TIME OF CONCENTRATION
FOR EX-1 & EX-4

Time of Concentration and Travel Time						
Flow Type	**Length (ft)**	**Slope(ft/ft)**	**Surface**	**Mannings "n"**	**Velocity (ft/sec)**	**Travel Time (min)**
Sheet	100	0.12	i	0.8	n/a	**19.520**
Shallow Concentrated	348	0.09	u	n/a	4.84	**1.198**
Shallow Concentrated	436	0.18	u	n/a	6.85	**1.062**
Shallow Concentrated	203	0.29	u	n/a	8.69	**0.389**
Shallow Concentrated	355	0.23	u	n/a	7.74	**0.765**
Shallow Concentrated	116	0.06	u	n/a	3.95	**0.489**
Time of Concentration						**23.423**

Sheet Flow Surfaces		
a	Smooth Surface	0.011
b	fallow (no residue)	0.05
c	cultivated < 20% Res.	0.06
d	cultivated > 20% Res.	0.17
e	grass - range, short	0.15
f	grass, dense	0.24
g	grass, bermuda	0.41
h	woods, light	0.4
I	woods, dense	0.8
j	range, natural	0.13
	2yr 24hr rain event	2.8

Shallow Concentrated Surface Codes
u
p

Shallow Concentrated Flow
T = Travel time (hr)
L = flow length (ft)
V= Average Velocity

T = L/3600V

Sheet Flow
T = Travel time (hr)
n = Manning's Roughness Coefficient = dense woods = 0.8
L = flow length (ft)
P = 2-year, 24-hour rainfall (in) = 2.8 in
s = Slope of Hydraulic Grade Line

T = [0.007(nL)^0.8] / (P^0.5)(s^0.4)

TIME OF CONCENTRATION WAS DETERMINED BY CONSIDERING THE FIRST 100' AS SHEET FLOW, AND FOLLOWING FLOW TYPES AS SHALLOW CONCENTRATED FLOW BY INTERVALS IN WHICH AVERAGE SLOPE CHANGED.

INTENSITY WAS DETERMINED BY CONSIDERING THE NOAA TABLES AND INTERPOLATING FOR THE TIME OF CONCENTRATION.

THE SWALE WAS SIZED CONSIDERING A 100-YEAR STORM EVENT FOR THE INTENSITY.

THE PROPOSED 12-IN PIPE WAS SIZED CONSIDERING A 25-YEAR STORM EVEN FOR THE INTENSITY.

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**1.78** (1.55-2.08)	**2.23** (1.93-2.62)	**2.84** (2.45-3.32)	**3.34** (2.84-3.95)	**4.01** (3.29-4.96)	**4.54** (3.61-5.75)	**5.08** (3.92-6.62)	**5.63** (4.20-7.61)	**6.37** (4.52-9.08)	**6.96** (4.73-10.3)
10-min	**1.28** (1.10-1.49)	**1.60** (1.39-1.87)	**2.03** (1.76-2.38)	**2.39** (2.04-2.83)	**2.87** (2.35-3.55)	**3.25** (2.59-4.12)	**3.64** (2.81-4.75)	**4.03** (3.01-5.45)	**4.57** (3.24-6.51)	**4.99** (3.39-7.41)
15-min	**1.03** (0.892-1.20)	**1.29** (1.12-1.51)	**1.64** (1.42-1.92)	**1.93** (1.64-2.28)	**2.32** (1.90-2.86)	**2.62** (2.09-3.32)	**2.93** (2.26-3.83)	**3.25** (2.42-4.40)	**3.68** (2.61-5.25)	**4.02** (2.73-5.97)
30-min	**0.716** (0.620-0.834)	**0.898** (0.778-1.05)	**1.14** (0.984-1.34)	**1.34** (1.14-1.59)	**1.61** (1.32-1.99)	**1.82** (1.45-2.31)	**2.04** (1.57-2.66)	**2.26** (1.69-3.06)	**2.56** (1.82-3.65)	**2.79** (1.90-4.15)
60-min	**0.505** (0.438-0.588)	**0.634** (0.549-0.740)	**0.806** (0.695-0.943)	**0.946** (0.807-1.12)	**1.14** (0.931-1.40)	**1.29** (1.02-1.63)	**1.44** (1.11-1.88)	**1.60** (1.19-2.16)	**1.81** (1.28-2.58)	**1.97** (1.34-2.93)

interpolated for 23.42 min duration
(SD Pipe Calculation)
i = 1.92 in/hr

interpolated for 23.42 min duration
(Swale Calculation)
i = 2.43 in/hr

TIME OF CONCENTRATION
FOR EX-2 & EX-3

Time of Concentration and Travel Time						
Flow Type	**Length (ft)**	**Slope(ft/ft)**	**Surface**	**Mannings "n"**	**Velocity (ft/sec)**	**Travel Time (min)**
Sheet	100	0.16	i	0.8	n/a	**17.398**
Shallow Concentrated	269	0.18	u	n/a	6.85	**0.655**
Shallow Concentrated	203	0.29	u	n/a	8.69	**0.389**
Shallow Concentrated	355	0.23	u	n/a	7.74	**0.765**
Shallow Concentrated	116	0.06	u	n/a	3.95	**0.489**
Time of Concentration						**19.696**

Sheet Flow Surfaces		
a	Smooth Surface	0.011
b	fallow (no residue)	0.05
c	cultivated < 20% Res.	0.06
d	cultivated > 20% Res.	0.17
e	grass - range, short	0.15
f	grass, dense	0.24
g	grass, bermuda	0.41
h	woods, light	0.4
I	woods, dense	0.8
j	range, natural	0.13
	2yr 24hr rain event	2.8

Shallow Concentrated Surface Codes

u

p

Shallow Concentrated Flow
T = Travel time (hr)
L = flow length (ft)
V= Average Velocity

T = L/3600V

Sheet Flow
T = Travel time (hr)
n = Manning's Roughness Coefficient = dense woods = 0.8
L = flow length (ft)
P = 2-year, 24-hour rainfall (in) = 2.8 in
s = Slope of Hydraulic Grade Line

T = [0.007(nL)^0.8] / (P^0.5)(s^0.4)

TIME OF CONCENTRATION WAS DETERMINED BY CONSIDERING THE FIRST 100' AS SHEET FLOW, AND FOLLOWING FLOW TYPES AS SHALLOW CONCENTRATED FLOW BY INTERVALS IN WHICH AVERAGE SLOPE CHANGED.

INTENSITY WAS DETERMINED BY CONSIDERING THE NOAA TABLES AND INTERPOLATING FOR THE TIME OF CONCENTRATION.

THE SWALE WAS SIZED CONSIDERING A 100-YEAR STORM EVENT FOR THE INTENSITY.

THE PROPOSED 12-IN PIPE WAS SIZED CONSIDERING A 25-YEAR STORM EVEN FOR THE INTENSITY.

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**1.78** (1.55-2.08)	**2.23** (1.93-2.62)	**2.84** (2.45-3.32)	**3.34** (2.84-3.95)	**4.01** (3.29-4.96)	**4.54** (3.61-5.75)	**5.08** (3.92-6.62)	**5.63** (4.20-7.61)	**6.37** (4.52-9.08)	**6.96** (4.73-10.3)
10-min	**1.28** (1.10-1.49)	**1.60** (1.39-1.87)	**2.03** (1.76-2.38)	**2.39** (2.04-2.83)	**2.87** (2.35-3.55)	**3.25** (2.59-4.12)	**3.64** (2.81-4.75)	**4.03** (3.01-5.45)	**4.57** (3.24-6.51)	**4.99** (3.39-7.41)
15-min	**1.03** (0.892-1.20)	**1.29** (1.12-1.51)	**1.64** (1.42-1.92)	**1.93** (1.64-2.28)	**2.32** (1.90-2.86)	**2.62** (2.09-3.32)	**2.93** (2.26-3.83)	**3.25** (2.42-4.40)	**3.68** (2.61-5.25)	**4.02** (2.73-5.97)
30-min	**0.716** (0.620-0.834)	**0.898** (0.778-1.05)	**1.14** (0.984-1.34)	**1.34** (1.14-1.59)	**1.61** (1.32-1.99)	**1.82** (1.45-2.31)	**2.04** (1.57-2.66)	**2.26** (1.69-3.06)	**2.56** (1.82-3.65)	**2.79** (1.90-4.15)
60-min	**0.505** (0.438-0.588)	**0.634** (0.549-0.740)	**0.806** (0.695-0.943)	**0.946** (0.807-1.12)	**1.14** (0.931-1.40)	**1.29** (1.02-1.63)	**1.44** (1.11-1.88)	**1.60** (1.19-2.16)	**1.81** (1.28-2.58)	**1.97** (1.34-2.93)

interpolated for 19.70 min duration
(SD Pipe Calculation)
i = 2.10 in/hr

interpolated for 19.70 min duration
(Swale Calculation)
i = 2.65 in/hr

50 0 50 100 200

SANDIS
SILICON VALLEY

SCALE: 1"=100'

LEGEND

DRAINAGE AREA ENTERING PIPE

DRAINAGE AREA ENTERING SWALE

PIPE DRAINAGE AREA:
79,232 SF ≈ 1.81 ACRES

SWALE DRAINAGE AREA:
18,506 SF ≈ 0.65 ACRES

10-IN SDR-35 SD PIPE CAPTURING PIPE DRAINAGE AREA

COMMON OPEN SPACE

BMR 1

BMR 2

BMR 3

Dense Trees

ALPINE ROAD

SANDIS
CIVIL ENGINEERS
SURVEYORS
PLANNERS

1700 S. Winchester Blvd, Suite 200, Campbell, CA 95008 I P. 408.636.0900 I F. 408.636.0999 I www.sandis.net

SILICON VALLEY TRI-VALLEY CENTRAL VALLEY SACRAMENTO EAST BAY/ SF

DATE: 08/24/2021
SCALE: 1"=100'
DRAWN BY: IG
APPROVED BY: ND
DRAWING NO.: 217062

HYDROLOGY CALCULATIONS EXHIBIT

STANFORD UNIVERSITY
PORTOLA VALLEY FACULTY HOUSING
PORTOLA VALLEY CALIFORNIA

SHEET
EX-3

File: S:\217062\(4) ENGINEERING\(3) EXHIBITS\2019-10-29_Swale-Pipe Sizing Exhibit\Swale Drainage Area Exhibit.dwg Date:Aug 24, 2021 - 1:00pm, Isolis

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Swale Sizing EX-3

Triangular

Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 0.75
Invert Elev (ft)	= 1.00
Slope (%)	= 0.50
N-Value	= 0.030

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

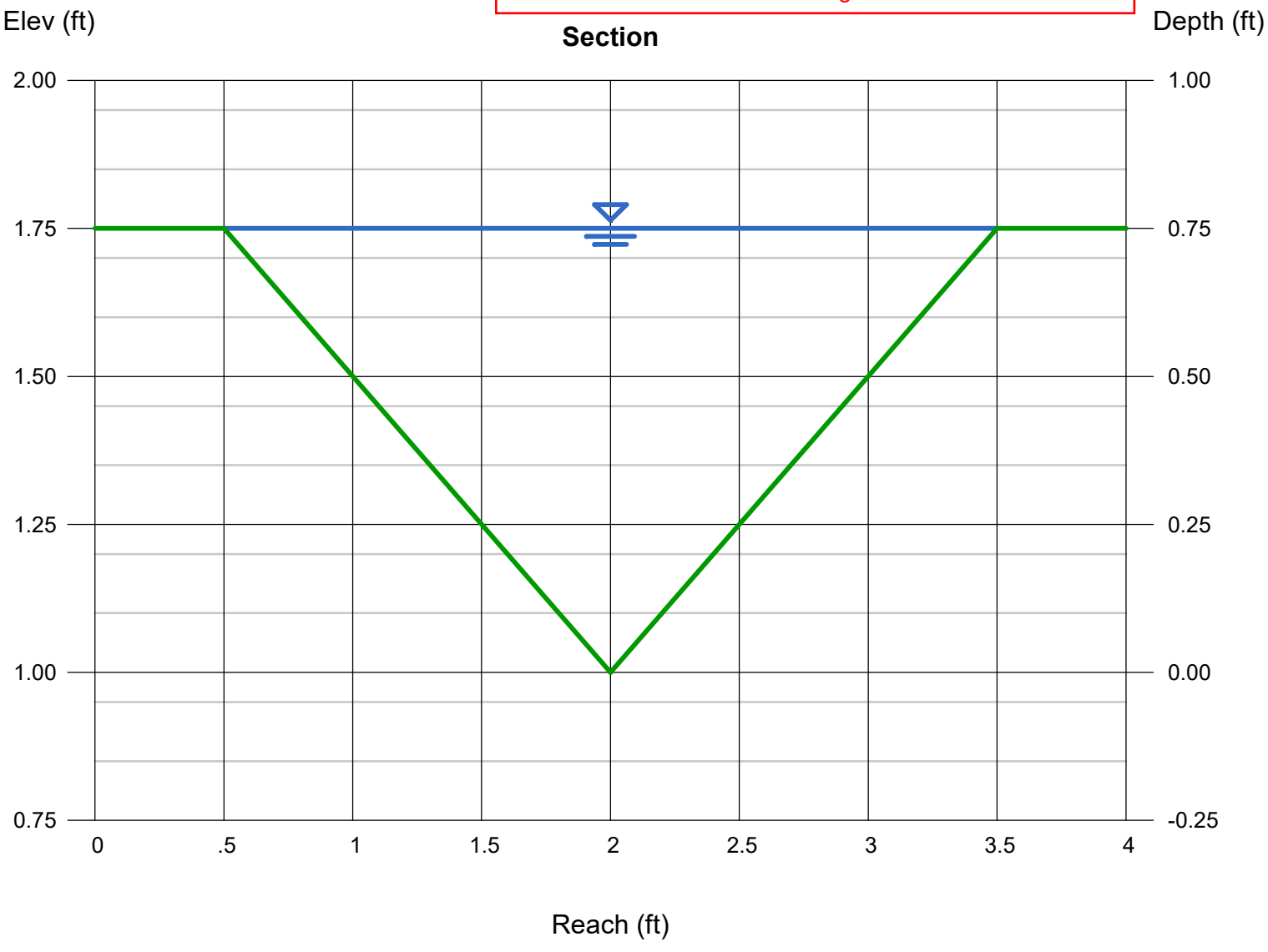
Highlighted

Depth (ft)	= 0.75
Q (cfs)	= 1.901
Area (sqft)	= 1.13
Velocity (ft/s)	= 1.69
Wetted Perim (ft)	= 3.35
Crit Depth, Yc (ft)	= 0.57
Top Width (ft)	= 3.00
EGL (ft)	= 0.79

Q = cia
c = runoff coefficient = 0.3
i = intensity = 2.65 in/hr (interpolated NOAA Estimate considering 100-year storm)
a = drainage area = 0.65 acres

Q = 0.3 x 2.65 in/hr x 0.65 acres = 0.52 **cfs**

Refer to EX-3 for Swale drainage area



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Pipe Sizing EX-3 (10-in SDR-35)

Circular

Diameter (ft)	= 0.83
Invert Elev (ft)	= 1.00
Slope (%)	= 0.30
N-Value	= 0.010

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

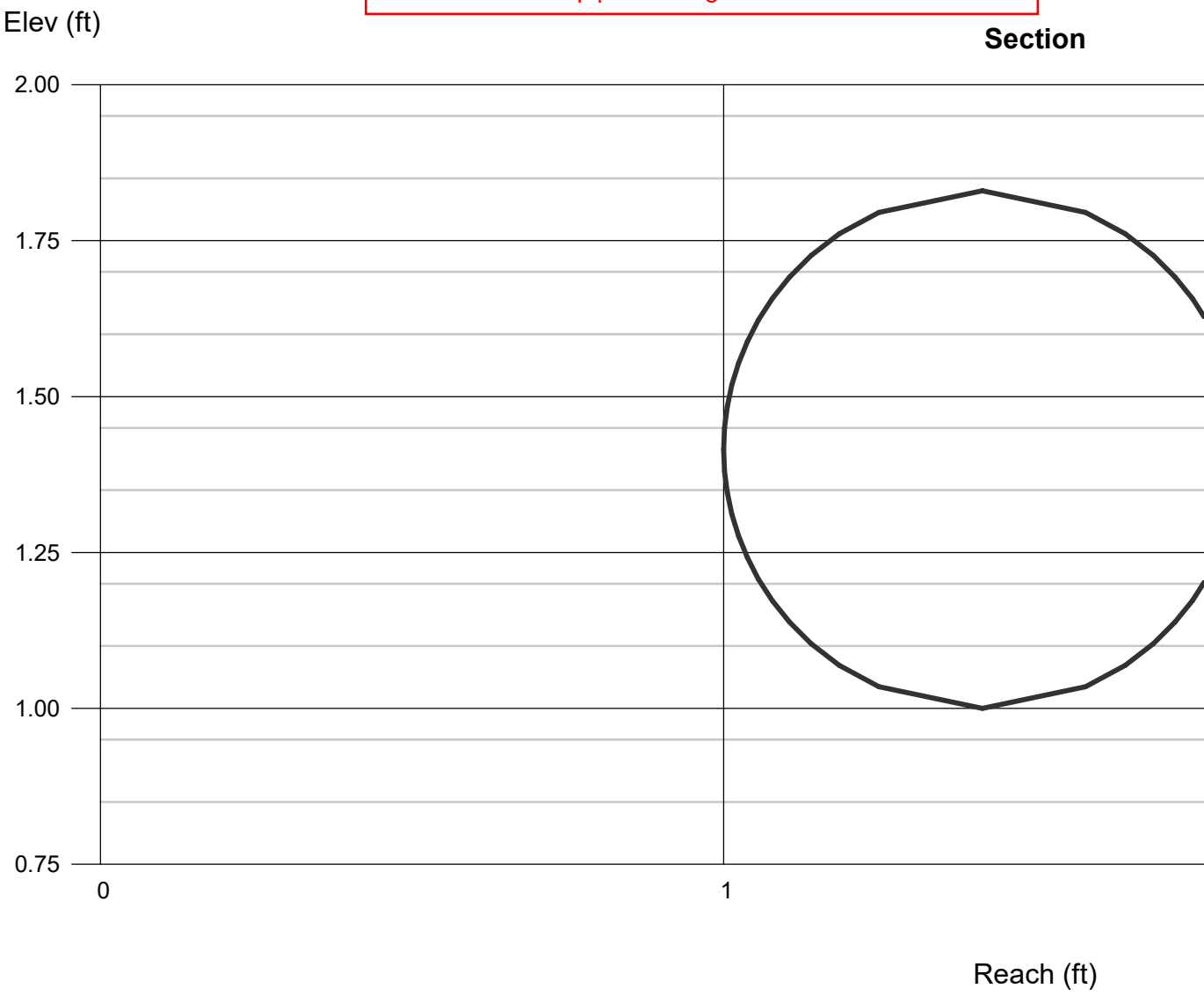
Highlighted

Depth (ft)	= 0.83
Q (cfs)	= 1.543
Area (sqft)	= 0.54
Velocity (ft/s)	= 2.85
Wetted Perim (ft)	= 2.61
Crit Depth, Yc (ft)	= 0.56
Top Width (ft)	= 0.00
EGL (ft)	= 0.96

Q = cia
c = runoff coefficient = 0.3
i = intensity = 2.10 in/hr (interpolated NOAA Estimate considering 25-year storm)
a = drainage area = 1.81 acres

Q = 0.3 x 2.10 in/hr x 1.81 acres = **1.14 cfs**

Refer to EX-3 for pipe drainage area



50 0 50 100 200

SANDIS
SILICON VALLEY

SCALE: 1"=100'

LEGEND

DRAINAGE AREA ENTERING PIPE

DRAINAGE AREA ENTERING SWALE

PIPE DRAINAGE AREA:
186,306 SF ≈ 4.28 ACRES

SWALE DRAINAGE AREA:
107,064 SF ≈ 2.46 ACRES

12-IN SDR-35 SD PIPE CAPTURING PIPE DRAINAGE AREA

COMMON OPEN SPACE

BMR 1

BMR 2

BMR 3

Dense Trees

ALPINE ROAD

SANDIS CIVIL ENGINEERS SURVEYORS PLANNERS

1700 S. Winchester Blvd, Suite 200, Campbell, CA 95008 I P. 408.636.0900 I F. 408.636.0999 I www.sandis.net

SILICON VALLEY TRI-VALLEY CENTRAL VALLEY SACRAMENTO EAST BAY/ SF

DATE: 08/24/2021
SCALE: 1"=100'
DRAWN BY: IG
APPROVED BY: ND
DRAWING NO: 217062

HYDROLOGY CALCULATIONS EXHIBIT

STANFORD UNIVERSITY
PORTOLA VALLEY FACULTY HOUSING
PORTOLA VALLEY CALIFORNIA

SHEET
EX-2

File: S:\217062\(4) ENGINEERING\(3) EXHIBITS\2019-10-29_Swale-Pipe Sizing Exhibit\Swale Drainage Area Exhibit.dwg Date:Aug 24, 2021 - 1:00pm, Isolis

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Swale Sizing EX-2

Triangular

Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 0.75
Invert Elev (ft)	= 1.00
Slope (%)	= 1.20
N-Value	= 0.030

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

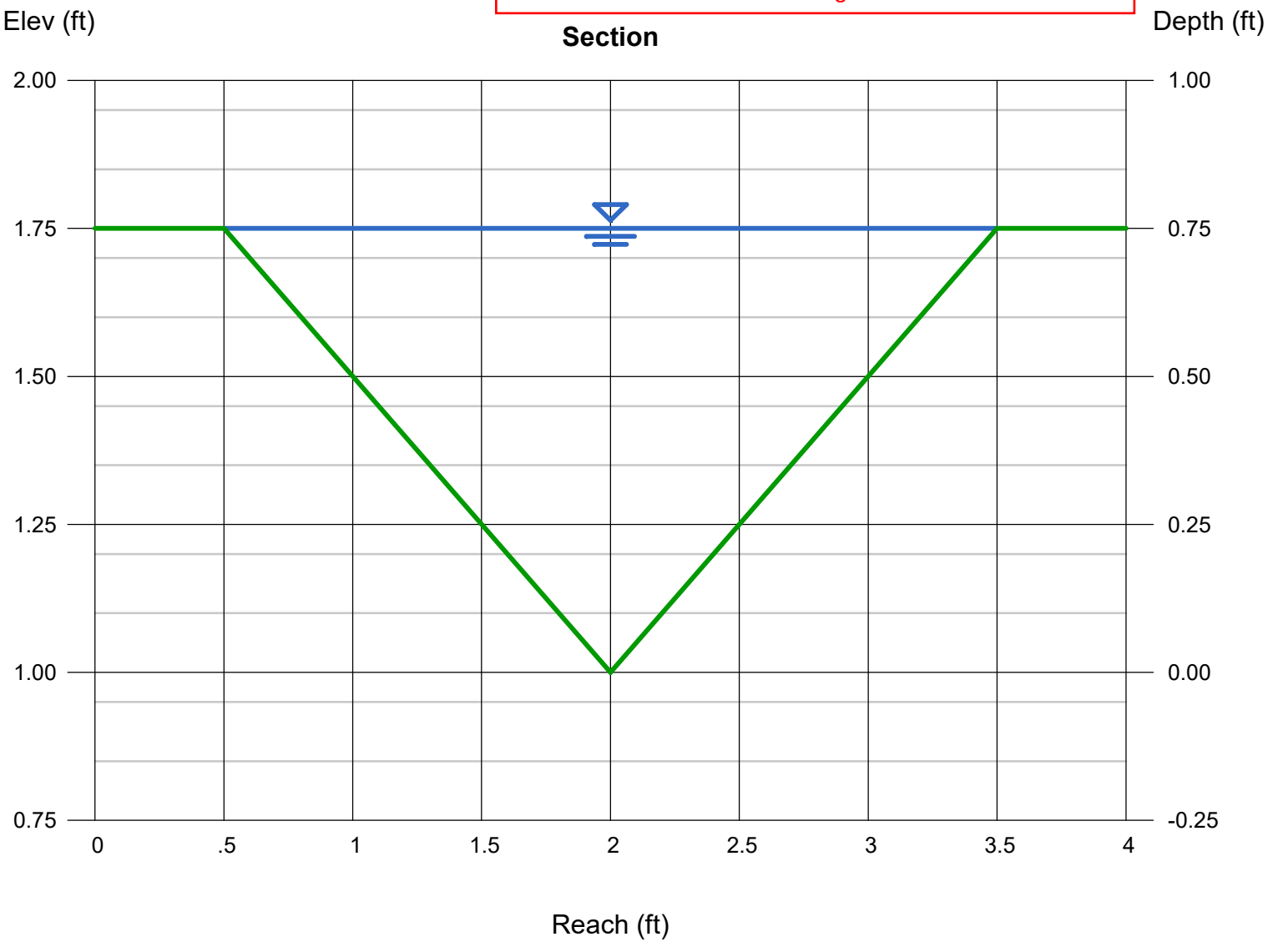
Highlighted

Depth (ft)	= 0.75
Q (cfs)	= 2.946
Area (sqft)	= 1.13
Velocity (ft/s)	= 2.62
Wetted Perim (ft)	= 3.35
Crit Depth, Yc (ft)	= 0.67
Top Width (ft)	= 3.00
EGL (ft)	= 0.86

Q = cia
c = runoff coefficient = 0.3
i = intensity = 2.65 in/hr (interpolated NOAA Estimate considering 100-year storm)
a = drainage area = 2.46 acres

Q = 0.3 x 2.65 in/hr x 2.46 acres = **1.96 cfs**

Refer to EX-2 for swale drainage area



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Pipe Sizing EX-2 (12-in SDR-35)

Circular

Diameter (ft)	= 1.00
Invert Elev (ft)	= 1.00
Slope (%)	= 0.80
N-Value	= 0.010

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

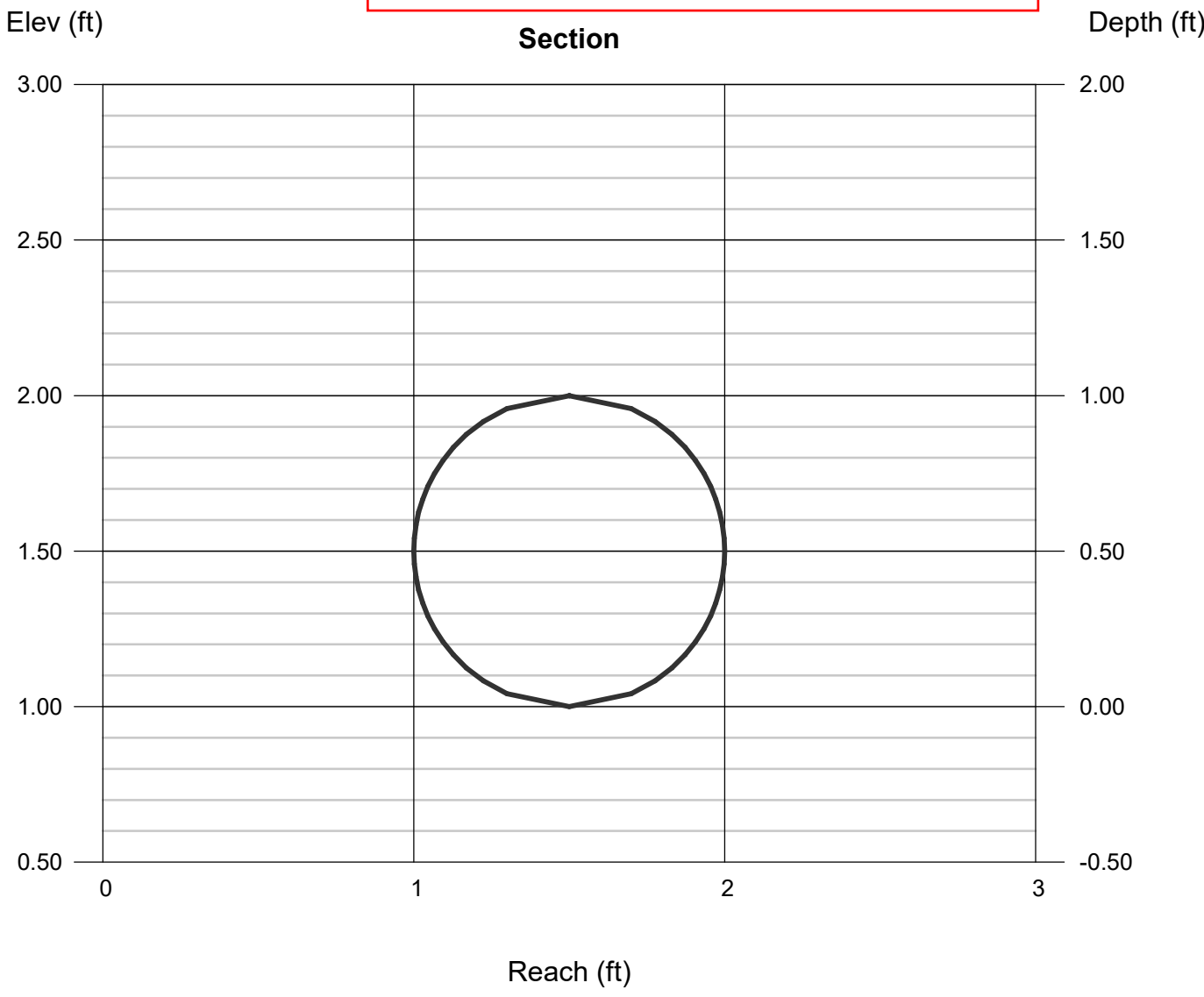
Highlighted

Depth (ft)	= 1.00
Q (cfs)	= 4.141
Area (sqft)	= 0.79
Velocity (ft/s)	= 5.27
Wetted Perim (ft)	= 3.14
Crit Depth, Yc (ft)	= 0.86
Top Width (ft)	= 0.00
EGL (ft)	= 1.43

Q = cia
c = runoff coefficient = 0.3
i = intensity = 1.92 in/hr (interpolated NOAA Estimate considering 25-year storm)
a = drainage area = 4.28 acres

Q = 0.3 x 2.10 in/hr x 4.28 acres = **2.70 cfs**

Refer to EX-2 for pipe drainage area



50 0 50 100 200

SANDIS
SILICON VALLEY

SCALE: 1"=100'

LEGEND

DRAINAGE AREA ENTERING PIPE

DRAINAGE AREA ENTERING SWALE

PIPE DRAINAGE AREA:
376,576 SF ≈ 8.64 ACRES

SWALE DRAINAGE AREA:
126,720 SF ≈ 2.91 ACRES

12-IN SDR-35 SD PIPE CAPTURING PIPE DRAINAGE AREA

COMMON OPEN SPACE

BMR 1

BMR 2

BMR 3

ALPINE ROAD

HYDROLOGY CALCULATIONS EXHIBIT

STANFORD UNIVERSITY
PORTOLA VALLEY FACULTY HOUSING
PORTOLA VALLEY CALIFORNIA

SHEET
EX-1

SANDIS CIVIL ENGINEERS SURVEYORS PLANNERS
1700 S. Winchester Blvd, Suite 200, Campbell, CA 95008 I P. 408.636.0900 I F. 408.636.0999 I www.sandis.net
SILICON VALLEY TRI-VALLEY CENTRAL VALLEY SACRAMENTO EAST BAY/ SF

DATE: 08/24/2021
SCALE: 1"=100'
DRAWN BY: IG
APPROVED BY: ND
DRAWING NO.: 217062

File: S:\217062\(4) ENGINEERING\(3) EXHIBITS\2019-10-29_Swale-Pipe Sizing Exhibit\Swale Drainage Area Exhibit.dwg Date: Aug 24, 2021 - 1:00pm, Isolis

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Swale Sizing EX-1

Triangular

Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 0.75
Invert Elev (ft)	= 1.00
Slope (%)	= 1.60
N-Value	= 0.030

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

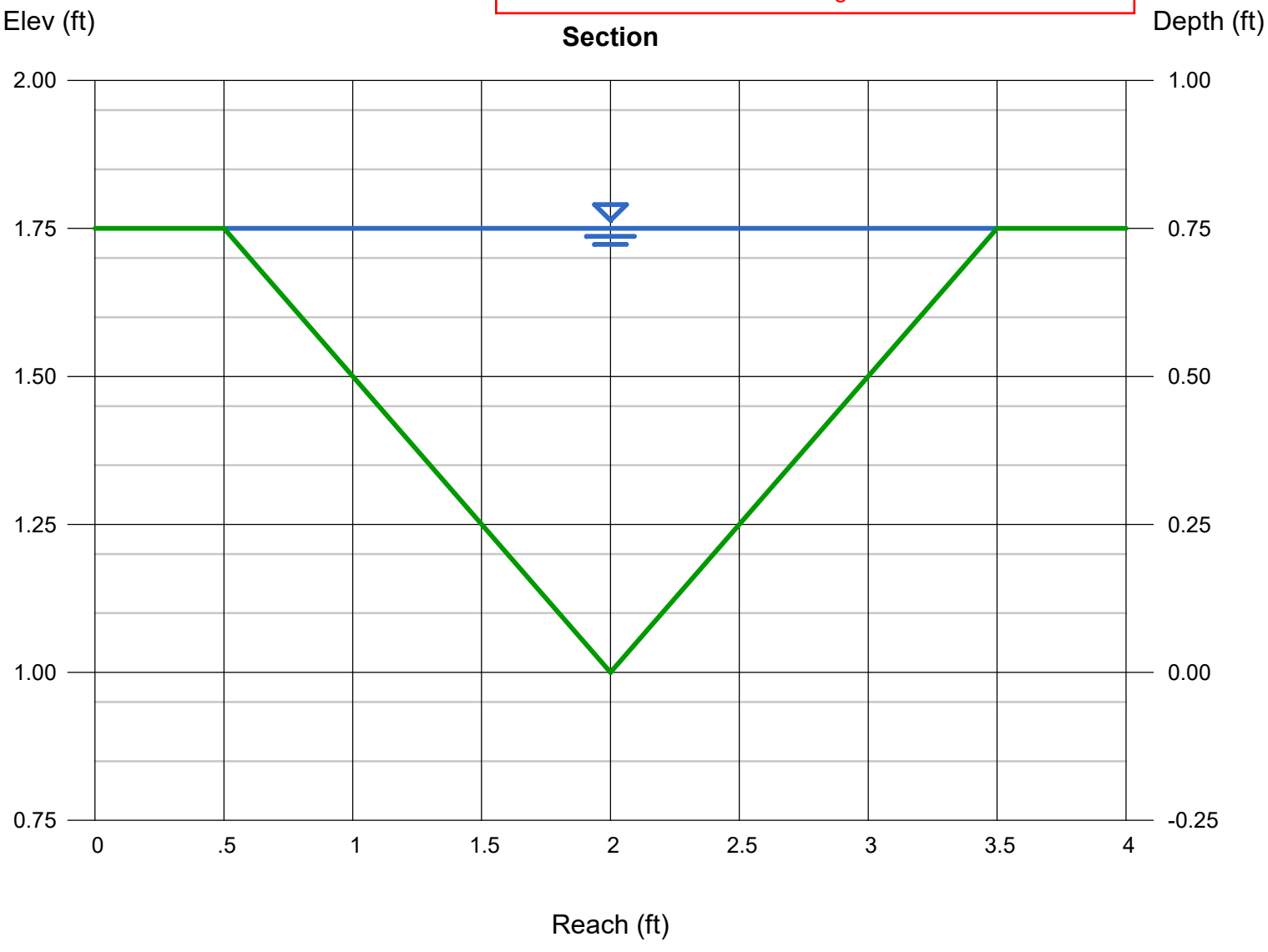
Highlighted

Depth (ft)	= 0.75
Q (cfs)	= 3.401
Area (sqft)	= 1.13
Velocity (ft/s)	= 3.02
Wetted Perim (ft)	= 3.35
Crit Depth, Yc (ft)	= 0.71
Top Width (ft)	= 3.00
EGL (ft)	= 0.89

Q = cia
c = runoff coefficient = 0.3
i = intensity = 2.43 in/hr (interpolated NOAA Estimate considering 100-year storm)
a = drainage area = 2.91 acres

Q = 0.3 x 2.43 in/hr x 2.91 acres = **2.12 cfs**

Refer to EX-1 for swale drainage area



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Pipe Sizing EX-1 (12-in SDR-35)

Circular

Diameter (ft)	= 1.00
Invert Elev (ft)	= 1.00
Slope (%)	= 1.20
N-Value	= 0.010

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

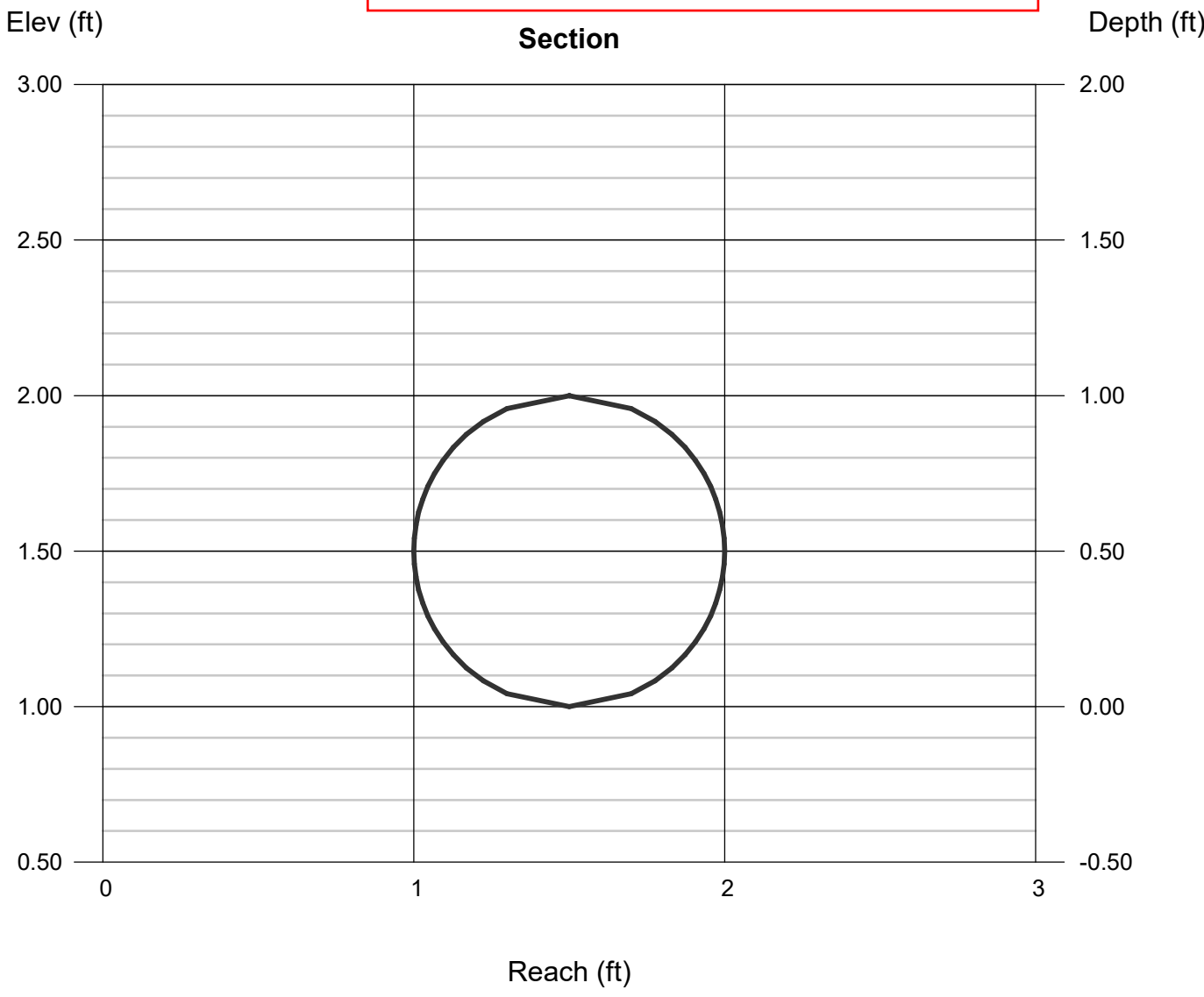
Highlighted

Depth (ft)	= 1.00
Q (cfs)	= 5.071
Area (sqft)	= 0.79
Velocity (ft/s)	= 6.46
Wetted Perim (ft)	= 3.14
Crit Depth, Yc (ft)	= 0.93
Top Width (ft)	= 0.00
EGL (ft)	= 1.65

Q = cia
c = runoff coefficient = 0.3
i = intensity = 1.92 in/hr (interpolated NOAA Estimate considering 25-year storm)
a = drainage area = 8.64 acres

Q = 0.3 x 1.92 in/hr x 8.64 acres = **4.98 cfs**

Refer to EX-1 for pipe drainage area



50 0 50 100 200

SCALE: 1"=100'

LEGEND

DRAINAGE AREA

HILLSIDE DRAINAGE AREA

HILLSIDE DRAINAGE AREA:
642,475 SF ≈ 14.75 ACRES

EXISTING SDCB

EXISTING 18" METAL CORRUDATED PIPE

EXISTING SDCB

ALPINE ROAD

SANDIS CIVIL ENGINEERS SURVEYORS PLANNERS

1700 S. Winchester Blvd, Suite 200, Campbell, CA 95008 I P. 408.636.0900 I F. 408.636.0999 I www.sandis.net

SILICON VALLEY TRI-VALLEY CENTRAL VALLEY SACRAMENTO EAST BAY/ SF

DATE: 08/24/2021
SCALE: 1"=100'
DRAWN BY: IG
APPROVED BY: ND
DRAWING NO.: 217062

HYDROLOGY CALCULATIONS EXHIBIT

STANFORD UNIVERSITY
PORTOLA VALLEY FACULTY HOUSING
PORTOLA VALLEY CALIFORNIA

SHEET
EX-4

File: S:\217062\(4) ENGINEERING\(3) EXHIBITS\2019-10-29_Swale-Pipe Sizing Exhibit\Swale Drainage Area Exhibit.dwg Date:Aug 24, 2021 - 1:01pm, Isolis

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Aug 24 2021

Existing SD Metal Corrugated Pipe Sizing EX-4

Circular

Diameter (ft)	= 1.50
Invert Elev (ft)	= 1.00
Slope (%)	= 5.40
N-Value	= 0.022

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 1.50
Q (cfs)	= 14.42
Area (sqft)	= 1.77
Velocity (ft/s)	= 8.16
Wetted Perim (ft)	= 4.71
Crit Depth, Yc (ft)	= 1.40
Top Width (ft)	= 0.00
EGL (ft)	= 2.54

Q = cia
c = runoff coefficient = 0.3
i = intensity = 1.92 in/hr (interpolated NOAA Estimate considering 25-year storm)
a = drainage area = 14.75 acres

Q = 0.3 x 1.92 in/hr x 14.75 acres = **8.50 cfs**

Refer to EX-4 for hill side drainage area