APPENDIX F: HEC-RAS RIVER ANALYSIS SYSTEM "HYDRAULIC REFERENCE MANUAL" EXCERPTS

Table 3-1 Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. *Natural Streams*			
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy. deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

Table 3-1 (Continued) Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
B. *Lined or Built-Up Channels*			
1. **Concrete**			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
2. **Concrete bottom float finished with sides of:**			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. **Gravel bottom with sides of:**			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. **Brick**			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. **Metal**			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. **Asphalt**			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
7. **Vegetal lining**	0.030		0.500

Table 3-1 (Continued) Manning's 'n' Values

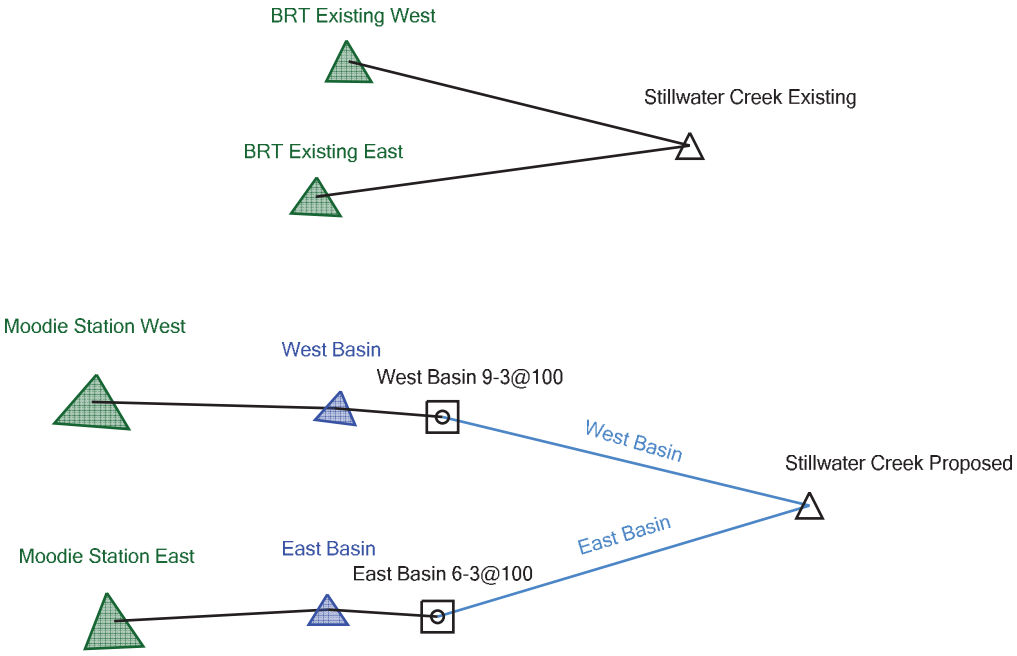
Type of Channel and Description	Minimum	Normal	Maximum
C. *Excavated or Dredged Channels*			
1. **Earth, straight and uniform**			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. **Earth, winding and sluggish**			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050
3. **Dragline-excavated or dredged**			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. **Rock cuts**			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. **Channels not maintained, weeds and brush**			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

Other sources that include pictures of selected streams as a guide to n value determination are available (Fasken, 1963; Barnes, 1967; and Hicks and Mason, 1991). In general, these references provide color photos with tables of calibrated n values for a range of flows.

Although there are many factors that affect the selection of the n value for the channel, some of the most important factors are the type and size of materials that compose the bed and banks of a channel, and the shape of the channel. Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of Manning's n of a channel. In Cowan's procedure, the value of n is computed by the following equation:

APPENDIX G: MOODIE STATION STORMWATER MANAGEMENT DESIGN

Scenario: Moodie Station



STORMWATER MANAGEMENT SUMMARY

Client: **Ottawa LRT**
Project: **Moodie Station**
Prepared by: **V Tricome**
Date: **21 Sep 17**

Checked by:

Print Date: 11:03 AM
Project #: 4018023

\\stvgroup.stvinc.com\v3\DGPA\Vol3\Projects\4018023\4018023_0001\60_Discipline Info\Moodie PE - Design\PondPack\[PondPack Summary.xls]Moodie Station

	Study Point:	**Stillwater Creek @ ST314**							
	Watershed:	Moodie Station							
	Controlling Basin:	West and East							
A	Pre Construction	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	12322.62	80.00	0.16	0.27	0.36	0.47	0.55	0.63
	East	10407.96	85.00						
B	Post Construction without Basin	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	12322.62	80.00	0.17	0.25	0.29	0.36	0.40	0.45
	East	10407.96	85.00	0.16	0.22	0.26	0.31	0.35	0.39
C	Post Construction into Basin	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	12322.62	80.00	0.17	0.25	0.29	0.36	0.40	0.45
	East	10407.96	85.00	0.16	0.22	0.26	0.31	0.35	0.39
D	Discharge from Basin			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
	West			0.08	0.13	0.16	0.20	0.23	0.26
	East			0.09	0.13	0.16	0.19	0.22	0.24
E	Post Construction Total to Study Point			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
				0.16	0.25	0.31	0.39	0.44	0.50
				100% Pre	*93% Pre*	*86% Pre*	*83% Pre*	*80% Pre*	*79% Pre*
	Pre vs. Post Differential			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
			*	0.00	-0.02	-0.05	-0.08	-0.11	-0.13

Notes:

* Negative number indicates a reduction in flow after construction

Project Summary	
Title	Ottawa LRT - Moodie
Engineer	Vincent J Tricome
Company	STV Incorporated
Date	9/21/2017

Notes	
	Study Point: Stillwater Creek at ST314 Watershed: Stillwater Creek

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Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
BRT Existing West	2	2.000	181.313	11.950	0.071
BRT Existing West	5	5.000	321.566	11.950	0.132
BRT Existing West	10	10.000	422.884	11.950	0.175
BRT Existing West	25	25.000	559.456	11.950	0.232
BRT Existing West	50	50.000	664.511	11.950	0.275
BRT Existing West	100	100.000	772.484	11.950	0.319
BRT Existing East	2	2.000	215.520	11.950	0.089
BRT Existing East	5	5.000	353.451	11.950	0.146
BRT Existing East	10	10.000	449.728	11.950	0.186
BRT Existing East	25	25.000	576.758	11.950	0.237
BRT Existing East	50	50.000	673.006	11.950	0.275
BRT Existing East	100	100.000	770.926	11.950	0.314
Moodie Station West	2	2.000	419.316	11.950	0.170
Moodie Station West	5	5.000	615.127	11.950	0.245
Moodie Station West	10	10.000	745.611	11.950	0.293
Moodie Station West	25	25.000	913.218	11.950	0.355
Moodie Station West	50	50.000	1,037.784	11.950	0.400
Moodie Station West	100	100.000	1,162.916	11.950	0.445
Moodie Station East	2	2.000	398.928	11.950	0.158
Moodie Station East	5	5.000	569.452	11.950	0.220
Moodie Station East	10	10.000	682.096	11.950	0.261
Moodie Station East	25	25.000	826.059	11.950	0.312
Moodie Station East	50	50.000	932.700	11.950	0.350
Moodie Station East	100	100.000	1,039.596	11.950	0.387

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
Stillwater Creek Existing	2	2.000	396.832	11.950	0.160
Stillwater Creek Existing	5	5.000	675.017	11.950	0.278
Stillwater Creek Existing	10	10.000	872.612	11.950	0.361
Stillwater Creek Existing	25	25.000	1,136.213	11.950	0.469
Stillwater Creek Existing	50	50.000	1,337.518	11.950	0.550
Stillwater Creek Existing	100	100.000	1,543.410	11.950	0.633
Stillwater Creek Proposed	2	2.000	818.244	12.050	0.167
Stillwater Creek Proposed	5	5.000	1,184.579	12.050	0.257

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
Stillwater Creek Proposed	10	10.000	1,427.707	12.050	0.314
Stillwater Creek Proposed	25	25.000	1,739.277	12.050	0.385
Stillwater Creek Proposed	50	50.000	1,970.484	12.050	0.441
Stillwater Creek Proposed	100	100.000	2,202.513	12.050	0.497

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m^3)
West Basin (IN)	2	2.000	419.316	11.950	0.170	(N/A)	(N/A)
West Basin (OUT)	2	2.000	419.316	12.100	0.079	66.511	135.100
West Basin (IN)	5	5.000	615.127	11.950	0.245	(N/A)	(N/A)
West Basin (OUT)	5	5.000	615.127	12.050	0.126	66.593	185.475
West Basin (IN)	10	10.000	745.611	11.950	0.293	(N/A)	(N/A)
West Basin (OUT)	10	10.000	745.611	12.050	0.157	66.637	218.068
West Basin (IN)	25	25.000	913.218	11.950	0.355	(N/A)	(N/A)
West Basin (OUT)	25	25.000	913.218	12.050	0.195	66.692	258.618
West Basin (IN)	50	50.000	1,037.784	11.950	0.400	(N/A)	(N/A)
West Basin (OUT)	50	50.000	1,037.784	12.050	0.226	66.731	287.727
West Basin (IN)	100	100.000	1,162.916	11.950	0.445	(N/A)	(N/A)
West Basin (OUT)	100	100.000	1,162.916	12.050	0.258	66.769	315.563
East Basin (IN)	2	2.000	398.928	11.950	0.158	(N/A)	(N/A)
East Basin (OUT)	2	2.000	398.928	12.050	0.089	65.082	111.767
East Basin (IN)	5	5.000	569.452	11.950	0.220	(N/A)	(N/A)
East Basin (OUT)	5	5.000	569.452	12.050	0.130	65.160	149.909

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m³)	Time to Peak (hours)	Peak Flow (m³/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m³)
East Basin (IN)	10	10.000	682.096	11.950	0.261	(N/A)	(N/A)
East Basin (OUT)	10	10.000	682.096	12.050	0.157	65.209	174.177
East Basin (IN)	25	25.000	826.059	11.950	0.312	(N/A)	(N/A)
East Basin (OUT)	25	25.000	826.059	12.050	0.191	65.270	204.363
East Basin (IN)	50	50.000	932.700	11.950	0.350	(N/A)	(N/A)
East Basin (OUT)	50	50.000	932.700	12.050	0.215	65.315	226.195
East Basin (IN)	100	100.000	1,039.596	11.950	0.387	(N/A)	(N/A)
East Basin (OUT)	100	100.000	1,039.596	12.050	0.240	65.359	247.829

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.089 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.089 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	20.711 mm
Runoff Volume (Pervious)	215.559 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	215.520 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.148 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.146 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	33.965 mm
Runoff Volume (Pervious)	353.502 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	353.451 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.189 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.186 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	43.214 mm
Runoff Volume (Pervious)	449.768 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	449.728 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.242 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.237 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	55.420 mm
Runoff Volume (Pervious)	576.811 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	576.758 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.281 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.275 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	64.668 mm
Runoff Volume (Pervious)	673.061 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	673.006 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.321 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.314 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	44.824 mm
Maximum Retention (Pervious, 20 percent)	8.965 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	74.075 mm
Runoff Volume (Pervious)	770.971 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	770.926 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.947 hours
Flow (Peak, Computed)	0.072 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.071 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	14.716 mm
Runoff Volume (Pervious)	181.343 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	181.313 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.947 hours
Flow (Peak, Computed)	0.132 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.132 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	26.100 mm
Runoff Volume (Pervious)	321.617 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	321.566 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.176 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.175 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	34.323 mm
Runoff Volume (Pervious)	422.946 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	422.884 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.235 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.232 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	45.406 mm
Runoff Volume (Pervious)	559.516 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	559.456 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.279 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.275 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	53.932 mm
Runoff Volume (Pervious)	664.586 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	664.511 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.324 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.319 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	62.694 mm
Runoff Volume (Pervious)	772.560 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	772.484 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.162 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.158 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	38.332 mm
Runoff Volume (Pervious)	398.956 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	398.928 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.227 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.220 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	54.715 mm
Runoff Volume (Pervious)	569.473 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	569.452 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.269 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.261 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	65.538 mm
Runoff Volume (Pervious)	682.116 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	682.096 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.322 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.312 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	79.371 mm
Runoff Volume (Pervious)	826.087 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	826.059 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.361 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.350 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	89.616 mm
Runoff Volume (Pervious)	932.717 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	932.700 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	10,407.957 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.400 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.387 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	10,407.957 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	99.887 mm
Runoff Volume (Pervious)	1,039.615 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,039.596 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.825 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.174 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.170 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	34.031 mm
Runoff Volume (Pervious)	419.347 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	419.316 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.251 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.245 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	49.921 mm
Runoff Volume (Pervious)	615.153 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	615.127 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.301 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.293 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	60.511 mm
Runoff Volume (Pervious)	745.648 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	745.611 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.365 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.355 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	74.112 mm
Runoff Volume (Pervious)	913.259 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	913.218 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.412 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.400 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	84.220 mm
Runoff Volume (Pervious)	1,037.816 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,037.784 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	12,322.619 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.458 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.445 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	12,322.619 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	94.375 mm
Runoff Volume (Pervious)	1,162.950 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,162.916 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.977 m³/s
Unit peak time, Tp	0.067 hours

Subsection: Outlet Input Data
Label: East Basin

Requested Pond Water Surface Elevations	
Minimum (Headwater)	64.784 m
Increment (Headwater)	0.152 m
Maximum (Headwater)	65.698 m

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (m)	E2 (m)
Orifice-Circular	Orifice	Forward	TW	64.764	65.678
Culvert-Circular	Culvert	Forward	TW	64.764	65.678
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: East Basin

Structure ID: Culvert Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	450.000 mm
Length	38.000 m
Length (Computed Barrel)	38.000 m
Slope (Computed)	0.005 m/m

Outlet Control Data	
Manning's n	0.012
Ke	0.500
Kb	0.016
Kr	0.000
Convergence Tolerance	0.000 m

Inlet Control Data	
Equation Form	Form 1
K	0.010
M	2.000
C	0.040
Y	0.670
T1 ratio (HW/D)	1.158
T2 ratio (HW/D)	1.304
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	65.285 m	T1 Flow	0.206 m³/s
T2 Elevation	65.351 m	T2 Flow	0.236 m³/s

Subsection: Outlet Input Data
Label: East Basin

Structure ID: Orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	64.764 m
Orifice Diameter	50.800 mm
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.003 m
Tailwater Tolerance (Maximum)	0.152 m
Headwater Tolerance (Minimum)	0.003 m
Headwater Tolerance (Maximum)	0.152 m
Flow Tolerance (Minimum)	0.000 m^3/s
Flow Tolerance (Maximum)	0.283 m^3/s

Subsection: Outlet Input Data
Label: West Basin

Requested Pond Water Surface Elevations	
Minimum (Headwater)	66.250 m
Increment (Headwater)	0.152 m
Maximum (Headwater)	67.164 m

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (m)	E2 (m)
Orifice-Circular	Orifice	Forward	TW	66.250	67.164
Culvert-Circular	Culvert	Forward	TW	66.250	67.164
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: West Basin

Structure ID: Culvert Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	610.000 mm
Length	20.000 m
Length (Computed Barrel)	20.000 m
Slope (Computed)	0.005 m/m

Outlet Control Data	
Manning's n	0.012
Ke	0.500
Kb	0.011
Kr	0.000
Convergence Tolerance	0.000 m

Inlet Control Data	
Equation Form	Form 1
K	0.010
M	2.000
C	0.040
Y	0.670
T1 ratio (HW/D)	1.158
T2 ratio (HW/D)	1.304
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	66.956 m	T1 Flow	0.441 m³/s
T2 Elevation	67.046 m	T2 Flow	0.504 m³/s

Subsection: Outlet Input Data
Label: West Basin

Structure ID: Orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	66.250 m
Orifice Diameter	50.800 mm
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.003 m
Tailwater Tolerance (Maximum)	0.152 m
Headwater Tolerance (Minimum)	0.003 m
Headwater Tolerance (Maximum)	0.152 m
Flow Tolerance (Minimum)	0.000 m^3/s
Flow Tolerance (Maximum)	0.283 m^3/s

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.158 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.089 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.082 m
Volume (Peak)	111.758 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	398.928 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	398.928 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: East Basin (IN)

Return Event: 5.000 years
Storm Event: 5 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.220 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.130 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.160 m
Volume (Peak)	149.916 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	569.452 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	569.452 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.261 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.157 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.209 m
Volume (Peak)	174.171 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	682.096 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	682.096 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.312 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.191 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.270 m
Volume (Peak)	204.350 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	826.059 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	826.059 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: East Basin (IN)

Return Event: 50.000 years
Storm Event: 50 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.350 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.215 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.315 m
Volume (Peak)	226.196 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	932.700 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	932.700 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: East Basin (IN)

Return Event: 100.000 years
Storm Event: 100 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	64.764 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.387 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.240 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	65.359 m
Volume (Peak)	247.826 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,039.596 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,039.596 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: West Basin (IN)

Return Event: 2.000 years
Storm Event: 2 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.170 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.079 m³/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	66.511 m
Volume (Peak)	135.101 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	419.316 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	419.316 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: West Basin (IN)

Return Event: 5.000 years
Storm Event: 5 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.245 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.126 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	66.593 m
Volume (Peak)	185.470 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	615.127 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	615.127 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.293 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.157 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	66.637 m
Volume (Peak)	218.066 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	745.611 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	745.611 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.355 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.195 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	66.692 m
Volume (Peak)	258.625 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	913.218 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	913.218 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.400 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.226 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	66.731 m
Volume (Peak)	287.725 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,037.784 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,037.784 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

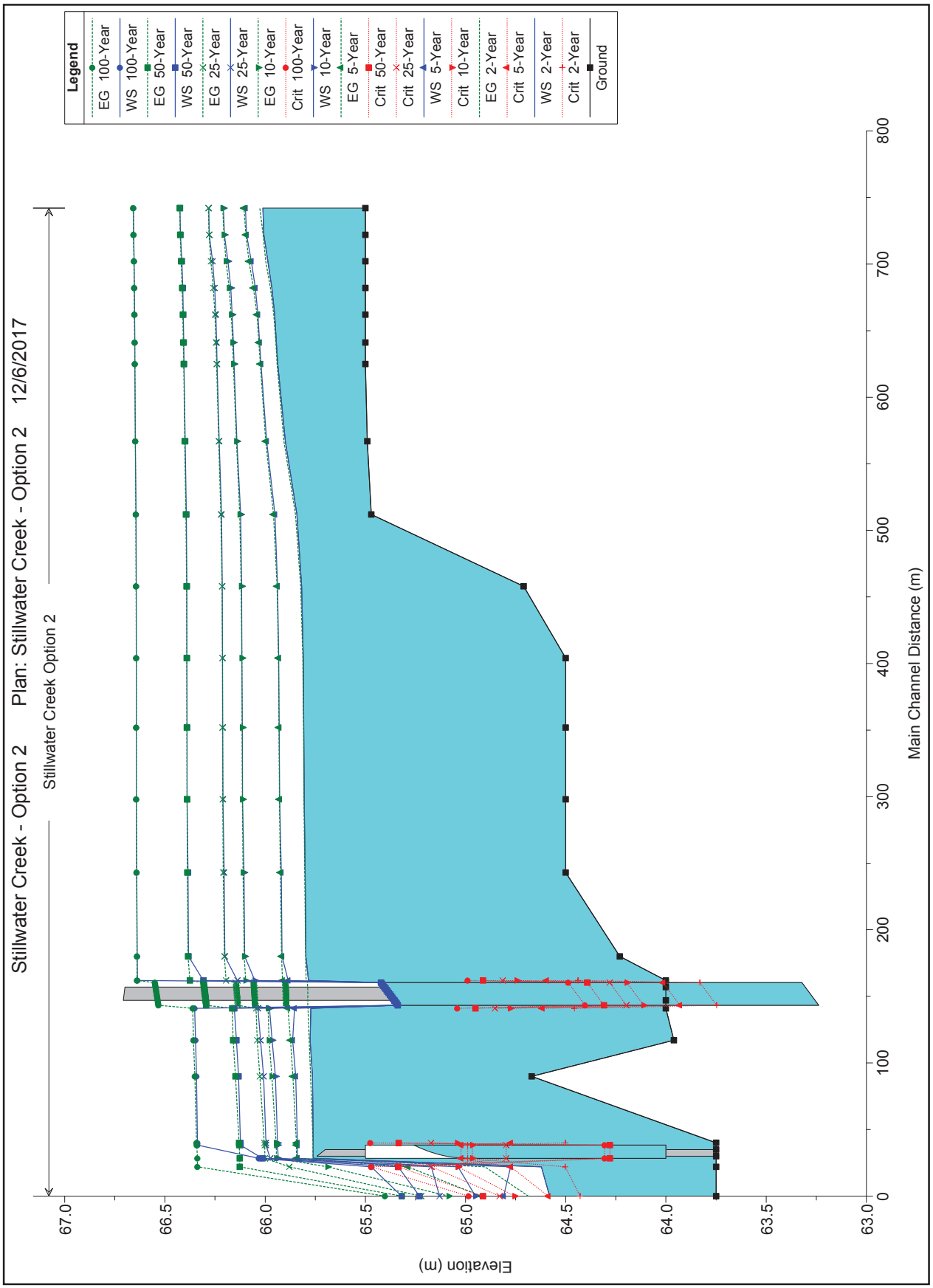
Initial Conditions	
Elevation (Water Surface, Initial)	66.250 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

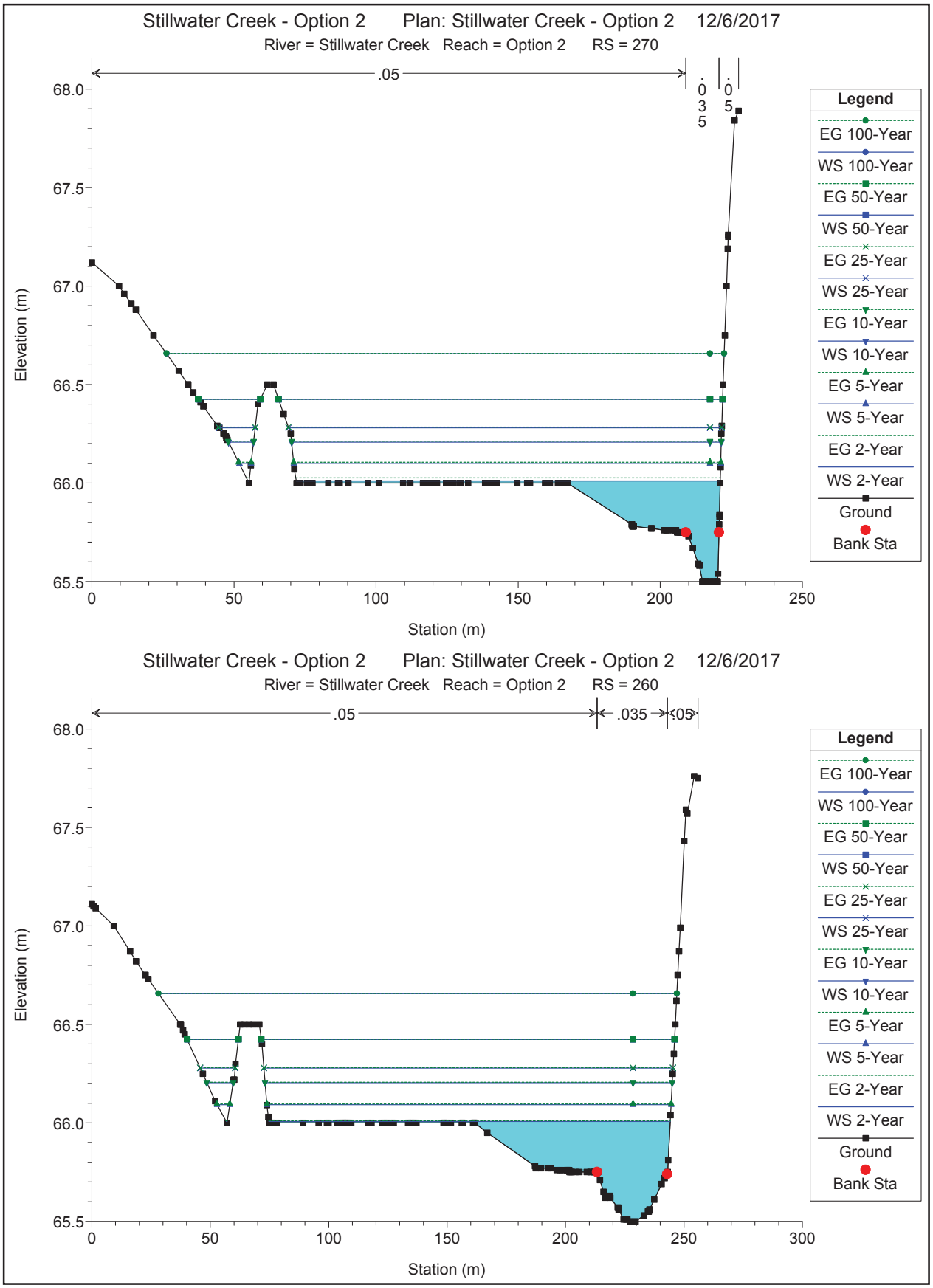
Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.445 m³/s	Time to Peak (Flow, In)	11.950 hours
Flow (Peak Outlet)	0.258 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

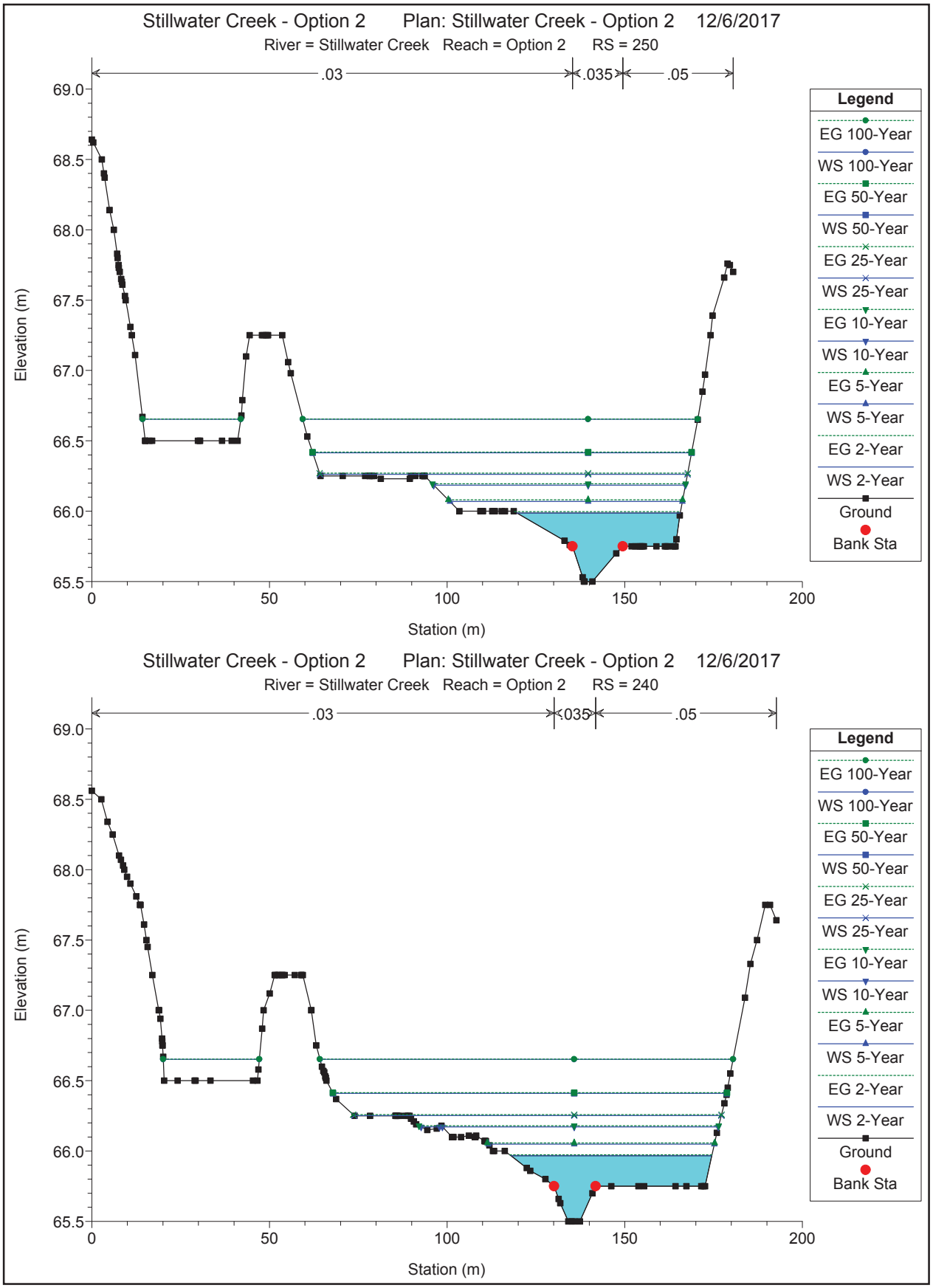
Elevation (Water Surface, Peak)	66.769 m
Volume (Peak)	315.562 m³

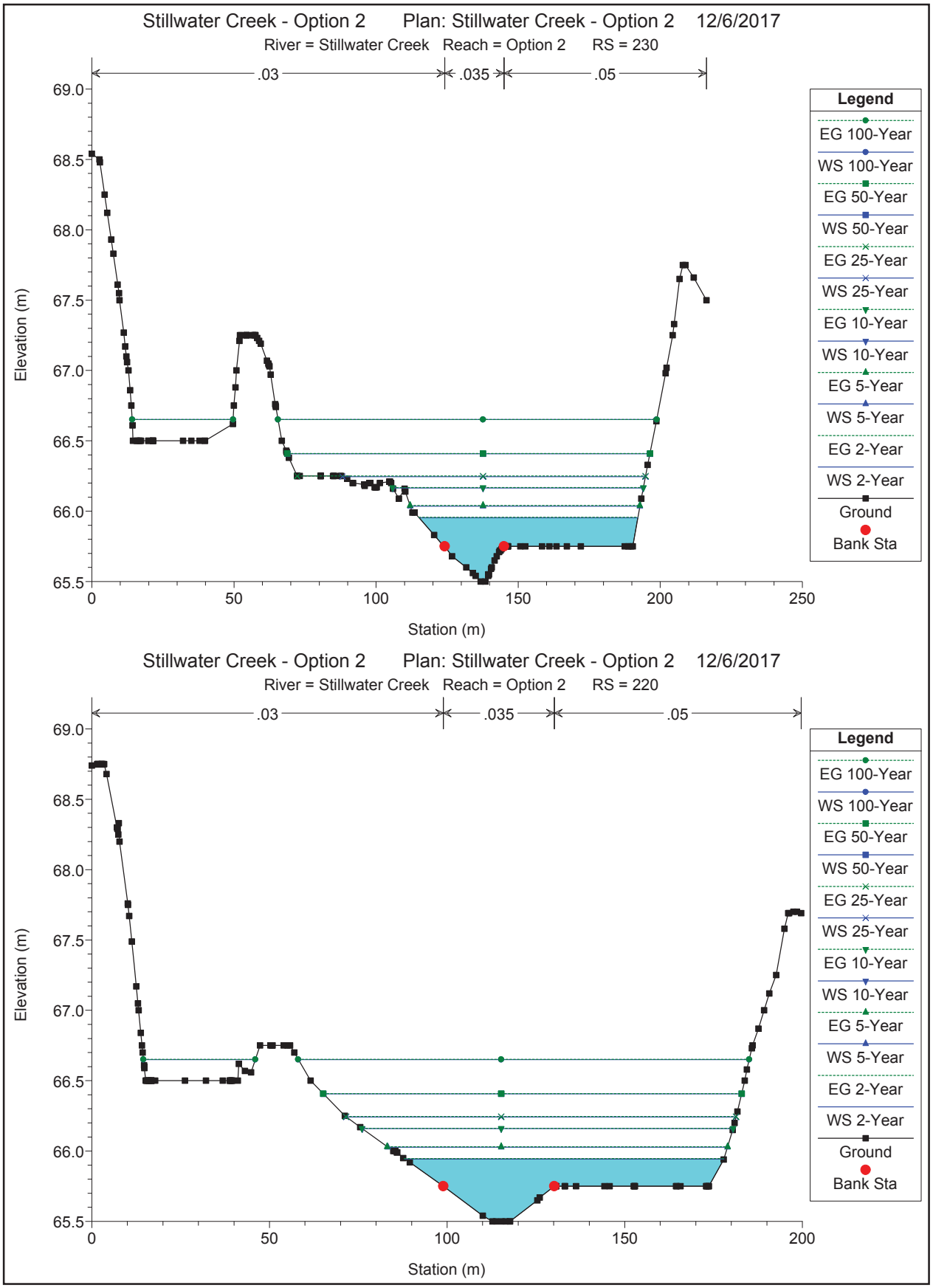
Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,162.916 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,162.916 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

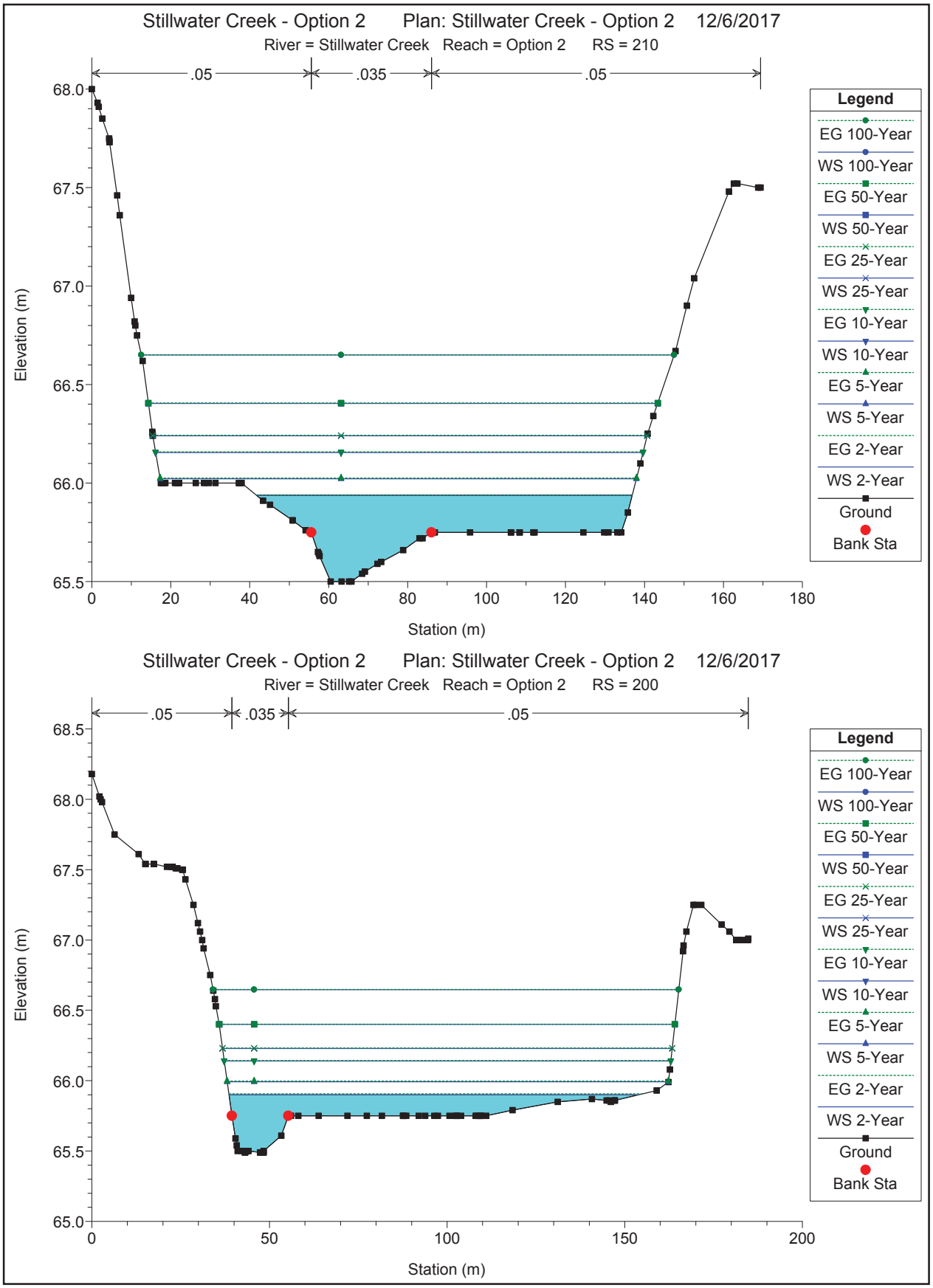
APPENDIX H: MOODIE STATION HEC-RAS RESULTS

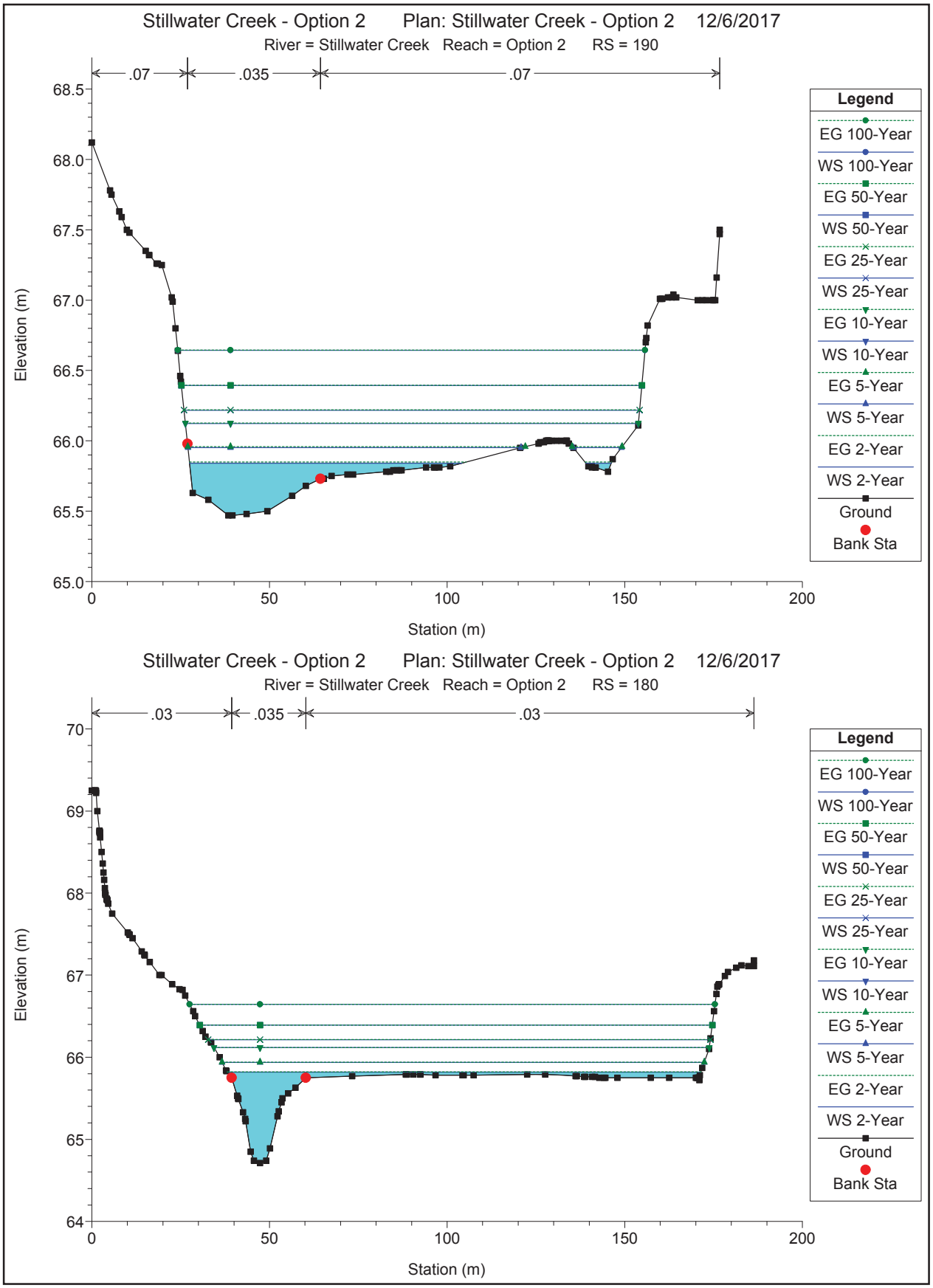

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
Stillwater Creek Option 2
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
Crit 100-Year
WS 10-Year
EG 5-Year
Crit 50-Year
Crit 25-Year
WS 5-Year
Crit 10-Year
EG 2-Year
Crit 5-Year
WS 2-Year
Crit 2-Year
Ground
Elevation (m)
67.0
66.5
66.0
65.5
65.0
64.5
64.0
63.5
63.0
Main Channel Distance (m)
0
100
200
300
400
500
600
700
800

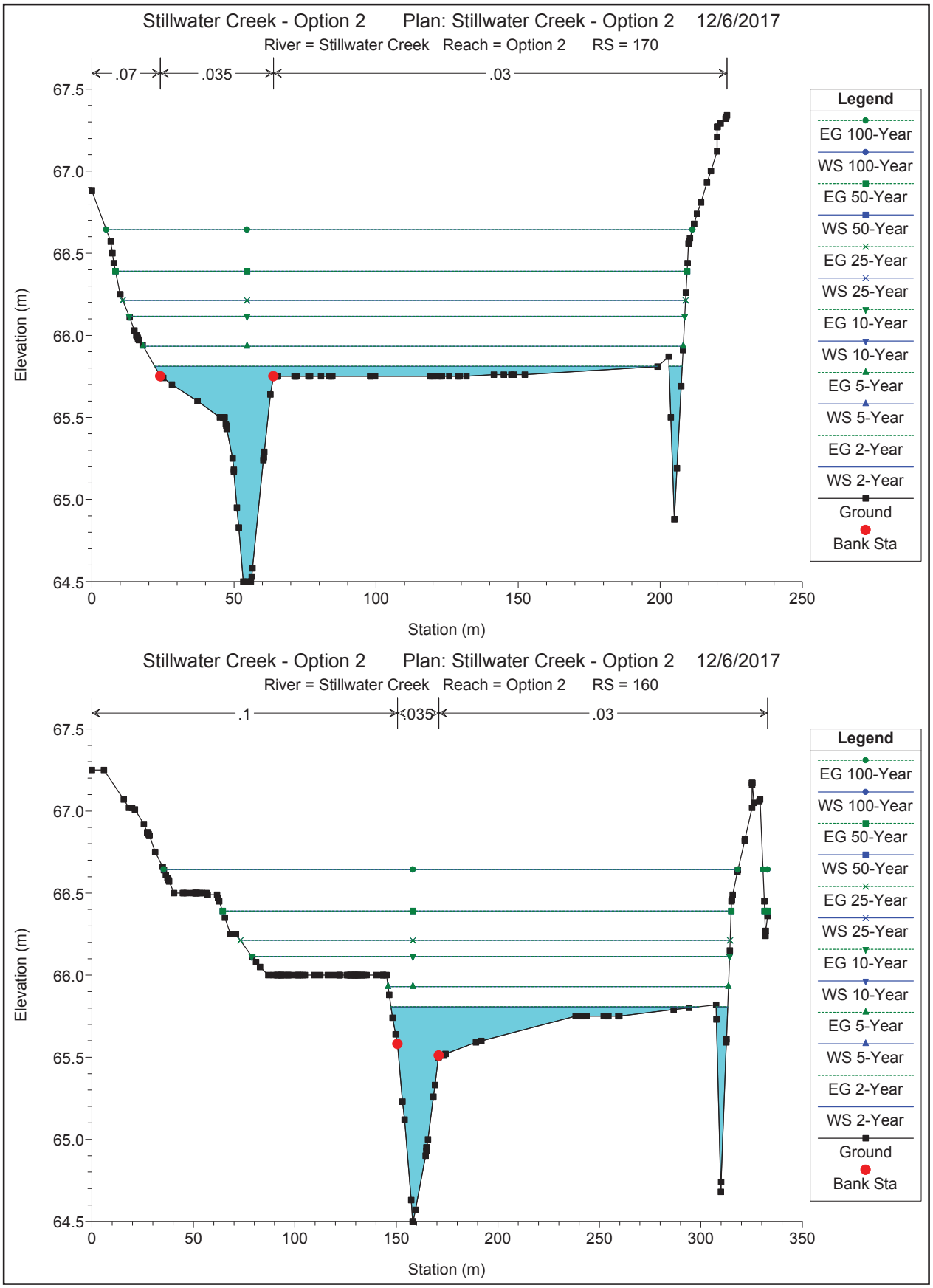

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 270
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 260
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

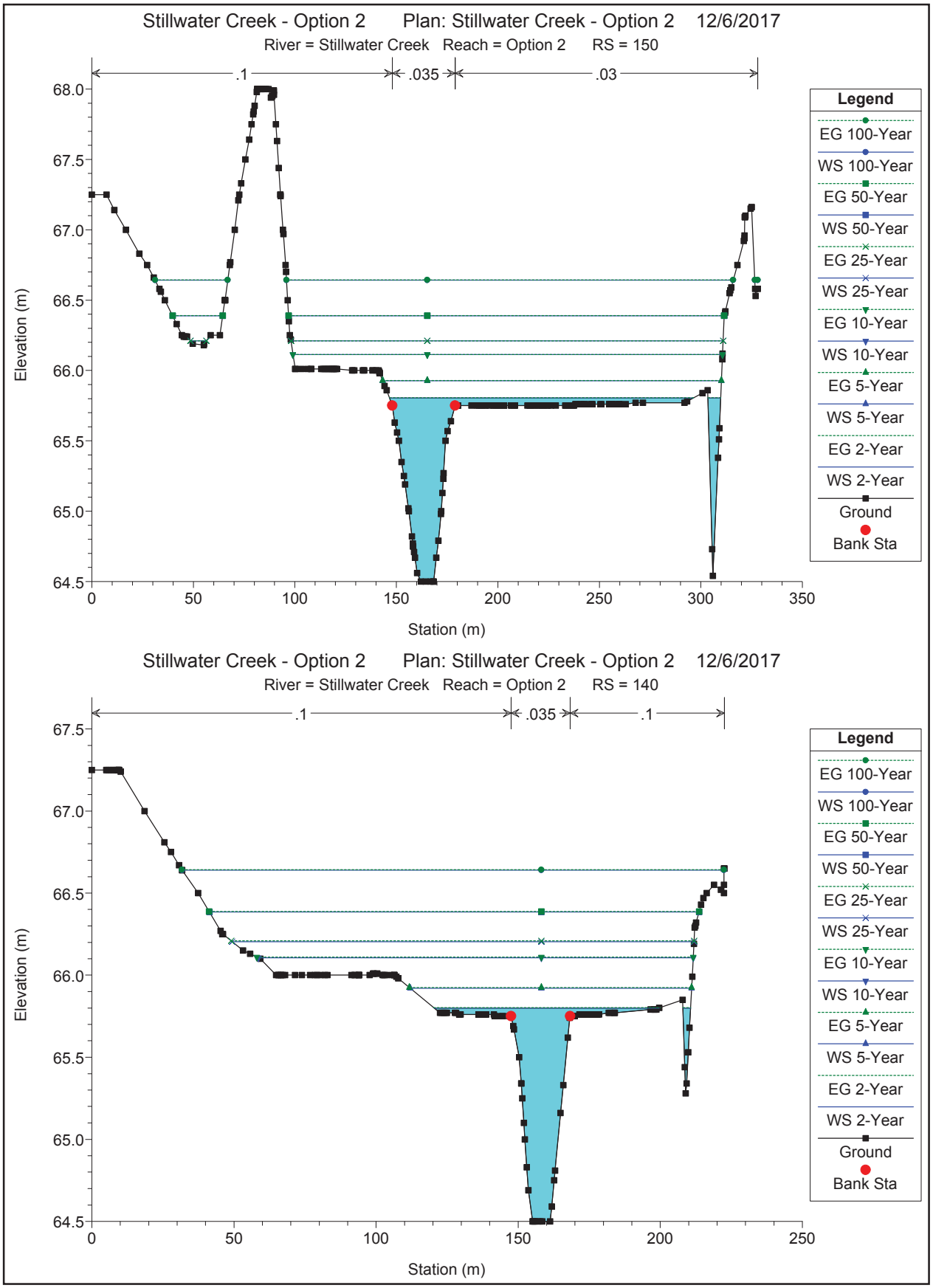

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 250
.03
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 240
.03
035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

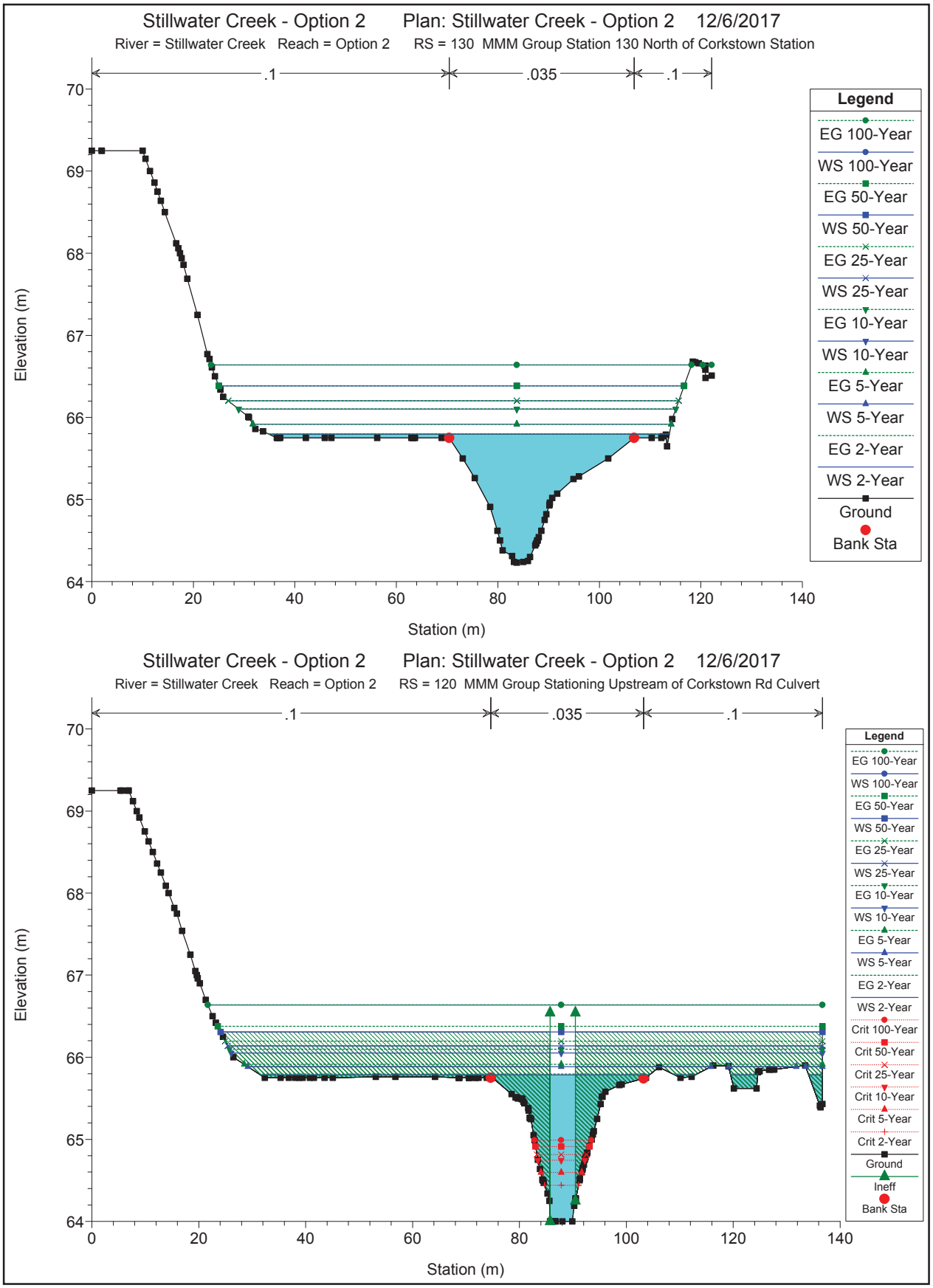

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 230
.03
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 220
.03
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

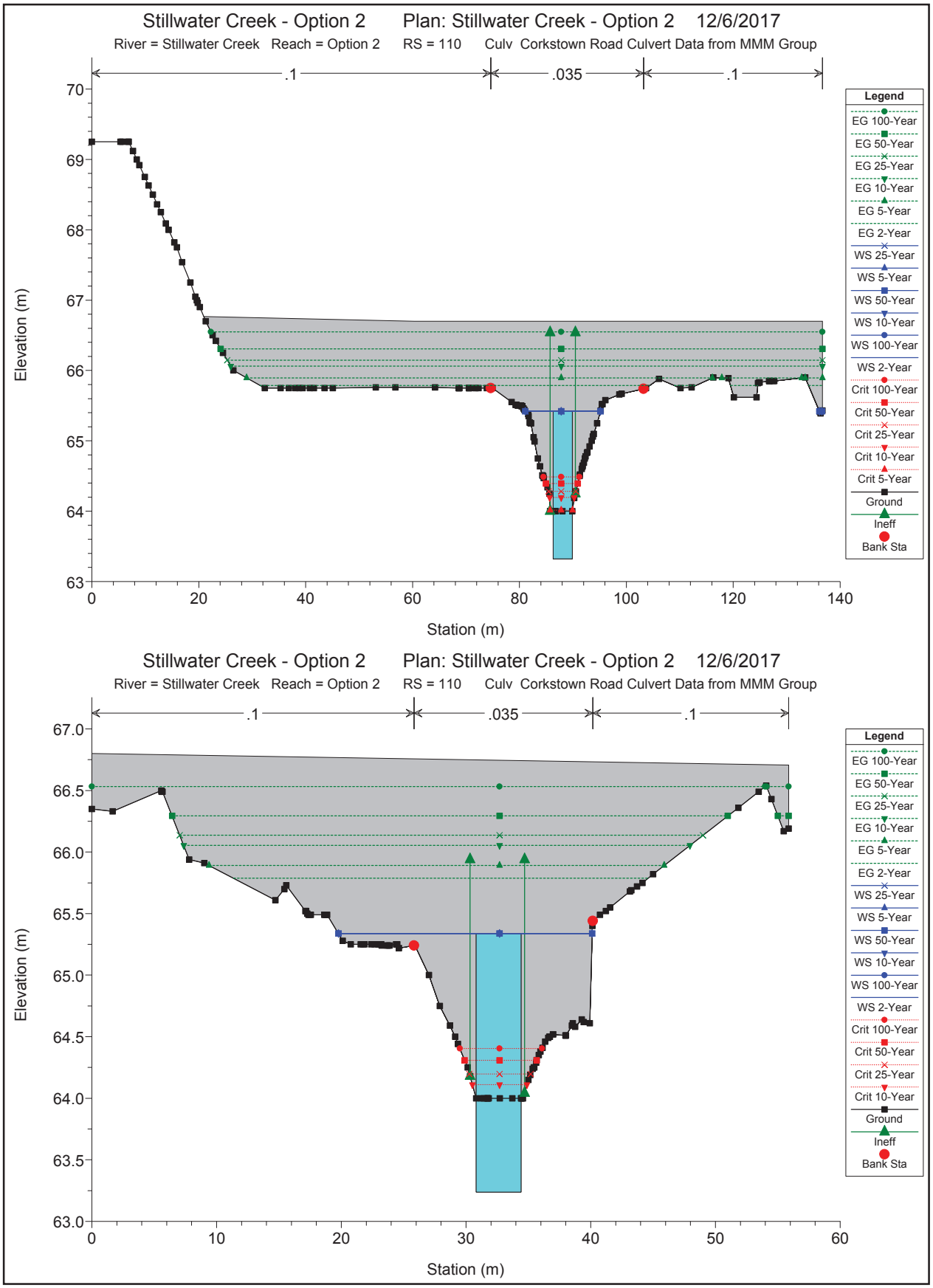

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 210
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 200
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

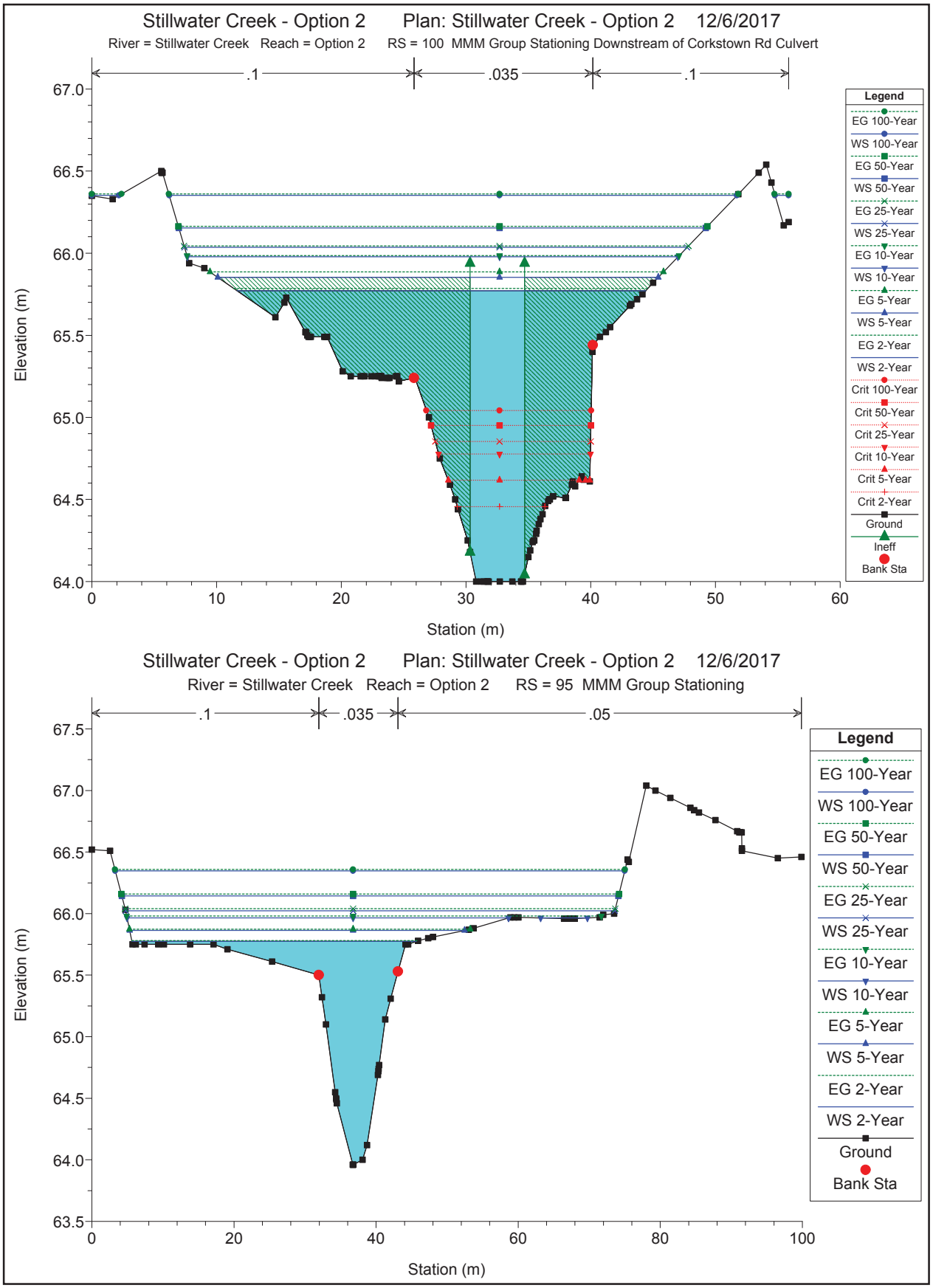

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 190
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 180
.03
.035
.03
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

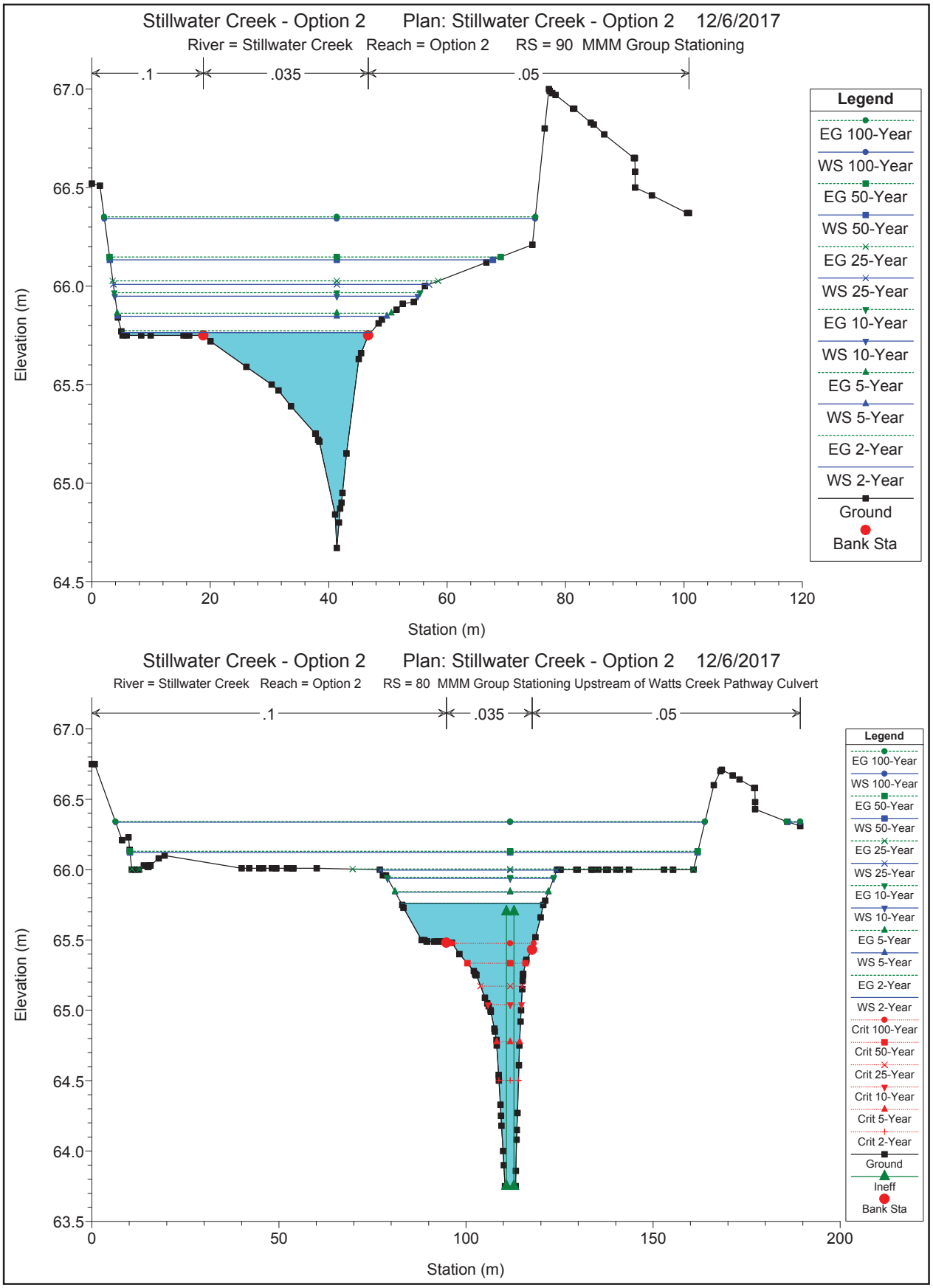

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 170
.07
.035
.03
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 160
.1
.035
.03
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

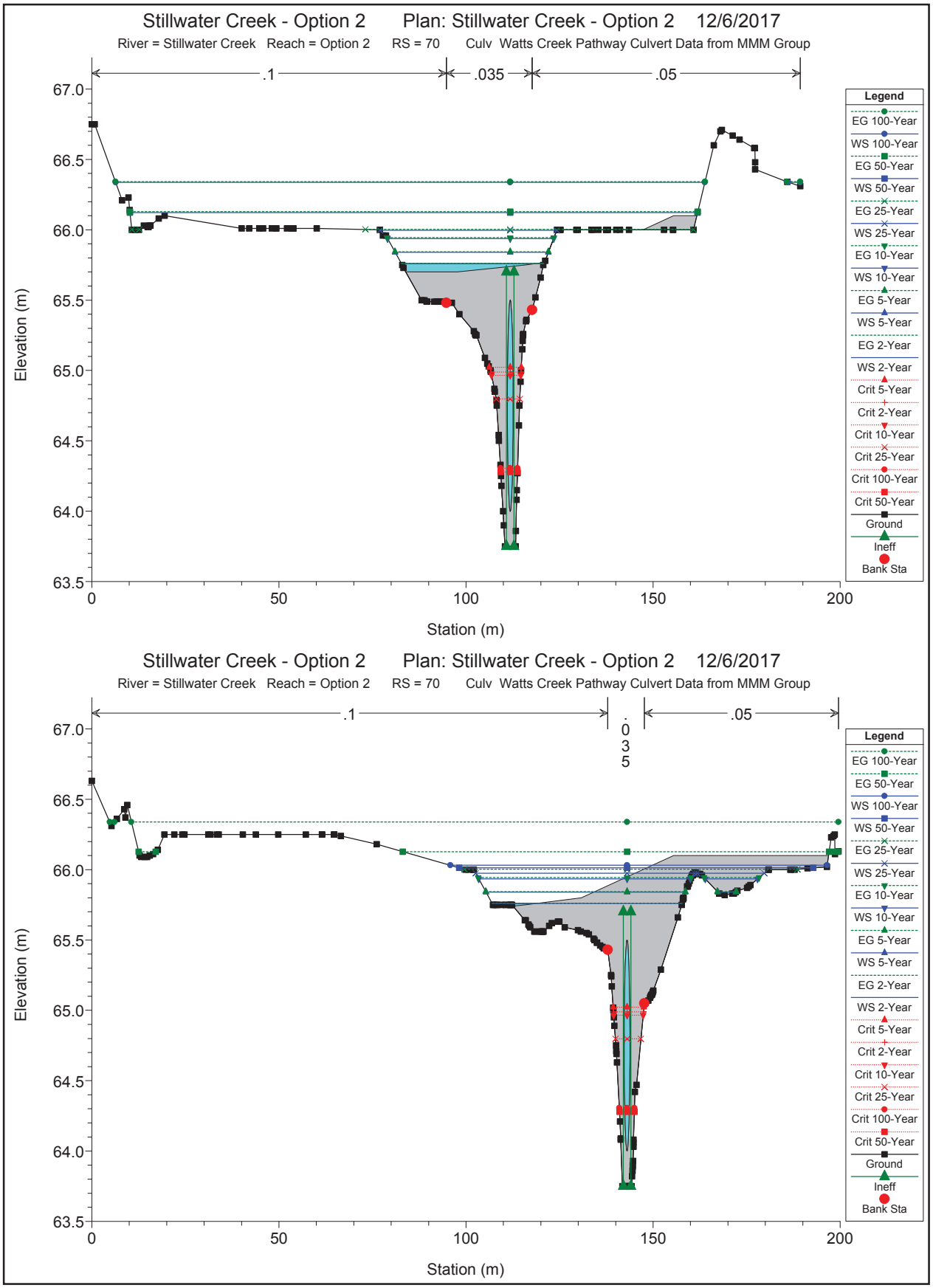

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 150
.1
.035
.03
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 140
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta

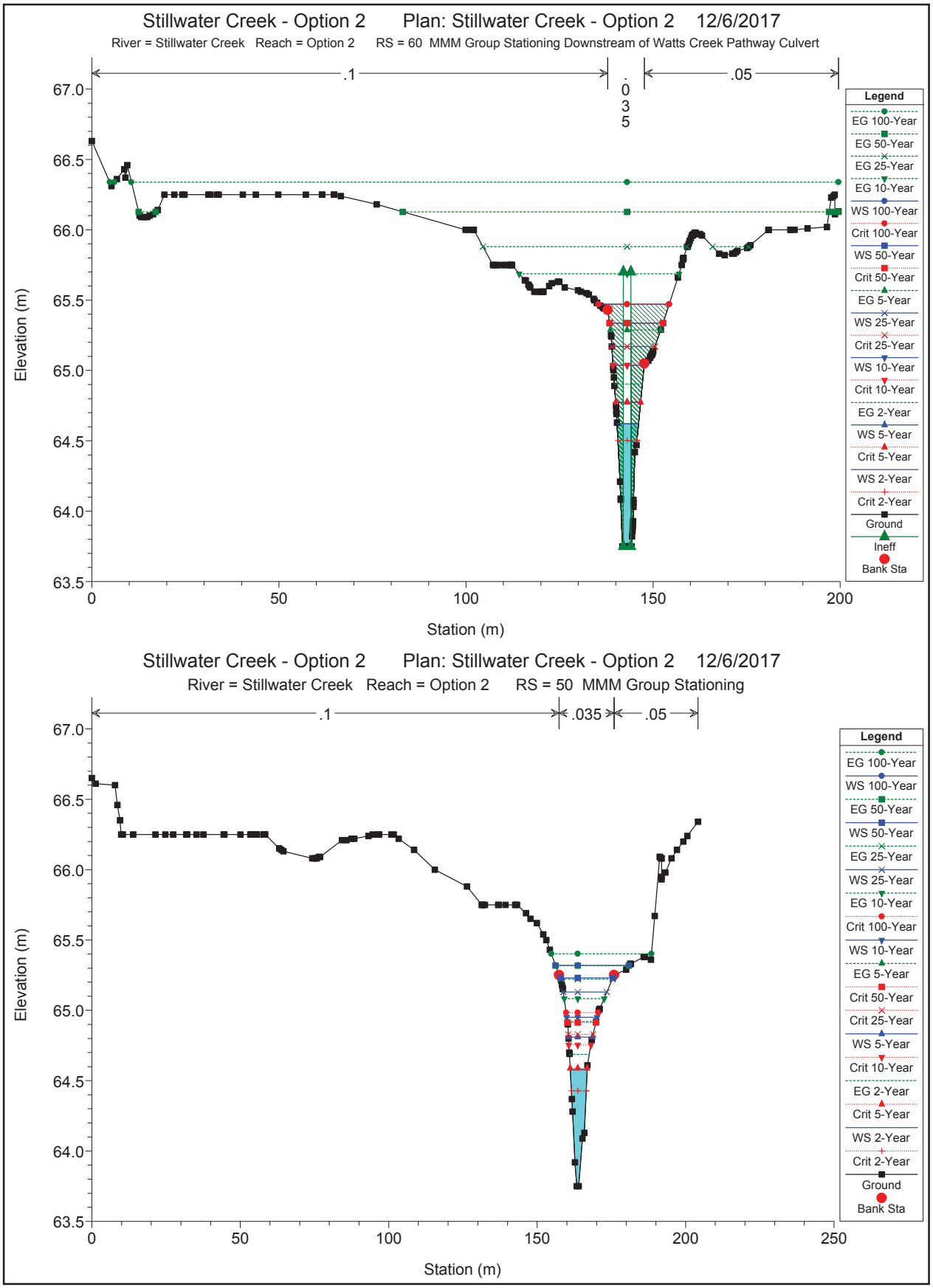

Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 130 MMM Group Station 130 North of Corkstown Station
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 120 MMM Group Stationing Upstream of Corkstown Rd Culvert
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Crit 100-Year
Crit 50-Year
Crit 25-Year
Crit 10-Year
Crit 5-Year
Crit 2-Year
Ground
Ineff
Bank Sta


Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 110 Culv Corkstown Road Culvert Data from MMM Group
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
EG 25-Year
EG 10-Year
EG 5-Year
EG 2-Year
WS 25-Year
WS 5-Year
WS 50-Year
WS 10-Year
WS 100-Year
WS 2-Year
Crit 100-Year
Crit 50-Year
Crit 25-Year
Crit 10-Year
Crit 5-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 110 Culv Corkstown Road Culvert Data from MMM Group
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
EG 25-Year
EG 10-Year
EG 5-Year
EG 2-Year
WS 25-Year
WS 5-Year
WS 50-Year
WS 10-Year
WS 100-Year
WS 2-Year
Crit 100-Year
Crit 50-Year
Crit 25-Year
Crit 10-Year
Ground
Ineff
Bank Sta


Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 100 MMM Group Stationing Downstream of Corkstown Rd Culvert
.1
.035
.1
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Crit 100-Year
Crit 50-Year
Crit 25-Year
Crit 10-Year
Crit 5-Year
Crit 2-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 95 MMM Group Stationing
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta


Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 90 MMM Group Stationing
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Ground
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 80 MMM Group Stationing Upstream of Watts Creek Pathway Culvert
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Crit 100-Year
Crit 50-Year
Crit 25-Year
Crit 10-Year
Crit 5-Year
Crit 2-Year
Ground
Ineff
Bank Sta


Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 70 Culv Watts Creek Pathway Culvert Data from MMM Group
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Crit 5-Year
Crit 2-Year
Crit 10-Year
Crit 25-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 70 Culv Watts Creek Pathway Culvert Data from MMM Group
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
WS 10-Year
EG 5-Year
WS 5-Year
EG 2-Year
WS 2-Year
Crit 5-Year
Crit 2-Year
Crit 10-Year
Crit 25-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta


Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 60 MMM Group Stationing Downstream of Watts Creek Pathway Culvert
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
EG 25-Year
EG 10-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
EG 5-Year
WS 25-Year
Crit 25-Year
WS 10-Year
Crit 10-Year
EG 2-Year
WS 5-Year
Crit 5-Year
WS 2-Year
Crit 2-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 2 Plan: Stillwater Creek - Option 2 12/6/2017
River = Stillwater Creek Reach = Option 2 RS = 50 MMM Group Stationing
.1
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
EG 25-Year
WS 25-Year
EG 10-Year
Crit 100-Year
WS 10-Year
EG 5-Year
Crit 50-Year
Crit 25-Year
WS 5-Year
Crit 10-Year
EG 2-Year
Crit 5-Year
WS 2-Year
Crit 2-Year
Ground
Bank Sta

Output Data: HEC-RAS - Existing Conditions

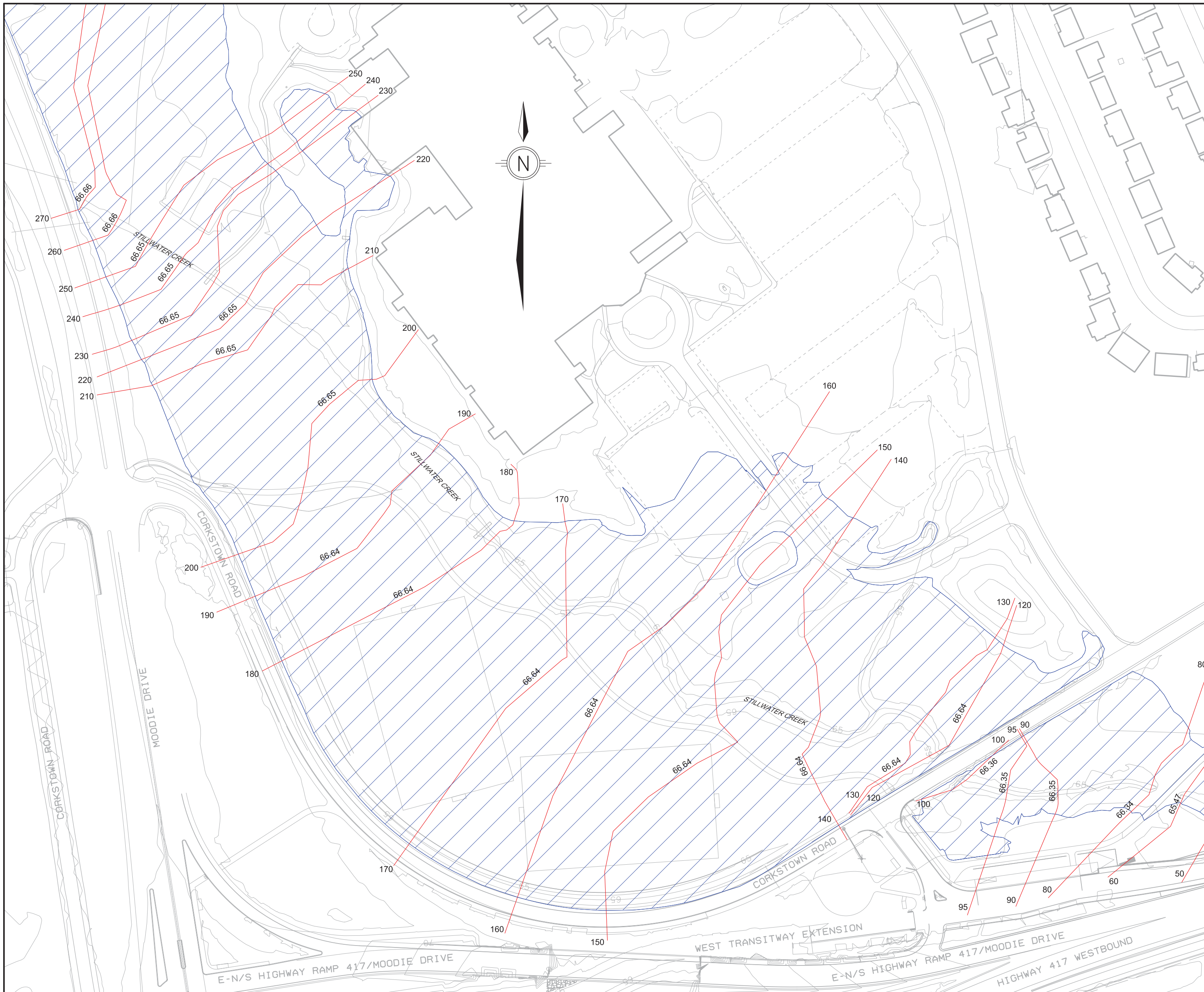
HEC-RAS Plan: Existing River: Stillwater Creek Reach: Option 2

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Option 2	270	2-Year	742.00	4.10	65.50	66.01	66.03	0.001424	0.62	13.51	149.64	0.30
Option 2	270	5-Year	742.00	6.50	65.50	66.10	66.11	0.000825	0.53	26.71	154.34	0.23
Option 2	270	10-Year	742.00	9.20	65.50	66.21	66.21	0.000428	0.43	43.92	159.91	0.17
Option 2	270	25-Year	742.00	10.60	65.50	66.28	66.28	0.000284	0.38	55.82	165.05	0.14
Option 2	270	50-Year	742.00	12.50	65.50	66.42	66.43	0.000137	0.30	80.41	177.94	0.10
Option 2	270	100-Year	742.00	14.20	65.50	66.66	66.66	0.000052	0.22	124.31	196.17	0.07
Option 2	260	2-Year	722.00	4.10	65.50	66.01	66.01	0.000307	0.28	22.72	169.92	0.14
Option 2	260	5-Year	722.00	6.50	65.50	66.09	66.10	0.000262	0.29	37.54	176.08	0.13
Option 2	260	10-Year	722.00	9.20	65.50	66.20	66.21	0.000174	0.27	57.50	183.00	0.11
Option 2	260	25-Year	722.00	10.60	65.50	66.28	66.28	0.000127	0.25	71.29	187.46	0.10
Option 2	260	50-Year	722.00	12.50	65.50	66.42	66.42	0.000068	0.21	99.06	196.09	0.07
Option 2	260	100-Year	722.00	14.20	65.50	66.66	66.66	0.000029	0.16	147.79	218.89	0.05
Option 2	250	2-Year	702.00	4.10	65.50	65.99	66.00	0.001117	0.50	10.88	46.01	0.26
Option 2	250	5-Year	702.00	6.50	65.50	66.07	66.08	0.001134	0.58	15.90	65.45	0.27
Option 2	250	10-Year	702.00	9.20	65.50	66.19	66.19	0.000719	0.53	23.81	70.86	0.22
Option 2	250	25-Year	702.00	10.60	65.50	66.26	66.27	0.000617	0.54	29.93	103.44	0.21
Option 2	250	50-Year	702.00	12.50	65.50	66.41	66.42	0.000243	0.39	45.98	106.60	0.14
Option 2	250	100-Year	702.00	14.20	65.50	66.65	66.66	0.000074	0.25	76.05	138.85	0.08
Option 2	240	2-Year	682.00	4.10	65.50	65.97	65.97	0.001085	0.49	12.61	56.50	0.26
Option 2	240	5-Year	682.00	6.50	65.50	66.05	66.06	0.001068	0.56	17.60	63.58	0.26
Option 2	240	10-Year	682.00	9.20	65.50	66.17	66.18	0.000699	0.53	26.47	82.82	0.22
Option 2	240	25-Year	682.00	10.60	65.50	66.25	66.26	0.000537	0.50	33.37	103.34	0.20
Option 2	240	50-Year	682.00	12.50	65.50	66.41	66.41	0.000224	0.38	50.43	110.84	0.13
Option 2	240	100-Year	682.00	14.20	65.50	66.65	66.65	0.000071	0.25	81.92	143.38	0.08
Option 2	230	2-Year	662.00	4.10	65.50	65.95	65.96	0.000602	0.34	17.29	76.89	0.19
Option 2	230	5-Year	662.00	6.50	65.50	66.04	66.04	0.000576	0.38	23.90	80.80	0.19
Option 2	230	10-Year	662.00	9.20	65.50	66.16	66.17	0.000380	0.37	34.62	88.10	0.16
Option 2	230	25-Year	662.00	10.60	65.50	66.25	66.25	0.000290	0.36	42.69	106.60	0.14
Option 2	230	50-Year	662.00	12.50	65.50	66.41	66.41	0.000138	0.29	62.88	127.55	0.10
Option 2	230	100-Year	662.00	14.20	65.50	66.65	66.65	0.000048	0.20	99.36	168.76	0.06
Option 2	220	2-Year	641.00	4.10	65.50	65.94	65.95	0.000370	0.27	20.54	89.89	0.15
Option 2	220	5-Year	641.00	6.50	65.50	66.03	66.03	0.000367	0.31	28.31	95.61	0.15
Option 2	220	10-Year	641.00	9.20	65.50	66.16	66.16	0.000239	0.30	41.44	104.31	0.13
Option 2	220	25-Year	641.00	10.60	65.50	66.24	66.25	0.000178	0.28	50.36	109.70	0.11
Option 2	220	50-Year	641.00	12.50	65.50	66.41	66.41	0.000096	0.24	68.98	117.70	0.09
Option 2	220	100-Year	641.00	14.20	65.50	66.65	66.65	0.000040	0.19	103.20	158.42	0.06
Option 2	210	2-Year	625.00	4.10	65.50	65.94	65.94	0.000403	0.28	20.75	95.16	0.15
Option 2	210	5-Year	625.00	6.50	65.50	66.02	66.02	0.000400	0.32	29.41	120.64	0.16
Option 2	210	10-Year	625.00	9.20	65.50	66.16	66.16	0.000235	0.29	45.78	123.48	0.13
Option 2	210	25-Year	625.00	10.60	65.50	66.24	66.24	0.000170	0.28	56.29	125.26	0.11
Option 2	210	50-Year	625.00	12.50	65.50	66.40	66.41	0.000092	0.24	77.26	129.05	0.08
Option 2	210	100-Year	625.00	14.20	65.50	66.65	66.65	0.000041	0.19	109.57	134.97	0.06
Option 2	200	2-Year	567.00	4.10	65.49	65.90	65.91	0.000998	0.45	16.63	115.19	0.24
Option 2	200	5-Year	567.00	6.50	65.49	65.99	66.00	0.000649	0.42	27.86	124.22	0.20
Option 2	200	10-Year	567.00	9.20	65.49	66.14	66.14	0.000282	0.34	46.40	125.70	0.14
Option 2	200	25-Year	567.00	10.60	65.49	66.23	66.23	0.000191	0.30	57.62	126.59	0.12
Option 2	200	50-Year	567.00	12.50	65.49	66.40	66.40	0.000097	0.25	79.28	128.28	0.09
Option 2	200	100-Year	567.00	14.20	65.49	66.65	66.65	0.000042	0.20	111.40	131.07	0.06
Option 2	190	2-Year	512.00	4.10	65.47	65.84	65.85	0.001012	0.39	12.73	83.86	0.23
Option 2	190	5-Year	512.00	6.50	65.47	65.95	65.96	0.000694	0.40	23.18	107.32	0.20
Option 2	190	10-Year	512.00	9.20	65.47	66.12	66.13	0.000297	0.33	44.09	127.50	0.14
Option 2	190	25-Year	512.00	10.60	65.47	66.22	66.22	0.000202	0.30	56.19	128.25	0.12
Option 2	190	50-Year	512.00	12.50	65.47	66.39	66.40	0.000105	0.26	78.84	129.63	0.09
Option 2	190	100-Year	512.00	14.20	65.47	66.64	66.65	0.000048	0.21	111.65	131.54	0.06
Option 2	180	2-Year	458.00	4.10	64.71	65.82	65.82	0.000274	0.32	16.94	133.30	0.14
Option 2	180	5-Year	458.00	6.50	64.71	65.94	65.94	0.000169	0.29	33.06	135.73	0.11
Option 2	180	10-Year	458.00	9.20	64.71	66.12	66.12	0.000069	0.21	57.82	139.41	0.07
Option 2	180	25-Year	458.00	10.60	64.71	66.21	66.22	0.000048	0.19	71.33	141.34	0.06
Option 2	180	50-Year	458.00	12.50	64.71	66.39	66.39	0.000026	0.16	96.68	144.28	0.05
Option 2	180	100-Year	458.00	14.20	64.71	66.64	66.64	0.000012	0.12	133.53	147.87	0.03
Option 2	170	2-Year	404.00	4.10	64.50	65.81	65.81	0.000126	0.19	26.35	181.60	0.09
Option 2	170	5-Year	404.00	6.50	64.50	65.93	65.93	0.000081	0.18	49.19	189.98	0.07
Option 2	170	10-Year	404.00	9.20	64.50	66.12	66.12	0.000033	0.14	84.53	195.47	0.05
Option 2	170	25-Year	404.00	10.60	64.50	66.21	66.21	0.000023	0.12	103.61	198.06	0.04
Option 2	170	50-Year	404.00	12.50	64.50	66.39	66.39	0.000013	0.10	139.18	201.13	0.03
Option 2	170	100-Year	404.00	14.20	64.50	66.64	66.64	0.000006	0.08	190.48	206.30	0.02
Option 2	160	2-Year	352.00	4.10	64.50	65.81	65.81	0.000049	0.17	33.86	157.07	0.06
Option 2	160	5-Year	352.00	6.50	64.50	65.93	65.93	0.000045	0.18	54.31	167.66	0.06

Output Data: HEC-RAS - Existing Conditions

HEC-RAS Plan: Existing River: Stillwater Creek Reach: Option 2 (Continued)

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Option 2	160	10-Year	352.00	9.20	64.50	66.11	66.11	0.000024	0.15	92.57	235.36	0.05
Option 2	160	25-Year	352.00	10.60	64.50	66.21	66.21	0.000018	0.14	115.76	241.26	0.04
Option 2	160	50-Year	352.00	12.50	64.50	66.39	66.39	0.000011	0.12	159.98	252.07	0.03
Option 2	160	100-Year	352.00	14.20	64.50	66.64	66.64	0.000006	0.09	228.16	285.19	0.02
Option 2	150	2-Year	298.00	4.10	64.50	65.80	65.81	0.000034	0.14	33.61	156.02	0.05
Option 2	150	5-Year	298.00	6.50	64.50	65.93	65.93	0.000040	0.17	53.64	166.90	0.06
Option 2	150	10-Year	298.00	9.20	64.50	66.11	66.11	0.000024	0.15	89.40	211.63	0.04
Option 2	150	25-Year	298.00	10.60	64.50	66.21	66.21	0.000018	0.14	110.29	220.74	0.04
Option 2	150	50-Year	298.00	12.50	64.50	66.39	66.39	0.000011	0.12	152.00	239.26	0.03
Option 2	150	100-Year	298.00	14.20	64.50	66.64	66.64	0.000006	0.09	214.79	257.25	0.02
Option 2	140	2-Year	243.00	4.10	64.50	65.80	65.80	0.000088	0.24	19.86	81.94	0.08
Option 2	140	5-Year	243.00	6.50	64.50	65.92	65.92	0.000130	0.31	31.00	98.99	0.10
Option 2	140	10-Year	243.00	9.20	64.50	66.11	66.11	0.000116	0.33	54.98	152.98	0.10
Option 2	140	25-Year	243.00	10.60	64.50	66.20	66.21	0.000102	0.33	70.58	162.52	0.09
Option 2	140	50-Year	243.00	12.50	64.50	66.39	66.39	0.000071	0.30	100.90	172.30	0.08
Option 2	140	100-Year	243.00	14.20	64.50	66.64	66.64	0.000040	0.25	147.20	190.72	0.06
Option 2	130	2-Year	180.00	4.10	64.23	65.80	65.80	0.000046	0.16	28.18	78.93	0.06
Option 2	130	5-Year	180.00	6.50	64.23	65.92	65.92	0.000067	0.21	37.82	82.43	0.07
Option 2	130	10-Year	180.00	9.20	64.23	66.10	66.10	0.000063	0.23	53.47	86.12	0.07
Option 2	130	25-Year	180.00	10.60	64.23	66.20	66.20	0.000059	0.24	62.08	88.71	0.07
Option 2	130	50-Year	180.00	12.50	64.23	66.38	66.38	0.000047	0.23	78.48	91.65	0.07
Option 2	130	100-Year	180.00	14.20	64.23	66.64	66.64	0.000031	0.21	102.50	96.39	0.05
Option 2	120	2-Year	162.00	4.10	64.00	65.78	65.80	0.000141	0.49	8.34	84.16	0.12
Option 2	120	5-Year	162.00	6.50	64.00	65.89	65.91	0.000294	0.74	8.82	102.48	0.17
Option 2	120	10-Year	162.00	9.20	64.00	66.05	66.10	0.000444	0.96	9.60	110.60	0.21
Option 2	120	25-Year	162.00	10.60	64.00	66.14	66.20	0.000512	1.06	10.01	111.28	0.23
Option 2	120	50-Year	162.00	12.50	64.00	66.31	66.38	0.000551	1.16	10.81	112.60	0.24
Option 2	120	100-Year	162.00	14.20	64.00	66.64	66.64	0.000039	0.23	115.74	114.95	0.06
Option 2	110		Culvert									
Option 2	100	2-Year	141.00	4.10	64.00	65.77	65.79	0.000165	0.53	7.70	32.76	0.13
Option 2	100	5-Year	141.00	6.50	64.00	65.85	65.89	0.000358	0.81	8.05	35.32	0.19
Option 2	100	10-Year	141.00	9.20	64.00	65.98	65.99	0.000110	0.39	32.05	39.34	0.10
Option 2	100	25-Year	141.00	10.60	64.00	66.04	66.04	0.000127	0.43	34.38	40.31	0.11
Option 2	100	50-Year	141.00	12.50	64.00	66.15	66.16	0.000134	0.46	39.25	42.26	0.11
Option 2	100	100-Year	141.00	14.20	64.00	66.35	66.36	0.000113	0.45	48.09	48.80	0.10
Option 2	95	2-Year	117.00	4.10	63.96	65.78	65.78	0.000106	0.31	15.57	40.06	0.09
Option 2	95	5-Year	117.00	6.50	63.96	65.86	65.87	0.000199	0.45	19.38	47.16	0.13
Option 2	95	10-Year	117.00	9.20	63.96	65.97	65.98	0.000282	0.57	24.56	60.29	0.16
Option 2	95	25-Year	117.00	10.60	63.96	66.02	66.04	0.000308	0.61	28.43	68.85	0.16
Option 2	95	50-Year	117.00	12.50	63.96	66.14	66.16	0.000277	0.61	36.81	69.91	0.16
Option 2	95	100-Year	117.00	14.20	63.96	66.35	66.36	0.000180	0.54	51.23	71.70	0.13
Option 2	90	2-Year	90.00	4.10	64.67	65.76	65.77	0.001014	0.44	9.55	42.04	0.24
Option 2	90	5-Year	90.00	6.50	64.67	65.85	65.86	0.001178	0.55	13.19	45.49	0.27
Option 2	90	10-Year	90.00	9.20	64.67	65.95	65.97	0.001079	0.61	18.13	51.18	0.27
Option 2	90	25-Year	90.00	10.60	64.67	66.01	66.03	0.000966	0.61	21.20	53.32	0.26
Option 2	90	50-Year	90.00	12.50	64.67	66.13	66.15	0.000651	0.57	28.57	64.69	0.22
Option 2	90	100-Year	90.00	14.20	64.67	66.34	66.35	0.000297	0.46	43.37	72.78	0.15
Option 2	80	2-Year	40.00	4.10	63.75	65.76	65.76	0.000072	0.21	22.08	38.06	0.07
Option 2	80	5-Year	40.00	6.50	63.75	65.84	65.84	0.000131	0.30	25.23	40.89	0.10
Option 2	80	10-Year	40.00	9.20	63.75	65.94	65.95	0.000181	0.38	29.44	44.38	0.12
Option 2	80	25-Year	40.00	10.60	63.75	66.00	66.00	0.000196	0.41	32.11	47.24	0.13
Option 2	80	50-Year	40.00	12.50	63.75	66.12	66.13	0.000174	0.41	49.07	151.69	0.12
Option 2	80	100-Year	40.00	14.20	63.75	66.34	66.34	0.000092	0.34	82.29	160.69	0.09
Option 2	70		Culvert									
Option 2	60	2-Year	22.00	4.10	63.75	64.62	64.90	0.008128	2.35	1.74	5.79	0.80
Option 2	60	5-Year	22.00	6.50	63.75	64.77	65.29	0.011933	3.17	2.05	6.66	1.00
Option 2	60	10-Year	22.00	9.20	63.75	65.04	65.69	0.011155	3.57	2.58	8.33	1.00
Option 2	60	25-Year	22.00	10.60	63.75	65.17	65.88	0.010668	3.73	2.84	11.51	1.00
Option 2	60	50-Year	22.00	12.50	63.75	65.34	66.13	0.010289	3.94	3.17	14.27	1.00
Option 2	60	100-Year	22.00	14.20	63.75	65.47	66.34	0.010124	4.13	3.44	18.88	1.00
Option 2	50	2-Year		4.10	63.75	64.58	64.69	0.006925	1.44	2.84	5.72	0.65
Option 2	50	5-Year		6.50	63.75	64.81	64.92	0.006361	1.48	4.40	8.09	0.64
Option 2	50	10-Year		9.20	63.75	64.95	65.08	0.007405	1.62	5.68	10.24	0.69
Option 2	50	25-Year		10.60	63.75	65.13	65.22	0.005231	1.34	7.89	14.67	0.58
Option 2	50	50-Year		12.50	63.75	65.23	65.32	0.004983	1.31	9.51	17.66	0.57
Option 2	50	100-Year		14.20	63.75	65.32	65.40	0.003985	1.27	11.42	24.77	0.52



OTTAWA STAGE 2
WEST TRANSITWAY EXTENSION
MOODIE DRIVE

FLOODPLAIN DELINEATION
EXISTING CONDITIONS

N/A Manager - Division	N/A Project Manager

Ottawa

Contract No.	Dwg. No. 1
Sheet 1 of 2	
Asset No. N/A	
Asset Group N/A	
Des. VJT	Chk'd. _
Dwn. SMD	Chk'd. _
Utility Circ. No. N/A	Index No. N/A
Const. Inspector N/A	
Scale: HORIZONTAL 0m 4 8 16	

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

LEGEND

HEC-RAS SECTION

FLOODPLAIN AREA

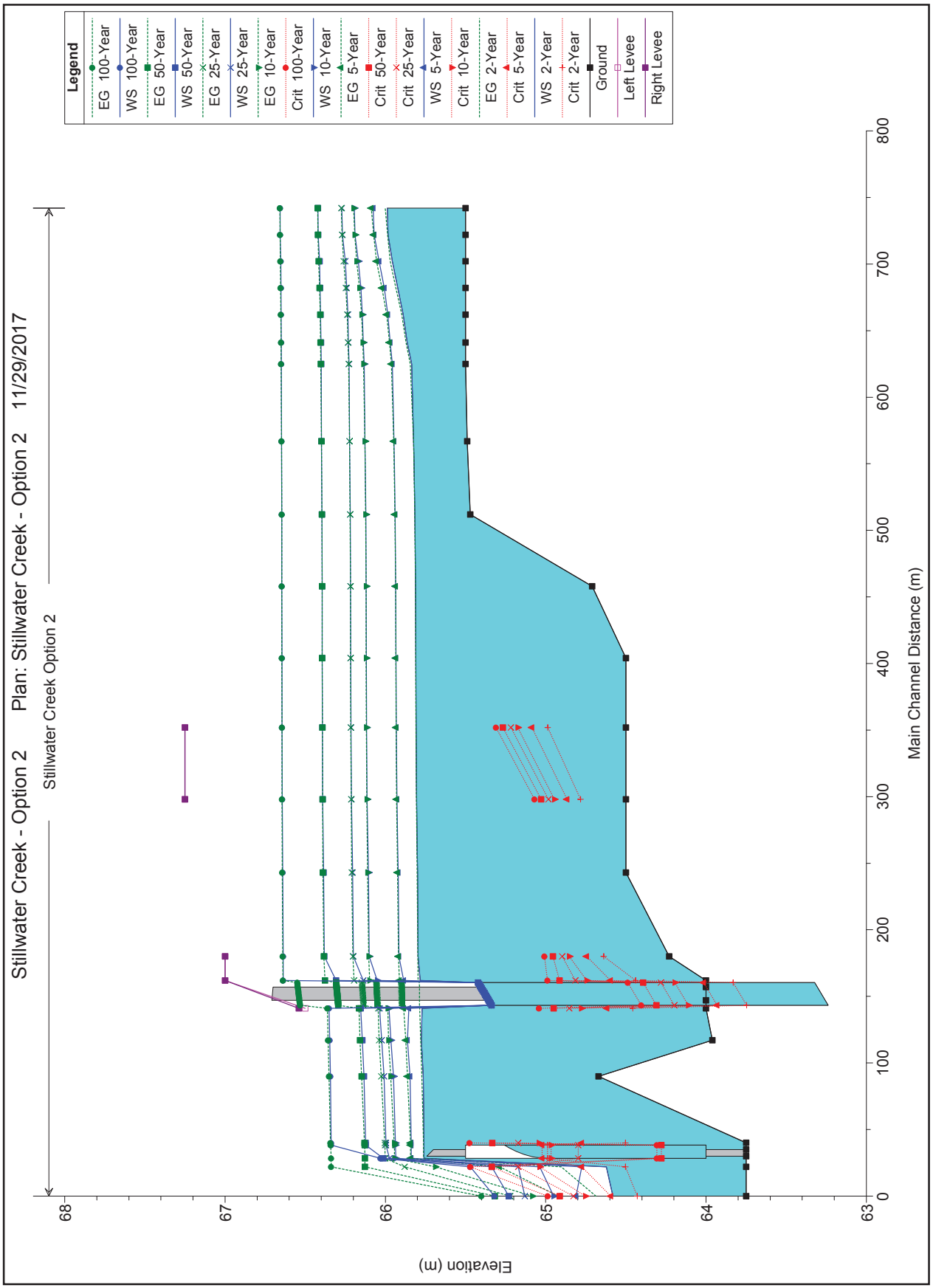
NOT FOR CONSTRUCTION

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

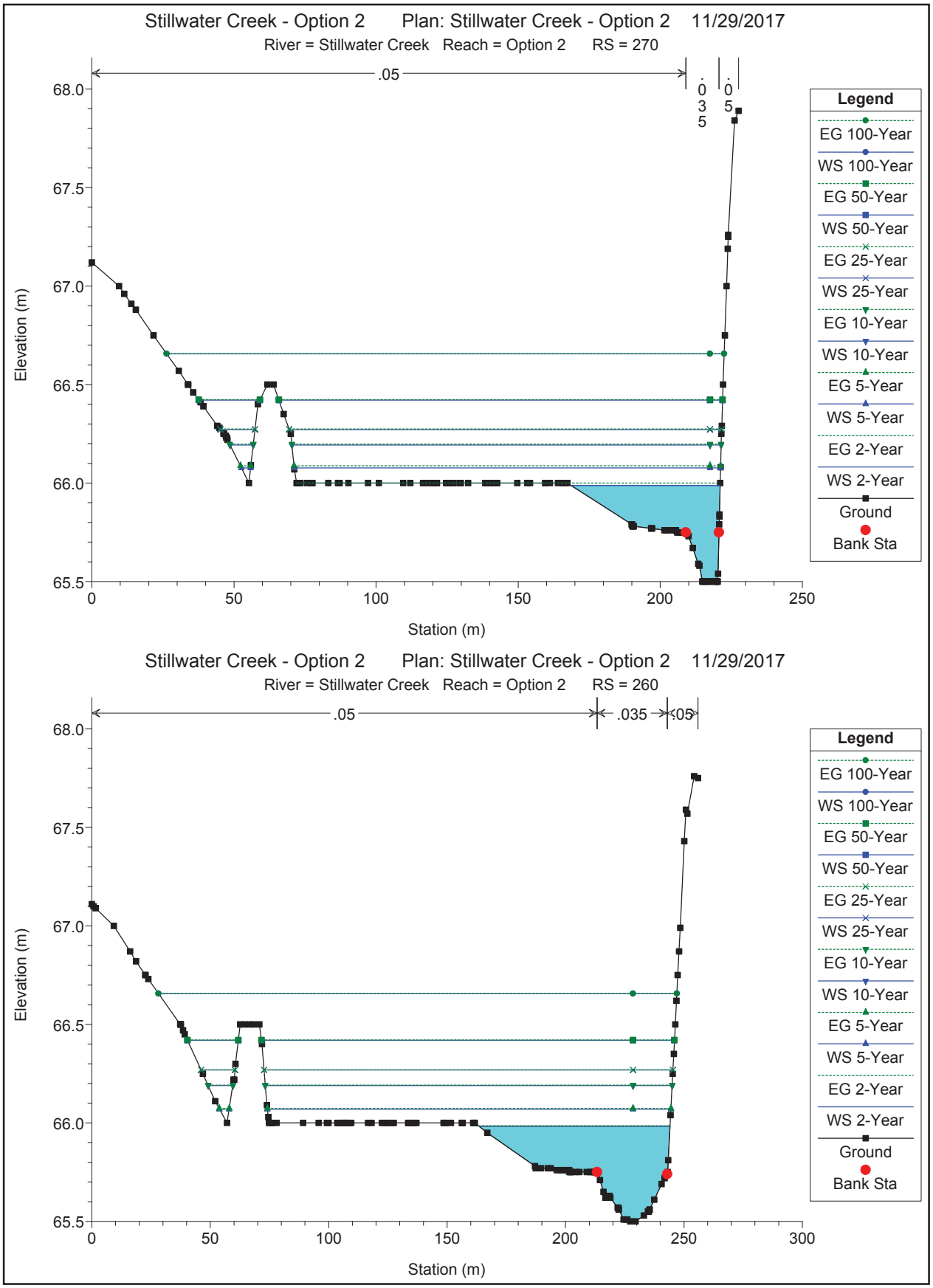
Consultant Drawing Number

2008-Jan-21 02:03:18 PM S:/PWS/CAD/ISB07-5063-000-cov.dgn

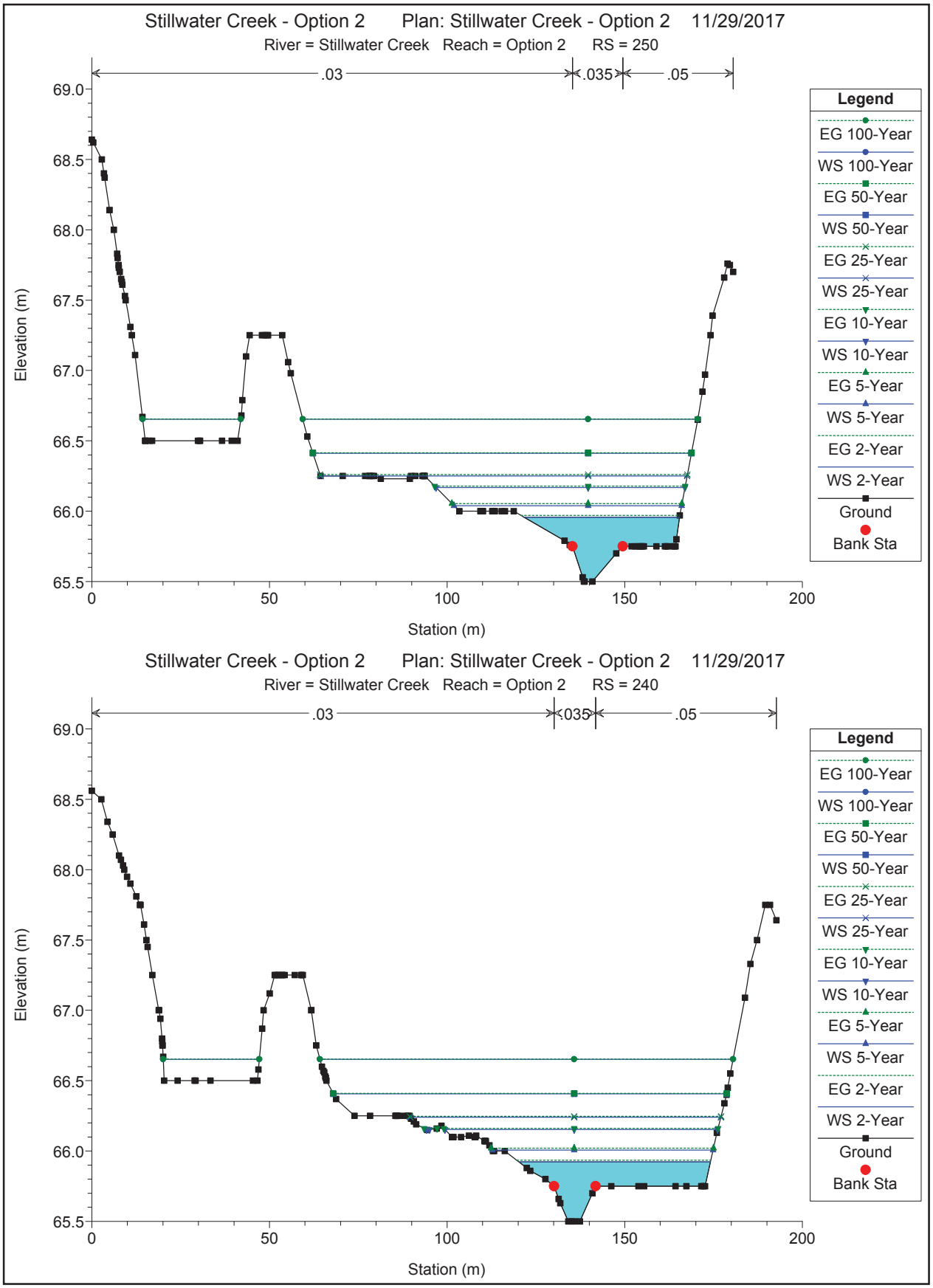
Output Data: HEC-RAS - Proposed Conditions
with 0.3 Meter Excavation



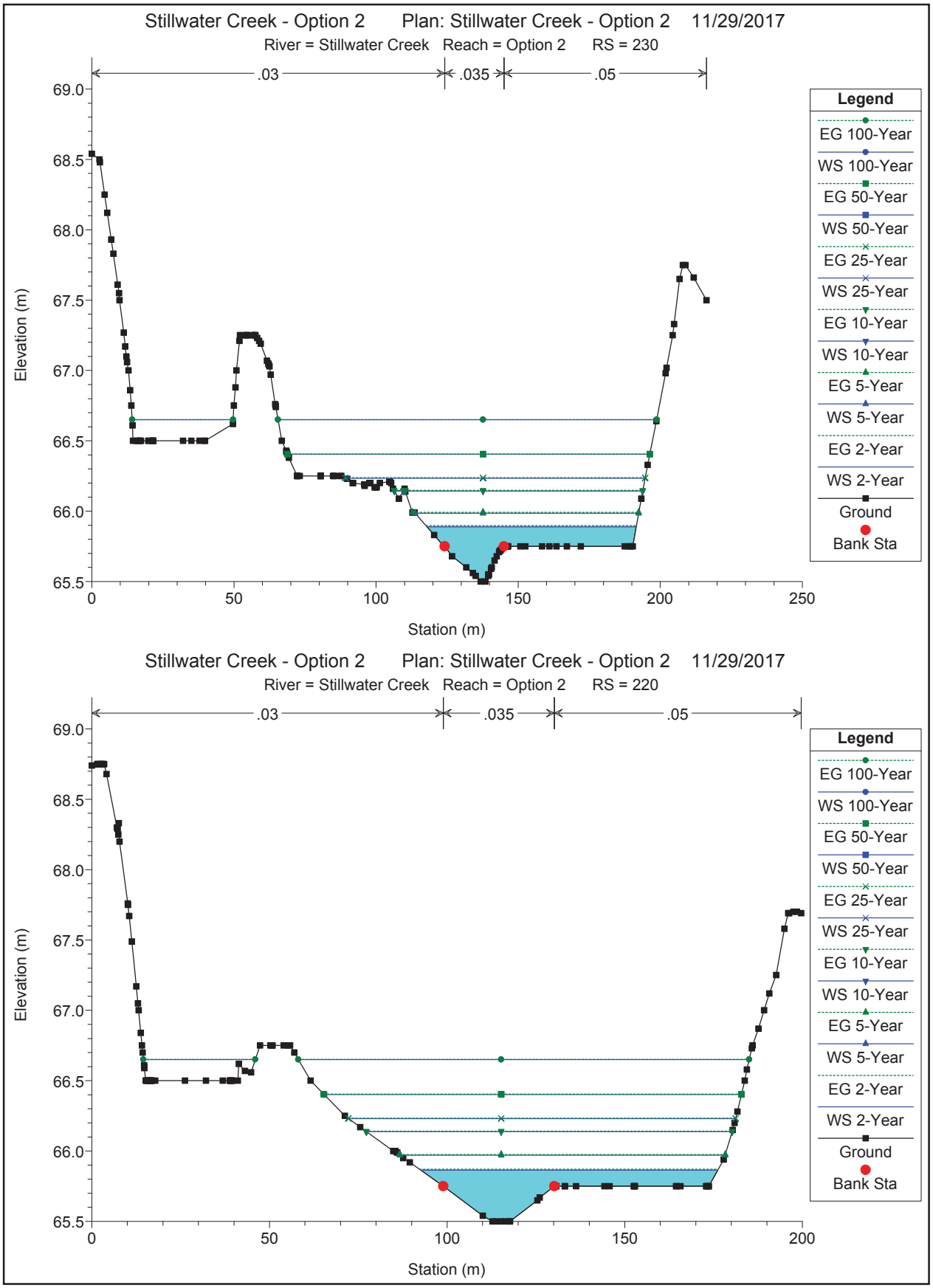
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



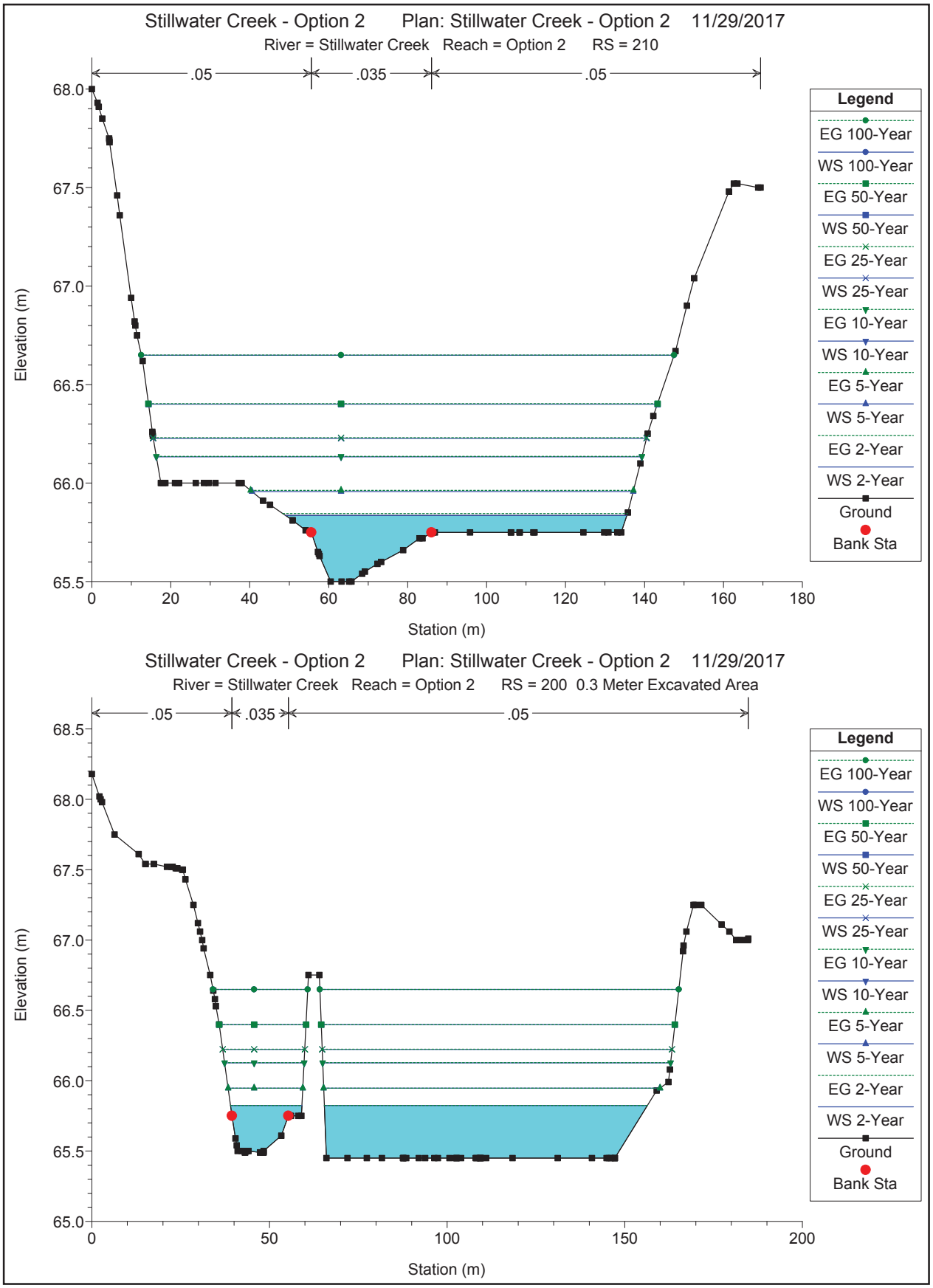
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



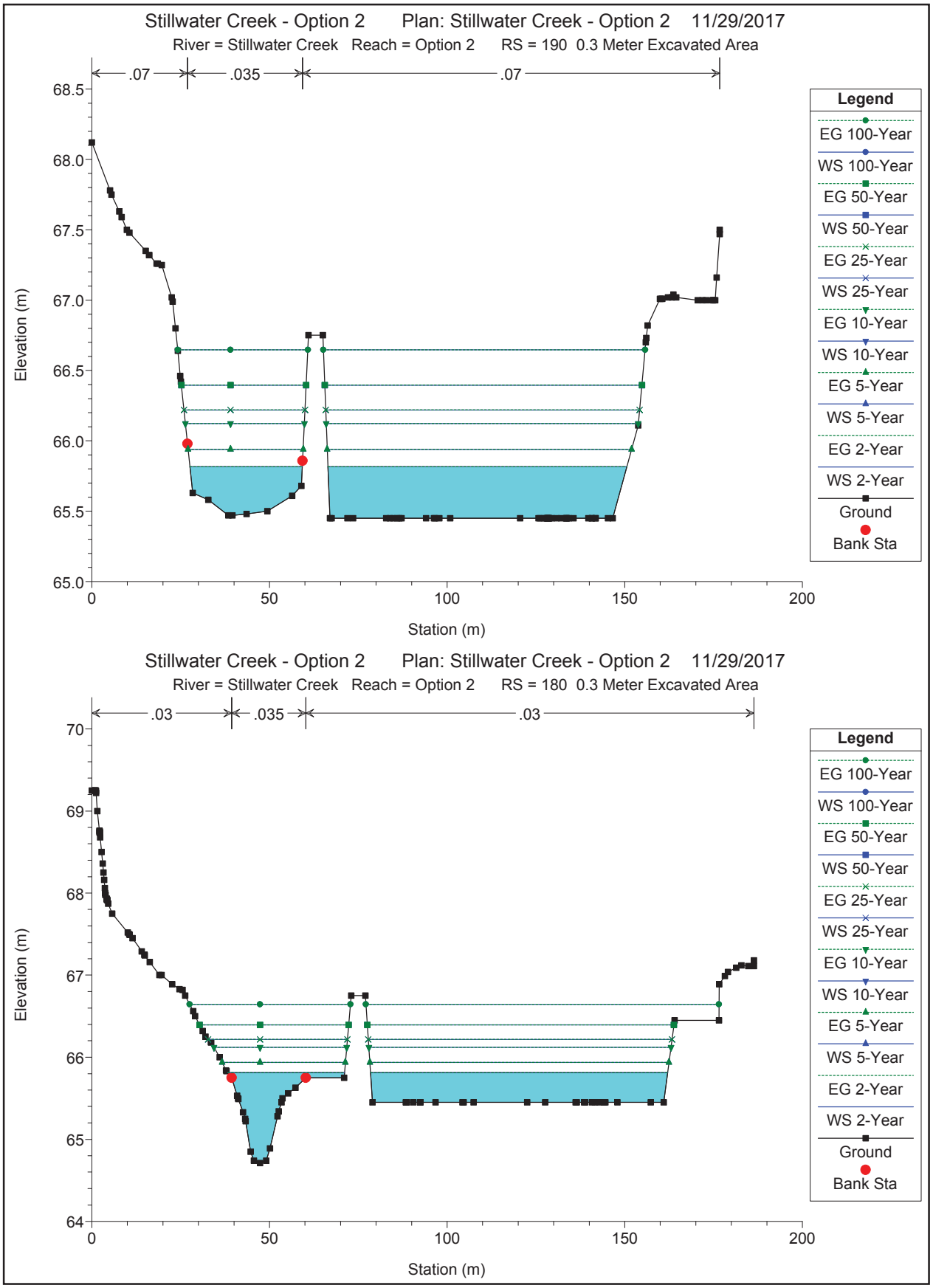
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



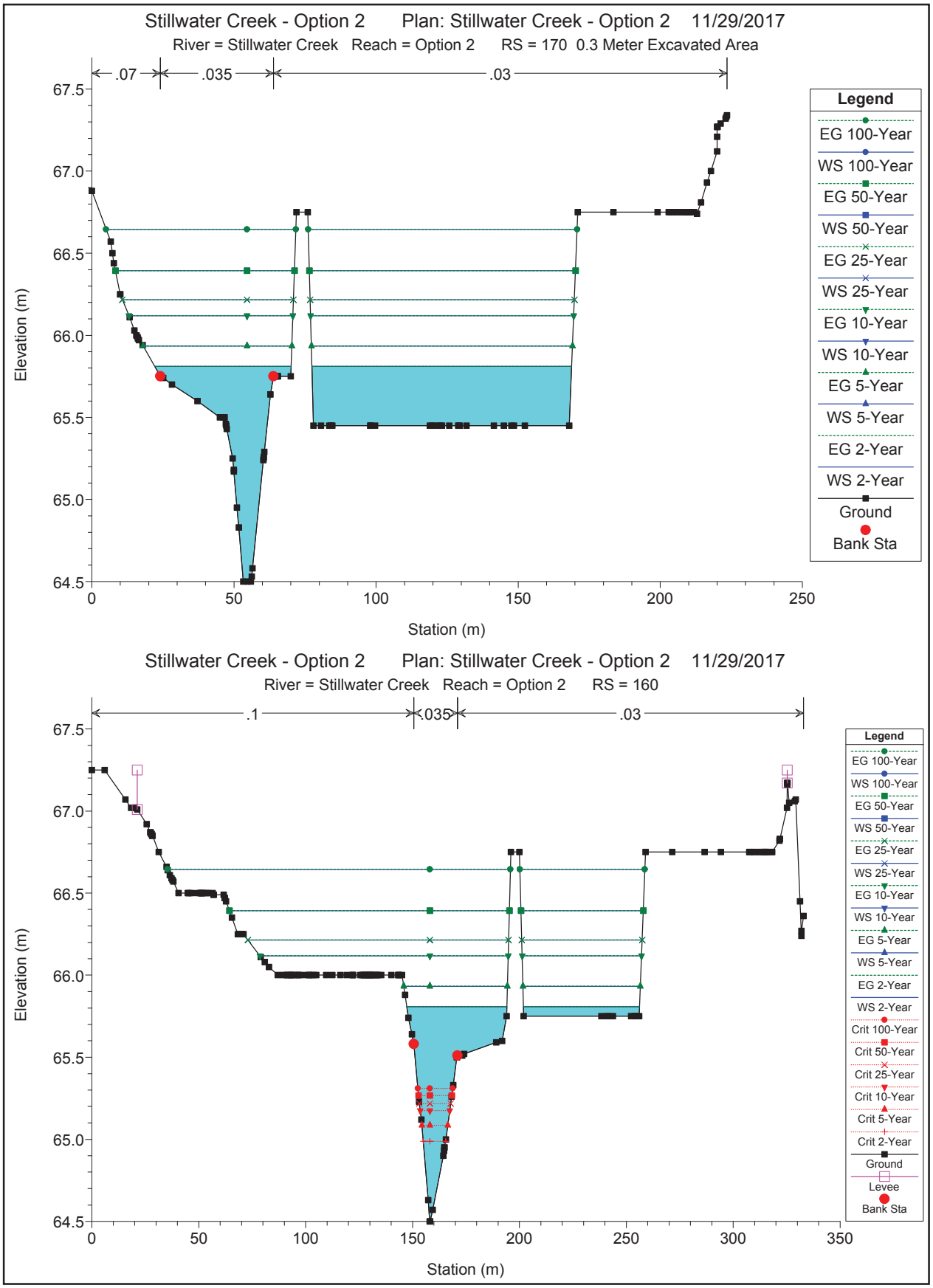
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



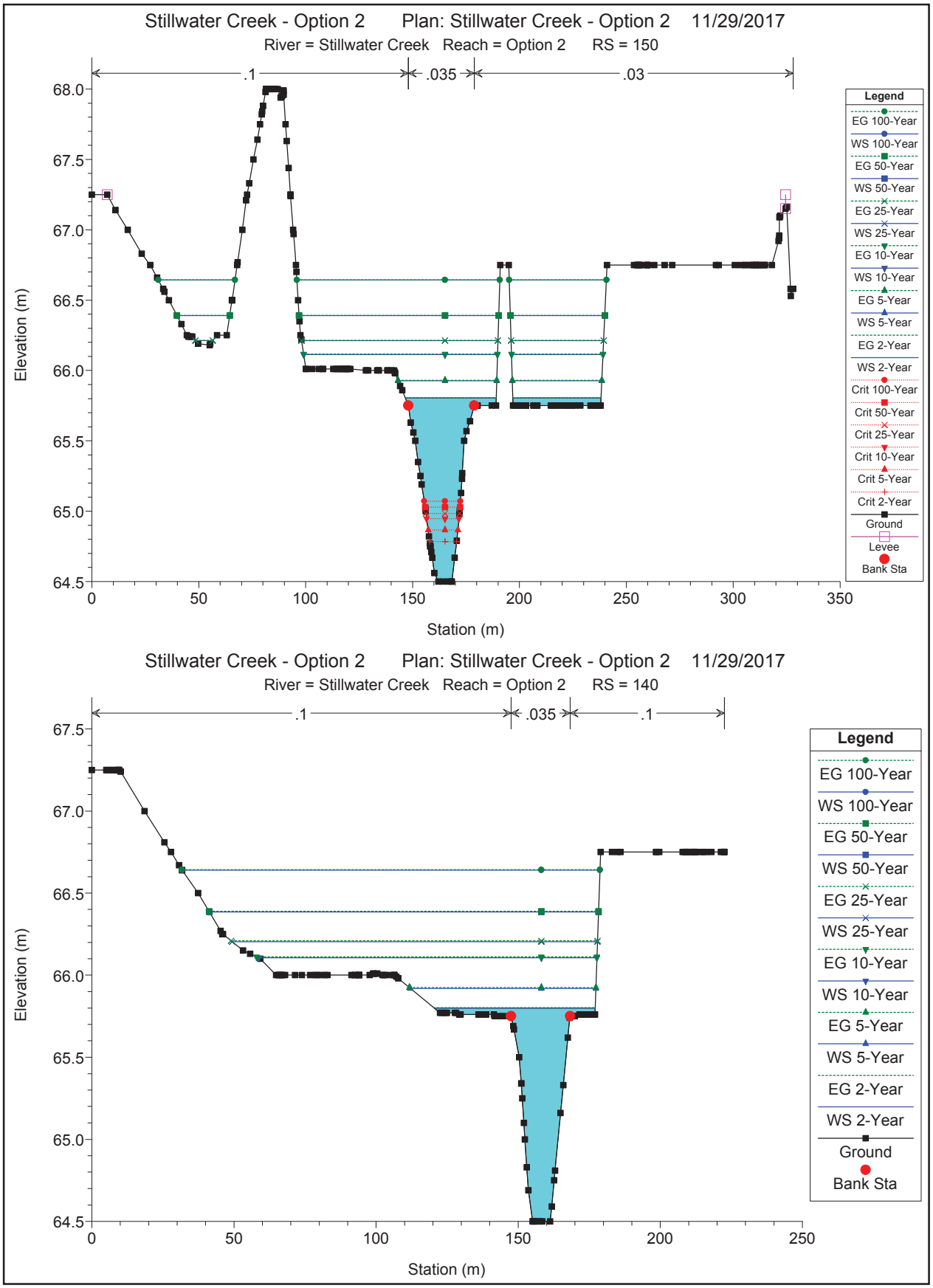
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



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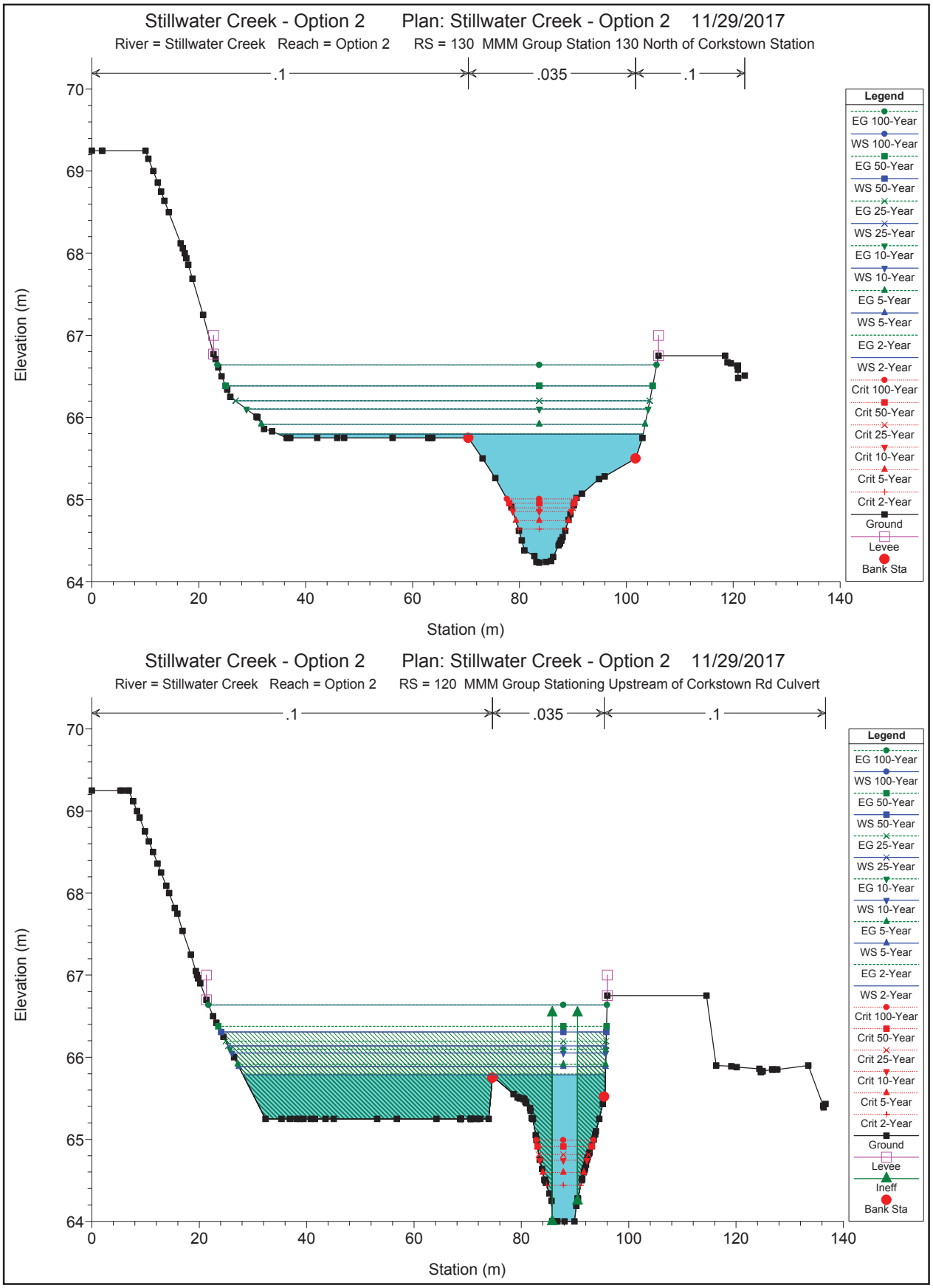
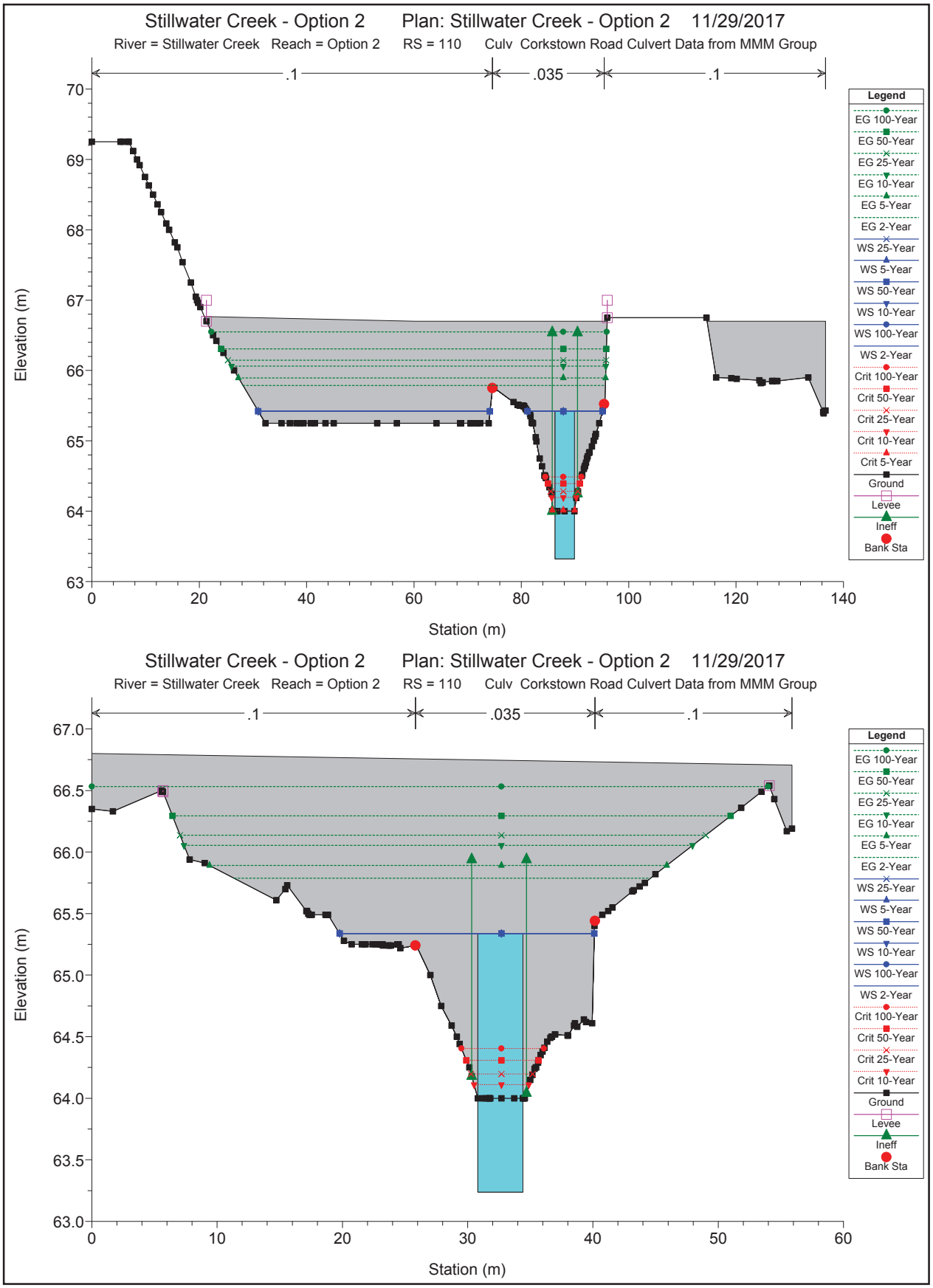
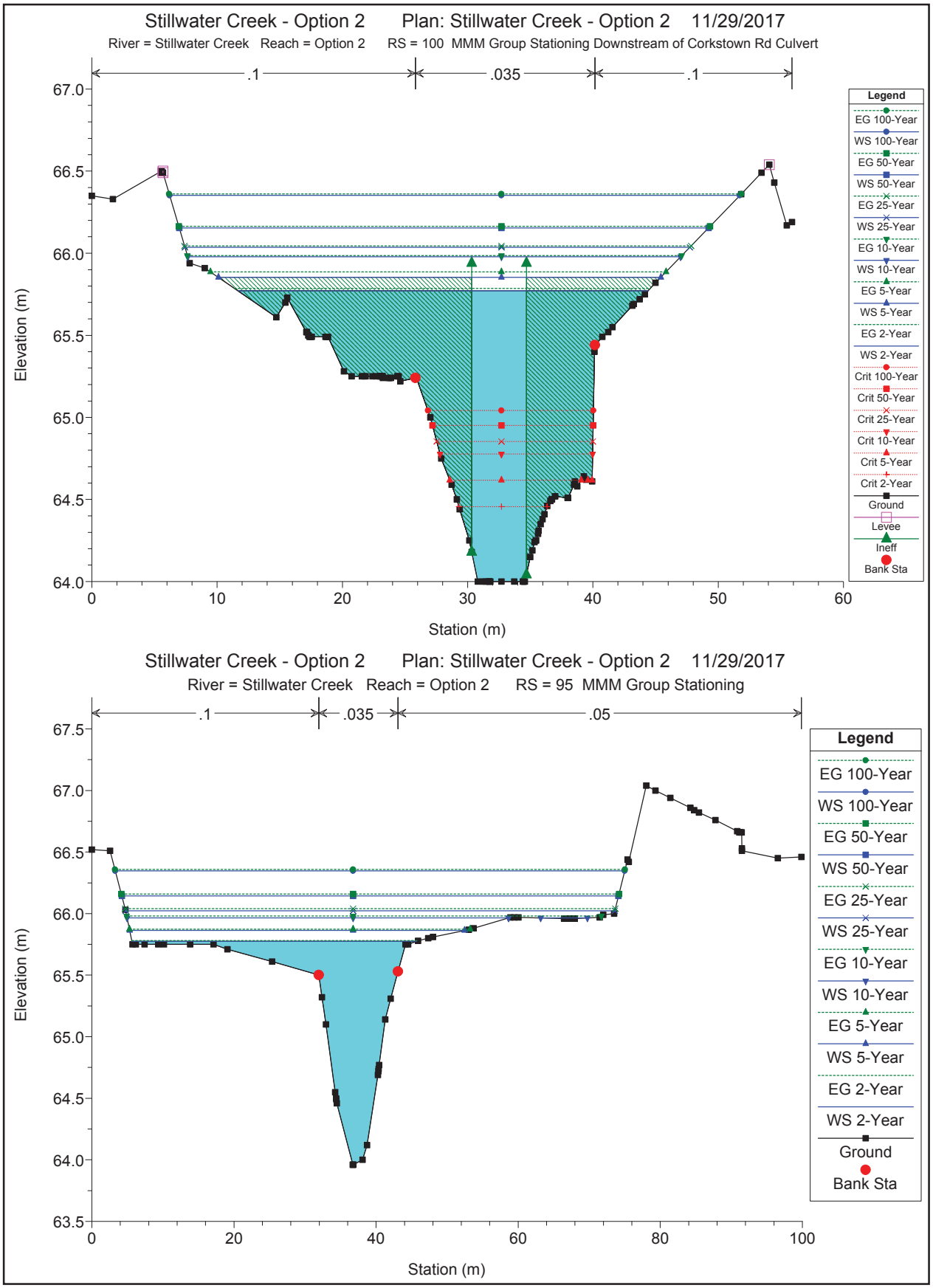


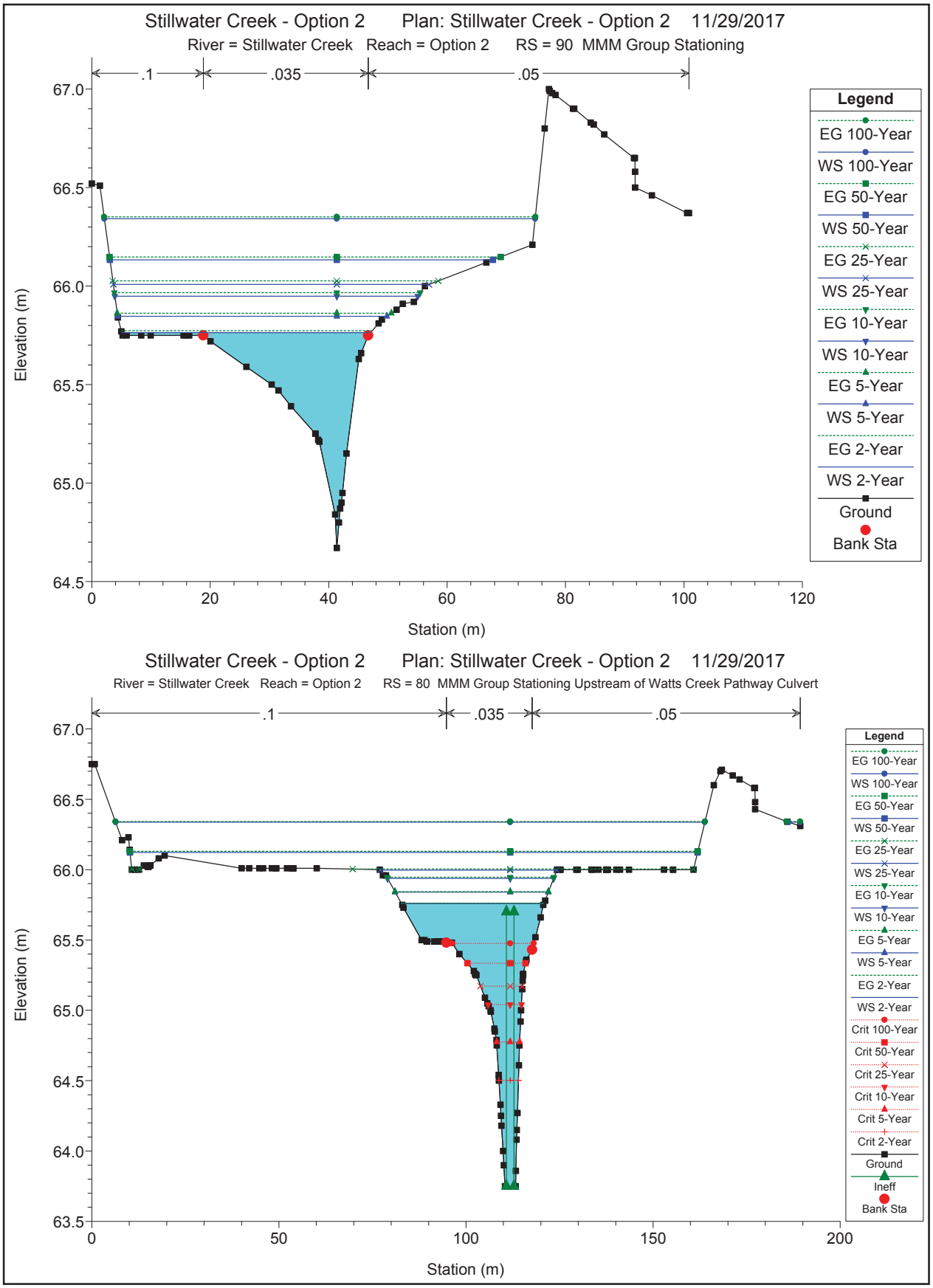
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



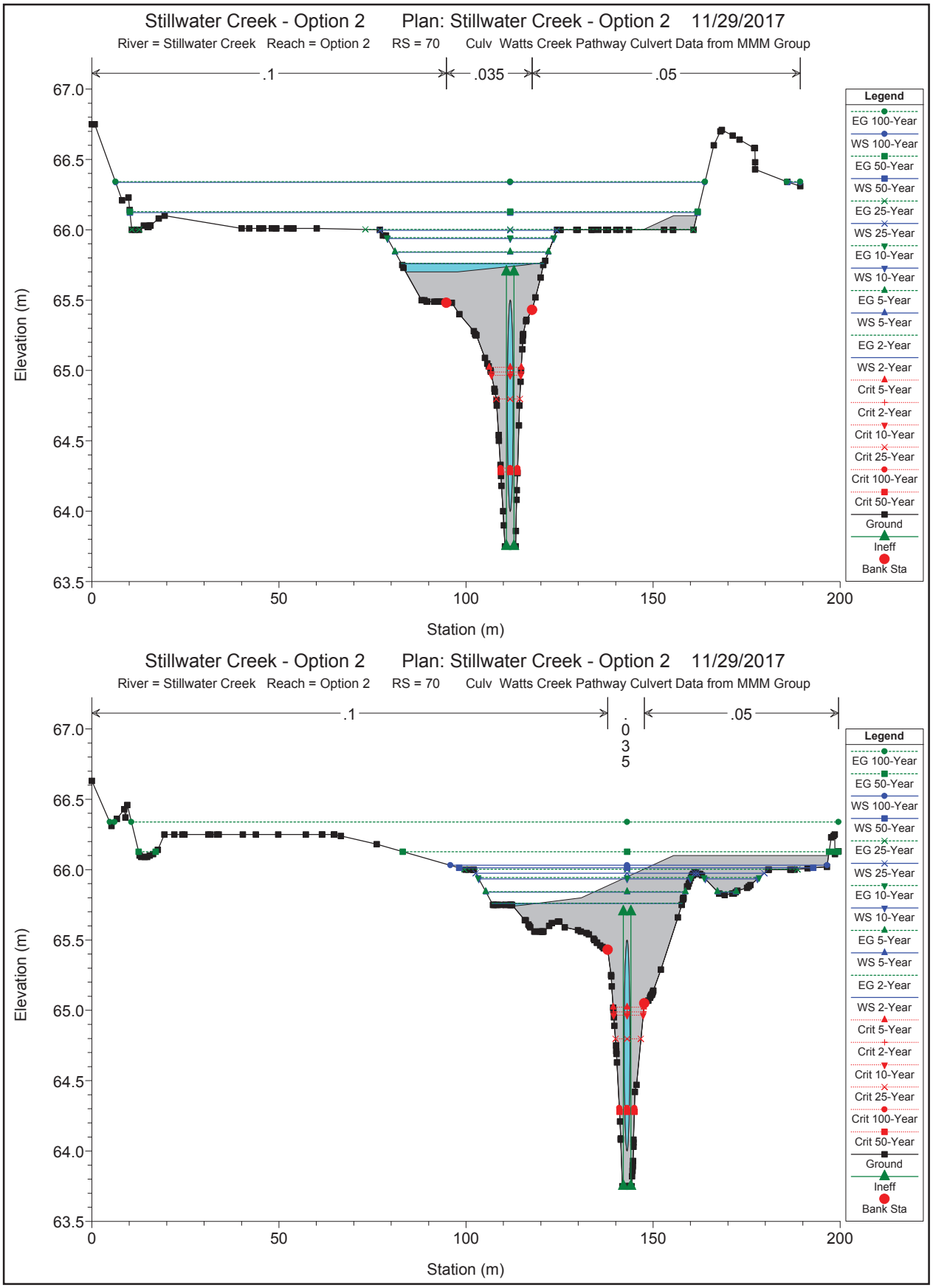
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



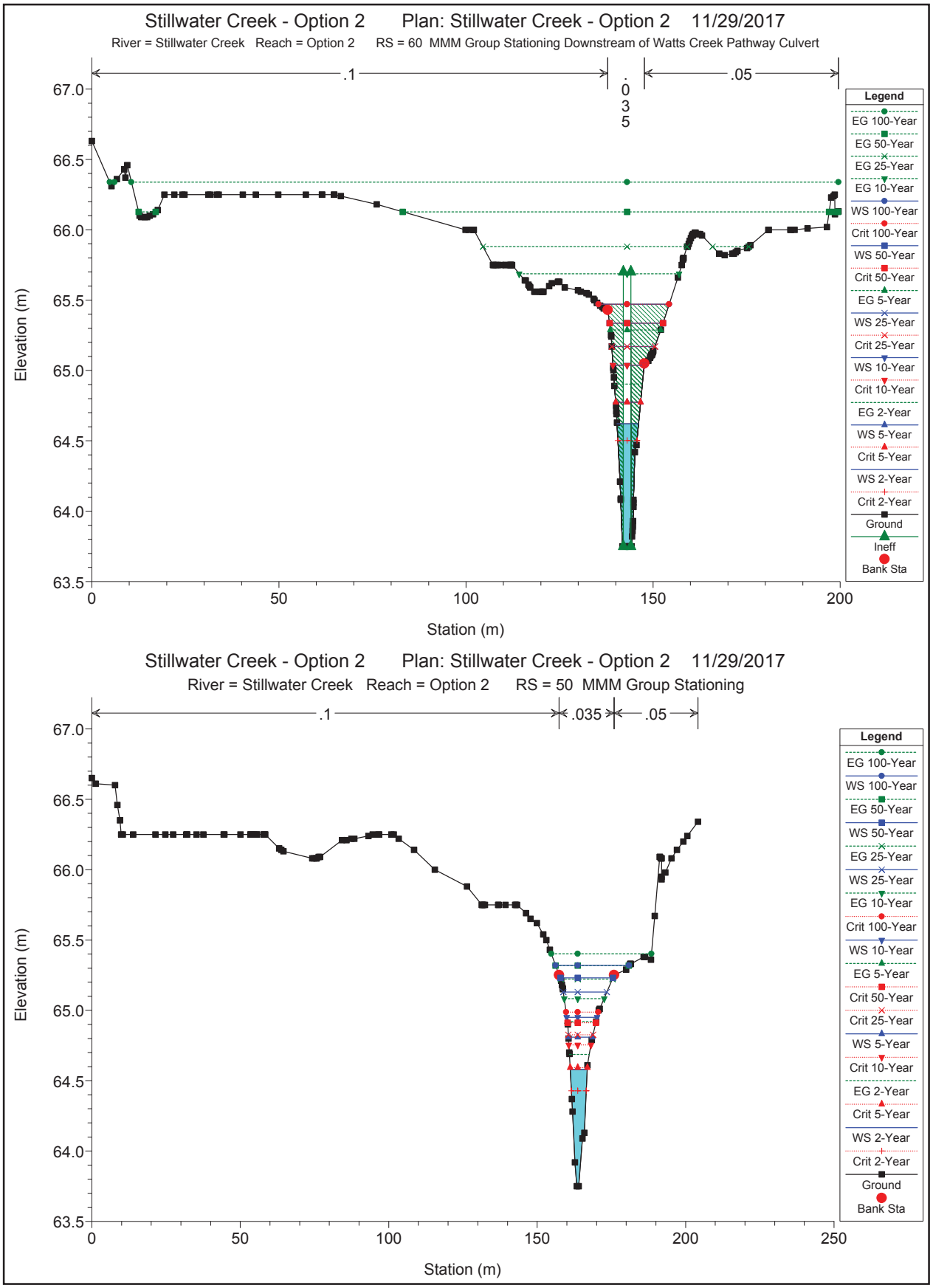
Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation



Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation

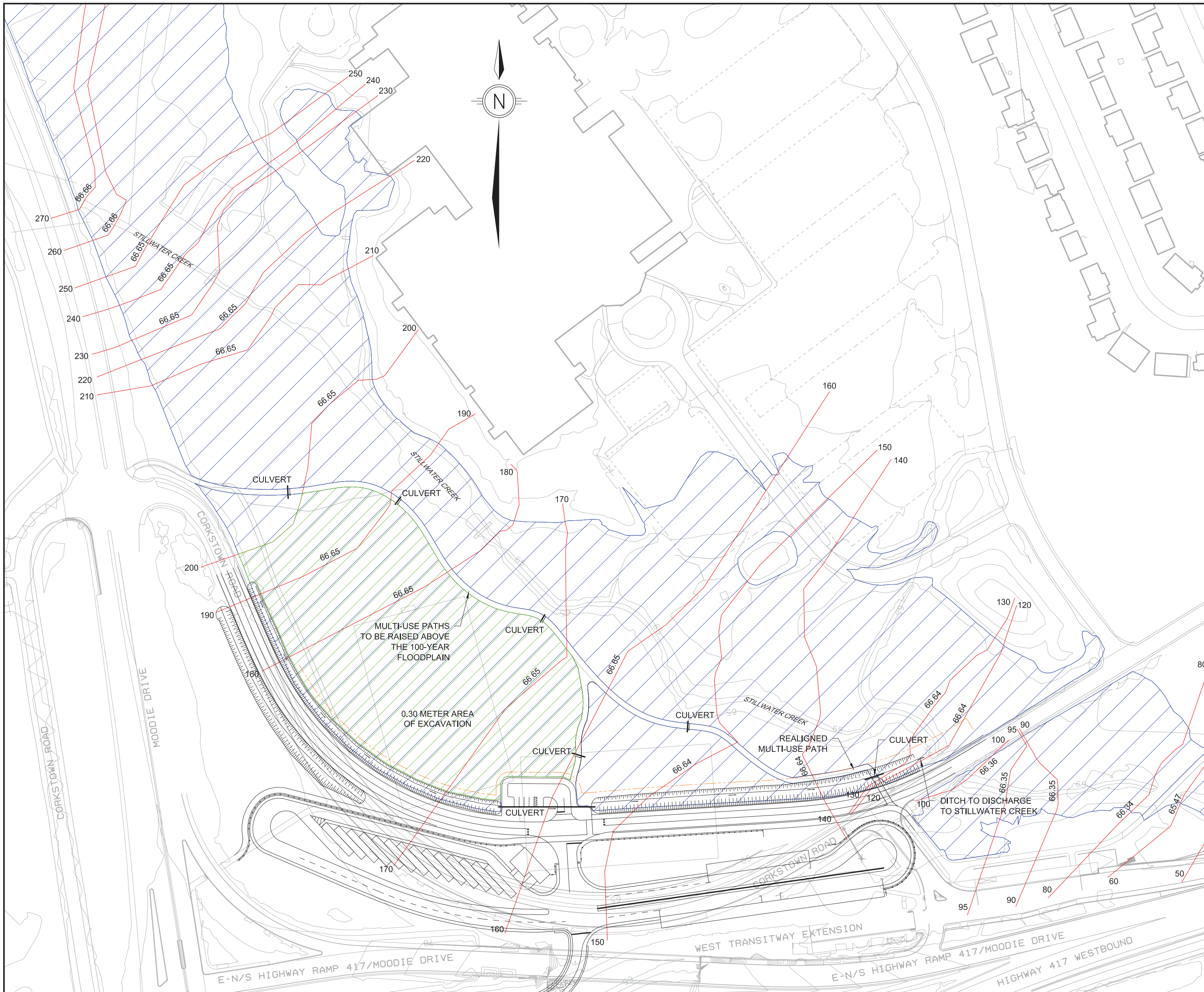
HEC-RAS Plan: Plan 03 River: Stillwater Creek Reach: Option 2

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Option 2	270	2-Year	742.00	4.10	65.50	65.99	66.00	0.001328	0.57	11.20	52.48	0.29
Option 2	270	5-Year	742.00	6.50	65.50	66.08	66.09	0.001142	0.61	23.42	153.26	0.27
Option 2	270	10-Year	742.00	9.20	65.50	66.19	66.20	0.000497	0.46	41.66	159.19	0.19
Option 2	270	25-Year	742.00	10.60	65.50	66.27	66.27	0.000309	0.39	54.21	164.22	0.15
Option 2	270	50-Year	742.00	12.50	65.50	66.42	66.42	0.000140	0.30	79.77	177.54	0.10
Option 2	270	100-Year	742.00	14.20	65.50	66.66	66.66	0.000052	0.22	124.22	196.14	0.07
Option 2	260	2-Year	722.00	4.10	65.50	65.98	65.99	0.000318	0.27	20.13	80.65	0.14
Option 2	260	5-Year	722.00	6.50	65.50	66.07	66.07	0.000343	0.32	33.53	174.45	0.15
Option 2	260	10-Year	722.00	9.20	65.50	66.19	66.19	0.000198	0.29	54.82	182.11	0.12
Option 2	260	25-Year	722.00	10.60	65.50	66.27	66.27	0.000136	0.26	69.43	186.90	0.10
Option 2	260	50-Year	722.00	12.50	65.50	66.42	66.42	0.000070	0.21	98.35	195.86	0.07
Option 2	260	100-Year	722.00	14.20	65.50	66.66	66.66	0.000029	0.16	147.68	218.86	0.05
Option 2	250	2-Year	702.00	4.10	65.50	65.96	65.97	0.001595	0.57	9.56	43.80	0.31
Option 2	250	5-Year	702.00	6.50	65.50	66.04	66.05	0.001610	0.66	13.97	64.06	0.32
Option 2	250	10-Year	702.00	9.20	65.50	66.17	66.18	0.000836	0.56	22.61	70.07	0.24
Option 2	250	25-Year	702.00	10.60	65.50	66.25	66.26	0.000690	0.56	28.74	103.20	0.22
Option 2	250	50-Year	702.00	12.50	65.50	66.41	66.42	0.000249	0.39	45.58	106.53	0.14
Option 2	250	100-Year	702.00	14.20	65.50	66.65	66.65	0.000074	0.25	75.98	138.84	0.08
Option 2	240	2-Year	682.00	4.10	65.50	65.92	65.93	0.001972	0.61	10.19	53.86	0.34
Option 2	240	5-Year	682.00	6.50	65.50	66.01	66.02	0.001700	0.66	15.01	62.12	0.33
Option 2	240	10-Year	682.00	9.20	65.50	66.15	66.16	0.000831	0.56	24.89	77.53	0.24
Option 2	240	25-Year	682.00	10.60	65.50	66.24	66.25	0.000538	0.50	32.34	87.43	0.20
Option 2	240	50-Year	682.00	12.50	65.50	66.41	66.41	0.000230	0.38	50.00	110.73	0.13
Option 2	240	100-Year	682.00	14.20	65.50	66.65	66.65	0.000071	0.25	81.85	143.37	0.08
Option 2	230	2-Year	662.00	4.10	65.50	65.89	65.90	0.001522	0.47	12.55	73.63	0.29
Option 2	230	5-Year	662.00	6.50	65.50	65.99	65.99	0.001009	0.47	19.82	78.59	0.25
Option 2	230	10-Year	662.00	9.20	65.50	66.14	66.15	0.000438	0.39	32.80	86.66	0.17
Option 2	230	25-Year	662.00	10.60	65.50	66.23	66.24	0.000316	0.37	41.41	105.24	0.15
Option 2	230	50-Year	662.00	12.50	65.50	66.40	66.41	0.000141	0.29	62.37	127.43	0.10
Option 2	230	100-Year	662.00	14.20	65.50	66.65	66.65	0.000048	0.20	99.28	168.75	0.06
Option 2	220	2-Year	641.00	4.10	65.50	65.86	65.87	0.001156	0.40	13.63	83.59	0.25
Option 2	220	5-Year	641.00	6.50	65.50	65.97	65.98	0.000681	0.38	22.87	91.41	0.20
Option 2	220	10-Year	641.00	9.20	65.50	66.14	66.14	0.000282	0.32	39.19	102.88	0.14
Option 2	220	25-Year	641.00	10.60	65.50	66.23	66.23	0.000193	0.29	49.01	108.90	0.12
Option 2	220	50-Year	641.00	12.50	65.50	66.40	66.40	0.000098	0.24	68.51	117.51	0.09
Option 2	220	100-Year	641.00	14.20	65.50	66.65	66.65	0.000040	0.19	103.12	158.39	0.06
Option 2	210	2-Year	625.00	4.10	65.50	65.84	65.84	0.001982	0.48	11.48	86.50	0.32
Option 2	210	5-Year	625.00	6.50	65.50	65.96	65.96	0.000798	0.40	22.59	96.56	0.22
Option 2	210	10-Year	625.00	9.20	65.50	66.13	66.14	0.000282	0.31	43.00	123.00	0.14
Option 2	210	25-Year	625.00	10.60	65.50	66.23	66.23	0.000185	0.28	54.71	125.00	0.11
Option 2	210	50-Year	625.00	12.50	65.50	66.40	66.40	0.000093	0.24	76.74	128.96	0.08
Option 2	210	100-Year	625.00	14.20	65.50	66.65	66.65	0.000041	0.19	109.50	134.95	0.06
Option 2	200	2-Year	567.00	4.10	65.49	65.82	65.82	0.000120	0.13	36.82	111.08	0.08
Option 2	200	5-Year	567.00	6.50	65.49	65.95	65.95	0.000110	0.16	50.70	115.71	0.08
Option 2	200	10-Year	567.00	9.20	65.49	66.13	66.13	0.000071	0.17	72.16	120.36	0.07
Option 2	200	25-Year	567.00	10.60	65.49	66.22	66.22	0.000059	0.17	83.74	121.65	0.07
Option 2	200	50-Year	567.00	12.50	65.49	66.40	66.40	0.000039	0.16	105.27	124.02	0.06
Option 2	200	100-Year	567.00	14.20	65.49	66.65	66.65	0.000022	0.14	136.68	127.71	0.04
Option 2	190	2-Year	512.00	4.10	65.47	65.82	65.82	0.000167	0.15	38.50	115.80	0.09
Option 2	190	5-Year	512.00	6.50	65.47	65.94	65.94	0.000145	0.18	52.95	118.07	0.09
Option 2	190	10-Year	512.00	9.20	65.47	66.12	66.12	0.000092	0.19	74.89	121.36	0.08
Option 2	190	25-Year	512.00	10.60	65.47	66.22	66.22	0.000075	0.19	86.65	122.45	0.07
Option 2	190	50-Year	512.00	12.50	65.47	66.40	66.40	0.000050	0.18	108.45	124.44	0.06
Option 2	190	100-Year	512.00	14.20	65.47	66.65	66.65	0.000028	0.16	140.01	127.20	0.05
Option 2	180	2-Year	458.00	4.10	64.71	65.81	65.81	0.000032	0.11	42.23	116.53	0.05
Option 2	180	5-Year	458.00	6.50	64.71	65.94	65.94	0.000032	0.12	56.81	118.90	0.05
Option 2	180	10-Year	458.00	9.20	64.71	66.12	66.12	0.000022	0.12	79.03	122.41	0.04
Option 2	180	25-Year	458.00	10.60	64.71	66.22	66.22	0.000019	0.12	91.00	124.71	0.04
Option 2	180	50-Year	458.00	12.50	64.71	66.39	66.39	0.000013	0.11	113.42	128.24	0.03
Option 2	180	100-Year	458.00	14.20	64.71	66.65	66.65	0.000008	0.10	148.60	144.65	0.03
Option 2	170	2-Year	404.00	4.10	64.50	65.81	65.81	0.000023	0.08	50.94	139.41	0.04
Option 2	170	5-Year	404.00	6.50	64.50	65.93	65.93	0.000023	0.09	68.50	144.21	0.04
Option 2	170	10-Year	404.00	9.20	64.50	66.12	66.12	0.000016	0.09	95.76	150.25	0.03
Option 2	170	25-Year	404.00	10.60	64.50	66.22	66.22	0.000014	0.09	110.48	153.12	0.03
Option 2	170	50-Year	404.00	12.50	64.50	66.39	66.39	0.000009	0.09	137.99	156.64	0.03
Option 2	170	100-Year	404.00	14.20	64.50	66.65	66.65	0.000006	0.08	177.90	161.38	0.02
Option 2	160	2-Year	352.00	4.10	64.50	65.81	65.81	0.000067	0.20	25.67	101.08	0.07
Option 2	160	5-Year	352.00	6.50	64.50	65.93	65.93	0.000071	0.23	38.32	103.37	0.08

Output Data: HEC-RAS - Proposed Conditions with 0.3 Meter Excavation

HEC-RAS Plan: Plan 03 River: Stillwater Creek Reach: Option 2 (Continued)

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Option 2	160	10-Year	352.00	9.20	64.50	66.12	66.12	0.000046	0.21	65.10	171.94	0.06
Option 2	160	25-Year	352.00	10.60	64.50	66.21	66.22	0.000037	0.20	82.16	178.24	0.06
Option 2	160	50-Year	352.00	12.50	64.50	66.39	66.39	0.000023	0.17	114.99	188.14	0.05
Option 2	160	100-Year	352.00	14.20	64.50	66.64	66.65	0.000012	0.14	166.66	218.91	0.03
Option 2	150	2-Year	298.00	4.10	64.50	65.80	65.81	0.000047	0.17	26.94	83.76	0.06
Option 2	150	5-Year	298.00	6.50	64.50	65.93	65.93	0.000060	0.21	37.50	88.02	0.07
Option 2	150	10-Year	298.00	9.20	64.50	66.11	66.12	0.000047	0.21	58.83	133.50	0.06
Option 2	150	25-Year	298.00	10.60	64.50	66.21	66.21	0.000040	0.20	72.16	143.18	0.06
Option 2	150	50-Year	298.00	12.50	64.50	66.39	66.39	0.000027	0.18	100.03	162.31	0.05
Option 2	150	100-Year	298.00	14.20	64.50	66.64	66.64	0.000015	0.15	142.81	176.21	0.04
Option 2	140	2-Year	243.00	4.10	64.50	65.80	65.80	0.000090	0.24	18.59	56.66	0.08
Option 2	140	5-Year	243.00	6.50	64.50	65.92	65.92	0.000137	0.32	25.90	65.27	0.10
Option 2	140	10-Year	243.00	9.20	64.50	66.11	66.11	0.000133	0.36	43.57	119.04	0.11
Option 2	140	25-Year	243.00	10.60	64.50	66.20	66.21	0.000120	0.36	55.83	128.50	0.10
Option 2	140	50-Year	243.00	12.50	64.50	66.38	66.39	0.000087	0.33	79.94	136.90	0.09
Option 2	140	100-Year	243.00	14.20	64.50	66.64	66.64	0.000051	0.28	116.11	147.03	0.07
Option 2	130	2-Year	180.00	4.10	64.23	65.80	65.80	0.000042	0.16	27.19	68.27	0.06
Option 2	130	5-Year	180.00	6.50	64.23	65.92	65.92	0.000065	0.22	35.55	71.77	0.07
Option 2	130	10-Year	180.00	9.20	64.23	66.10	66.10	0.000066	0.25	49.18	75.12	0.07
Option 2	130	25-Year	180.00	10.60	64.23	66.20	66.20	0.000063	0.26	56.70	77.43	0.07
Option 2	130	50-Year	180.00	12.50	64.23	66.38	66.38	0.000052	0.26	71.00	79.86	0.07
Option 2	130	100-Year	180.00	14.20	64.23	66.64	66.64	0.000035	0.24	91.74	82.16	0.06
Option 2	120	2-Year	162.00	4.10	64.00	65.78	65.80	0.000141	0.49	8.34	67.49	0.12
Option 2	120	5-Year	162.00	6.50	64.00	65.89	65.91	0.000294	0.74	8.82	68.33	0.17
Option 2	120	10-Year	162.00	9.20	64.00	66.05	66.10	0.000444	0.96	9.60	69.68	0.21
Option 2	120	25-Year	162.00	10.60	64.00	66.14	66.20	0.000512	1.06	10.01	70.39	0.23
Option 2	120	50-Year	162.00	12.50	64.00	66.31	66.38	0.000551	1.16	10.81	71.77	0.24
Option 2	120	100-Year	162.00	14.20	64.00	66.64	66.64	0.000040	0.26	102.60	74.24	0.06
Option 2	110		Culvert									
Option 2	100	2-Year	141.00	4.10	64.00	65.77	65.79	0.000165	0.53	7.70	32.76	0.13
Option 2	100	5-Year	141.00	6.50	64.00	65.85	65.89	0.000358	0.81	8.05	35.32	0.19
Option 2	100	10-Year	141.00	9.20	64.00	65.98	65.99	0.000110	0.39	32.05	39.34	0.10
Option 2	100	25-Year	141.00	10.60	64.00	66.04	66.04	0.000127	0.43	34.38	40.31	0.11
Option 2	100	50-Year	141.00	12.50	64.00	66.15	66.16	0.000134	0.46	39.25	42.26	0.11
Option 2	100	100-Year	141.00	14.20	64.00	66.35	66.36	0.000113	0.45	47.93	45.52	0.10
Option 2	95	2-Year	117.00	4.10	63.96	65.78	65.78	0.000106	0.31	15.57	40.06	0.09
Option 2	95	5-Year	117.00	6.50	63.96	65.86	65.87	0.000199	0.45	19.38	47.16	0.13
Option 2	95	10-Year	117.00	9.20	63.96	65.97	65.98	0.000282	0.57	24.56	60.29	0.16
Option 2	95	25-Year	117.00	10.60	63.96	66.02	66.04	0.000308	0.61	28.43	68.85	0.16
Option 2	95	50-Year	117.00	12.50	63.96	66.14	66.16	0.000277	0.61	36.81	69.91	0.16
Option 2	95	100-Year	117.00	14.20	63.96	66.35	66.36	0.000180	0.54	51.23	71.70	0.13
Option 2	90	2-Year	90.00	4.10	64.67	65.76	65.77	0.001014	0.44	9.55	42.04	0.24
Option 2	90	5-Year	90.00	6.50	64.67	65.85	65.86	0.001178	0.55	13.19	45.49	0.27
Option 2	90	10-Year	90.00	9.20	64.67	65.95	65.97	0.001079	0.61	18.13	51.18	0.27
Option 2	90	25-Year	90.00	10.60	64.67	66.01	66.03	0.000966	0.61	21.20	53.32	0.26
Option 2	90	50-Year	90.00	12.50	64.67	66.13	66.15	0.000651	0.57	28.57	64.69	0.22
Option 2	90	100-Year	90.00	14.20	64.67	66.34	66.35	0.000297	0.46	43.37	72.78	0.15
Option 2	80	2-Year	40.00	4.10	63.75	65.76	65.76	0.000072	0.21	22.08	38.06	0.07
Option 2	80	5-Year	40.00	6.50	63.75	65.84	65.84	0.000131	0.30	25.23	40.89	0.10
Option 2	80	10-Year	40.00	9.20	63.75	65.94	65.95	0.000181	0.38	29.44	44.38	0.12
Option 2	80	25-Year	40.00	10.60	63.75	66.00	66.00	0.000196	0.41	32.11	47.24	0.13
Option 2	80	50-Year	40.00	12.50	63.75	66.12	66.13	0.000174	0.41	49.07	151.69	0.12
Option 2	80	100-Year	40.00	14.20	63.75	66.34	66.34	0.000092	0.34	82.29	160.69	0.09
Option 2	70		Culvert									
Option 2	60	2-Year	22.00	4.10	63.75	64.62	64.90	0.008128	2.35	1.74	5.79	0.80
Option 2	60	5-Year	22.00	6.50	63.75	64.77	65.29	0.011933	3.17	2.05	6.66	1.00
Option 2	60	10-Year	22.00	9.20	63.75	65.04	65.69	0.011155	3.57	2.58	8.33	1.00
Option 2	60	25-Year	22.00	10.60	63.75	65.17	65.88	0.010668	3.73	2.84	11.51	1.00
Option 2	60	50-Year	22.00	12.50	63.75	65.34	66.13	0.010289	3.94	3.17	14.27	1.00
Option 2	60	100-Year	22.00	14.20	63.75	65.47	66.34	0.010124	4.13	3.44	18.88	1.00
Option 2	50	2-Year		4.10	63.75	64.58	64.69	0.006925	1.44	2.84	5.72	0.65
Option 2	50	5-Year		6.50	63.75	64.81	64.92	0.006361	1.48	4.40	8.09	0.64
Option 2	50	10-Year		9.20	63.75	64.95	65.08	0.007405	1.62	5.68	10.24	0.69
Option 2	50	25-Year		10.60	63.75	65.13	65.22	0.005231	1.34	7.89	14.67	0.58
Option 2	50	50-Year		12.50	63.75	65.23	65.32	0.004983	1.31	9.51	17.66	0.57
Option 2	50	100-Year		14.20	63.75	65.32	65.40	0.003985	1.27	11.42	24.77	0.52



OTTAWA STAGE 2
WEST TRANSITWAY EXTENSION
MOODIE DRIVE

FLOODPLAIN DELINEATION
PROPOSED CONDITIONS WITH
0.3 METERS OF EXCAVATION

N/A	N/A
Manager - Division	Project Manager

Ottawa

Contract No. | Dwg. No. 2
Sheet 2 of 2
Asset No. N/A
Asset Group N/A
Des. VJT | Chk'd. _
Dwn. SMD | Chk'd. _
Utility Circ. No. N/A | Index No. N/A
Const. Inspector N/A
Scale: HORIZONTAL 0m 4 8 16

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

LEGEND

HEC-RAS SECTION
FLOODPLAIN AREA
PROPOSED CULVERT
EXCAVATION AREA

NOTE

APPROXIMATE VOLUME OF FILL = 4,800 m³
APPROXIMATE VOLUME OF CUT = 4,860 m³

NOT FOR CONSTRUCTION

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008
Consultant Drawing Number
2008-Jan-21 02:03:18 PM S:/PWS/CAD/ISB07-5063-000-cov.dgn

APPENDIX I: HIGHWAY 417 WIDENING TO EIGHT LANES, FROM HIGHWAY 416 WESTERLY TO 0.5KM WEST OF EAGLESON ROAD, FOR 6.5KM DRAINAGE REPORT BY TSH, DATED NOVEMBER 2004

Ontario

Ministry of Transportation

HIGHWAY 417 WIDENING TO EIGHT LANES, FROM HIGHWAY 416 WESTERLY TO 0.5KM WEST OF EAGLESON ROAD, FOR 6.5KM

G.W.P. 302-89-00

DRAINAGE REPORT

November 2004

TSH
engineers
architects
planners

Ministry of Transportation

HIGHWAY 417 WIDENING TO EIGHT LANES, FROM HIGHWAY 416 WESTERLY TO 0.5KM WEST OF EAGLESON ROAD, FOR 6.5KM

G.W.P. 302-89-00

DRAINAGE REPORT

TSH Project No. 42-91061

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1.0 INTRODUCTION

1.1 GENERAL

The Ministry of Transportation has retained TSH to undertake a detailed design study for the widening of a 6.5 km section of Highway 417 from Highway 416 westerly to Eagelson Road (G.W.P. 302-89-00).

A scope of the study related to this analysis includes:

- Widening of Highway 417 from 4 lanes to 8 lanes (including median HOV and buffer area) plus auxiliary lanes;
- Ramp modification at Moodie Drive;
- Rehabilitation of Moodie Drive structure;
- Median High-Mast;
- Median High Mast Pole illumination;
- New concrete barrier separator between traffic on Ramp 416S-417W and Highway 417 WB traffic to a point west of the Moodie Drive Ramp W-NS bullnose (pavement drainage);
- Replacement or construction of new storm sewers; and
- Construction of the Stormwater Management Pond at Moodie Drive Interchange.

In general, the median width will be used to accommodate expansion of the highway, which will minimize extent of the construction area. However, it will result in a reduction or elimination of pervious area available for surface conveyance and water quality treatment (grassed swales). Therefore, site specific drainage considerations, based on the detail road design, are required to provide effective conveyance of minor and major flows under proposed conditions.

This analysis is to identify water quantity and quality requirements as well as erosion and sediment control measures. Supporting data, calculations and modeling results are included in the attached appendices.

1.2 BACKGROUND DOCUMENTS

The following information has been reviewed for this Detailed Design study:

- MTO W.P. 458-98-00 Highway 417. Highway 7 to Highway 416. Drainage and Stormwater Management Final Report. McCormick Rankin. 2002;
- Ministry of Natural Resources, Ontario Base Mapping, Topographic Maps;
- MTO Directive B-100, Design Flood Criteria;
- MTO Drainage Management Manual. 1997;
- Stormwater Management Planning and Design Manual, Ministry of the Environment, 2003;
- Stillwater Creek Erosion Control Study City of Nepean – Hydrology and Hydraulics Report for Rideau Valley Conservation Authority. Totten Sims Hubicki. 1987;
- Stillwater Creek Erosion Control Study City of Nepean for Rideau Valley Conservation Authority. Totten Sims Hubicki. June 1987;
- The Shirley's Brook and Watts Creek Subwatershed Study. Summary Document. Dillon Consulting Ltd. September 1999;
- Soil Maps; and
- Floodplain Mapping.

1.3 STUDY AREA

The Study Area is located within the City of Ottawa within the Townships of March and Nepean. **Figure 1** shows the Study Area within its geographic context and the limits of the proposed road improvements along the Highway 417. The highway drainage system comprises of roadside ditches, storm sewers and a number of cross-culverts.

The existing highway is mainly comprised of two (2) general-purpose lanes in each direction plus auxiliary lanes. The shoulder is partially paved for a 1.0-m width and the existing crown is between the two passenger-vehicle lanes. The present median width is 34 metres.

The proposed widening of Highway 417 will provide eight (8) lanes (including median HOV and buffer area) plus auxiliary lanes. In general, expansion of the Highway will be accommodated by reduction of current median width to approximately 16.75 m.

2.0 HYDROLOGY

As a result of the proposed highway improvement works there will be an increase in impervious area within the Study Area. This will consequently result in an increase in peak flows and total discharge runoff volumes from the highway right-of-way. Therefore, the hydrology of the site for both existing and future conditions needs to be verified to provide basis for water quantity and water quality requirements within the Study Area.

2.1 DRAINAGE AREAS

Information pertaining to watershed characteristic (i.e. hydrologic parameters) was obtained from the Preliminary Design Report (McCormick Rankin, 2002). The external drainage areas were verified using the Ontario Base Mapping (OBM) prior to the application of hydrologic parameters in the model. The drainage mosaic and culvert crossing location under the existing land use conditions, as derived from the OBM's, is presented in **Figure 2**. This plan has been further updated to reflect proposed construction within the right-of-way (**Figure 2A**).

In general, the landscape within the catchment areas is gently sloping with rural and urban land use characteristics. The proposed widening of Highway 417 extends through seven (7) major watercourse crossings, of which two (2) are found within the Watts Creek Watershed and five (5) are found within the Stillwater Creek Watershed. The Watts Creek and the Stillwater Creek Watersheds fall within the Mississauga Valley Conservation Authority and the Rideau Valley Conservation Authorities' jurisdiction, respectively.

2.2 HYDROLOGIC ANALYSIS

2.2.1 Model Setup

In the preliminary design, OTTHYMO hydrologic model was used to simulate watershed responses at critical locations. For the purpose of this study the Visual OTTHYMO model (OTTHYMO based) was used to perform hydrologic analysis. The model representing existing and future scenarios was developed for the Study Area.

Upon examination of the set-up and characteristic of the model developed during the preliminary design, catchment parameters representing existing scenario has been adopted for this analysis. For methodology and development of the detail parameters, refer to the Drainage and Stormwater Management Final Report (McCormick Rankin, 2002).

The Future Scenario model reflects the proposed right-of-way areas and changes within the Moodie Drive Interchange (local drainage diversion to SWM Pond) as well as the proposed increase in pavement area (percent of imperviousness) due to the proposed widening.

2.2.2 Design Storms

The intensity-duration-frequency (IDF) rainfall data for the Ottawa International Airport station (24 years of rainfall record) was used for this analysis. This rainfall gauge is operated by the Atmospheric Environment Service and is the closest to the Study Area. Summarized in **Table 1** are the IDF a, b and c parameters applied to generate the design storm events. The peak design flows were simulated using the Chicago 3-hour distribution.

2.2.3 Model Results

In order to examine potential impact of highway widening, the peak design flows were compared at key locations for both, existing and future scenarios. **Table 2** provides a summary of the 50-year and 100-year peak design flows at those locations. In general, there has been minor increases in peak design flows under proposed conditions. This is mostly due to a small increase in imperviousness and a short response time of the urban right-of-way relative to the overall upstream drainage area.

The noted increases do not require major quantity control measures since contributing drainage areas are relatively small, therefore, resulting in low peak flows. They can be managed by enhancing the existing conveyance system (roadside ditches). The hydraulic analysis and the overall Stormwater Management Plan are discussed in the following sections of this report.

3.0 HYDRAULICS

The existing highway drainage system is comprised of:

- Roadside ditches that convey surface runoff from the highway and right-of-way towards either the upstream or downstream side of the transverse culverts, and;
- Median ditch/ditch-inlet system that conveys the median drainage to the transverse culverts or downstream receiver outside of the right-of way.

Design Criteria require new culverts with a total span up to 6.0 m to be designed to convey flood flow based on 50-year return period, as per the Ministry Directive B-100 (MTO Design Flood Criteria) for Freeways. Additional recommendations for the transverse culverts are: a 1-m freeboard from the high water level to the edge of travel lane and conveyance of the 100-year peak flow without overtopping the traveled part of the highway. For the purpose of this analysis, the High Water Levels are assumed those generated by the 50-year storm event. Hydraulic structures should be designed to the 100-year return period where the total span of the culvert/bridge exceeds 6.0 metres. Under the Canadian Bridge Design Code a minimum clearance of 1.0 m between the lowest point of a straight soffit and the design high-water level for freeways, arterial roads and collector roads is also recommended. These criteria will be implemented where applicable.

Existing culverts within the scope of this study will be checked for the compliance and the recommendations for upgrades will be provided on the site-specific basis.

A total of seven (7) transverse culverts crossing the eastbound and westbound lanes where identified within the Study Area. In addition, there are thirty seven (37) culverts that convey the flows from the median and across interchange ramps and side roads. A visual inspection of the culverts was conducted in November of 2003 and the record from the site visit, including photos, is included in the **'Appendix D'**. Based on the scope of work, some culverts were excluded from the final analysis. These are culverts scheduled for upgrades as a part of the Eagleson Road Interchange re-construction to be completed by others. Included are culverts No. 3, 4 and 6 to10. In addition, culverts, which require additional field inspection (CVT) to establish their existing conditions, will be evaluated once the data is available.

Hydraulic analyses of the major culverts were completed using the HY-8 program. Consistent with the preliminary design report, all existing culverts were assumed free of excess sediment. Results of the hydraulic analysis are as follows:

Existing conditions:

- Culverts No. 32 and 38 do not meet freeboard requirement under the 50-year storm event;
- Culvert No. 38 was found to overtop during the 100-year storm event due to combined flows – potential spill from Culvert 42 and 44;
- Culvert No. 38, 42 and 44 will act as an interconnected system during the 100-year storm event due to spill between all culverts; and
- Culvert No. 38 and 42 will act as an interconnected system during the 50-year storm event, while flows at Culvert No. 44 will spill to east.

Future conditions:

Culverts No. 32, 38, 42 and 44 were found to act in the same manner under the proposed scenario. In addition, Culvert No. 36 will not meet 50-year and 100-year flow requirements. An increase in flows at this location is due to the proposed stormwater pond intercepting flows from additional areas within the Moodie Drive interchange. Culvert No. 36 is to be part of the outlet system from the pond.

Tables 3 and **4** provide the culvert characteristics and results of hydraulic analysis for existing and future scenarios, respectively.

Based on the modelled results, it is proposed to replace Culvert No. 36 to accommodate new flows. This is to provide a 1.0-m freeboard in the event of a 50-year storm and prevent overtopping of the road in the event of a 100-year storm, as per MTO design criteria (B-100). Provided that there is no change in land use, therefore, no increase in flows at Culvert No. 32 (ramp cross-culvert), a rehabilitation of the culvert or replacement with an equivalent concrete pipe is recommended for this location. Culvert No. 32 and 36 are also recommended for rehabilitation/ replacement based on the field inspection (**Appendix D**).

The analyses of Culvert No. 38, 42 and 44 were completed without accounting for the storage behind the highway embankment. Therefore, the results reflect more conservative scenario (higher water levels) at Culvert No. 38, where the low point on the road occurs. Under future conditions, a raised road profile as well as a reduction in peak flows (a re-direction of some of the flows to the SWM pond) will result in removing the overtopping of the highway. However, there is a potential for flooding within two travel lanes (EBL) during 100-year storm event. The storage available behind the embankment will further attenuate peak flows. Additional topographic information, for the area outside of ROW, would be required to more accurately estimate the effect of storage on flood levels.

In addition, to further alleviate potential problems, an upgrade of the north extension of Culvert No. 42 (610mm CSP) to match its downstream culvert size (1200mm CSP) is recommended. Culvert No. 42 will then act as a relief culvert during the major storm events. MTO should also investigate further the spill to east at Culvert No. 44, to evaluate its potential impact on Culvert No. 47, which is outside of the Study Limits. Additional data would be required to complete this assessment (i.e. culvert data, topographic information).

Listed in **Table 5** is the proposed characteristic of the culverts identified for upgrades.

The proposed widening of the Highway 417 within the median will not require extension of transverse culverts. However, median outlets need to be upgraded to accommodate proposed modifications to the highway. This will include replacement or lining of the existing CSP pipes, extension of the pipe (where required) and provision of ditch inlets to account for vertical differences. As a result of the proposed re-construction of the Eagleson Road Interchange, additional culverts will be required to accommodate the changes. The upgrades of the Eagleson Road Interchange will be addressed by others under the separate project.

Provided that the culvert analyses were completed for culverts free of sediment and debris, all culverts should be cleaned-out to restore their design function. Culverts, which are buried or require other rehabilitation, are identified in **Table 3** and **Table 4** and field inspection record (**Appendix D**).

Due to the geotechnical requirements, an alternative drainage system will be provided at specific locations for the median and outside ditches. The location and type of the drainage system is discussed in Section 4.2.2 of this report.

4.0 STORMWATER MANAGEMENT

4.1 STORMWATER POLICIES AND DESIGN CRITERIA

Stormwater design criteria are based on current guidelines and policies from the Ministry of the Environment (MOE), Ministry of Transportation (MTO) and the local Conservation Authorities. Key technical references include MOE Stormwater Management Planning and Design Manual (March, 2003), Drainage Management Manual (MTO, 1997) and available watershed study reports.

4.1.1 Water Quality Control

Various Best Management Practices (BMP's) have been considered for provision of water quality control and included the following:

- Storage facilities such as wet ponds, constructed wetlands.
- Vegetative measures such as buffer strips, grassed swales and filter strips;
- Conservation /restoration and source controls; and
- Special purpose applications such as oil/grit separators and filter devices.

Storage facility

The use of extended detention wet pond was selected as an appropriate measure for the Study Area. This is based on the availability of land at the Moodie Drive Interchange and opportunity to enhance water quality of surface runoff from areas with limited or no water quality treatment at this time. The water quality storage requirements (Table 3.2, MOE) for the wet pond is based on the receiving Stillwater Creek

tributary Enhanced Level of Protection. Volumetric sizing of the extended detention storage will provide the larger of the erosion control active storage and the water quality storage requirement.

Vegetative measures

The flat-bottom grassed swales will be provided, where feasible, as a part of the "stormwater treatment train". Grassed swales provide water quality treatment primarily by filtering out sediments and promoting infiltration, and can be used to provide secondary erosion control. Grassed swales are primarily designed to provide water quality control by limiting flow velocities and increasing the wetted perimeter. The flat bottoms of the swales increase storage and contact area as well as increase retention time to promote infiltration and particle settlement.

General design criteria for a grass swale, as per MOE SWM Planning and Design Manual (2003) to provide an effective water treatment are as follows:

- Bottom widths no less than 0.75m;
- Longitudinal slopes no greater than 1.0%; and
- Peak velocity for 25mm (4hr) storm event no greater than 0.5 m/s.

Special purpose applications

Special purpose BMP's such as oil/grit separators, are not generally used for highway water quality control for the following reasons:

- These devices are mainly used for storm sewer systems;
- MTO does not recommend them due to their relative inefficiency and the potentially large number required; and
- Safety concerns associated with water quality inlets due to potential for backup of water onto the road in the event of ice blockage.

4.1.2 Water Quantity Control

The water quantity control objective is to maintain peak flows as per existing land use conditions. For the purpose of this analysis, the requirement to provide adequate water quantity control is based on the increase in design peak flows, as a result of an increase in impervious area under the proposed highway widening. It is also based on the assumption that the future development within the watershed areas will be controlled to pre-development land use conditions.

4.1.3 Erosion Control

Erosion control analysis for the roadside ditches will be based on the assessment of flow velocities generated during the 100-year storm event. The velocity generated by the 100-year design storm should not exceed 1.5 m/s for grass-lined channels; a rock protection should be used otherwise. The level of erosion control using a stormwater detention facility will be defined by the MOE stormwater design criteria.

4.2 STORMWATER MANAGEMENT PLAN

The proposed widening will increase pavement areas and result in local peak flow increases, which may potentially impair water quality of the receiving watercourses and increase erosion along the highway ditches. Consistent with the Stormwater Management Report (McCormick Rankin, 2002) the increase in

pavement area as a percentage of upstream drainage area has been used to assess the potential impacts of the highway widening at each culvert crossing. The impact has been classified as follows:

- An increase of less than 2% represents a low impact;
- An increase of between 2% and 5% represents a medium impact; and,
- An increase equal to or greater than 5% represents a high impact.

Table 6 summarizes an increase in pavement area at specific locations. In general, the increase has been low, except for Culvert No. 8 where the increase has been classified as 'medium'. Therefore, it does not appear that any additional quantity control is necessary. However, some attenuation of the peak flows will be provided within the proposed Moodie Drive stormwater pond and through routing along the grassed swales and roadside ditches.

With respect to water quality treatment, currently one stormwater pond facility (Pond1, McCormick, 2002) provides for stormwater treatment for the portion of the Study Area. It serves approximately 2.6 ha of highway pavement and is located west of Watts Creek. As noted above, the new stormwater facility (wet pond) within the Moodie Drive Interchange is proposed to provide additional water quality treatment. Grassed swales will also be used to address water quality concerns, where applicable. Site-specific recommendations outlined in the Stormwater Management Report (McCormick Rankin Co., 2002) will be addressed as required.

The overall Stormwater Management Plan will include grassed swales, roadside ditches, stormwater pond and storm sewer system. **Figures 3 to 12** show the location of the proposed stormwater management facilities.

4.2.1 Stormwater Management Pond at Moodie Drive Interchange

The proposed stormwater facility will be located within the Moodie Drive Interchange and will service approximately 24 ha of contributing drainage area. Presented in **Figure 15** is a breakdown of the drainage area to the facility and **Figure 10** shows its general location. The stormwater facility will provide water quality treatment for areas associated with the proposed highway widening (mitigation measures) as well as areas currently discharging to the Stillwater Creek Tributary without water quality treatment. Consistent with the MTO principles the wet pond will provide compensation for potential deficiencies in provision of the water quality treatment in other locations.

The design criteria for the extended detention pond are per Enhanced Level of Protection (Table 3.2, MOE Stormwater Management Planning and Design Manual). A general characteristic of the proposed stormwater facility is outlined in **Table 7**, whereas **Figure 16 and Figure 17** provide plan, profiles and details of the proposed facility.

The water quality sizing of the facility is based on the level of the imperviousness for the overall drainage area to the pond. An estimated imperviousness for the site is approximately 37%. Accordingly, a required permanent pool storage volume is $105m^3/ha$ (Table 3.2, MOE) with a total volume of 2,520 m^3. The actual storage volume available in the proposed pond is approximately 3,590 m^3. As per MOE design criteria (Table 3.2, MOE), an estimate of the extended detention storage requirement should be based on the greater of the $40m^3/ha$ or the runoff volume from the 25-mm storm event. Using a more conservative criterion of $175m^3/ha$, approximately 4,200 m^3 of extended detention volume will be required. Based on

the proposed design, approximately 5,100 m^3 will be provided. Individual drainage areas to the pond and their imperviousness are summarized in **Table 8** and estimated pond volumes are listed in **Table 9**.

The proposed outlet for the pond is a reverse sloped pipe with a ø100 mm orifice plate and an overflow weir to convey larger flows. The ø100 mm orifice will provide a shorter detention time (estimated 9.3 hrs), however, it was chosen over the ø75 mm orifice due to the local climate restriction. The spillway has been designed to safely convey the flows up to the 100-year storm event. A 0.5-metre freeboard will allow for some attenuation of the peak flows. **Table 10** provides supportive calculations. As a part of the outlet system a 1.2m x 2.4 m concrete box culvert is proposed to convey flows under the Moodie Ramp W-NS.

4.2.2 Roadside Ditches

As a result of highway widening there will be an increase of total suspended sediments (TSS) and other contaminants in the surface runoff from the highway. Therefore, mitigation measures will be required, where possible. Within the limits of the Study Area, slopes range from approximately 0 to 6% and drainage will be primarily by swales and roadside ditches. The analysis was undertaken to determine the water quality and erosion control requirements. The peak design flows and associated velocities in the roadside ditches for the 25-mm and 100-year storm events were assessed under proposed conditions (increase in impervious areas) to identify site-specific water quality and erosion control requirements. Based on the feasibility of the site, flat-bottom grassed swales will be constructed where the criteria for water quality control cannot be met.

Flat-Bottom Grassed Swales

A 1.0-meter bottom-width swale will satisfy water quality criteria at specified locations. As per the design criteria provided in MOE Planning and Design Manual (2003), grassed swales with a slope up to 4% can be used for water quality purposes with some reduction in their effectiveness as the velocities increase. However, to achieve higher efficiency of pollutant removal, the swales should be constructed at 1.0% or lower grade. In order to prevent erosion, all areas where the velocity design criterion ($V_{100\text{-year}}$ less than 1.5 m/s) cannot be met, will be provided with the appropriate rock protection.

The swales will also provide some attenuation of peak flows due to routing. Allowing the small sizes of the right-of-way areas for the modelling purposes (Visual OTTHYMO model) it does not appear effective to incorporate the short routing reaches within the model. However, it is expected that the actual routing effect based on length and available storage of the channel will attenuate the peak flows.

Location of the proposed ditches is shown in **Figures 3** to **12**. The complete erosion analysis will be provided at the final design stage.

In addition to the above, the following sites were identified based on the site-specific requirements.

South Ditch at Station12+800 to 13+200

The National Capital Commission has identified a drainage problem within the property adjacent to the above noted ditch. Currently, the property has agricultural land use characteristic. The seasonal ponding of water on the adjacent field has been identified in the vicinity of Station 12+800. In order to mitigate flooding concerns, a ditch clean out was recommended. In addition, based on the assessment of the

environmental conditions of the site, a removal of the existing drop structure within the ditch (Station 13+200) was recommended. To provide an adequate conveyance and enhance natural habitat, a design mimicking a natural channel is proposed south of the CNR culvert. Approximately 420 m of the ditch length has been identified for re-grading and re-construction. **Figure 18** shows the concept design for the south ditch.

The total drainage area contributing to the south ditch is approximately 81.0 ha, which includes approximately 67.0 ha of external drainage area and approximately 14.0 ha of the right-of-way area. The design peak flows for the existing and future conditions, generated using Visual OTTHYMO model, are summarized in **Table 11**. The hydraulic analysis for the south ditch was conducted using the CHANDE program (MTO approved). Provided in **Table 12** are the design input and output parameters. Consistent with the MTO design criteria the channel will be design to provide a capacity for the 10-year storm event and convey safely major flows.

WBL – Station 11+160 to 12+250 and EBL – Station 11+100 to 12+220

As per geotechnical recommendations (Terraspec Engineering), reconstruction of outside roadside ditches in the rock-cut areas is proposed for the above noted locations. The ditches will be constructed with a 1.2-m bottom width and 1.5 m depth. This is to provide an adequate drainage to the pavement sub-grade. **Figure 6** and **Figure 7** show location of the rock ditches.

Median drainage

Alternative drainage system (i.e. in rock fill areas) will be provided within the median at the following locations:

Tangent Section (Earth Subgrade)
- 13+720.00 (March TWP) to 13+828.45 (March TWP)
- 10+092.32 (Nepean TWP) to 10+860.00 (Nepean TWP)
- 13+400.00 (Nepean TWP) to 13+460.00 (Nepean TWP)

Superelevated Section (Earth Subgrade)
- 13+828.45 (Nepean TWP) to 10+092.32 (Nepean TWP)

Tangent Section (Flat Bottom Ditch in Rock)
- 12+600 (Nepean TWP) to 12+760 (Nepean TWP)
- 13+120 (Nepean TWP) to 13+400 (Nepean TWP)

Tangent Section ('V' Shaped Ditch in Rock)
- 10+860 (Nepean TWP) to 11+170 (Nepean TWP)
- 12+210 (Nepean TWP) to 12+600 (Nepean TWP)
- 12+760 (Nepean TWP) to 13+120 (Nepean TWP)

Figure 3 to **Figure 9** shows locations of the proposed drainage works whereas typical sections and preliminary drainage solutions are provided in **Figure 13** and **Figure 14**.

In order to facilitate new high masts within the median, by –pass culverts or new outlets from the median will be required to provide adequate drainage away from the structures. This might require a removal or improvements to some of the existing structures.

4.2.3 Storm Sewer System

The storm sewer system within the Study Area provides outlets for median drainage, pavement drainage from existing curb and gutter in bullnose locations, pavement drainage from CN Rail structures, and provide drainage from most of the interchange quadrants at Eagelson Road and Moodie Drive.

Storm Sewer System at the Moodie Drive Interchange

The upgrades of the existing storm sewer system has been proposed in order to accommodate a widening of the Highway 417, construction of the new, jersey barrier separator and re-direction of collected flows to the stormwater pond. Modified system will intercept surface runoff from the interchange area and re-direct flows to the wet pond for water quality treatment. This will allow for water quality treatment for areas currently draining directly to the Stillwater Creek Tributary. The eastern extension of the system will also provide pavement drainage along the proposed separation concrete barrier.

The proposed changes include the following:

- Disconnection of the existing storm sewer at MH (Station 14+043.7)
- Extension of the existing storm sewer from MH (Station 14+043.7) to Inlet No.3 (SWM pond)
- Construction of the new section of the sewer intercepting surface runoff from the eastern portion of the highway (CB 5 to CB16)
- Construction of a short section of the sewer (CB 7 to ditch outlet) collecting runoff from the portion of the south ditch.

The section of the storm sewer system between CB 10 and outlet to the pond (Inlet No.3) will be design to accommodate 100-year design storm event.

Provided in **Figure 19** and **Figure 20** is the existing storm sewer system and the proposed modifications to the layout within the Moodie Drive interchange. A detail design of the storm sewer system will be provided in the subsequent phase of this project.

Figure 21 and **Figure 22** show the proposed storm sewer system upgrades further to the east.
A detail survey of the storm sewer system is scheduled for completion during the detail design stage. Findings will be summarized and examined, and additional requirements defined for construction.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following are the conclusions and recommendations for this phase of the study:

- Seven (7) major transverse culverts are located within the Study Area. In addition, thirty seven (37) culverts conveying flows across interchange ramps and side roads were reviewed and analyzed, where applicable.

- The impact at the culvert crossings due to the proposed highway widening is generally low.

- Under existing conditions all analyzed culverts, except Culvert No. 38 and 32, meet the 50-year design criterion. Culvert No. 38 overtops under the 100-year storm event.

- Under future conditions, Culverts No. 38 and 36 do not meet the 50-year design criterion.

- Culverts No. 38, 42 and 44 are acting as an interconnected system during 50-year and 100-year flow events. Under existing conditions, there is a potential for overtopping during the 100-year event at Culvert No. 38 due to spill. Under future conditions, as a result of raising the road profile as well as reduction of peak flows at the culvert no road overtopping was observed. However, there is a potential for flooding within two travel lanes (EBL) during 100-year storm event. The storage available behind the embankment will further attenuate peak flows. Additional topographic information, for the area outside of ROW, would be required to more accurately estimate the effect of storage on flood levels.

- Culverts No. 20, 23, 24, 29, 32 and 42 require rehabilitation/replacement due to corrosion of the CSP pipes. It is recommended to replace CSP pipes with equivalent or greater concrete pipes. Rehabilitation of Culvert No. 42 should include headwall construction.

- Bank stabilization is proposed at the Culvert No. 42 (Station 14+969) due to the bank erosion at the north end of the structure.

- Culvert No. 36 is proposed for replacement in order to accommodate outflows from the new stormwater pond at the Moodie Drive Interchange.

- Upgrades to Culvert No. 42 can provide a flow relief function for Culvert No. 38.

- The proposed Eagleson Road Interchange improvements are outside of the scope of this project. Culvert No. 3, 4 and 8 to 10 are part of the Eagleson Road Interchange future analysis to be undertaken by others.

- Culverts No. 2 and 51 are outside of the project limits; however, they have been recorded during the field inventory data. Based on the field inspection, both structures require rehabilitation or replacement due to corrosion and outlet damage (Culvert No. 2). To provide adequate upgrades, the MTO maintenance staff should further assess both structures.

- All culverts will be cleaned-out and extension to median culverts will be provided as required.

- To confirm the conditions of storm sewers a video inspection is required. TSH is currently in the process of verifying the requirements with MTO staff.

- A stormwater pond located within the Moodie Drive Interchange has been design to provide water quality treatment and some flow attenuation for approximately 14.7 ha of right-of-way area and approximately 9.0 ha of external drainage area.

- In order to accommodate a widening of the Highway 417, construction of the new, concrete barrier separator between traffic on Ramp 416S-417W and Highway 417 WB traffic is required. Therefore, the upgrades to the existing storm sewer system are proposed within the Moodie Drive Interchange to intercept surface runoff along the wall. The flows will be conveyed via new storm sewer to the proposed stormwater pond.

- Flat-bottom grassed swales are proposed to provide additional water quality treatment.

- All roadside ditches, where the erosion control design criteria cannot be met, will be provided with appropriate rock protection. Some erosion control will be achieved within the stormwater detention

facility. Final analysis of the water quality and erosion control requirements for the proposed system will be provided at the later stage of the project.

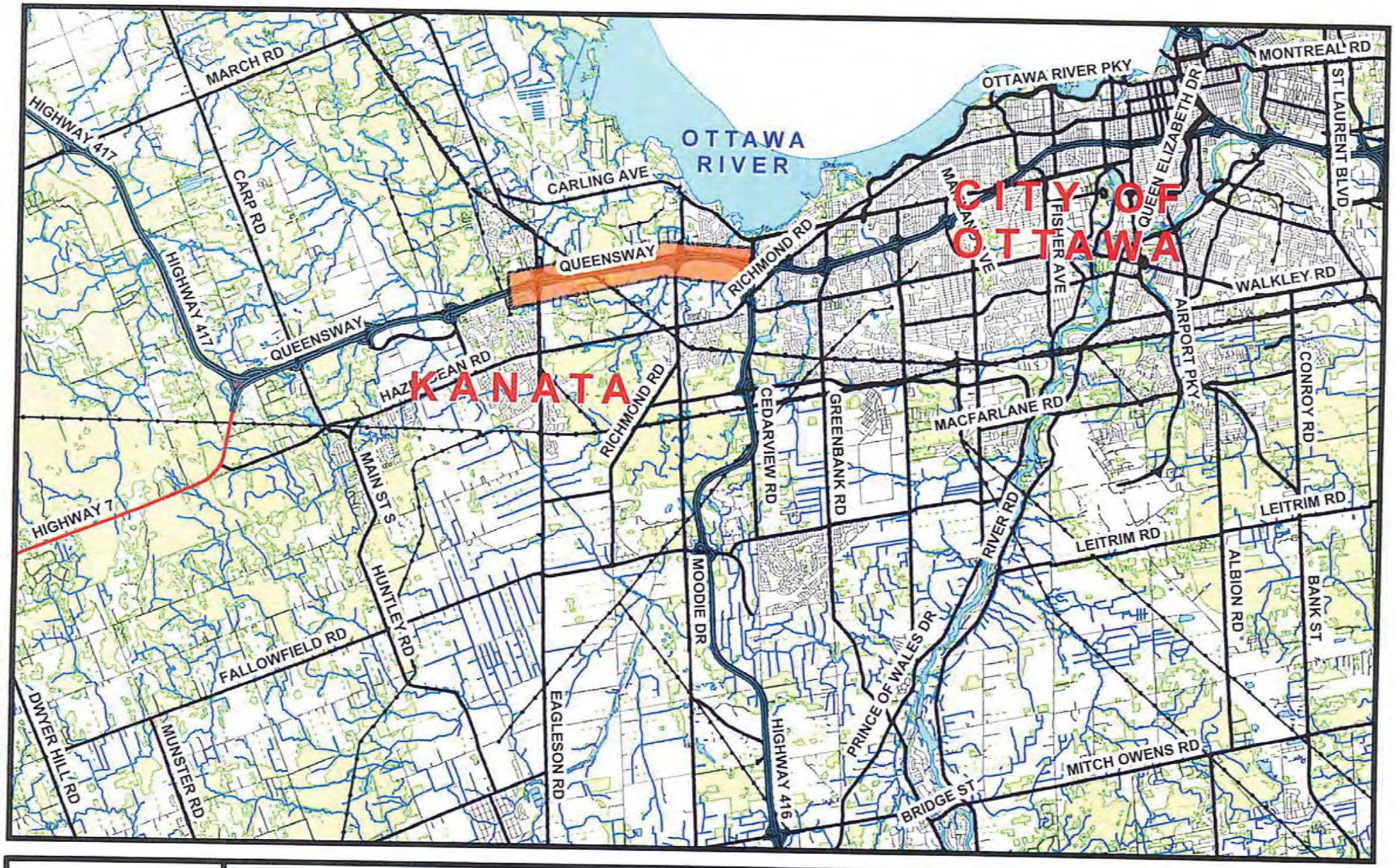
- The south ditch re-construction (Station 12+800 to 13-364) has been proposed to address local flooding problems within the adjacent property (in the vicinity of the station 12+800) and to enhance natural habitat, a removal of the existing drop structure (Station 13+216). The proposed channel will provide more natural linkage between the tributaries of the Stillwater Creek. Additional survey data is required within the south perimeter of the ditch to complete the detail design for the proposed channel.

- In order to meet geotechnical requirements, an alternative drainage system will be provided at specific locations (i.e. rock-cut and rock fill areas) for the median and outside ditches. This is to provide an adequate drainage to the pavement sub-grade.

- In order to facilitate new high masts within the median and provide adequate drainage away from the structures, the by–pass culverts or new outlets from the median need to be provided. This might require a removal or adjustments to some of the existing structures.

APPENDIX A

- FIGURES



engineers architects planners

N W E S

DETAILED DESIGN FOR HIGHWAY 417
WIDENING TO EIGHT LANES,
FOM HIGHWAY 416 WESTERLY
TO 0.5 KM. WEST OF EAGLESON ROAD FOR 6.5 KM

W.P. 302-89-00

STUDY AREA

SCALE: 1:150,000

FIGURE: 1

Map Document: (E:\PROJECTS\Other Depts\42-91061\GIS\Arc_GIS\Study Area.mxd)
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APPENDIX B

- TABLES

Table 1: Parameters Used to Generate the Design Storms*

Return Period (year)	a	b	c	Rainfall Volume (mm)
2	885.7	6.8	0.836	48.46
5	1119.9	6.47	0.83	64.02
10	1277	6.36	0.827	74.62
25	1464.3	6.17	0.823	88.1
50	1622.9	6.18	0.823	97.64
100	1764.4	6.1	0.821	107.72

*Based on the Chicago 3 -hour rainfall distribution

Table 2: Peak Design Flow Summary for the 50-year and 100-year Storms

Culvert #	Highway Station	Peak Flow (m^3/s)			
		50 year		100 year	
	(m)	Existing	Future	Existing	Future
1	14+200	-	-	20.5	20.5
8	10+120	4.66	4.93	5.49	5.94
23	12+590	0.78	1.36	0.88	1.53
CNR	-	1.15	1.81	1.32	2.04
30	13+360	6.24	6.24	7.29	7.29
38	14+600	35.1	33.75	39.5	37.9
42	14+980	1.01	1.01	1.17	1.18
44	15+280	14.29	14.71	16.59	17.04

Table 3: Culvert Characteristics and Hydraulic Assessment - Existing Conditions

Structure ID	Culvert # (2)	Culvert # (3)	Station	Location	Size (mm)	Type	Length (m)	Culvert Inverts (m) U/S	Culvert Inverts (m) D/S	Culvert Obverts (m) U/S	Culvert Obverts (m) D/S	Slope (%)	Peak Flow (m3/s) 50-yr	Peak Flow (m3/s) 100-yr	Road Crown Elevation (m)	Edge of Pavement Elevation (m)	Tailwater Elevation (m)	Sag Elevation (m)	Edge of Pavement at Sag Elevation (m)	Spill Elevation (m)	Headwater Elevation (m) 50-yr	Headwater Elevation (m) 100-yr	Depth of Headwater 50-yr	Depth of Headwater 100-yr	Freeboard [1] (m) 50-yr	Freeboard [1] (m) 100-yr	Road Overtopping during a Design Storm 50-yr	Road Overtopping during a Design Storm 100-yr	Freeboard [2] (m) 50-yr	Freeboard [2] (m) 100-yr	Program: HY-8 (File Name)	Comments	Culvert Category
Township of March																																	
1	60	1	14+200	EBL/WBL	4370x2870	CSPA	202.8	88.19	86.77	91.06	89.64	0.70%	-	20.50	94.04	93.90	89.67	91.66			-	90.96		2.8	na	3.08	n/a	No	n/a	2.94	417-1	Sag elevation at Station 10+040 (east)	Transverse-culvert
2	*	2	14+190	Eagleson W-S ramp	610	CSP	24.7	91.11	90.74	91.71	91.35	1.50%	0.14	0.16	94.70	94.63	91.31				91.46	91.48	0.3	0.4	3.24	3.22	No	No	3.17	3.15	417-2	Outside Project limits	Ramp
3			14+350	EBL	457	CSP																										Future Analysis [5]	Ditch inlet / SWM sewer
4			14+400	EBL/WBL	457 to 1067	CSP																										Future Analysis [5]	Ditch inlet / SWM sewer
Township of March/Nepean																																	
5	*60D2	3	10+000		4724 x 3073	CSPA	133.0						-	20.50	91.75																	Outside Project limits	
Township of Nepean																																	
6			10+025	EBL/WBL	610 to 914	CSP									91.70	91.56																Analysis pending	Ditch inlet / SWM sewer
7	*	4	10+100	Eagleson S-E ramp	1220 x 620	RFB	22.2		92.38		93.60				91.82	91.68																Outside Project limits	
8	70	5	10+120	S. Extension	1829	CSP	160.7						4.66	5.49	92.07	91.93																Future Analysis [6]	Transverse-culvert
	70	5			1828x1524	RCB							4.66	5.49	92.07	91.93																	
	70	5		N. Extension	1676	CSP	6.0	89.41	89.40		91.30	0.17%	3.60	4.30	92.07	91.93		91.67															
9		6	10+120	Eagleson S-W ramp	610	CSP	28.3	90.13	89.95	90.78	90.60	0.64%	0.08	0.10	92.26	91.94	90.61				90.64	90.66	0.5	0.5	1.62	1.60	No	No	1.30	1.28	417-9	Future Analysis [6]	Ramp
10	*70D1	7	10+120	Eagleson E-N-E ramp	4800 x 2850	CSPA	83.7																									Future Analysis [6]	Ramp
11			10+270	WBL	381	CSP									93.26	93.14																North end burried	Median culvert
12		8	10+710	WBL	305	CSP	44.2	94.38	93.48	94.71	93.78	2.04%	0.03	0.04	96.67	96.53	93.81				94.6	94.67	0.2	0.3	2.07	2.00	No	No	1.93	1.86	417-12		Median culvert
13			10+865	WBL	381	CSP							0.01	0.04	99.30																	North end burried	Median culvert
14			11+030	WBL	457	CSP							0.01	0.04	102.48	102.34																North end burried	Median culvert
15		9	11+160	WBL	533	CSP	40.9	101.77	100.01	102.30	100.54	4.30%	0.24	0.27	104.74	104.60	100.53				102.34	102.4	0.6	0.6	2.40	2.34	No	No	2.26	2.20	417-15		Median culvert
16			11+445	WBL	305	CSP							0.12	0.14	109.80	109.66																North end burried	Median culvert
17			11+755	EBL	305	CSP							0.07	0.08	110.00	109.86																South end burried	Median culvert
18			11+905	EBL	381	CSP							0.07	0.08	107.30	107.16																South end burried	Median culvert
19			12+060	EBL	381	CSP							0.07	0.08	103.70	103.56																South end burried	Median culvert
20		10	12+220	EBL	457	CSP	43.3	96.83	96.74	97.29	97.20	0.21%	0.15	0.16	99.95	99.81	97.16				97.34	97.34	0.5	0.5	2.61	2.61	No	No	2.47	2.47	417-20		Median culvert
21			12+350	EBL	457	CSP							0.11	0.12	98.25	98.11																South end burried	Median culvert
22			12+485	EBL	457	CSP							0.11	0.12	96.83	96.69																South end burried	Median culvert
23	80	11	12+590	EBL/WBL	1067	CSP	103.5	87.26	86.55	88.35	87.62	0.71%	0.78	0.88	95.17	95.03	87.67	94.59	94.45		88.15	88.22	0.9	0.9	7.02	6.95	No	No	6.88	6.81	417-23		Transverse-culvert
24		12	12+610	EBL	457	CSP	58.0	90.74	86.88	91.20	87.34	6.65%	0.11	0.12	95.46	95.31	87.36				91.09	91.09	0.4	0.4	4.36	4.36	No	No	4.22	4.22	417-24		Median culvert
25	80D1		12+700	CNR																												Outside Project limits	
26			12+715	EBL/WBL	406	CSP																										South end not found	Ditch inlet / SWM sewer
27			12+880	EBL		CSP							0.25	0.29	88.20	88.06																	Median culvert
28		13	13+050	EBL	457	CSP	53.6	78.21	77.18	78.67	77.64	1.92%	0.25	0.29	83.24	83.10	77.66				78.9	79.04	0.7	0.8	4.34	4.20	No	No	4.20	4.06	417-28		Median culvert
29		14	13+215	EBL	457	CSP	56.0	74.73	74.14	75.19	74.67	1.02%	0.25	0.29	78.44	78.30	74.56				75.4	75.54	0.7	0.8	3.04	2.90	No	No	2.90	2.76	417-29		Median culvert
30	90	15	13+360	EBL/WBL	4900x2100	RFO	83.1	70.18	70.04	72.28	72.20	0.17%	6.24	7.29	74.37	74.37	72.1				72.14	72.15	2.0	2.0	2.23	2.22	No	No	2.23	2.22	417-30		Transverse-culvert (Stillwater Ck Trib. 1)
31		16	14+120	Moodie S-E ramp	900	CP	31.8	66.02	65.90	66.92	66.82	0.38%	0.33	0.39	68.05	67.91																Section to be removed	SWM system
32	92	17	14+200	Moodie S-W	533	CSP	29.5	65.55	65.50	66.08		0.17%	0.28	0.33	67.42	67.79	65.73				66.48	66.73	0.9	1.2	0.94	0.69	No	No	1.31	1.06	417-32		Ramp
33		18	14+210	Moodie S-E	914	CSP	26.3	65.71	65.24	66.62	66.15	1.79%	0.29	0.35	67.39	67.80																Section to be removed	Median culvert
34		18A	14+210	Moodie S-E	457	CSP	9.0	66.23	66.14	66.69	66.60	1.00%			67.39	67.80																2nd Inlet to Culvert 33	
35		19	14+240	Moodie E-NS	530	CSP	23.0	65.85	65.84	66.38	66.37	0.04%	0.33	0.39	68.00	67.93																Road Elevations based on OBM	SWM sewer outlet
36	93	20	14+420	Moodie E-NS	762	CSP	26.4	65.05	64.81	65.85	65.61	0.84%	0.41	0.48	66.68	67.01	65.56				65.77	65.83	0.7	0.8	1.11	1.05	No	No	1.24	1.18	417-36		Interchange North
37			14+330		305	CSP																											SWM sewer outlet
38 [3]	100	21	14+600	EBL/WBL	5470x1890	RFO	108.4	63.43	63.08	65.32	64.97	0.32%	38.20	43.67	67.20	67.06	65.23	67.07	66.44	66.05 (E)	66.67	67.23	3.2	3.8	**0.40**	**-0.16**	No	Yes	**-0.23**	**-0.79**	417-38	Superelevated section. Spill to east	Transverse-culvert (Stillwater Ck Trib. 2)
39			14+600	WBL	610	CSP									66.80	66.66																North end burried	Median culvert
40			14+635	WBL	610	CP									66.87	66.73																North end burried	Median culvert
41			14+615	WBL	457	CP									67.36	67.22																North end burried	Median culvert
42	110	22	14+980	EBL/WBL	1200	CSP	110.5	64.14	61.53	65.41	62.80	2.36%	1.01	1.17	68.08	67.94	62.7	66.95	66.81		64.92	65.00	0.8	0.9	3.16	3.08	No	No	3.02	2.94	417-42	South Extension	Transverse-culvert
42	110	22	14+980	EBL/WBL	610	CSP	110.5	64.14	61.53	65.41	62.80	2.36%	1.01	1.17	68.08	67.94	62.7	66.95	66.81	66.05(W) 66.5 (E)	66.19	66.35	2.1	2.2	1.89	1.73	No	No	1.75	1.59	417-42	North extension/ Spill to west	Transverse-culvert (Stillwater Ck Trib. 2)
43			15+090	WBL	506	CP									68.11	67.97																North end burried	Median culvert
44	120	23	15+260	EBL/WBL	3040x1850	RFO	107.3	64.62	64.26	66.45	66.19	0.34%	14.29	16.59	68.46	68.32	66.15	66.95	66.81	66.5 (W) 65.6 (E)	66.88	67.19	2.3	2.6	1.58	1.27	No	No	1.44	1.13	417-44	Spill to east and west	Transverse-culvert (Stillwater Ck Trib. 4)

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11/24/04

Structure ID	Culvert # (2)	Culvert # (3)	Station	Location	Size (mm)	Type	Length (m)	Culvert				Slope (%)	Peak Flow (m3/s)		Road Crown Elevation	Edge of Pavement	Tailwater Elevation	Sag Elevation	Edge of Pavement at Sag Elevation	Spill Elevation	Headwater Elevation (m)		Depth of Headwater		Freeboard [1] (m)		Road Overtopping during a Design Storm		Freeboard [2] (m)		Program: HY-8 (File Name)	Comments	Culvert Category
								Inverts (m)		Obverts (m)																							
								U/S	D/S	U/S	D/S		50-yr	100-yr	(m)	(m)	(m)	(m)	(m)	(m)	50-yr	100-yr	50-yr	100-yr	50-yr	100-yr	50-yr	100-yr	50-yr	100-yr			
45		24	15+360	WBL	505	CP	44.9						0.46	0.53	68.25	68.11																Required survey data	Median culvert
46			15+590	WBL	300	PVC	25.9								67.78	67.64																CB inlet	Median culvert
47		25	15+700	HWY 416 W-	762	CSP	34.0	764.12		764.88																						Outside Project limits	Ramp
48			15+850	EBL	914	CSP																										Outside Project limits	Ditch culvert
49		28	15+919	EBL	2500x2000	RCB																										Outside Project limits	Transverse-culvert
50		26	15+999	WBL	2500x2000	RCB																										Outside Project limits	Transverse-culvert
51		27	14+980	EBL	800	CSP																										Outside Project limits	Median culvert

Notes:

1 Freeboard measured from the low point on the road (e.g. sag elevation)

2 Freeboard measured from the edge of pavement

3 Flows calculated at culvert 38 are 33.75 cms and 37.9 cms for 50-yr and 100-yr event respectively.
These are combined flows and include flows at culvert 38 and potential spill from culvert 42 and 44 (worst case scenario)

4 Culvert 42 consists of two pipe sections: north extension 610mm CSP and south extension 1200mm CSP

5 Culverts to be addressed during the Eagleson Road re-construction by Others

6 Detail base mapping required for spill/ storage analysis at culverts 38, 42, 44 and 47

Table 4: Culvert Characteristics and Hydraulic Assessment - Proposed Conditions

Structure ID	Station	Location	Culvert Size (mm)	Culvert Type	Culvert Length (m)	Culvert Inverts (m) U/S	Culvert Inverts (m) D/S	Culvert Obverts (m) U/S	Culvert Obverts (m) D/S	Culvert Slope (%)	Peak Flow (m3/s) 50-yr	Peak Flow (m3/s) 100-yr	Road Crown Elevation (m)	Edge of Pavement (m)	Tailwater Elevation (m)	Sag Elevation (m)	Edge of Pavement at Sag Elevation (m)	Spill Elevation	Headwater Elevation (m) 50-yr	Headwater Elevation (m) 100-yr	Depth of Headwater 50-yr	Depth of Headwater 100-yr	Freeboard [1] (m) 50-yr	Freeboard [1] (m) 100-yr	Road Overtopping during a Design Storm 50-yr	Road Overtopping during a Design Storm 100-yr	Freeboard [2] (m) 50-yr	Freeboard [2] (m) 100-yr	Program: HY-8 (File Name)	Comments	Culvert Category
Township of March																																
1	14+200	EBL/WBL	4370x2870	CSPA	202.8	88.19	86.77	91.06	89.64	0.70%	-	20.50	94.25	93.88	89.67	91.74	91.37		-	90.96		2.8	na	3.29	n/a	No	n/a	2.92	417-1F		Transverse-culvert
2	14+190	Eagleson W S ramp	610	CSP	24.7	91.11	90.74	91.71	91.35	1.50%	0.14	0.16	94.70	94.33	91.31				91.46	91.48	0.3	0.4	3.24	3.22	No	No	2.87	2.85	417-2F	Outside Project limits	Ramp
3	14+350	EBL	457	CSP																										Future Analysis [3]	Ditch inlet / SWM sewer
4	14+400	EBL/WBL	457 to 1067	CSP																										Future Analysis [3]	Ditch inlet / SWM sewer
Township of March/Nepean																																
5	10+000		4724 x 3073	CSPA	133.6						-	20.50	91.75	91.38																Outside Project limits	
Township of Nepean																																
6	10+025	EBL/WBL	610 to 914	CSP																										Analysis pending	Ditch inlet / SWM sewer
7	10+100	Eagleson S-E ramp	1220 x 620	RFB	22.2		92.38		93.60		4.15	4.61	91.82	91.68																Outside Project limits	
8	10+120	S. Extension	1829	CSP	160.7					0.00%	4.66	5.49	92.41	92.04																Future Analysis [3]	Transverse-culvert
			1828x1524	RCB							4.66	5.49	92.41	92.04																	
		N. Extension	1676	CSP	6.0	89.41	89.40		91.30	0.17%	4.66	5.49	92.41	92.04		91.74															
9	10+120	Eagleson S-W ramp	610	CSP	28.3	90.13	89.95	90.78	90.60	0.64%	0.08	0.10	92.26	91.94	90.61				90.64	90.66	0.5	0.5	1.62	1.60	No	No	1.30	1.28	417-9	Future Analysis [3]	Ramp
10	10+120	Eagleson E-N-E ramp	800 x 2850	CSPA	63.7																									Future Analysis [3]	Ramp
11	10+270	WBL	381	CSP										-0.38																Required new ditch inlet/ culvert clean-up	Median culvert
12	10+710	WBL	305	CSP	44.2	94.38	93.46	94.71	93.78	2.04%	0.03	0.04	96.70	96.33	93.81				94.6	94.67	0.2	0.3	2.10	2.03	No	No	1.73	1.66	417-12	Required culvert clean-up	Median culvert
13	10+865	WBL	381	CSP							0.01	0.04	99.55	99.18																Required new ditch inlet/ culvert clean-up	Median culvert
14	11+030	WBL	457	CSP							0.01	0.04	102.27	101.90																Required new ditch inlet/ culvert clean-up	Median culvert
15	11+160	WBL	533	CSP	40.9	101.77	100.01	102.30	100.54	4.30%	0.29	0.33	104.98	104.61	100.53				102.44	102.52	0.7	0.8	2.54	2.46	No	No	2.17	2.09	417-15F		Median culvert
16	11+445	WBL	305	CSP							0.15	0.17	109.95	109.58																Required new ditch inlet/ culvert clean-up	Median culvert
17	11+755	EBL	305	CSP							0.09	0.10	97.83	97.46																Required new ditch inlet/ culvert clean-up	Median culvert
18	11+905	EBL	381	CSP							0.09	0.10	107.78	107.41																Required culvert clean-up	Median culvert
19	12+060	EBL	381	CSP							0.09	0.10	103.92	103.55																Required culvert clean-up	Median culvert
20	12+220	EBL	457	CSP	43.3	96.83	96.74	97.29	97.20	0.21%	0.18	0.20	100.32	99.95	97.16				97.37	97.37	0.5	0.5	2.95	2.95	No	No	2.57	2.57	417-20F	Culvert rehabilitation required due to corrosion.	Median culvert
21	12+350	EBL	457	CSP							0.12	0.14	98.71	98.34																Required new ditch inlet/ culvert clean-up	Median culvert
22	12+485	EBL	457	CSP							0.12	0.14	97.67	97.30																Required new ditch inlet/ culvert clean-up	Median culvert
23	12+590	EBL/WBL	1067	CSP	103.5	87.28	86.55	88.35	87.62	0.71%	1.36	1.53	95.43	95.06	87.67	94.71	94.34		88.59	88.65	1.3	1.4	6.84	6.78	No	No	6.47	6.41	417-23F		Transverse-culvert
24	12+610	EBL	457	CSP	58.0	90.74	86.88	91.20	87.34	6.65%	0.12	0.14	96.04	95.67	87.36				91.11	91.15	0.4	0.4	4.93	4.89	No	No	4.56	4.52	417-24F	Culvert rehabilitation/ replacement required due to corrosion.	Median culvert
25	12+700	CNR																														
26	12+715	EBL/WBL	406	CSP																										Outside Project limits	
27	12+880	EBL	457	CSP							0.41	0.47	88.76	88.39																Required culvert clean-up	Ditch inlet / SWM sewer
28	13+050	EBL	457	CSP	53.6	78.21	77.18	78.67	77.64	1.92%	0.41	0.47	83.57	83.20	77.66				79.6	80	1.4	1.8	3.97	3.57	No	No	3.60	3.19	417-28F	Required new ditch inlet/ culvert clean-up	Median culvert
29	13+215	EBL	457	CSP	58.0	74.73	74.14	75.19	74.67	1.02%	0.41	0.47	78.69	78.32	74.56				76.1	76.5	1.4	1.8	2.59	2.19	No	No	2.22	1.82	417-29F	Required new ditch inlet/ culvert clean-up	Culvert rehabilitation/ replacement required due to corrosion. Newditch inlet to be provided.	Median culvert
30	13+360	EBL/WBL	4900x2100	RFO	83.1	70.18	70.04	72.28	72.20	0.17%	6.24	7.29	74.80	74.43	72.1				72.14	72.15	2.0	2.0	2.66	2.65	No	No	2.29	2.27	417-30F		Transverse-culvert (Stillwater Ck Trib. 1)
31	14+120	Moodie S-E ramp	900	CP	31.8	66.02	65.90	66.92	66.82	0.38%	0.33	0.39	68.26	67.89																Section of the storm sewer to be disconnected and removed	Storm sewer outlet
32	14+200	Moodie S-W ramp	533	CSP	29.5	65.55	65.50	66.08		0.17%	0.28	0.33	67.42	67.79	65.73				66.28	66.5	0.7	1.0	1.14	0.92	No	No	1.51	1.29	417-32	Culvert rehabilitation/ replacement required due to corrosion.	Ramp

Structure ID	Station	Location	Size (mm)	Type	Length (m)	Culvert				Slope (%)	Peak Flow (m3/s)		Road Crown Elevation	Edge of Pavement	Tailwater Elevation	Sag Elevation	Edge of Pavement at Sag Elevation	Spill Elevation	Headwater Elevation (m)		Depth of Headwater		Freeboard [1] (m)		Road Overtopping during a Design Storm		Freeboard [2] (m)		Program: HY-8 (File Name)	Comments	Culvert Category
						Inverts (m)		Obverts (m)																						
						U/S	D/S	U/S	D/S		50-yr	100-yr	(m)	(m)	(m)	(m)	(m)		50-yr	100-yr	50-yr	100-yr	50-yr	100-yr	No	No	50-yr	100-yr			
33	14+210	Moodie S-E ramp	914	CSP	26.3	65.71	65.24	66.62	66.15	1.79%	0.29	0.35	68.15	67.78	66.11				66.15	66.2	0.4	0.5	2.00	1.95	No	No	1.63	1.58	417-33F	To be removed	Median culvert
34	14+210	Moodie S-E ramp	457	CSP	9.0	66.23	66.14	66.69	66.60	1.00%	0.29	0.35																		To be removed	Ditch inlet to Culvert 33
35	14+240	Moodie E-NS	530	CSP	23.0	65.85	65.84	66.38	66.37	0.04%	0.33	0.39	68.00	67.63																Inlet to SWM Pond / Road Elevations based on OBM	SWM sewer outlet
36	14+420	Moodie E-NS ramp	762	CSP	28.4	64.95	64.81	65.85	65.61	0.49%	3.50	4.50	67.40	67.33	65.56															Diversion of local drainage areas to proposed SWM Pond / New culvert required (Outlet from SWM Pond)	Ramp
37	14+330		305	CSP																											SWM sewer outlet
38 [3]	14+600	EBL/WBL	5470x1890	RFO	108.4	63.43	63.08	65.32	64.97	0.32%	**36.85**	**42.08**	67.55	67.18	65.23	67.42	66.71	66.05 (E)	66.55	67.06	3.1	3.6	**0.87**	**0.36**	No	No	**0.16**	**-0.35**	417-38F	Superelevated section. Spill to east	Transverse-culvert (Stillwater Ck Trib. 2)
39	14+600	WBL	610	CSP									66.91	66.54																Required culvert clean-up	Median culvert
40	14+635	WBL	610	CP									66.94	66.57																Required culvert clean-up, extension and new ditch inlet	Median culvert
41	14+815	WBL	457	CP									67.47	67.10																Required culvert clean-up, extension and new ditch inlet	Median culvert
42 [4]	14+980	EBL/WBL	1200	CSP	112.1	64.14	61.53	65.41	62.80	2.33%	1.01	1.18	68.34	67.97	62.7				64.92	65.00	0.8	0.9	3.42	3.34	No	No	3.05	2.97	417-42F	South Extension	Transverse-culvert (Stillwater Ck Trib. 3)
42	14+980	EBL/WBL	610	CSP	112.1	64.14	61.53	65.41	62.80	2.33%	1.01	1.18	68.34	67.97	62.7	67.03	66.66	66.05(W) 66.5 (E)	66.2	66.40	2.1	2.3	2.14	1.94	No	No	1.77	1.57	417-42F	North extension/ Spill to west	Transverse-culvert (Stillwater Ck Trib. 3)
43	15+090	WBL	508	CP									68.21	67.84																Required culvert clean-up, extension and new ditch inlet	Median culvert
44	15+280	EBL/WBL	3040x1850	RFO	107.3	64.62	64.26	66.45	66.19	0.34%	14.71	17.04	68.67	68.30	66.15	67.03	66.66	66.5 (W) 65.6 (E)	66.93	67.25	2.3	2.6	1.74	1.42	No	No	1.36	1.05	417-44F	Spill to east and west	Transverse-culvert (Stillwater Ck Trib. 4)
45	15+360	WBL	508	CP	44.9						0.87	0.97	68.33	68.19																Required culvert clean-up, new ditch inlet	Median culvert
46	15+590	WBL	300	PVC	25.9								67.88																	Required culvert extension/ new CB inlet	Median culvert
47	15+700	HWY 416 W-S ramp	762	CSP	34.0	64.12		64.88																						Outside Project limits	Ramp
48	15+850	EBL	914	CSP																										Outside Project limits	Ditch culvert
49	15+919	EBL	2500x2000	RCB																										Outside Project limits	Transverse-culvert
50	15+999	WBL	2500x2000	RCB																										Outside Project limits	Transverse-culvert
51	14+980	EBL	800	CSP																										Outside Project limits	Median culvert

Notes:

1 Freeboard measured from the low point on the road (e.g. sag elevation)
2 Freeboard measured from the edge of pavement
3 Flows calculated at culvert 38 are 33.75 cms and 37.9 cms for 50-yr and 100-yr event respectively.
These are combined flows and include flows at culvert 38 and potential spill from culvert 42 and 44 (worst case scenario).
4 Culvert 42 consists of two pipe sections: north extension 610mm CSP and south extension 1200mm CSP
5 Culverts to be addressed during the Eagleson Road re-construction by Others
6 Detail base mapping required for spill/ storage analysis at culverts 38, 42, 44 and 47

Table 5: Culvert Upgrades

Culvert Characteristics

Culvert #	Chainage	Location	Size (mm)	Type	Length (m)	Inverts (m) Original Ground		Slope (%)	Peak Flow (m3/s)		Road Crown Elev.	Edge of Pavement Elev.	Tailwater Elevation	Headwater Elevation (m)		Depth of Headwater		Freeboard From Edge of Pavement	Freeboard 1.0 m criterion	From Edge of Pavement	Road Overtopping during a 100-yr Storm	Comments
						U/S	D/S		50-yr	100-yr	(m)	(m)	(m)	50-yr	100-yr	50-yr	100-yr	50-yr	met	100-yr		
Township of March																						
36	14+420	Moodie E-NS ramp	2400x1200	Conc.	29.00	64.23	64.08	0.52%	3.5	4.5	67.40	67.33	65.56	65.69	65.78	1.5	1.6	1.64	yes	1.55	no	
42	14+980	EBL/WBL	1200	Conc.	112.1	64.14	61.53	2.33%	1.01	1.18	68.34	67.97	62.7	64.86	64.93	0.7	0.8	3.11	yes	3.04	no	to match south extension

Table 6: Increase in Pavement Area

Culvert #	Increase in Pavement Area	Drainage Area Upstream of Culvert	Increase in Pavement Area as a Percentage of U/S Drainage Area
	(ha)	(ha)	(%)
1	5.8	528.2	1.10
8	5.05	164.8	3.06
23	0.18	9.7	1.86
30	1.7	995	0.17
38	2.94	818.4	0.36
42	0.33	17.4	1.90
44	1.62	274	0.59

Table 7: Stormwater Management Facility Detail Design Characteristics

Location			Moodie Drive Interchange
SWM Facility Characteristics			Wet Pond
Total Upstream tributary Area (ha)			24
Impervious (%)			37
Composite Runoff Coefficient			0.45
Level of Water Quality Protection [1]			Enhanced
Type			Wet Pond
Permanent Pool Requirement (m3/ha)			105
Extended Detention Requirement (m^3/ha) [2]	Water Quality Control		40
	Erosion Control		175
Proposed Flow Control Depth Above Extended Detention (m)			0.5
Depth (m)	Permanent Pool		1.0
	Extended Detention		1.0
	Attenuation		0.5
	Total		2.5
Storage Volume (m^3)	Permanent Pool	Required	2,520
		Provided	3,592
	Extended Detention (Max of Water Quality Control and Erosion Control)	Required	4,200
		Provided	5,106
	Attenuation	Provided	3,169
	Total Provided		11,867
Surface Area of Pond at Permanent Pool (ha)			0.43

Notes:
(1) Level of Protection is based on Table 3.2 of the MOE Storm Water Management Practices Planning and Design Manual (2003).
(2) Greater of Water Quality control and Erosion Control volume.
(3) Proposed flow control depth above extended detention is 0.5 metres.
Pond side slopes are 5:1 (H:V). Slopes to match existing ground are 3:1 (H:V)

Table 8: Drainage Area to SWM Pond

Catchment #	Catchment Area (ha)	Existing Conditions		Future Conditions		Increase in Impervious Area (ha)	Increase in Impervious Area (%)
		Total Impervious Area (ha)	TIMP (%)	Total Impervious Area (ha)	TIMP (%)		
1	9.25	0.57	6.2%	0.77	8.3%	0.20	2.1%
2	3.34	0.72	21.4%	1.21	36.3%	0.50	14.9%
3	1.19	0.49	41.0%	1.00	83.9%	0.51	42.9%
4	1.80	0.48	26.8%	0.88	48.7%	0.39	21.9%
5	8.48	1.31	15.5%	4.87	57.5%	3.56	42.0%
6	0.02	0.02	100.0%	0.02	100.0%	0.00	0.0%
Total	**24.08**	**3.59**	**14.9%**	**8.75**	**36.3%**	5.16	21.4%

Table 9: SWM Facility - Volume Provided

Elevation (m)	Area (m2)	Average Area (m2)	Depth (m)	Incremental Volume (m3)	Total Volume (m3)
63.5	2881.0				
64.5	4303.0	3592.0	1.0	3592.0	3592.0
65.5	5909.0	5106.0	1.0	5106.0	8698.0
66.0	6768.0	6338.5	0.5	3169.0	11867.0

Table 10 **Stormwater Facility at the Moodie Drive Interchange**
Supportive Calculations

Flow from Orifice:

$Q = CA_o * Sqrt(2gh)$

C =	0.63	
g =	9.81	m/s^2
A_o =	0.00785	m^2
h =	1	
Q =	0.021906	

Drowdown Time calculation

A	5909	m2	
C	0.63		
Ao	0.00303988	m2	
g	9.81	m3/s2	
h1	65.5	m	
h2	64.5	m	
t	86400	sec	24hrs
d (*)	62.21	mm	
	(*)based on 24 hr drowdown time		
$d_{(provided)}$	100	mm	
A	0.0079	m2	
t	33442.1	sec	
t	9.3	hr	

500 diameter capacity check:

Pond Outlet Pipe Size: MTO Drainage Manual Pg 122

a= A*H^0.5/0.5*Cd*sqrt(2*g)*3600*T

T =	9.30	hrs
A =	5909	m^2
H =	1.00	m
Cd =	0.63	
a =	0.126494	m^2
A =	PI()*((D)^2/	m^2

Rearranging above equation to solve for D gives:

D =	sqrt((a *4)/pi())	
D =	0.401	m
$D_{(min)}$ =	400	mm
$D_{(provided)}$ =	500	mm

Spillway Weir
Weir Elevations: Top- 65.5 m and Crest- 64.5 m
Q = CLH^3/2

C =	1.55
Q =	4.4 m^3/s
H =	0.5 m

Solve for L:

L = Q/CH^3/2

L =	7.98 m
Allow for L=	**8 m**

From Elevation 64.5 to Elevation 64.35

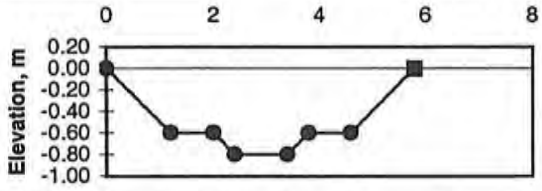
			A_T =	4.5 m^2
			P =	9.00 m
V=R^2/3 S^1/2/n			R =	0.50 m
V=	4.33 m/s		Slope =	0.058
Q=VA	19.51 m^3/s	> 4.4 m^3/s		ok

From Elevation 64.35 to Elevation 64.23(Invert at Culvert)

S =	0.0070		
V =	1.51 m/s		
Q =	6.77 m^3/s	> 4.4 m^3/s	ok

Table 11: South Ditch Station 12+680 to Station 13+364
Design Peak Flow Summary

	Existing	Future
Drainage Area (ha)	79.4	81.4
Return Period	Peak Flow (m^3/s)	
100-year	2.16	3.76
50-year	1.9	3.34
25-year	1.65	2.94
10-year	1.27	2.14
5-year	1.03	1.78
2-year	0.71	1.28



Title : HWY 417 - South Ditch Reconstruction Station 12+800 to Station 13+210

INPUT PARAMETERS

Lower Channel				Upper Channel			
bw =	1			bwul =	0.8	bwur =	0.8
Zll =	2	Zlr =	2	Zul =	2	Zur =	2
nl =	0.030	dl =	0.2	nu =	0.015	du =	0.6
nrl =		D50l =		nru =		D50u =	

Lower and Upper Channel

S = 0.0150 K = 1.38

Note: Input only (D50l and D50u) or (nl and nu). Input 0 for the parameters not used. nru and nrl are not input values. If

OUTPUT PARAMETERS

y (m)	A (m^2)	Wp (m)	R (m)	Qsum (m^3/s)	Vmax (m/s)	Tw (m)	Fr	Upper KTau (kg /m^2)	Lower KTau (kg /m^2)	VR (m^2/s)
0.00	0.0	1.0	0.00	0.00	0.0	1.0	0.41		0.0	0.0
0.20	0.3	1.9	0.15	0.32	1.1	1.8	0.92		3.1	0.2
0.40	1.0	4.4	0.24	2.23	2.0	4.2	1.42	3.3	7.0	0.5
0.50	1.5	4.8	0.31	3.91	2.3	4.6	1.56	4.6	9.0	0.8
0.60	2.0	5.3	0.37	6.05	2.7	5.0	1.66	5.9	10.9	1.1
0.70	2.5	5.7	0.43	8.67	3.0	5.4	1.75	7.0	12.9	1.5
0.80	3.0	6.2	0.49	11.80	3.3	5.8	1.81	8.1	14.9	1.9
1.00	4.3	7.1	0.61	19.65	3.8	6.6	1.92	10.2	18.8	2.8
1.20	5.7	8.0	0.71	29.78	4.3	7.4	2.01	12.3	22.7	3.7

Input Parameter Definition

bw = bottom width, m y = flow depth, m
bwul = upper left bottom width, m
bwur = upper right bottom width, m
Zll = lower left side slope, hor.:vert., m/m
Zlr = lower right side slope, hor.:vert., m/m
Zul = upper left side slope, hor.:vert., m/m
Zur = upper right side slope, hor.:vert., m/m
S = channel slope, m/m
du = depth for upper channel section, m
dl = depth for lower channel section, m
K = tractive force coefficient
nl = Manning's roughness coefficient lower section
nu = Manning's roughness coefficient upper section
nrl = Manning's riprap roughness coefficient lower section
nru = Manning's riprap roughness coefficient upper section
D50l = median stone diameter, lower section, mm
D50u = median stone diameter, upper section, mm

WARNING

The spreadsheet results are only valid for conditions where the channel shape, slope and dimensions are constant and flow is not influenced by upstream or downstream conditions.

Output Parameter Definition

A = flow area, m^2
Wp = wetted perimeter, m
R = hydraulic radius, m
Qsum = flow rate, m^3/s
Vmax = flow velocity, m/s
Tw = top width, m
Fr = Froude number, minimized energy
KTau = coefficient * tractive force, kg/m^2
VR = velocity * hydraulic radius, m^2/s
^ Denotes superscript

APPENDIX C

- VISUAL OTTHYMO: OUTPUT FILES

- HY8 ANALYSIS: INPUT/OUTPUT FILES (CD)

APPENDIX D

- CULVERT INVENTORY SHEETS / PHOTOS

Structure Inventory

A total of 29 culverts were identified and inspected during the site visit in November 2003. General findings are outlined below. Photographs of the structures are provided in this Appendix.

No.	Structure Reference No.	Station	Type	Size	Condition/Comments
	Township of March				
1	1	14+200 EBL/WBL	CSPA	4370 x 2870 mm	- Good condition - Grate at north end.
2	2	14+190 Eagleson W-S ramp	CSP	610 mm	- Bottom 25% rusted. - Outlet damaged. - Vegetation overgrowth.
	Township of Nepean				
3	5	10+000 Under Eagleson Rd/ E-N Ramp	CSPA	4724 x 3073 mm	- Good Condition - Depth appears less than 620 mm.
4	7	10+100 Eagleson S-E ramp	RFB	1220 x 620 mm	- Good Condition
5	8	12+120 EBL/WBL	CSP RCB CSP	1829 mm (S. ext.) 1828 x 1524 mm 1676 mm (N. ext.)	- Concrete Box Culvert with CSP extensions on both ends - Good Condition - Accumulated debris on inlet grate - Some sedimentation build-up
6	9	10+120 Eagleson S-W ramp	CSP	610 mm	- Outlet buried - Sedimentation build-up - Corrosion evident
7	10	10+120 Eagleson E-N/S-W ramps	CSPA	4800 x 2850 mm	- Good condition - Sediment accumulation at south end - Headwall broken on north end
8	12	10+710 WBL	CSP	305 mm	- Outlet buried.
9	15	11+160 WBL	CSP	533 mm	- Outlet filled approximately 50% with sediment
10	20	12+220 EBL	CSP	457 mm	- Outlet partially buried - Corrosion evident
11	23	15+590 EBL/WBL	CSP	1067 mm	- Corroded through - Outlet projects approx. 1.5 m out from embankment

12	24	12+610 EBL	CSP	457 mm	- Corroded through - Outlet projects approx. 1m out from embankment
13	28	13+050 EBL	CSP	457 mm	- Good condition
14	29	13+210 EBL	CSP	457 mm	- corroded through at outlet
15	30	13+360 EBL/WBL	RFO	4900 x 2100 mm	- Good condition
16	31	14+120 Moodie S-E ramp	CP	900 mm	- Good condition
17	32	14+200 Moodie S-W ramp	CSP	533 mm	- Heavy corrosion - East end buried
18	33	14+210 Moodie S-E ramp	CSP	533 mm	- Some corrosion evident
19	34	14+210 Moodie S-E ramp	CSP	457 mm	- Some corrosion evident
20	35	14+240 Moodie E-NS	CSP	762 mm	- Culvert details to be determined.
21	36	14+420 Moodie E-NS ramp	CSP	762 mm	- South end partially crushed - Some rusting at inlet/outlet
22	38	14+600 EBL/WBL	RFO	5470 x 1890 mm	- Good Condition -
23	42	14+980 EBL/WBL	CSP	1200 mm	- North end damaged and partially buried by bank failure - 610 CP extension on north end - Bottom of pipe rusted out
24	44	15+280 EBL/WBL	RFO	3040 x 1850 mm	- Good condition
25	45	15+360 WBL	CP	508 mm	- (Culvert details to be determined)
26	47	15+700 HWY 416 W-S ramp	CSP	762 mm	- North end 50% buried - Good condition
27	49	15+919 EBL	RCB	2500 x 2000 mm	- Good Condition
28	50	15+999 WBL	RCB	2500 x 2000 mm	- Good condition
29	51	15+963 EBL	CSP	800 mm	- Fair condition, some corrosion

Field Recommendations

Field recommendations for drainage include the following:

- Detailed condition survey of existing sewers to be salvaged will be completed in detailed design.
- Repairs to existing drainage system to correct deficiencies and ensure proper co-ordination of the drainage design with the grading design.
- Culverts # 2, 23, 24, 29, 32, 36, 42 are severely corroded and/or damaged and should be replaced.
- The replacement of culvert #42 should include embankment stabilization and headwall construction.
- Culverts # 9, 10, 12, 15, 20, 47 have significant build-up of sediment and cleaning out is recommended.
- Ditch clean out/construction to ensure proper pavement drainage.
- Drainage improvements between the CNR and Culvert # 30 to alleviate flooding problems in this area.
- Due to the nature the proposed improvements, most of the existing curb and gutter will be removed. Detailed design will include elimination of as much curb and gutter as possible (particularly in the bullnose areas) as the curb represents a hazard and a maintenance issue.
- Placement of granular sealing throughout, in shoulder areas in accordance with Ontario standards.

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 1 Station Reference: 14+200 (March)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000018

Photograph Description- North end.
Photo #- P0000054

Structure Details

Structure Material:	CSPA	Type:	N/A
Dimensions:	4370 x 2870 mm	Length:	202.75 m
Condition:	Good	Road Angle:	125°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 2 Station Reference: 14+190 (March)
Item: Eagleson Road Interchange W-S Ramp Culvert

Photograph Description – North end.
Photo # Mvc-257s

Photograph Description- South end.
Photo # Mvc-258s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	610 mm	Length:	24.73 m
Condition:	Good	Road Angle:	90°
Details:	Bottom 25% rusted. Outlet damaged.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 5 Station Reference: 10+000 (Nepean)
Item: Eagleson Road/E-N Ramp Culvert

Photograph Description – South end.
Photo # P0000053

Photograph Description- North end.
Photo # P0000052

Structure Details

Structure Material:	CSPA	Type:	N/A
Dimensions:	4724 x 3073 mm	Length:	133 m
Condition:	Good	Road Angle:	40°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 7 Station Reference: 10+100 (Nepean)
Item: Eagleson Road Interchange S-E Ramp Culvert

Photograph Description – West end.
Photo # **Mvc-260s**

Photograph Description – East end.
Photo # Mvc-259s

Structure Details

Structure Material:	Concrete	Type:	RFB
Dimensions:	1220 x 620 mm	Length:	22.2 m
Condition:	Good	Road Angle:	90°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 8 Station Reference: 10+120 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000019

Photograph Description- North end.
Photo #- P0000051

Structure Details

Structure Material:	CSP/RFB	Type:	N/A
Dimensions:	1829 mm (S. Ext.)	Length:	71 m
	1828 x 1524mm		180 m
	1676 mm (N. Ext.)		6 m
Condition:	Good	Road Angle:	85°
Details:	Concrete Box Culvert with CSP extensions on both ends.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE

Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 9 Station Reference: 10+120 (Nepean)

Item: Eagleson Road Interchange S-W Ramps Culvert

Photograph Description – West end.

Photo # P0000050

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	610 mm	Length:	28.3 m
Condition:	Fair	Road Angle:	N/A
Details:	Outlet buried, sedimentation build-up		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 10 Station Reference: 10+120 (Nepean)
Item: Eagleson Road Interchange E-N/S-W Ramps Culvert

Photograph Description – South end.
Photo # P0000049

Photograph Description- North end.
Photo # P0000048

Structure Details

Structure Material:	CSPA	Type:	N/A
Dimensions:	4800 x 2850 mm	Length:	83.7 m
Condition:	Fair	Road Angle:	N/A
Details:	Sedimentation build-up; North end section damaged		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 12 Station Reference: 10+710 (Nepean)
Item: Highway 417 WBL Culvert

Photograph Description- North end.
Photo #- P0000047

Photograph Description- South end.
Photo # Mvc-294s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	305 mm	Length:	44.18 m
Condition:	Unknown	Road Angle:	90°
Details:	Outlet buried.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 15 Station Reference: 11+160 (Nepean)
Item: Highway 417 WBL Culvert

Photograph Description- North end.
Photo #- P0000046

Photograph Description- South end.
Photo # Mvc-293s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	533 mm	Length:	40.90 m
Condition:	Good	Road Angle:	90°
Details:	Sedimentation fills approx. 50% of outlet.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 20 Station Reference: 12+220 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description- South end.
Photo #- P0000021

Photograph Description- North end.
Photo # Mvc-288s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	457 mm	Length:	43.31 m
Condition:	Fair	Road Angle:	90°
Details:	Corrosion evident.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 23 Station Reference: 12+590 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000022

Photograph Description- North end.
Photo #- P0000045

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	1067 mm	Length:	103.51 m
Condition:	Poor	Road Angle:	80°
Details:	Corroded through at outlet; Outlet projects approx. 1.5 m out from embankment		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 24 Station Reference: 12+610 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description- South end.
Photo #- P0000022

Photograph Description- North end.
Photo # Mvc-285s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	457 mm	Length:	58.14 m
Condition:	Poor	Road Angle:	110°
Details:	Outlet corroded through; Outlet extends approx. 1m out from embankment.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 28 Station Reference: 13+050 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description- South end.
Photo #- P0000024

Photograph Description- North end.
Photo # Mvc-296s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	457 mm	Length:	53.55 mm
Condition:	Good	Road Angle:	90°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 29 Station Reference: 13+210 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description- South end.
Photo #- P0000025

Photograph Description- North end.
Photo # Mvc-297s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	457 mm	Length:	58.00 m
Condition:	Poor	Road Angle:	90°
Details:	Bottom rusted through.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 30 Station Reference: 13+390 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000026

Photograph Description- North end.
Photo #- P0000044

Structure Details

Structure Material:	Concrete	Type:	RFO
Dimensions:	4900 x 2100 mm	Length:	83.08 m
Condition:	Good	Road Angle:	115°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 31 Station Reference: 14+120 (Nepean)
Item: Moodie Drive Interchange S-E Ramp Culvert

Photograph Description- East end.
Photo #- P0000024

Structure Details

Structure Material:	Concrete	Type:	CP
Dimensions:	900 mm	Length:	31.78 m
Condition:	Good	Road Angle:	N/A
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 32 Station Reference: 14+210 (Nepean)
Item: Moodie Drive Interchange S-W Ramp Culvert

Photograph Description- East end.
Photo #- P0000043

Photograph Description- West end.
Photo #- P0000042

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	533 mm	Length:	30 m
Condition:	Poor	Road Angle:	N/A
Details:	Heavy corrosion; East end buried		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 33 Station Reference: 14+210 (Nepean)
Item: Moodie Drive Interchange S-E Ramp Culvert

Photograph Description- South end.
Photo #- P0000030

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	914 mm	Length:	26.31 m
Condition:	Fair	Road Angle:	N/A
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 34 Station Reference: 14+210 (Nepean)
Item: Moodie Drive Interchange S-E Ramp Culvert

Photograph Description- North end.
Photo #- P0000029

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	457 mm	Length:	9 m
Condition:	Fair	Road Angle:	N/A
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 36 Station Reference: 14+420 (Nepean)
Item: Moodie Drive Interchange E-NS Ramp Cross-Culvert

Photograph Description- South end.
Photo #- P0000041

Photograph Description- North end.
Photo #- P0000040

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	762 mm	Length:	28.43 m
Condition:	Poor	Road Angle:	N/A
Details:	South end crushed.		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 38 Station Reference: 14+600 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000031

Photograph Description- North end.
Photo #- P0000039

Structure Details

Structure Material:	Concrete	Type:	RFO
Dimensions:	5470 x 1890 mm	Length:	108.37 m
Condition:	Good	Road Angle:	125°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 42 Station Reference: 14+980 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000032

Photograph Description- North end.
Photo #- P0000038

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	1200 mm	Length:	110.49 m
Condition:	Poor	Road Angle:	105°
Details:	610 CP Extension on north end; north end buried under failed embankment		

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 44 Station Reference: 15+280 (Nepean)
Item: Highway 417 Culvert

Photograph Description- South end.
Photo #- P0000033

Photograph Description- North end.
Photo #- P0000037

Structure Details

Structure Material:	Concrete	Type:	RFO
Dimensions:	3040 x 1850 mm	Length:	107.27 m
Condition:	Good	Road Angle:	85°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 47 Station Reference: 15+700 (Nepean)
Item: Highway 416 Interchange W-S Ramp Culvert

Photograph Description- South end.
Photo #- P0000035

Photograph Description- North end.
Photo #- P0000034

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	762 mm	Length:	34 m
Condition:	Good	Road Angle:	135°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 49 Station Reference: 15+919 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description – South end.
Photo # Mvc-135s

Photograph Description- North end.
Photo # Mvc-303s

Structure Details

Structure Material:	RCB	Type:	N/A
Dimensions:	2500 x 2000 mm	Length:	146 m
Condition:	Good	Road Angle:	120°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 50 Station Reference: 15+999 (Nepean)
Item: Highway 417 WBL Culvert

Photograph Description – South end.
Photo # Mvc-301s

Photograph Description- North end.
Photo # Mvc-136s

Structure Details

Structure Material:	Rigid Concrete Box	Type:	Closed
Dimensions:	2500 x 2000 mm	Length:	63.2 m
Condition:	Good	Road Angle:	120°
Details:			

FIELD INVESTIGATION SHEET FOR DRAINAGE STRUCTURE
Highway 417 Widening to Eight Lanes, from Highway 416 westerly to 0.5km west of Eagleson Road

Structure Reference: 51 Station Reference: 15+963 (Nepean)
Item: Highway 417 EBL Culvert

Photograph Description – South end.
Photo # Mvc-247s

Photograph Description- North end.
Photo # Mvc-261s

Structure Details

Structure Material:	CSP	Type:	N/A
Dimensions:	800 mm	Length:	43 m
Condition:	Fair	Road Angle:	55°
Details:	Bottom 10%-25% of CSP rusted.		

APPENDIX J: MOODIE YARD LMSF PHOTOGRAPHS

Photograph 1 Looking north at downstream face of the Highway OR 417 4.9 meter span by 2.1 meter rise open bottom box culvert

Photograph 2 Looking north at downstream face of the Highway OR 417 4.9 meter span by 2.1 meter rise open bottom box culvert

Photograph 3 Looking downstream (north) from the Highway OR 417 4.9 meter span by 2.1 meter rise open bottom box culvert towards Corkstown Road

Photograph 4 Looking south at upstream face of the Highway OR 417 4.9 meter span by 2.1 meter rise open bottom box culvert

Photograph 5 Looking south at upstream face of the Highway OR 417 4.9 meter span by 2.1 meter rise open bottom box culvert

Photograph 6 Looking upstream (south) from the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert towards Highway OR 417

Photograph 7 Looking downstream (north) at upstream face of the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert

Photograph 8 Looking upstream (south) at downstream face of the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert

Photograph 9 Looking downstream (north) from the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert

Photograph 10 Looking downstream (north) from the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert

Photograph 11 Looking downstream (north) from the Corkstown Road 3.0 meter span by 2.0 meter rise open bottom box culvert

Photograph 12 Looking upstream (south) at the downstream face of the 1200 mm corrugated metal pipe under the Wesley Clover Farms path

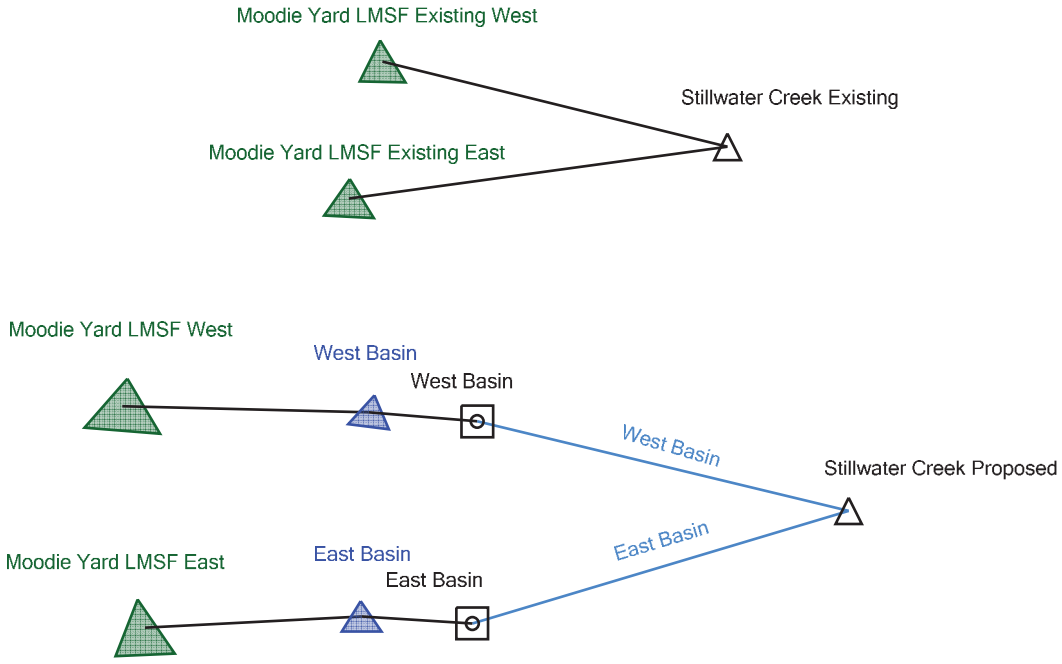
Photograph 13 Looking upstream (south) from the 1200 mm corrugated metal pipe under the Wesley Clover Farms path

Photograph 14 Looking downstream (north) from the 1200 mm corrugated metal pipe under the Wesley Clover Farms path

Photograph 15 Looking upstream (south) at the downstream face of the 1200 mm corrugated metal pipe under the Wesley Clover Farms path

APPENDIX K: MOODIE YARD LMSF STORMWATER MANAGEMENT DESIGN

Scenario: Moodie Yard LMSF



STORMWATER MANAGEMENT SUMMARY

Client: **Ottawa LRT**
Project: **Moodie Station**
Prepared by: **S Dillon**
Date: **27 Sep 17**

Checked by:

Print Date: 10:57 AM
Project #: 4018023

\\stvgroup.stvinc.com\v3\DGPA\Vol3\Projects\4018023\4018023_0001\60_Discipline Info\Moodie PE - Design\PondPack\[PondPack Summary.xls]Moodie Yard LMSF

	Study Point:	**Stillwater Creek**							
	Watershed:	Moodie Yard LMSF							
	Controlling Basin:	West and East							
A	Pre Construction	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	62444.28	80.00	0.23	0.43	0.57	0.76	0.90	1.05
	East	5840.27	95.00						
B	Post Construction without Basin	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	54938.62	93.00	0.17	0.20	0.24	0.29	0.33	0.36
	East	17791.35	96.00	0.13	0.35	0.42	0.50	0.55	0.61
C	Post Construction into Basin	Area	CN_{simple}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
		sq m		cms	cms	cms	cms	cms	cms
	West	54938.62	93.00	0.17	0.20	0.24	0.29	0.33	0.36
	East	17791.35	96.00	0.13	0.35	0.42	0.50	0.55	0.61
D	Discharge from Basin			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
	West			0.12	0.17	0.21	0.26	0.30	0.33
	East			0.19	0.26	0.32	0.38	0.43	0.48
E	Post Construction Total to Study Point			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
				0.16	0.25	0.31	0.39	0.44	0.50
				69% Pre	*58% Pre*	*54% Pre*	*51% Pre*	*49% Pre*	*48% Pre*
	Pre vs. Post Differential			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
				cms	cms	cms	cms	cms	cms
			*	-0.07	-0.18	-0.26	-0.37	-0.46	-0.55

Notes:
* Negative number indicates a reduction in flow after construction

Project Summary	
Title	Ottawa LRT - Moodie Yard LMSF
Engineer	Stephen M. Dillon
Company	STV Incorporated
Date	9/27/2017

Notes	
	Study Point: Stillwater Creek between Highway 417 and Corkstown Road
	Watershed: Stillwater Creek

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Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
Moodie Yard LMSF Existing West	2	2.000	919.052	12.150	0.213
Moodie Yard LMSF Existing West	5	5.000	1,630.031	12.150	0.403
Moodie Yard LMSF Existing West	10	10.000	2,143.614	12.150	0.539
Moodie Yard LMSF Existing West	25	25.000	2,835.791	12.150	0.720
Moodie Yard LMSF Existing West	50	50.000	3,368.346	12.150	0.858
Moodie Yard LMSF Existing West	100	100.000	3,915.597	12.150	0.999
Moodie Yard LMSF Existing East	2	2.000	223.845	11.950	0.089
Moodie Yard LMSF Existing East	5	5.000	319.527	11.950	0.124
Moodie Yard LMSF Existing East	10	10.000	382.759	11.950	0.146
Moodie Yard LMSF Existing East	25	25.000	463.547	11.950	0.175
Moodie Yard LMSF Existing East	50	50.000	523.380	11.950	0.196
Moodie Yard LMSF Existing East	100	100.000	583.355	11.950	0.217
Moodie Yard LMSF West	2	2.000	1,869.535	13.500	0.134
Moodie Yard LMSF West	5	5.000	2,742.487	13.450	0.196
Moodie Yard LMSF West	10	10.000	3,324.284	13.450	0.236
Moodie Yard LMSF West	25	25.000	4,071.509	13.450	0.288
Moodie Yard LMSF West	50	50.000	4,626.831	13.450	0.326
Moodie Yard LMSF West	100	100.000	5,184.701	13.450	0.364
Moodie Yard LMSF East	2	2.000	723.552	12.000	0.257
Moodie Yard LMSF East	5	5.000	1,018.670	12.000	0.354
Moodie Yard LMSF East	10	10.000	1,212.895	12.000	0.417
Moodie Yard LMSF East	25	25.000	1,460.611	12.000	0.496
Moodie Yard LMSF East	50	50.000	1,643.850	12.000	0.554
Moodie Yard LMSF East	100	100.000	1,827.399	12.000	0.612

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m³)	Time to Peak (hours)	Peak Flow (m³/s)
Stillwater Creek Existing	2	2.000	1,142.925	12.150	0.231
Stillwater Creek Existing	5	5.000	1,949.558	12.150	0.428
Stillwater Creek Existing	10	10.000	2,526.344	12.100	0.569
Stillwater Creek Existing	25	25.000	3,299.337	12.100	0.758
Stillwater Creek Existing	50	50.000	3,891.697	12.100	0.902
Stillwater Creek Existing	100	100.000	4,498.952	12.100	1.050
Stillwater Creek Proposed	2	2.000	2,593.087	12.100	0.197
Stillwater Creek Proposed	5	5.000	3,761.157	12.100	0.284
Stillwater Creek Proposed	10	10.000	4,537.152	12.100	0.341
Stillwater Creek Proposed	25	25.000	5,532.149	12.100	0.423
Stillwater Creek Proposed	50	50.000	6,270.681	12.100	0.482
Stillwater Creek Proposed	100	100.000	7,012.072	12.100	0.540

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m³)	Time to Peak (hours)	Peak Flow (m³/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m³)
West Basin (IN)	2	2.000	1,869.535	13.500	0.134	(N/A)	(N/A)
West Basin (OUT)	2	2.000	1,869.535	14.100	0.118	70.841	306.502
West Basin (IN)	5	5.000	2,742.487	13.450	0.196	(N/A)	(N/A)
West Basin (OUT)	5	5.000	2,742.487	14.050	0.173	70.920	419.995
West Basin (IN)	10	10.000	3,324.284	13.450	0.236	(N/A)	(N/A)
West Basin (OUT)	10	10.000	3,324.284	14.050	0.210	70.972	494.242
West Basin (IN)	25	25.000	4,071.509	13.450	0.288	(N/A)	(N/A)
West Basin (OUT)	25	25.000	4,071.509	14.000	0.259	71.031	579.108

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m³)	Time to Peak (hours)	Peak Flow (m³/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m³)
West Basin (IN)	50	50.000	4,626.831	13.450	0.326	(N/A)	(N/A)
West Basin (OUT)	50	50.000	4,626.831	13.950	0.295	71.073	639.932
West Basin (IN)	100	100.000	5,184.701	13.450	0.364	(N/A)	(N/A)
West Basin (OUT)	100	100.000	5,184.701	13.950	0.330	71.115	700.191
East Basin (IN)	2	2.000	723.552	12.000	0.257	(N/A)	(N/A)
East Basin (OUT)	2	2.000	723.552	12.100	0.186	70.922	143.397
East Basin (IN)	5	5.000	1,018.670	12.000	0.354	(N/A)	(N/A)
East Basin (OUT)	5	5.000	1,018.670	12.100	0.264	71.020	187.118
East Basin (IN)	10	10.000	1,212.895	12.000	0.417	(N/A)	(N/A)
East Basin (OUT)	10	10.000	1,212.895	12.100	0.315	71.080	213.905
East Basin (IN)	25	25.000	1,460.611	12.000	0.496	(N/A)	(N/A)
East Basin (OUT)	25	25.000	1,460.611	12.050	0.382	71.154	246.696
East Basin (IN)	50	50.000	1,643.850	12.000	0.554	(N/A)	(N/A)
East Basin (OUT)	50	50.000	1,643.850	12.050	0.432	71.207	270.171
East Basin (IN)	100	100.000	1,827.399	12.000	0.612	(N/A)	(N/A)
East Basin (OUT)	100	100.000	1,827.399	12.050	0.480	71.260	293.532

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.260 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.257 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	40.668 mm
Runoff Volume (Pervious)	723.544 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	723.552 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.359 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.354 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	57.256 mm
Runoff Volume (Pervious)	1,018.660 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,018.670 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.423 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.417 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	68.173 mm
Runoff Volume (Pervious)	1,212.883 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,212.895 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.504 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.496 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	82.097 mm
Runoff Volume (Pervious)	1,460.621 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,460.611 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.564 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.554 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	92.396 mm
Runoff Volume (Pervious)	1,643.851 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,643.850 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.167 hours
Area (User Defined)	17,791.350 m²

Computational Time Increment	0.022 hours
Time to Peak (Computed)	11.977 hours
Flow (Peak, Computed)	0.623 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.612 m³/s

Drainage Area	
SCS CN (Composite)	96.000
Area (User Defined)	17,791.350 m²
Maximum Retention (Pervious)	10.583 mm
Maximum Retention (Pervious, 20 percent)	2.117 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	102.712 mm
Runoff Volume (Pervious)	1,827.385 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,827.399 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.167 hours
Computational Time Increment	0.022 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.846 m³/s
Unit peak time, Tp	0.111 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.091 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.089 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	38.332 mm
Runoff Volume (Pervious)	223.868 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	223.845 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.127 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.124 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	54.715 mm
Runoff Volume (Pervious)	319.551 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	319.527 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.151 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.146 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	65.538 mm
Runoff Volume (Pervious)	382.759 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	382.759 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.181 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.175 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	79.371 mm
Runoff Volume (Pervious)	463.546 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	463.547 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.203 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.196 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	89.616 mm
Runoff Volume (Pervious)	523.380 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	523.380 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	5,840.270 m²

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.920 hours
Flow (Peak, Computed)	0.225 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.217 m³/s

Drainage Area	
SCS CN (Composite)	95.000
Area (User Defined)	5,840.270 m²
Maximum Retention (Pervious)	13.368 mm
Maximum Retention (Pervious, 20 percent)	2.674 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	99.887 mm
Runoff Volume (Pervious)	583.364 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	583.355 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.463 m³/s
Unit peak time, Tp	0.067 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	0.216 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.213 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	14.716 mm
Runoff Volume (Pervious)	918.946 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	919.052 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	0.406 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.403 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	26.100 mm
Runoff Volume (Pervious)	1,629.779 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,630.031 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	0.542 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.539 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	34.323 mm
Runoff Volume (Pervious)	2,143.261 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,143.614 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	0.723 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.720 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	45.406 mm
Runoff Volume (Pervious)	2,835.320 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,835.791 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	0.860 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.858 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	53.932 mm
Runoff Volume (Pervious)	3,367.756 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,368.346 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	0.428 hours
Area (User Defined)	62,444.280 m²

Computational Time Increment	0.057 hours
Time to Peak (Computed)	12.165 hours
Flow (Peak, Computed)	1.001 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	0.999 m³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	62,444.280 m²
Maximum Retention (Pervious)	63.500 mm
Maximum Retention (Pervious, 20 percent)	12.700 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	62.695 mm
Runoff Volume (Pervious)	3,914.913 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,915.597 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.428 hours
Computational Time Increment	0.057 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.156 m³/s
Unit peak time, Tp	0.286 hours

Storm Event	2 YR
Return Event	2.000 years
Duration	72.000 hours
Depth	51.501 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.134 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.500 hours
Flow (Peak Interpolated Output)	0.134 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	34.031 mm
Runoff Volume (Pervious)	1,869.598 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,869.535 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Storm Event	5 YR
Return Event	5.000 years
Duration	72.000 hours
Depth	68.501 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.196 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.450 hours
Flow (Peak Interpolated Output)	0.196 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	49.921 mm
Runoff Volume (Pervious)	2,742.573 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,742.487 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Storm Event	10 YR
Return Event	10.000 years
Duration	72.000 hours
Depth	79.601 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.237 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.450 hours
Flow (Peak Interpolated Output)	0.236 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	60.511 mm
Runoff Volume (Pervious)	3,324.367 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,324.284 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Storm Event	25 YR
Return Event	25.000 years
Duration	72.000 hours
Depth	93.701 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.289 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.450 hours
Flow (Peak Interpolated Output)	0.288 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	74.112 mm
Runoff Volume (Pervious)	4,071.635 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4,071.509 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Storm Event	50 YR
Return Event	50.000 years
Duration	72.000 hours
Depth	104.101 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.327 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.450 hours
Flow (Peak Interpolated Output)	0.326 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	84.220 mm
Runoff Volume (Pervious)	4,626.954 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4,626.831 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Storm Event	100 YR
Return Event	100.000 years
Duration	72.000 hours
Depth	114.501 mm
Time of Concentration (Composite)	2.590 hours
Area (User Defined)	54,938.620 m²

Computational Time Increment	0.345 hours
Time to Peak (Computed)	13.468 hours
Flow (Peak, Computed)	0.365 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	13.450 hours
Flow (Peak Interpolated Output)	0.364 m³/s

Drainage Area	
SCS CN (Composite)	93.000
Area (User Defined)	54,938.620 m²
Maximum Retention (Pervious)	19.118 mm
Maximum Retention (Pervious, 20 percent)	3.824 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	94.375 mm
Runoff Volume (Pervious)	5,184.845 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	5,184.701 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	2.590 hours
Computational Time Increment	0.345 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.168 m³/s
Unit peak time, Tp	1.727 hours

Subsection: Outlet Input Data
Label: East Basin

Requested Pond Water Surface Elevations	
Minimum (Headwater)	69.780 m
Increment (Headwater)	0.152 m
Maximum (Headwater)	70.694 m

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (m)	E2 (m)
Orifice-Circular	Orifice	Forward	TW	70.490	71.709
Culvert-Circular	Culvert	Forward	TW	70.490	71.709
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: East Basin

Structure ID: Culvert Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	610.000 mm
Length	10.000 m
Length (Computed Barrel)	10.000 m
Slope (Computed)	0.005 m/m

Outlet Control Data	
Manning's n	0.012
Ke	0.500
Kb	0.011
Kr	0.000
Convergence Tolerance	0.000 m

Inlet Control Data	
Equation Form	Form 1
K	0.010
M	2.000
C	0.040
Y	0.670
T1 ratio (HW/D)	1.158
T2 ratio (HW/D)	1.304
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	71.196 m	T1 Flow	0.441 m³/s
T2 Elevation	71.286 m	T2 Flow	0.504 m³/s

Subsection: Outlet Input Data
Label: East Basin

Structure ID: Orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	70.490 m
Orifice Diameter	25.400 mm
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.003 m
Tailwater Tolerance (Maximum)	0.152 m
Headwater Tolerance (Minimum)	0.003 m
Headwater Tolerance (Maximum)	0.152 m
Flow Tolerance (Minimum)	0.000 m^3/s
Flow Tolerance (Maximum)	0.283 m^3/s

Subsection: Outlet Input Data
Label: West Basin

Requested Pond Water Surface Elevations	
Minimum (Headwater)	70.510 m
Increment (Headwater)	0.152 m
Maximum (Headwater)	72.034 m

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (m)	E2 (m)
Orifice-Circular	Orifice	Forward	TW	70.510	72.034
Culvert-Circular	Culvert	Forward	TW	70.510	72.034
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: West Basin

Structure ID: Culvert Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	610.000 mm
Length	12.000 m
Length (Computed Barrel)	12.003 m
Slope (Computed)	0.022 m/m

Outlet Control Data	
Manning's n	0.012
Ke	0.500
Kb	0.011
Kr	0.000
Convergence Tolerance	0.000 m

Inlet Control Data	
Equation Form	Form 1
K	0.010
M	2.000
C	0.040
Y	0.670
T1 ratio (HW/D)	1.149
T2 ratio (HW/D)	1.296
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	71.211 m	T1 Flow	0.441 m³/s
T2 Elevation	71.301 m	T2 Flow	0.504 m³/s

Subsection: Outlet Input Data
Label: West Basin

Structure ID: Orifice Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	70.510 m
Orifice Diameter	50.800 mm
Orifice Coefficient	0.600

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.003 m
Tailwater Tolerance (Maximum)	0.152 m
Headwater Tolerance (Minimum)	0.003 m
Headwater Tolerance (Maximum)	0.152 m
Flow Tolerance (Minimum)	0.000 m^3/s
Flow Tolerance (Maximum)	0.283 m^3/s

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.257 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.186 m³/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	70.922 m
Volume (Peak)	143.392 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	723.552 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	723.552 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.354 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.264 m³/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	71.020 m
Volume (Peak)	187.127 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,018.670 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,018.670 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: East Basin (IN)

Return Event: 10.000 years
Storm Event: 10 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.417 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.315 m³/s	Time to Peak (Flow, Outlet)	12.100 hours

Elevation (Water Surface, Peak)	71.080 m
Volume (Peak)	213.906 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,212.895 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,212.895 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.496 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.382 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	71.154 m
Volume (Peak)	246.691 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,460.611 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,460.611 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.554 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.432 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	71.207 m
Volume (Peak)	270.184 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,643.850 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,643.850 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.490 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.612 m³/s	Time to Peak (Flow, In)	12.000 hours
Flow (Peak Outlet)	0.480 m³/s	Time to Peak (Flow, Outlet)	12.050 hours

Elevation (Water Surface, Peak)	71.260 m
Volume (Peak)	293.522 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,827.399 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,827.399 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.134 m³/s	Time to Peak (Flow, In)	13.500 hours
Flow (Peak Outlet)	0.118 m³/s	Time to Peak (Flow, Outlet)	14.100 hours

Elevation (Water Surface, Peak)	70.841 m
Volume (Peak)	306.495 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,869.535 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,869.535 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.196 m³/s	Time to Peak (Flow, In)	13.450 hours
Flow (Peak Outlet)	0.173 m³/s	Time to Peak (Flow, Outlet)	14.050 hours

Elevation (Water Surface, Peak)	70.920 m
Volume (Peak)	419.995 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	2,742.487 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	2,742.487 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.236 m³/s	Time to Peak (Flow, In)	13.450 hours
Flow (Peak Outlet)	0.210 m³/s	Time to Peak (Flow, Outlet)	14.050 hours

Elevation (Water Surface, Peak)	70.972 m
Volume (Peak)	494.237 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	3,324.284 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	3,324.284 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.288 m³/s	Time to Peak (Flow, In)	13.450 hours
Flow (Peak Outlet)	0.259 m³/s	Time to Peak (Flow, Outlet)	14.000 hours

Elevation (Water Surface, Peak)	71.031 m
Volume (Peak)	579.118 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	4,071.509 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	4,071.509 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.326 m³/s	Time to Peak (Flow, In)	13.450 hours
Flow (Peak Outlet)	0.295 m³/s	Time to Peak (Flow, Outlet)	13.950 hours

Elevation (Water Surface, Peak)	71.073 m
Volume (Peak)	639.934 m³

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	4,626.831 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	4,626.831 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

Subsection: Level Pool Pond Routing Summary
Label: West Basin (IN)

Return Event: 100.000 years
Storm Event: 100 YR

Infiltration	
Infiltration Method (Computed)	No Infiltration

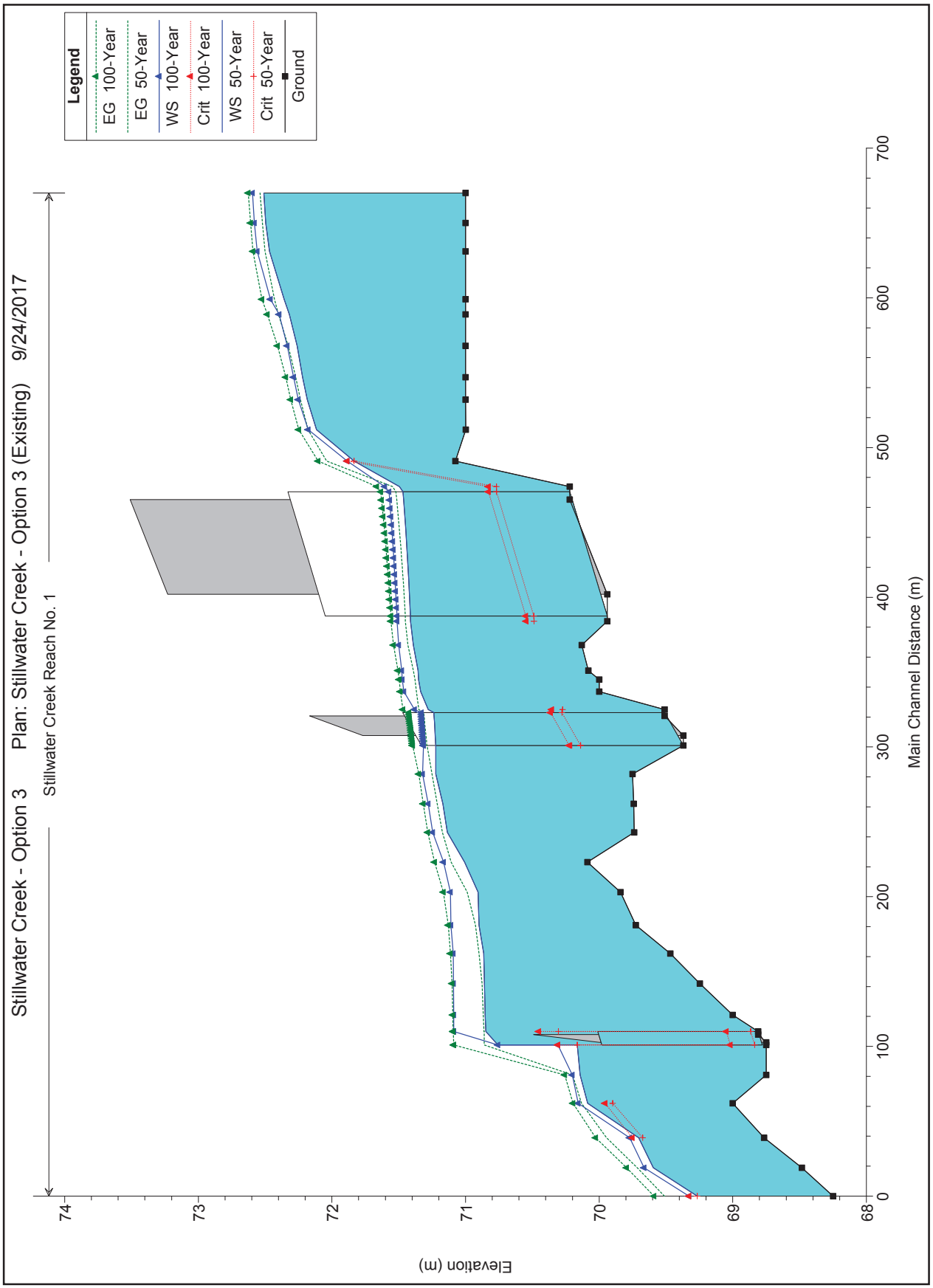
Initial Conditions	
Elevation (Water Surface, Initial)	70.510 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.000 m³/s
Flow (Initial Infiltration)	0.000 m³/s
Flow (Initial, Total)	0.000 m³/s
Time Increment	0.050 hours

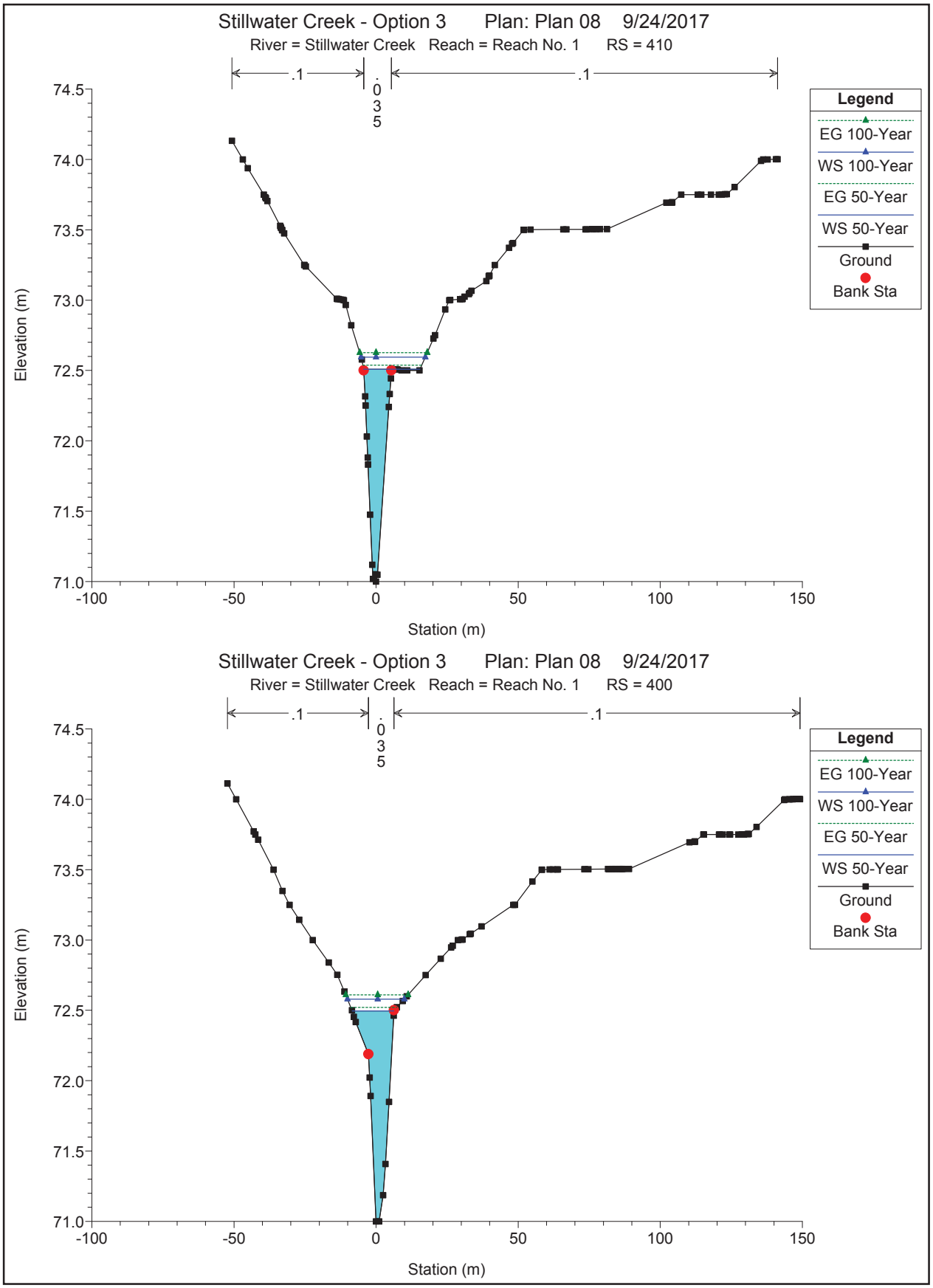
Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.364 m³/s	Time to Peak (Flow, In)	13.450 hours
Flow (Peak Outlet)	0.330 m³/s	Time to Peak (Flow, Outlet)	13.950 hours

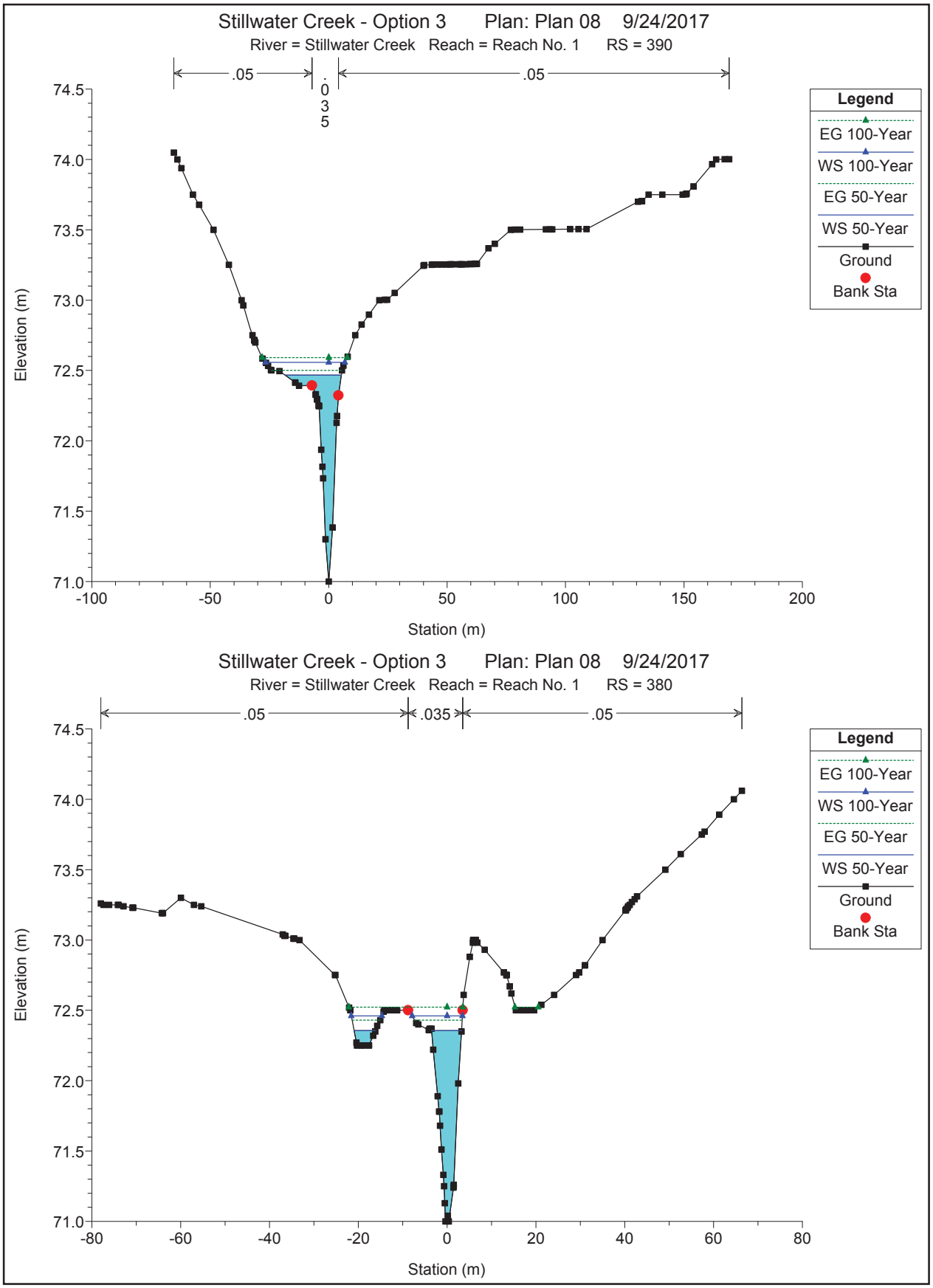
Elevation (Water Surface, Peak)	71.115 m
Volume (Peak)	700.189 m³

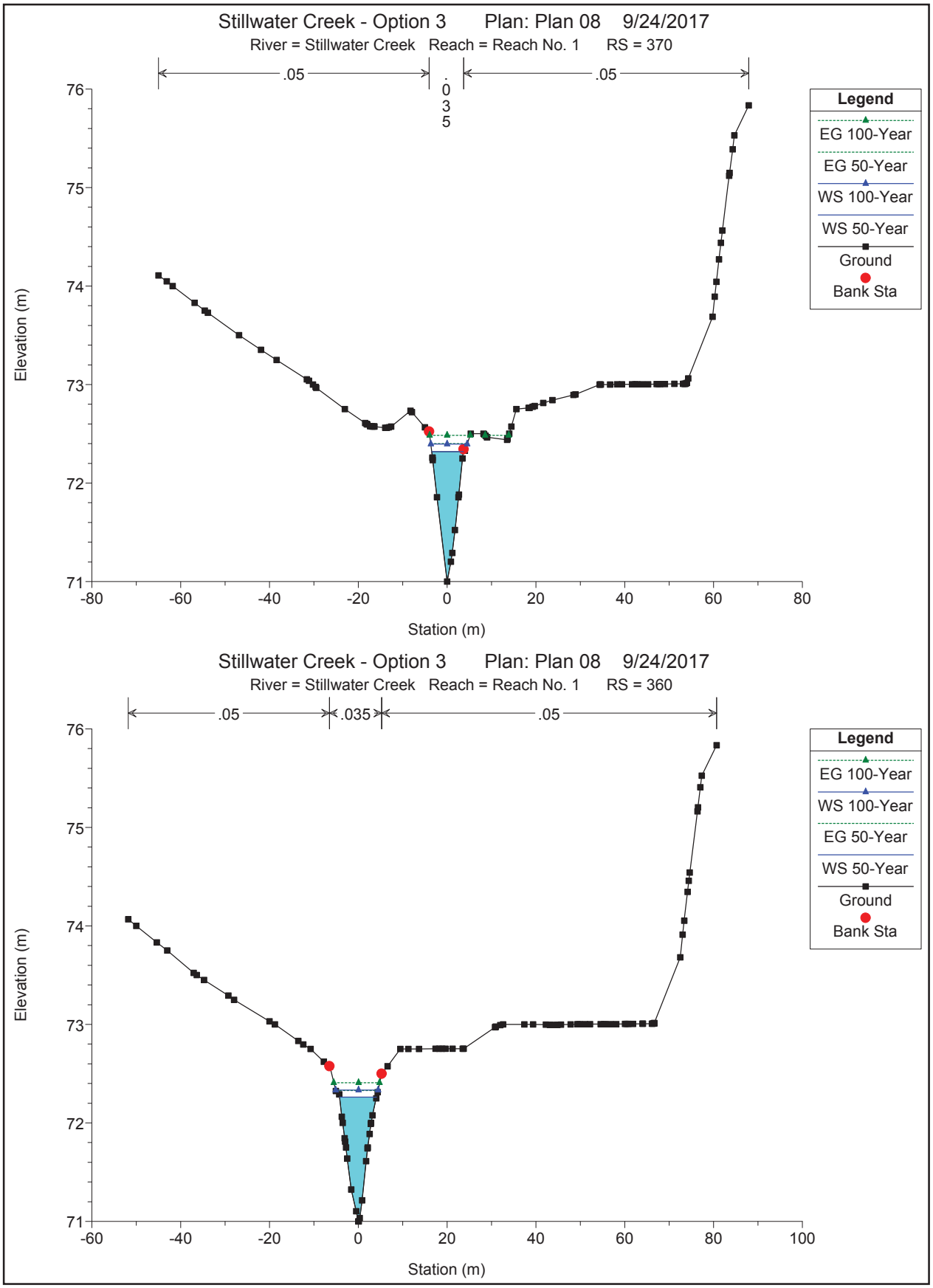
Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	5,184.701 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	5,184.701 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.000 %

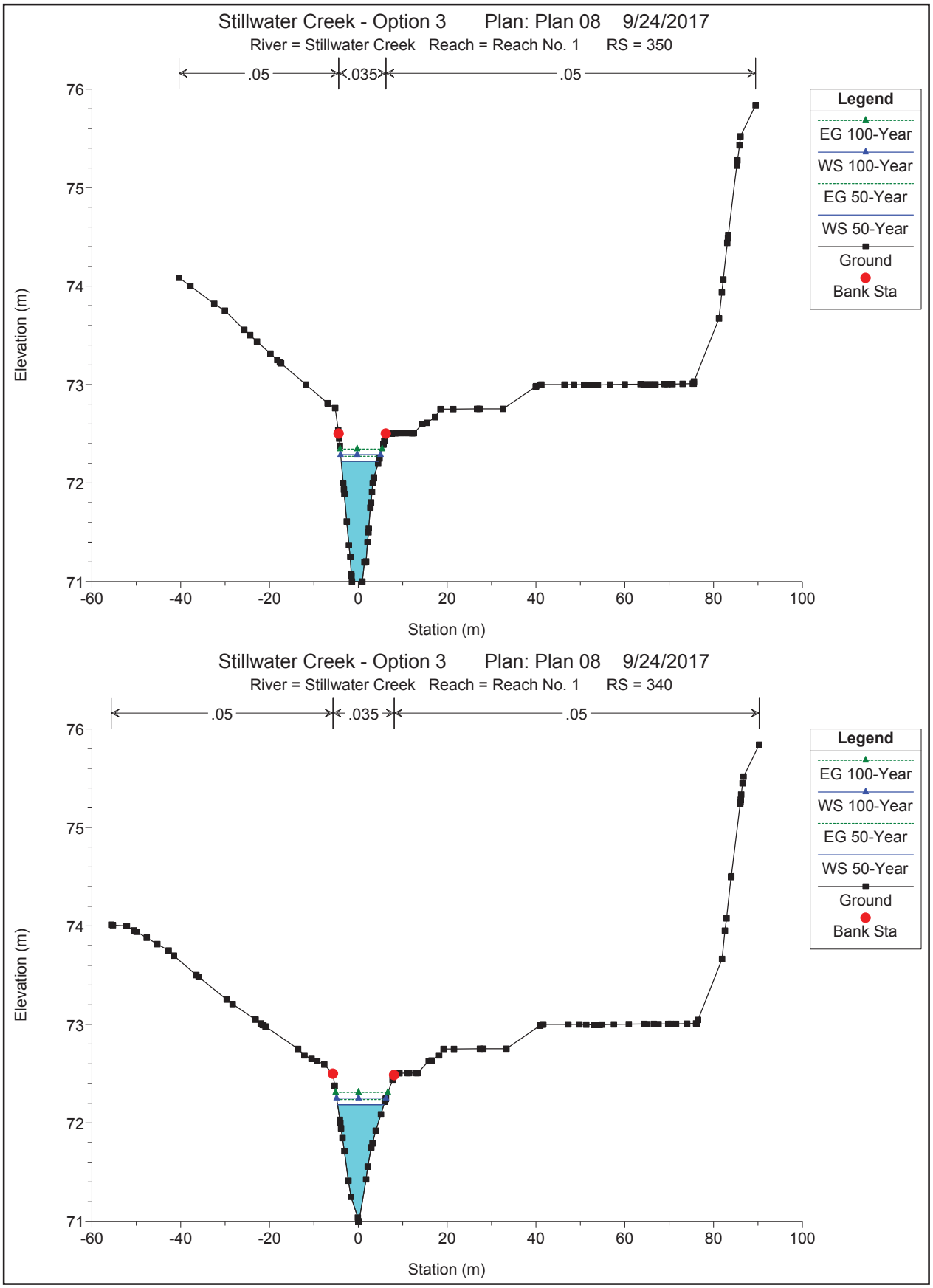
APPENDIX L: MOODIE YARD LMSF HEC-RAS RESULTS

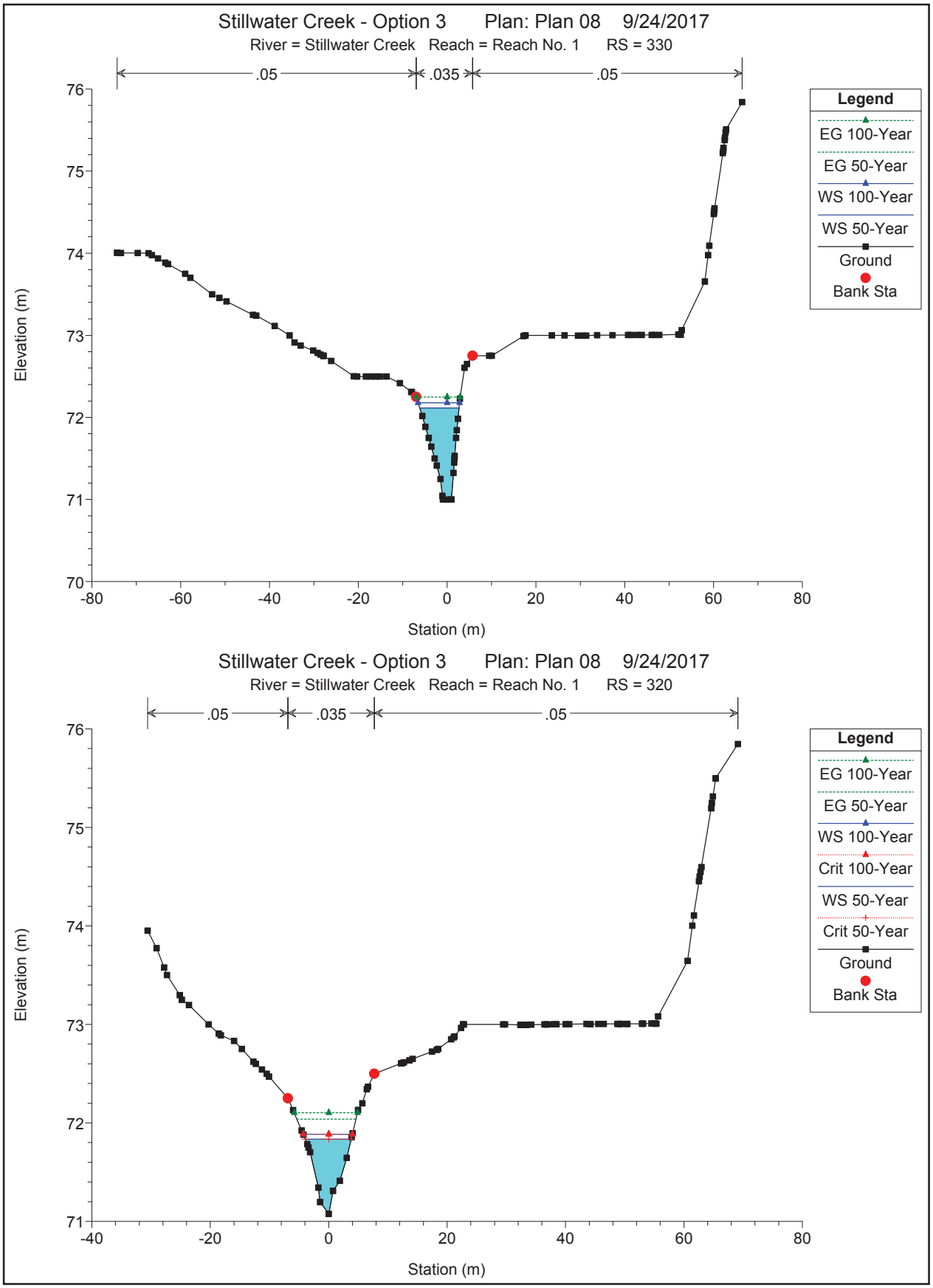

Stillwater Creek - Option 3 Plan: Stillwater Creek - Option 3 (Existing) 9/24/2017
Stillwater Creek Reach No. 1
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Elevation (m)
74
73
72
71
70
69
68
Main Channel Distance (m)
0
100
200
300
400
500
600
700

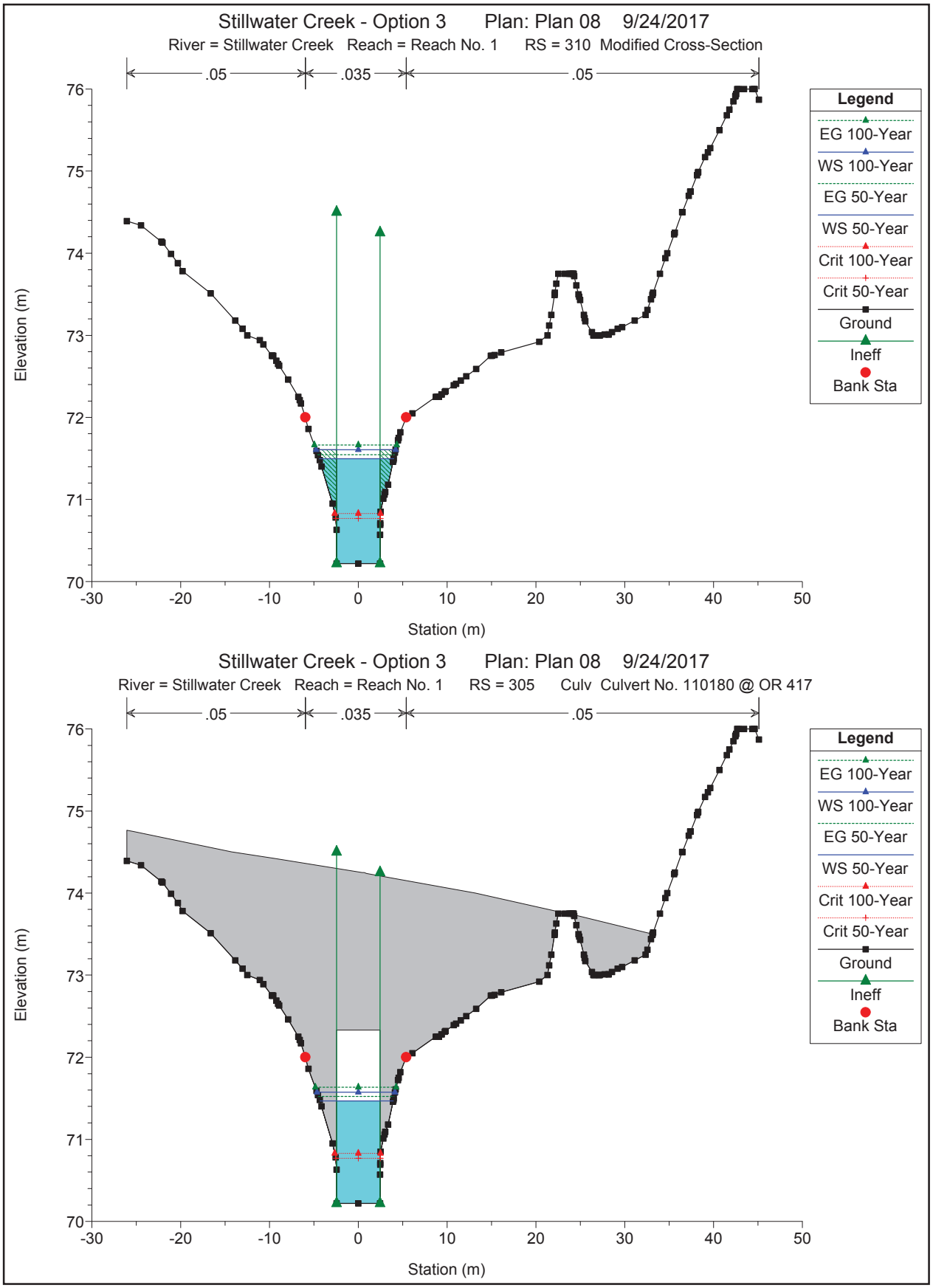

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 410
.1
.035
.1
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
74.5
74.0
73.5
73.0
72.5
72.0
71.5
71.0
-100
-50
0
50
100
150
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 400
.1
.035
.1
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
74.5
74.0
73.5
73.0
72.5
72.0
71.5
71.0
-100
-50
0
50
100
150
Station (m)

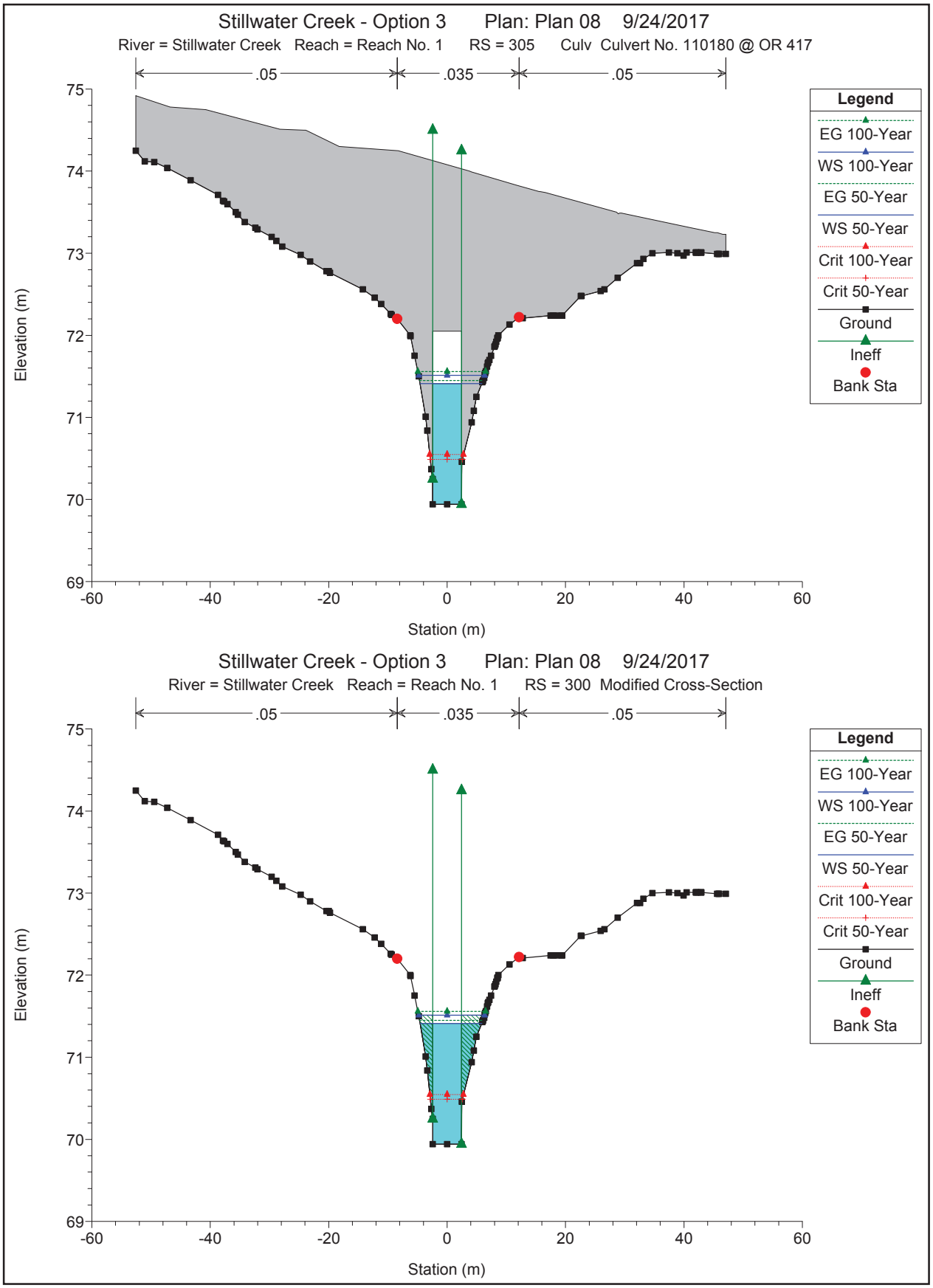

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 390
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 380
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

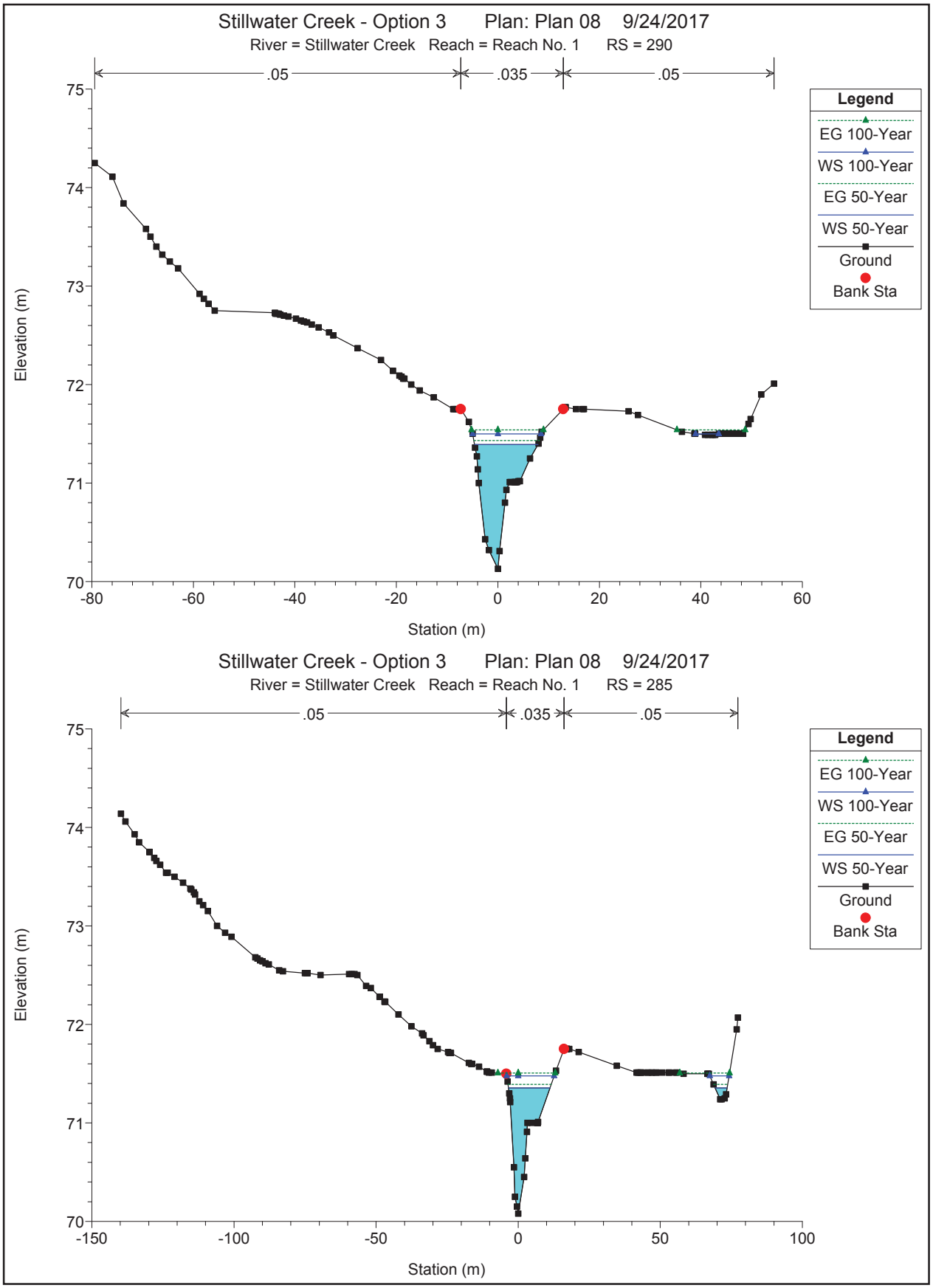

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 370
.05
.035
.05
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 360
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

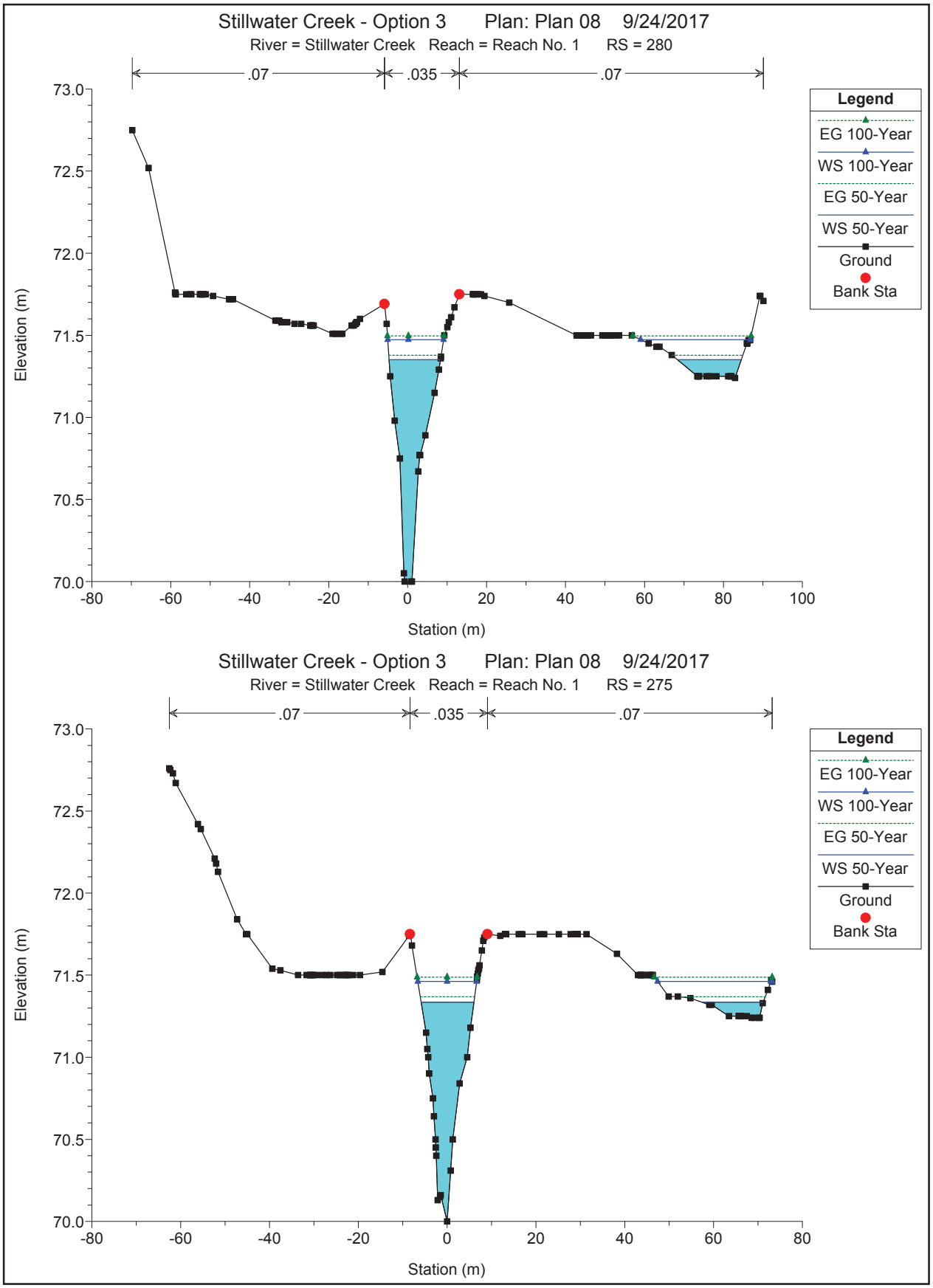

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 350
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
76
75
74
73
72
71
-60
-40
-20
0
20
40
60
80
100
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 340
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

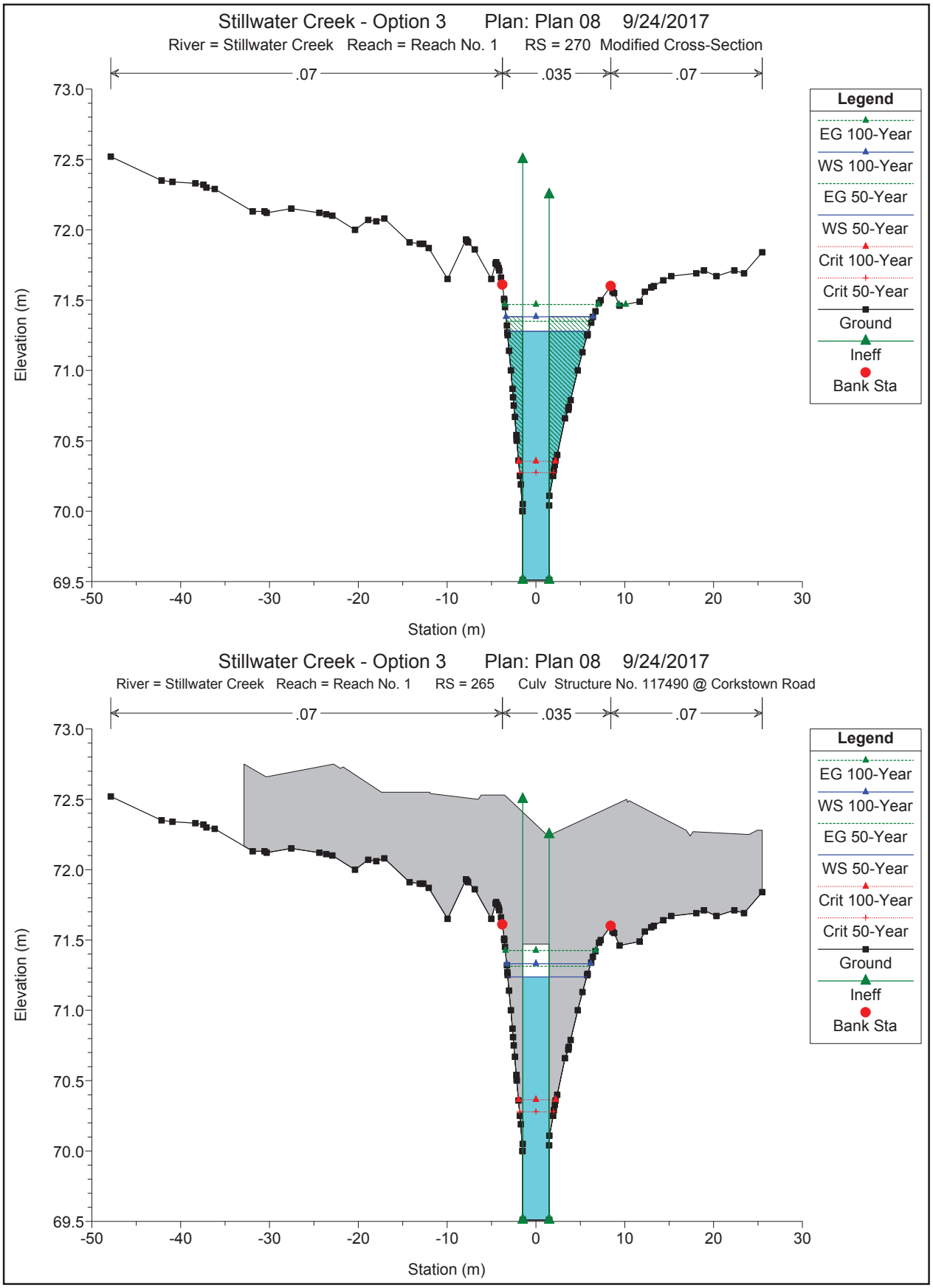

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 330
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 320
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta

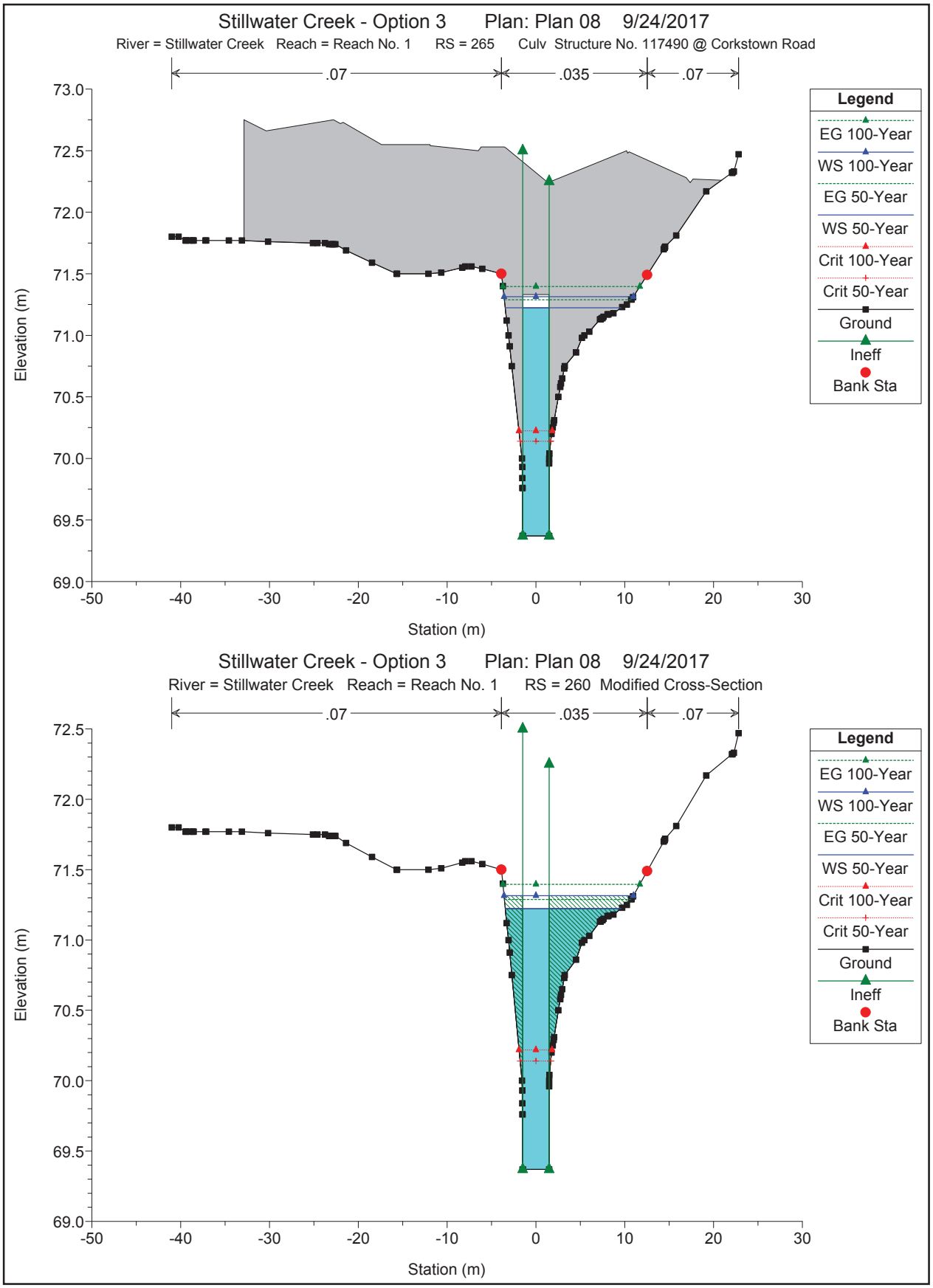

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 310 Modified Cross-Section
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 305 Culv Culvert No. 110180 @ OR 417
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta

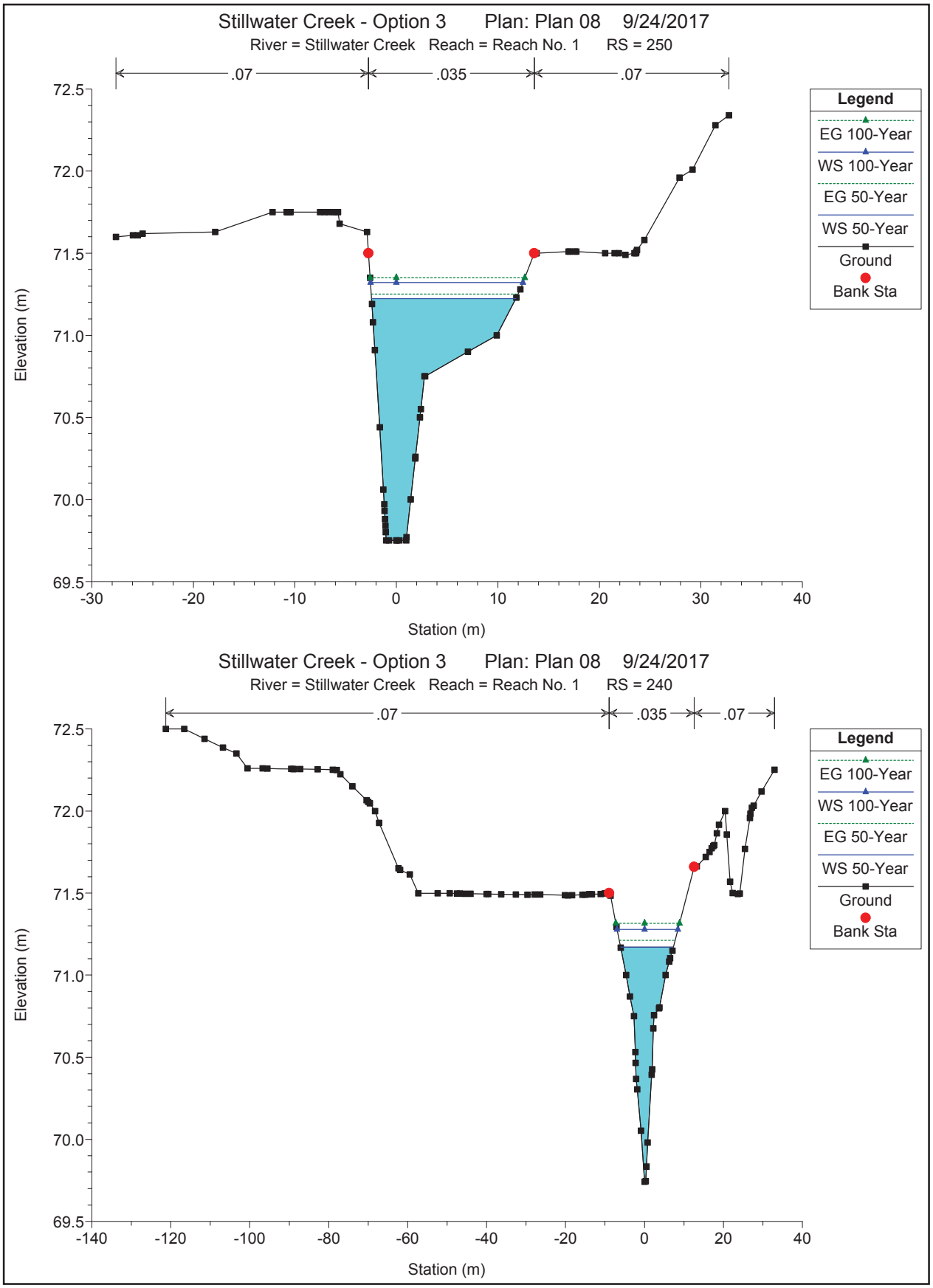

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 305 Culv Culvert No. 110180 @ OR 417
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
75
74
73
72
71
70
69
-60
-40
-20
0
20
40
60
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 300 Modified Cross-Section
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
75
74
73
72
71
70
69
-60
-40
-20
0
20
40
60

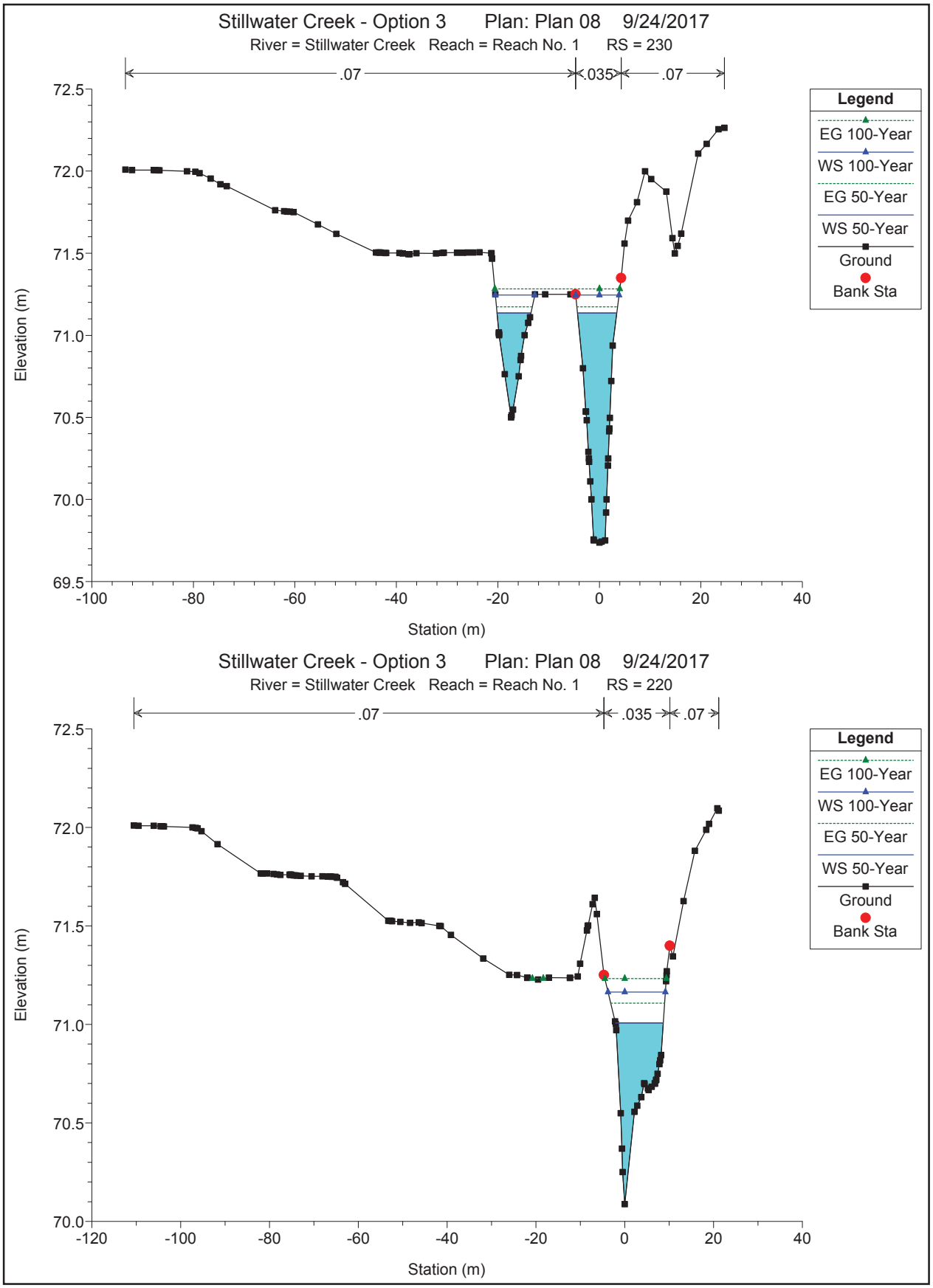

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 290
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
75
74
73
72
71
70
-80
-60
-40
-20
0
20
40
60
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 285
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
75
74
73
72
71
70
-150
-100
-50
0
50
100

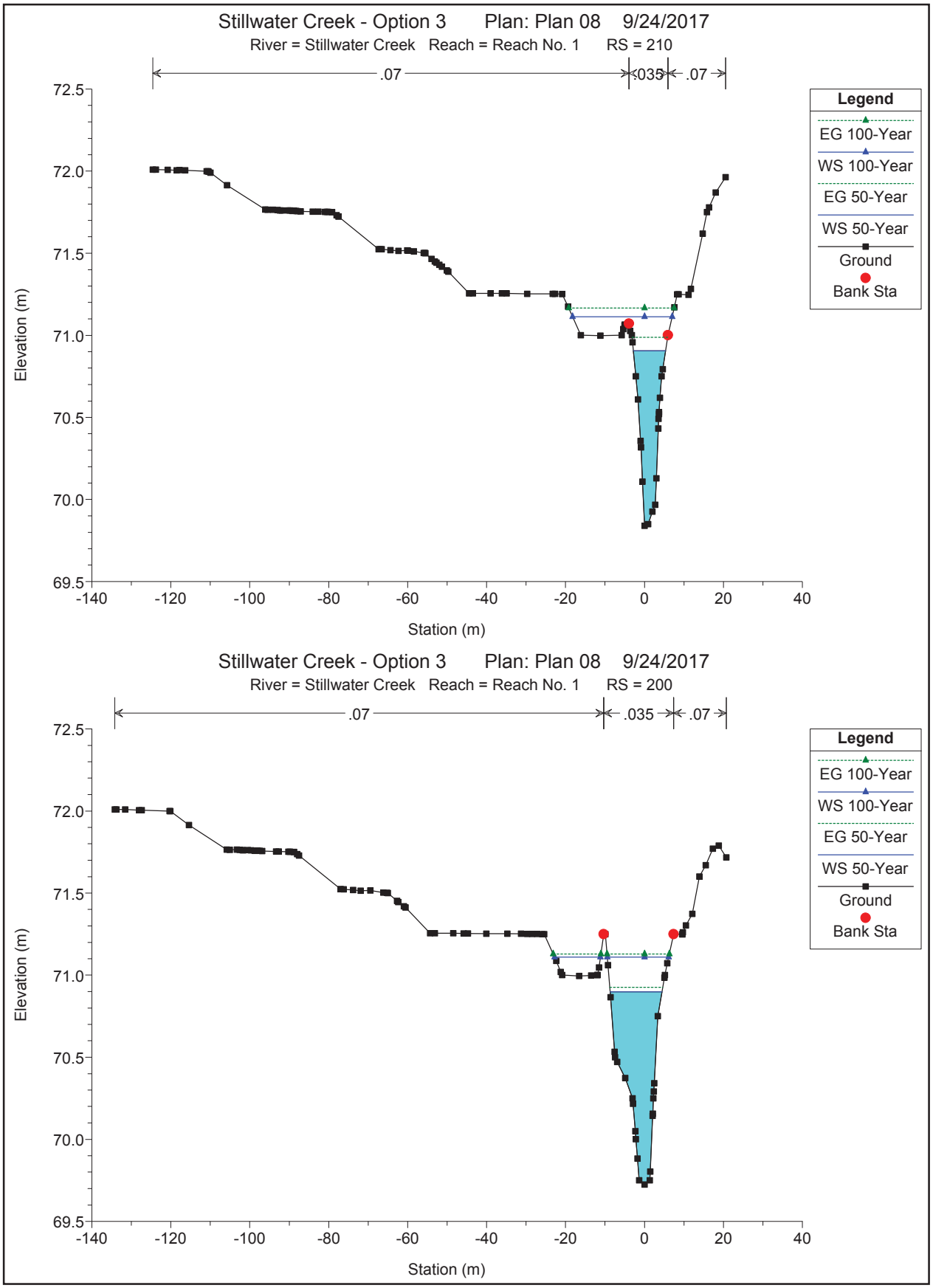

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 280
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
73.0
72.5
72.0
71.5
71.0
70.5
70.0
-80
-60
-40
-20
0
20
40
60
80
100
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 275
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
73.0
72.5
72.0
71.5
71.0
70.5
70.0
-80
-60
-40
-20
0
20
40
60
80

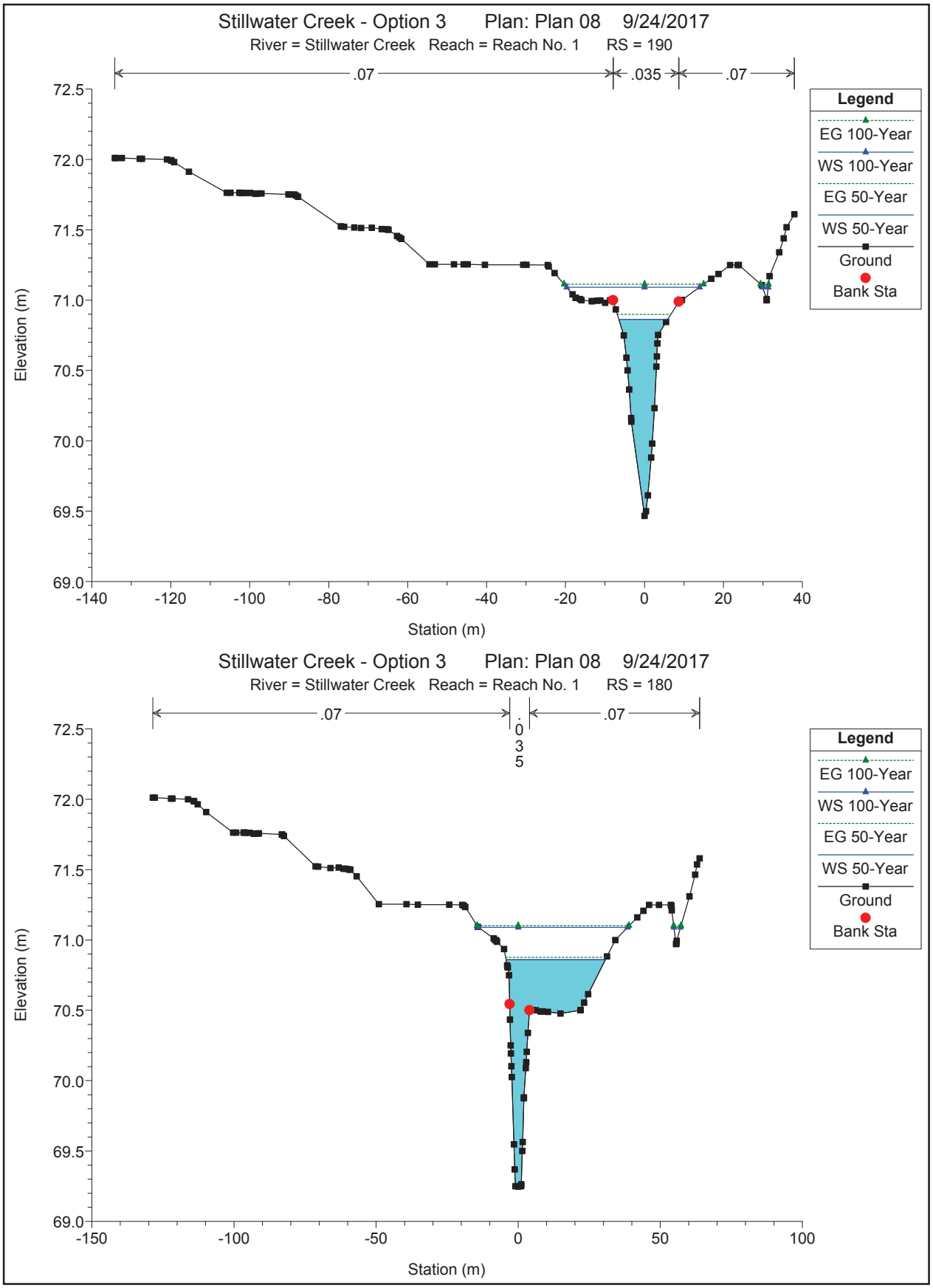

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 270 Modified Cross-Section
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 265 Culv Structure No. 117490 @ Corkstown Road
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta

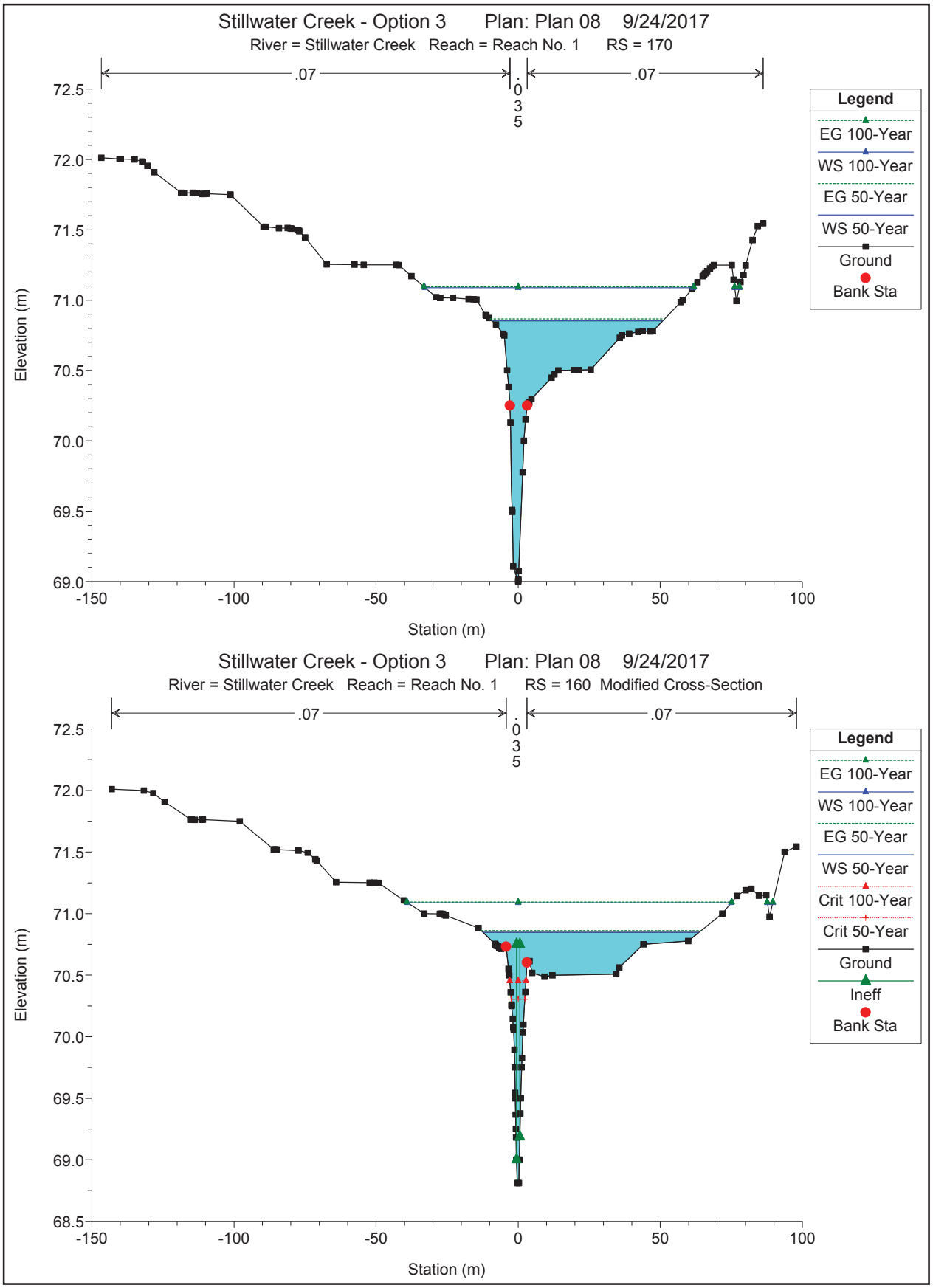

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 265 Culv Structure No. 117490 @ Corkstown Road
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 260 Modified Cross-Section
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta

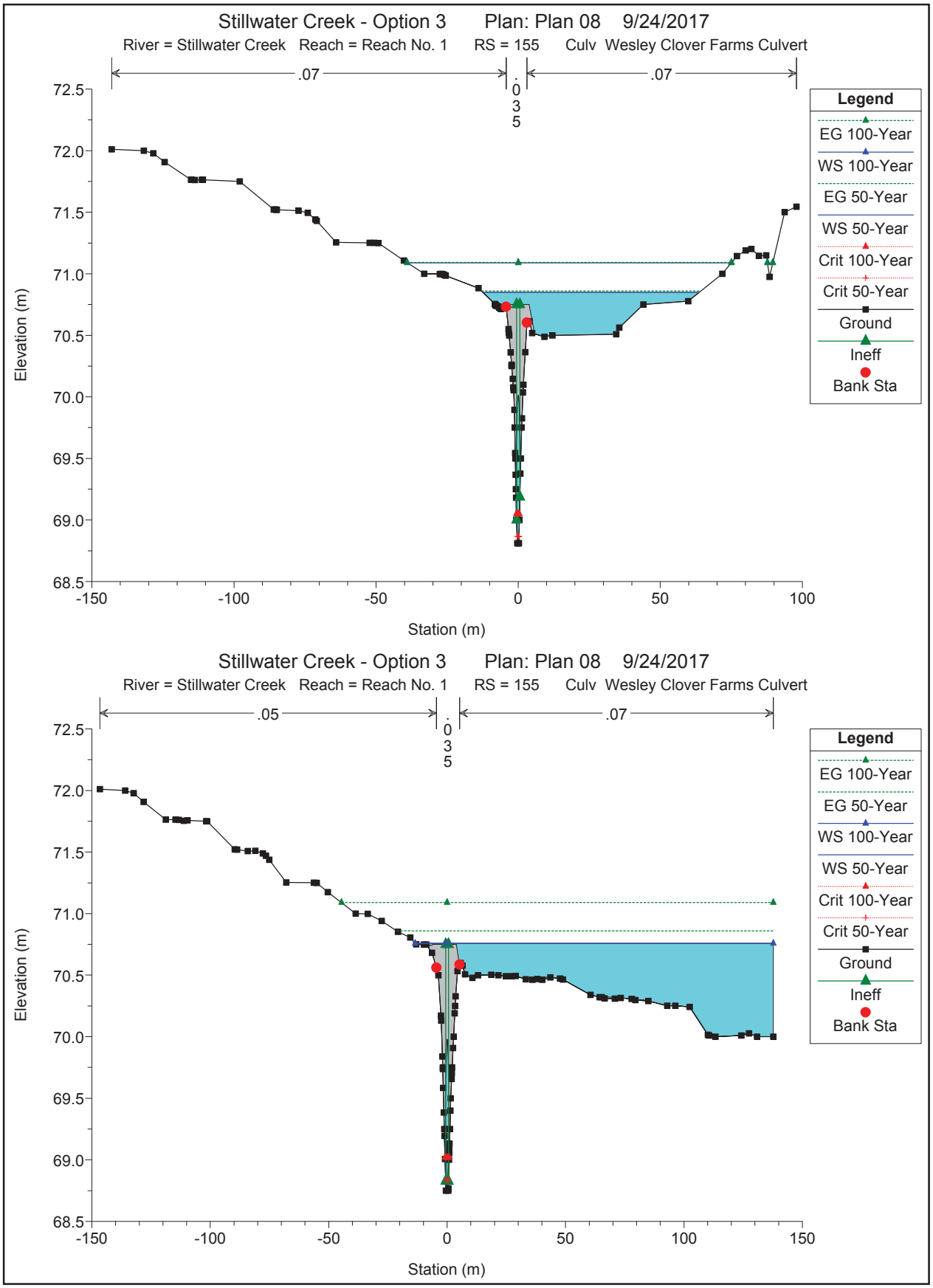

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 250
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 240
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

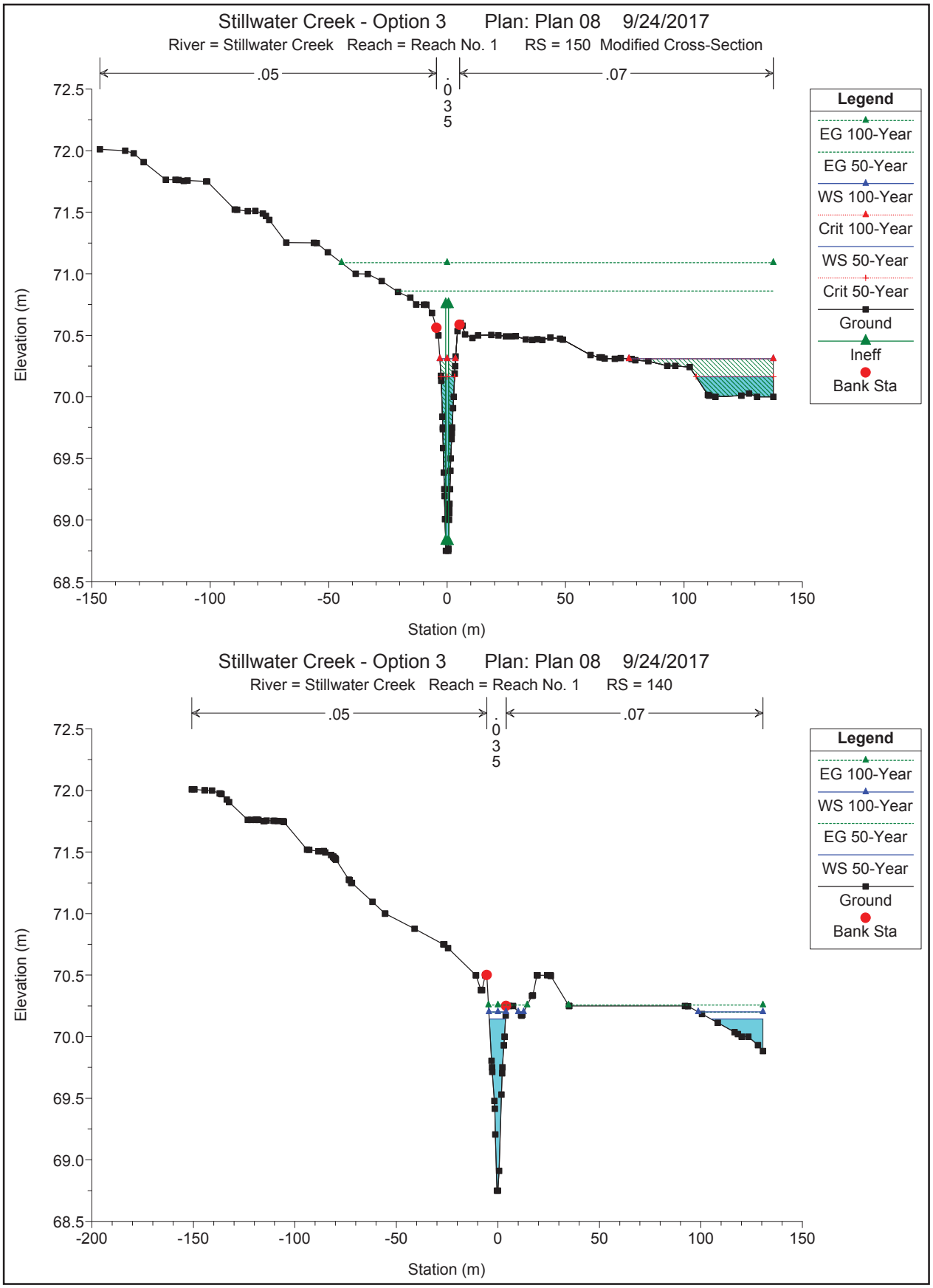

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 230
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 220
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta

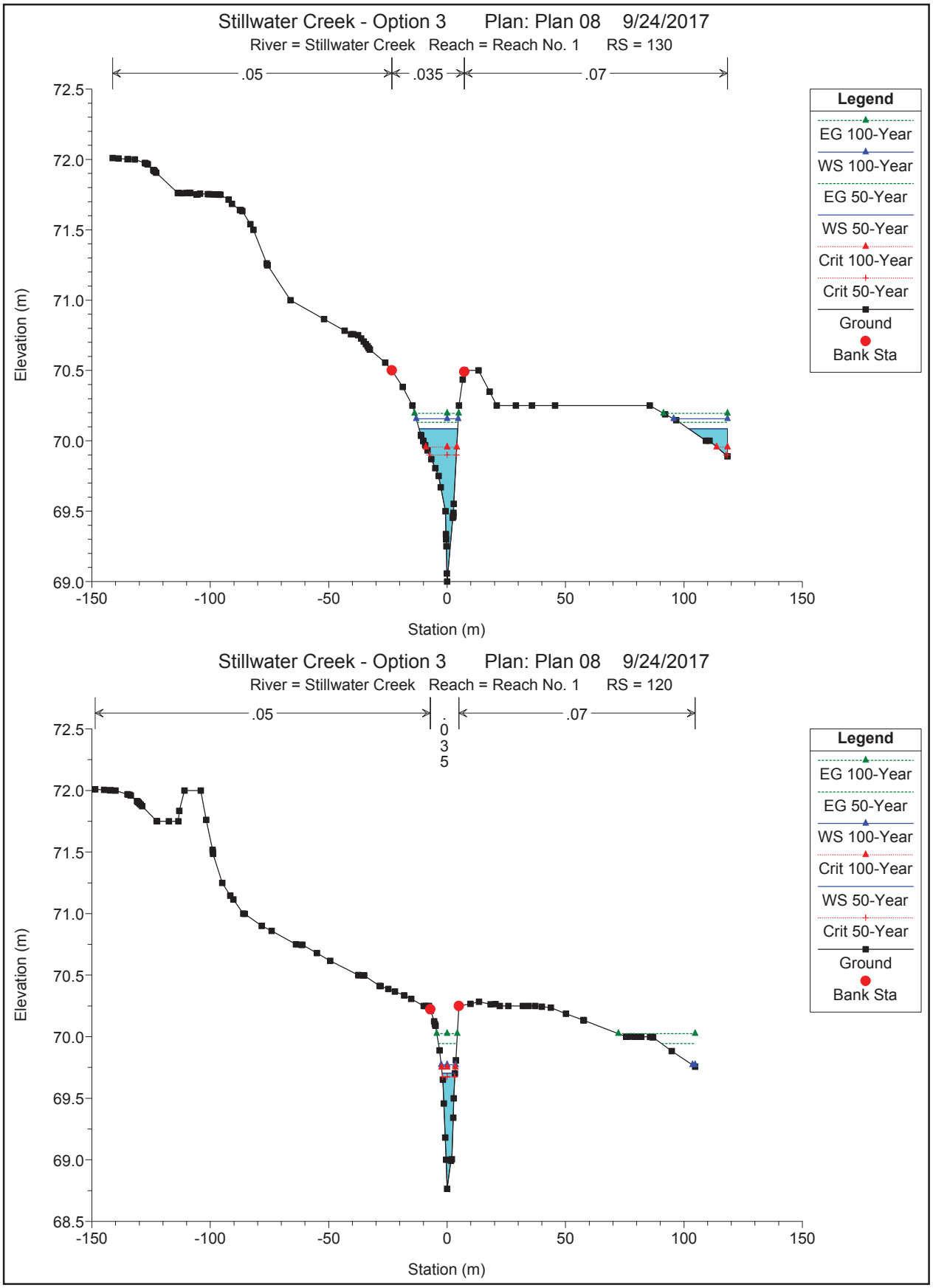

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 210
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
-140
-120
-100
-80
-60
-40
-20
0
20
40
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 200
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

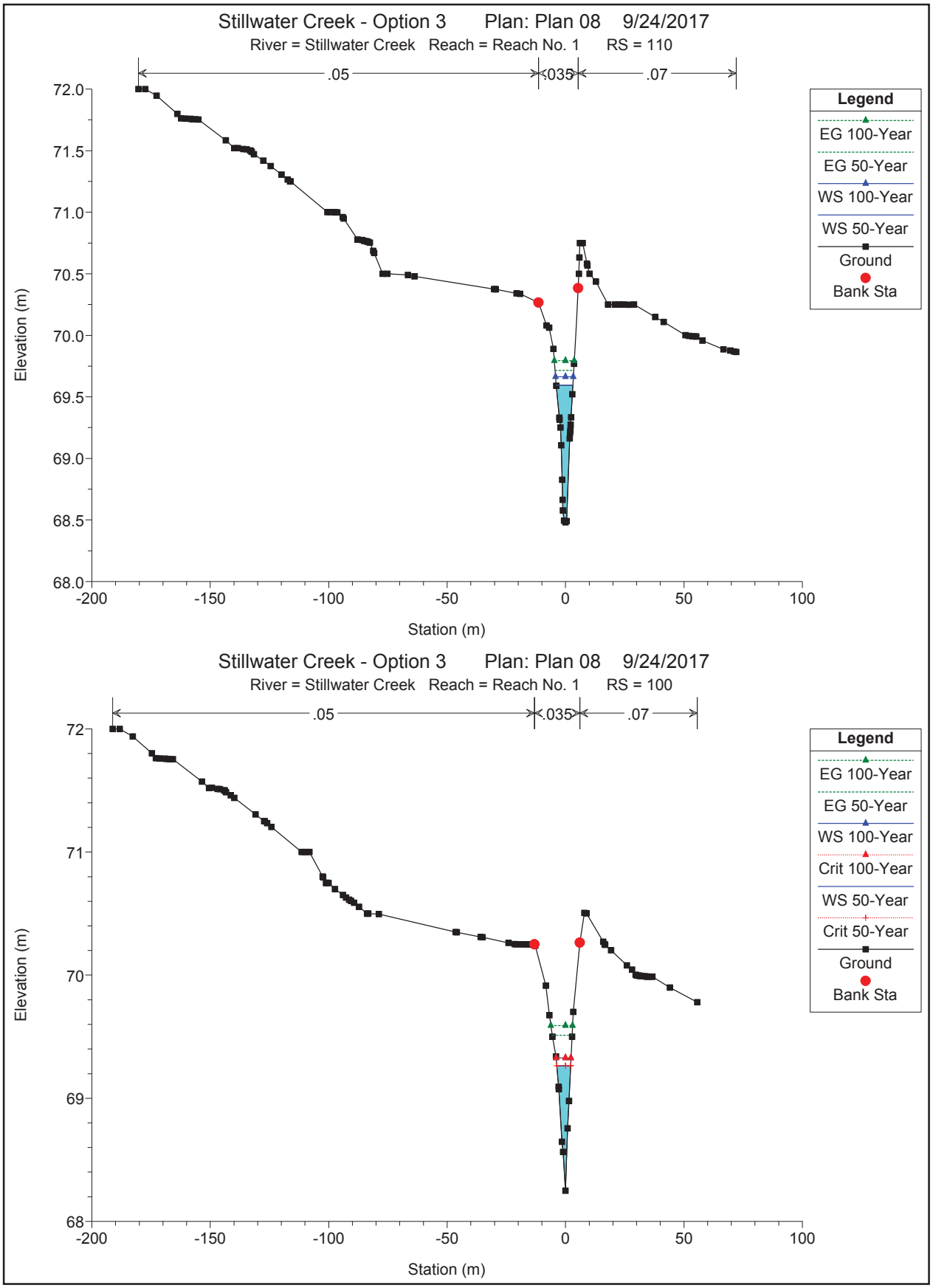

Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 190
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
-140
-120
-100
-80
-60
-40
-20
0
20
40
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 180
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
-150
-100
-50
0
50
100
Station (m)


Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 170
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 160 Modified Cross-Section
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 155 Culv Wesley Clover Farms Culvert
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
68.5
-150
-100
-50
0
50
100
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 155 Culv Wesley Clover Farms Culvert
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
68.5
-150
-100
-50
0
50
100
150


Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 150 Modified Cross-Section
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 140
.05
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 130
.05
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 120
.05
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta


Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 110
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
72.0
71.5
71.0
70.5
70.0
69.5
69.0
68.5
68.0
-200
-150
-100
-50
0
50
100
Stillwater Creek - Option 3 Plan: Plan 08 9/24/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 100
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
72
71
70
69
68
-200
-150
-100
-50
0
50
100

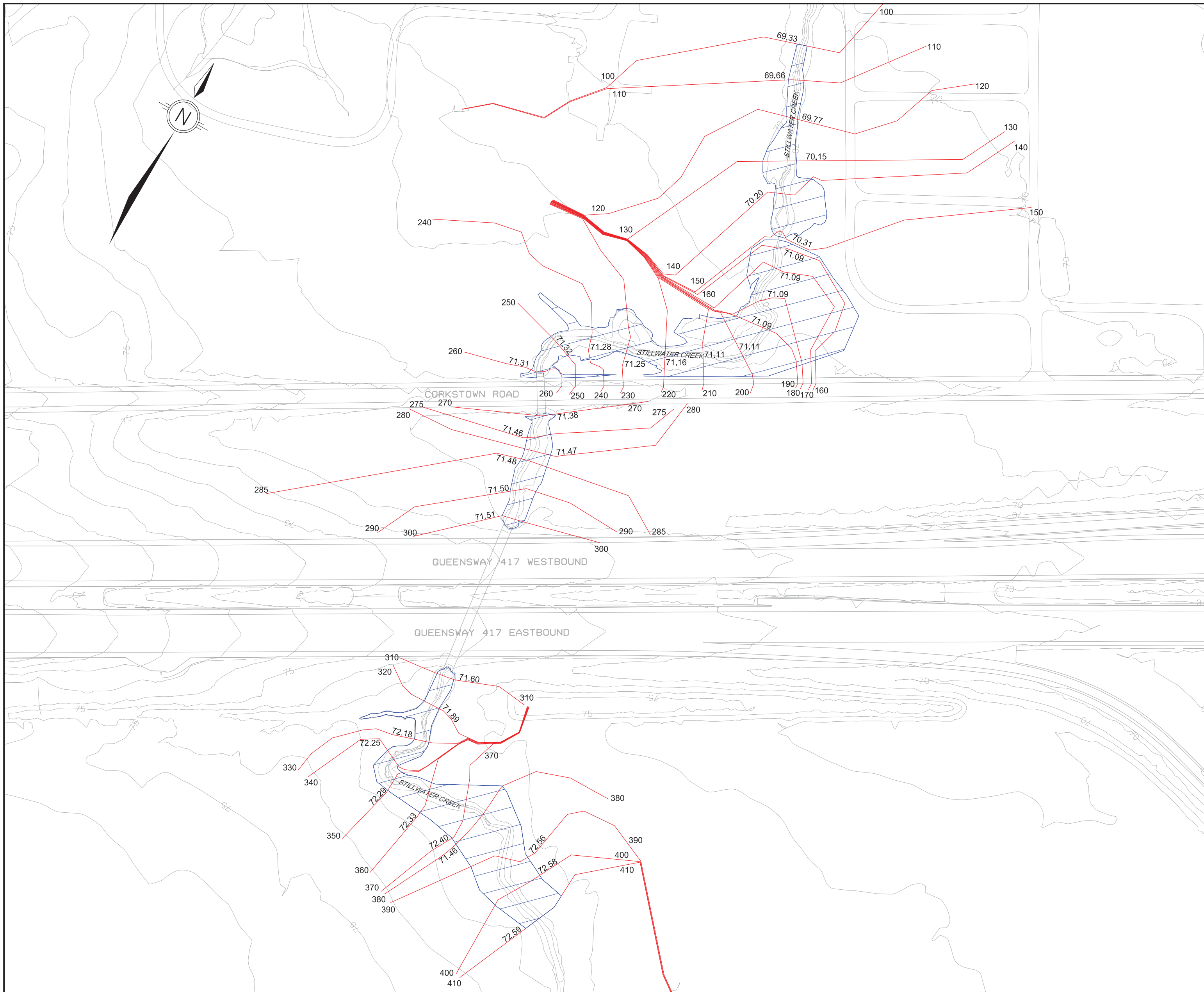
Output Data: HEC-RAS - Existing Conditions

HEC-RAS Plan: Stillwater C River: Stillwater Creek Reach: Reach No. 1

Reach	River Sta	Profile	Cum Ch Len	Q Total	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach No. 1	410	50-Year	670.00	6.24	72.51	72.54	0.000931	0.75	8.37	19.92	0.26
Reach No. 1	410	100-Year	670.00	7.29	72.59	72.63	0.000908	0.79	10.17	22.60	0.26
Reach No. 1	400	50-Year	650.00	6.24	72.49	72.52	0.000726	0.72	9.46	14.65	0.24
Reach No. 1	400	100-Year	650.00	7.29	72.58	72.61	0.000736	0.77	10.93	20.02	0.24
Reach No. 1	390	50-Year	631.00	6.24	72.47	72.50	0.001506	0.83	8.16	23.79	0.32
Reach No. 1	390	100-Year	631.00	7.29	72.56	72.59	0.001234	0.81	10.86	33.58	0.30
Reach No. 1	380	50-Year	599.00	6.24	72.36	72.43	0.002964	1.21	5.49	11.60	0.44
Reach No. 1	380	100-Year	599.00	7.29	72.46	72.52	0.003961	1.14	7.09	18.22	0.50
Reach No. 1	370	50-Year	589.00	6.24	72.32	72.40	0.003396	1.25	4.98	7.13	0.48
Reach No. 1	370	100-Year	589.00	7.29	72.40	72.48	0.003421	1.32	5.57	8.20	0.49
Reach No. 1	360	50-Year	568.00	6.24	72.26	72.33	0.003080	1.15	5.41	8.33	0.46
Reach No. 1	360	100-Year	568.00	7.29	72.33	72.41	0.003439	1.20	6.06	9.56	0.48
Reach No. 1	350	50-Year	547.00	6.24	72.22	72.27	0.001997	1.00	6.23	8.43	0.37
Reach No. 1	350	100-Year	547.00	7.29	72.29	72.35	0.002193	1.07	6.82	8.97	0.39
Reach No. 1	340	50-Year	532.00	6.24	72.18	72.24	0.002634	1.01	6.16	10.42	0.42
Reach No. 1	340	100-Year	532.00	7.29	72.25	72.31	0.002699	1.06	6.88	11.11	0.43
Reach No. 1	330	50-Year	512.00	6.24	72.12	72.18	0.003012	1.11	5.60	8.87	0.45
Reach No. 1	330	100-Year	512.00	7.29	72.18	72.25	0.003201	1.18	6.16	9.33	0.47
Reach No. 1	320	50-Year	491.00	6.24	71.83	72.04	0.017193	2.01	3.11	7.75	1.01
Reach No. 1	320	100-Year	491.00	7.29	71.89	72.10	0.016913	2.07	3.53	8.31	1.01
Reach No. 1	310	50-Year	474.00	6.24	71.50	71.55	0.000883	1.00	6.25	8.38	0.28
Reach No. 1	310	100-Year	474.00	7.29	71.61	71.66	0.000915	1.07	6.79	8.94	0.29
Reach No. 1	305		Culvert								
Reach No. 1	300	50-Year	384.00	6.24	71.41	71.45	0.000594	0.87	7.21	10.43	0.23
Reach No. 1	300	100-Year	384.00	7.29	71.51	71.56	0.000650	0.95	7.71	11.15	0.24
Reach No. 1	290	50-Year	368.00	6.24	71.39	71.43	0.002358	0.91	6.87	12.52	0.39
Reach No. 1	290	100-Year	368.00	7.29	71.50	71.54	0.001900	0.88	8.33	18.09	0.36
Reach No. 1	285	50-Year	351.00	6.24	71.36	71.39	0.002200	0.83	7.75	18.87	0.37
Reach No. 1	285	100-Year	351.00	7.29	71.48	71.51	0.001600	0.76	10.32	23.52	0.32
Reach No. 1	280	50-Year	345.00	6.24	71.35	71.38	0.001336	0.75	9.49	29.21	0.30
Reach No. 1	280	100-Year	345.00	7.29	71.47	71.50	0.000998	0.69	13.76	41.97	0.26
Reach No. 1	275	50-Year	337.00	6.24	71.34	71.37	0.001499	0.81	8.51	25.56	0.32
Reach No. 1	275	100-Year	337.00	7.29	71.46	71.49	0.001128	0.74	12.84	38.80	0.28
Reach No. 1	270	50-Year	325.00	6.24	71.28	71.35	0.000803	1.18	5.27	9.14	0.28
Reach No. 1	270	100-Year	325.00	7.29	71.38	71.47	0.000907	1.31	5.58	9.80	0.30
Reach No. 1	265		Culvert								
Reach No. 1	260	50-Year	301.00	6.24	71.22	71.29	0.000692	1.13	5.50	13.02	0.27
Reach No. 1	260	100-Year	301.00	7.29	71.31	71.40	0.000805	1.26	5.77	14.56	0.29
Reach No. 1	250	50-Year	282.00	6.24	71.22	71.25	0.001495	0.75	8.37	14.21	0.31
Reach No. 1	250	100-Year	282.00	7.29	71.32	71.35	0.001293	0.74	9.81	15.02	0.29
Reach No. 1	240	50-Year	262.00	6.24	71.17	71.21	0.002527	0.90	6.91	13.35	0.40
Reach No. 1	240	100-Year	262.00	7.29	71.28	71.32	0.002110	0.86	8.46	15.41	0.37
Reach No. 1	230	50-Year	243.00	6.24	71.14	71.17	0.001472	0.90	8.43	14.43	0.32
Reach No. 1	230	100-Year	243.00	7.29	71.25	71.28	0.001391	0.90	10.11	16.33	0.31
Reach No. 1	220	50-Year	223.00	6.24	71.01	71.11	0.008229	1.41	4.43	10.76	0.70
Reach No. 1	220	100-Year	223.00	7.29	71.16	71.23	0.004446	1.16	6.29	12.91	0.53
Reach No. 1	210	50-Year	203.00	6.24	70.91	70.99	0.004197	1.27	4.91	8.19	0.52
Reach No. 1	210	100-Year	203.00	7.29	71.11	71.17	0.002299	1.04	8.27	25.23	0.40

HEC-RAS Plan: Stillwater C River: Stillwater Creek Reach: Reach No. 1 (Continued)

Reach	River Sta	Profile	Cum Ch Len	Q Total	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach No. 1	200	50-Year	181.00	6.24	70.90	70.93	0.001223	0.73	8.52	13.17	0.29
Reach No. 1	200	100-Year	181.00	7.29	71.11	71.13	0.000736	0.62	12.68	27.17	0.23
Reach No. 1	190	50-Year	162.00	6.24	70.86	70.90	0.001685	0.82	7.58	12.43	0.34
Reach No. 1	190	100-Year	162.00	7.29	71.09	71.11	0.000910	0.65	12.45	35.19	0.25
Reach No. 1	180	50-Year	142.00	6.24	70.86	70.88	0.000492	0.64	16.13	34.96	0.19
Reach No. 1	180	100-Year	142.00	7.29	71.09	71.10	0.000275	0.54	25.87	54.80	0.15
Reach No. 1	170	50-Year	121.00	6.24	70.85	70.87	0.000346	0.60	21.64	59.98	0.16
Reach No. 1	170	100-Year	121.00	7.29	71.09	71.10	0.000169	0.46	39.31	95.97	0.12
Reach No. 1	160	50-Year	110.00	6.24	70.85	70.86	0.000655	0.63	21.57	75.99	0.21
Reach No. 1	160	100-Year	110.00	7.29	71.09	71.09	0.000205	0.41	44.52	115.85	0.12
Reach No. 1	155		Culvert								
Reach No. 1	150	50-Year	101.00	6.24	70.16	70.86	0.011225	3.70	1.69	38.38	1.00
Reach No. 1	150	100-Year	101.00	7.29	70.31	71.09	0.011024	3.91	1.86	67.57	1.00
Reach No. 1	140	50-Year	81.00	6.24	70.14	70.20	0.002873	1.10	8.16	33.56	0.43
Reach No. 1	140	100-Year	81.00	7.29	70.20	70.26	0.002807	1.11	10.35	43.03	0.43
Reach No. 1	130	50-Year	62.00	6.24	70.09	70.13	0.004372	0.97	7.65	32.75	0.51
Reach No. 1	130	100-Year	62.00	7.29	70.16	70.20	0.003389	0.91	10.24	40.52	0.45
Reach No. 1	120	50-Year	39.00	6.24	69.70	69.94	0.014789	2.17	2.87	5.39	0.95
Reach No. 1	120	100-Year	39.00	7.29	69.77	70.03	0.015295	2.23	3.27	7.17	0.97
Reach No. 1	110	50-Year	19.00	6.24	69.59	69.72	0.006639	1.54	4.05	7.05	0.65
Reach No. 1	110	100-Year	19.00	7.29	69.66	69.79	0.006682	1.60	4.55	7.51	0.66
Reach No. 1	100	50-Year		6.24	69.27	69.51	0.016919	2.20	2.83	5.84	1.01
Reach No. 1	100	100-Year		7.29	69.33	69.59	0.016736	2.27	3.21	6.28	1.01



LEGEND

HEC-RAS SECTION

FLOODPLAIN AREA

NOT FOR CONSTRUCTION

OTTAWA STAGE 2
WEST TRANSITWAY EXTENSION
MOODIE LMSF

FLOODPLAIN DELINEATION
EXISTING CONDITIONS

N/A Manager - Division	N/A Project Manager

Ottawa

Contract No.	Dwg. No. 1
Sheet 1 of 2	
Asset No.	N/A
Asset Group	N/A
Des. VJT	Chk'd.
Dwn. SMD	Chk'd.
Utility Circ. No. N/A	Index No. N/A
Const. Inspector	N/A
Scale: HORIZONTAL 0m 4 8 16	

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

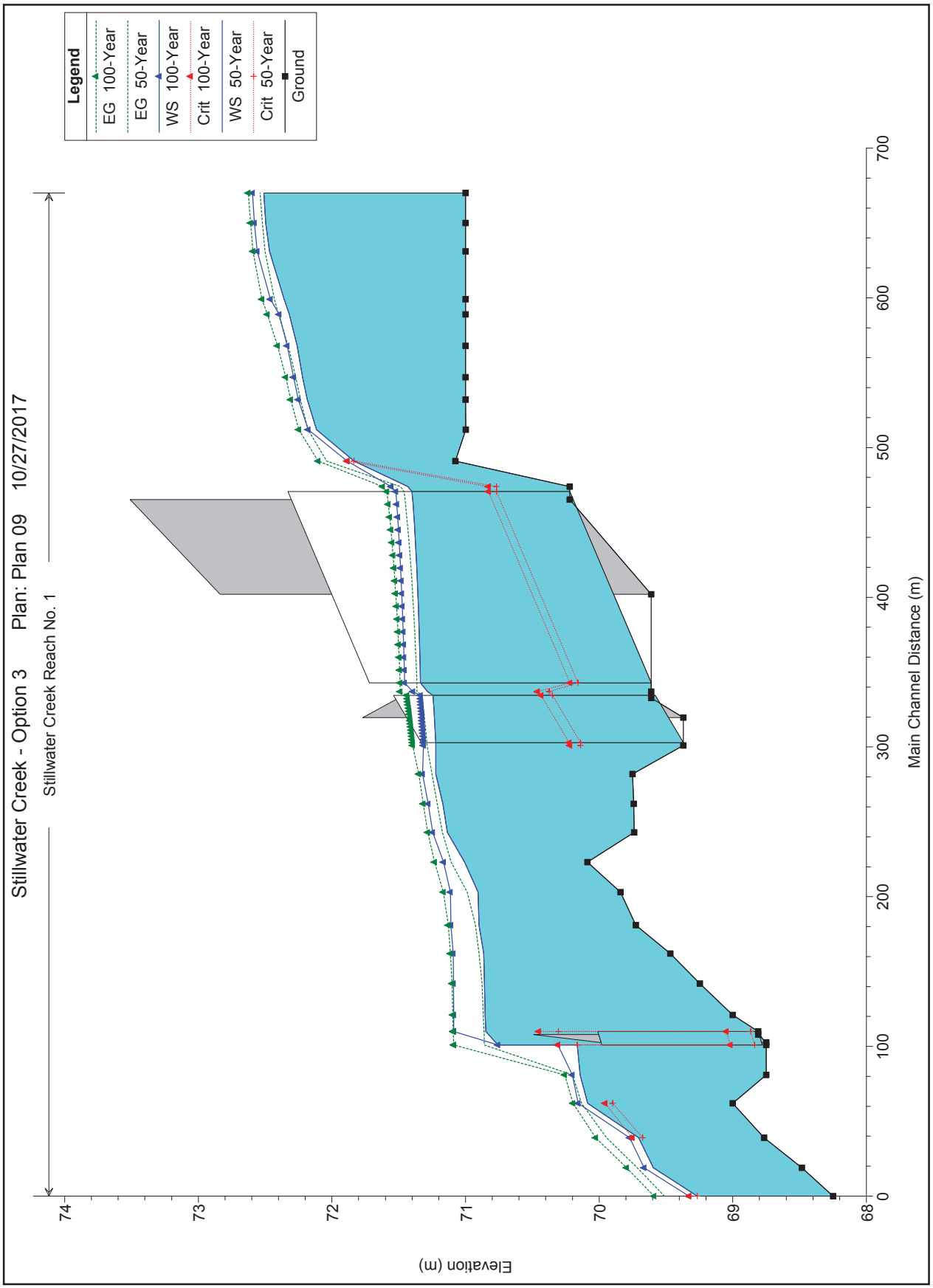
REVISIONS

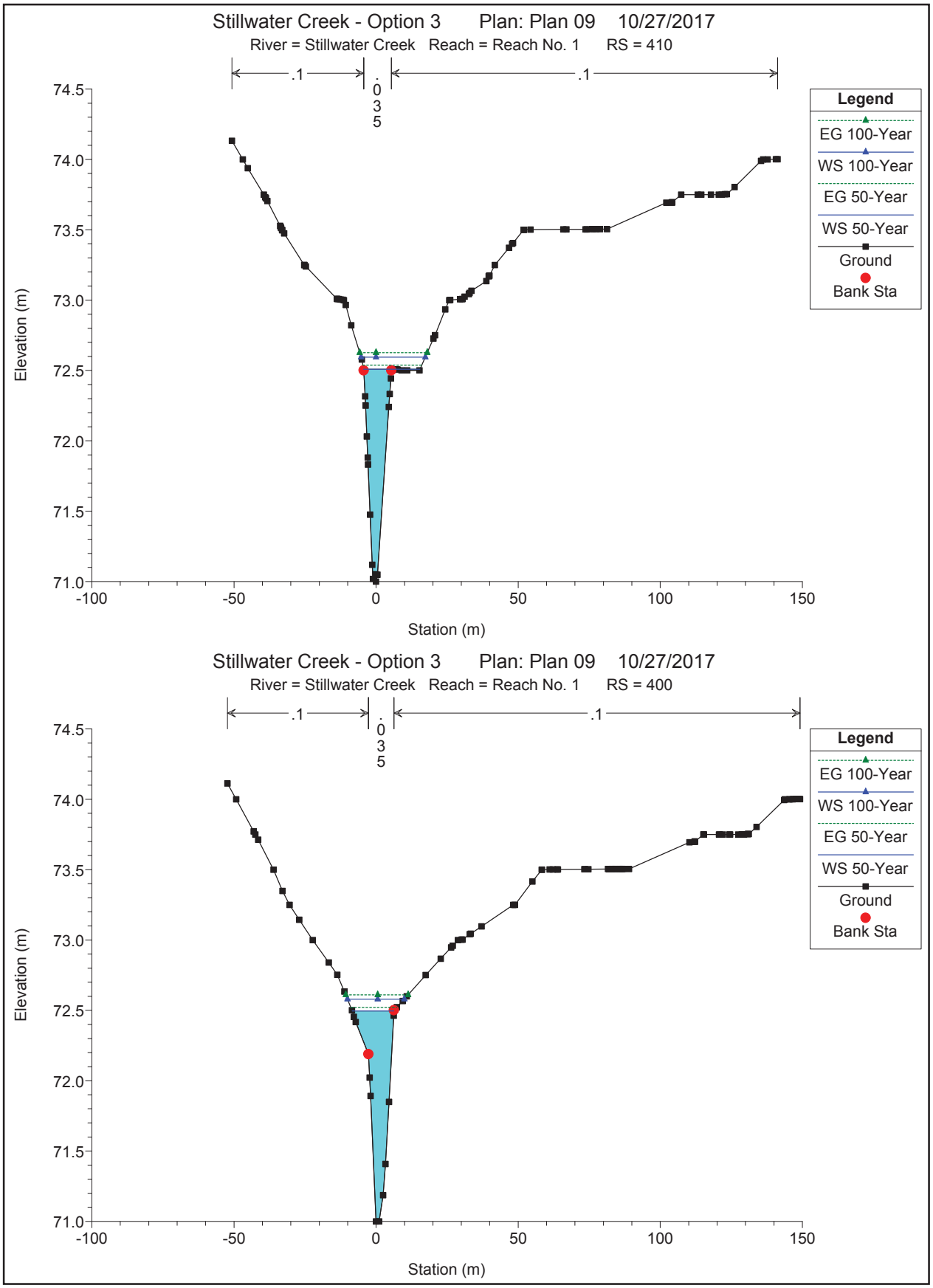
No.	Description	By	Date (dd/mm/yy)

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

Consultant Drawing Number

2008-Jan-21 02:03:18 PM S:/PWS/CAD/SB07-5063-000-cov.dgn


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
Stillwater Creek Reach No. 1
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Elevation (m)
Main Channel Distance (m)
74
73
72
71
70
69
68
0
100
200
300
400
500
600
700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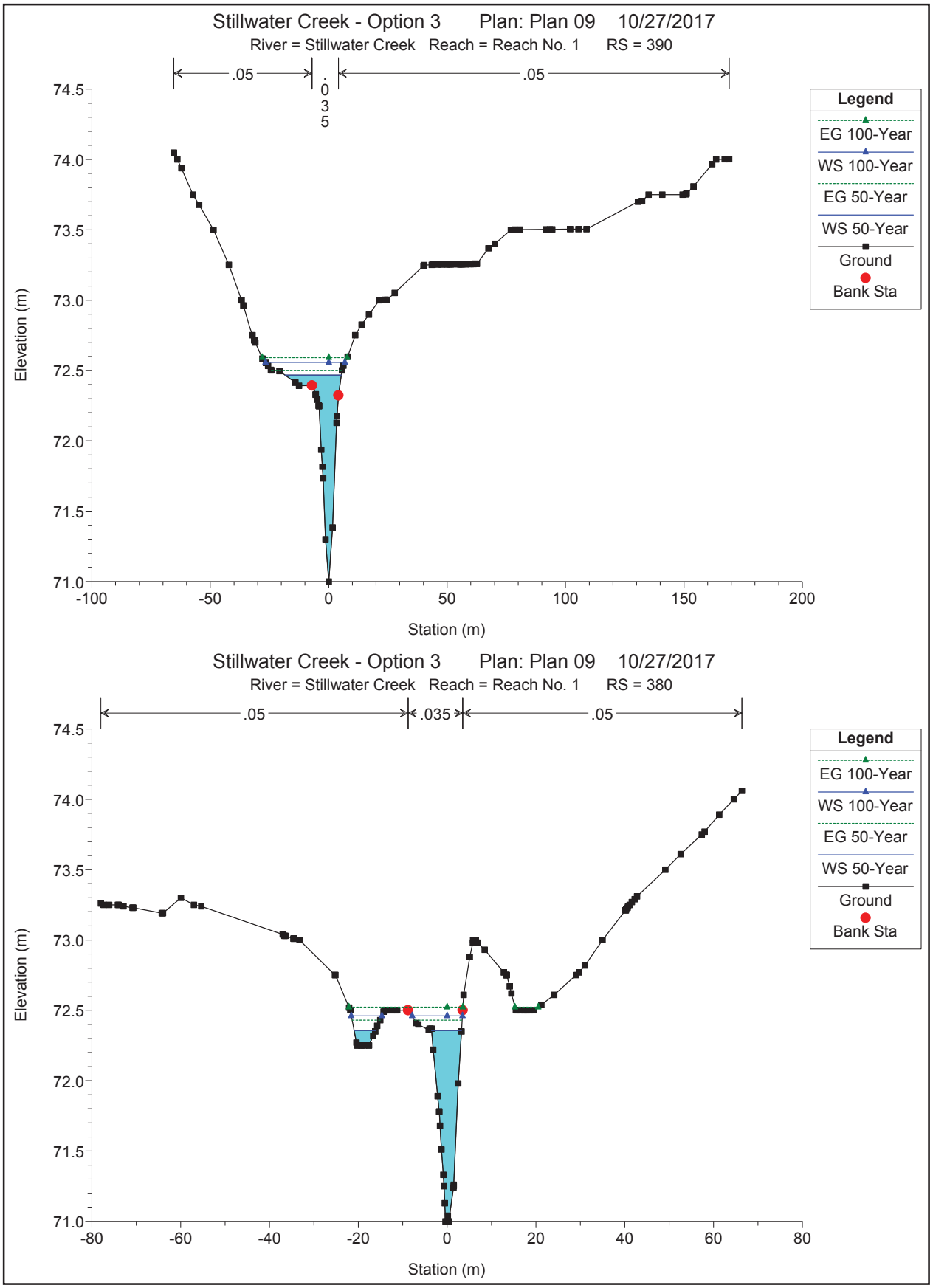
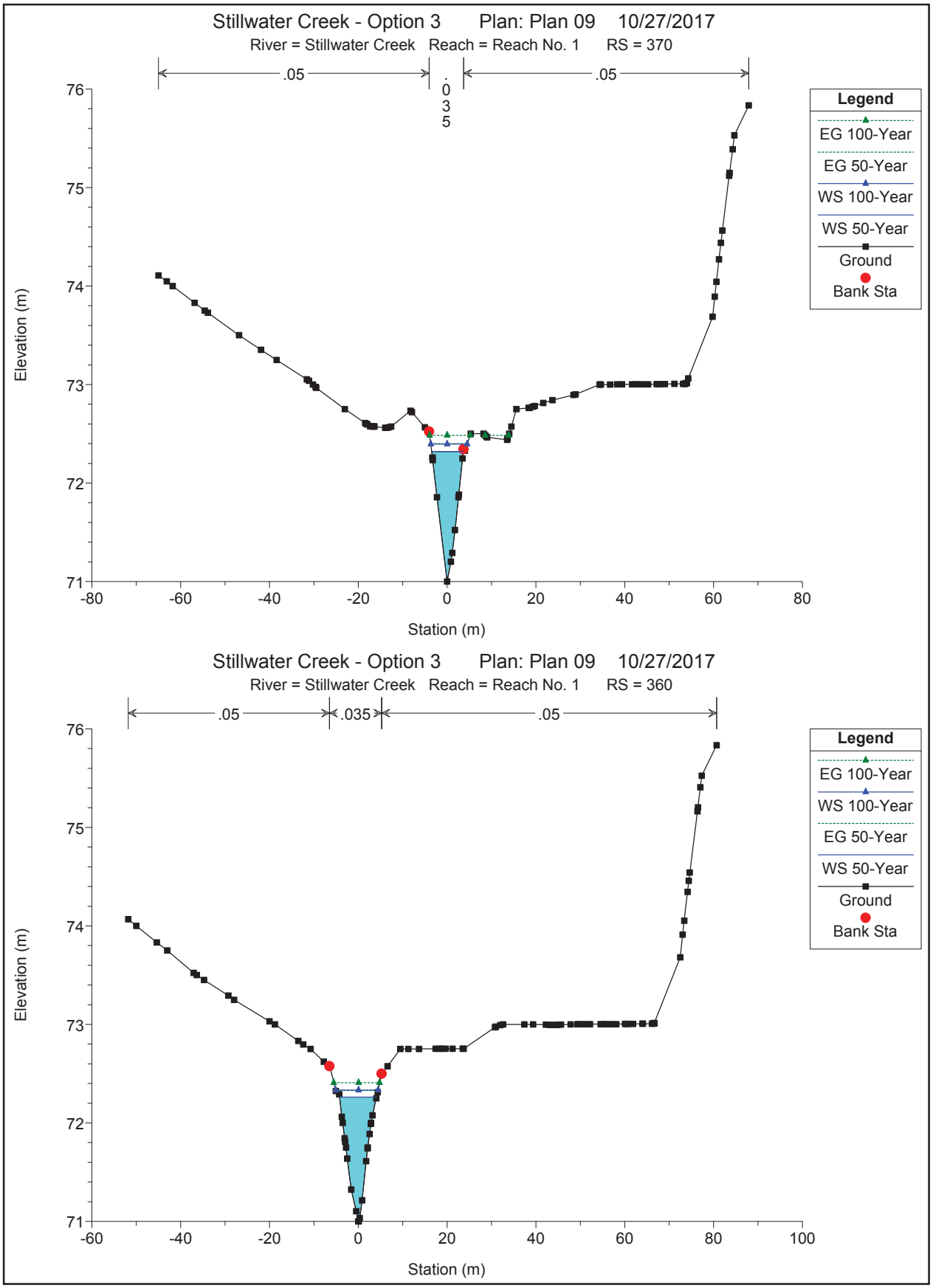
River = Stillwater Creek Reach = Reach No. 1 RS = 410
.1
.035
.1
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
74.5
74.0
73.5
73.0
72.5
72.0
71.5
71.0
-100
-50
0
50
100
150
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 400
.1
.035
.1
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 390
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 380
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)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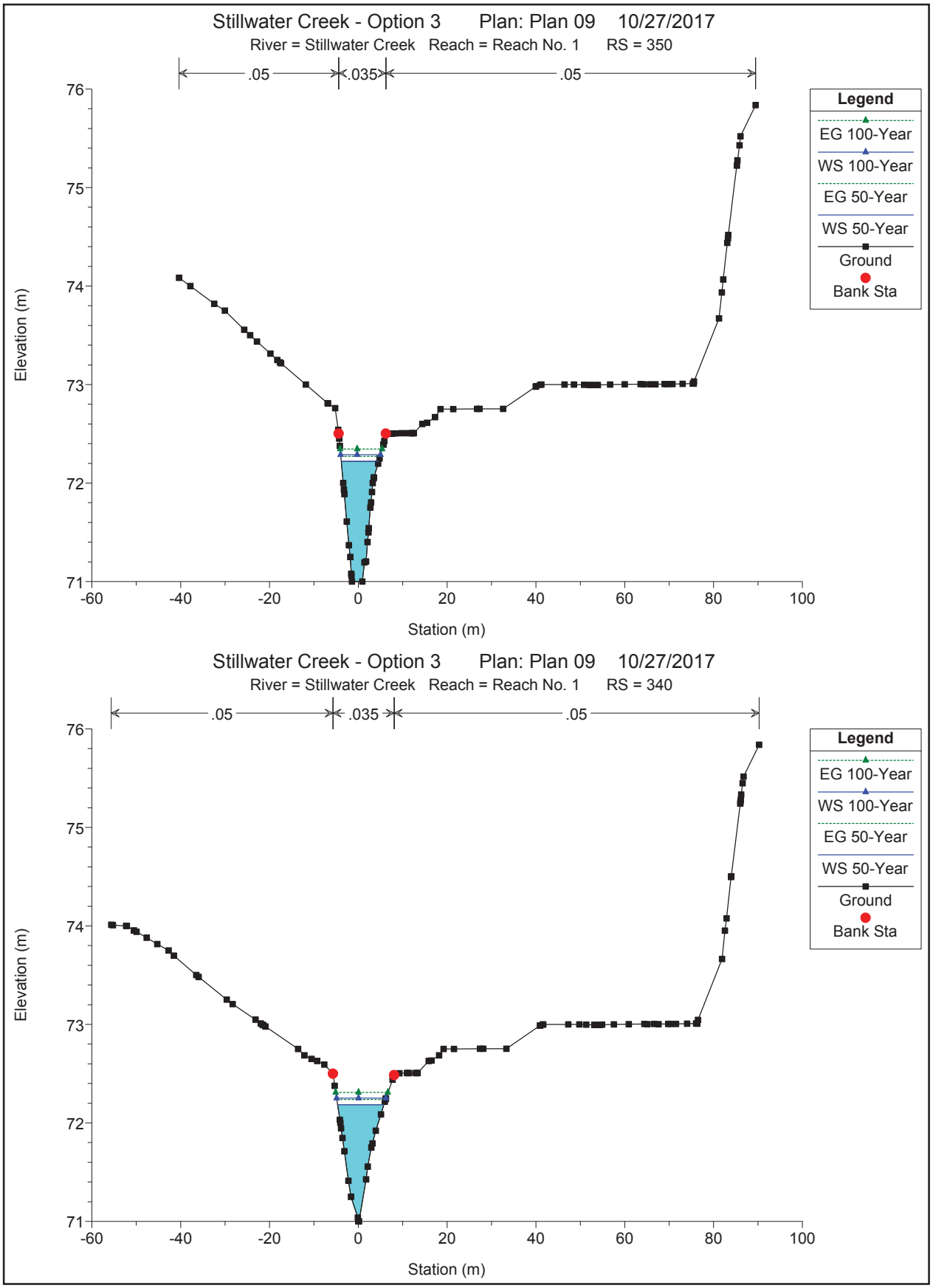
River = Stillwater Creek Reach = Reach No. 1 RS = 370
.05
.035
.05
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 360
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)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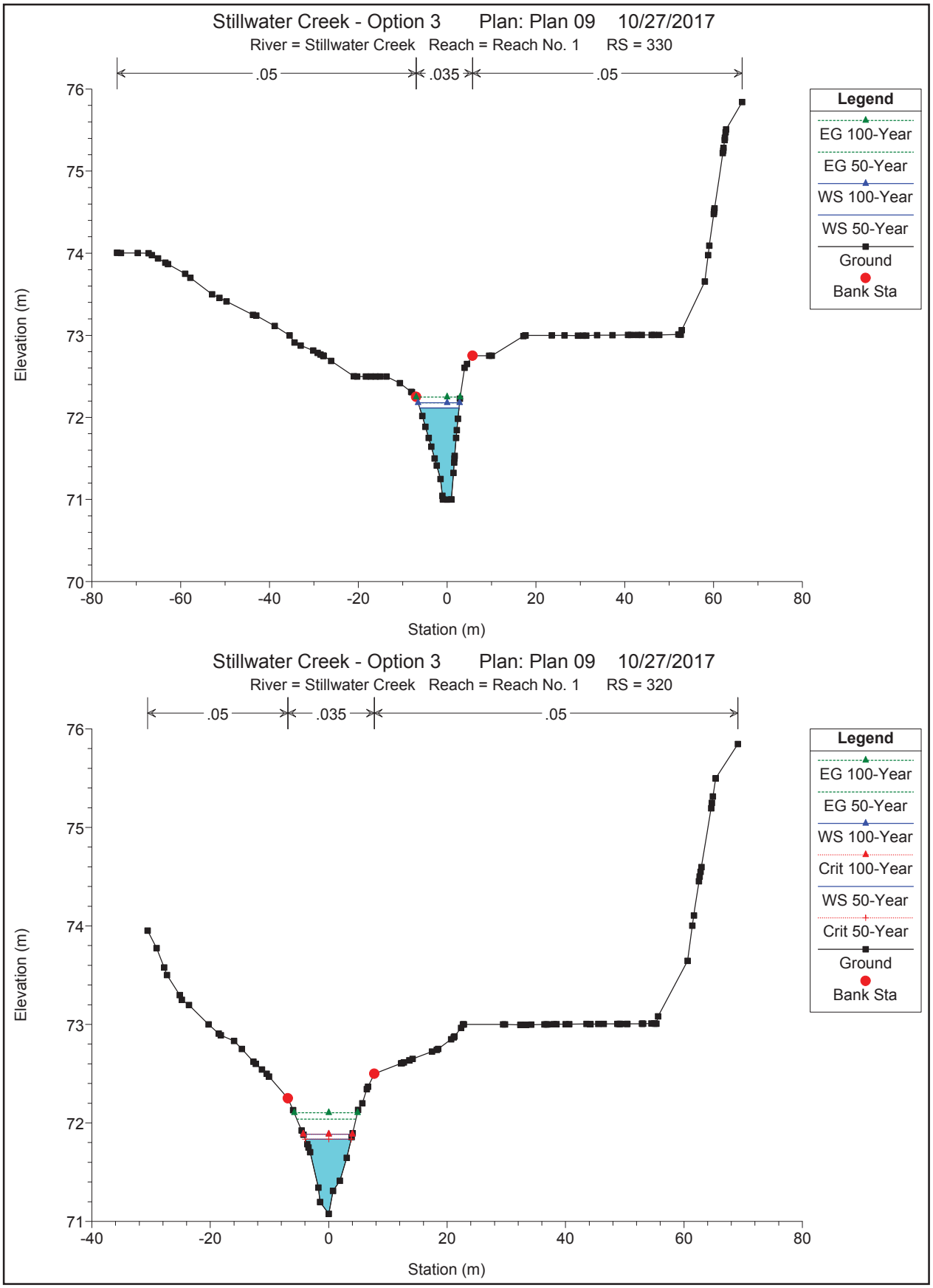
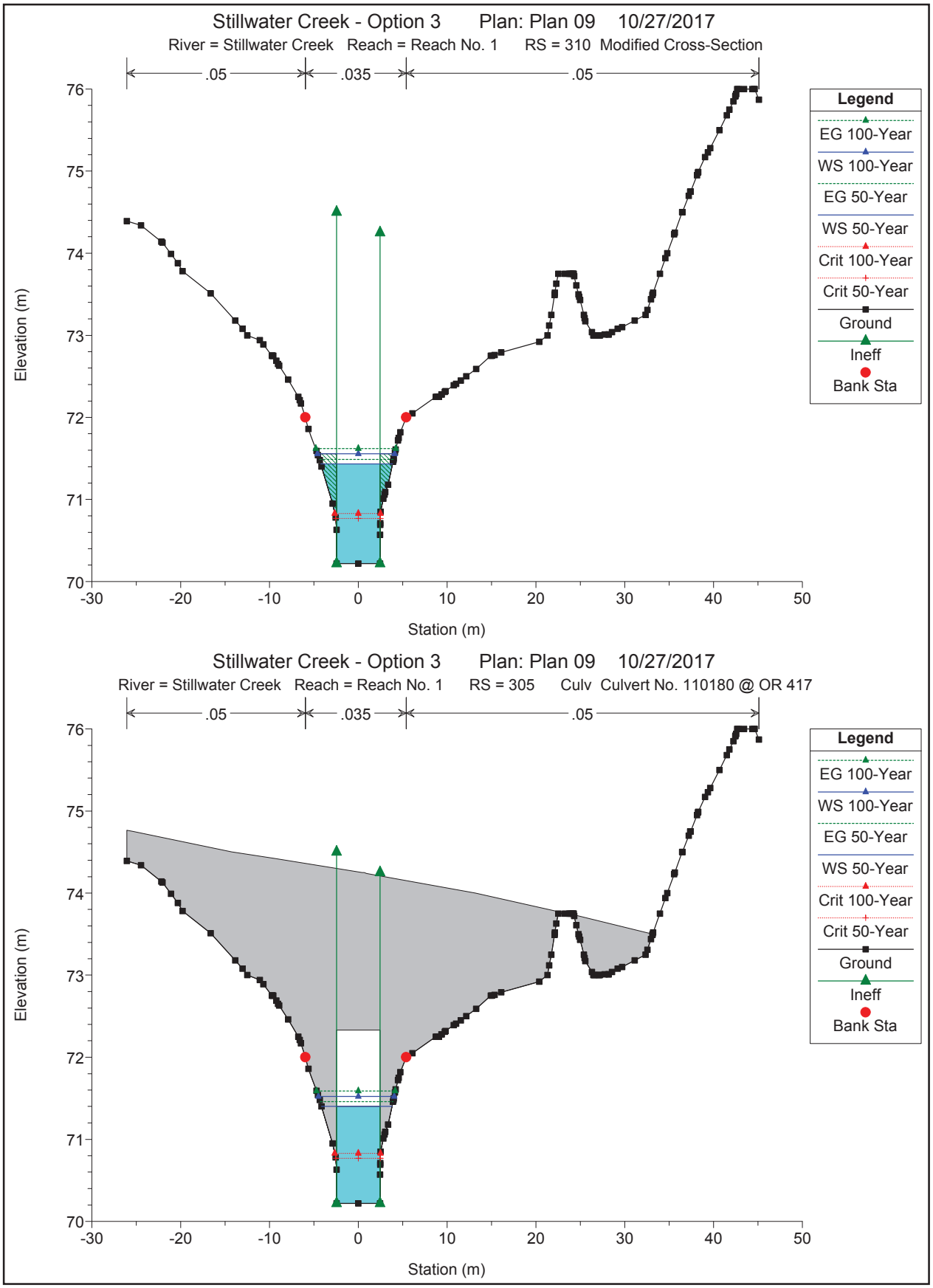
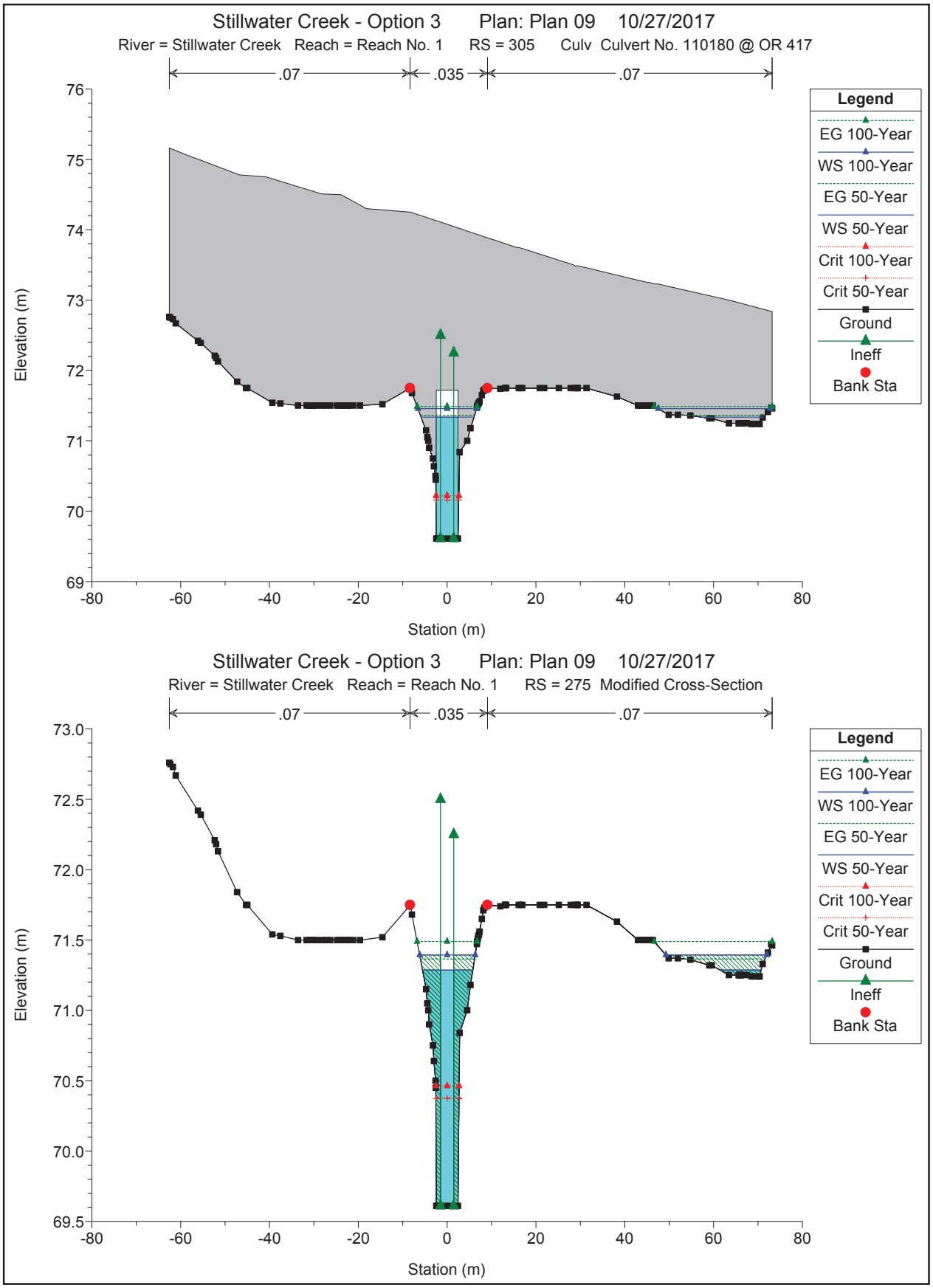
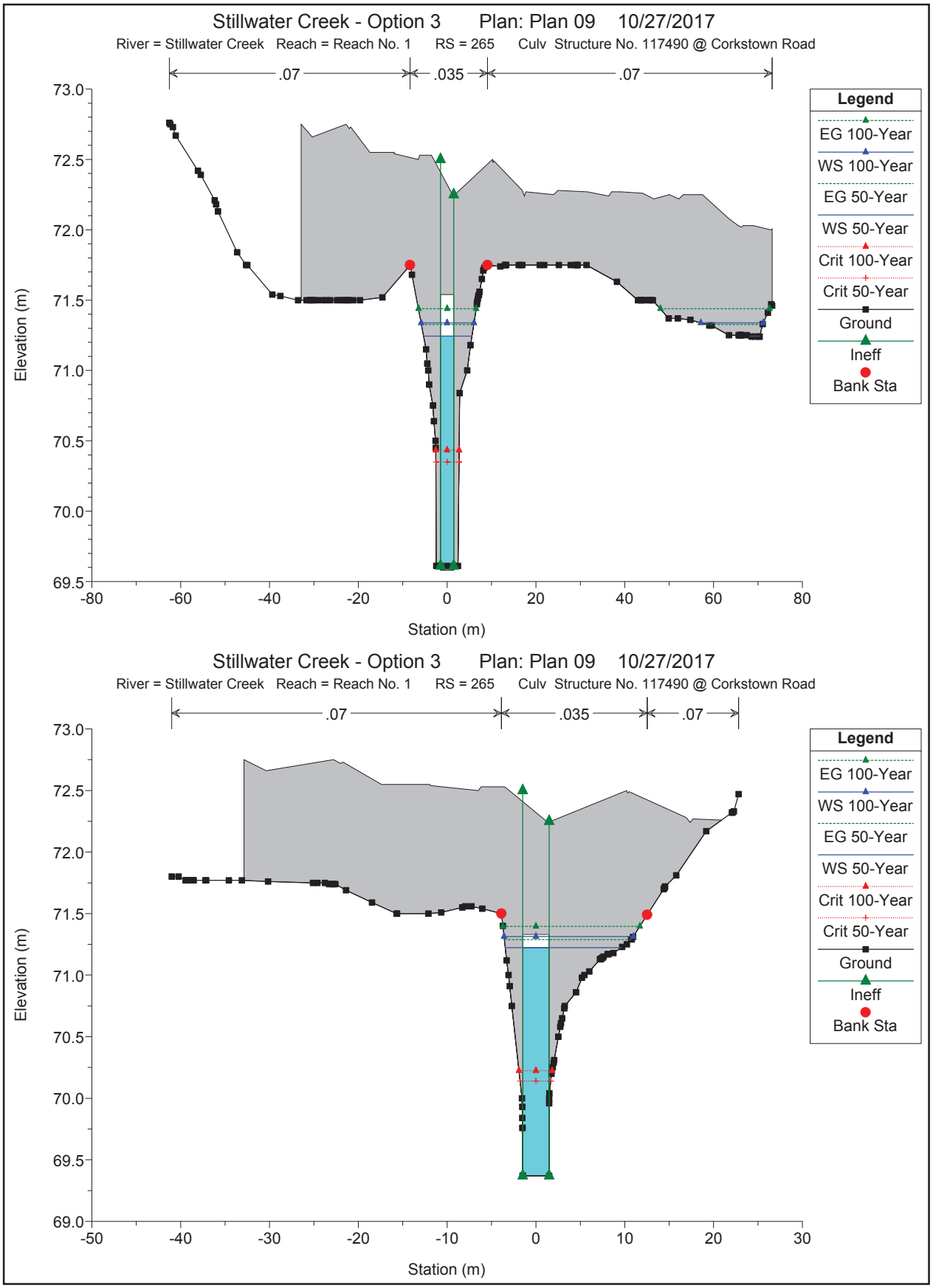
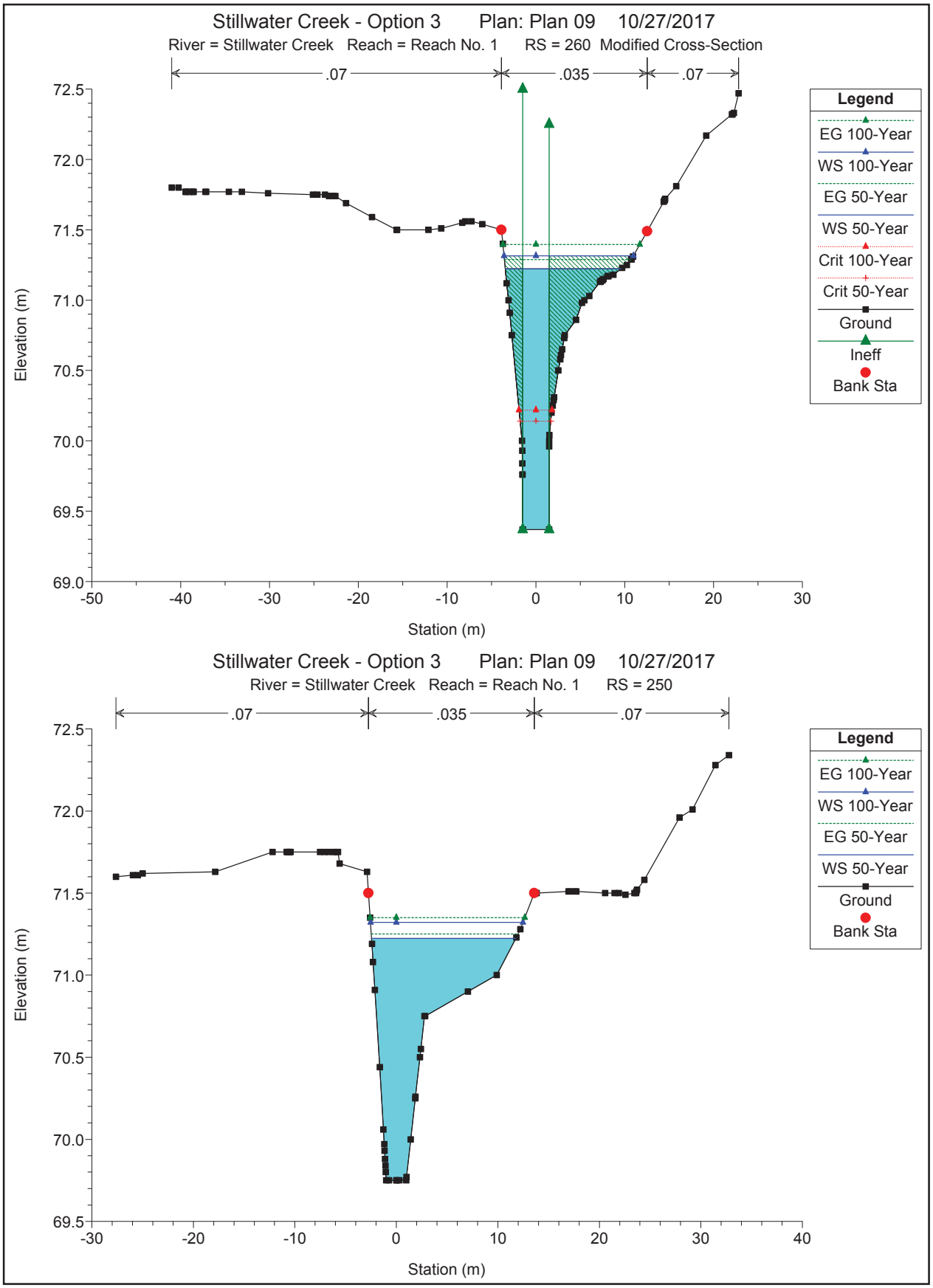
River = Stillwater Creek Reach = Reach No. 1 RS = 350
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 340
.05
.035
.05
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

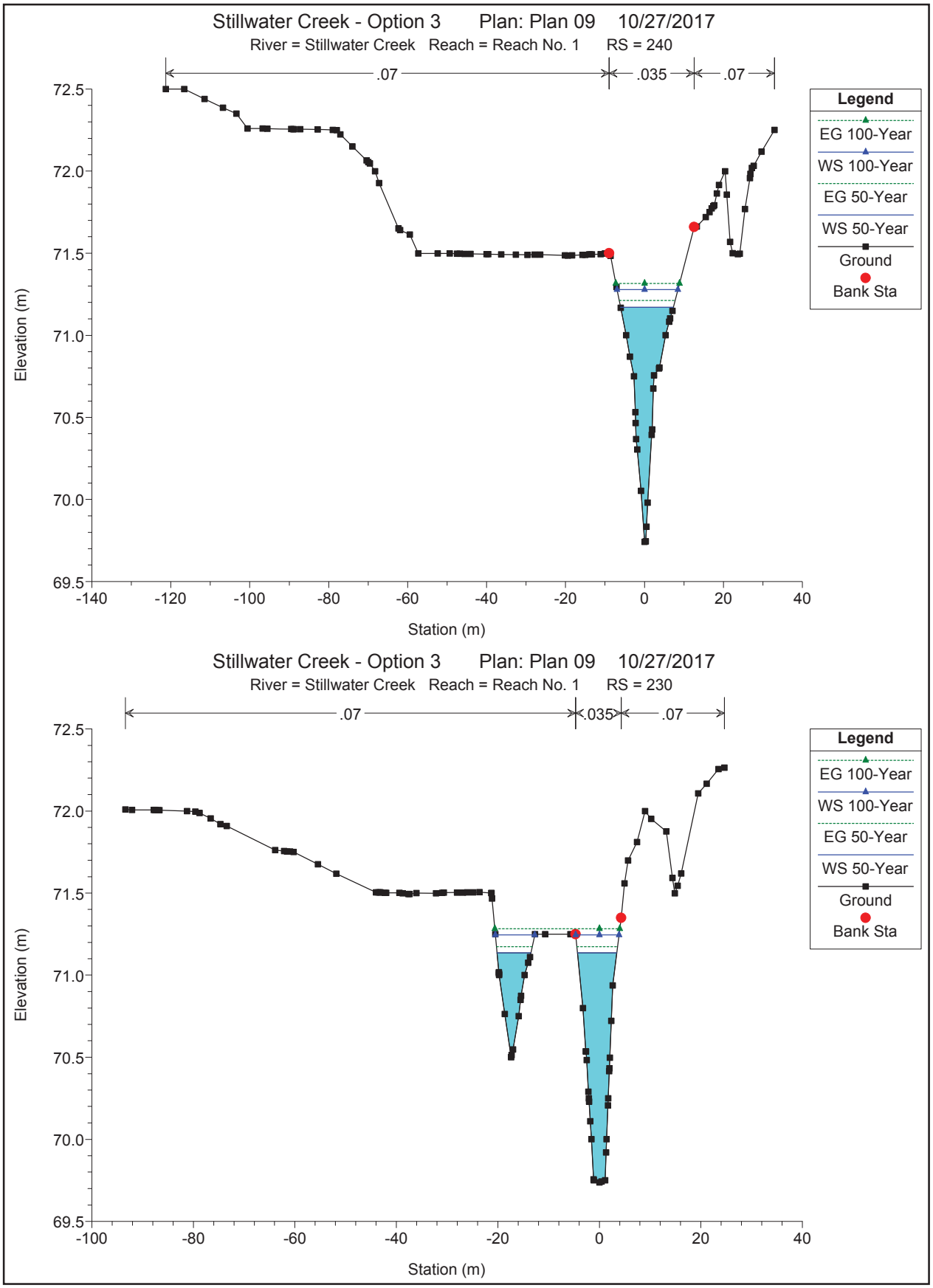

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 330
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 320
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta

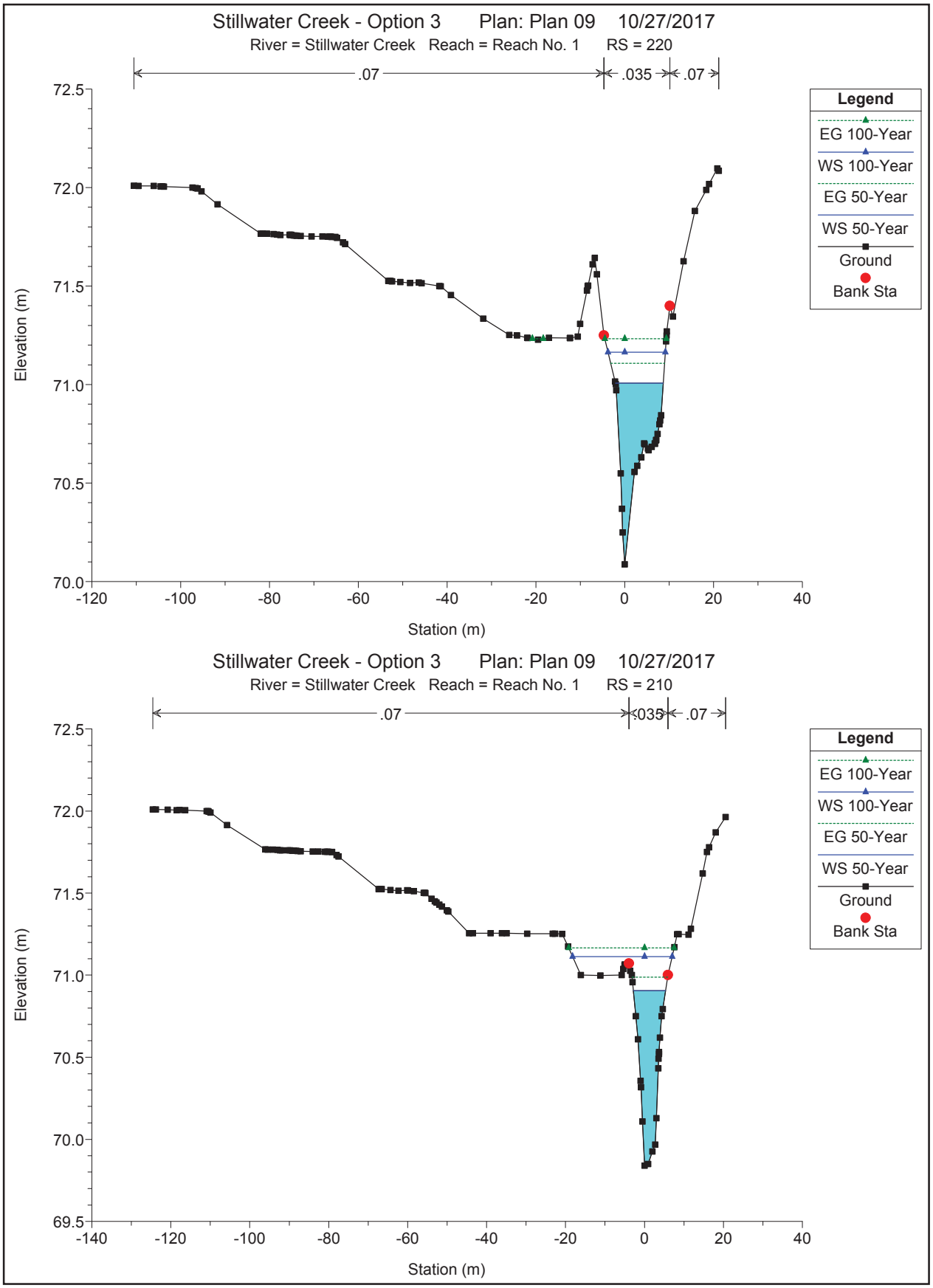

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 310 Modified Cross-Section
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 305 Culv Culvert No. 110180 @ OR 417
.05
.035
.05
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta

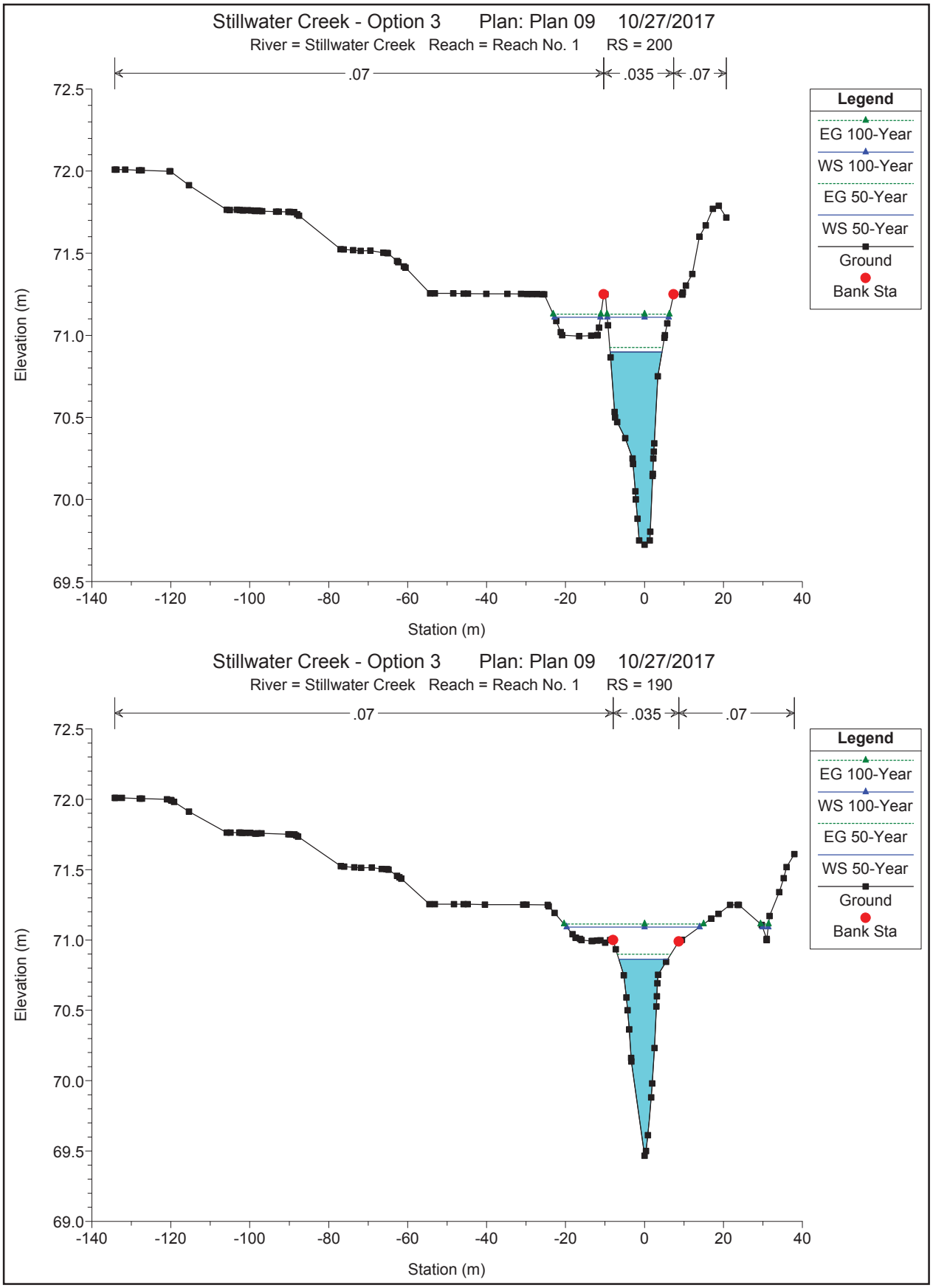

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 305 Culv Culvert No. 110180 @ OR 417
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 275 Modified Cross-Section
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

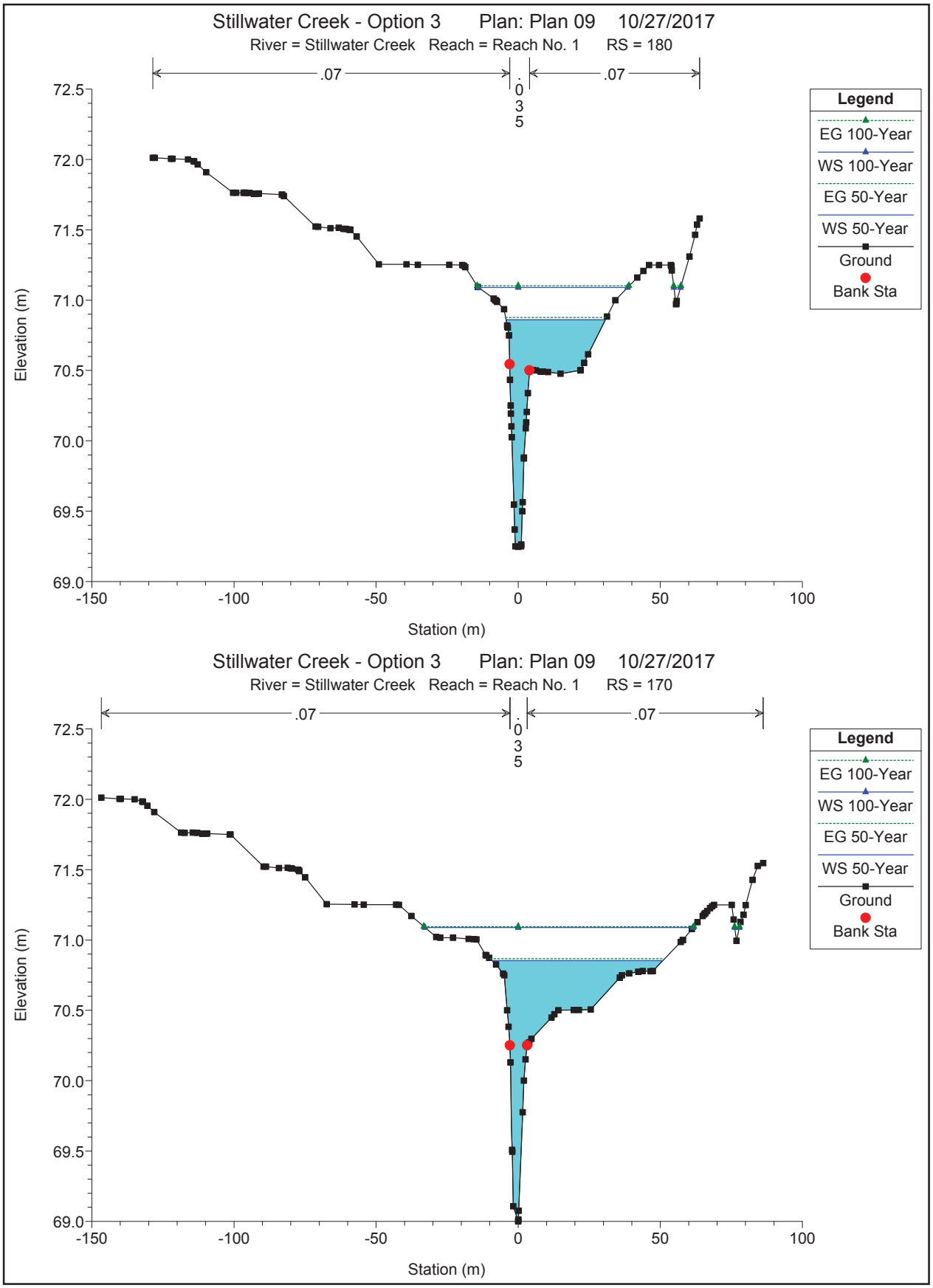

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 265 Culv Structure No. 117490 @ Corkstown Road
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
73.0
72.5
72.0
71.5
71.0
70.5
70.0
69.5
-80
-60
-40
-20
0
20
40
60
80
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 265 Culv Structure No. 117490 @ Corkstown Road
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
73.0
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
-50
-40
-30
-20
-10
0
10
20
30

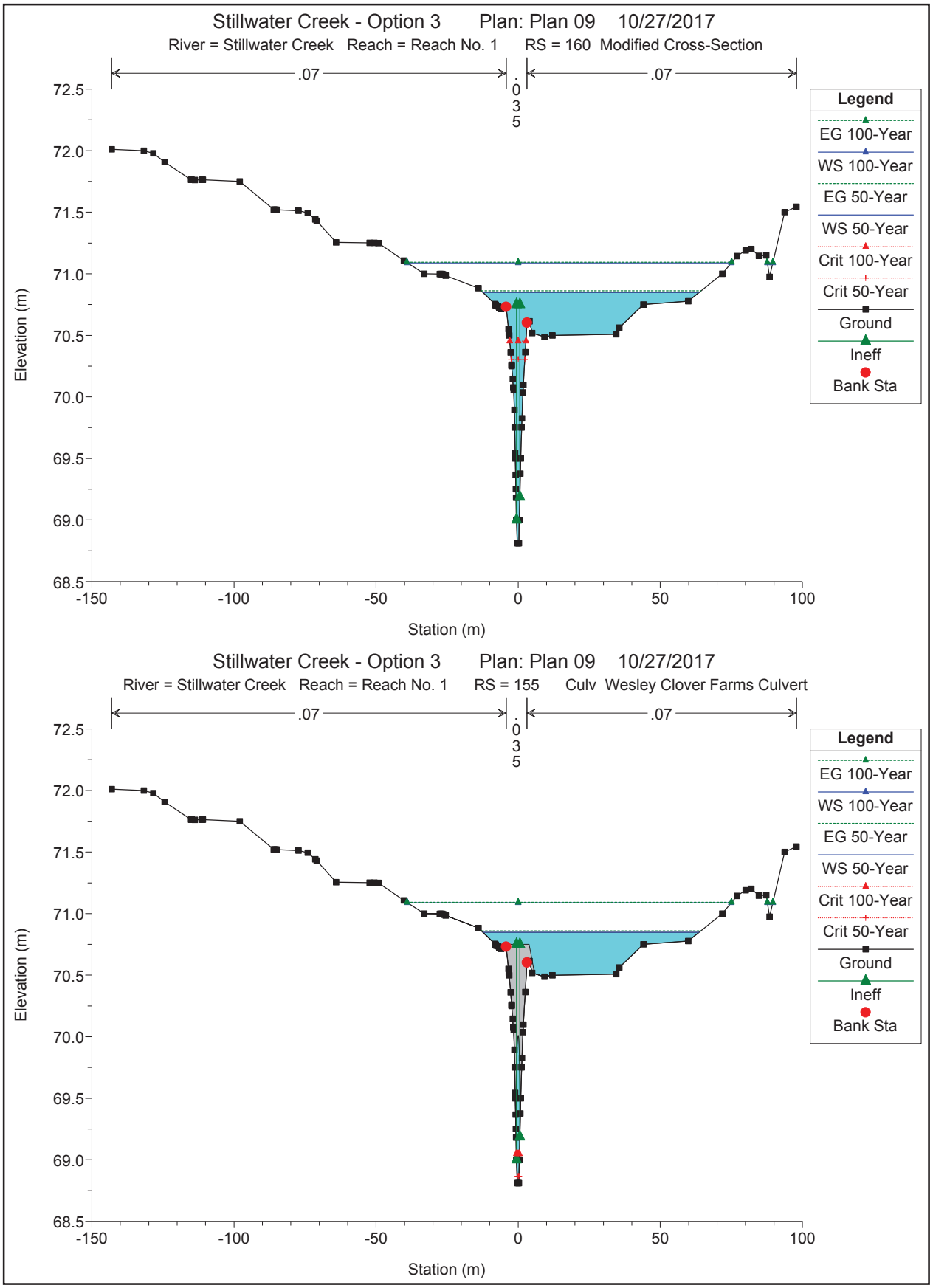

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 260 Modified Cross-Section
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 250
.07
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta

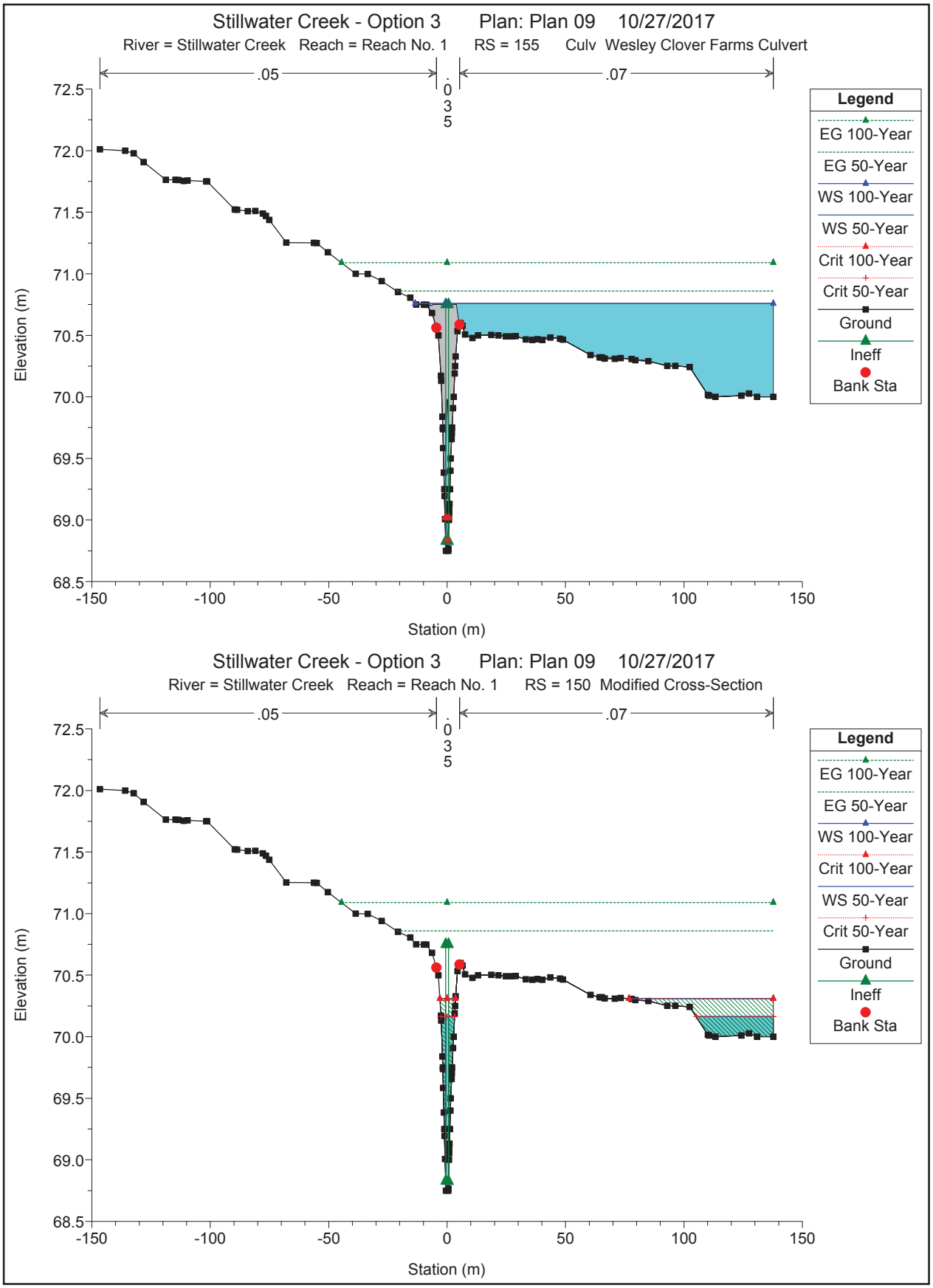

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 240
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
-140
-120
-100
-80
-60
-40
-20
0
20
40
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 230
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
-100
-80
-60
-40
-20
0
20
40
Station (m)

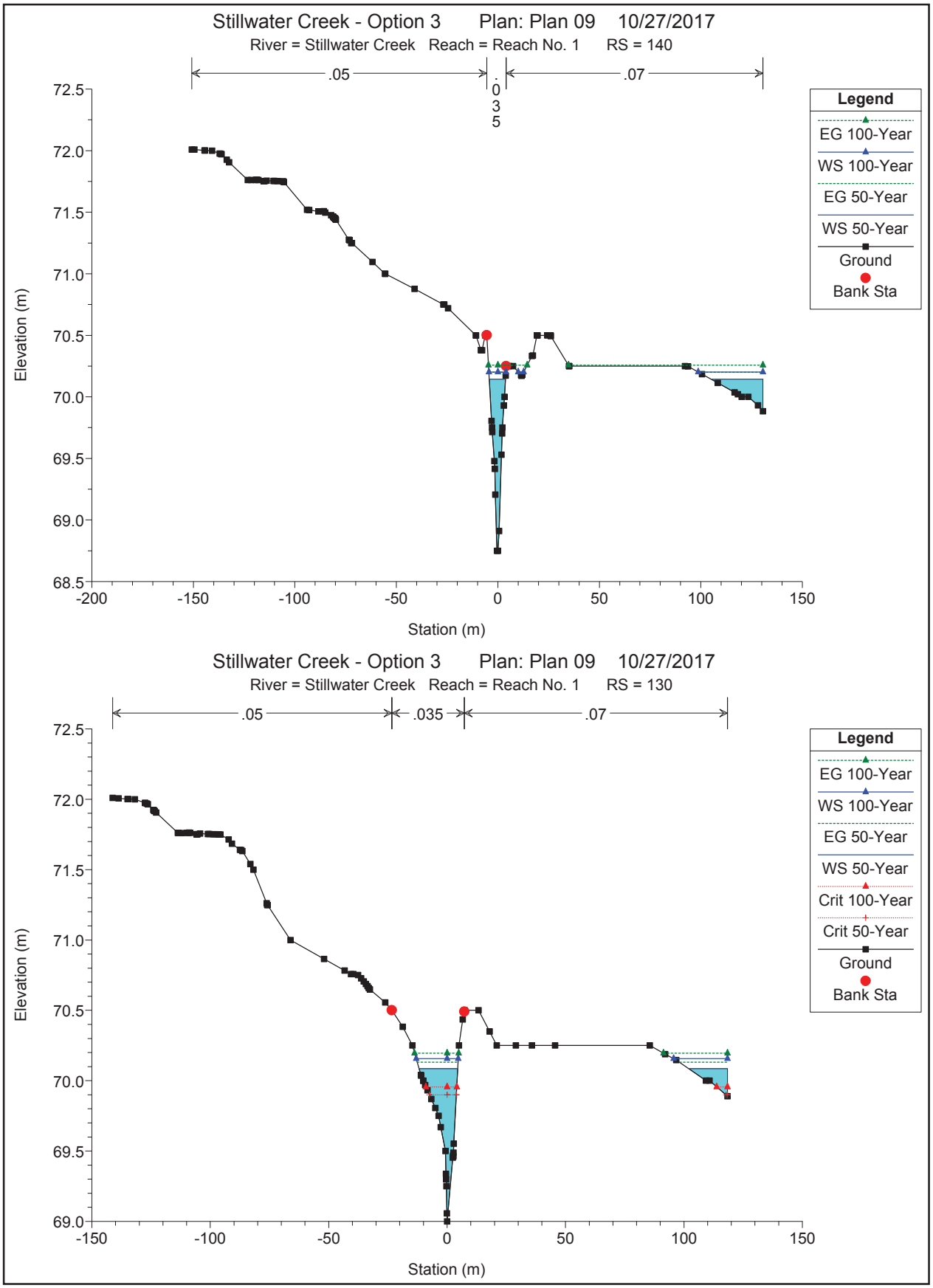

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 220
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 210
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

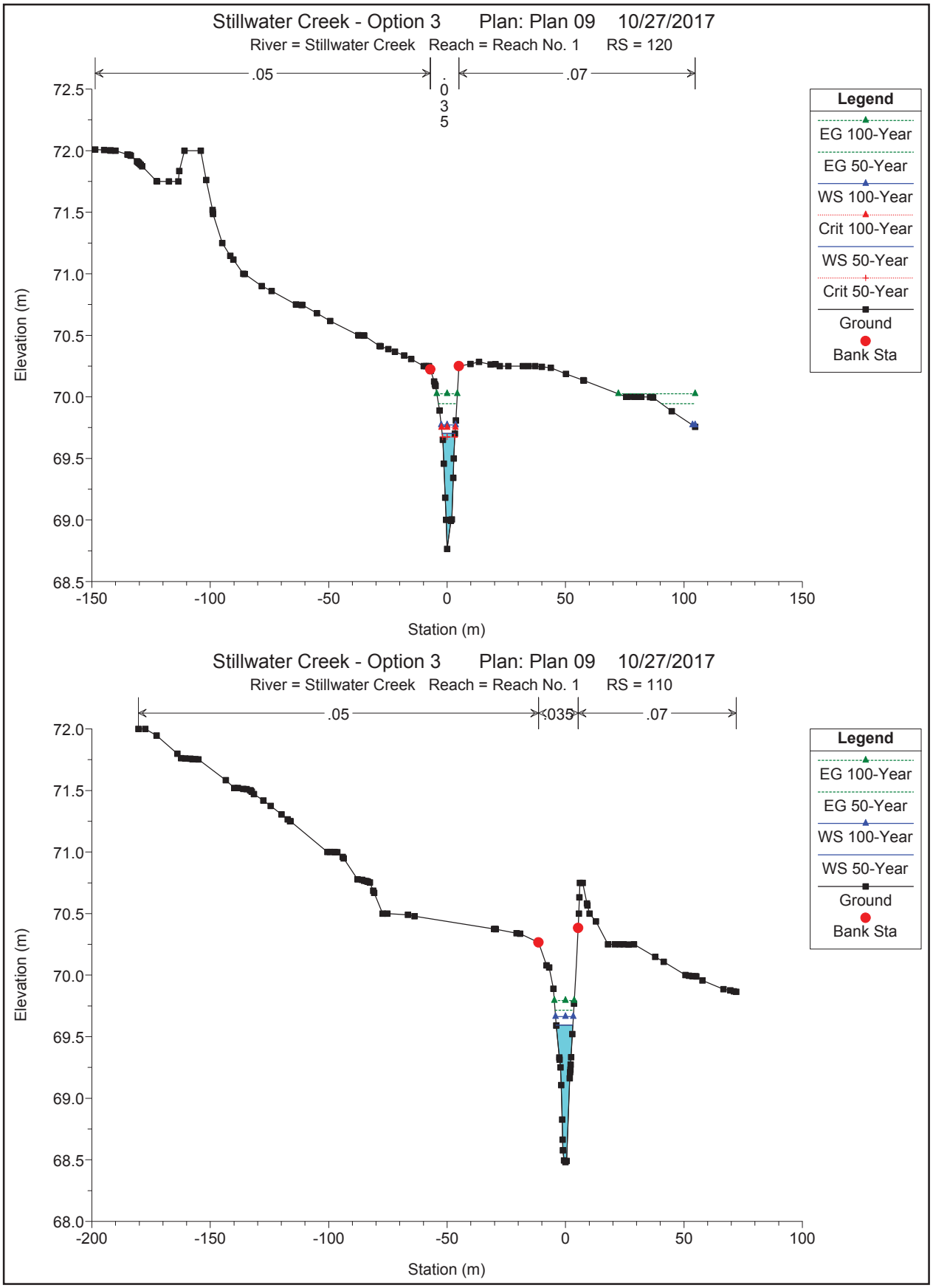

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 200
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 190
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)

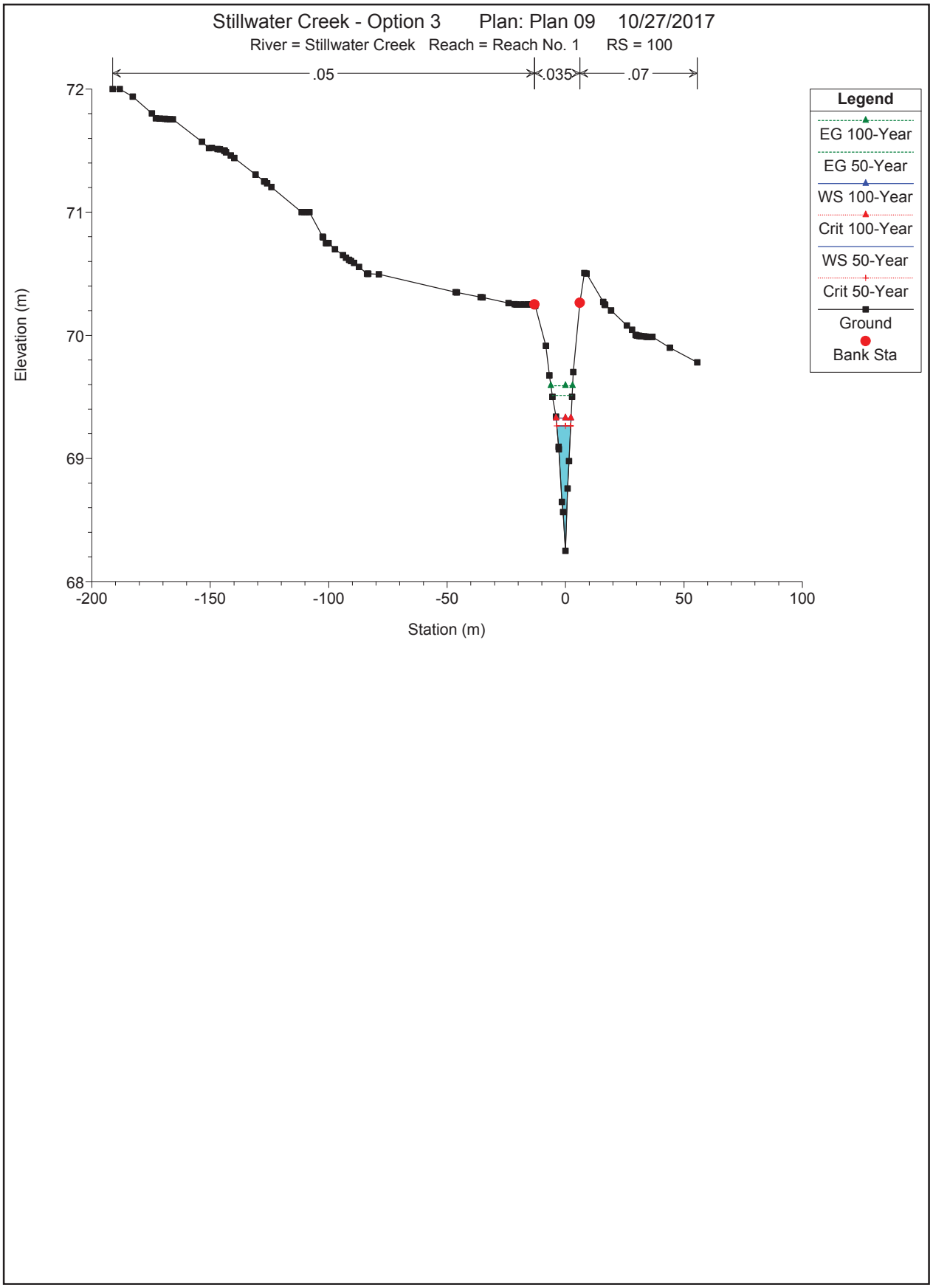

Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 180
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
-150
-100
-50
0
50
100
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 170
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 160 Modified Cross-Section
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
68.5
-150
-100
-50
0
50
100
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 155 Culv Wesley Clover Farms Culvert
.07
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
72.5
72.0
71.5
71.0
70.5
70.0
69.5
69.0
68.5
-150
-100
-50
0
50
100


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 155 Culv Wesley Clover Farms Culvert
.05
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Ineff
Bank Sta
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 150 Modified Cross-Section
.05
.035
.07
Elevation (m)
Station (m)
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Ineff
Bank Sta


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 140
.05
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 130
.05
.035
.07
Legend
EG 100-Year
WS 100-Year
EG 50-Year
WS 50-Year
Crit 100-Year
Crit 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 120
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)
Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 110
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
WS 50-Year
Ground
Bank Sta
Elevation (m)
Station (m)


Stillwater Creek - Option 3 Plan: Plan 09 10/27/2017
River = Stillwater Creek Reach = Reach No. 1 RS = 100
.05
.035
.07
Legend
EG 100-Year
EG 50-Year
WS 100-Year
Crit 100-Year
WS 50-Year
Crit 50-Year
Ground
Bank Sta
Elevation (m)
72
71
70
69
68
-200
-150
-100
-50
0
50
100
Station (m)

Output Data: HEC-RAS - Proposed Conditions

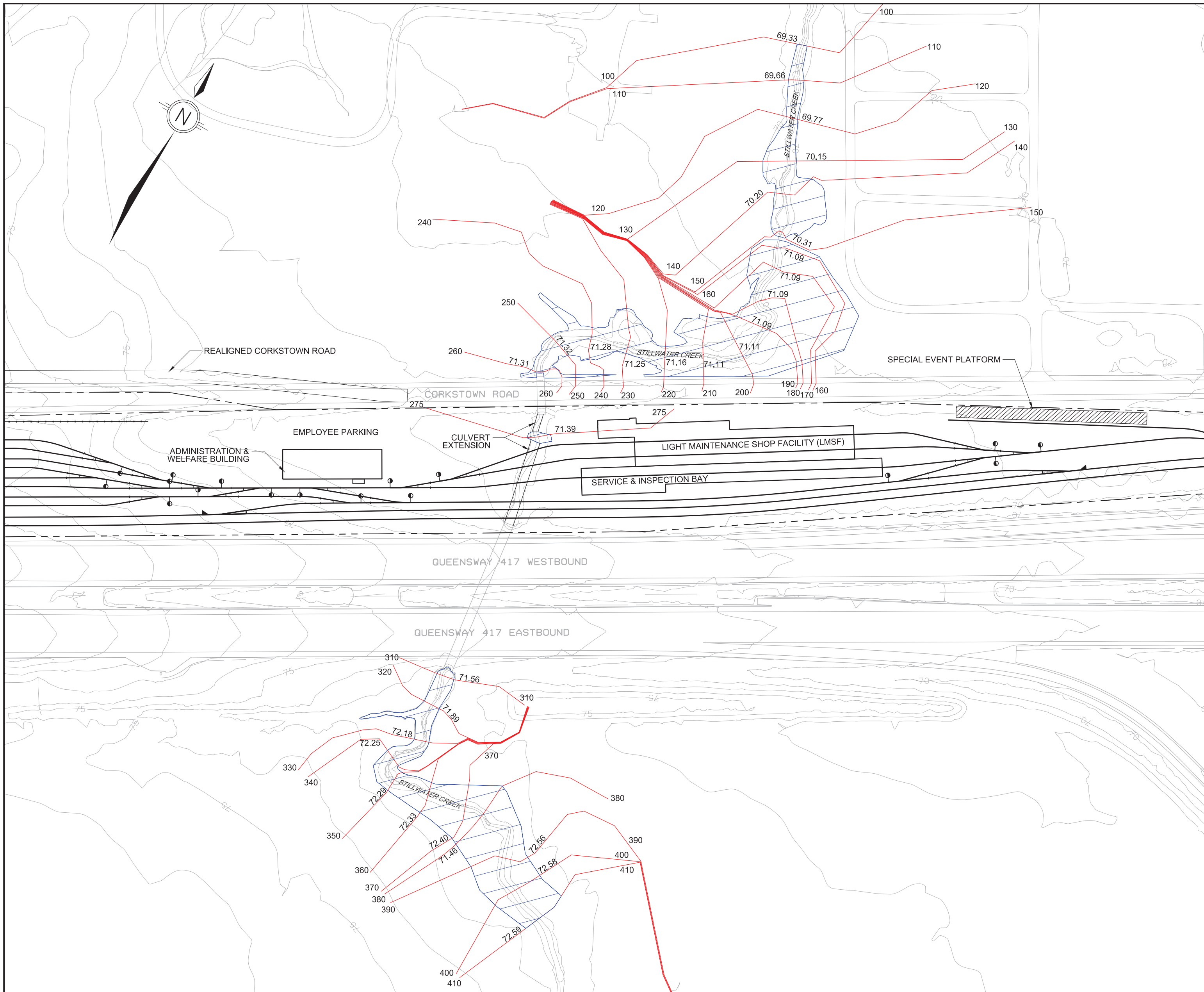
HEC-RAS Plan: Stillwater Creek River: Stillwater Creek Reach: Reach No. 1

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach No. 1	410	50-Year	670.00	6.24	71.00	72.51	72.54	0.000931	0.75	8.37	19.92	0.26
Reach No. 1	410	100-Year	670.00	7.29	71.00	72.59	72.63	0.000908	0.79	10.17	22.60	0.26
Reach No. 1	400	50-Year	650.00	6.24	71.00	72.49	72.52	0.000726	0.72	9.46	14.65	0.24
Reach No. 1	400	100-Year	650.00	7.29	71.00	72.58	72.61	0.000736	0.77	10.93	20.03	0.24
Reach No. 1	390	50-Year	631.00	6.24	71.00	72.47	72.50	0.001506	0.83	8.16	23.79	0.32
Reach No. 1	390	100-Year	631.00	7.29	71.00	72.56	72.59	0.001234	0.81	10.86	33.58	0.30
Reach No. 1	380	50-Year	599.00	6.24	71.00	72.36	72.43	0.002964	1.21	5.49	11.60	0.44
Reach No. 1	380	100-Year	599.00	7.29	71.00	72.46	72.52	0.003960	1.14	7.09	18.23	0.50
Reach No. 1	370	50-Year	589.00	6.24	71.00	72.32	72.40	0.003395	1.25	4.98	7.13	0.48
Reach No. 1	370	100-Year	589.00	7.29	71.00	72.40	72.48	0.003420	1.32	5.57	8.20	0.49
Reach No. 1	360	50-Year	568.00	6.24	71.00	72.26	72.33	0.003080	1.15	5.41	8.33	0.46
Reach No. 1	360	100-Year	568.00	7.29	71.00	72.33	72.41	0.003439	1.20	6.06	9.56	0.48
Reach No. 1	350	50-Year	547.00	6.24	71.00	72.22	72.27	0.001997	1.00	6.23	8.43	0.37
Reach No. 1	350	100-Year	547.00	7.29	71.00	72.29	72.35	0.002193	1.07	6.82	8.97	0.39
Reach No. 1	340	50-Year	532.00	6.24	71.00	72.18	72.24	0.002634	1.01	6.16	10.42	0.42
Reach No. 1	340	100-Year	532.00	7.29	71.00	72.25	72.31	0.002699	1.06	6.88	11.11	0.43
Reach No. 1	330	50-Year	512.00	6.24	71.00	72.12	72.18	0.003011	1.11	5.60	8.87	0.45
Reach No. 1	330	100-Year	512.00	7.29	71.00	72.18	72.25	0.003201	1.18	6.16	9.33	0.47
Reach No. 1	320	50-Year	491.00	6.24	71.08	71.83	72.04	0.017193	2.01	3.11	7.75	1.01
Reach No. 1	320	100-Year	491.00	7.29	71.08	71.89	72.10	0.016913	2.07	3.53	8.31	1.01
Reach No. 1	310	50-Year	474.00	6.24	70.22	71.43	71.49	0.001048	1.05	5.94	8.08	0.30
Reach No. 1	310	100-Year	474.00	7.29	70.22	71.56	71.62	0.001030	1.11	6.55	8.70	0.31
Reach No. 1	305		Culvert									
Reach No. 1	275	50-Year	337.00	6.24	69.61	71.29	71.36	0.000962	1.25	4.99	20.54	0.31
Reach No. 1	275	100-Year	337.00	7.29	69.61	71.39	71.49	0.001066	1.37	5.31	35.23	0.33
Reach No. 1	265		Culvert									
Reach No. 1	260	50-Year	301.00	6.24	69.37	71.22	71.29	0.000692	1.13	5.50	13.02	0.27
Reach No. 1	260	100-Year	301.00	7.29	69.37	71.31	71.40	0.000805	1.26	5.77	14.56	0.29
Reach No. 1	250	50-Year	282.00	6.24	69.75	71.22	71.25	0.001495	0.75	8.37	14.21	0.31
Reach No. 1	250	100-Year	282.00	7.29	69.75	71.32	71.35	0.001293	0.74	9.81	15.02	0.29
Reach No. 1	240	50-Year	262.00	6.24	69.74	71.17	71.21	0.002527	0.90	6.91	13.35	0.40
Reach No. 1	240	100-Year	262.00	7.29	69.74	71.28	71.32	0.002110	0.86	8.46	15.41	0.37
Reach No. 1	230	50-Year	243.00	6.24	69.74	71.14	71.17	0.001472	0.90	8.43	14.43	0.32
Reach No. 1	230	100-Year	243.00	7.29	69.74	71.25	71.28	0.001391	0.90	10.11	16.33	0.31
Reach No. 1	220	50-Year	223.00	6.24	70.09	71.01	71.11	0.008229	1.41	4.43	10.76	0.70
Reach No. 1	220	100-Year	223.00	7.29	70.09	71.16	71.23	0.004446	1.16	6.29	12.91	0.53
Reach No. 1	210	50-Year	203.00	6.24	69.84	70.91	70.99	0.004197	1.27	4.91	8.19	0.52
Reach No. 1	210	100-Year	203.00	7.29	69.84	71.11	71.17	0.002299	1.04	8.27	25.23	0.40
Reach No. 1	200	50-Year	181.00	6.24	69.73	70.90	70.93	0.001223	0.73	8.52	13.17	0.29
Reach No. 1	200	100-Year	181.00	7.29	69.73	71.11	71.13	0.000736	0.62	12.68	27.17	0.23
Reach No. 1	190	50-Year	162.00	6.24	69.47	70.86	70.90	0.001685	0.82	7.58	12.43	0.34
Reach No. 1	190	100-Year	162.00	7.29	69.47	71.09	71.11	0.000910	0.65	12.45	35.19	0.25
Reach No. 1	180	50-Year	142.00	6.24	69.25	70.86	70.88	0.000492	0.64	16.13	34.96	0.19
Reach No. 1	180	100-Year	142.00	7.29	69.25	71.09	71.10	0.000275	0.54	25.87	54.80	0.15
Reach No. 1	170	50-Year	121.00	6.24	69.00	70.85	70.87	0.000346	0.60	21.64	59.98	0.16
Reach No. 1	170	100-Year	121.00	7.29	69.00	71.09	71.10	0.000169	0.46	39.31	95.97	0.12
Reach No. 1	160	50-Year	110.00	6.24	68.81	70.85	70.86	0.000655	0.63	21.57	75.99	0.21
Reach No. 1	160	100-Year	110.00	7.29	68.81	71.09	71.09	0.000205	0.41	44.52	115.85	0.12
Reach No. 1	155		Culvert									
Reach No. 1	150	50-Year	101.00	6.24	68.75	70.16	70.86	0.011225	3.70	1.69	38.38	1.00
Reach No. 1	150	100-Year	101.00	7.29	68.75	70.31	71.09	0.011024	3.91	1.86	67.57	1.00
Reach No. 1	140	50-Year	81.00	6.24	68.75	70.14	70.20	0.002873	1.10	8.16	33.56	0.43
Reach No. 1	140	100-Year	81.00	7.29	68.75	70.20	70.26	0.002807	1.11	10.35	43.03	0.43
Reach No. 1	130	50-Year	62.00	6.24	69.00	70.09	70.13	0.004372	0.97	7.65	32.75	0.51

Output Data: HEC-RAS - Proposed Conditions

HEC-RAS Plan: Stillwater Creek River: Stillwater Creek Reach: Reach No. 1 (Continued)

Reach	River Sta	Profile	Cum Ch Len	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m)	(m3/s)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach No. 1	130	100-Year	62.00	7.29	69.00	70.16	70.20	0.003389	0.91	10.24	40.52	0.45
Reach No. 1	120	50-Year	39.00	6.24	68.77	69.70	69.94	0.014789	2.17	2.87	5.39	0.95
Reach No. 1	120	100-Year	39.00	7.29	68.77	69.77	70.03	0.015295	2.23	3.27	7.17	0.97
Reach No. 1	110	50-Year	19.00	6.24	68.48	69.59	69.72	0.006639	1.54	4.05	7.05	0.65
Reach No. 1	110	100-Year	19.00	7.29	68.48	69.66	69.79	0.006682	1.60	4.55	7.51	0.66
Reach No. 1	100	50-Year		6.24	68.25	69.27	69.51	0.016919	2.20	2.83	5.84	1.01
Reach No. 1	100	100-Year		7.29	68.25	69.33	69.59	0.016736	2.27	3.21	6.28	1.01



LEGEND

HEC-RAS SECTION

FLOODPLAIN AREA

NOT FOR CONSTRUCTION

OTTAWA STAGE 2
WEST TRANSITWAY EXTENSION
MOODIE LMSF

FLOODPLAIN DELINEATION
PROPOSED CONDITIONS

N/A — Manager - Division
N/A — Project Manager

Ottawa

Contract No. | Dwg. No. 2
Sheet 2 of 2
Asset No. N/A
Asset Group N/A
Des. VJT | Chk'd. —
Dwn. SMD | Chk'd. —
Utility Circ. No. N/A | Index No. N/A
Const. Inspector N/A
Scale: HORIZONTAL 0m 4 8 16

NOTE:
The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)

Consultant Drawing Number

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