63.86 \text{ cfs}$

Check $Q_{AVG} = 22.97$ cfs

$Q_{AVG} = 1.81 + (63.86 - 1.81)/2 = 32.84 \text{ cfs} \neq 22.97 \text{ cfs}$

2nd ASSUMPTION:

$q_{avg} = 2.5 \text{ cfs/acre}$

$Q_{AVG} = 1.81 + 2.5(21.46/2) = 28.64 \text{ cfs}$

FIG 3-6 $V = 3.4$ fps

$T_t = \frac{1509 LF}{3.4} \cdot \frac{1}{60} = 7.4 \text{ min}$

$T_{103} = 5 + 7.4 = 12.4 \text{ min} \quad I = 4.68$

$Q_{103} = 14.16 \cdot 4.68 = 66.3 \text{ cfs}$

Check $Q_{AVG} = 28.64$

$Q_{AVG} = 1.81 + \frac{(66.3 - 1.81)}{2} = 34.1 \text{ cfs} \neq 28.64 \text{ cfs}$

3RD ASSUMPTION:

$q_{avg} = 3.0 \text{ cfs/acre}$

$Q_{AVG} = 1.81 + 3.0\left(\frac{21.46}{2}\right) = 34.0 \text{ cfs}$

Fig 3-6, $V = 3.5$ fps

$$T_t = \frac{1509 \text{ LF}}{3.5 \text{ FPS}} \cdot \frac{1}{60} = 7.2 \text{ min}$$

$$T_{103} = 5 + 7.2 = 12.2 \text{ min} \qquad I = 4.73$$

$$Q_{103} = 14.16 \cdot 4.73 = 70.0 \text{ cfs}$$

Check $Q_{AVG} = 34.0$ cfs

$$Q_{AVG} = 1.81 + \frac{(70 - 1.81)}{2} = 35.9 \text{ cfs} \neq 34.0 \text{ cfs}$$

4TH ASSUMPTION:

$$q_{avg} = 3.2 \text{ cfs/acre}$$

$$Q_{AVG} = 1.81 + 3.2\left(\frac{21.46}{2}\right) = 36.1 \text{ cfs}$$

$V = 3.5$ fps

$$T_t = \frac{1509 \text{ LF}}{3.5 \text{ FPS}} \cdot \frac{1}{60} = 7.2 \text{ min}$$

$T_{103} = 5 + 7.2 = 12.2$ min $\quad I = 4.73$

$$\boxed{Q_{103} = 14.16 \cdot 4.73 = 70.0 \text{ cfs}}$$

67.1

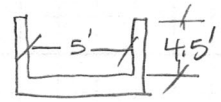
Check $Q_{AVG} = 36.1$ cfs

$$Q_{AVG} = 1.81 + \frac{(70 - 1.81)}{2} = 35.9 \text{ cfs} \cong 36.1 \text{ cfs}$$ OK

103 ⟶ 102

$A = 428380\ SF = 9.83\ ACRE$ $\quad \Delta ELEV = 1418 - 1414 = 4'$

$L_{CHANNEL} = 557\ LF$ $\quad S = 0.7\%$



$C = 0.69$

$\Sigma CA = 20.95$

1ST ASSUMPTION

Assume $q_{avg} = 3.0$ cfs/acre

$$Q_{AVG} = 70 + \frac{3.0(9.83)}{2} = 84.7\ cfs$$

$n = 0.016$ (fair condition)

Hydraflow* ⇒ $V = 8.34$ FPS

* (See attached output)

$$T_t = \frac{557\ LF}{8.34\ FPS} \cdot \frac{1}{60} = 1.1\ min$$

$T_C = 12.2 + 1.1\ min = 13.3\ min$ $\quad I = 4.47$

$$Q = \Sigma CA \cdot I = 20.95(4.47) = 93.65\ cfs$$

Check assumption

$$Q_{AVG} = 70 + \frac{(93.65 - 70)}{2} = 81.8\ cfs \neq 84.7\ cfs$$

2ND ASSUMPTION

Assume $q_{avg} = 2.5$ cfs/acre

$$Q_{AVG} = 70 + \frac{2.5(9.83)}{2} = 82.3\ cfs$$

Hydraflow ⇒ $V = 8.27$ FPS

$T_t = \frac{557 \text{ FPS}}{8.27 \text{ FPS}} \cdot \frac{1}{60} = 1.1 \text{ min}$

$T_c = 12.2 + 1.1 = 13.3 \text{ min} \qquad I = 4.47$

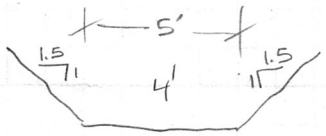
$Q_{102} = 20.95(4.47) = 93.65 \text{ cfs}$

Check!

$Q_{AVG} = 70 + \frac{(93.65 - 70)}{2} = 81.8 \cong 82.3$ Ok.

102 → 101 A

TRAPEZOIDAL CHANNEL $n = 0.09$



BASED ON R.S.# 2380, SHT 10 OF 13

L = 560' ELEV = 1414 - 1412.30
S = 0.03

A 422215 SF = 9.69 a

C:

HDR (24 DU/A)	= 140,533 SF	× C = 0.69	96968
NATURAL	= 58,133	× C = 0.30	17440
G. COMM	= 150979 + 72570	× C = 0.81	181075

$C_{AVG} = 0.70$

% IMP

140,533	×	% 0.65	91346
58,133	×	0	0
223549	×	0.85	190017

% Avg 0.67

1ST ASSUMPTION

$q_{avg} = 2.0 \text{ cfs/Acre}$

$Q_{AVG} = 93.7 \text{ cfs} + \frac{2.0(9.69)}{2} = 103.39 \text{ cfs}$

Hydraflow ⇒ V = 1.73 FPS

$$T_t = \frac{560' \text{ LF}}{1.73 \text{ FPS}} \cdot \frac{1}{60} = 5.4 \text{ MIN}$$

$T_c = 13.3 + 5.4 = 18.7$ MIN $I = 3.59$

$Q = \Sigma CA \cdot I = 27.64 \cdot 3.59 = 99.23$ cfs

Check

$$Q_{AVG} = \frac{93.65 + (99.23 - 93.65)}{2} = 138.44 \text{cfs} \neq 103.39$$

2ND ASSUMPTION

$q_{avg} = 3.5$ cfs/acre

$$Q_{AVG} = 93.7 + \frac{3.5(9.69)}{2} = 110.7 \text{ cfs}$$

HYDRAFLOW ⇒ V = 1.76 FPS

$$T_t = \frac{560}{1.76} \cdot \frac{1}{60} = 5.3 \text{ MIN}$$

$T_c = 13.3 + 5.3 = 18.6$ MIN $I = 3.60$

$Q = 27.64 \cdot 3.60 = 99.50$

Check

$$Q_{AVG} = 93.7 + \frac{(99.50 - 93.7)}{2} = 96.6 \text{ cfs} \neq 110.7 \text{ cfs}$$

3RD ASSUMPTION

$q_{avg} = 3.0$ cfs/acre

$$Q_{Avg} = 93.7 + \frac{3(9.69)}{2} = 108.2 \text{ cfs}$$

Hydraflow ⇒ $V = 1.75$ FPS

$$T_t = \frac{560\ LF}{1.7\ FPS} \cdot \frac{1}{60} = 5.49\ min$$

$$T_C = 13.3 + 5.49 = 18.8 \qquad I = 3.58$$

$$Q = 27.64 \cdot 3.58 = 98.95\ cfs$$

Check

$$Q_{AVG} = 93.7 + \frac{(98.95 - 93.7)}{2} = 96.3\ cfs \neq 108.2\ cfs$$

4th ASSUMPTION

$$q_{avg} = 3.25\ cfs/acre$$

$$Q_{AVG} = 93.7 + \frac{3.25(9.69)}{2} = 109.4\ cfs$$

HYDRA flow $V = 1.76$ fps

$$T_t = \frac{560\ LF}{1.76\ FPS} \cdot \frac{1}{60} = 5.30\ min$$

$$T_C = 13.3 + 5.30 = 18.6\ min \qquad I = 3.60$$

$$Q = 27.64 \cdot 3.60 = 99.50\ cfs$$

Check

$$Q = 93.7 + \frac{(99.50 - 93.7)}{2} = 96.6\ cfs \neq 109.4\ cfs$$

5TH ASSUMPTION

$q_{avg} = 2.5$ cfs/acre

$$Q_{AVG} = 93.7 + \frac{2.5(9.69)}{2} = 105.8 \text{ cfs}$$

HYDRAFLOW ⇒ $V = 1.74$ FPS

$$T_t = \frac{560 \text{ LF}}{1.74 \text{ FPS}} \cdot \frac{1}{60} = 5.4 \text{ min}$$

$T_c = 13.3 + 5.4 = 18.7$ min $I = 3.59$

$Q = (27.64)(3.59) = 99.2$ cfs

Check

$$Q_{AVG} = 93.7 + \frac{(99.2 - 93.7)}{2} = 96.5 \neq 105.8 \text{ cfs}$$

6TH ASSUMPTION

$q_{avg} = 2.2$ cfs/acre

$$Q_{AVG} = 93.7 + \frac{2.2(9.69)}{2} = 104.4 \text{ cfs}$$

HYDRAFLOW ⇒ $V = 1.74$ FPS

$T_t = 5.4$ min $T_c = 18.7$ min $I = 3.59$

$Q_{101A} = (27.64)(3.59) = 99.2$ cfs

$$Q_{AVG} = 93.7 + \frac{(99.2 - 93.7)}{2} = 96.5 \text{ cfs} \cong 104.4 \text{ cfs}$$

OK

101A → 100

A = 442,302 = 10.15 acre

C_{avg} =

C. Comm	= 313063	× 0.81	=	253581
HDR (24 du/Ac)	= 94500	× 0.69	=	65,205
NATURAL	= 34739	× 0.30	=	10422

C_{avg} = 0.74

%IMP =

313063 × 0.85	=	266104
94500 × 0.65	=	61425
34739 × 0	=	0

%IMP AVG 0.74

L = 641 LF S = 0.1%

Natural Trap CHANNEL

n = 0.06

1st ASSUMPTION

q_{avg} = 2.2 cfs/acre

Q_{AVG} = 99.2 cfs + $\frac{2.2(10.15)}{2}$ = 110.4 cfs

Hydraflow V = 1.16 FPS

$T_t = \frac{641 \text{ LF}}{1.16 \text{ FPS}} \cdot \frac{1}{60}$ = 9.2 MIN

T_C = 18.7 + 9.2 = 27.9 MIN I = 2.77

$Q = \Sigma CA \cdot I$

$= 35.25 \times 2.77 = 97.64$ cfs

Check

$Q_{AVG} = 99.2 + \frac{(97.64 - 99.2)}{2} = 98.42$ cfs $\neq 110.4$ cfs

2ND ASSUMPTION

$q_{avg} = 1.8$ cfs/acre

$Q_{AVG} = 99.2 + \frac{1.8(10.15)}{2} = 108.3$ cfs

HYDRAFLOW $\Rightarrow$ $V = 1.16$

$T_t = 9.2$ $T_c = 27.9$ $I = 2.77$

$Q = 35.25 \times 2.77 = 97.64$ cfs

Check

$Q_{AVG} = 98.42 \neq 108.3$ cfs

3RD ASSUMPTION

$q_{avg} = 1.0$ cfs/acre

$Q_{AVG} = 99.2 + \frac{1(10.15)}{2} = 104.3$ cfs

Hydraflow $\Rightarrow$ $V = 1.15$ FPS

$T_t = \frac{641 \text{ LF}}{1.15} \cdot \frac{1}{60} = 9.3$ MIN

$T_c = 18.7 + 9.3 = 28$ MIN $I = 2.77$

$Q_{100} = 35.25 \times 2.77 = 97.64$ cfs Hydraflow $\Rightarrow$ $V_{100} = 1.1$ fps

Check $Q_{AVG} = 99.2 + \frac{(97.64 - 99.2)}{2} = 98.42 \cong 104.4$

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

103 to 102 Concrete Channel (1st Assumption)

Rectangular

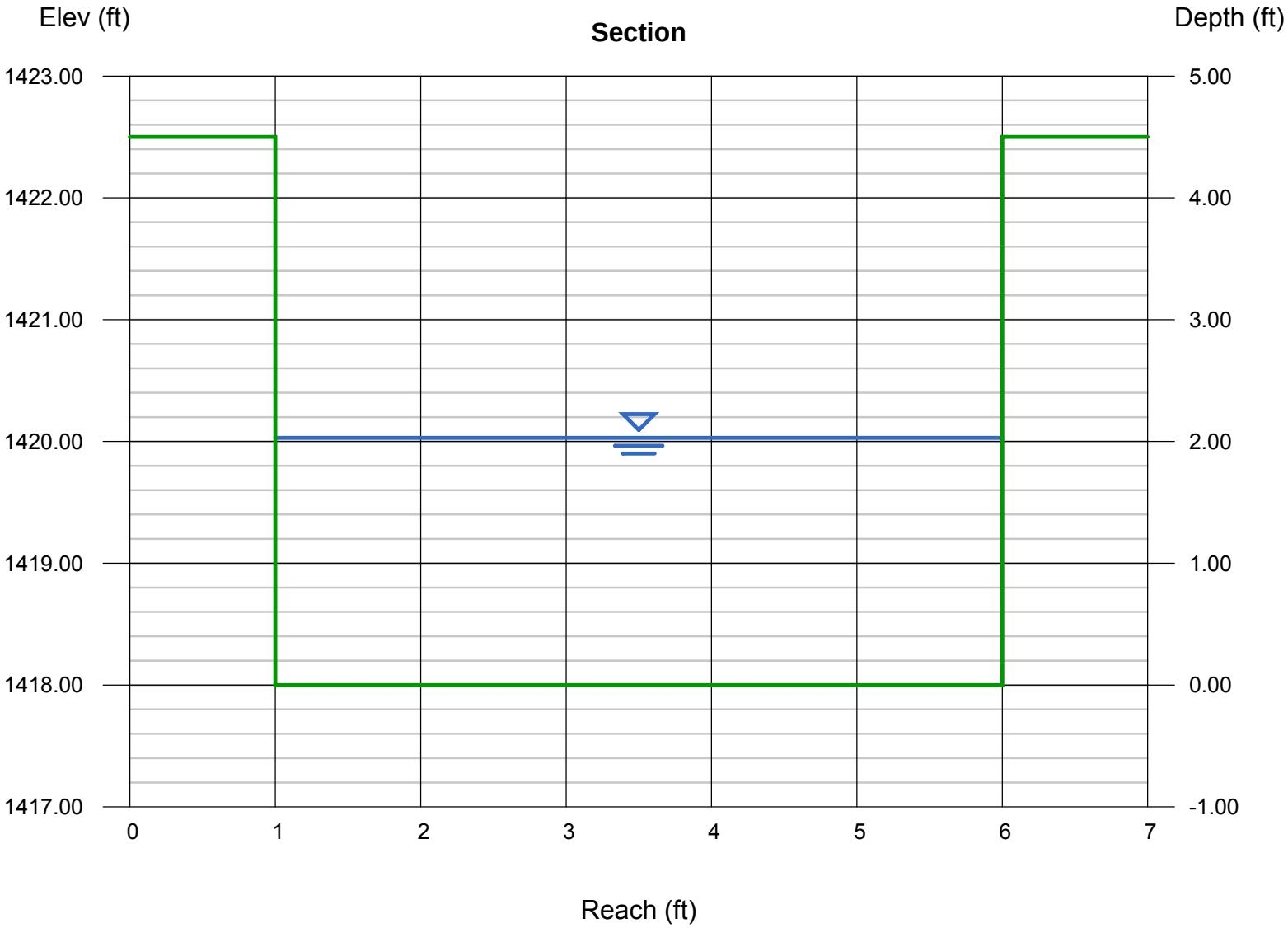
Bottom Width (ft)	= 5.00
Total Depth (ft)	= 4.50
Invert Elev (ft)	= 1418.00
Slope (%)	= 0.70
N-Value	= 0.016

Calculations

Compute by:	Known Q
Known Q (cfs)	= 84.70

Highlighted

Depth (ft)	= 2.03
Q (cfs)	= 84.70
Area (sqft)	= 10.15
Velocity (ft/s)	= 8.34
Wetted Perim (ft)	= 9.06
Crit Depth, Yc (ft)	= 2.08
Top Width (ft)	= 5.00
EGL (ft)	= 3.11



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

103 to 102 Concrete Channel (2nd Assumption)

Rectangular

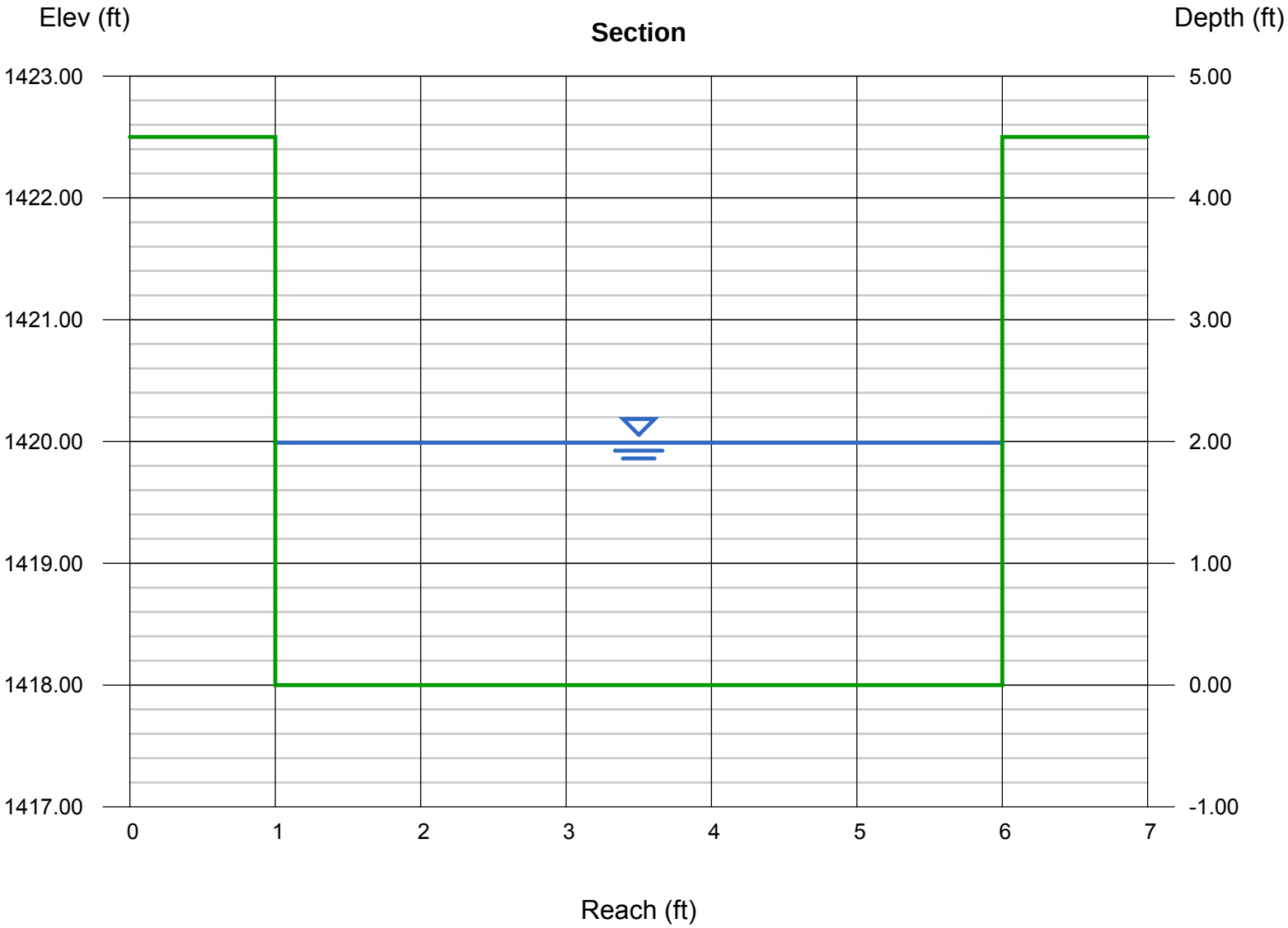
Bottom Width (ft)	= 5.00
Total Depth (ft)	= 4.50
Invert Elev (ft)	= 1418.00
Slope (%)	= 0.70
N-Value	= 0.016

Calculations

Compute by:	Known Q
Known Q (cfs)	= 82.30

Highlighted

Depth (ft)	= 1.99
Q (cfs)	= 82.30
Area (sqft)	= 9.95
Velocity (ft/s)	= 8.27
Wetted Perim (ft)	= 8.98
Crit Depth, Yc (ft)	= 2.04
Top Width (ft)	= 5.00
EGL (ft)	= 3.05



Channel Report

102 to 101A Trapezoidal Channel (1st Assumption)

Trapezoidal

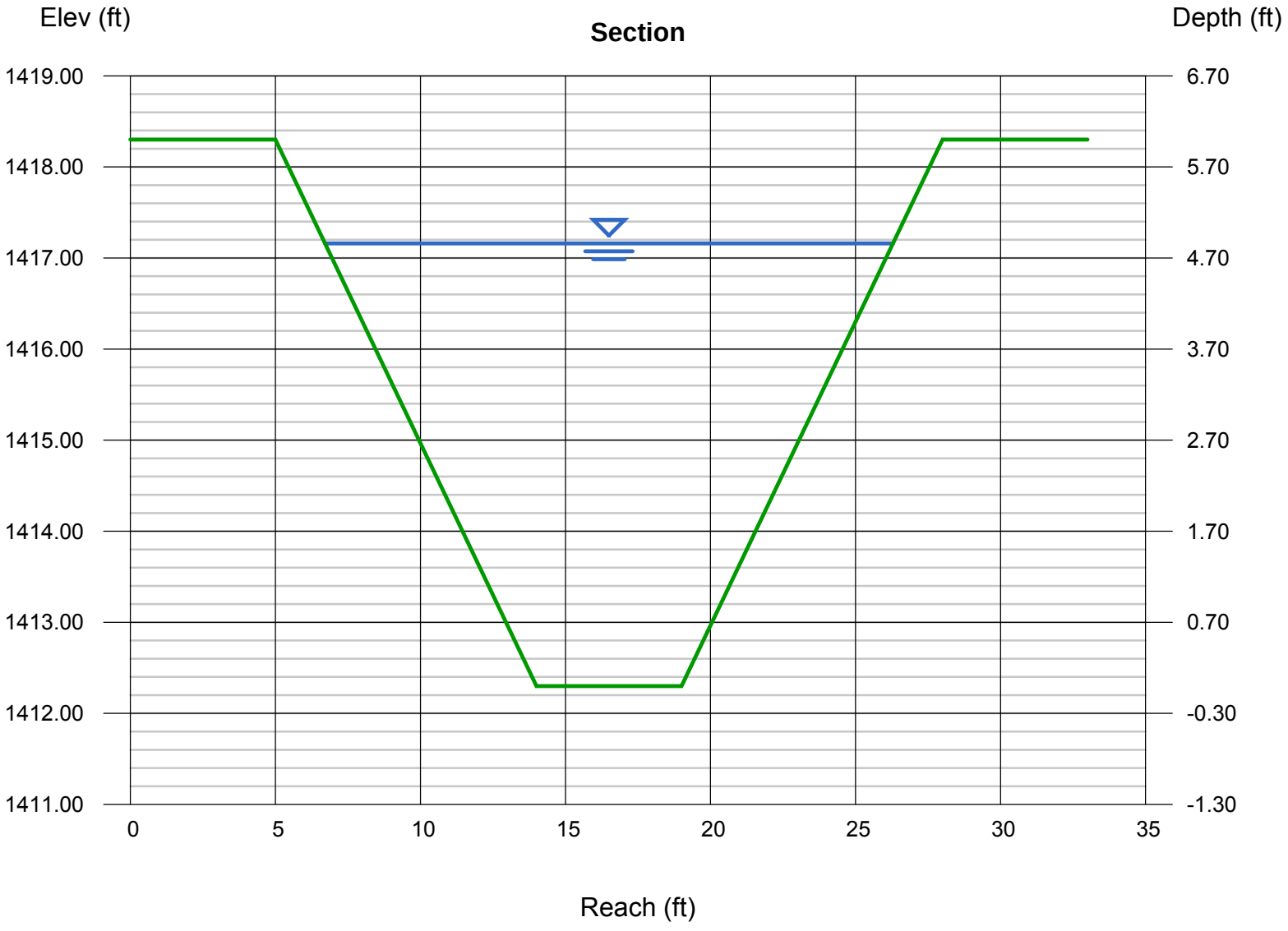
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 1.50, 1.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1412.30
Slope (%)	= 0.30
N-Value	= 0.090

Calculations

Compute by:	Known Q
Known Q (cfs)	= 103.39

Highlighted

Depth (ft)	= 4.86
Q (cfs)	= 103.39
Area (sqft)	= 59.73
Velocity (ft/s)	= 1.73
Wetted Perim (ft)	= 22.52
Crit Depth, Yc (ft)	= 1.94
Top Width (ft)	= 19.58
EGL (ft)	= 4.91



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

102 to 101A Trapezoidal Channel (2nd Assumption)

Trapezoidal

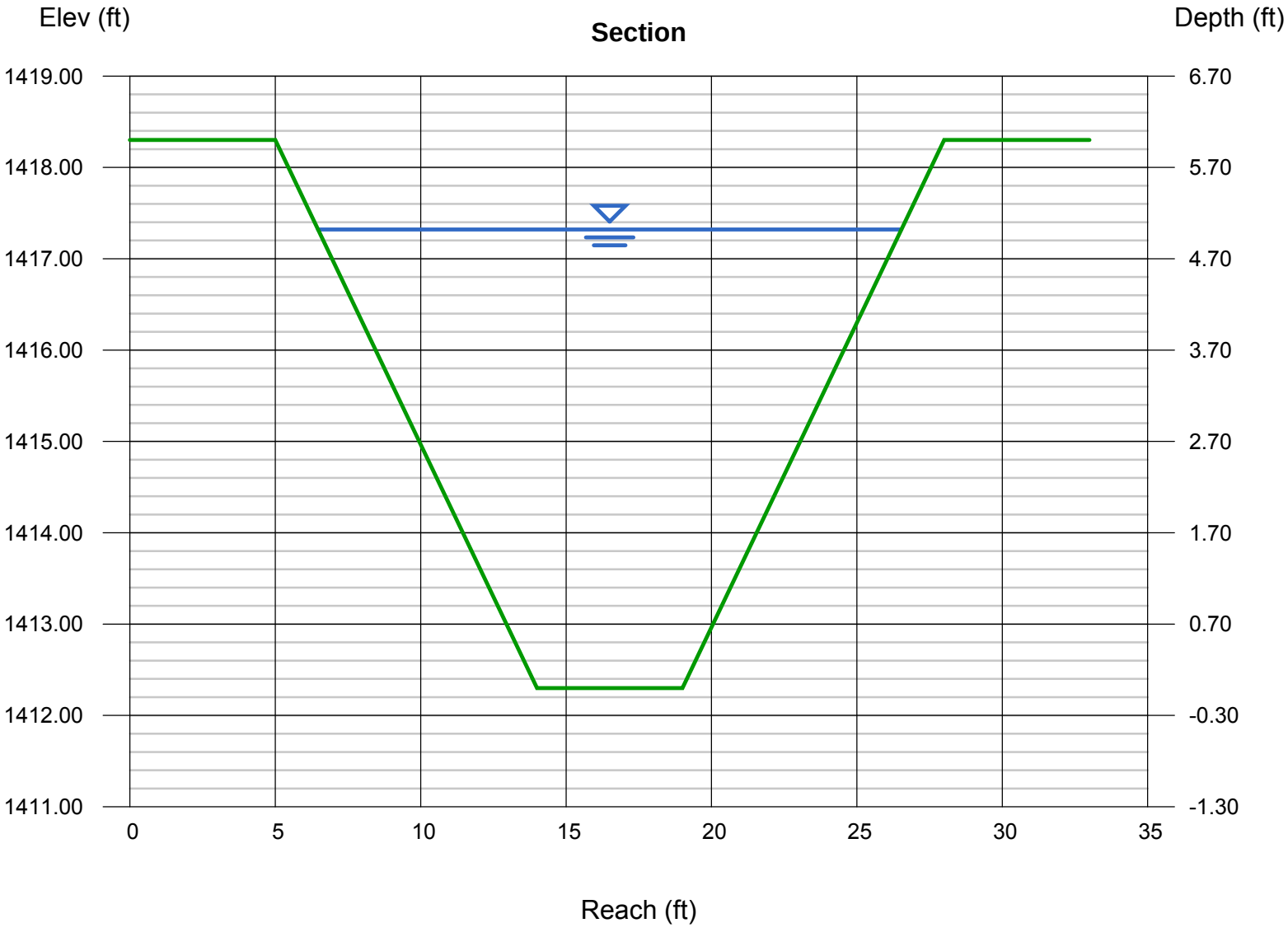
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 1.50, 1.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1412.30
Slope (%)	= 0.30
N-Value	= 0.090

Calculations

Compute by:	Known Q
Known Q (cfs)	= 110.70

Highlighted

Depth (ft)	= 5.02
Q (cfs)	= 110.70
Area (sqft)	= 62.90
Velocity (ft/s)	= 1.76
Wetted Perim (ft)	= 23.10
Crit Depth, Yc (ft)	= 2.02
Top Width (ft)	= 20.06
EGL (ft)	= 5.07



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

102 to 101A Trapezoidal Channel (3rd Assumption)

Trapezoidal

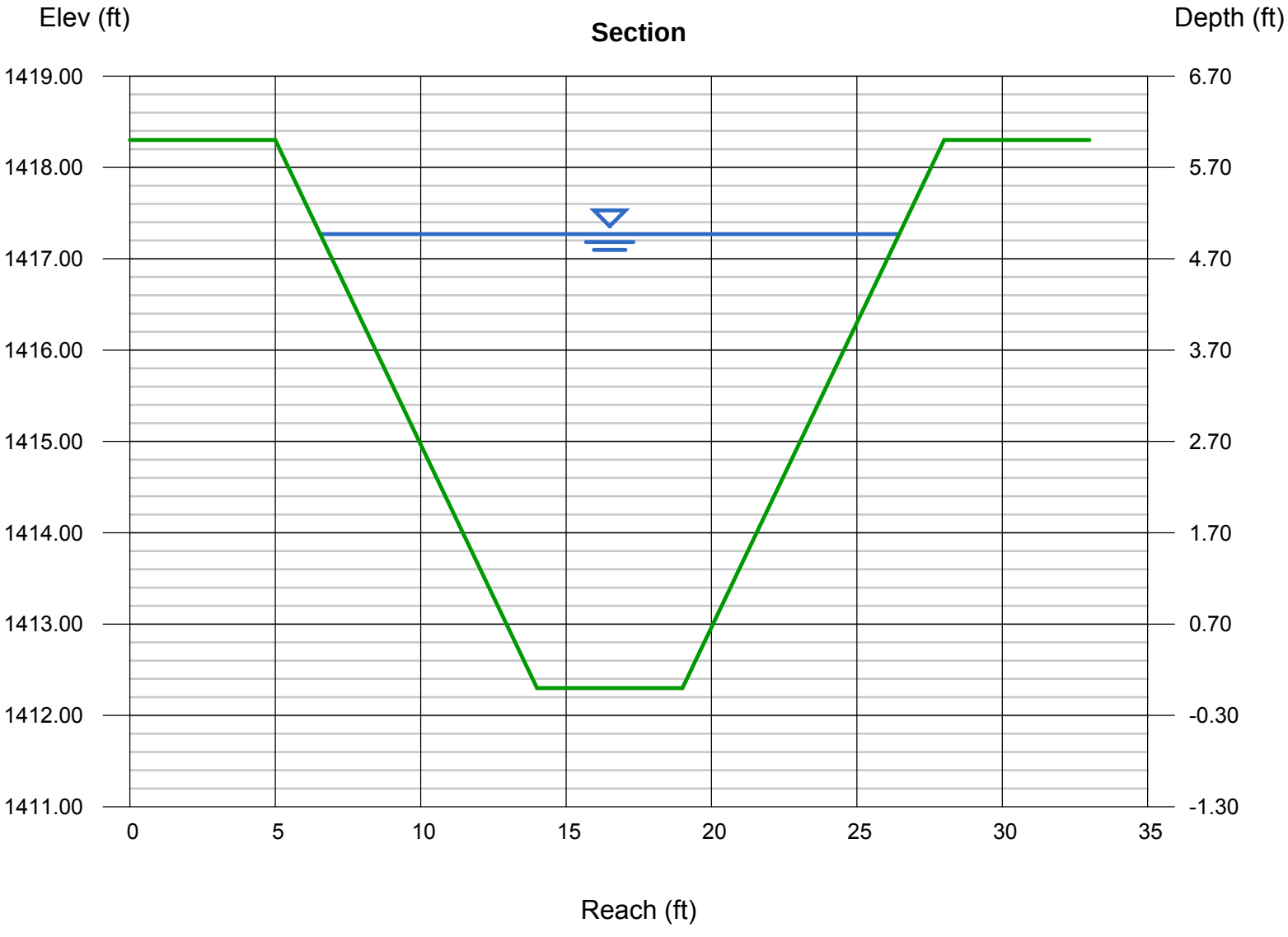
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 1.50, 1.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1412.30
Slope (%)	= 0.30
N-Value	= 0.090

Calculations

Compute by:	Known Q
Known Q (cfs)	= 108.20

Highlighted

Depth (ft)	= 4.97
Q (cfs)	= 108.20
Area (sqft)	= 61.90
Velocity (ft/s)	= 1.75
Wetted Perim (ft)	= 22.92
Crit Depth, Yc (ft)	= 1.99
Top Width (ft)	= 19.91
EGL (ft)	= 5.02



Channel Report

102 to 101A Trapezoidal Channel (4th Assumption)

Trapezoidal

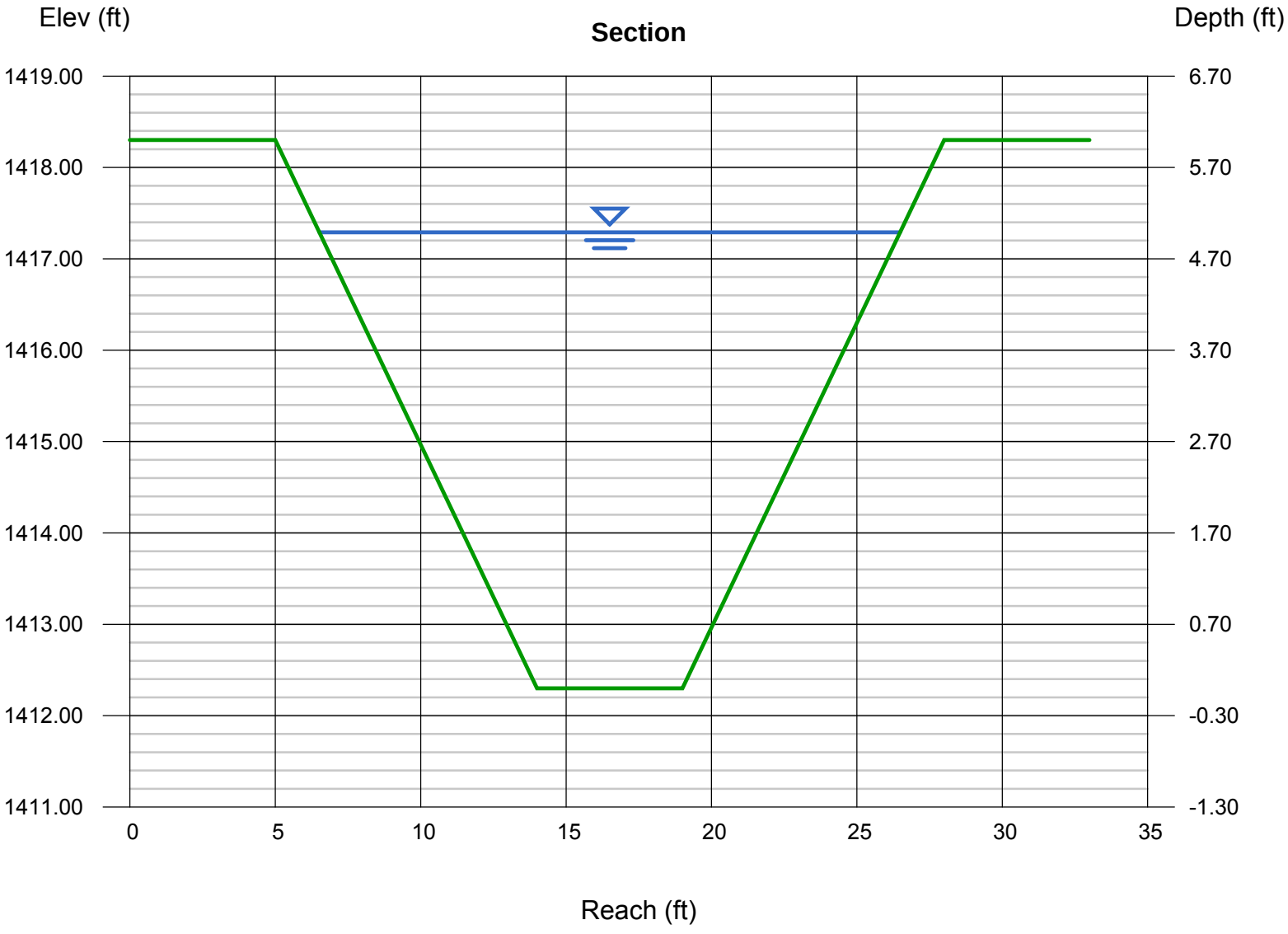
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 1.50, 1.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1412.30
Slope (%)	= 0.30
N-Value	= 0.090

Calculations

Compute by:	Known Q
Known Q (cfs)	= 109.40

Highlighted

Depth (ft)	= 4.99
Q (cfs)	= 109.40
Area (sqft)	= 62.30
Velocity (ft/s)	= 1.76
Wetted Perim (ft)	= 22.99
Crit Depth, Yc (ft)	= 2.00
Top Width (ft)	= 19.97
EGL (ft)	= 5.04



Channel Report

102 to 101A Trapezoidal Channel (5th Assumption)

Trapezoidal

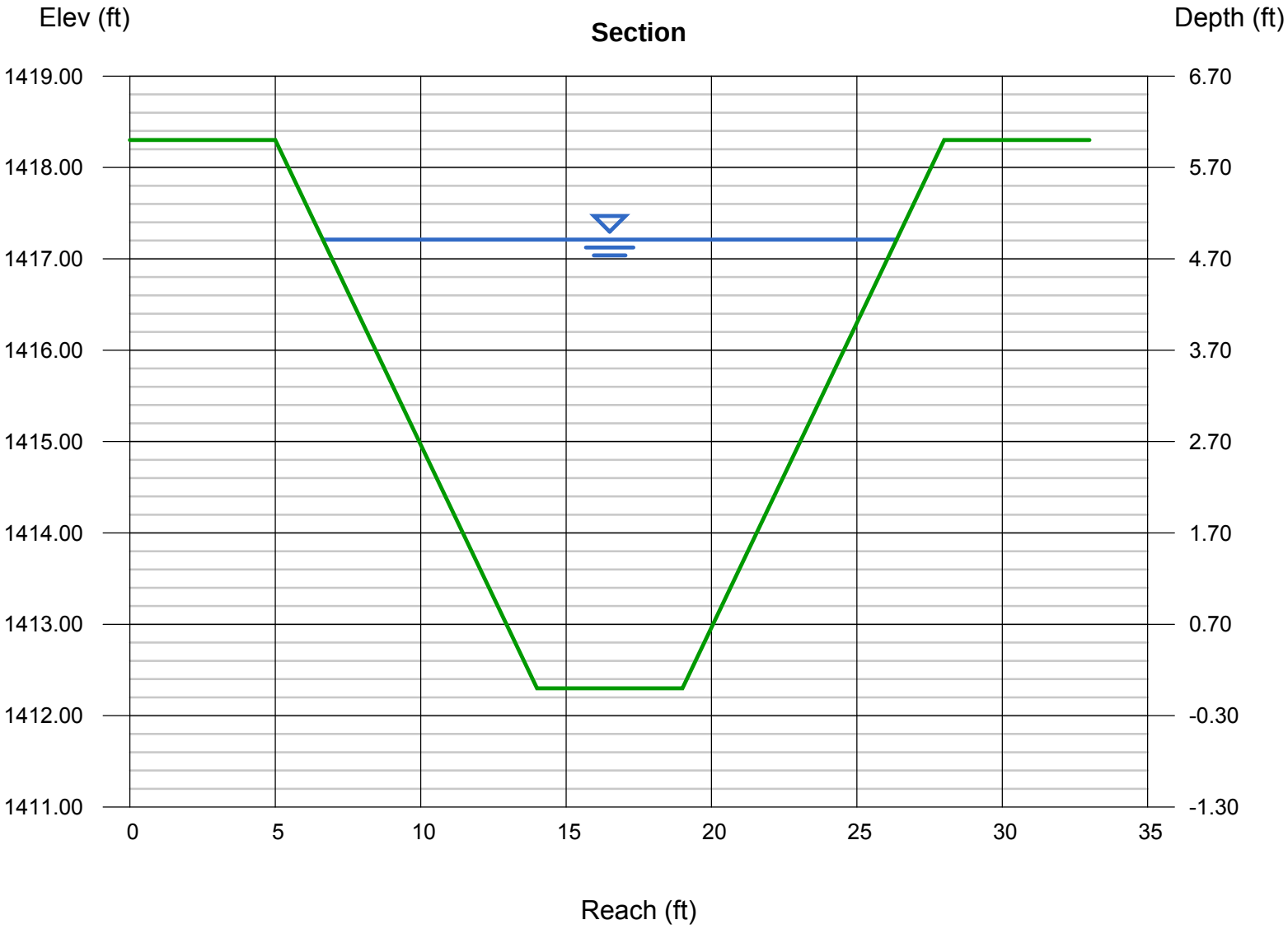
Bottom Width (ft)	= 5.00
Side Slopes (z:1)	= 1.50, 1.50
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1412.30
Slope (%)	= 0.30
N-Value	= 0.090

Calculations

Compute by:	Known Q
Known Q (cfs)	= 105.80

Highlighted

Depth (ft)	= 4.91
Q (cfs)	= 105.80
Area (sqft)	= 60.71
Velocity (ft/s)	= 1.74
Wetted Perim (ft)	= 22.70
Crit Depth, Yc (ft)	= 1.97
Top Width (ft)	= 19.73
EGL (ft)	= 4.96



Channel Report

101A to 100 Natural Trapezoidal Channel (1st Assumption)

Triangular

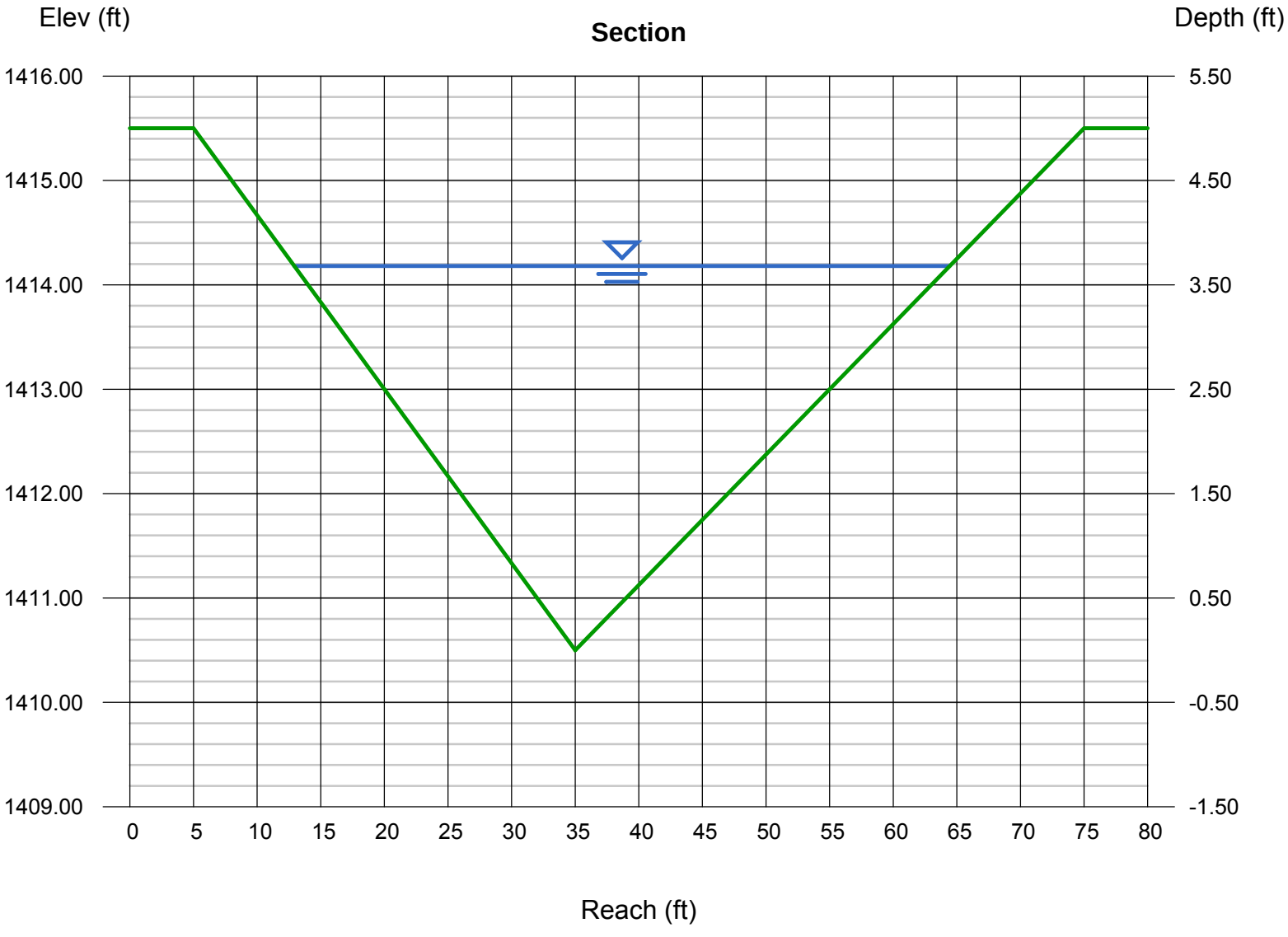
Side Slopes (z:1)	= 6.00, 8.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1410.50
Slope (%)	= 0.10
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 110.40

Highlighted

Depth (ft)	= 3.68
Q (cfs)	= 110.40
Area (sqft)	= 94.80
Velocity (ft/s)	= 1.16
Wetted Perim (ft)	= 52.05
Crit Depth, Yc (ft)	= 1.73
Top Width (ft)	= 51.52
EGL (ft)	= 3.70



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

101A to 100 Natural Trapezoidal Channel (2nd Assumption)

Triangular

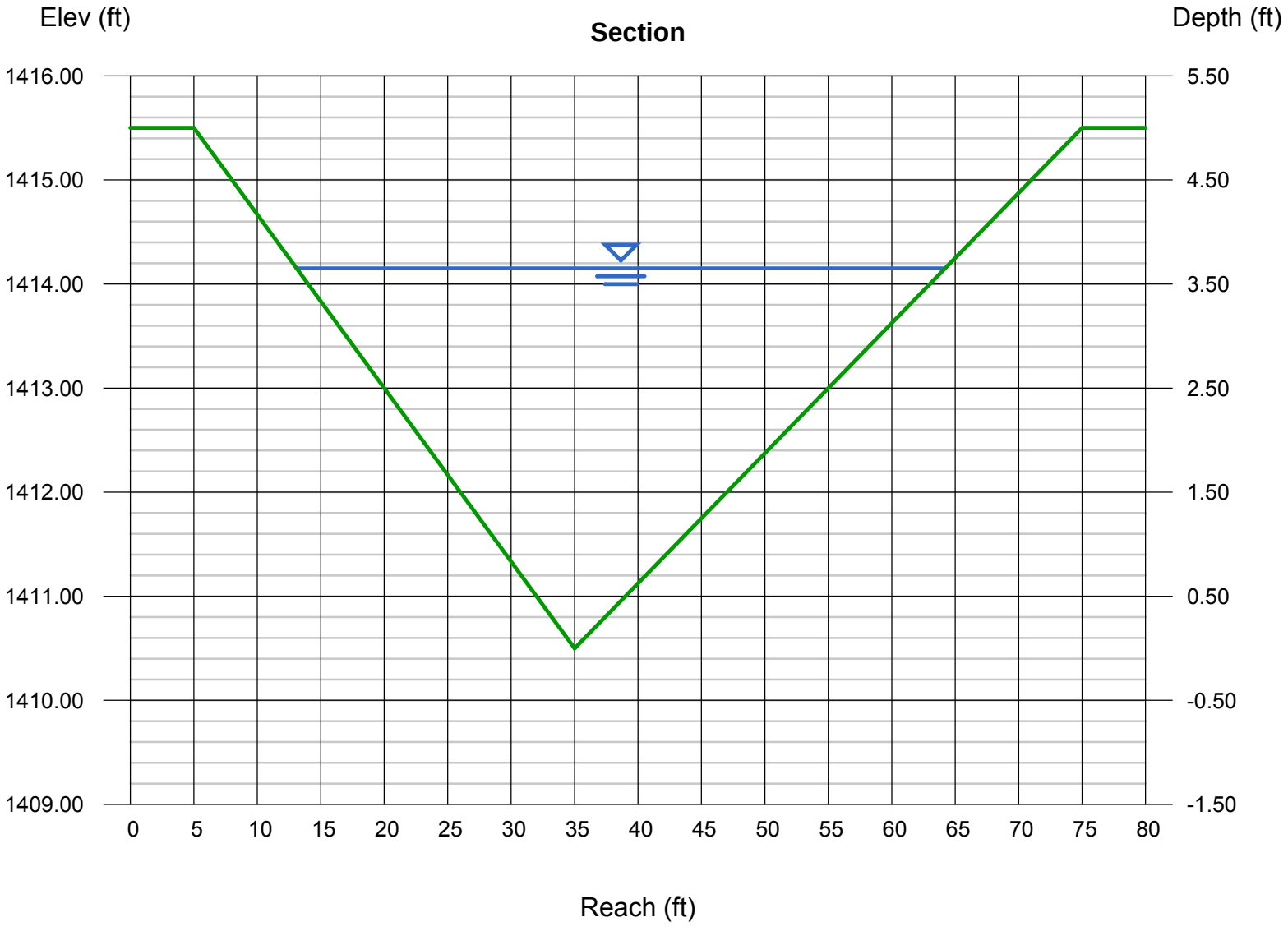
Side Slopes (z:1)	= 6.00, 8.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1410.50
Slope (%)	= 0.10
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 108.30

Highlighted

Depth (ft)	= 3.65
Q (cfs)	= 108.30
Area (sqft)	= 93.26
Velocity (ft/s)	= 1.16
Wetted Perim (ft)	= 51.63
Crit Depth, Yc (ft)	= 1.72
Top Width (ft)	= 51.10
EGL (ft)	= 3.67



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Sunday, Nov 19 2017

101A to 100 Natural Trapezoidal Channel (3rd Assumption)

Triangular

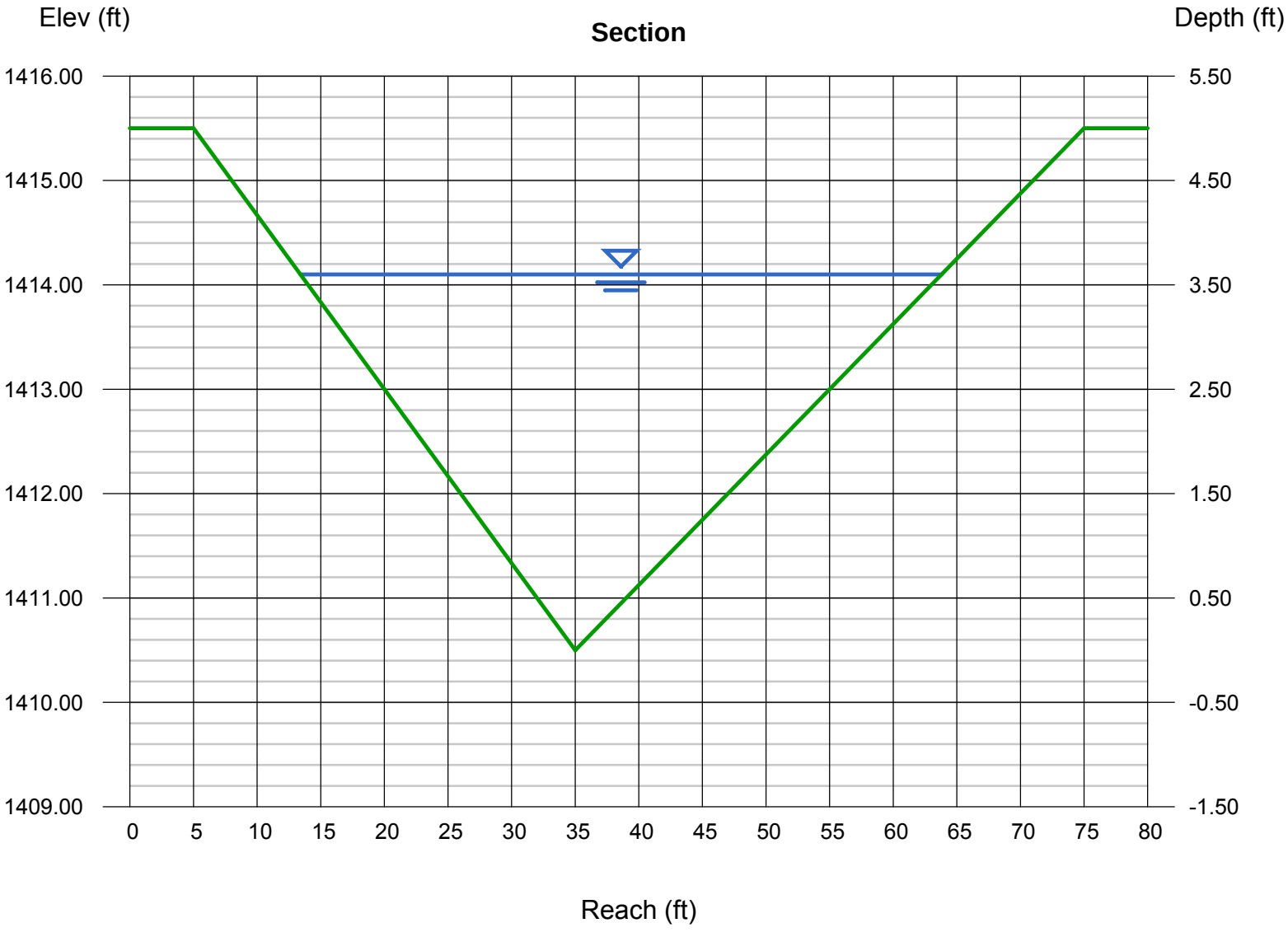
Side Slopes (z:1)	= 6.00, 8.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1410.50
Slope (%)	= 0.10
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 104.30

Highlighted

Depth (ft)	= 3.60
Q (cfs)	= 104.30
Area (sqft)	= 90.72
Velocity (ft/s)	= 1.15
Wetted Perim (ft)	= 50.92
Crit Depth, Yc (ft)	= 1.70
Top Width (ft)	= 50.40
EGL (ft)	= 3.62



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Monday, Nov 20 2017

SYSTEM EX-1, NODE 100

Triangular

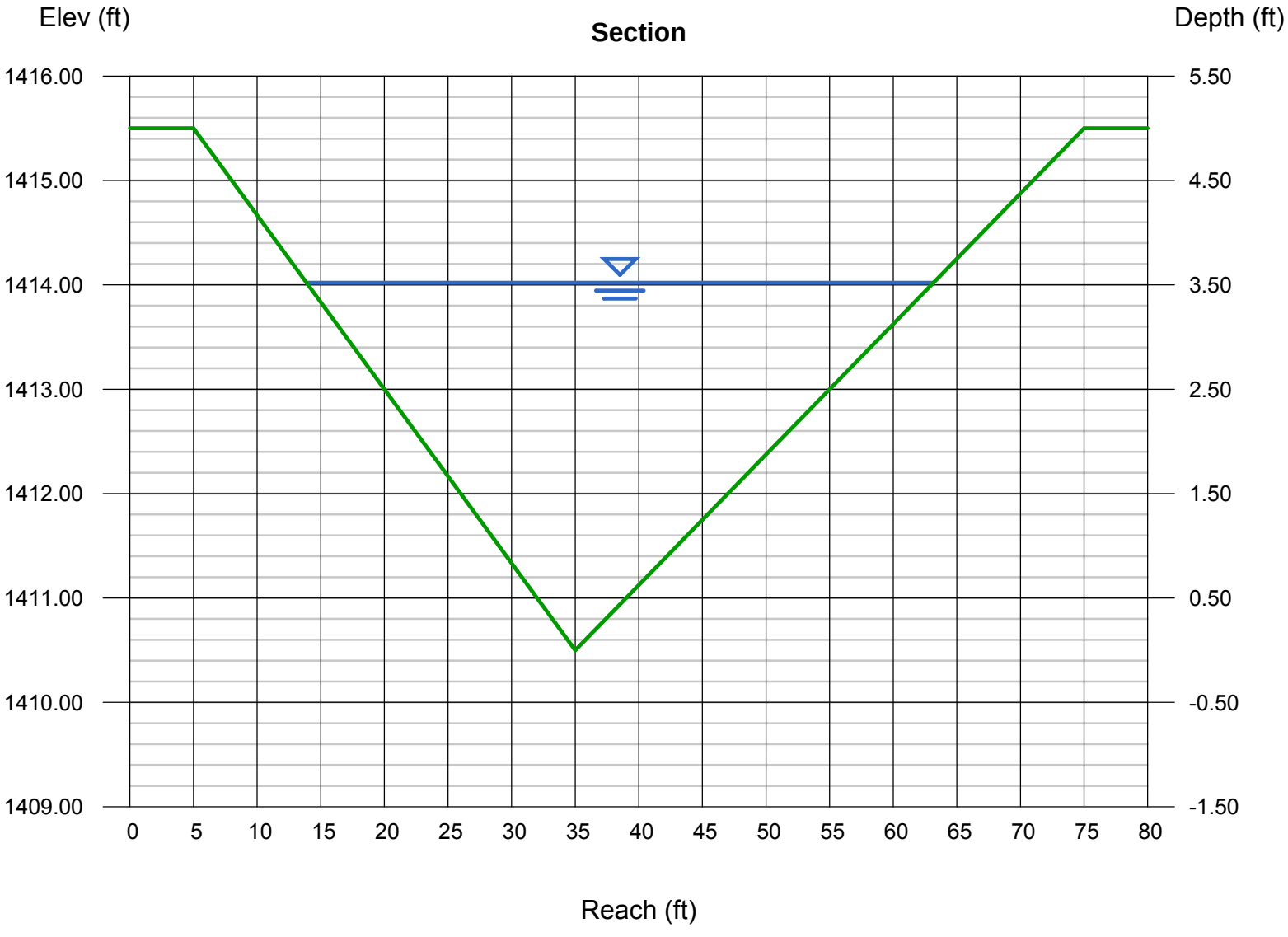
Side Slopes (z:1)	= 6.00, 8.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 1410.50
Slope (%)	= 0.10
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 98.00

Highlighted

Depth (ft)	= 3.52
Q (cfs)	= 98.00
Area (sqft)	= 86.73
Velocity (ft/s)	= 1.13
Wetted Perim (ft)	= 49.79
Crit Depth, Yc (ft)	= 1.65
Top Width (ft)	= 49.28
EGL (ft)	= 3.54



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Monday, Nov 20 2017

SYSTEM EX-2, NODE 200

Triangular

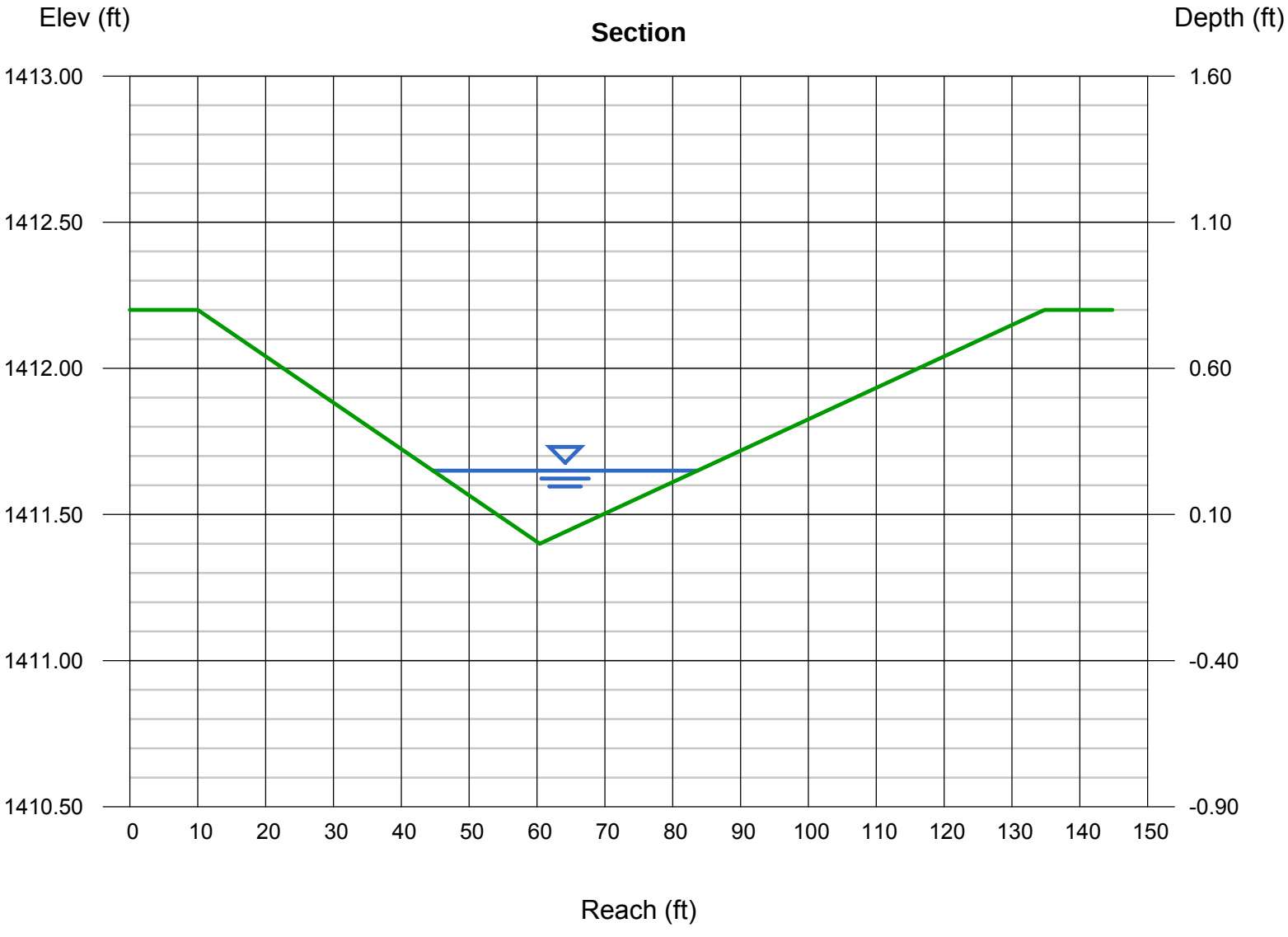
Side Slopes (z:1)	= 63.00, 93.00
Total Depth (ft)	= 0.80
Invert Elev (ft)	= 1411.40
Slope (%)	= 1.00
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.99

Highlighted

Depth (ft)	= 0.25
Q (cfs)	= 2.990
Area (sqft)	= 4.88
Velocity (ft/s)	= 0.61
Wetted Perim (ft)	= 39.00
Crit Depth, Yc (ft)	= 0.16
Top Width (ft)	= 39.00
EGL (ft)	= 0.26



POST DEVELOPMENT SYSTEM 1

105 → 104 → 103 → 102 → 101A SAME AS PREDEVELOPMENT

Q_{101A} = 99.2 CFS T_c = 18.7 MIN

101A → 100

NATURAL CHANNEL FLOW

A = 442,302 SF + D5 + D4 + D2 + D3

= 442,302 + 2586 + 249 + 5334 + 36784 = 487,255 SF
= 11.19 acre

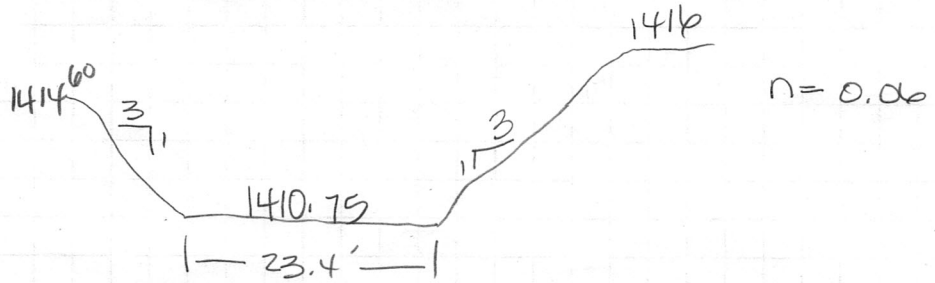
C_{avg} =

442,302	×	0.74	=	327303
2586	×	0.32	=	828
249	×	0.90	=	224
5334	×	0.32	=	1707
36784	×	0.30	=	11035

C_{avg} = 0.70

L = 641 LF S = 0.2%

NATURAL TRAPEZOIDAL CHANNEL



n = 0.06

1st ASSUMPTION

$q_{avg} = 1.0$ cfs/acre

$Q_{ANG} = 99.2 + 1.0\left(\frac{11.19}{2}\right) = 104.8$ CFS

HYDRAFLOW $V = 1.61$ FPS

$T_t = \frac{641 \text{ FT}}{1.61 \text{ FPS}} \cdot \frac{1}{60} = 6.6$ min

$T_c = 18.7 + 6.6 =$ 25.3 min $I = 2.95$

$Q = \Sigma CA \cdot I = 36.0 \times 2.95 =$ 106.2 CFS $= Q_{100}$

Check $Q_{ANG} = 99.2 + \left(\frac{106.2 - 99.2}{2}\right) = 102.7 \cong 104.8$ ok

SYSTEM 3

303 → 302

$A = 5929$ SF $= 0.14$ acre $L = 46'$

$T_c = 5$ min $Q_{100} = 0.77$ cfs (see spreadsheet)

302 → 301

PIPE FLOW $L = 473'$ $S = 0.5\%$

$A =$ DMA A+B+C+E $= 98,957$ SF $= 2.27$ ACRE

$C_{avg} =$ PAVEMENT/ROOFS $= 59428 \times 0.90 = 53485$

LANDSCAPE $= 39529 \times 0.30 = 11859$

$C_{avg} = 0.60$

1st ASSUMPTION

$q_{avg} = 2.0$ cfs/acre

$Q_{AVG} = 0.77 + \frac{2.0(2.27)}{2} = 3.0$ cfs

HYDRAFLOW ⇒ $V = 4.68$ FPS

$T_t = \frac{473 \text{ LF}}{4.68 \text{ FPS}} \cdot \frac{1}{60} = 1.7$ min

$T_c = 5 + 1.7 = 6.7$ min $\quad I = 6.96$

$Q = \Sigma CA \cdot I = 1.59 \times 6.96 = 11.06$

Check $Q_{AVG} = 0.77 + \frac{(11.06 - 0.77)}{2} = 5.92$ CFS $\neq 3.0$ CFS

2ND ASSUMPTION

$q_{avg} = 2.5$ cfs/acre

$Q_{AVG} = 0.77 + \frac{2.5(2.27)}{2} = 3.61$ CFS

HYDRAFLOW ⇒ $V = 5.01$ FPS

$T_t = \frac{473}{5.01} \cdot \frac{1}{60} = 1.6$ min

$T_c = 5 + 1.6 = 6.6$ min $\quad I = 7.03$

$Q = 1.59 \times 7.03 = 11.17$ CFS

Check

$Q_{AVG} = 0.77 + \frac{(11.17 - 0.77)}{2} = 5.97$ CFS $\neq 3.61$ CFS

3RD ASSUMPTION

$q_{avg} = 3.5$ cfs/ac

$Q_{AVG} = 0.77 + \frac{3.5(2.27)}{2} = 4.74$ cfs

HYDRAFLOW $\Rightarrow$ $V = 5.34$ fps

$T_t = \frac{473}{5.34} \cdot \frac{1}{60} = 1.5$ min

$T_c = 5 + 1.5 = 6.5$ min $\quad I = 7.10$

$Q = 1.59 \times 7.10 = 11.3$ CFS

Check

$Q_{AVG} = 0.77 + \frac{(11.3 - 0.77)}{2} = 6.04$ cfs $\neq 4.74$

4TH ASSUMPTION

$q_{avg} = 4.5$ cfs/acre

$Q_{AVG} = 0.77 + \frac{4.5(2.27)}{2} = 5.9$ CFS

HYDRAFLOW $\Rightarrow$ $V = 5.71$ FPS

$T_t = \frac{473}{5.71} \cdot \frac{1}{60} = 1.4$ min

$T_c = 5 + 1.4 \neq 6.4$ min $\quad I = 7.17$

$Q = 1.59 \times 7.17 \neq 11.40$ cfs

Check

$Q_{AVG} = 0.77 + \frac{(11.4 - 0.77)}{2} = 6.09 \cong 5.9$ CFS OK

301 ⟶ 300

$Q_{IN} = 11.40$ CFS

BIORETENTION POND Volume & Riser overflow

= S.A @ W.LEVEL 1415.3 = 8,756 SF

DEPTH = 1'

$V = 8{,}756 \times 1 = 8{,}756$ CF

$$T_t = \frac{8{,}756 \text{ CF}}{11.40 \text{ CFS}} \cdot \frac{1}{60} = 12.80 \text{ min}$$

$T_c = 12.80 \text{ min} + 6.4 \text{ min} = 19.2 \text{ min}$ $\quad I = 3.53$

$Q_{300} = 1.59 \times 3.53 = 5.12$ cfs (spreadsheet 5.61 cfs)

JUNCTION SYSTEM 1 & 3

System	Q (cfs)	Tc (min)	I (in/hr)	A (acres)	Σ CA
1	106.4	25.3	2.95	52.4	36.0
3	5.61	19.2	3.93	2.41	1.59
					37.59

$T_3 < T_1$

$$Q_{T3} = Q_3 + \frac{T_1}{T_3} \cdot Q_1$$

$$= 5.61 + \frac{19.2}{25.3} \cdot 106.4 = 86.4 \text{ cfs}$$

$$Q_{T1} = Q_1 + \frac{I_1}{I_3} Q_3 = 111.1 \text{ cfs}$$ (Q_{100} =)

HYDRA FLOW V = 1.64 cfs

$$T_c = \left[\frac{(\Sigma CA)\, 7.44\, P_6}{Q} \right]^{1.55}$$

$P_6 = 3.19 \qquad Q = 111.1 \text{ cfs} \qquad \Sigma CA = 37.59$

$$T_c = \left[\frac{37.59 \times 7.44 \times 3.19}{111.1} \right]^{1.55} = 25.3 \text{ MIN}$$

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Monday, Nov 20 2017

POST DEVELOPMENT: 101A to 101 Natural Channel (1st Assumption)

Trapezoidal

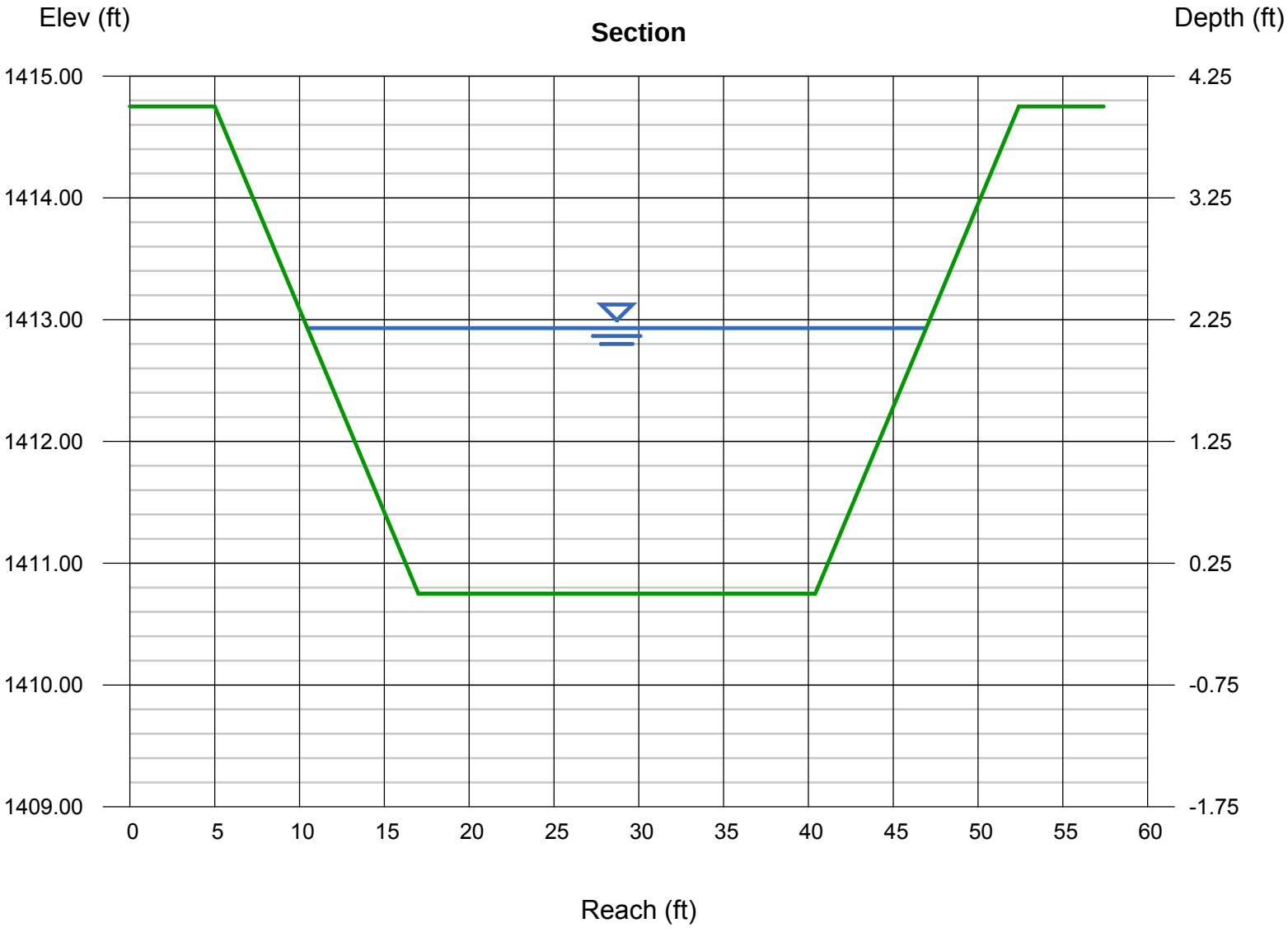
Bottom Width (ft)	= 23.40
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 4.00
Invert Elev (ft)	= 1410.75
Slope (%)	= 0.20
N-Value	= 0.060

Calculations

Compute by:	Known Q
Known Q (cfs)	= 104.80

Highlighted

Depth (ft)	= 2.18
Q (cfs)	= 104.80
Area (sqft)	= 65.27
Velocity (ft/s)	= 1.61
Wetted Perim (ft)	= 37.19
Crit Depth, Yc (ft)	= 0.83
Top Width (ft)	= 36.48
EGL (ft)	= 2.22



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. Monday, Nov 20 2017

POST DEVELOPMENT: 302 to 301 Pipe Flow (1st Assumption)

Circular

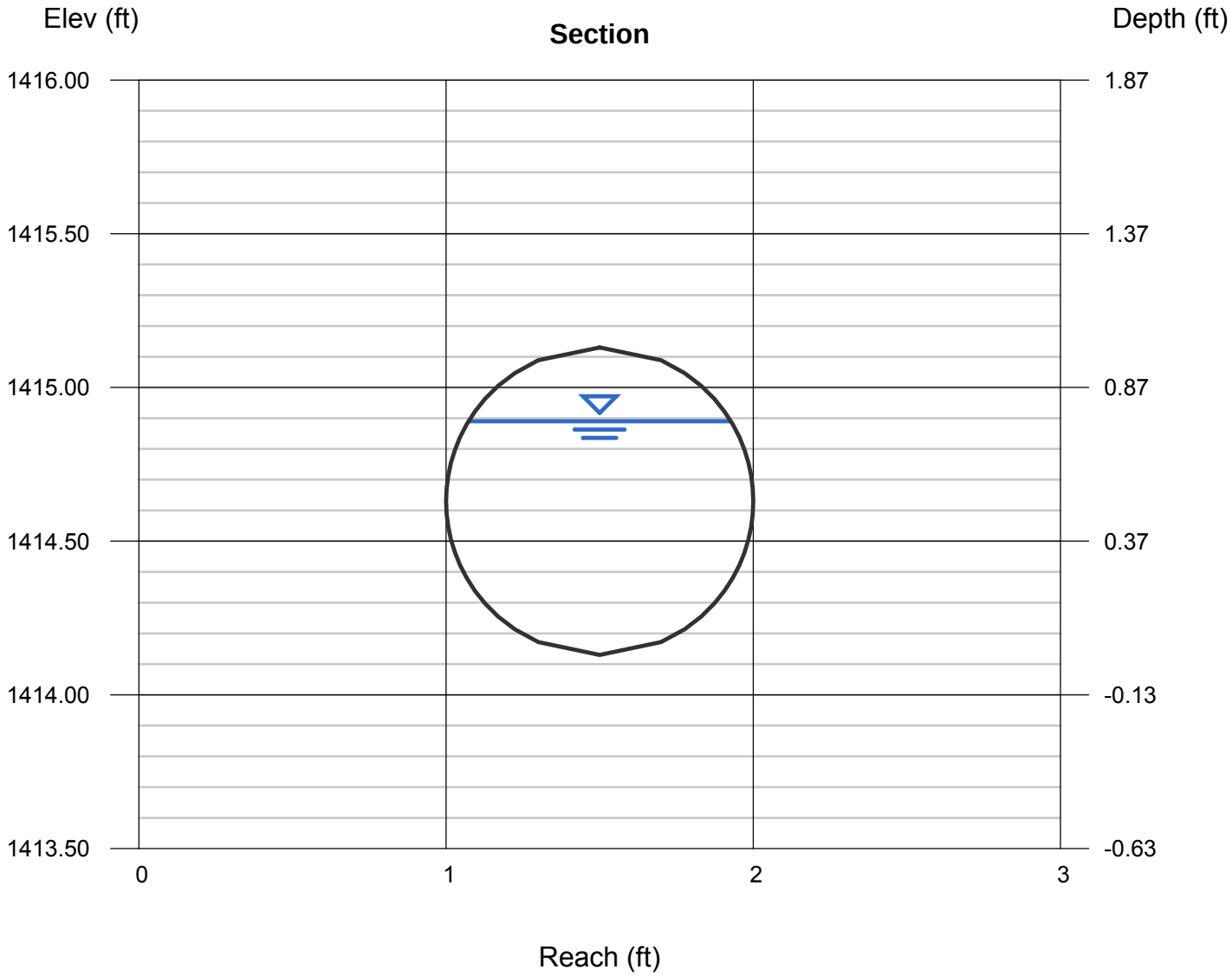
Diameter (ft)	= 1.00
Invert Elev (ft)	= 1414.13
Slope (%)	= 0.50
N-Value	= 0.010

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.00

Highlighted

Depth (ft)	= 0.76
Q (cfs)	= 3.000
Area (sqft)	= 0.64
Velocity (ft/s)	= 4.68
Wetted Perim (ft)	= 2.12
Crit Depth, Yc (ft)	= 0.75
Top Width (ft)	= 0.85
EGL (ft)	= 1.10



Channel Report

POST DEVELOPMENT: 302 to 301 Pipe Flow (2nd Assumption)

Circular

Diameter (ft)	= 1.50
Invert Elev (ft)	= 1414.13
Slope (%)	= 0.50
N-Value	= 0.010

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.61

Highlighted

Depth (ft)	= 0.64
Q (cfs)	= 3.610
Area (sqft)	= 0.72
Velocity (ft/s)	= 5.01
Wetted Perim (ft)	= 2.14
Crit Depth, Yc (ft)	= 0.73
Top Width (ft)	= 1.48
EGL (ft)	= 1.03