APPENDIX E2

HYDRAULIC ASSESSMENT

Culvert Designer/Analyzer Report
Culvert C1-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	3.1810	m³/s	Check Discharge	3.6780	m³/s

Grades Model: Inverts					
Invert Upstream	195.55	m	Invert Downstream	193.42	m
Length	36.90	m	Slope	0.057724	m/m
Drop	2.13	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	194.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	3.1810 m³/s	200.27 m	4.87 m/s
	Trial-2	1-900 mm Circular	3.6780 m³/s	202.14 m	5.61 m/s

Culvert Designer/Analyzer Report
Culvert C1-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	200.27	m	Discharge	3.1810	m³/s
Headwater Depth/Height	5.17		Tailwater Elevation	194.05	m
Inlet Control HW Elev.	200.27	m	Control Type	Inlet Control	
Outlet Control HW Elev.	200.17	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	193.42	m
Length	36.90	m	Constructed Slope	0.057724	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.89	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.89	m
Velocity Downstream	4.87	m/s	Critical Slope	0.086197	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	200.17	m	Upstream Velocity Head	1.20	m
Ke	0.90		Entrance Loss	1.08	m

Inlet Control Properties					
Inlet Control HW Elev.	200.27	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C1-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	202.14	m	Discharge	3.6780	m³/s
Headwater Depth/Height	7.21		Tailwater Elevation	194.05	m
Inlet Control HW Elev.	201.71	m	Control Type	Outlet Control	
Outlet Control HW Elev.	202.14	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	193.42	m
Length	36.90	m	Constructed Slope	0.057724	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.90	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.90	m
Velocity Downstream	5.61	m/s	Critical Slope	0.118018	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	202.14	m	Upstream Velocity Head	1.60	m
Ke	0.90		Entrance Loss	1.44	m

Inlet Control Properties					
Inlet Control HW Elev.	201.71	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C1-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	3.3220	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	195.55	m	Invert Downstream	193.42	m
Length	36.90	m	Slope	0.057724	m/m
Drop	2.13	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	194.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	3.3220 m³/s	200.70 m	5.08 m/s

Culvert Designer/Analyzer Report
Culvert C1-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	200.70	m	Discharge	3.3220	m³/s
Headwater Depth/Height	5.63		Tailwater Elevation	194.05	m
Inlet Control HW Elev.	200.66	m	Control Type	Outlet Control	
Outlet Control HW Elev.	200.70	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	193.42	m
Length	36.90	m	Constructed Slope	0.057724	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.90	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.90	m
Velocity Downstream	5.08	m/s	Critical Slope	0.094691	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	200.70	m	Upstream Velocity Head	1.30	m
Ke	0.90		Entrance Loss	1.17	m

Inlet Control Properties					
Inlet Control HW Elev.	200.66	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C1-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	3.1810	m³/s	Check Discharge	3.6780	m³/s

Grades Model: Inverts					
Invert Upstream	195.55	m	Invert Downstream	194.88	m
Length	45.00	m	Slope	0.015000	m/m
Drop	0.67	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	195.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	3.1810 m³/s	197.60 m	4.31 m/s
	Trial-2	1-1050 mm Circular	3.6780 m³/s	198.04 m	4.38 m/s

Culvert Designer/Analyzer Report
Culvert C1-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	197.60	m	Discharge	3.1810	m³/s
Headwater Depth/Height	1.92		Tailwater Elevation	195.62	m
Inlet Control HW Elev.	197.60	m	Control Type	Inlet Control	
Outlet Control HW Elev.	197.37	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	194.88	m
Length	45.00	m	Constructed Slope	0.015000	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.82	m
Slope Type	Steep		Normal Depth	0.80	m
Flow Regime	Supercritical		Critical Depth	0.97	m
Velocity Downstream	4.31	m/s	Critical Slope	0.010876	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.37	m	Upstream Velocity Head	0.71	m
Ke	0.20		Entrance Loss	0.14	m

Inlet Control Properties					
Inlet Control HW Elev.	197.60	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C1-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	198.04	m	Discharge	3.6780	m³/s
Headwater Depth/Height	2.33		Tailwater Elevation	195.62	m
Inlet Control HW Elev.	198.04	m	Control Type	Inlet Control	
Outlet Control HW Elev.	197.64	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	194.88	m
Length	45.00	m	Constructed Slope	0.015000	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.95	m
Slope Type	Steep		Normal Depth	0.94	m
Flow Regime	Supercritical		Critical Depth	1.01	m
Velocity Downstream	4.38	m/s	Critical Slope	0.014416	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.64	m	Upstream Velocity Head	0.90	m
Ke	0.20		Entrance Loss	0.18	m

Inlet Control Properties					
Inlet Control HW Elev.	198.04	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C1-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	3.3220	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	195.55	m	Invert Downstream	194.83	m
Length	48.00	m	Slope	0.015000	m/m
Drop	0.72	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	195.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	3.3220 m³/s	197.71 m	4.35 m/s

Culvert Designer/Analyzer Report
Culvert C1-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	197.71	m	Discharge	3.3220	m³/s
Headwater Depth/Height	2.03		Tailwater Elevation	195.62	m
Inlet Control HW Elev.	197.71	m	Control Type	Inlet Control	
Outlet Control HW Elev.	197.44	m			

Grades					
Upstream Invert	195.55	m	Downstream Invert	194.83	m
Length	48.00	m	Constructed Slope	0.015000	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.85	m
Slope Type	Steep		Normal Depth	0.83	m
Flow Regime	Supercritical		Critical Depth	0.98	m
Velocity Downstream	4.35	m/s	Critical Slope	0.011790	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.44	m	Upstream Velocity Head	0.76	m
Ke	0.20		Entrance Loss	0.15	m

Inlet Control Properties					
Inlet Control HW Elev.	197.71	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C2-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	3.0320	m³/s	Check Discharge	3.5040	m³/s

Grades Model: Inverts					
Invert Upstream	191.52	m	Invert Downstream	191.16	m
Length	30.20	m	Slope	0.011921	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	191.84	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-2	1-970 x 1520 mm Horizontal Ellipse	3.032 m³/s	192.92 m	2.91 m/s
	Trial-1	1-970 x 1520 mm Horizontal Ellipse	3.504 m³/s	193.26 m	3.19 m/s

Culvert Designer/Analyzer Report
Culvert C2-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	192.92	m	Discharge	3.0320	m³/s
Headwater Depth/Height	1.44		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	192.85	m	Control Type	Outlet Control	
Outlet Control HW Elev.	192.92	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	30.20	m	Constructed Slope	0.011921	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.78	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.78	m
Velocity Downstream	2.91	m/s	Critical Slope	0.017302	m/m

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.52	m
Section Size	970 x 1520 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	192.92	m	Upstream Velocity Head	0.33	m
Ke	0.20		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	192.85	m	Flow Control	N/A	
Inlet Type	Groove end projecting (horizontal ellipse)		Area Full	1.2	m²
K	0.00450		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C2-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	193.26	m	Discharge	3.5040	m³/s
Headwater Depth/Height	1.79		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	193.07	m	Control Type	Outlet Control	
Outlet Control HW Elev.	193.26	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	30.20	m	Constructed Slope	0.011921	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.83	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.83	m
Velocity Downstream	3.19	m/s	Critical Slope	0.021305	m/m

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.52	m
Section Size	970 x 1520 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	193.26	m	Upstream Velocity Head	0.44	m
Ke	0.20		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	193.07	m	Flow Control	N/A	
Inlet Type	Groove end projecting (horizontal ellipse)		Area Full	1.2	m²
K	0.00450		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C2-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	3.8810	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	191.52	m	Invert Downstream	191.16	m
Length	30.20	m	Slope	0.011921	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	191.84	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-2	1-970 x 1520 mm Horizontal Ellipse	3.881 m³/s	193.54 m	3.43 m/s

Culvert Designer/Analyzer Report
Culvert C2-Reg-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	193.54	m	Discharge	3.8810	m³/s
Headwater Depth/Height	2.08		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	193.28	m	Control Type	Outlet Control	
Outlet Control HW Elev.	193.54	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	30.20	m	Constructed Slope	0.011921	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.87	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.87	m
Velocity Downstream	3.43	m/s	Critical Slope	0.025399	m/m

Section					
Section Shape	Horizontal Ellipse		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.52	m
Section Size	970 x 1520 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	193.54	m	Upstream Velocity Head	0.53	m
Ke	0.20		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	193.28	m	Flow Control	N/A	
Inlet Type	Inlet projecting (horizontal ellipse)		Area Full	1.2	m²
K	0.00450		HDS 5 Chart	29	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C2-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	3.0320	m³/s	Check Discharge	3.5040	m³/s

Grades Model: Inverts					
Invert Upstream	191.52	m	Invert Downstream	191.16	m
Length	45.00	m	Slope	0.008000	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	191.84	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1220 mm Box	3.0320 m³/s	192.38 m	1.83 m/s
	Trial-2	1-2440 x 1220 mm Box	3.5040 m³/s	192.47 m	2.12 m/s

Culvert Designer/Analyzer Report
Culvert C2-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	192.38	m	Discharge	3.0320	m³/s
Headwater Depth/Height	0.71		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	192.37	m	Control Type	Entrance Control	
Outlet Control HW Elev.	192.38	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	45.00	m	Constructed Slope	0.008000	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.68	m
Slope Type	Steep		Normal Depth	0.40	m
Flow Regime	N/A		Critical Depth	0.54	m
Velocity Downstream	1.83	m/s	Critical Slope	0.003319	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	192.38	m	Upstream Velocity Head	0.27	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	192.37	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C2-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	192.47	m	Discharge	3.5040	m³/s
Headwater Depth/Height	0.78		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	192.46	m	Control Type	Entrance Control	
Outlet Control HW Elev.	192.47	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	45.00	m	Constructed Slope	0.008000	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.68	m
Slope Type	Steep		Normal Depth	0.44	m
Flow Regime	N/A		Critical Depth	0.59	m
Velocity Downstream	2.12	m/s	Critical Slope	0.003347	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	192.47	m	Upstream Velocity Head	0.30	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	192.46	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C2-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	3.8810	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	191.52	m	Invert Downstream	191.16	m
Length	45.00	m	Slope	0.008000	m/m
Drop	0.36	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	191.84	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1220 mm Box	3.8810 m³/s	192.54 m	2.34 m/s

Culvert Designer/Analyzer Report
Culvert C2-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	192.54	m	Discharge	3.8810	m³/s
Headwater Depth/Height	0.84		Tailwater Elevation	191.84	m
Inlet Control HW Elev.	192.52	m	Control Type	Entrance Control	
Outlet Control HW Elev.	192.54	m			

Grades					
Upstream Invert	191.52	m	Downstream Invert	191.16	m
Length	45.00	m	Constructed Slope	0.008000	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.68	m
Slope Type	Steep		Normal Depth	0.47	m
Flow Regime	N/A		Critical Depth	0.64	m
Velocity Downstream	2.34	m/s	Critical Slope	0.003374	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	192.54	m	Upstream Velocity Head	0.32	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	192.52	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	4.0880	m³/s	Check Discharge	4.6930	m³/s

Grades Model: Inverts					
Invert Upstream	183.20	m	Invert Downstream	182.77	m
Length	32.60	m	Slope	0.013190	m/m
Drop	0.43	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	183.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1830 x 1220 mm Arch	4.0880 m³/s	184.68 m	2.63 m/s
	Trial-2	1-1830 x 1220 mm Arch	4.6930 m³/s	184.82 m	4.06 m/s

Culvert Designer/Analyzer Report
Culvert C3-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	184.68	m	Discharge	4.0880	m³/s
Headwater Depth/Height	1.21		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	184.56	m	Control Type	Entrance Control	
Outlet Control HW Elev.	184.68	m			

Grades					
Upstream Invert	183.20	m	Downstream Invert	182.77	m
Length	32.60	m	Constructed Slope	0.013190	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.85	m
Slope Type	Steep		Normal Depth	0.53	m
Flow Regime	N/A		Critical Depth	0.80	m
Velocity Downstream	2.63	m/s	Critical Slope	0.004125	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	184.68	m	Upstream Velocity Head	0.40	m
Ke	0.70		Entrance Loss	0.28	m

Inlet Control Properties					
Inlet Control HW Elev.	184.56	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	2.2	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	184.82	m	Discharge	4.6930	m³/s
Headwater Depth/Height	1.33		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	184.69	m	Control Type	Entrance Control	
Outlet Control HW Elev.	184.82	m			

Grades					
Upstream Invert	183.20	m	Downstream Invert	182.77	m
Length	32.60	m	Constructed Slope	0.013190	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.63	m
Slope Type	Steep		Normal Depth	0.58	m
Flow Regime	Supercritical		Critical Depth	0.88	m
Velocity Downstream	4.06	m/s	Critical Slope	0.004242	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	184.82	m	Upstream Velocity Head	0.44	m
Ke	0.70		Entrance Loss	0.31	m

Inlet Control Properties					
Inlet Control HW Elev.	184.69	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	2.2	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	5.5310	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	183.20	m	Invert Downstream	182.77	m
Length	32.60	m	Slope	0.013190	m/m
Drop	0.43	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	183.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1830 x 1220 mm Box	5.5310 m³/s	185.05 m	4.23 m/s

Culvert Designer/Analyzer Report
Culvert C3-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	185.05	m	Discharge	5.5310	m³/s
Headwater Depth/Height	1.51		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	185.05	m	Control Type	Inlet Control	
Outlet Control HW Elev.	185.01	m			

Grades					
Upstream Invert	183.20	m	Downstream Invert	182.77	m
Length	32.60	m	Constructed Slope	0.013190	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.71	m
Slope Type	Steep		Normal Depth	0.65	m
Flow Regime	Supercritical		Critical Depth	0.98	m
Velocity Downstream	4.23	m/s	Critical Slope	0.004402	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	185.01	m	Upstream Velocity Head	0.49	m
Ke	0.70		Entrance Loss	0.34	m

Inlet Control Properties					
Inlet Control HW Elev.	185.05	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	2.2	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	4.0880	m³/s	Check Discharge	4.6930	m³/s

Grades Model: Inverts					
Invert Upstream	183.25	m	Invert Downstream	183.19	m
Length	45.00	m	Slope	0.001319	m/m
Drop	0.06	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	183.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-3660 x 1220 mm Arch	4.0880 m³/s	184.15 m	2.22 m/s
	Trial-2	1-3660 x 1220 mm Arch	4.6930 m³/s	184.24 m	2.33 m/s

Culvert Designer/Analyzer Report
Culvert C3-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	184.15	m	Discharge	4.0880	m³/s
Headwater Depth/Height	0.74		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	184.10	m	Control Type	Outlet Control	
Outlet Control HW Elev.	184.15	m			

Grades					
Upstream Invert	183.25	m	Downstream Invert	183.19	m
Length	45.00	m	Constructed Slope	0.001319	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.50	m
Slope Type	Mild		Normal Depth	0.65	m
Flow Regime	Subcritical		Critical Depth	0.50	m
Velocity Downstream	2.22	m/s	Critical Slope	0.002881	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	184.15	m	Upstream Velocity Head	0.17	m
Ke	0.70		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	184.10	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	184.24	m	Discharge	4.6930	m³/s
Headwater Depth/Height	0.81		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	184.19	m	Control Type	Outlet Control	
Outlet Control HW Elev.	184.24	m			

Grades					
Upstream Invert	183.25	m	Downstream Invert	183.19	m
Length	45.00	m	Constructed Slope	0.001319	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.72	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.33	m/s	Critical Slope	0.002872	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	184.24	m	Upstream Velocity Head	0.19	m
Ke	0.70		Entrance Loss	0.13	m

Inlet Control Properties					
Inlet Control HW Elev.	184.19	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C3-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	5.5310	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	183.25	m	Invert Downstream	183.19	m
Length	45.00	m	Slope	0.001319	m/m
Drop	0.06	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	183.62	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-3660 x 1220 mm Box	5.5310 m³/s	184.35 m	2.46 m/s

Culvert Designer/Analyzer Report
Culvert C3-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	184.35	m	Discharge	5.5310	m³/s
Headwater Depth/Height	0.90		Tailwater Elevation	183.62	m
Inlet Control HW Elev.	184.30	m	Control Type	Outlet Control	
Outlet Control HW Elev.	184.35	m			

Grades					
Upstream Invert	183.25	m	Downstream Invert	183.19	m
Length	45.00	m	Constructed Slope	0.001319	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.62	m
Slope Type	Mild		Normal Depth	0.80	m
Flow Regime	Subcritical		Critical Depth	0.62	m
Velocity Downstream	2.46	m/s	Critical Slope	0.002868	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	184.35	m	Upstream Velocity Head	0.21	m
Ke	0.70		Entrance Loss	0.15	m

Inlet Control Properties					
Inlet Control HW Elev.	184.30	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C4-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.8350	m³/s	Check Discharge	0.9540	m³/s

Grades Model: Inverts					
Invert Upstream	181.06	m	Invert Downstream	180.94	m
Length	39.60	m	Slope	0.003030	m/m
Drop	0.12	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	181.52	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.8350 m³/s	182.25 m	2.03 m/s
	Trial-2	1-825 mm Circular	0.9540 m³/s	182.47 m	2.30 m/s

Culvert Designer/Analyzer Report
Culvert C4-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	182.25	m	Discharge	0.8350	m³/s
Headwater Depth/Height	1.42		Tailwater Elevation	181.52	m
Inlet Control HW Elev.	181.99	m	Control Type	Outlet Control	
Outlet Control HW Elev.	182.25	m			

Grades					
Upstream Invert	181.06	m	Downstream Invert	180.94	m
Length	39.60	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.59	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.03	m/s	Critical Slope	0.018010	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	182.25	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	181.99	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C4-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	182.47	m	Discharge	0.9540	m³/s
Headwater Depth/Height	1.69		Tailwater Elevation	181.52	m
Inlet Control HW Elev.	182.09	m	Control Type	Outlet Control	
Outlet Control HW Elev.	182.47	m			

Grades					
Upstream Invert	181.06	m	Downstream Invert	180.94	m
Length	39.60	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.59	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.59	m
Velocity Downstream	2.30	m/s	Critical Slope	0.019538	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	182.47	m	Upstream Velocity Head	0.15	m
Ke	0.90		Entrance Loss	0.14	m

Inlet Control Properties					
Inlet Control HW Elev.	182.09	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C4-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.7530	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	181.06	m	Invert Downstream	180.94	m
Length	39.60	m	Slope	0.003030	m/m
Drop	0.12	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	181.51	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.7530 m³/s	182.11 m	1.86 m/s

Culvert Designer/Analyzer Report
Culvert C4-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	182.11	m	Discharge	0.7530	m³/s
Headwater Depth/Height	1.26		Tailwater Elevation	181.51	m
Inlet Control HW Elev.	181.92	m	Control Type	Outlet Control	
Outlet Control HW Elev.	182.11	m			

Grades					
Upstream Invert	181.06	m	Downstream Invert	180.94	m
Length	39.60	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.58	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.52	m
Velocity Downstream	1.86	m/s	Critical Slope	0.017108	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	182.11	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	181.92	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C4-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.8350	m³/s	Check Discharge	0.9540	m³/s

Grades Model: Inverts					
Invert Upstream	181.08	m	Invert Downstream	180.94	m
Length	45.00	m	Slope	0.003030	m/m
Drop	0.14	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	181.52	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.8350 m³/s	181.93 m	2.05 m/s
	Trial-2	1-825 mm Circular	0.9540 m³/s	182.02 m	2.30 m/s

Culvert Designer/Analyzer Report
Culvert C4-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	181.93	m	Discharge	0.8350	m³/s
Headwater Depth/Height	1.02		Tailwater Elevation	181.52	m
Inlet Control HW Elev.	181.90	m	Control Type	Outlet Control	
Outlet Control HW Elev.	181.93	m			

Grades					
Upstream Invert	181.08	m	Downstream Invert	180.94	m
Length	45.00	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.58	m
Slope Type	Mild		Normal Depth	0.70	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.05	m/s	Critical Slope	0.005284	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	181.93	m	Upstream Velocity Head	0.16	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	181.90	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C4-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	182.02	m	Discharge	0.9540	m³/s
Headwater Depth/Height	1.13		Tailwater Elevation	181.52	m
Inlet Control HW Elev.	181.98	m	Control Type	Outlet Control	
Outlet Control HW Elev.	182.02	m			

Grades					
Upstream Invert	181.08	m	Downstream Invert	180.94	m
Length	45.00	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.59	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.59	m
Velocity Downstream	2.30	m/s	Critical Slope	0.005732	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	182.02	m	Upstream Velocity Head	0.18	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	181.98	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C4-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.7530	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	181.08	m	Invert Downstream	180.94	m
Length	45.00	m	Slope	0.003030	m/m
Drop	0.14	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	181.52	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.7530 m³/s	181.88 m	1.85 m/s

Culvert Designer/Analyzer Report
Culvert C4-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	181.88	m	Discharge	0.7530	m³/s
Headwater Depth/Height	0.95		Tailwater Elevation	181.52	m
Inlet Control HW Elev.	181.85	m	Control Type	Outlet Control	
Outlet Control HW Elev.	181.88	m			

Grades					
Upstream Invert	181.08	m	Downstream Invert	180.94	m
Length	45.00	m	Constructed Slope	0.003030	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.58	m
Slope Type	Mild		Normal Depth	0.63	m
Flow Regime	Subcritical		Critical Depth	0.52	m
Velocity Downstream	1.85	m/s	Critical Slope	0.005020	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	181.88	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	181.85	m	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	1.3250	m³/s	Check Discharge	1.5380	m³/s

Grades Model: Inverts					
Invert Upstream	178.18	m	Invert Downstream	177.78	m
Length	36.30	m	Slope	0.011019	m/m
Drop	0.40	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	178.20	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	1.3250 m³/s	180.97 m	4.55 m/s
	Trial-2	1-600 mm Circular	1.5380 m³/s	181.87 m	5.28 m/s

Culvert Designer/Analyzer Report
Culvert C5-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	180.97	m	Discharge	1.3250	m³/s
Headwater Depth/Height	4.58		Tailwater Elevation	178.20	m
Inlet Control HW Elev.	180.74	m	Control Type	Outlet Control	
Outlet Control HW Elev.	180.97	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	36.30	m	Constructed Slope	0.011019	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.60	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.60	m
Velocity Downstream	4.55	m/s	Critical Slope	0.033247	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	180.97	m	Upstream Velocity Head	1.05	m
Ke	0.20		Entrance Loss	0.21	m

Inlet Control Properties					
Inlet Control HW Elev.	180.74	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	181.87	m	Discharge	1.5380	m³/s
Headwater Depth/Height	6.05		Tailwater Elevation	178.20	m
Inlet Control HW Elev.	181.49	m	Control Type	Outlet Control	
Outlet Control HW Elev.	181.87	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	36.30	m	Constructed Slope	0.011019	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.61	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.61	m
Velocity Downstream	5.28	m/s	Critical Slope	0.045777	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	181.87	m	Upstream Velocity Head	1.42	m
Ke	0.20		Entrance Loss	0.28	m

Inlet Control Properties					
Inlet Control HW Elev.	181.49	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	2.1270	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	178.18	m	Invert Downstream	177.78	m
Length	36.30	m	Slope	0.011019	m/m
Drop	0.40	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	178.20	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	2.1270 m³/s	185.05 m	7.29 m/s

Culvert Designer/Analyzer Report
Culvert C5-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	185.05	m	Discharge	2.1270	m³/s
Headwater Depth/Height	11.27		Tailwater Elevation	178.20	m
Inlet Control HW Elev.	184.12	m	Control Type	Outlet Control	
Outlet Control HW Elev.	185.05	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	36.30	m	Constructed Slope	0.011019	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.61	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.61	m
Velocity Downstream	7.29	m/s	Critical Slope	0.090516	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	185.05	m	Upstream Velocity Head	2.71	m
Ke	0.20		Entrance Loss	0.54	m

Inlet Control Properties					
Inlet Control HW Elev.	184.12	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	1.3250	m³/s	Check Discharge	1.5380	m³/s

Grades Model: Inverts					
Invert Upstream	178.18	m	Invert Downstream	177.78	m
Length	45.00	m	Slope	0.008889	m/m
Drop	0.40	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	178.36	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	1.3250 m³/s	179.35 m	2.91 m/s
	Trial-2	1-825 mm Circular	1.5380 m³/s	179.56 m	3.01 m/s

Culvert Designer/Analyzer Report
Culvert C5-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	179.35	m	Discharge	1.3250	m³/s
Headwater Depth/Height	1.40		Tailwater Elevation	178.36	m
Inlet Control HW Elev.	179.35	m	Control Type	Inlet Control	
Outlet Control HW Elev.	179.32	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	45.00	m	Constructed Slope	0.008889	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.64	m
Slope Type	Steep		Normal Depth	0.64	m
Flow Regime	Supercritical		Critical Depth	0.69	m
Velocity Downstream	2.91	m/s	Critical Slope	0.007776	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	179.32	m	Upstream Velocity Head	0.38	m
Ke	0.20		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	179.35	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	179.56	m	Discharge	1.5380	m³/s
Headwater Depth/Height	1.65		Tailwater Elevation	178.36	m
Inlet Control HW Elev.	179.56	m	Control Type	Inlet Control	
Outlet Control HW Elev.	179.47	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	45.00	m	Constructed Slope	0.008889	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.73	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.73	m
Velocity Downstream	3.01	m/s	Critical Slope	0.009562	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	179.47	m	Upstream Velocity Head	0.41	m
Ke	0.20		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	179.56	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C5-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	2.1270	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	178.18	m	Invert Downstream	177.78	m
Length	45.00	m	Slope	0.008889	m/m
Drop	0.40	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	178.36	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	2.1270 m³/s	180.42 m	3.92 m/s

Culvert Designer/Analyzer Report
Culvert C5-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	180.42	m	Discharge	2.1270	m³/s
Headwater Depth/Height	2.67		Tailwater Elevation	178.36	m
Inlet Control HW Elev.	180.30	m	Control Type	Outlet Control	
Outlet Control HW Elev.	180.42	m			

Grades					
Upstream Invert	178.18	m	Downstream Invert	177.78	m
Length	45.00	m	Constructed Slope	0.008889	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.80	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.80	m
Velocity Downstream	3.92	m/s	Critical Slope	0.017517	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	180.42	m	Upstream Velocity Head	0.76	m
Ke	0.20		Entrance Loss	0.15	m

Inlet Control Properties					
Inlet Control HW Elev.	180.30	m	Flow Control	Submerged	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C6-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	1.6440	m³/s	Check Discharge	1.9190	m³/s

Grades Model: Inverts					
Invert Upstream	173.60	m	Invert Downstream	171.96	m
Length	41.60	m	Slope	0.039423	m/m
Drop	1.64	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	172.35	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-525 mm Circular	1.6440 m³/s	180.56 m	7.36 m/s
	Trial-2	1-525 mm Circular	1.9190 m³/s	183.49 m	8.59 m/s

Culvert Designer/Analyzer Report
Culvert C6-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	180.56	m	Discharge	1.6440	m³/s
Headwater Depth/Height	13.06		Tailwater Elevation	172.35	m
Inlet Control HW Elev.	178.35	m	Control Type	Outlet Control	
Outlet Control HW Elev.	180.56	m			

Grades					
Upstream Invert	173.60	m	Downstream Invert	171.96	m
Length	41.60	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.53	m
Velocity Downstream	7.36	m/s	Critical Slope	0.110768	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.53	m
Section Size	525 mm		Rise	0.53	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	180.56	m	Upstream Velocity Head	2.76	m
Ke	0.20		Entrance Loss	0.55	m

Inlet Control Properties					
Inlet Control HW Elev.	178.35	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.2	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C6-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	183.49	m	Discharge	1.9190	m³/s
Headwater Depth/Height	18.54		Tailwater Elevation	172.35	m
Inlet Control HW Elev.	179.91	m	Control Type	Outlet Control	
Outlet Control HW Elev.	183.49	m			

Grades					
Upstream Invert	173.60	m	Downstream Invert	171.96	m
Length	41.60	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.53	m
Velocity Downstream	8.59	m/s	Critical Slope	0.152225	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.53	m
Section Size	525 mm		Rise	0.53	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	183.49	m	Upstream Velocity Head	3.76	m
Ke	0.20		Entrance Loss	0.75	m

Inlet Control Properties					
Inlet Control HW Elev.	179.91	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.2	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C6-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	2.8270	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	173.60	m	Invert Downstream	171.96	m
Length	41.60	m	Slope	0.039423	m/m
Drop	1.64	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	172.35	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-525 mm Circular	2.8270 m³/s	196.36 m	12.65 m/s

Culvert Designer/Analyzer Report
Culvert C6-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	196.36	m	Discharge	2.8270	m³/s
Headwater Depth/Height	42.67		Tailwater Elevation	172.35	m
Inlet Control HW Elev.	186.79	m	Control Type	Outlet Control	
Outlet Control HW Elev.	196.36	m			

Grades					
Upstream Invert	173.60	m	Downstream Invert	171.96	m
Length	41.60	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	0.53	m
Slope Type	N/A		Normal Depth	N/A	m
Flow Regime	N/A		Critical Depth	0.53	m
Velocity Downstream	12.65	m/s	Critical Slope	0.333225	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.53	m
Section Size	525 mm		Rise	0.53	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.36	m	Upstream Velocity Head	8.16	m
Ke	0.20		Entrance Loss	1.63	m

Inlet Control Properties					
Inlet Control HW Elev.	186.79	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.2	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C6-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	1.6440	m³/s	Check Discharge	1.9190	m³/s

Grades Model: Inverts					
Invert Upstream	173.73	m	Invert Downstream	171.96	m
Length	45.00	m	Slope	0.039423	m/m
Drop	1.77	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	172.70	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	1.6440 m³/s	174.85 m	2.48 m/s
	Trial-2	1-1050 mm Circular	1.9190 m³/s	174.97 m	5.36 m/s

Culvert Designer/Analyzer Report
Culvert C6-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	174.85	m	Discharge	1.6440	m³/s
Headwater Depth/Height	1.05		Tailwater Elevation	172.70	m
Inlet Control HW Elev.	174.82	m	Control Type	Entrance Control	
Outlet Control HW Elev.	174.85	m			

Grades					
Upstream Invert	173.73	m	Downstream Invert	171.96	m
Length	45.00	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.74	m
Slope Type	Steep		Normal Depth	0.39	m
Flow Regime	N/A		Critical Depth	0.73	m
Velocity Downstream	2.48	m/s	Critical Slope	0.005091	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	174.85	m	Upstream Velocity Head	0.33	m
Ke	0.20		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	174.82	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C6-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	174.97	m	Discharge	1.9190	m³/s
Headwater Depth/Height	1.16		Tailwater Elevation	172.70	m
Inlet Control HW Elev.	174.94	m	Control Type	Entrance Control	
Outlet Control HW Elev.	174.97	m			

Grades					
Upstream Invert	173.73	m	Downstream Invert	171.96	m
Length	45.00	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.45	m
Slope Type	Steep		Normal Depth	0.43	m
Flow Regime	Supercritical		Critical Depth	0.79	m
Velocity Downstream	5.36	m/s	Critical Slope	0.005682	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	174.97	m	Upstream Velocity Head	0.38	m
Ke	0.20		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	174.94	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C6-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	2.8270	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	173.73	m	Invert Downstream	171.96	m
Length	45.00	m	Slope	0.039423	m/m
Drop	1.77	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	172.70	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	2.8270 m³/s	175.49 m	5.79 m/s

Culvert Designer/Analyzer Report
Culvert C6-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	175.49	m	Discharge	2.8270	m³/s
Headwater Depth/Height	1.65		Tailwater Elevation	172.70	m
Inlet Control HW Elev.	175.49	m	Control Type	Inlet Control	
Outlet Control HW Elev.	175.38	m			

Grades					
Upstream Invert	173.73	m	Downstream Invert	171.96	m
Length	45.00	m	Constructed Slope	0.039423	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.57	m
Slope Type	Steep		Normal Depth	0.53	m
Flow Regime	Supercritical		Critical Depth	0.93	m
Velocity Downstream	5.79	m/s	Critical Slope	0.008904	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	175.38	m	Upstream Velocity Head	0.59	m
Ke	0.20		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	175.49	m	Flow Control	Submerged	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
Culvert C9-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	7.3000	m³/s	Check Discharge	8.3850	m³/s

Grades Model: Inverts					
Invert Upstream	155.28	m	Invert Downstream	155.06	m
Length	59.10	m	Slope	0.003723	m/m
Drop	0.22	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.34	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1830 mm Arch	7.3000 m³/s	157.03 m	2.34 m/s
	Trial-2	1-2440 x 1830 mm Arch	8.3850 m³/s	157.24 m	2.69 m/s

Culvert Designer/Analyzer Report
Culvert C9-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	157.03	m	Discharge	7.3000	m³/s
Headwater Depth/Height	0.96		Tailwater Elevation	156.34	m
Inlet Control HW Elev.	156.93	m	Control Type	Outlet Control	
Outlet Control HW Elev.	157.03	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	S1		Depth, Downstream	1.28	m
Slope Type	Steep		Normal Depth	0.96	m
Flow Regime	Subcritical		Critical Depth	0.97	m
Velocity Downstream	2.34	m/s	Critical Slope	0.003654	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1830 mm		Rise	1.83	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	157.03	m	Upstream Velocity Head	0.40	m
Ke	0.70		Entrance Loss	0.28	m

Inlet Control Properties					
Inlet Control HW Elev.	156.93	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C9-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	157.24	m	Discharge	8.3850	m³/s
Headwater Depth/Height	1.07		Tailwater Elevation	156.34	m
Inlet Control HW Elev.	157.10	m	Control Type	Outlet Control	
Outlet Control HW Elev.	157.24	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	1.28	m
Slope Type	Mild		Normal Depth	1.07	m
Flow Regime	Subcritical		Critical Depth	1.06	m
Velocity Downstream	2.69	m/s	Critical Slope	0.003748	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1830 mm		Rise	1.83	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	157.24	m	Upstream Velocity Head	0.51	m
Ke	0.70		Entrance Loss	0.36	m

Inlet Control Properties					
Inlet Control HW Elev.	157.10	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C9-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	14.2890	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	155.28	m	Invert Downstream	155.06	m
Length	59.10	m	Slope	0.003723	m/m
Drop	0.22	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.34	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1830 mm Arch	14.2890 m³/s	158.20 m	3.86 m/s

Culvert Designer/Analyzer Report
Culvert C9-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	158.20	m	Discharge	14.2890	m³/s
Headwater Depth/Height	1.60		Tailwater Elevation	156.34	m
Inlet Control HW Elev.	158.20	m	Control Type	Inlet Control	
Outlet Control HW Elev.	158.04	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.52	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	1.52	m
Velocity Downstream	3.86	m/s	Critical Slope	0.004240	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1830 mm		Rise	1.83	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.04	m	Upstream Velocity Head	0.69	m
Ke	0.70		Entrance Loss	0.48	m

Inlet Control Properties					
Inlet Control HW Elev.	158.20	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	4.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C9-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	7.3000	m³/s	Check Discharge	8.3850	m³/s

Grades Model: Inverts					
Invert Upstream	155.28	m	Invert Downstream	155.06	m
Length	59.10	m	Slope	0.003723	m/m
Drop	0.22	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.11	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-3660 x 1520 mm CSP	7.3000 m³/s	156.65 m	1.90 m/s
	Trial-2	1-3660 x 1520 mm CSP	8.3850 m³/s	156.78 m	2.18 m/s

Culvert Designer/Analyzer Report
Culvert C9-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.65	m	Discharge	7.3000	m³/s
Headwater Depth/Height	0.90		Tailwater Elevation	156.11	m
Inlet Control HW Elev.	156.54	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.65	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	1.05	m
Slope Type	Steep		Normal Depth	0.68	m
Flow Regime	N/A		Critical Depth	0.74	m
Velocity Downstream	1.90	m/s	Critical Slope	0.002882	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1520 mm		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.65	m	Upstream Velocity Head	0.37	m
Ke	0.70		Entrance Loss	0.26	m

Inlet Control Properties					
Inlet Control HW Elev.	156.54	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	5.6	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C9-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	156.78	m	Discharge	8.3850	m³/s
Headwater Depth/Height	0.99		Tailwater Elevation	156.11	m
Inlet Control HW Elev.	156.66	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.78	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	1.05	m
Slope Type	Steep		Normal Depth	0.75	m
Flow Regime	N/A		Critical Depth	0.81	m
Velocity Downstream	2.18	m/s	Critical Slope	0.002900	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1520 mm		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.78	m	Upstream Velocity Head	0.41	m
Ke	0.70		Entrance Loss	0.28	m

Inlet Control Properties					
Inlet Control HW Elev.	156.66	m	Flow Control	N/A	
Inlet Type	0°wingwall flares		Area Full	5.6	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C9-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	14.2890	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	155.28	m	Invert Downstream	155.06	m
Length	59.10	m	Slope	0.003723	m/m
Drop	0.22	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.11	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-3660 x 1520 mm Arch	14.2890 m³/s	157.42 m	3.62 m/s

Culvert Designer/Analyzer Report
Culvert C9-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	157.42	m	Discharge	14.2890	m³/s
Headwater Depth/Height	1.41		Tailwater Elevation	156.11	m
Inlet Control HW Elev.	157.37	m	Control Type	Entrance Control	
Outlet Control HW Elev.	157.42	m			

Grades					
Upstream Invert	155.28	m	Downstream Invert	155.06	m
Length	59.10	m	Constructed Slope	0.003723	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.08	m
Slope Type	Steep		Normal Depth	1.08	m
Flow Regime	Supercritical		Critical Depth	1.16	m
Velocity Downstream	3.62	m/s	Critical Slope	0.003036	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.66	m
Section Size	3660 x 1520 mm		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	157.42	m	Upstream Velocity Head	0.58	m
Ke	0.70		Entrance Loss	0.41	m

Inlet Control Properties					
Inlet Control HW Elev.	157.37	m	Flow Control	Transition	
Inlet Type	0°wingwall flares		Area Full	5.6	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C16-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	1.5510	m³/s	Check Discharge	1.7660	m³/s

Grades Model: Inverts					
Invert Upstream	151.06	m	Invert Downstream	150.24	m
Length	43.20	m	Slope	0.018981	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	151.08	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1220 mm Arch	1.5510 m³/s	151.61 m	0.76 m/s
	Trial-2	1-2440 x 1220 mm Arch	1.7660 m³/s	151.66 m	0.86 m/s

Culvert Designer/Analyzer Report
Culvert C16-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	151.61	m	Discharge	1.5510	m³/s
Headwater Depth/Height	0.45		Tailwater Elevation	151.08	m
Inlet Control HW Elev.	151.60	m	Control Type	Entrance Control	
Outlet Control HW Elev.	151.61	m			

Grades					
Upstream Invert	151.06	m	Downstream Invert	150.24	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.84	m
Slope Type	Steep		Normal Depth	0.20	m
Flow Regime	N/A		Critical Depth	0.35	m
Velocity Downstream	0.76	m/s	Critical Slope	0.003294	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	151.61	m	Upstream Velocity Head	0.17	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	151.60	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C16-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	151.66	m	Discharge	1.7660	m³/s
Headwater Depth/Height	0.49		Tailwater Elevation	151.08	m
Inlet Control HW Elev.	151.65	m	Control Type	Entrance Control	
Outlet Control HW Elev.	151.66	m			

Grades					
Upstream Invert	151.06	m	Downstream Invert	150.24	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.84	m
Slope Type	Steep		Normal Depth	0.21	m
Flow Regime	N/A		Critical Depth	0.38	m
Velocity Downstream	0.86	m/s	Critical Slope	0.003286	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	151.66	m	Upstream Velocity Head	0.19	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	151.65	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 16-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	3.2300	m³/s	Check Discharge	3.8760	m³/s

Grades Model: Inverts					
Invert Upstream	151.06	m	Invert Downstream	150.24	m
Length	43.20	m	Slope	0.018981	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	151.08	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-2440 x 1220 mm Arch	3.2300 m³/s	151.96 m	1.58 m/s
	Trial-2	1-2440 x 1220 mm Arch	3.8760 m³/s	152.08 m	1.89 m/s

Culvert Designer/Analyzer Report
Culvert 16-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	151.96	m	Discharge	3.2300	m³/s
Headwater Depth/Height	0.74		Tailwater Elevation	151.08	m
Inlet Control HW Elev.	151.95	m	Control Type	Entrance Control	
Outlet Control HW Elev.	151.96	m			

Grades					
Upstream Invert	151.06	m	Downstream Invert	150.24	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.84	m
Slope Type	Steep		Normal Depth	0.31	m
Flow Regime	N/A		Critical Depth	0.56	m
Velocity Downstream	1.58	m/s	Critical Slope	0.003330	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	151.96	m	Upstream Velocity Head	0.28	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	151.95	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert 16-Reg-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	152.08	m	Discharge	3.8760	m³/s
Headwater Depth/Height	0.84		Tailwater Elevation	151.08	m
Inlet Control HW Elev.	152.06	m	Control Type	Entrance Control	
Outlet Control HW Elev.	152.08	m			

Grades					
Upstream Invert	151.06	m	Downstream Invert	150.24	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.84	m
Slope Type	Steep		Normal Depth	0.35	m
Flow Regime	N/A		Critical Depth	0.64	m
Velocity Downstream	1.89	m/s	Critical Slope	0.003373	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.44	m
Section Size	2440 x 1220 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	152.08	m	Upstream Velocity Head	0.32	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	152.06	m	Flow Control	N/A	
Inlet Type	90° headwall w 45° bevels		Area Full	3.0	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Designer/Analyzer Report
Culvert C18-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.0356	m³/s	Check Discharge	0.0400	m³/s

Grades Model: Inverts					
Invert Upstream	156.59	m	Invert Downstream	155.47	m
Length	43.80	m	Slope	0.025342	m/m
Drop	1.11	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.0356 m³/s	156.76 m	0.09 m/s
	Trial-2	1-825 mm Circular	0.0400 m³/s	156.77 m	0.10 m/s

Culvert Designer/Analyzer Report
Culvert C18-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.76	m	Discharge	0.0356	m³/s
Headwater Depth/Height	0.21		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.72	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.76	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	43.80	m	Constructed Slope	0.025342	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.10	m
Flow Regime	N/A		Critical Depth	0.11	m
Velocity Downstream	0.09	m/s	Critical Slope	0.015190	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.76	m	Upstream Velocity Head	0.04	m
Ke	0.90		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	156.72	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C18-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	156.77	m	Discharge	0.0400	m³/s
Headwater Depth/Height	0.23		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.73	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.77	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	43.80	m	Constructed Slope	0.025342	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.10	m
Flow Regime	N/A		Critical Depth	0.11	m
Velocity Downstream	0.10	m/s	Critical Slope	0.015004	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.77	m	Upstream Velocity Head	0.04	m
Ke	0.90		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	156.73	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C18-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.0760	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	156.59	m	Invert Downstream	155.47	m
Length	43.80	m	Slope	0.025342	m/m
Drop	1.11	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.0760 m³/s	156.85 m	0.19 m/s

Culvert Designer/Analyzer Report
Culvert C18-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.85	m	Discharge	0.0760	m³/s
Headwater Depth/Height	0.32		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.79	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.85	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	43.80	m	Constructed Slope	0.025342	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	N/A		Critical Depth	0.16	m
Velocity Downstream	0.19	m/s	Critical Slope	0.014153	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.85	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	156.79	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C18-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.0356	m³/s	Check Discharge	0.0400	m³/s

Grades Model: Inverts					
Invert Upstream	156.59	m	Invert Downstream	155.47	m
Length	45.00	m	Slope	0.024667	m/m
Drop	1.11	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.0356 m³/s	156.74 m	0.09 m/s
	Trial-2	1-825 mm Circular	0.0400 m³/s	156.75 m	0.10 m/s

Culvert Designer/Analyzer Report
Culvert C18-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.74	m	Discharge	0.0356	m³/s
Headwater Depth/Height	0.18		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.72	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.74	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	45.00	m	Constructed Slope	0.024667	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.07	m
Flow Regime	N/A		Critical Depth	0.11	m
Velocity Downstream	0.09	m/s	Critical Slope	0.004457	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.74	m	Upstream Velocity Head	0.04	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	156.72	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C18-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	156.75	m	Discharge	0.0400	m³/s
Headwater Depth/Height	0.19		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.73	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.75	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	45.00	m	Constructed Slope	0.024667	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.08	m
Flow Regime	N/A		Critical Depth	0.11	m
Velocity Downstream	0.10	m/s	Critical Slope	0.004402	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.75	m	Upstream Velocity Head	0.04	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	156.73	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C18-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.0760	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	156.59	m	Invert Downstream	155.47	m
Length	45.00	m	Slope	0.024667	m/m
Drop	1.11	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	156.05	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.0760 m³/s	156.81 m	0.19 m/s

Culvert Designer/Analyzer Report
Culvert C18-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.81	m	Discharge	0.0760	m³/s
Headwater Depth/Height	0.27		Tailwater Elevation	156.05	m
Inlet Control HW Elev.	156.79	m	Control Type	Entrance Control	
Outlet Control HW Elev.	156.81	m			

Grades					
Upstream Invert	156.59	m	Downstream Invert	155.47	m
Length	45.00	m	Constructed Slope	0.024667	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.58	m
Slope Type	Steep		Normal Depth	0.10	m
Flow Regime	N/A		Critical Depth	0.16	m
Velocity Downstream	0.19	m/s	Critical Slope	0.004152	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.81	m	Upstream Velocity Head	0.06	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	156.79	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.1630	m³/s	Check Discharge	0.1830	m³/s

Grades Model: Inverts					
Invert Upstream	158.60	m	Invert Downstream	157.78	m
Length	43.20	m	Slope	0.018981	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	158.31	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.1630 m³/s	158.95 m	0.48 m/s
	Trial-2	1-750 mm Circular	0.1830 m³/s	158.97 m	0.54 m/s

Culvert Designer/Analyzer Report
Culvert C19-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	158.95	m	Discharge	0.1630	m³/s
Headwater Depth/Height	0.46		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	158.92	m	Control Type	Entrance Control	
Outlet Control HW Elev.	158.95	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.16	m
Flow Regime	N/A		Critical Depth	0.24	m
Velocity Downstream	0.48	m/s	Critical Slope	0.003528	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.95	m	Upstream Velocity Head	0.09	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	158.92	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	158.97	m	Discharge	0.1830	m³/s
Headwater Depth/Height	0.48		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	158.94	m	Control Type	Entrance Control	
Outlet Control HW Elev.	158.97	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.17	m
Flow Regime	N/A		Critical Depth	0.26	m
Velocity Downstream	0.54	m/s	Critical Slope	0.003538	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior Corrugated)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.97	m	Upstream Velocity Head	0.09	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	158.94	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.3460	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	158.60	m	Invert Downstream	157.78	m
Length	43.20	m	Slope	0.018981	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	158.31	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.3460 m³/s	159.12 m	1.02 m/s

Culvert Designer/Analyzer Report
Culvert C19-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	159.12	m	Discharge	0.3460	m³/s
Headwater Depth/Height	0.69		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	159.09	m	Control Type	Entrance Control	
Outlet Control HW Elev.	159.12	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	43.20	m	Constructed Slope	0.018981	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.23	m
Flow Regime	N/A		Critical Depth	0.36	m
Velocity Downstream	1.02	m/s	Critical Slope	0.003762	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	159.12	m	Upstream Velocity Head	0.14	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	159.09	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.1630	m³/s	Check Discharge	0.1830	m³/s

Grades Model: Inverts					
Invert Upstream	158.60	m	Invert Downstream	157.78	m
Length	45.00	m	Slope	0.018222	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	158.31	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.1630 m³/s	158.95 m	0.48 m/s
	Trial-2	1-750 mm Circular	0.1830 m³/s	158.97 m	0.54 m/s

Culvert Designer/Analyzer Report
Culvert C19-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	158.95	m	Discharge	0.1630	m³/s
Headwater Depth/Height	0.46		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	158.92	m	Control Type	Entrance Control	
Outlet Control HW Elev.	158.95	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	45.00	m	Constructed Slope	0.018222	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.16	m
Flow Regime	N/A		Critical Depth	0.24	m
Velocity Downstream	0.48	m/s	Critical Slope	0.003528	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.95	m	Upstream Velocity Head	0.09	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	158.92	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	158.97	m	Discharge	0.1830	m³/s
Headwater Depth/Height	0.48		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	158.94	m	Control Type	Entrance Control	
Outlet Control HW Elev.	158.97	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	45.00	m	Constructed Slope	0.018222	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.17	m
Flow Regime	N/A		Critical Depth	0.26	m
Velocity Downstream	0.54	m/s	Critical Slope	0.003538	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.97	m	Upstream Velocity Head	0.09	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	158.94	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C19-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.3460	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	158.60	m	Invert Downstream	157.78	m
Length	45.00	m	Slope	0.018222	m/m
Drop	0.82	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	158.31	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.3460 m³/s	159.12 m	1.02 m/s

Culvert Designer/Analyzer Report
Culvert C19-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	159.12	m	Discharge	0.3460	m³/s
Headwater Depth/Height	0.69		Tailwater Elevation	158.31	m
Inlet Control HW Elev.	159.09	m	Control Type	Entrance Control	
Outlet Control HW Elev.	159.12	m			

Grades					
Upstream Invert	158.60	m	Downstream Invert	157.78	m
Length	45.00	m	Constructed Slope	0.018222	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.23	m
Flow Regime	N/A		Critical Depth	0.36	m
Velocity Downstream	1.02	m/s	Critical Slope	0.003762	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior Corrugated)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	159.12	m	Upstream Velocity Head	0.14	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	159.09	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C20-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.6550	m³/s	Check Discharge	0.7370	m³/s

Grades Model: Inverts					
Invert Upstream	154.64	m	Invert Downstream	154.38	m
Length	42.00	m	Slope	0.006190	m/m
Drop	0.26	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	155.01	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	0.6550 m³/s	155.45 m	1.36 m/s
	Trial-2	1-900 mm Circular	0.7370 m³/s	155.51 m	1.53 m/s

Culvert Designer/Analyzer Report
Culvert C20-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	155.45	m	Discharge	0.6550	m³/s
Headwater Depth/Height	0.88		Tailwater Elevation	155.01	m
Inlet Control HW Elev.	155.38	m	Control Type	Outlet Control	
Outlet Control HW Elev.	155.45	m			

Grades					
Upstream Invert	154.64	m	Downstream Invert	154.38	m
Length	42.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.63	m
Slope Type	Mild		Normal Depth	0.63	m
Flow Regime	Subcritical		Critical Depth	0.47	m
Velocity Downstream	1.36	m/s	Critical Slope	0.014722	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	155.45	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	155.38	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C20-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	155.51	m	Discharge	0.7370	m³/s
Headwater Depth/Height	0.95		Tailwater Elevation	155.01	m
Inlet Control HW Elev.	155.44	m	Control Type	Outlet Control	
Outlet Control HW Elev.	155.51	m			

Grades					
Upstream Invert	154.64	m	Downstream Invert	154.38	m
Length	42.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.63	m
Slope Type	Mild		Normal Depth	0.69	m
Flow Regime	Subcritical		Critical Depth	0.50	m
Velocity Downstream	1.53	m/s	Critical Slope	0.015209	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	155.51	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	155.44	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C20-Reg.-Existing

Peak Discharge Method: User-Specified					
Design Discharge	1.6660	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	154.64	m	Invert Downstream	154.38	m
Length	42.00	m	Slope	0.006190	m/m
Drop	0.26	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	154.74	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	1.6660 m³/s	156.96 m	2.87 m/s

Culvert Designer/Analyzer Report
Culvert C20-Reg.-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	156.96	m	Discharge	1.6660	m³/s
Headwater Depth/Height	2.53		Tailwater Elevation	154.74	m
Inlet Control HW Elev.	156.30	m	Control Type	Outlet Control	
Outlet Control HW Elev.	156.96	m			

Grades					
Upstream Invert	154.64	m	Downstream Invert	154.38	m
Length	42.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.76	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.76	m
Velocity Downstream	2.87	m/s	Critical Slope	0.026112	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	156.96	m	Upstream Velocity Head	0.33	m
Ke	0.90		Entrance Loss	0.30	m

Inlet Control Properties					
Inlet Control HW Elev.	156.30	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C20-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.6550	m³/s	Check Discharge	0.7370	m³/s

Grades Model: Inverts					
Invert Upstream	154.66	m	Invert Downstream	154.38	m
Length	45.00	m	Slope	0.006190	m/m
Drop	0.28	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	155.12	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	0.6550 m³/s	155.31 m	0.99 m/s
	Trial-2	1-1050 mm Circular	0.7370 m³/s	155.36 m	1.11 m/s

Culvert Designer/Analyzer Report
Culvert C20-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	155.31	m	Discharge	0.6550	m³/s
Headwater Depth/Height	0.61		Tailwater Elevation	155.12	m
Inlet Control HW Elev.	155.28	m	Control Type	Entrance Control	
Outlet Control HW Elev.	155.31	m			

Grades					
Upstream Invert	154.66	m	Downstream Invert	154.38	m
Length	45.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.74	m
Slope Type	Steep		Normal Depth	0.40	m
Flow Regime	N/A		Critical Depth	0.45	m
Velocity Downstream	0.99	m/s	Critical Slope	0.003831	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	155.31	m	Upstream Velocity Head	0.17	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	155.28	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C20-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	155.36	m	Discharge	0.7370	m³/s
Headwater Depth/Height	0.65		Tailwater Elevation	155.12	m
Inlet Control HW Elev.	155.32	m	Control Type	Entrance Control	
Outlet Control HW Elev.	155.36	m			

Grades					
Upstream Invert	154.66	m	Downstream Invert	154.38	m
Length	45.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.74	m
Slope Type	Steep		Normal Depth	0.42	m
Flow Regime	N/A		Critical Depth	0.48	m
Velocity Downstream	1.11	m/s	Critical Slope	0.003894	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	155.36	m	Upstream Velocity Head	0.18	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	155.32	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C20-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	1.6660	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	154.66	m	Invert Downstream	154.38	m
Length	45.00	m	Slope	0.006190	m/m
Drop	0.28	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	155.12	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	1.6660 m³/s	155.79 m	2.52 m/s

Culvert Designer/Analyzer Report
Culvert C20-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	155.79	m	Discharge	1.6660	m³/s
Headwater Depth/Height	1.06		Tailwater Elevation	155.12	m
Inlet Control HW Elev.	155.76	m	Control Type	Entrance Control	
Outlet Control HW Elev.	155.79	m			

Grades					
Upstream Invert	154.66	m	Downstream Invert	154.38	m
Length	45.00	m	Constructed Slope	0.006190	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.74	m
Slope Type	Steep		Normal Depth	0.69	m
Flow Regime	N/A		Critical Depth	0.73	m
Velocity Downstream	2.52	m/s	Critical Slope	0.005134	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	155.79	m	Upstream Velocity Head	0.33	m
Ke	0.20		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	155.76	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.9200	m³/s	Check Discharge	1.0400	m³/s

Grades Model: Inverts					
Invert Upstream	151.75	m	Invert Downstream	151.59	m
Length	42.90	m	Slope	0.003730	m/m
Drop	0.16	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	152.19	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.9200 m³/s	153.10 m	2.20 m/s
	Trial-2	1-825 mm Circular	1.0400 m³/s	153.36 m	2.40 m/s

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	153.10	m	Discharge	0.9200	m³/s
Headwater Depth/Height	1.61		Tailwater Elevation	152.19	m
Inlet Control HW Elev.	152.76	m	Control Type	Outlet Control	
Outlet Control HW Elev.	153.10	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.59	m
Length	42.90	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.59	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.58	m
Velocity Downstream	2.20	m/s	Critical Slope	0.019074	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	153.10	m	Upstream Velocity Head	0.14	m
Ke	0.90		Entrance Loss	0.13	m

Inlet Control Properties					
Inlet Control HW Elev.	152.76	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	153.36	m	Discharge	1.0400	m³/s
Headwater Depth/Height	1.92		Tailwater Elevation	152.19	m
Inlet Control HW Elev.	152.87	m	Control Type	Outlet Control	
Outlet Control HW Elev.	153.36	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.59	m
Length	42.90	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.62	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.62	m
Velocity Downstream	2.40	m/s	Critical Slope	0.020823	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	153.36	m	Upstream Velocity Head	0.18	m
Ke	0.90		Entrance Loss	0.16	m

Inlet Control Properties					
Inlet Control HW Elev.	152.87	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21A-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	2.5000	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	151.75	m	Invert Downstream	151.59	m
Length	42.90	m	Slope	0.003730	m/m
Drop	0.16	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	152.19	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	2.5000 m³/s	158.48 m	4.56 m/s

Culvert Designer/Analyzer Report
Culvert C21A-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	158.48	m	Discharge	2.5000	m³/s
Headwater Depth/Height	8.03		Tailwater Elevation	152.19	m
Inlet Control HW Elev.	155.93	m	Control Type	Outlet Control	
Outlet Control HW Elev.	158.48	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.59	m
Length	42.90	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.82	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.82	m
Velocity Downstream	4.56	m/s	Critical Slope	0.084356	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	158.48	m	Upstream Velocity Head	1.05	m
Ke	0.90		Entrance Loss	0.94	m

Inlet Control Properties					
Inlet Control HW Elev.	155.93	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.9200	m³/s	Check Discharge	1.0400	m³/s

Grades Model: Inverts					
Invert Upstream	151.75	m	Invert Downstream	151.58	m
Length	45.00	m	Slope	0.003730	m/m
Drop	0.17	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	152.32	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	0.9200 m³/s	152.54 m	1.39 m/s
	Trial-2	1-1050 mm Circular	1.0400 m³/s	152.60 m	1.58 m/s

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	152.54	m	Discharge	0.9200	m³/s
Headwater Depth/Height	0.74		Tailwater Elevation	152.32	m
Inlet Control HW Elev.	152.51	m	Control Type	Outlet Control	
Outlet Control HW Elev.	152.54	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.58	m
Length	45.00	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.74	m
Slope Type	Mild		Normal Depth	0.55	m
Flow Regime	Subcritical		Critical Depth	0.54	m
Velocity Downstream	1.39	m/s	Critical Slope	0.004059	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	152.54	m	Upstream Velocity Head	0.16	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	152.51	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21A-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	152.60	m	Discharge	1.0400	m³/s
Headwater Depth/Height	0.80		Tailwater Elevation	152.32	m
Inlet Control HW Elev.	152.56	m	Control Type	Outlet Control	
Outlet Control HW Elev.	152.60	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.58	m
Length	45.00	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.74	m
Slope Type	Mild		Normal Depth	0.59	m
Flow Regime	Subcritical		Critical Depth	0.57	m
Velocity Downstream	1.58	m/s	Critical Slope	0.004188	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	152.60	m	Upstream Velocity Head	0.19	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	152.56	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21A-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	2.5000	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	151.75	m	Invert Downstream	151.58	m
Length	45.00	m	Slope	0.003730	m/m
Drop	0.17	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	152.32	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	2.5000 m³/s	153.38 m	3.14 m/s

Culvert Designer/Analyzer Report
Culvert C21A-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	153.38	m	Discharge	2.5000	m³/s
Headwater Depth/Height	1.53		Tailwater Elevation	152.32	m
Inlet Control HW Elev.	153.26	m	Control Type	Outlet Control	
Outlet Control HW Elev.	153.38	m			

Grades					
Upstream Invert	151.75	m	Downstream Invert	151.58	m
Length	45.00	m	Constructed Slope	0.003730	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.89	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.89	m
Velocity Downstream	3.14	m/s	Critical Slope	0.007470	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	153.38	m	Upstream Velocity Head	0.40	m
Ke	0.20		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	153.26	m	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.9	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.3200	m³/s	Check Discharge	0.3600	m³/s

Grades Model: Inverts					
Invert Upstream	150.00	m	Invert Downstream	149.50	m
Length	35.00	m	Slope	0.014286	m/m
Drop	0.50	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	149.92	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.3200 m³/s	150.64 m	1.49 m/s
	Trial-2	1-600 mm Circular	0.3600 m³/s	150.69 m	1.68 m/s

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	150.64	m	Discharge	0.3200	m³/s
Headwater Depth/Height	1.05		Tailwater Elevation	149.92	m
Inlet Control HW Elev.	150.60	m	Control Type	Outlet Control	
Outlet Control HW Elev.	150.64	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.50	m
Length	35.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.42	m
Slope Type	Mild		Normal Depth	0.40	m
Flow Regime	Subcritical		Critical Depth	0.37	m
Velocity Downstream	1.49	m/s	Critical Slope	0.018556	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	150.64	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	150.60	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	150.69	m	Discharge	0.3600	m³/s
Headwater Depth/Height	1.13		Tailwater Elevation	149.92	m
Inlet Control HW Elev.	150.66	m	Control Type	Outlet Control	
Outlet Control HW Elev.	150.69	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.50	m
Length	35.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.42	m
Slope Type	Mild		Normal Depth	0.44	m
Flow Regime	Subcritical		Critical Depth	0.39	m
Velocity Downstream	1.68	m/s	Critical Slope	0.019554	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	150.69	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	150.66	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21B-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.7600	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	150.00	m	Invert Downstream	149.50	m
Length	35.00	m	Slope	0.014286	m/m
Drop	0.50	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	149.92	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.7600 m³/s	152.42 m	2.74 m/s

Culvert Designer/Analyzer Report
Culvert C21B-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	152.42	m	Discharge	0.7600	m³/s
Headwater Depth/Height	3.97		Tailwater Elevation	149.92	m
Inlet Control HW Elev.	151.56	m	Control Type	Outlet Control	
Outlet Control HW Elev.	152.42	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.50	m
Length	35.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.74	m/s	Critical Slope	0.042146	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	152.42	m	Upstream Velocity Head	0.35	m
Ke	0.90		Entrance Loss	0.31	m

Inlet Control Properties					
Inlet Control HW Elev.	151.56	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.3200	m³/s	Check Discharge	0.3600	m³/s

Grades Model: Inverts					
Invert Upstream	150.00	m	Invert Downstream	149.36	m
Length	45.00	m	Slope	0.014286	m/m
Drop	0.64	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	149.93	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.3200 m³/s	150.48 m	0.80 m/s
	Trial-2	1-825 mm Circular	0.3600 m³/s	150.52 m	0.90 m/s

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	150.48	m	Discharge	0.3200	m³/s
Headwater Depth/Height	0.58		Tailwater Elevation	149.93	m
Inlet Control HW Elev.	150.45	m	Control Type	Entrance Control	
Outlet Control HW Elev.	150.48	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.36	m
Length	45.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.57	m
Slope Type	Steep		Normal Depth	0.24	m
Flow Regime	N/A		Critical Depth	0.33	m
Velocity Downstream	0.80	m/s	Critical Slope	0.004102	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	150.48	m	Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	150.45	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21B-50-100-Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	150.52	m	Discharge	0.3600	m³/s
Headwater Depth/Height	0.61		Tailwater Elevation	149.93	m
Inlet Control HW Elev.	150.49	m	Control Type	Entrance Control	
Outlet Control HW Elev.	150.52	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.36	m
Length	45.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.57	m
Slope Type	Steep		Normal Depth	0.25	m
Flow Regime	N/A		Critical Depth	0.35	m
Velocity Downstream	0.90	m/s	Critical Slope	0.004154	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	150.52	m	Upstream Velocity Head	0.13	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	150.49	m	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert C21B-Reg-Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.7600	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	150.00	m	Invert Downstream	149.36	m
Length	45.00	m	Slope	0.014286	m/m
Drop	0.64	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	149.93	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-825 mm Circular	0.7600 m³/s	150.79 m	1.89 m/s

Culvert Designer/Analyzer Report
Culvert C21B-Reg-Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	150.79	m	Discharge	0.7600	m³/s
Headwater Depth/Height	0.95		Tailwater Elevation	149.93	m
Inlet Control HW Elev.	150.76	m	Control Type	Entrance Control	
Outlet Control HW Elev.	150.79	m			

Grades					
Upstream Invert	150.00	m	Downstream Invert	149.36	m
Length	45.00	m	Constructed Slope	0.014286	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.57	m
Slope Type	Steep		Normal Depth	0.38	m
Flow Regime	N/A		Critical Depth	0.52	m
Velocity Downstream	1.89	m/s	Critical Slope	0.005041	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	150.79	m	Upstream Velocity Head	0.22	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	150.76	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Designer/Analyzer Report
Culvert 22A-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.1400	m³/s	Check Discharge	0.1600	m³/s

Grades Model: Inverts					
Invert Upstream	145.15	m	Invert Downstream	144.70	m
Length	40.00	m	Slope	0.011250	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	145.23	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.1400 m³/s	145.52 m	0.41 m/s
	Trial-2	1-750 mm Circular	0.1600 m³/s	145.54 m	0.47 m/s

Culvert Designer/Analyzer Report
Culvert 22A-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	145.52	m	Discharge	0.1400	m³/s
Headwater Depth/Height	0.48		Tailwater Elevation	145.23	m
Inlet Control HW Elev.	145.46	m	Control Type	Outlet Control	
Outlet Control HW Elev.	145.52	m			

Grades					
Upstream Invert	145.15	m	Downstream Invert	144.70	m
Length	40.00	m	Constructed Slope	0.011250	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	0.24	m
Flow Regime	Subcritical		Critical Depth	0.22	m
Velocity Downstream	0.41	m/s	Critical Slope	0.014101	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	145.52	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	145.46	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 22A-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Eleva	145.54	m	Discharge	0.1600	m³/s
Headwater Depth/Height	0.52		Tailwater Elevation	145.23	m
Inlet Control HW Elev.	145.49	m	Control Type	Outlet Control	
Outlet Control HW Elev.	145.54	m			

Grades					
Upstream Invert	145.15	m	Downstream Invert	144.70	m
Length	40.00	m	Constructed Slope	0.011250	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	0.25	m
Flow Regime	Subcritical		Critical Depth	0.24	m
Velocity Downstream	0.47	m/s	Critical Slope	0.014109	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	145.54	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	145.49	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert 22A-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.3900	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	145.15	m	Invert Downstream	144.70	m
Length	40.00	m	Slope	0.011250	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	145.23	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.3900 m³/s	145.79 m	1.15 m/s

Culvert Designer/Analyzer Report
Culvert 22A-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	145.79	m	Discharge	0.3900	m³/s
Headwater Depth/Height	0.84		Tailwater Elevation	145.23	m
Inlet Control HW Elev.	145.74	m	Control Type	Outlet Control	
Outlet Control HW Elev.	145.79	m			

Grades					
Upstream Invert	145.15	m	Downstream Invert	144.70	m
Length	40.00	m	Constructed Slope	0.011250	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	0.42	m
Flow Regime	Subcritical		Critical Depth	0.38	m
Velocity Downstream	1.15	m/s	Critical Slope	0.015415	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	145.79	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	145.74	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C22B-50-100-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.1100	m³/s	Check Discharge	0.1200	m³/s

Grades Model: Inverts					
Invert Upstream	143.65	m	Invert Downstream	143.20	m
Length	4.00	m	Slope	0.112500	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	143.73	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.1100 m³/s	143.98 m	0.32 m/s
	Trial-2	1-750 mm Circular	0.1200 m³/s	144.00 m	0.35 m/s

Culvert Designer/Analyzer Report
Culvert C22B-50-100-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	143.98	m	Discharge	0.1100	m³/s
Headwater Depth/Height	0.43		Tailwater Elevation	143.73	m
Inlet Control HW Elev.	143.88	m	Control Type	Entrance Control	
Outlet Control HW Elev.	143.98	m			

Grades					
Upstream Invert	143.65	m	Downstream Invert	143.20	m
Length	4.00	m	Constructed Slope	0.112500	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.12	m
Flow Regime	N/A		Critical Depth	0.20	m
Velocity Downstream	0.32	m/s	Critical Slope	0.014162	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	143.98	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	143.88	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C22B-50-100-Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	144.00	m	Discharge	0.1200	m³/s
Headwater Depth/Height	0.45		Tailwater Elevation	143.73	m
Inlet Control HW Elev.	143.90	m	Control Type	Entrance Control	
Outlet Control HW Elev.	144.00	m			

Grades					
Upstream Invert	143.65	m	Downstream Invert	143.20	m
Length	4.00	m	Constructed Slope	0.112500	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.53	m
Slope Type	Steep		Normal Depth	0.12	m
Flow Regime	N/A		Critical Depth	0.21	m
Velocity Downstream	0.35	m/s	Critical Slope	0.014130	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	144.00	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	143.90	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
Culvert C22B-Reg-Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.2800	m³/s	Check Discharge	0.0000	m³/s

Grades Model: Inverts					
Invert Upstream	143.65	m	Invert Downstream	143.20	m
Length	40.00	m	Slope	0.011250	m/m
Drop	0.45	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	143.73	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-750 mm Circular	0.2800 m³/s	144.18 m	0.83 m/s

Culvert Designer/Analyzer Report
Culvert C22B-Reg-Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Eleva	144.18	m	Discharge	0.2800	m³/s
Headwater Depth/Height	0.70		Tailwater Elevation	143.73	m
Inlet Control HW Elev.	144.12	m	Control Type	Outlet Control	
Outlet Control HW Elev.	144.18	m			

Grades					
Upstream Invert	143.65	m	Downstream Invert	143.20	m
Length	40.00	m	Constructed Slope	0.011250	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.53	m
Slope Type	Mild		Normal Depth	0.34	m
Flow Regime	Subcritical		Critical Depth	0.32	m
Velocity Downstream	0.83	m/s	Critical Slope	0.014591	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	144.18	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	144.12	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.5	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				