<u>APPENDIX 'A'</u> 2017 CITY OF ST. JOHN'S RAINFALL HYETOGRAPHS – CLIMATE CHANGE

City of St. John's 2017 Rainfall Design Hyetographs For Climate Change

2-Year C	2-Year Cumulative Rainfall Design Hyetographs					
Percent						
Time	0.5-Hour	1-Hour	2-Hour	6-Hour	12-Hour	24-Hour
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	1.4	1.8	2.3	3.7	0.7	5.6
16.7%	3.6	4.5	5.8	9.3	1.4	14.0
25.0%	6.3	8.0	10.3	16.3	5.0	24.8
33.3%	9.8	12.5	16.1	25.7	12.6	38.9
41.7%	14.0	17.9	23.1	36.8	26.7	55.7
50.0%	17.4	22.0	28.5	45.4	44.3	68.7
58.3%	18.5	23.5	30.3	48.3	57.0	73.0
66.7%	19.3	24.5	31.6	50.4	64.0	76.4
75.0%	20.0	25.4	32.8	52.2	67.5	79.1
83.3%	20.4	26.0	33.5	53.5	68.9	80.9
91.7%	20.7	26.2	33.9	54.1	69.6	81.8
100.0%	20.8	26.4	34.1	54.4	70.3	82.3

	Cumulativ	e Rainfal	l Design	Hyetogra	aphs	
Percent Time	0.5-Hour (mm)	1-Hour (mm)	2-Hour (mm)	6-Hour (mm)	12-Hour (mm)	24-Hour (mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	1.9	2.5	3.2	5.1	1.0	7.7
16.7%	4.9	6.2	8.1	12.6	2.0	19.4
25.0%	8.6	11.1	14.3	22.3	6.9	34.5
33.3%	13.4	17.3	22.5	35.1	17.5	54.1
41.7%	19.2	24.8	32.1	50.2	37.0	77.5
50.0%	23.8	30.6	39.6	61.9	61.4	95.5
58.3%	25.3	32.6	42.1	65.9	79.0	101.6
66.7%	26.5	34.0	44.0	68.8	88.7	106.3
75.0%	27.4	35.3	45.6	71.3	93.6	110.0
83.3%	28.0	36.1	46.6	73.0	95.5	112.6
91.7%	28.3	36.4	47.1	73.8	96.5	113.8
100.0%	28.5	36.7	47.4	74.2	97.5	114.5

10-Year Percent	Cumulati	ve Rainfa	all Desigr	n Hyetog	raphs		
Time	0.5-Hour (mm)	1-Hour (mm)	2-Hour (mm)	6-Hour (mm)	12-Hour (mm)	24-Hour (mm)	
0.0%	0.0	0.0	0.0	0.0	0.0	0.0	
8.3%	2.3	3.0	3.8	6.0	1.2	9.2	
16.7%	5.8	7.4	9.6	14.9	2.4	23.1	
25.0%	10.2	13.2	17.0	26.3	8.1	41.0	
33.3%	16.0	20.6	26.8	41.4	20.8	64.4	
41.7%	22.9	29.5	38.3	59.3	43.9	92.2	
50.0%	28.2	36.4	47.2	73.0	72.8	113.7	
58.3%	30.0	38.8	50.2	77.7	93.7	120.9	
66.7%	31.4	40.5	52.4	81.2	105.3	126.5	
75.0%	32.5	42.0	54.3	84.1	111.1	130.9	
83.3%	33.2	42.9	55.6	86.0	113.3	134.0	
91.7%	33.6	43.3	56.2	87.0	114.5	135.5	
100.0%	33.8	43.6	56.5	87.5	115.7	136.3	

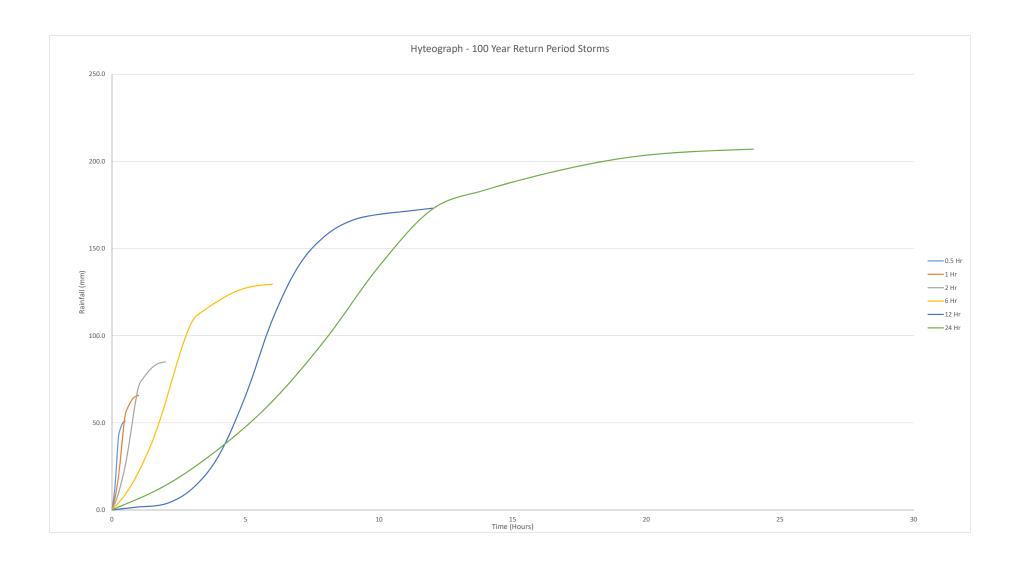
Percent						
Time	0.5-Hour (mm)	1-Hour (mm)	2-Hour (mm)	6-Hour (mm)	12-Hour (mm)	24-Hour (mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	2.7	3.5	4.4	6.8	1.4	10.6
16.7%	6.7	8.5	11.1	17.1	2.7	26.7
25.0%	11.8	15.2	19.6	30.2	9.4	47.3
33.3%	18.4	23.8	30.9	47.5	23.9	74.3
41.7%	26.4	34.0	44.1	68.0	50.6	106.3
50.0%	32.6	42.0	54.4	83.8	83.9	131.1
58.3%	34.7	44.7	57.9	89.2	107.9	139.4
66.7%	36.3	46.7	60.5	93.2	121.3	145.8
75.0%	37.6	48.4	62.6	96.5	127.9	151.0
83.3%	38.4	49.6	64.1	98.7	130.5	154.5
91.7%	38.8	50.0	64.8	99.9	131.9	156.2
100.0%	39.1	50.4	65.2	100.5	133.2	157.2

Percent						
Time	0.5-Hour (mm)	1-Hour (mm)	2-Hour (mm)	6-Hour (mm)	12-Hour (mm)	24-Hour (mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	2.8	3.6	4.6	7.1	1.4	11.0
16.7%	7.0	8.9	11.6	17.8	2.8	27.8
25.0%	12.3	15.8	20.5	31.4	9.8	49.3
33.3%	19.2	24.8	32.2	49.4	24.9	77.4
41.7%	27.5	35.5	46.0	70.7	52.7	110.8
50.0%	34.0	43.7	56.7	87.2	87.4	136.6
58.3%	36.1	46.6	60.3	92.7	112.4	145.3
66.7%	37.8	48.7	63.0	96.9	126.3	152.0
75.0%	39.1	50.5	65.3	100.3	133.3	157.3
83.3%	40.0	51.7	66.8	102.7	136.0	161.1
91.7%	40.5	52.1	67.5	103.9	137.4	162.8
100.0%	40.7	52.5	68.0	104.5	138.8	163.8

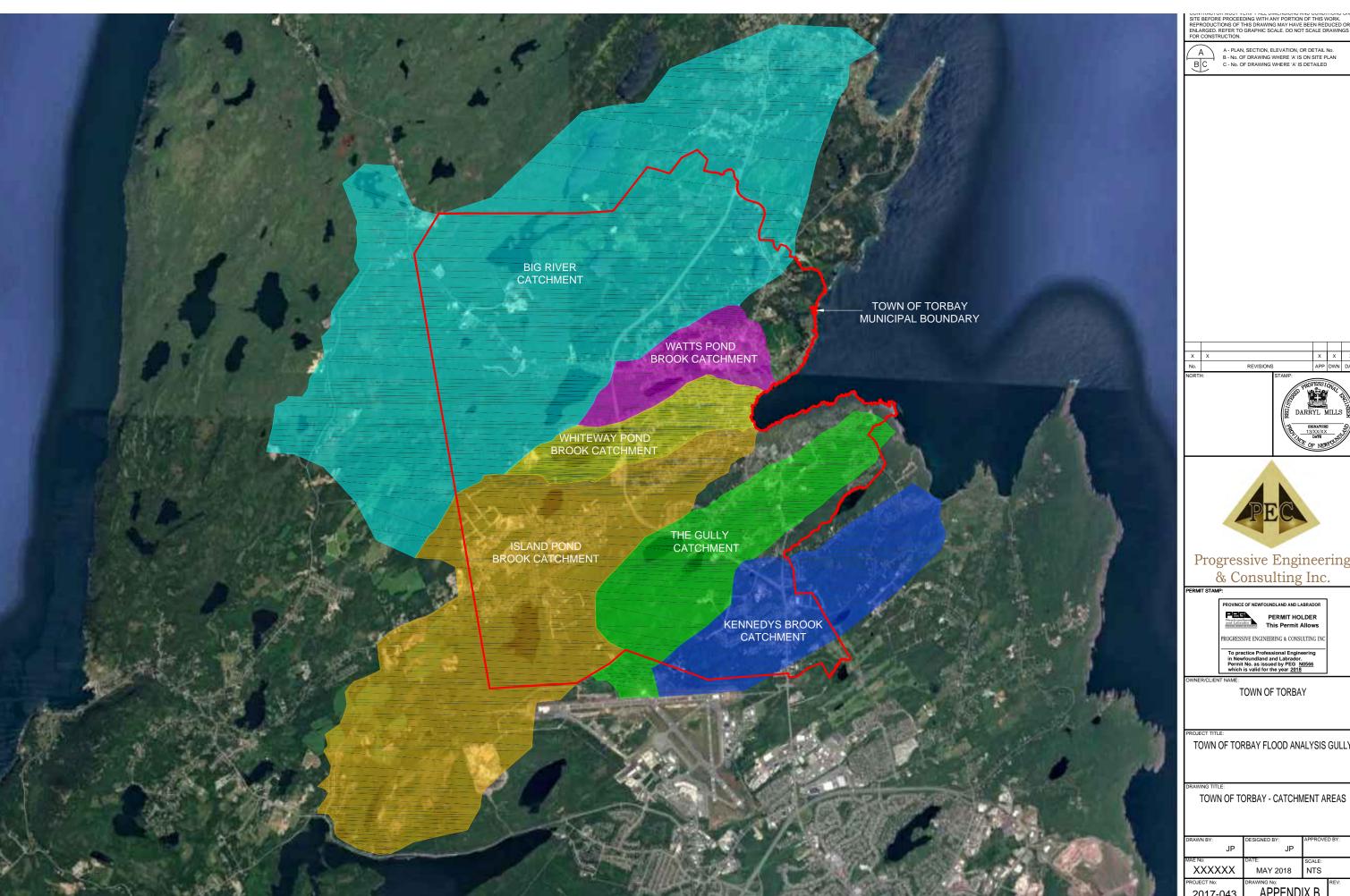
Percent						
Time	0.5-Hour (mm)	1-Hour (mm)	2-Hour (mm)	6-Hour (mm)	12-Hour (mm)	24-Hour (mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	3.1	4.1	5.2	8.0	1.6	12.5
16.7%	7.9	10.0	13.0	19.9	3.2	31.4
25.0%	13.8	17.8	23.1	35.2	11.0	55.7
33.3%	21.7	28.0	36.2	55.3	28.0	87.6
41.7%	31.0	40.0	51.8	79.2	59.2	125.3
50.0%	38.4	49.3	63.8	97.7	98.3	154.5
58.3%	40.8	52.6	67.9	103.9	126.4	164.3
66.7%	42.7	54.9	71.0	108.5	142.0	171.9
75.0%	44.2	56.9	73.5	112.4	149.8	178.0
83.3%	45.1	58.3	75.2	115.0	152.9	182.2
91.7%	45.7	58.8	76.0	116.4	154.5	184.1
100.0%	45.9	59.2	76.5	117.0	156.0	185.3

100-Yea	100-Year Cumulative Rainfall Design Hyetographs					
Percent						
Time	0.5-Hour	1-Hour	2-Hour	6-Hour	12-Hour	24-Hour
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
0.0%	0.0	0.0	0.0	0.0	0.0	0.0
8.3%	3.5	4.5	5.8	8.8	1.8	14.0
16.7%	8.7	11.1	14.5	22.0	3.5	35.1
25.0%	15.4	19.8	25.6	38.9	12.2	62.3
33.3%	24.1	31.1	40.2	61.2	31.1	97.9
41.7%	34.5	44.4	57.5	87.7	65.7	140.1
50.0%	42.6	54.8	70.9	108.1	109.0	172.7
58.3%	45.4	58.4	75.5	115.0	140.3	183.7
66.7%	47.5	60.9	78.8	120.1	157.6	192.1
75.0%	49.1	63.2	81.6	124.4	166.2	198.9
83.3%	50.2	64.7	83.5	127.3	169.6	203.6
91.7%	50.8	65.3	84.5	128.8	171.4	205.8
100.0%	51.1	65.7	85.0	129.5	173.1	207.0

<u>APPENDIX 'B'</u> 2017 CITY OF ST. JOHN'S RAINFALL HYETOGRAPHS – CLIMATE CHANGE



APPENDIX 'C' TOWN OF TORBAY CATCHMENT AREAS







Progressive Engineering & Consulting Inc.

TOWN OF TORBAY FLOOD ANALYSIS GULLY

	DRAWN BY:	DESIGNED BY:	APPROVED BY:
ı	JP	JP	
	MAE No:	DATE:	SCALE:
ı	XXXXXX	MAY 2018	NTS
	PROJECT No:	DRAWING No:	REV:
	2017-043	APPEND	IX B

<u>APPENDIX 'D'</u> INSPECTION REPORT – EXISTING INFRASTRUCTURE



2000mm CSP - South Pond

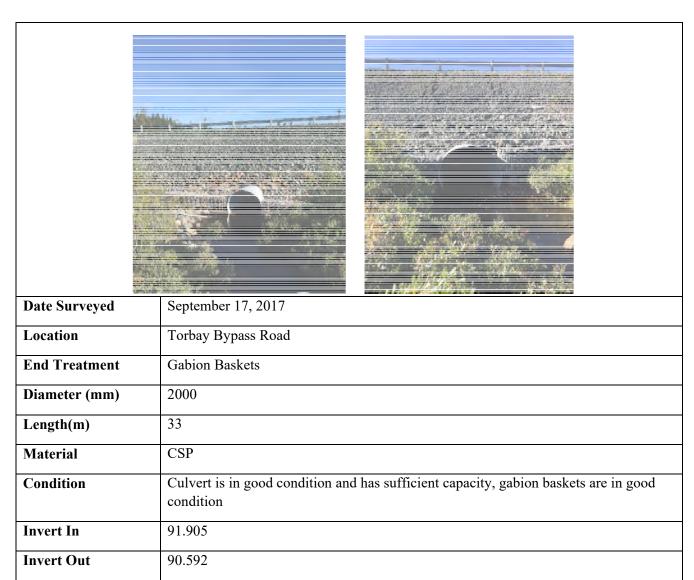




Date Surveyed	September 17, 2017
Location	South Pond
End Treatment	Gabion Baskets
Diameter (mm)	2000
Length(m)	20
Material	CSP
Condition	Culvert is in good condition and has sufficient capacity, gabion baskets are in good condition
Invert In	92.596
Invert Out	91.552

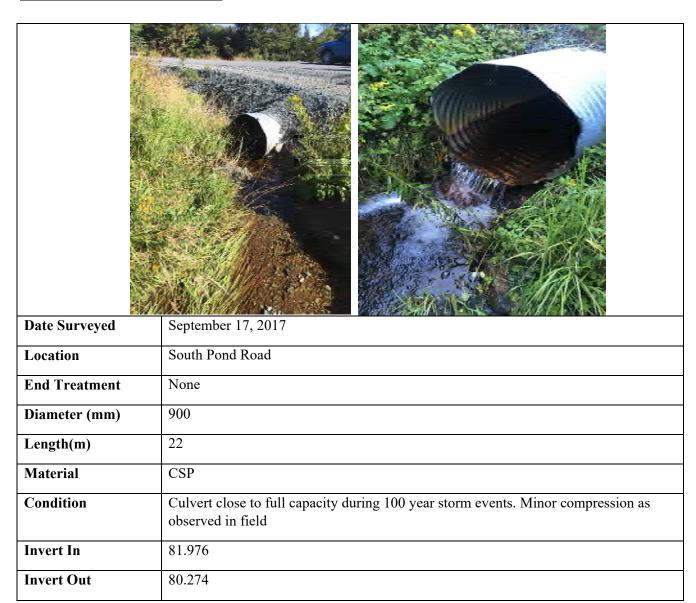


2000mm CSP - Torbay Bypass Road





900mm CSP - South Pond Road





Twin 600 & 900mm CSP – Quigley's Lane



Date Surveyed	September 19, 2017
Location	Quigley's Lane
End Treatment	Concrete
Diameter (mm)	Twin 600 & 900
Length(m)	14
Material	CSP
Condition	Culverts in poor condition. Concrete structure deteriorating, culverts partially buried and deformed. A lot of standing water near culvert inverts
Invert In	79.241, 79.410
Invert Out	79.547,79.365



2200 x 3100mm Arch CSP - Torbay Road







Date Surveyed	September 19, 2017
Location	Torbay Road
End Treatment	None
Diameter (mm)	2200 x 3100 Arch
Length(m)	14
Material	CSP
Condition	Culvert in fair condition
Invert In	44.249
Invert Out	44.899



1600 x 3500mm Rectangular Concrete Bridge – Marine Drive







Date Surveyed	September 19, 2017
Location	Marine Drive
End Treatment	None
Diameter (mm)	1600 x 3500
Length(m)	18
Material	Concrete
Condition	Exposed rebar on structure, as well as deteriorating concrete. Inspection by a structural engineer is highly recommended
Invert In	25.311
Invert Out	25.3



Twin 600 & 700mm CSP - Skipper's Landing





	_
Date Surveyed	September 19, 2017
Location	Skipper's Landing
End Treatment	None
Diameter (mm)	Twin 600 & 700mm
Length(m)	18
Material	CSP
Condition	Culverts in good condition
Invert In	116.605, 115.700
Invert Out	116.416, 115.433



1200 x 4000mm Aluminum Arch Bottomless – Lynch's Lane







Date Surveyed	September 19, 2017
Location	Lynch's Lane
End Treatment	Aluminum Headwall
Diameter (mm)	1200 x 4000 Arch
Length(m)	14
Material	CSP w/ Aluminum Headwall
Condition	Structurally the culvert is in good condition
Invert In	41.217
Invert Out	41.184



<u>Triple 600mm & 900mm – Crowe's Lane</u>





Date Surveyed	June 21, 2018
Location	Crowes Lane
End Treatment	Circular
Diameter (mm)	Triple 600 & 900
Length(m)	12
Material	CSP
Condition	Culverts in good condition, a lot of standing water near culverts, poor conveyance through culverts
Invert In	86.339, 86.288,86.149, 86.161
Invert Out	86.347, 86.253, 86.294, 85.990



Twin 600mm CSP - Cannon Marsh Road







A. B. Waller and A. Williams	
Date Surveyed	June 21, 2018
Location	Cannon Marsh Road
End Treatment	Circular
Diameter (mm)	Twin 600
Length(m)	9
Material	CSP
Condition	Culverts are in poor condition due to compression from concrete barrier. Thus, capacity of these culverts have been lowered. Removal of concrete barrier and replacement of culverts strongly recommended
Invert In	78.583, 78.567
Invert Out	78.159, 78.175



3600 x 2000mm Arch Bottomless CSP - Captain Matthew Davis Drive



Date Surveyed	June 21, 2018
Location	Captain Matthew Davis Drive
End Treatment	Arch Bottomless
Diameter (mm)	Triple 600
Length(m)	3600 x 2000
Material	CSP
Condition	Culverts are in poor condition due to compression from concrete barrier. Thus, capacity of these culverts have been lowered. Removal of concrete barrier and replacement of culverts strongly
Invert In	110.853
Invert Out	110.811



Twin 1500mm CSP - Rattling Brook Road





Date Surveyed	June 21, 2018
Location	Rattling Brook Road
End Treatment	None
Diameter (mm)	Twin 1500
Length(m)	18
Material	CSP
Condition	Culverts and gabion baskets in good condition
Invert In	81.767, 81.678
Invert Out	81.521, 81.460



1200mm CSP - Western Island Pond Road





Date Surveyed	June 21, 2018
Location	Western Island Pond Road
End Treatment	Gabion Baskets
Diameter (mm)	1200
Length(m)	12
Material	CSP
Condition	Culverts and gabion baskets in good condition
Invert In	109.339
Invert Out	109.358



Twin 1200mm CSP - Dunphy's Lane





Date Surveyed	June 21, 2018
Location	Dunphy's Lane
End Treatment	Brick
Diameter (mm)	Twin 1200
Length(m)	12
Material	CSP
Condition	Culverts and end treatments are in good condition
Invert In	66.017, 65.745
Invert Out	65.896, 65. 895



Twin 600mm CSP - Country Drive





Date Surveyed	June 21, 2018
Location	Country Drive
End Treatment	None
Diameter (mm)	Twin 600 CSP
Length(m)	11
Material	CSP
Condition	Culverts in good condition
Invert In	111.293, 111.019
Invert Out	111.089, 111.111



900mm CSP – Hickey's Place



Date Surveyed	June 21, 2018	
Location	Hickey's Place	
End Treatment	Concrete headwall	
Diameter (mm)	900	
Length(m)	30	
Material	CSP	
Condition	Concrete headwall experiencing minor concrete deterioration. Culvert slightly compressed	
Invert In	60.955	
Invert Out	60.170	



2400 x 900mm Rectangular Concrete - Kennedy's Brook Drive





Date Surveyed	June 21, 2018
Location	Kennedy's Brook Drive
End Treatment	Gabion Basket
Diameter (mm)	2400 x 900 rectangular
Length(m)	13
Material	Concrete
Condition	Good condition
Invert In	81.437
Invert Out	80.390



900mm CSP - Rosebud Street





Date Surveyed	June 21, 2018
Location	Rosebud Street
End Treatment	Circular
Diameter (mm)	900
Length(m)	12
Material	CSP
Condition	Large rock compressing inlet side of culvert. Outlet side of culvert in good condition
Invert In	87.724
Invert Out	87.866



Twin 900 CSP - Woodfine's Place





Date Surveyed	June 21, 2018
Location	Woodfine's Place
End Treatment	Circular
Diameter (mm)	Twin 900
Length(m)	12
Material	CSP
Condition	Culverts in good condition
Invert In	117.483, 117.506
Invert Out	117.269, 117.305



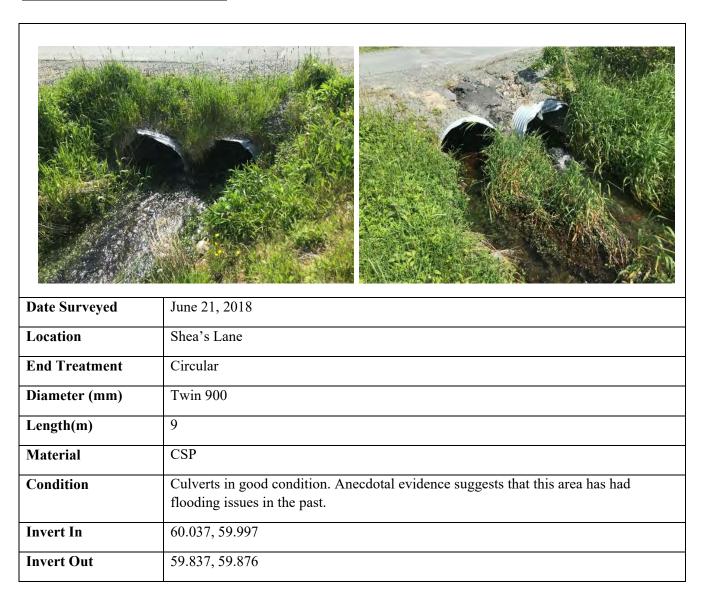




Date Surveyed	June 21, 2018
Location	Karon Drive
End Treatment	Circular
Diameter (mm)	600
Length(m)	12
Material	CSP
Condition	Culverts in good condition
Invert In	98.510
Invert Out	98.160



Twin 900mm CSP - Shea's Lane





Twin 1200mm CSP - Moore's Valley Road





The Battery Bridge Structure





Date Surveyed	June 21, 2018
Location	The Battery
End Treatment	Circular
Diameter (mm)	N/A
Length(m)	3
Material	Concrete
Condition	Excessive concrete deterioration, concrete located in stream. Inspection from a structural engineer is strongly recommended.
Invert In	-
Invert Out	-



<u>Twin 600mm Concrete – 526 Bauline Line</u>





Date Surveyed	June 21, 2018
Location	596 Bauline Line
End Treatment	None
Diameter (mm)	Twin 600
Length(m)	14
Material	Concrete
Condition	Concrete culverts are in good condition
Invert In	122.296, 122.185
Invert Out	122.299, 122.336



700mm CSP - Bauline Line





Date Surveyed	June 21, 2018
Location	455 Bauline Line
End Treatment	None
Diameter (mm)	700
Length(m)	14
Material	CSP
Condition	Culvert in good condition
Invert In	115.379
Invert Out	115.189



1200mm CSP - Bauline Line

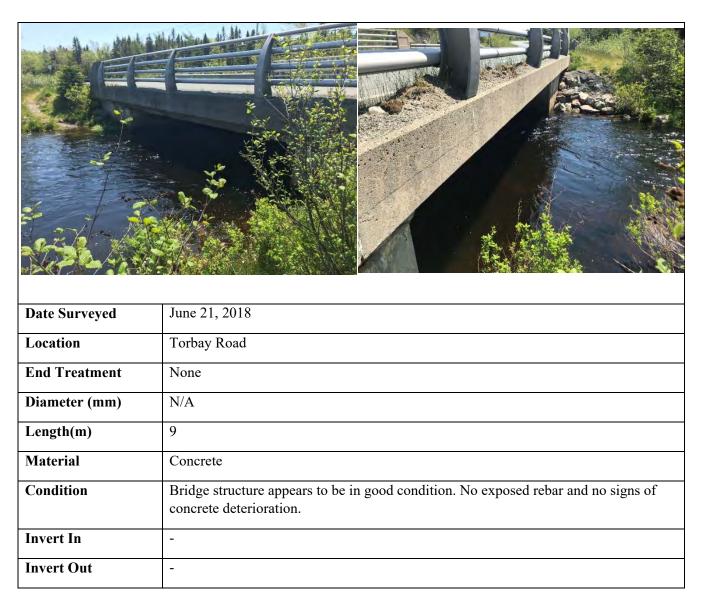




Date Surveyed	June 21, 2018
Location	395 Bauline Line
End Treatment	None
Diameter (mm)	1200
Length(m)	14
Material	CSP
Condition	Culvert in good condition
Invert In	110.675
Invert Out	110.624



Bridge Structure - Torbay Road





4600 x 6700 CSP – Torbay Bypass Road





Date Surveyed	June 21, 2018
Location	Torbay Bypass Road
End Treatment	None
Diameter (mm)	4600 x 6700
Length(m)	26
Material	CSP
Condition	Culvert in good condition
Invert In	-
Invert Out	-



2000mm CSP - Torbay Road







Date Surveyed	June 21, 2018
Location	Torbay Road
End Treatment	Gabion basket
Diameter (mm)	2000
Length(m)	48
Material	CSP
Condition	Culvert in good condition
Invert In	83.389
Invert Out	82.178



400mm CSP – Bauline Line



Date Surveyed	August 13, 2018	
Location	Bauline Line	
End Treatment None		
Diameter (mm)	400	
Length(m)		
Material	CSP	
Condition	Culvert in poor condition. Excessive standing water and bottom half of culvert appears to be rusted out.	
Invert In	88.625	
Invert Out	82.547	



1200mm CSP - Torbay Road





Date Surveyed	August 13, 2018	
Location	Torbay Road	
End Treatment	Gabion Baskets	
Diameter (mm)	1200	
Length(m)		
Material	CSP	
Condition	Culvert in good condition	
Invert In	rt In 47.557	
Invert Out	47.533	



<u>500mm CSP – Victoria Place</u>



Date Surveyed	August 13, 2018	
Location	Victoria Place	
End Treatment	Brick	
Diameter (mm)	500	
Length(m)	12	
Material	CSP	
Condition	Brick end treatment appears to be deteriorating. The culvert is slightly compressed	
Invert In	113.225	
Invert Out	113.192	

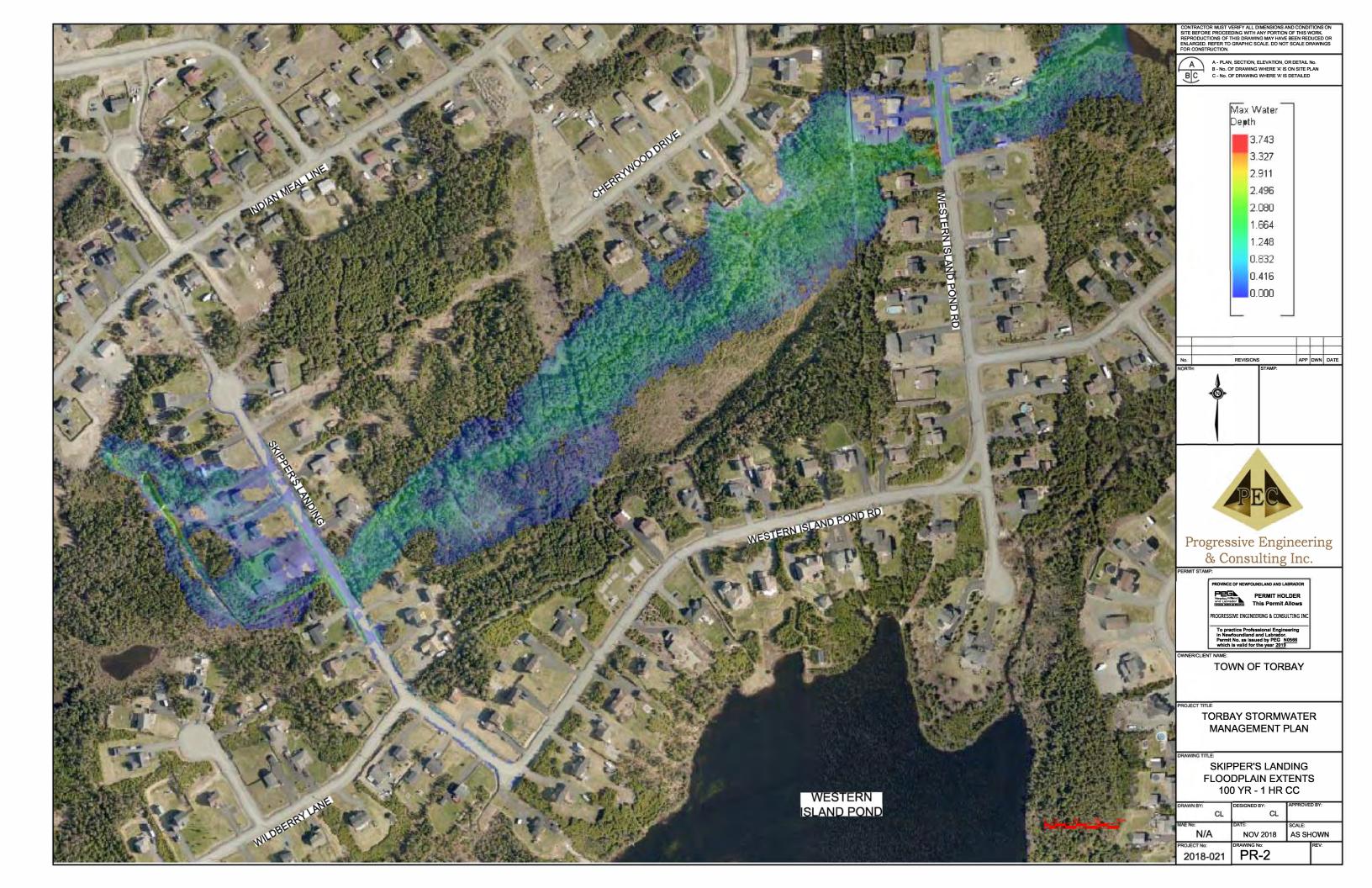


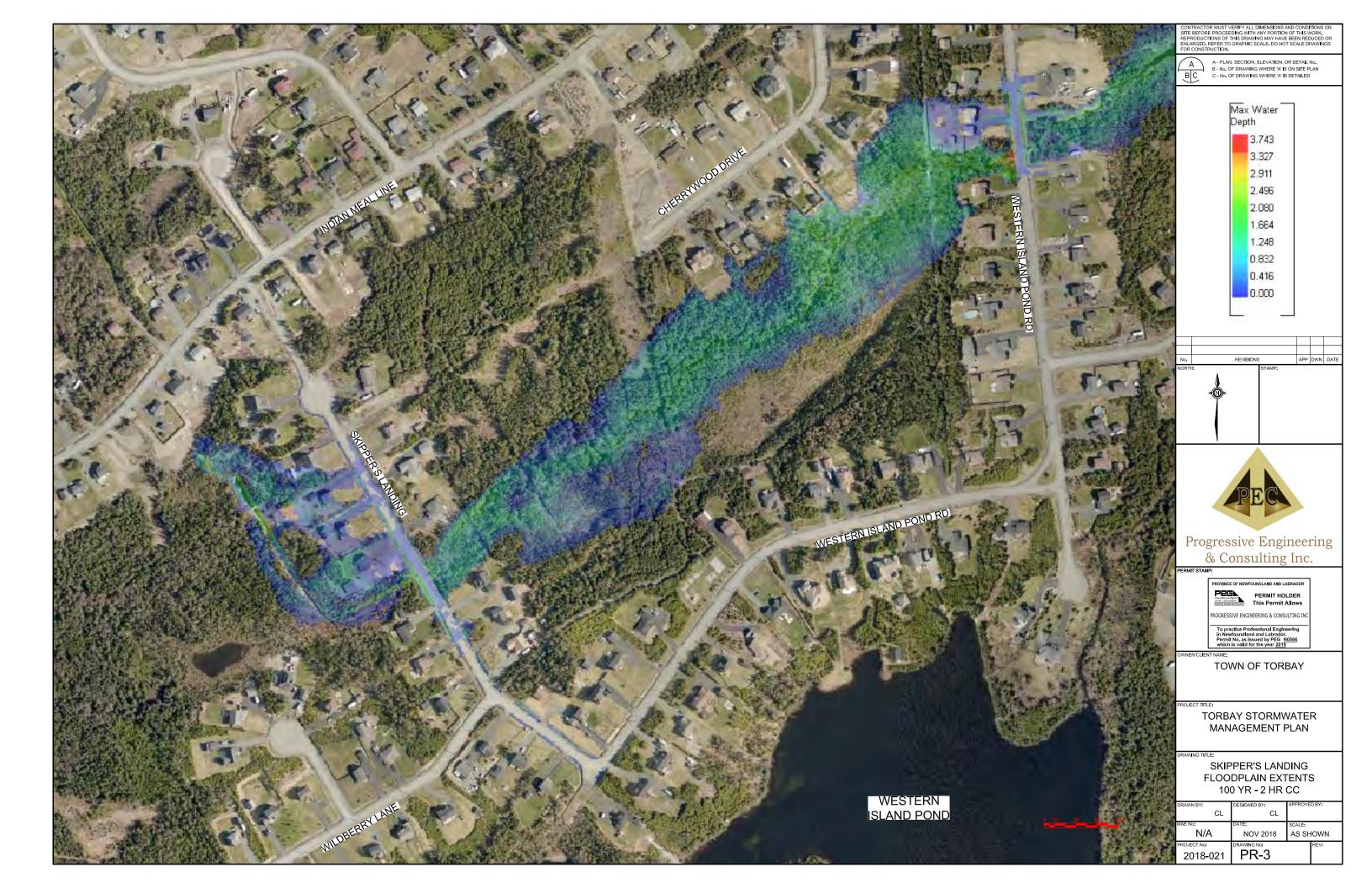


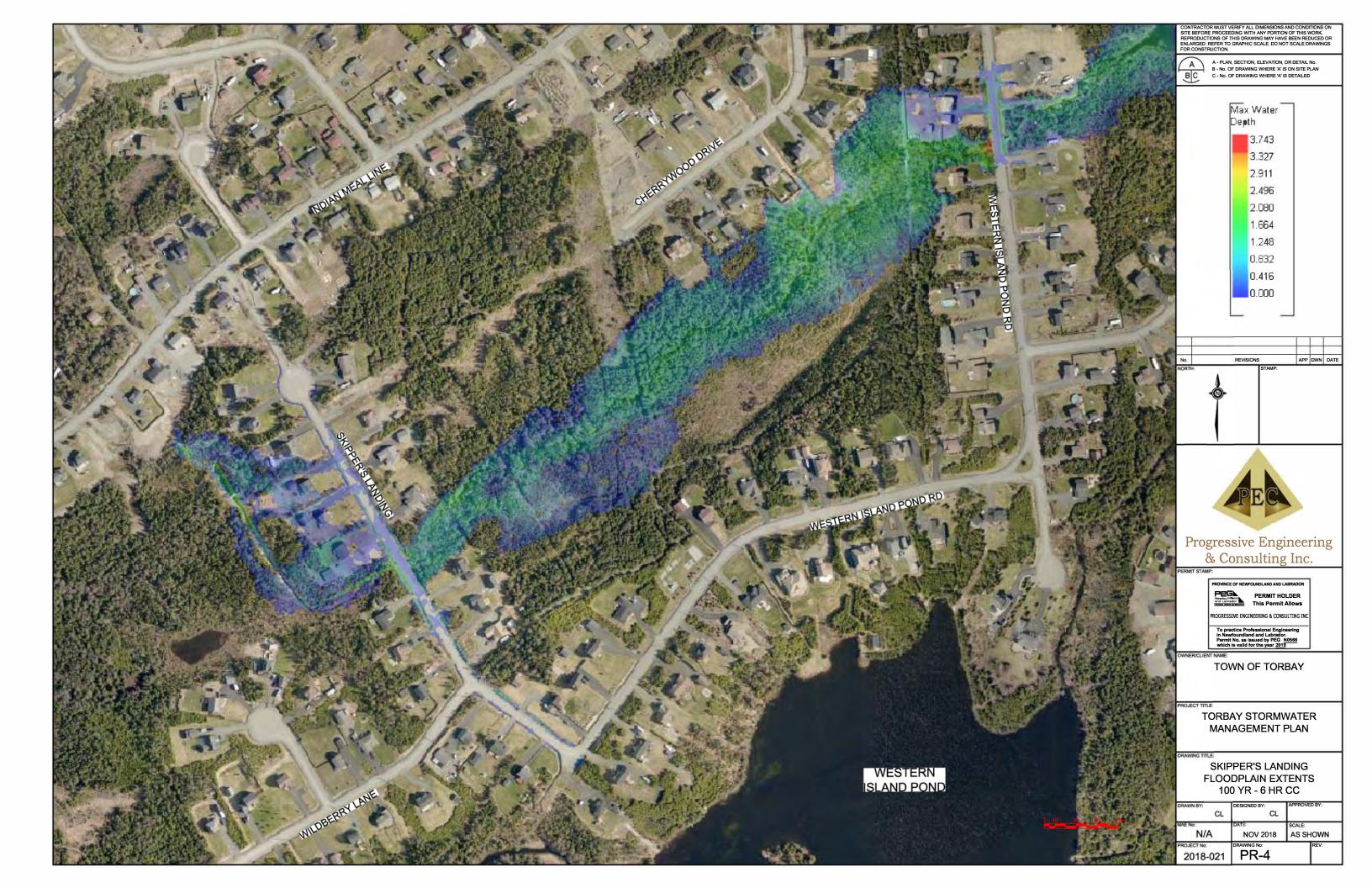


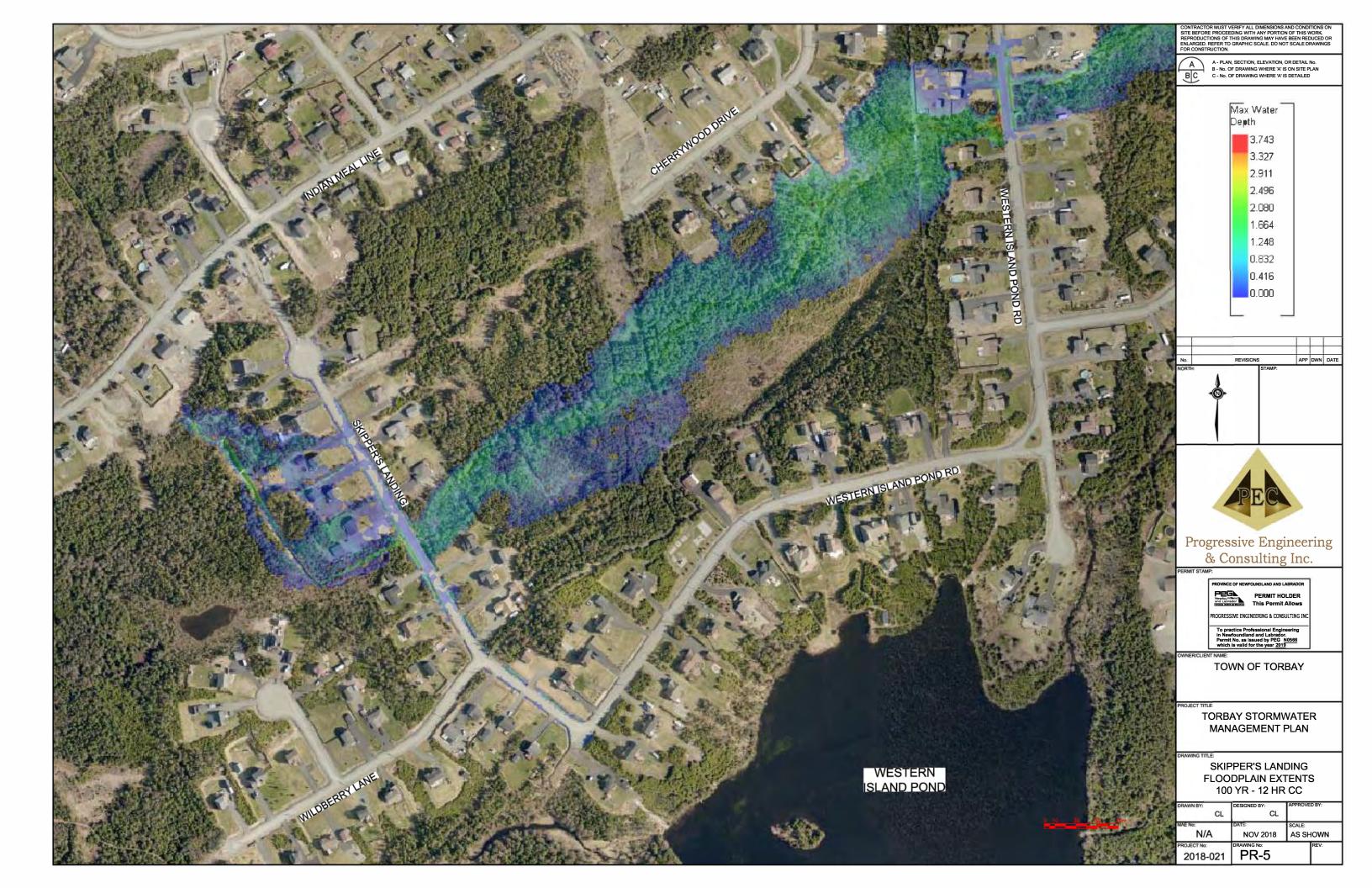
Date Surveyed	August 13, 2018	
Location	Torbay Road	
End Treatment	Concrete	
Diameter (mm)	1200	
Length(m)		
Material	CSP	
Condition	Culvert appears to be in good condition. Brick end treatment and concrete headware type structure show no signs of deterioration.	
Invert In	81.906	
Invert Out	81.560	

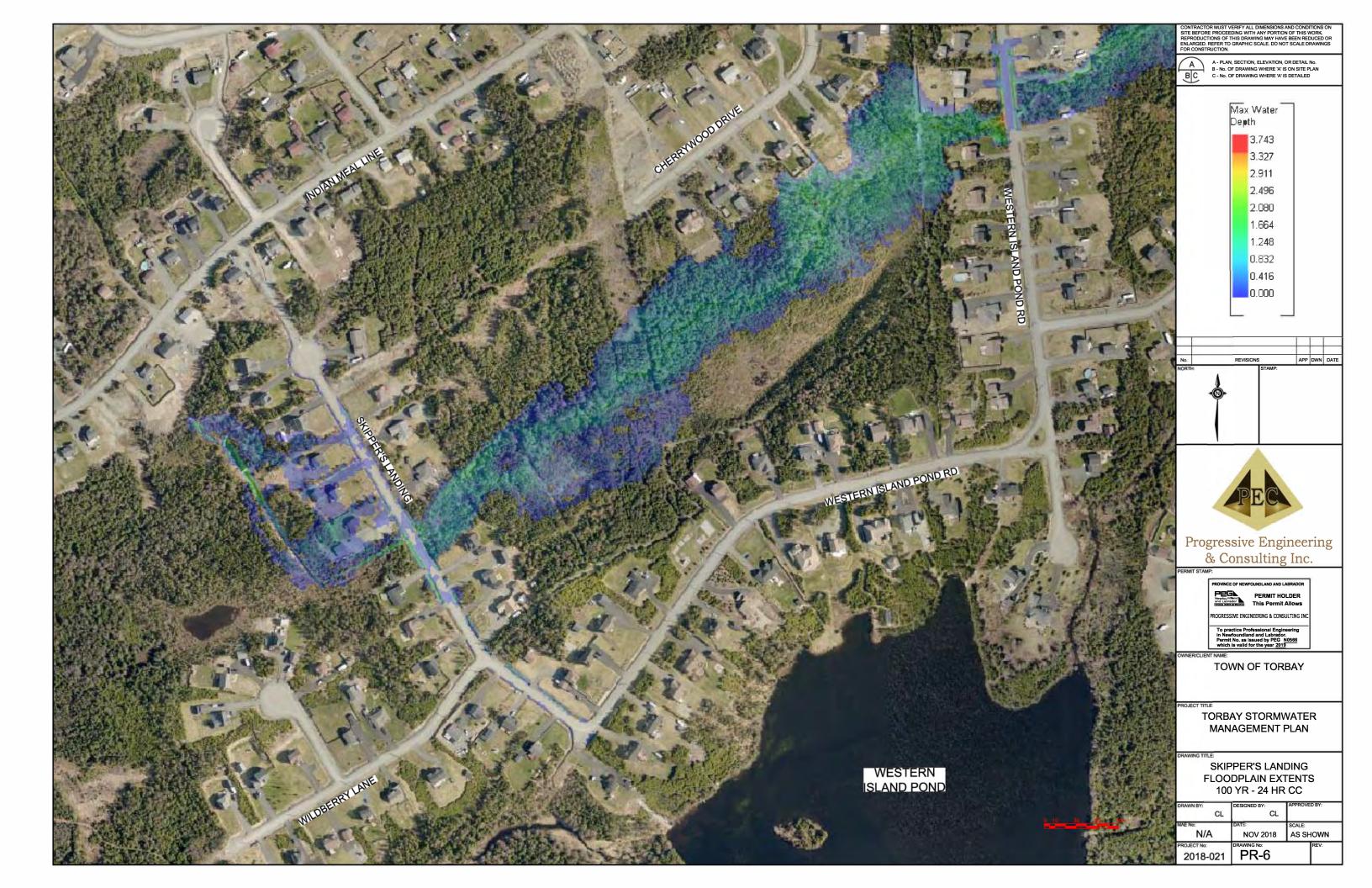
APPENDIX 'E' EXISTING CONDITIONS – EXISTING BUILDOUT FLOODPLAINS

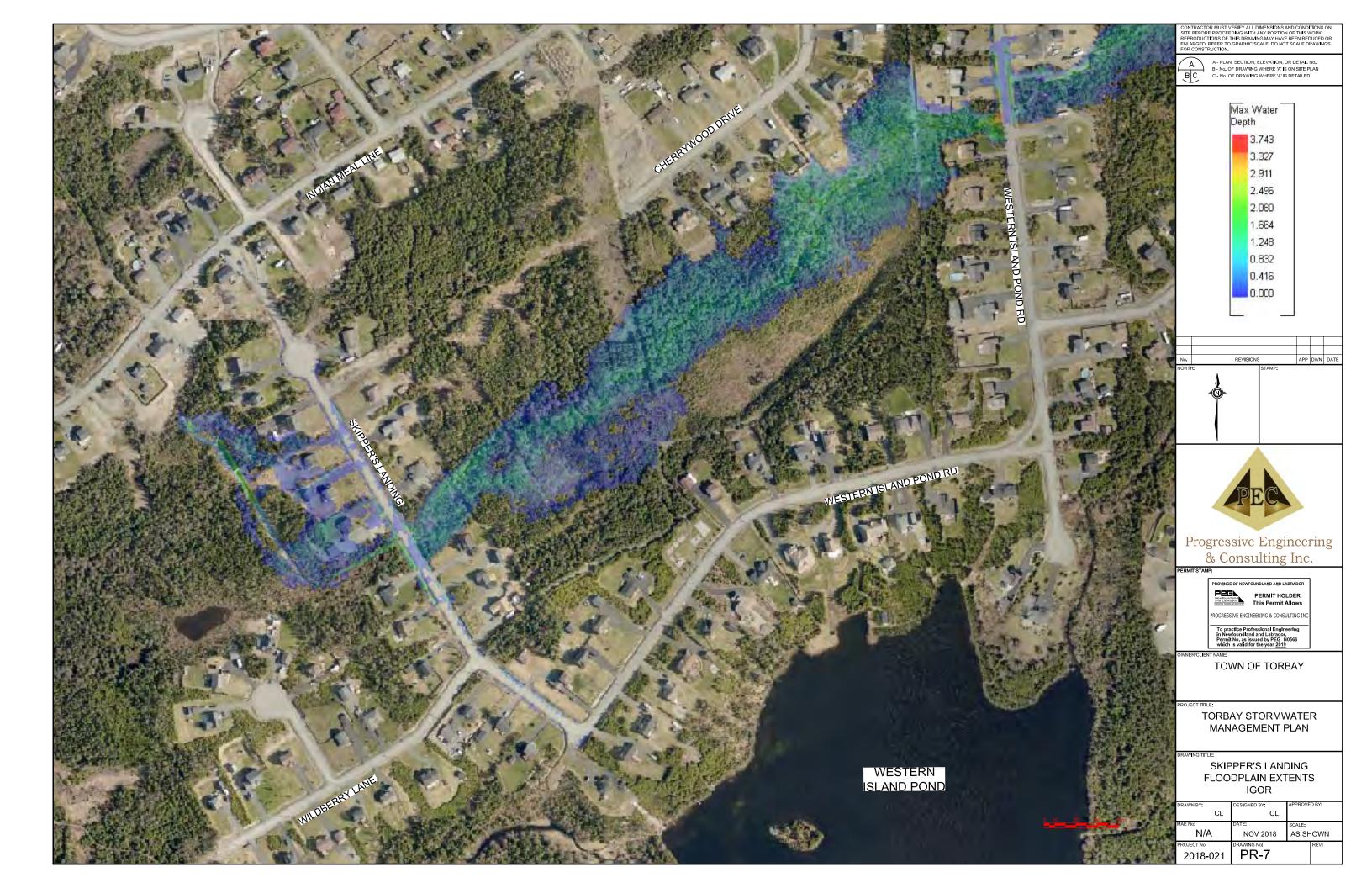


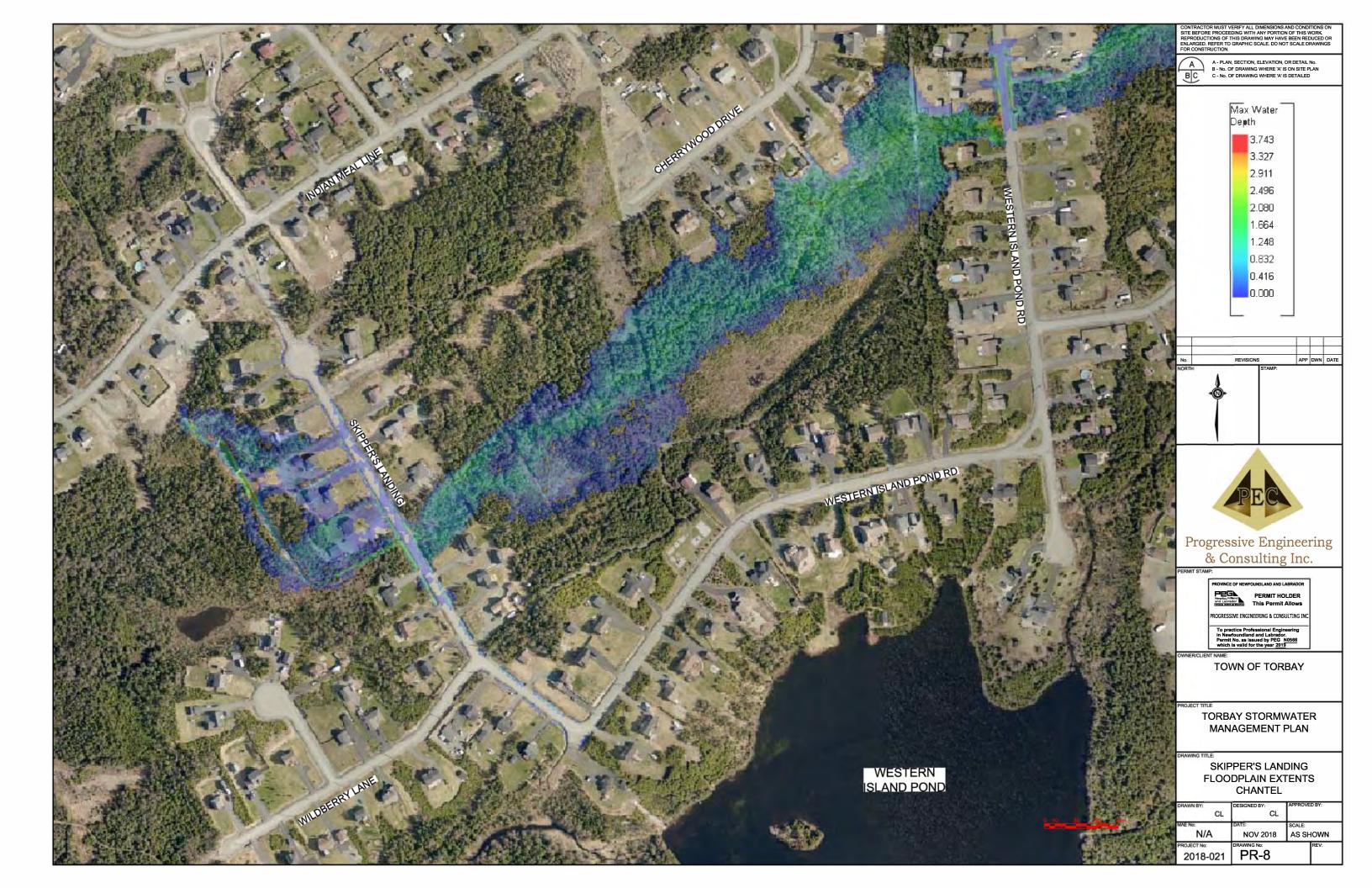




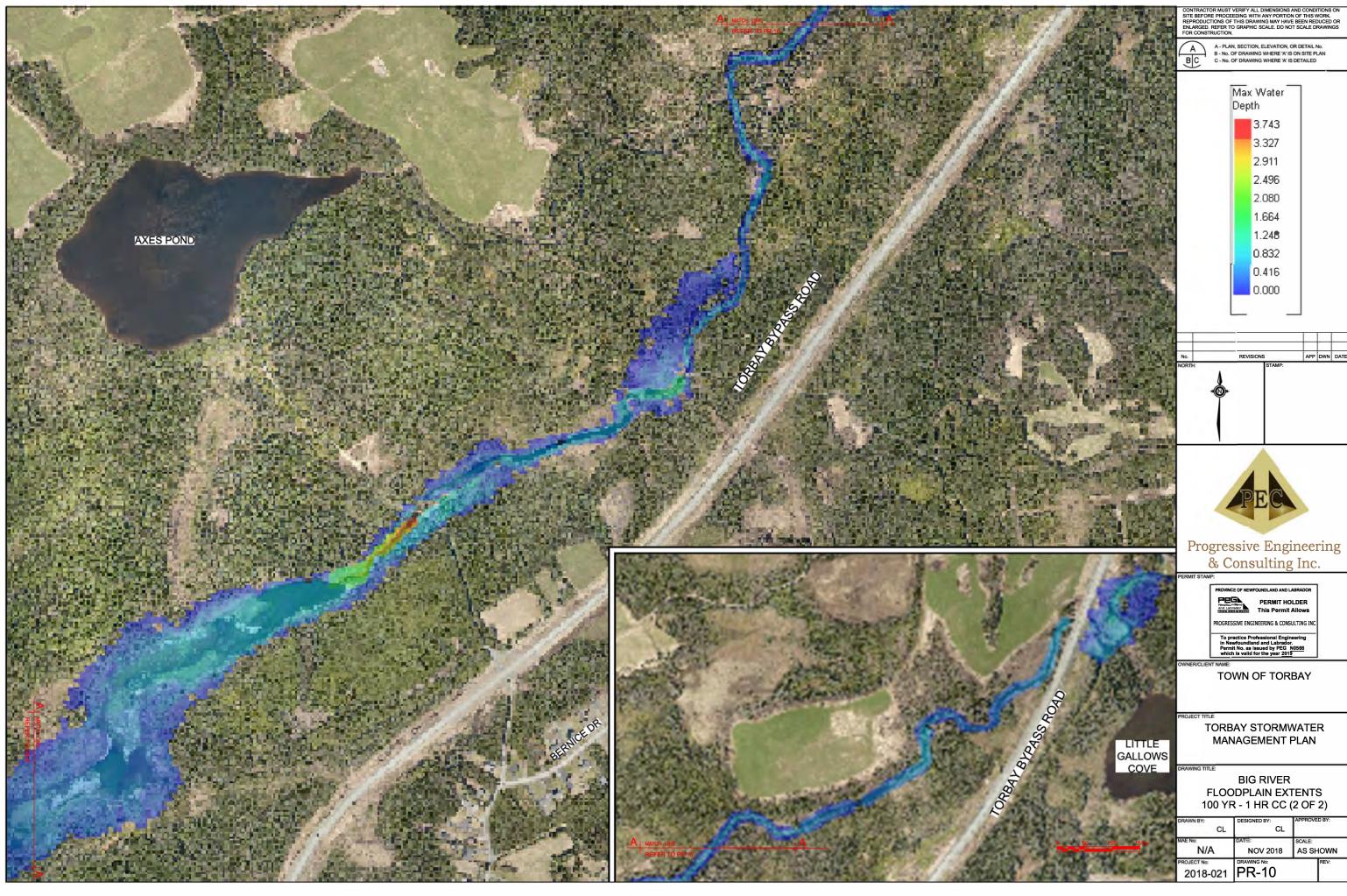






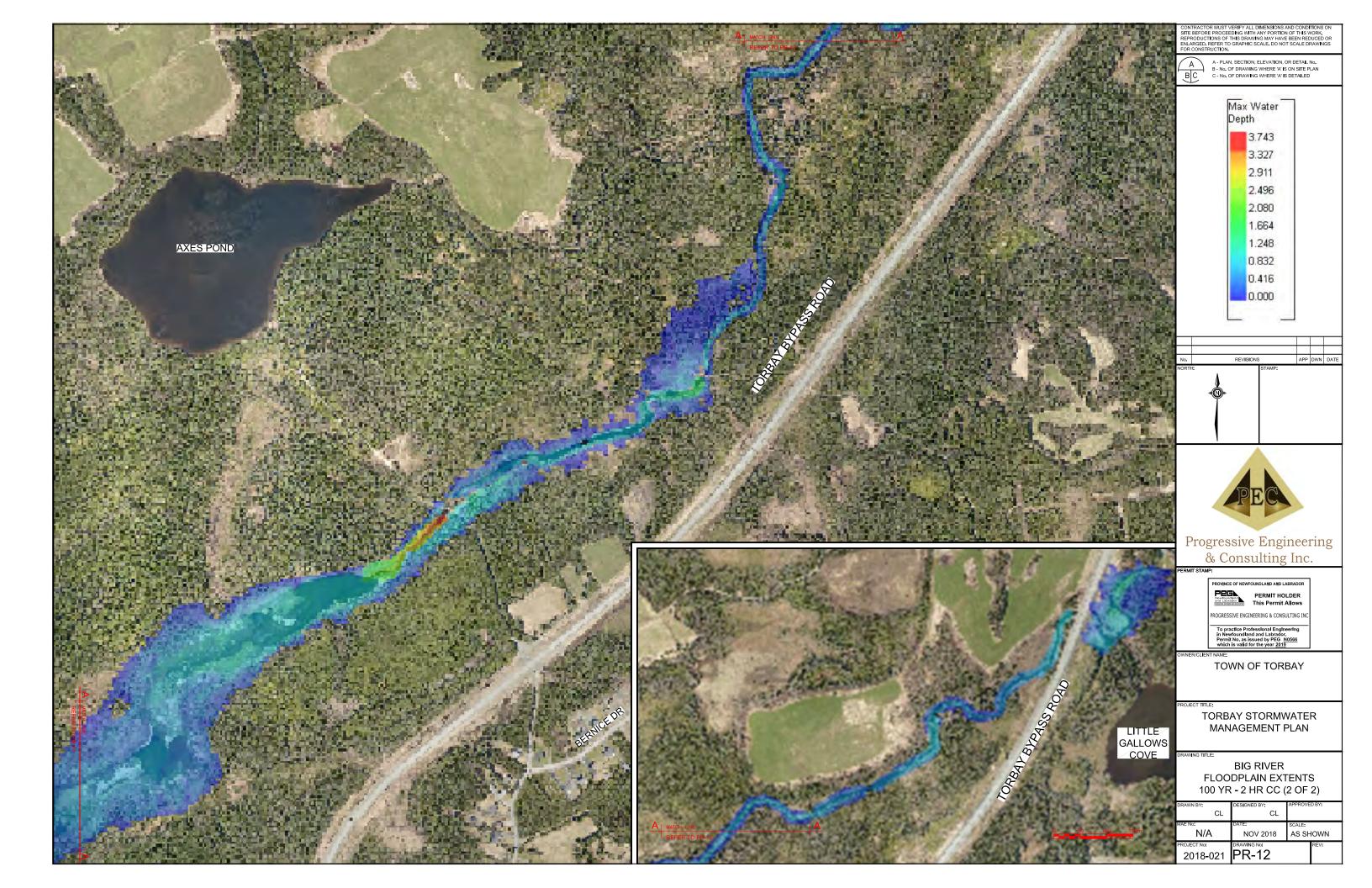




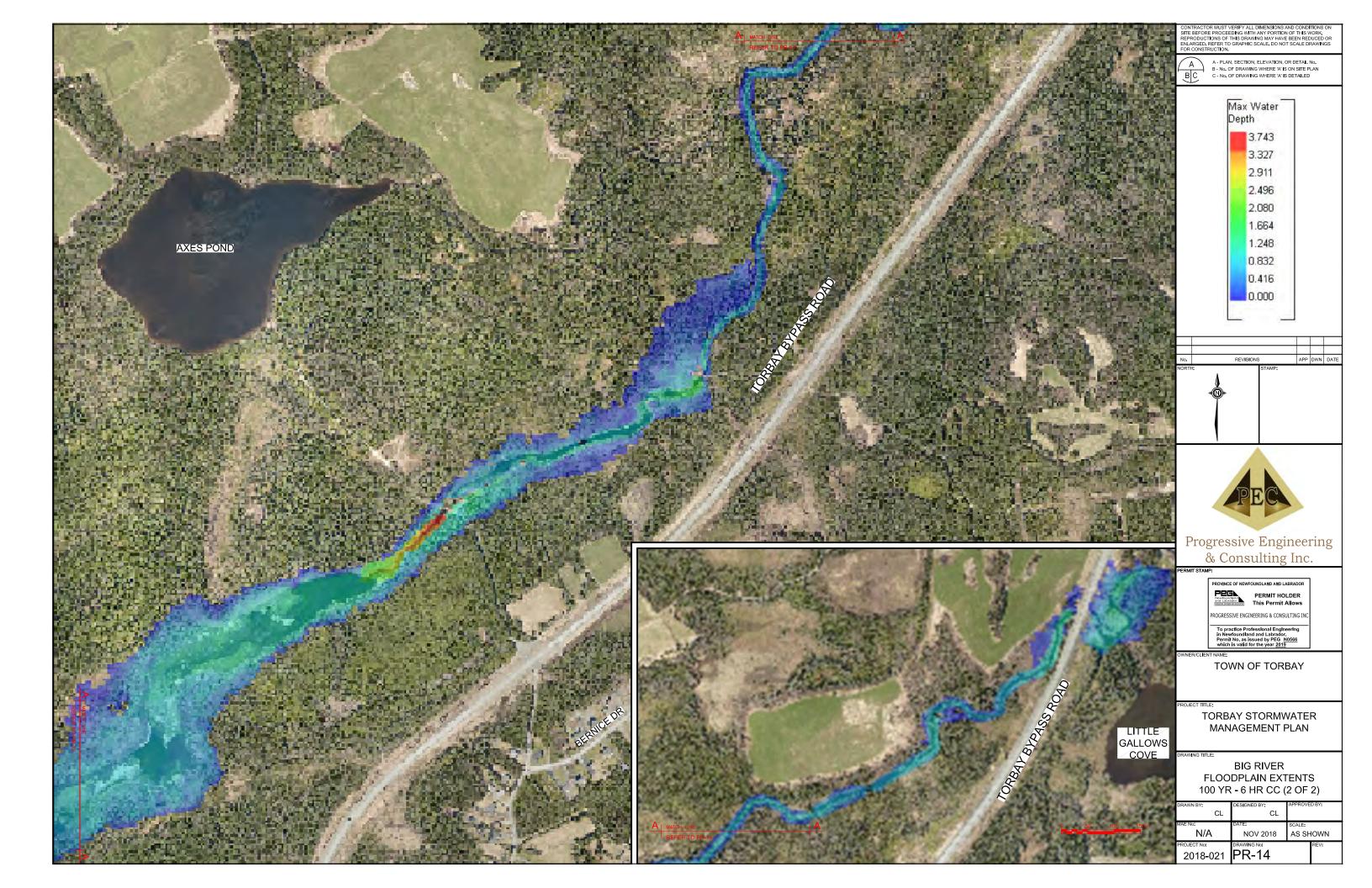


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	PROJECT No: 2018-021	PR-10		REV:

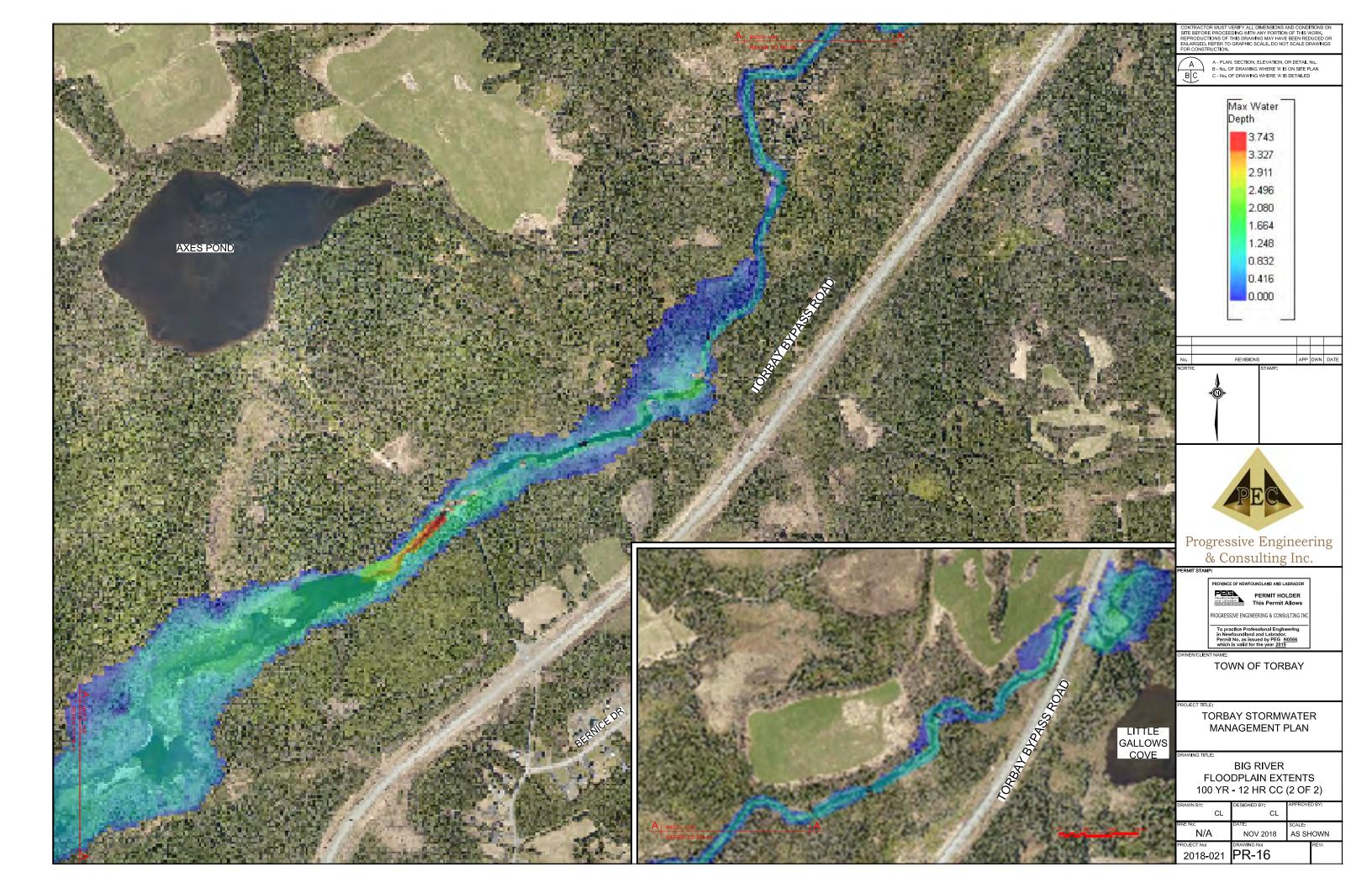




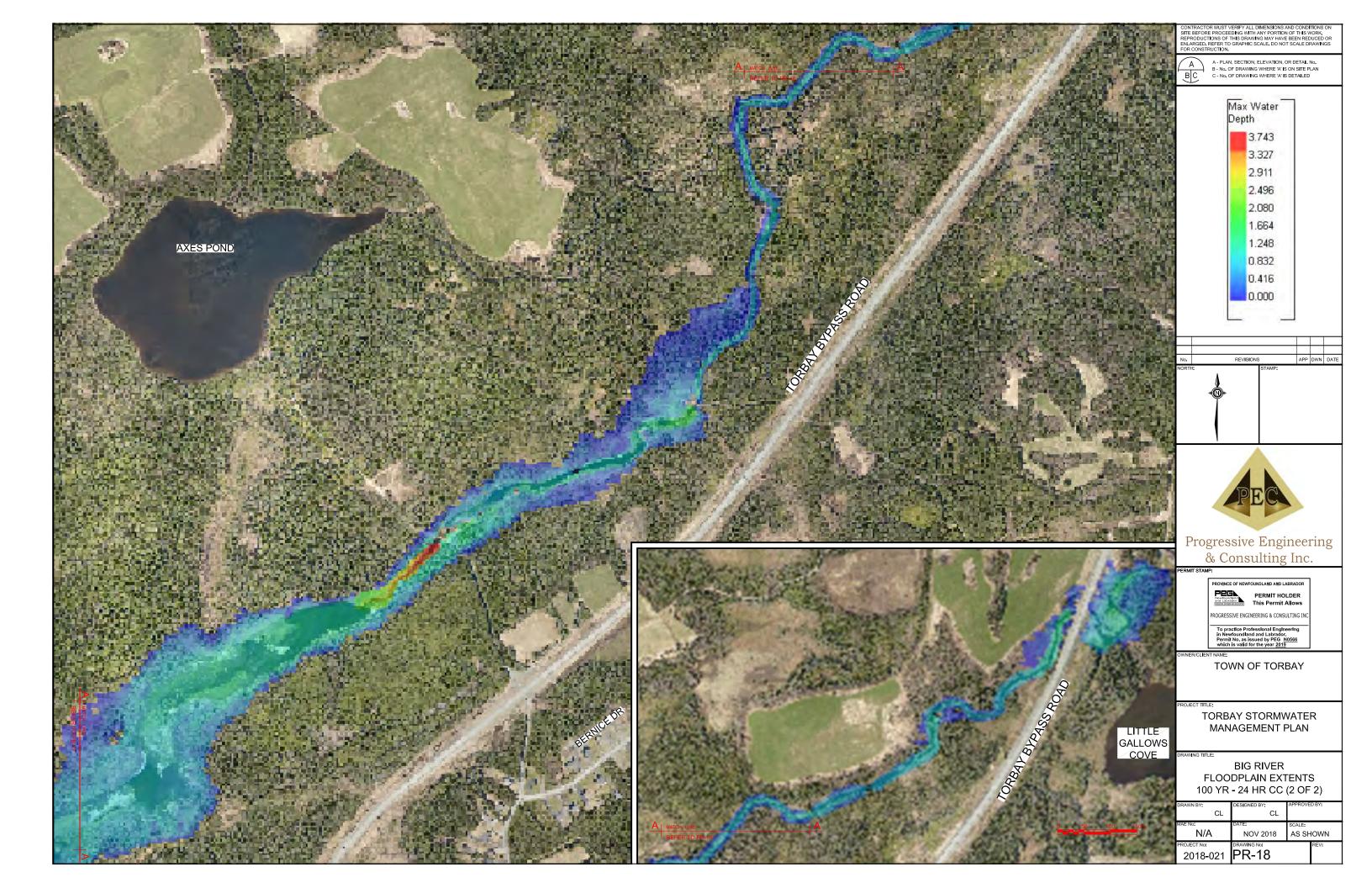


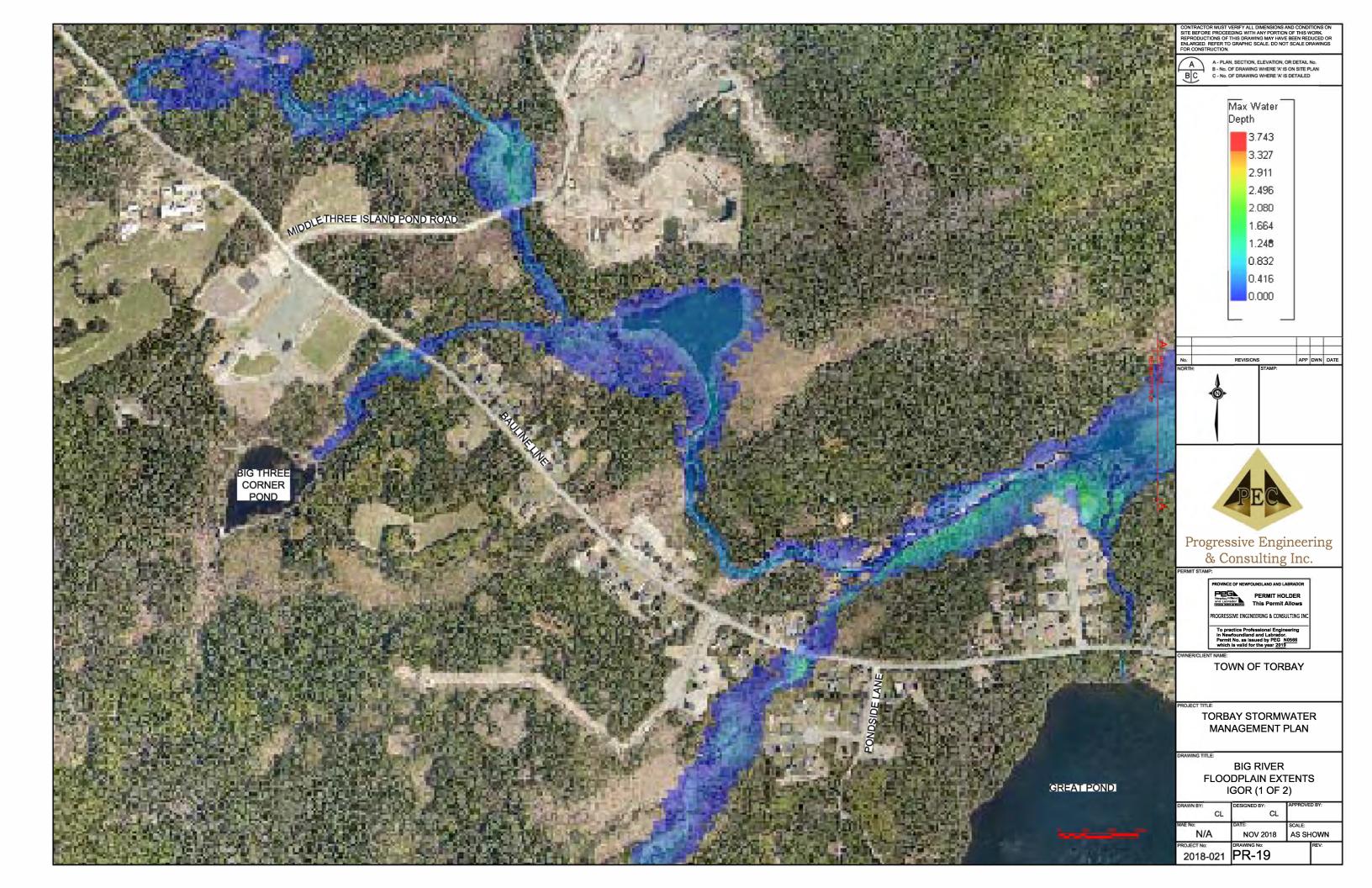


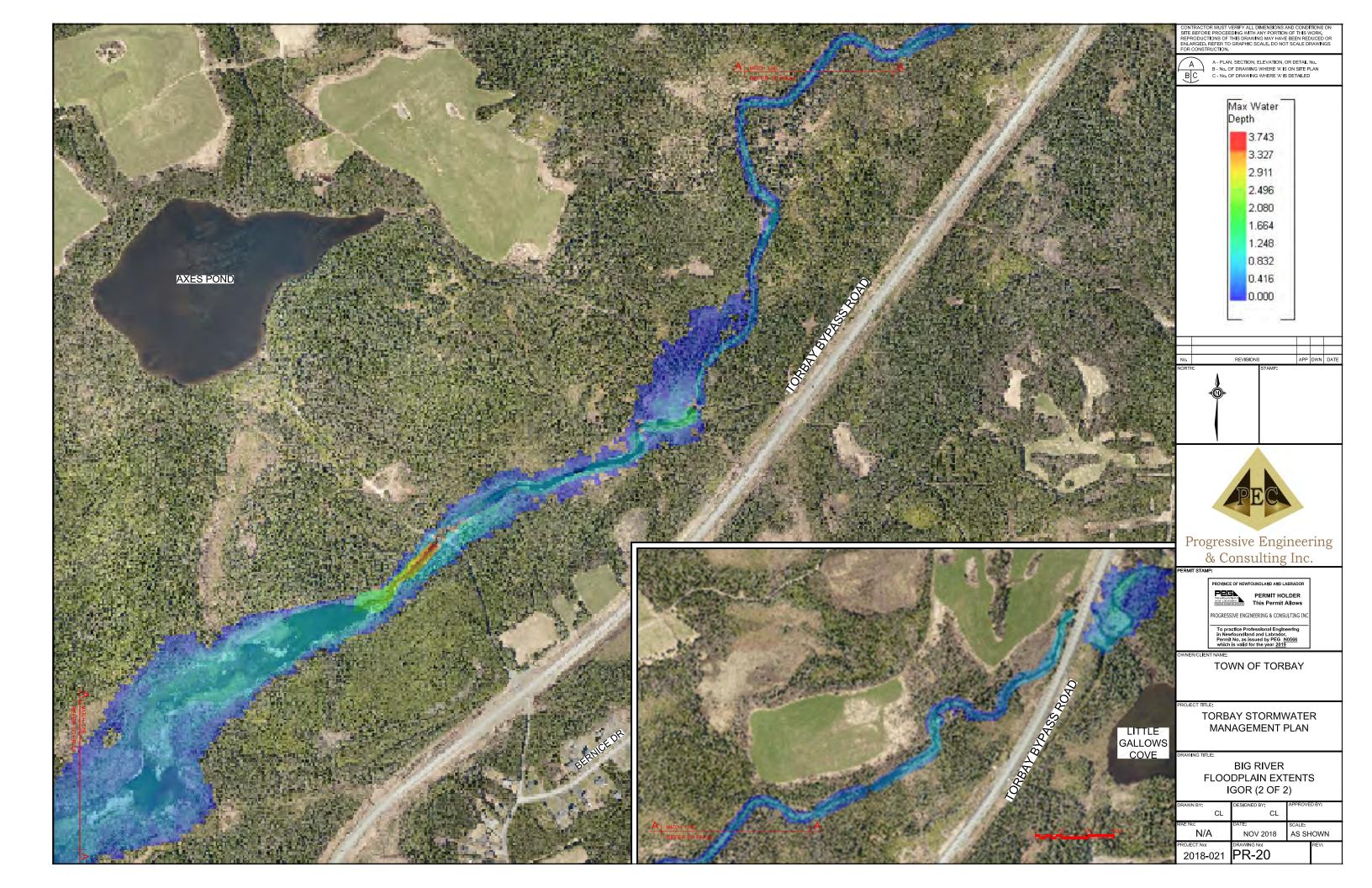




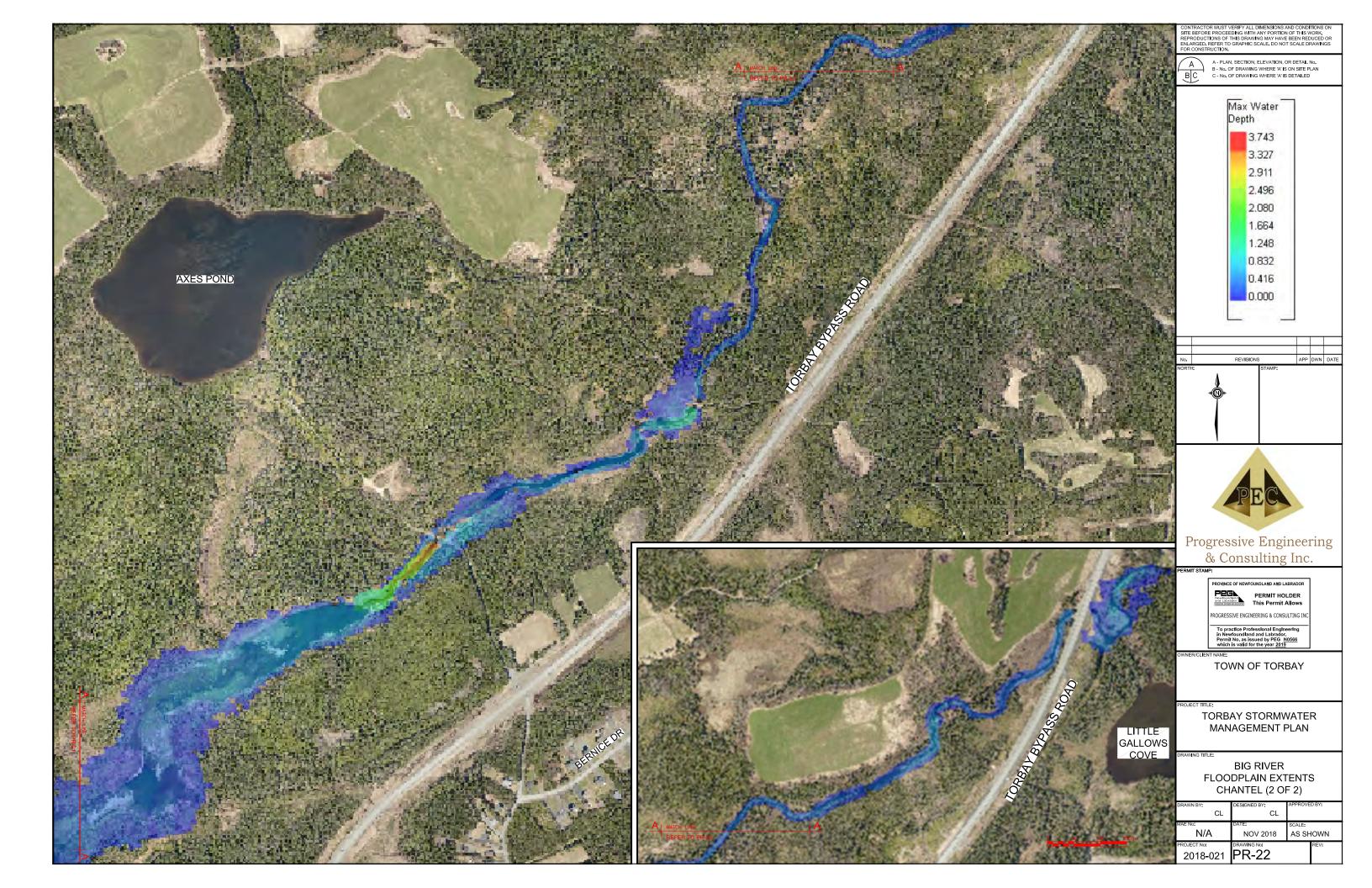


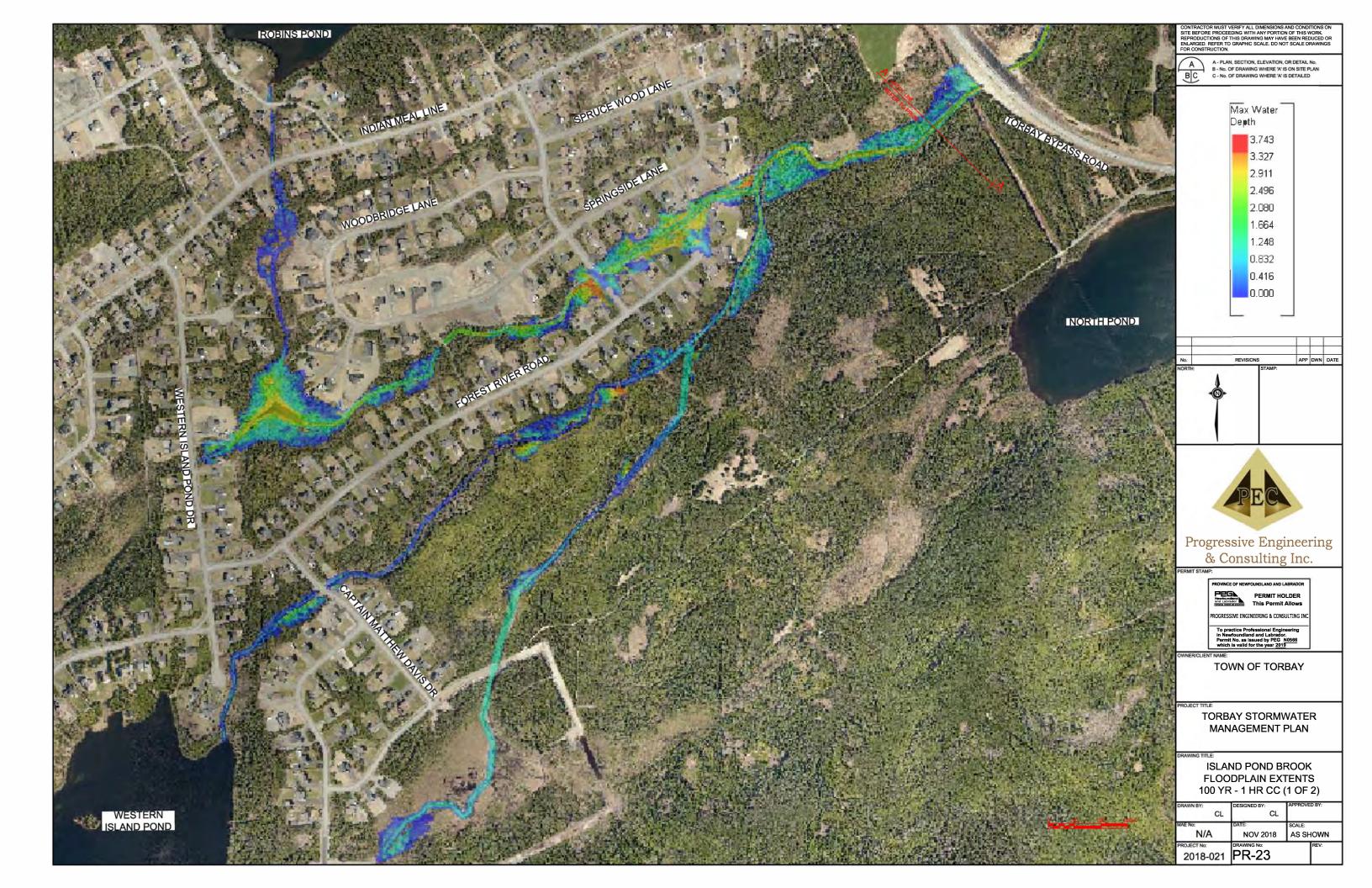


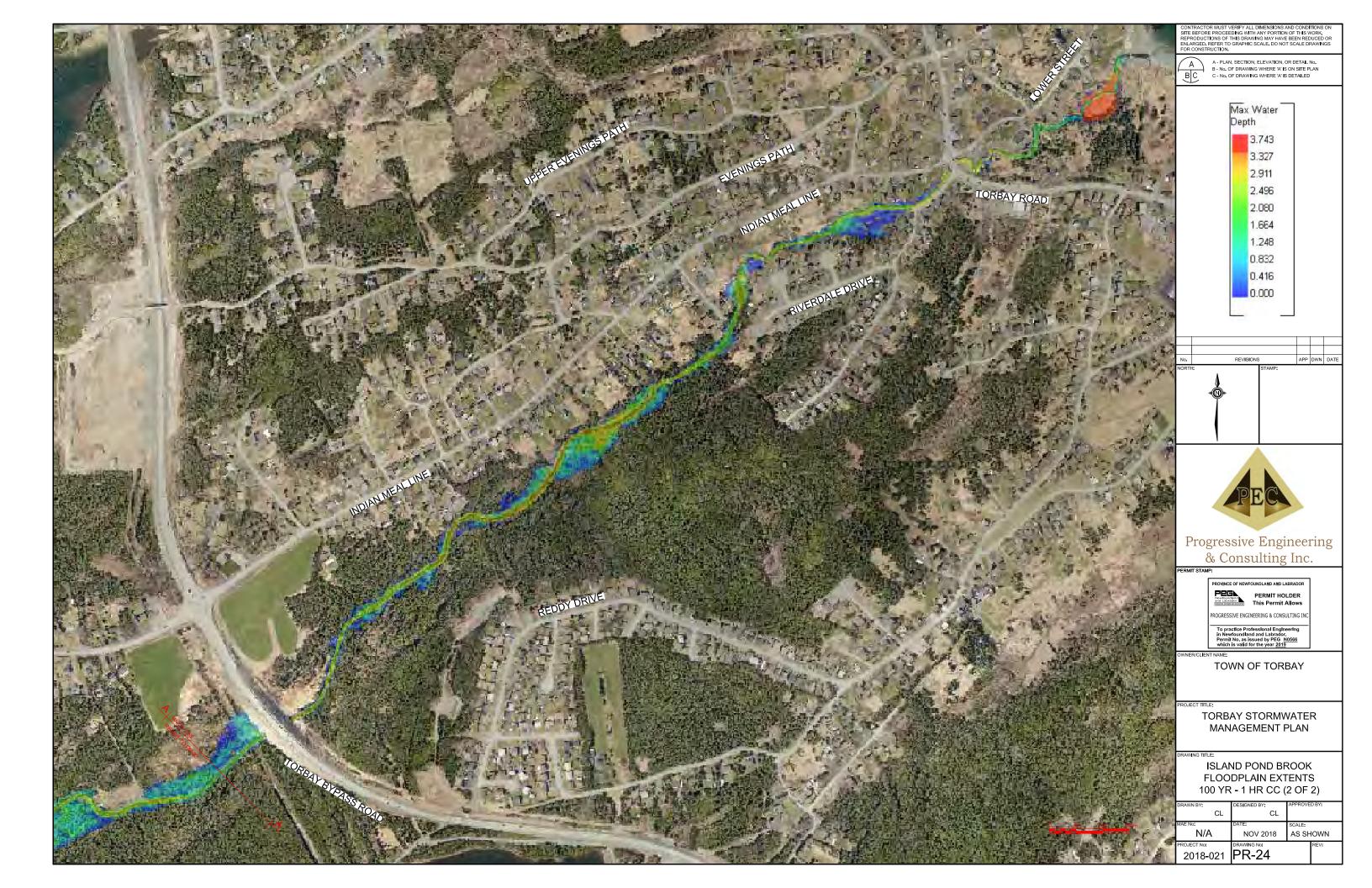


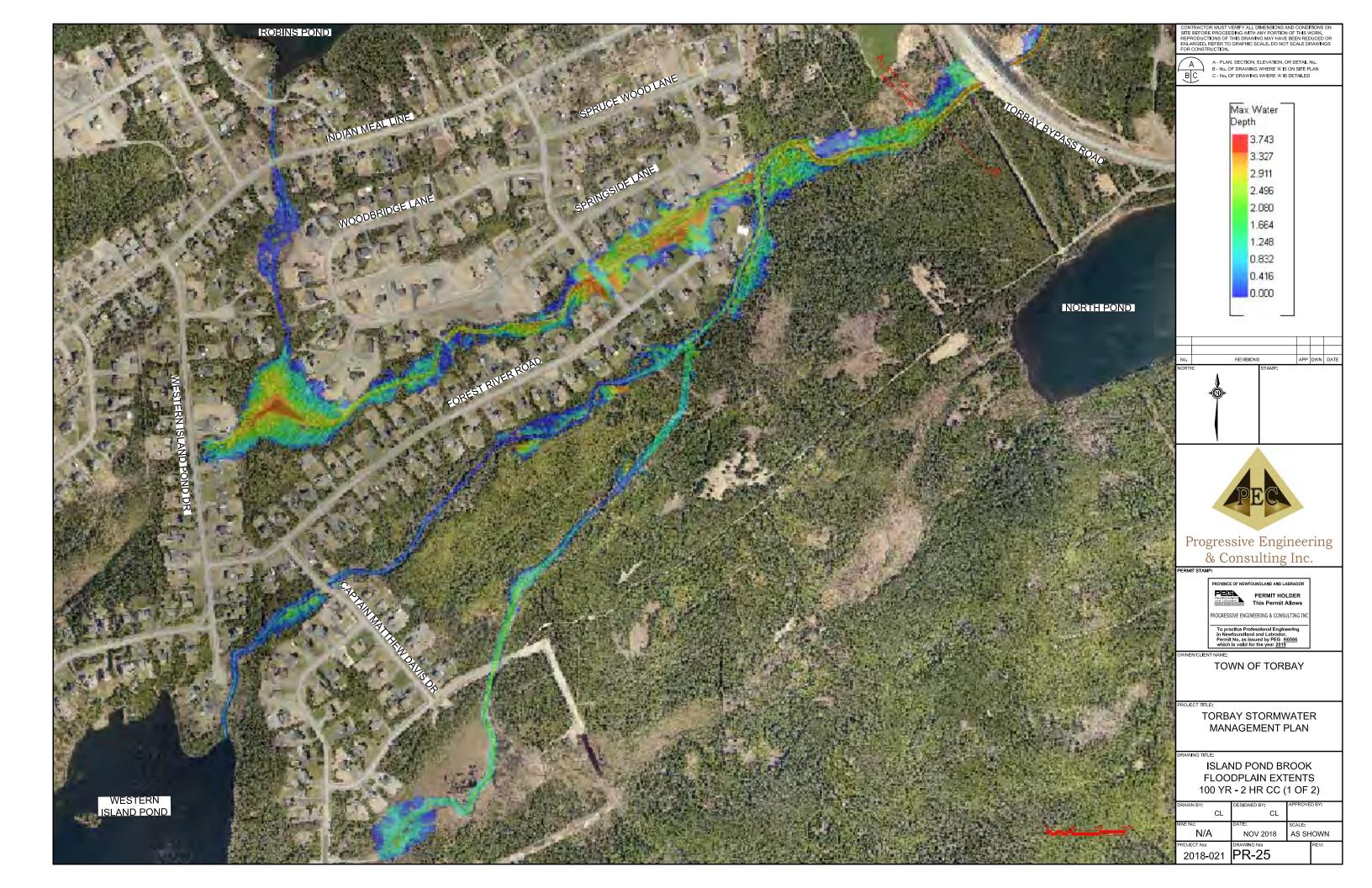
















- A PLAN, SECTION, ELEVATION, OR DETAIL NO. B No. OF DRAWING WHERE 'A' IS ON SITE PLAN C No. OF DRAWING WHERE 'A' IS DETAILED
 - Max Water 3.743
 - 3.327 2.911 2.496 2.080 1.664 1.248 0.832

REVISIONS

0.416 0.000

Progressive Engineering & Consulting Inc.

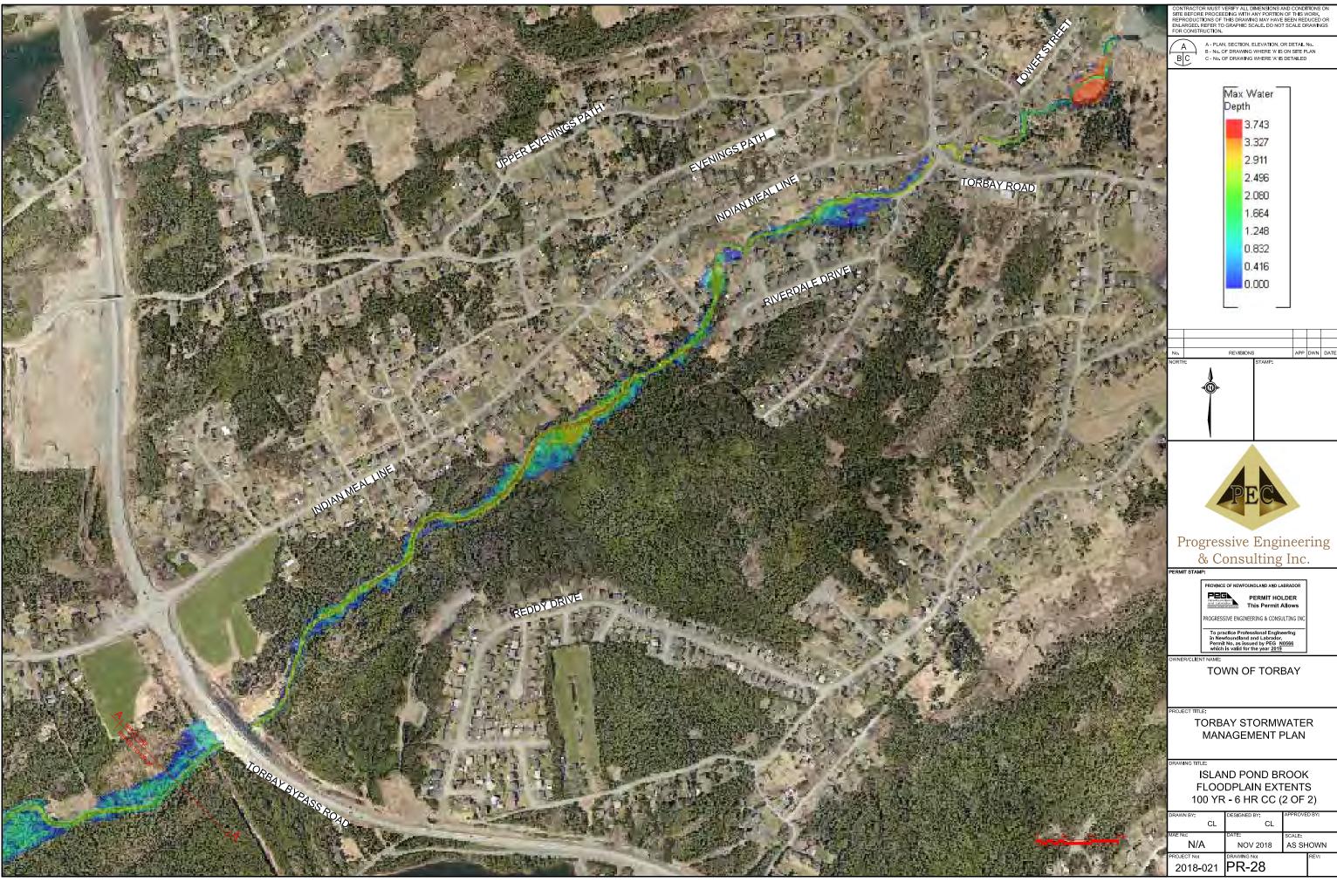
TOWN OF TORBAY

TORBAY STORMWATER MANAGEMENT PLAN

ISLAND POND BROOK FLOODPLAIN EXTENTS 100 YR - 2 HR CC (2 OF 2)

DRAWN BY:	DESIGNED BY:	APPROVED BY:
CL	CL	
MAE No:	DATE:	SCALE:
N/A	NOV 2018	AS SHOWN
PROJECT No:	DRAWING No:	REV:
2018-021	PR-26	

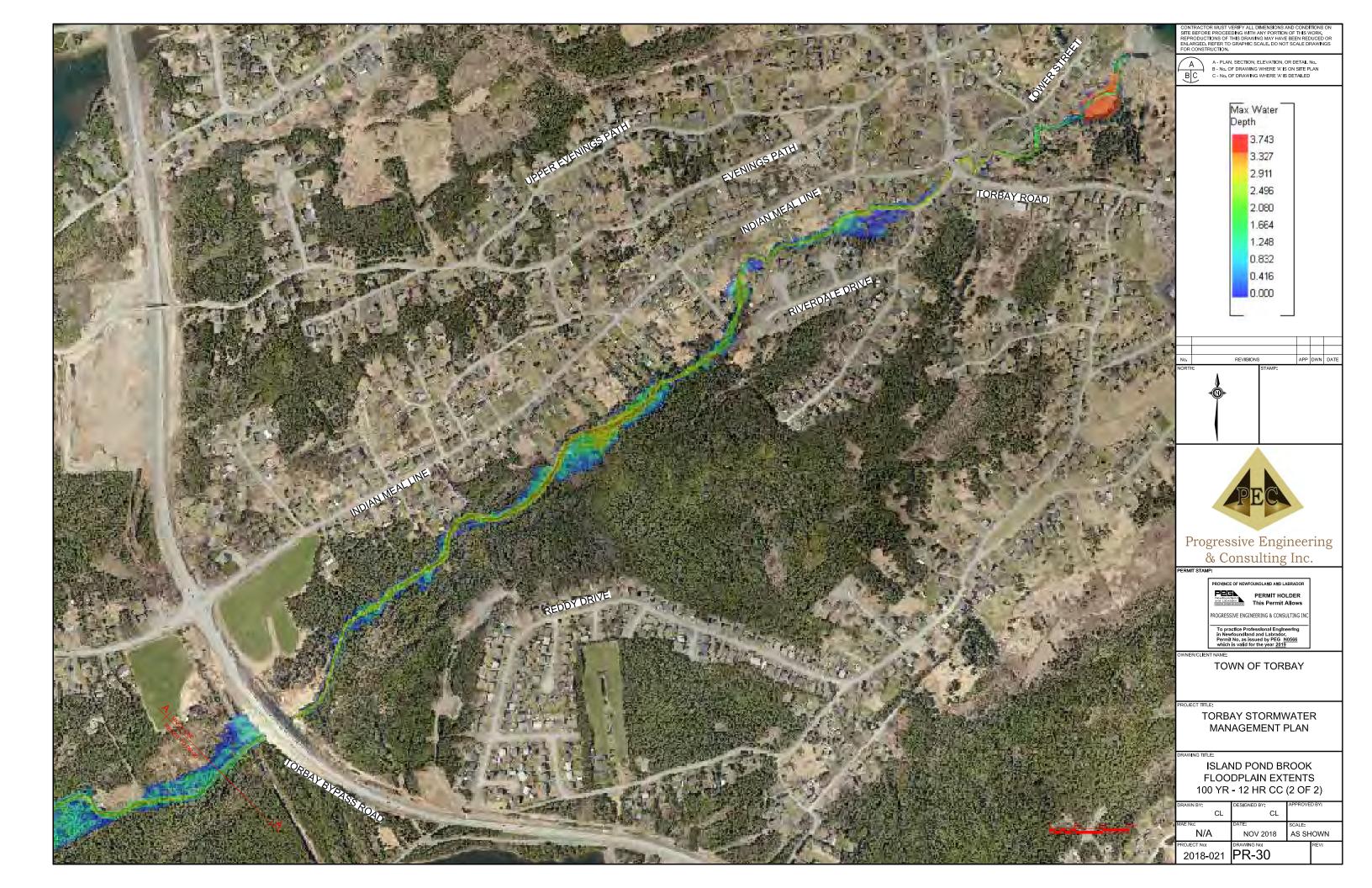






l	DRAWN BY:	DESIGNED BY:	APPROVED BY:
i	CL	CL	
	MAE NO: N/A	DATE: NOV 2018	SCALE: AS SHOWN
	PROJECT No: 2018-021	DRAWING NO: PR-28	REV:









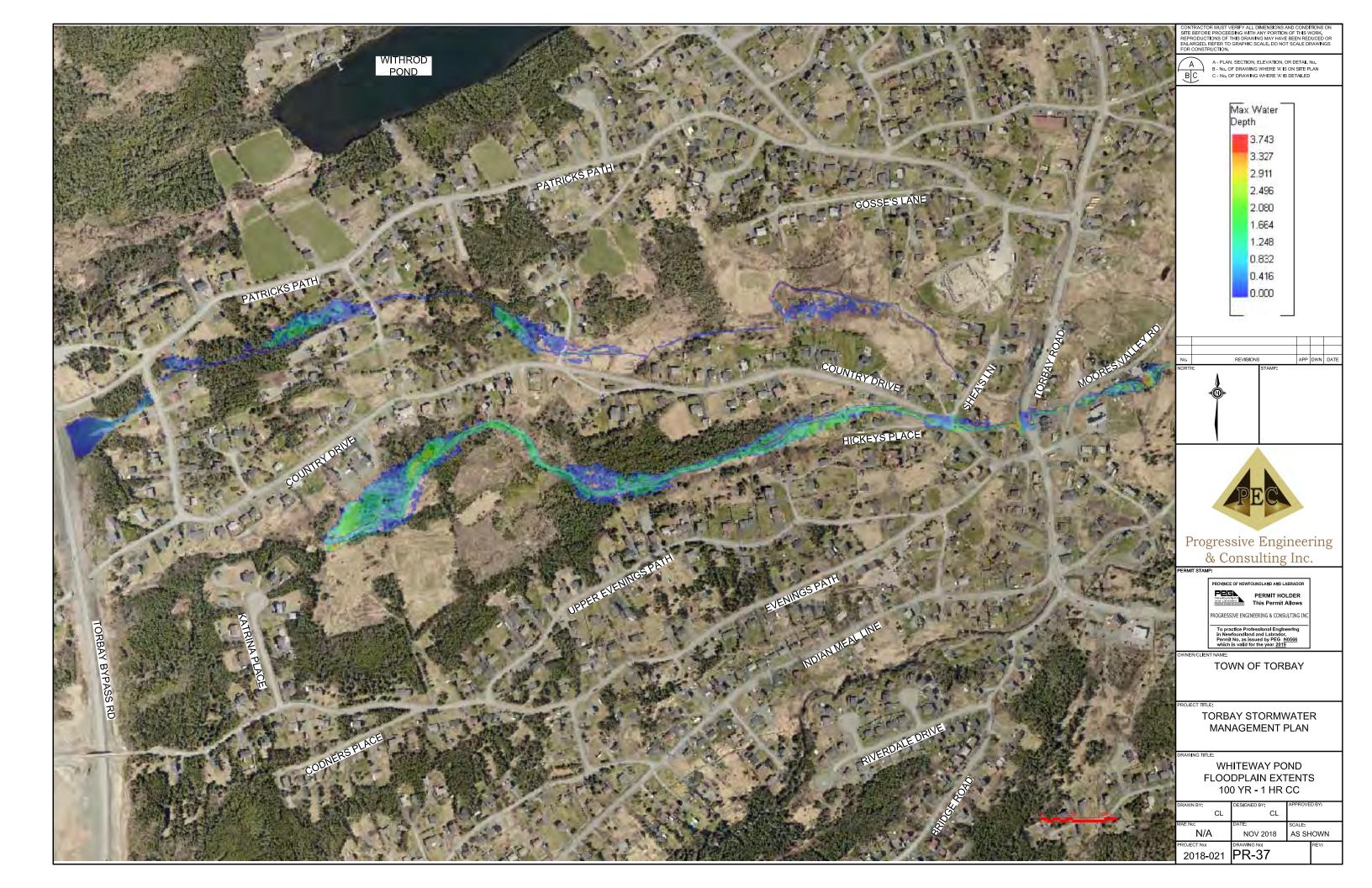




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Į	2018-021	PR-34		l









15	DRAWN BY:	DESIGNED BY:	APPROVED BY:
-	CL	CL	
	MAE No:	DATE:	SCALE:
b	N/A	NOV 2018	AS SHOWN
30	PROJECT No:	DRAWING No:	REV:
	2018-021	PR-38	





100	DRAWN BY:	DESIGNED BY:	APPROVED BY:
1	CL	CL	
16	MAE No:	DATE:	SCALE:
	N/A	NOV 2018	AS SHOWN
Bb.	PROJECT No:	DRAWING No:	REV:
1	2018-021	PR-39	

