NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Normal Depth Calculator

Alaska-Pacific RFC
River Forecast Center

Normal Depth Demonstration Tool

One the most commonly used equations governing Open Channel Flow is known as the Mannings's Equation. It was introduced by the Irish Engineer Robert Manning in 1889 as an alternative to the Chezy Equation. The Mannings equation is an empirical equation that applies to uniform flow in open channels and is a function of the channel velocity, flow area and channel slope.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [U.S.]$$

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

Instructions: Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For:
Water Surface (normal depth)

Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Slope: 0.016 (ft/ft)

WSE: 2459.99 (ft)

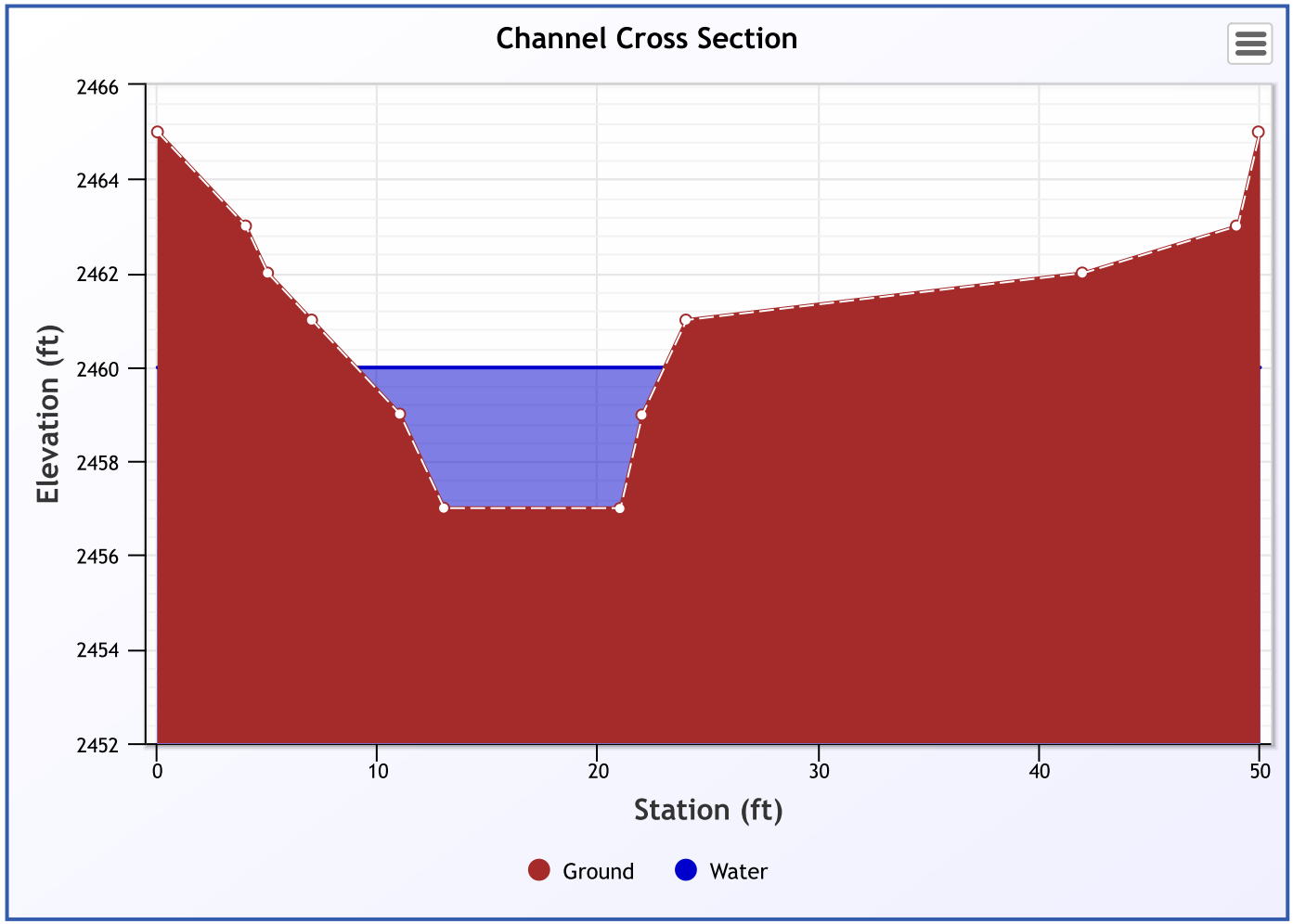
Channel Manning n: 0.050

Flow: 180 (ft3/s)

100 40000

Reset Cross Section

Flow Area:	31.4 (ft2)
Wetted Perimeter:	16.7 (ft)
Max Depth:	2.99 (ft)
Average Velocity:	5.74 (ft/s)
Top Width:	14 (ft)
Iterations:	47
Froude Number:	0.68



Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,2465.00
4.00,2463.00
5.00,2462.00
7.00,2461.00
11.00,2459.00
13.00,2457.00
21.00,2457.00
22.00,2459.00
24.00,2461.00
42.00,2462.00
49.00,2463.00
50.00,2465.00
```

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For:
Water Surface (normal depth)

Slope: 0.016 (ft/ft)

WSE: 2461.34 (ft)

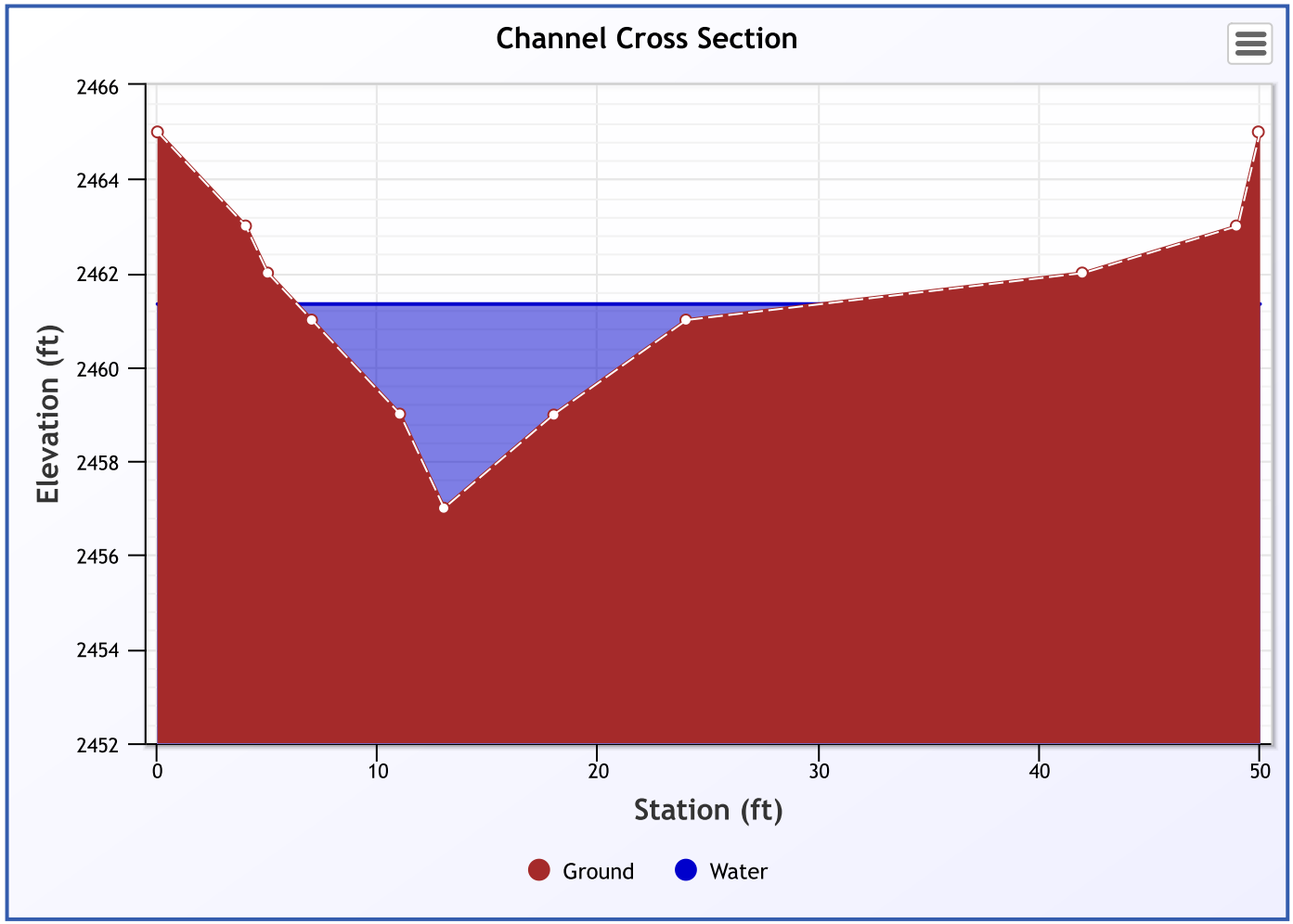
Channel Manning n: 0.050

Flow: 183 (ft3/s)

100 40000

Reset Cross Section

Flow Area:	38.0 (ft2)
Wetted Perimeter:	26.1 (ft)
Max Depth:	4.34 (ft)
Average Velocity:	4.82 (ft/s)
Top Width:	24 (ft)
Iterations:	273
Froude Number:	0.68



Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,2465.00
4.00,2463.00
5.00,2462.00
7.00,2461.00
11.00,2459.00
13.00,2457.00
18.00,2459.00
24.00,2461.00
42.00,2462.00
49.00,2463.00
50.00,2465.00
```

APPENDIX C - EXHIBIT 3: SAMPLE BRIGHT ANGEL CREEK CROSS SECTION BETWEEN ROCK SPRINGS AND PHANTOM RANCH DURING LOW FLOWS PRIOR TO ACTION

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Normal Depth Calculator

Weather.gov > Alaska-Pacific RFC > Normal Depth Calculator

Alaska-Pacific RFC
River Forecast Center

River Observations and Forecasts | Weather Observations and Forecasts | Water Supply | Climate and History | Seasonal Interest | Additional Info

Normal Depth Demonstration Tool

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Where:
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A = Flow Area, (ft2)
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S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.024 (ft/ft)

WSE: 2467.91 (ft)

Channel Manning n: 0.050

Flow: 35 (ft3/s)

100 40000

Reset Cross Section

Flow Area:	10.1 (ft2)
Wetted Perimeter:	15.4 (ft)
Max Depth:	0.91 (ft)
Average Velocity:	3.48 (ft/s)
Top Width:	15 (ft)
Iterations:	5001

Froude Number: 0.75

Load CSV XS Data Below
(station,elevation)

Update Plot

```
-10.00,2472.00
0.00,2470.00
5.00,2469.00
21.00,2467.00
28.00,2467.00
30.00,2469.00
46.00,2470.00
50.00,2472.00
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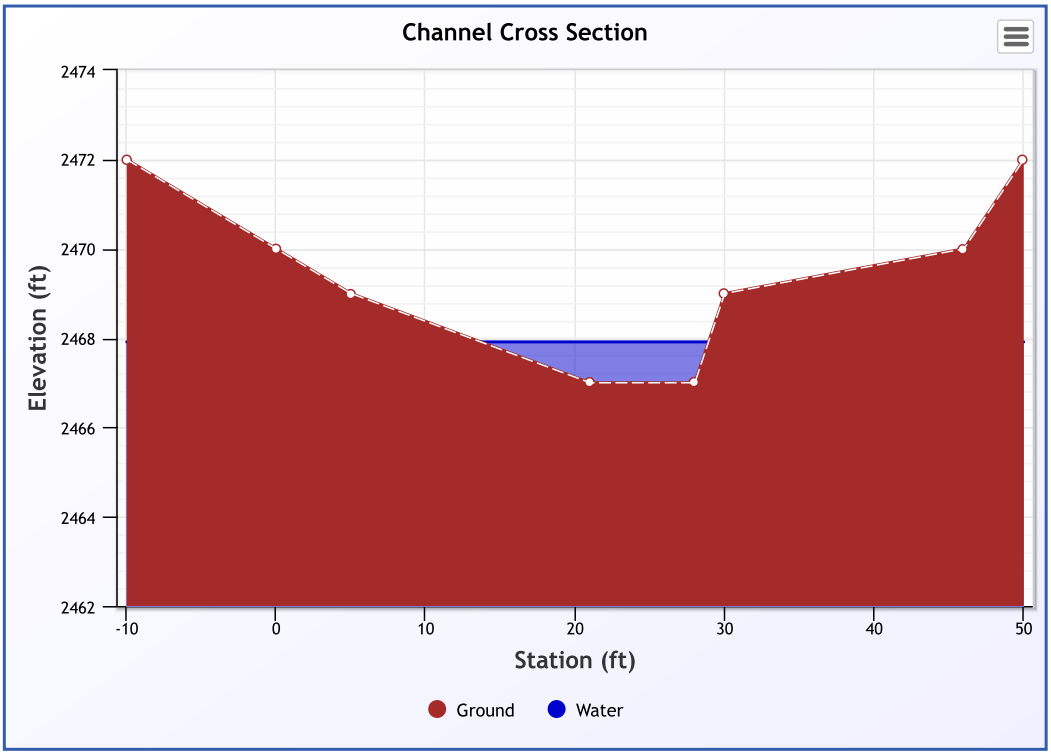

APPENDIX C - EXHIBIT 4: SAMPLE BRIGHT ANGEL CREEK CROSS SECTION BETWEEN ROCK SPRINGS AND PHANTOM RANCH DURING LOW FLOWS FOLLOWING ACTION

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Normal Depth Calculator

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Normal Depth Demonstration Tool

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Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For:
Water Surface (normal depth)

Slope: 0.024 (ft/ft)

WSE: 2467.95 (ft)

Channel Manning n: 0.050

Flow: 38 (ft3/s)
100 40000

Reset Cross Section

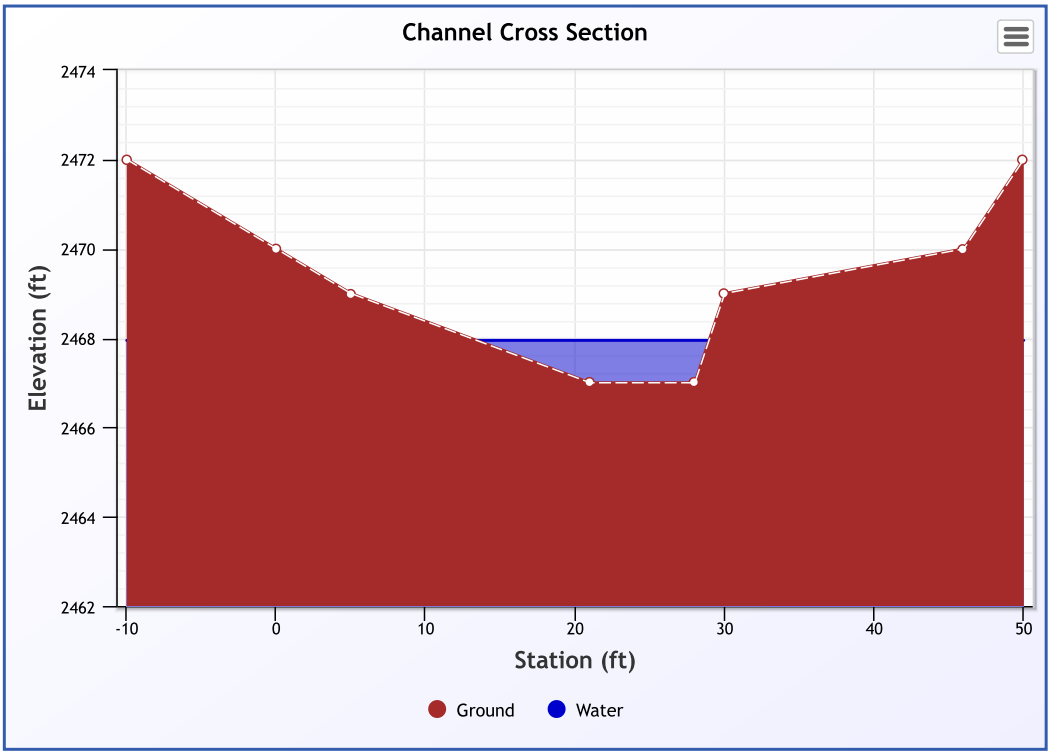
Flow Area:	10.9 (ft2)
Wetted Perimeter:	16.4 (ft)
Max Depth:	0.95 (ft)
Average Velocity:	3.48 (ft/s)
Top Width:	16 (ft)
Iterations:	14

Froude Number: 0.74

Load CSV XS Data Below
(station,elevation)

Update Plot

```
-10.00,2472.00
0.00,2470.00
5.00,2469.00
21.00,2467.00
28.00,2467.00
30.00,2469.00
46.00,2470.00
50.00,2472.00
```



APPENDIX C - EXHIBIT 5: SECOND SAMPLE BRIGHT ANGEL CREEK CROSS SECTION BETWEEN ROCK SPRINGS AND PHANTOM RANCH DURING LOW FLOWS PRIOR TO ACTION

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
Q = Flow Rate, (ft3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

Under the assumption of uniform flow conditions the bottom slope is the same as the slope of the energy grade line and the water surface slope. The Manning's n is a coefficient which represents the roughness or friction applied to the flow by the channel. Manning's n-values are often selected from tables, but can be back calculated from field measurements. In many flow conditions the selection of a Manning's roughness coefficient can greatly affect computational results.

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For:
Water Surface (normal depth)

Slope: 0.02 (ft/ft)

WSE: 2541.72 (ft)

Channel Manning n: 0.050

Flow: 35 (ft3/s)
100 40000

Reset Cross Section

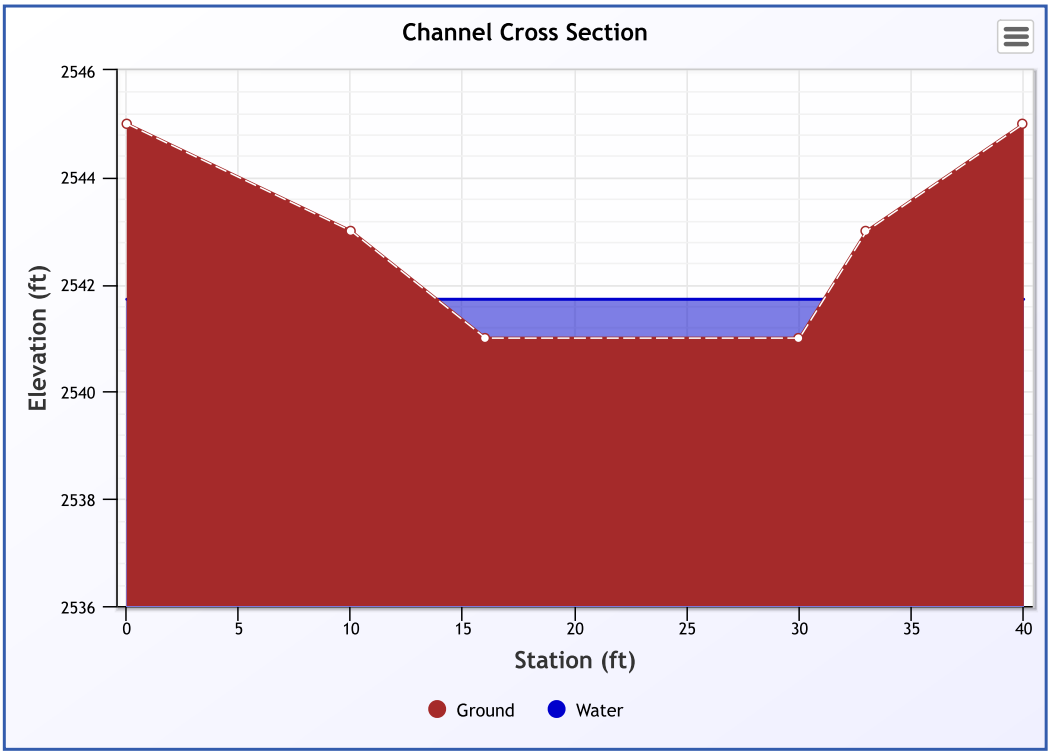
Flow Area:	11.2 (ft2)
Wetted Perimeter:	17.4 (ft)
Max Depth:	0.72 (ft)
Average Velocity:	3.11 (ft/s)
Top Width:	17 (ft)
Iterations:	862

Froude Number: 0.68

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,2545.00
10.00,2543.00
16.00,2541.00
30.00,2541.00
33.00,2543.00
40.00,2545.00
```



APPENDIX C - EXHIBIT 6: SECOND SAMPLE BRIGHT ANGEL CREEK CROSS SECTION BETWEEN ROCK SPRINGS AND PHANTOM RANCH DURING LOW FLOWS FOLLOWING ACTION

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$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}}\sqrt{S} \quad [SI]$$

Where:
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v = Velocity, (ft/s)
A = Flow Area, (ft2)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

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Select HECRAS Geometry: Choose File No file chosen Load HEC-RAS Data

Solve For: Water Surface (normal depth)

Slope: 0.02 (ft/ft)

WSE: 2541.76 (ft)

Channel Manning n: 0.050

Flow: 38 (ft3/s)

100 40000

Reset Cross Section

Flow Area:	11.8 (ft2)
Wetted Perimeter:	17.4 (ft)
Max Depth:	0.76 (ft)
Average Velocity:	3.23 (ft/s)
Top Width:	17 (ft)
Iterations:	5001

Froude Number: 0.69

Load CSV XS Data Below
(station,elevation)

Update Plot

```
0.00,2545.00
10.00,2543.00
16.00,2541.00
30.00,2541.00
33.00,2543.00
40.00,2545.00
```