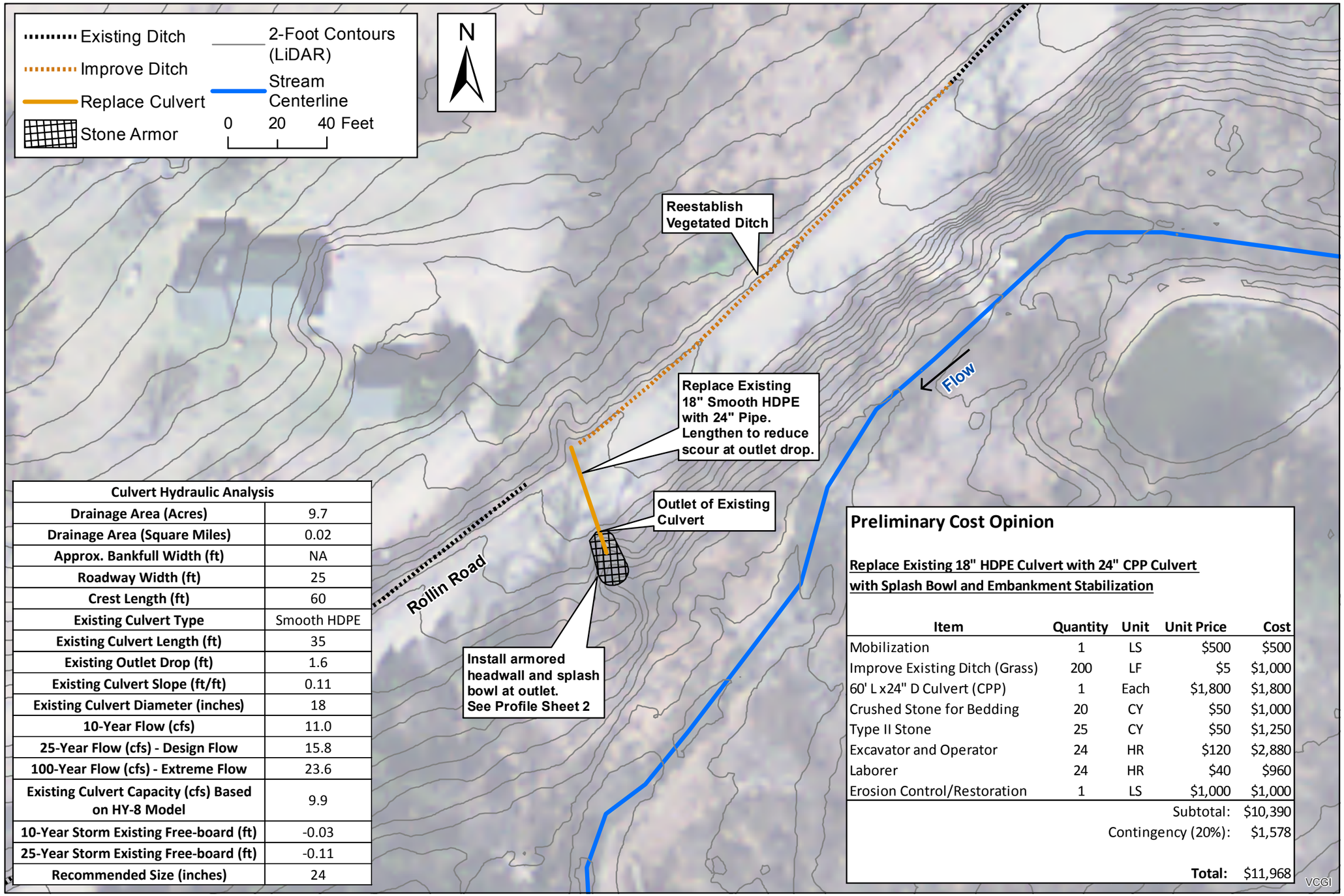
APPENDIX E

30% Conceptual Designs (11”x17”)



Culvert Hydraulic Analysis	
Drainage Area (Acres)	9.7
Drainage Area (Square Miles)	0.02
Approx. Bankfull Width (ft)	NA
Roadway Width (ft)	25
Crest Length (ft)	60
Existing Culvert Type	Smooth HDPE
Existing Culvert Length (ft)	35
Existing Outlet Drop (ft)	1.6
Existing Culvert Slope (ft/ft)	0.11
Existing Culvert Diameter (inches)	18
10-Year Flow (cfs)	11.0
25-Year Flow (cfs) - Design Flow	15.8
100-Year Flow (cfs) - Extreme Flow	23.6
Existing Culvert Capacity (cfs) Based on HY-8 Model	9.9
10-Year Storm Existing Free-board (ft)	-0.03
25-Year Storm Existing Free-board (ft)	-0.11
Recommended Size (inches)	24

Preliminary Cost Opinion

Replace Existing 18" HDPE Culvert with 24" CPP Culvert with Splash Bowl and Embankment Stabilization

Item	Quantity	Unit	Unit Price	Cost
Mobilization	1	LS	$500	$500
Improve Existing Ditch (Grass)	200	LF	$5	$1,000
60' L x24" D Culvert (CPP)	1	Each	$1,800	$1,800
Crushed Stone for Bedding	20	CY	$50	$1,000
Type II Stone	25	CY	$50	$1,250
Excavator and Operator	24	HR	$120	$2,880
Laborer	24	HR	$40	$960
Erosion Control/Restoration	1	LS	$1,000	$1,000
			Subtotal:	$10,390
			Contingency (20%):	$1,578
			Total:	$11,968

VCGI

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Notes
- Imagery is from 2015.
- Contours generated from 0.7 meter LiDAR data for Bennington County (2017).

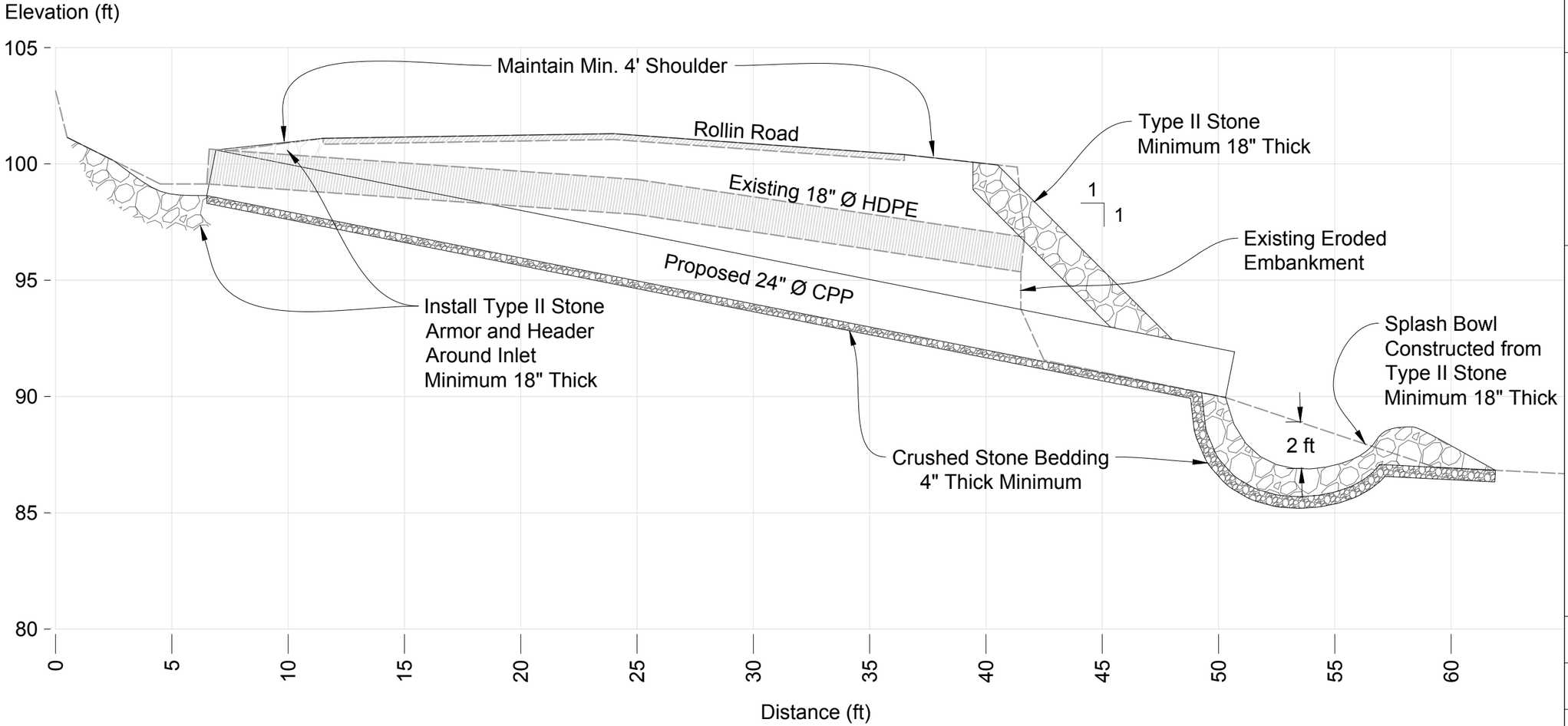
Shaftsbury Stormwater Master Plan
30% Concept Design
Rollin Road (DC-7)
Shaftsbury, VT

EHB	EPF
Map By	Checked By

1" = 40'
Scale

December 3, 2019
Date

DC-7
SHEET 1
SHEET NO.



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Notes: Existing profile based on field survey by FEA (October 2019). Elevations are based on a relative datum established in the field.

Shaftsbury Stormwater Master Plan
30% Concept Design
Rollin Road (DC-7)
Shaftsbury, VT

EHB	EPF
DRAWN	CHECKED

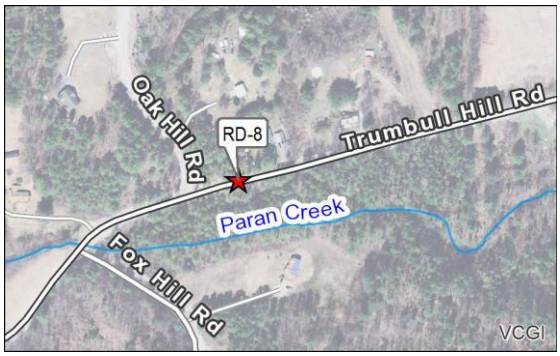
1" = 5'
SCALE

December 3, 2019
DATE

DC-7
SHEET 2
SHEET NO.

Town: Shaftsbury	**Road Name:** Trumbull Hill Road	**SWMP Project ID:** RD-8

Hydrologically Connected Road Segment IDs (West to East): 118162, 118161, 118160, 118659



Existing Conditions

Field Determined Slope: 2%, 3%, 6%, 10%

Road Type: Gravel

Conveyance Area/Turnout: 1 Poor

Erosion Types Present: Rill

Drainage Culverts: 2 Cross, 1 Conveyance

Driveway Culverts: 1

Municipal Road General Permit Standards:

+ Meets Standard, **--** Partially Meets Standard (needs work), **X** Does Not Meet Standard

Roadway Crown/Travel Lane	+	Grader Berm/Windrow	X
Road Drainage	X	Conveyance Area/Turnout	X
Municipal Drainage Culverts	--	Driveway Culverts (within ROW)	--

Existing Conditions Notes: Four (4) hydrologically connected segments along Trumbull Hill Road all drain to Paran Creek. The two eastern segments are steep (6-10% slope). The road crown is generally good, but grader berms and a lack of drainage ditches cause the formation of a secondary ditch on the north side of the road that extends west to Paran Creek. The existing cross culvert to the east is undersized and should be replaced with an 18" culvert to meet MRGP standards. Given the road slope at this location, 12" minus stone is recommended in the eastern ditches to meet MRGP standards. Turnouts and cross culverts should be installed to improve drainage and reduce erosion.

Photo 1: Runoff is eroding the roadway and bypassing an existing turnout on Trumbull Hill Road near the Oak Hill Road intersection.

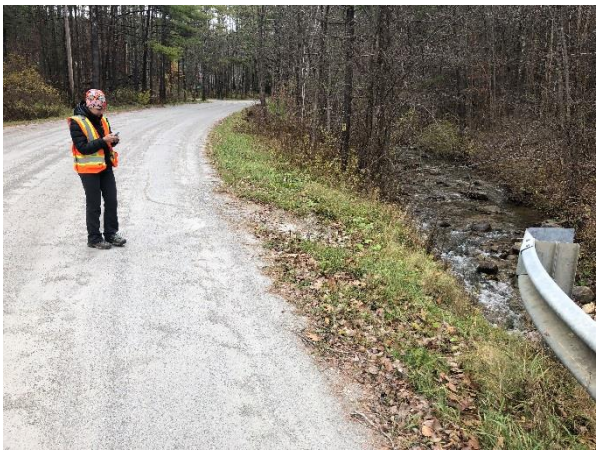


Photo 2: Runoff on the south side of the road drains via a poor conveyance directly into Paran Creek.

Proposed Scope of Work

Roadway/Travel Lane Practices

	Improve Road Crown		Adjust Road Grade
X	Remove Grader Berm/Lower Shoulder		Edge of Road Stabilization/Maintenance

Roadway Drainage Practices

X	Install New Ditch	X	Improve Existing Ditch
	Side Slope Excavation for New Ditch		

Conveyance/Turnout Practices

X	Install Turnout	X	Stabilize/Improve Existing Turnout
	Install Sediment Trap		Stone Armor on Bank/Slope

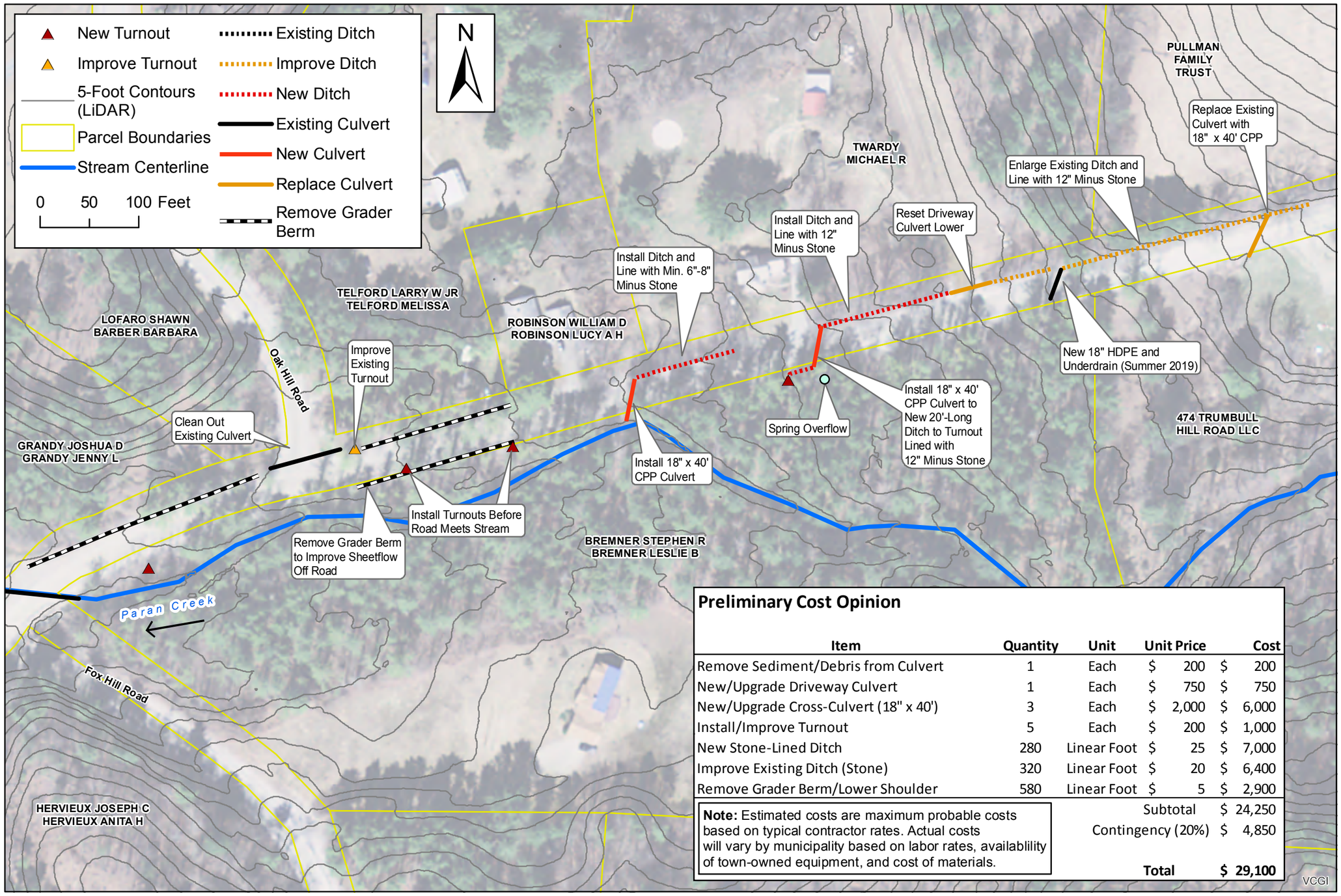
Culvert Practices

X	New Municipal Culvert	X	Upgrade Municipal Culvert
	New Driveway Culvert		Upgrade Driveway Culvert
	Headwall or Armor at Culvert Inlet/Outlet	X	Clean Sediment/Debris from Culvert

Preliminary Cost Opinion

Item	Quantity	Unit	Unit Price	Cost
Remove Sediment/Debris from Culvert	1	Each	$ 200	$ 200
New/Upgrade Driveway Culvert	1	Each	$ 750	$ 750
New/Upgrade Cross-Culvert (18" x 40')	3	Each	$ 2,000	$ 6,000
Install/Improve Turnout	5	Each	$ 200	$ 1,000
New Stone-Lined Ditch	280	Linear Foot	$ 25	$ 7,000
Improve Existing Ditch (Stone)	320	Linear Foot	$ 20	$ 6,400
Remove Grader Berm/Lower Shoulder	580	Linear Foot	$ 5	$ 2,900
			Subtotal	$ 24,250
			Contingency (20%)	$ 4,850
			Total	**$ 29,100**

Note: Estimated costs are maximum probable costs based on typical contractor rates. Actual costs will vary by municipality based on labor rates, availability of town-owned equipment, and cost of materials.



Preliminary Cost Opinion

Item	Quantity	Unit	Unit Price	Cost
Remove Sediment/Debris from Culvert	1	Each	$ 200	$ 200
New/Upgrade Driveway Culvert	1	Each	$ 750	$ 750
New/Upgrade Cross-Culvert (18" x 40')	3	Each	$ 2,000	$ 6,000
Install/Improve Turnout	5	Each	$ 200	$ 1,000
New Stone-Lined Ditch	280	Linear Foot	$ 25	$ 7,000
Improve Existing Ditch (Stone)	320	Linear Foot	$ 20	$ 6,400
Remove Grader Berm/Lower Shoulder	580	Linear Foot	$ 5	$ 2,900
			Subtotal	$ 24,250
			Contingency (20%)	$ 4,850
			Total	**$ 29,100**

Note: Estimated costs are maximum probable costs based on typical contractor rates. Actual costs will vary by municipality based on labor rates, availablility of town-owned equipment, and cost of materials.

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Notes
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- Contours generated from 0.7 meter LiDAR data for Bennington County (2017).

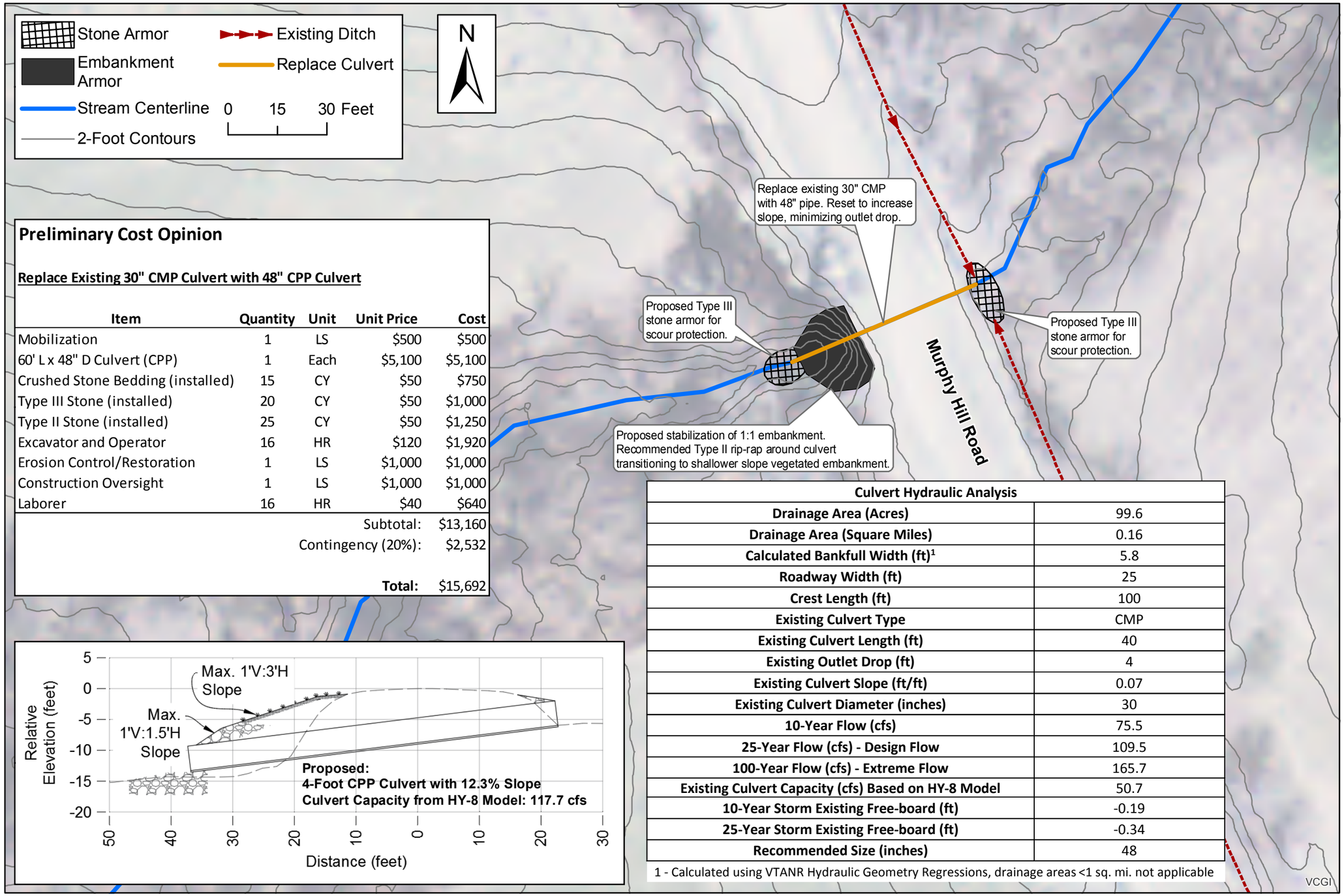
Shaftsbury Stormwater Master Plan
30% Concept Design
Trumbull Hill Road (RD-8)
Shaftsbury, VT

EHB, JHB	EPF
Map By	Checked By

1" = 100'
Scale

December 3, 2019
Date

RD-8
SHEET 1
SHEET NO.



Preliminary Cost Opinion

Replace Existing 30" CMP Culvert with 48" CPP Culvert

Item	Quantity	Unit	Unit Price	Cost
Mobilization	1	LS	$500	$500
60' L x 48" D Culvert (CPP)	1	Each	$5,100	$5,100
Crushed Stone Bedding (installed)	15	CY	$50	$750
Type III Stone (installed)	20	CY	$50	$1,000
Type II Stone (installed)	25	CY	$50	$1,250
Excavator and Operator	16	HR	$120	$1,920
Erosion Control/Restoration	1	LS	$1,000	$1,000
Construction Oversight	1	LS	$1,000	$1,000
Laborer	16	HR	$40	$640
			Subtotal:	$13,160
			Contingency (20%):	$2,532
			Total:	$15,692

Culvert Hydraulic Analysis	
Drainage Area (Acres)	99.6
Drainage Area (Square Miles)	0.16
Calculated Bankfull Width (ft)[1]	5.8
Roadway Width (ft)	25
Crest Length (ft)	100
Existing Culvert Type	CMP
Existing Culvert Length (ft)	40
Existing Outlet Drop (ft)	4
Existing Culvert Slope (ft/ft)	0.07
Existing Culvert Diameter (inches)	30
10-Year Flow (cfs)	75.5
25-Year Flow (cfs) - Design Flow	109.5
100-Year Flow (cfs) - Extreme Flow	165.7
Existing Culvert Capacity (cfs) Based on HY-8 Model	50.7
10-Year Storm Existing Free-board (ft)	-0.19
25-Year Storm Existing Free-board (ft)	-0.34
Recommended Size (inches)	48

1 - Calculated using VTANR Hydraulic Geometry Regressions, drainage areas <1 sq. mi. not applicable

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Notes
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- Elevations for culvert modeling based on relative datum established in the field.
- Contours generated from 0.7 meter LiDAR data for Bennington County (2017).

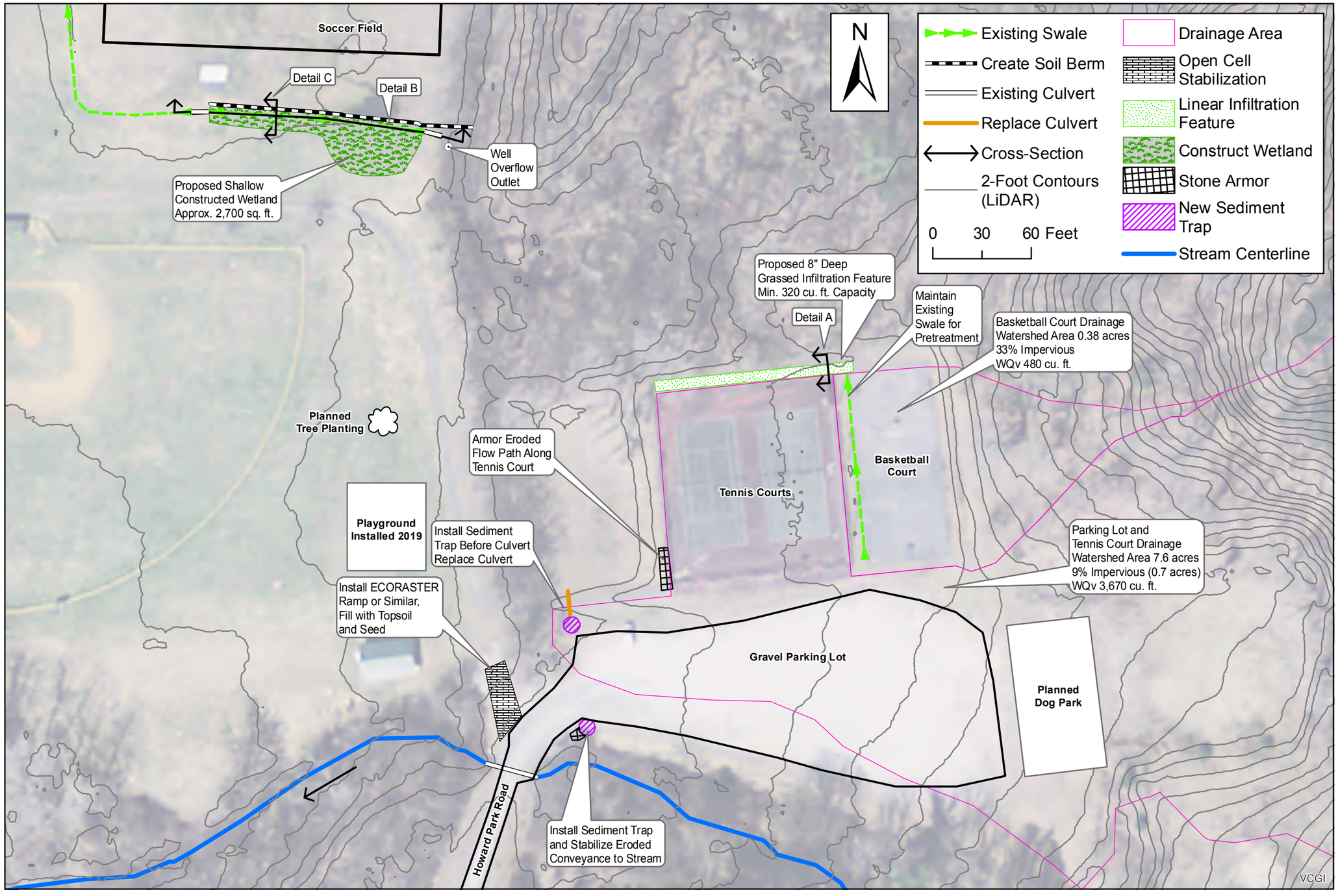
Shaftsbury Stormwater Master Plan
30% Concept Design
Murphy Hill Road (C-6)
Shaftsbury, VT

EHB	EPF
Map By	Checked By

1" = 30'
Scale

December 3, 2019
Date

C-6
SHEET 1
SHEET NO.



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Notes
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- Contours generated from0.7 meter LiDAR data for Bennington County (2017).

Shaftsbury Stormwater Master Plan
30% Concept Design
Howard Park (SW-9 & 10)
Shaftsbury, VT

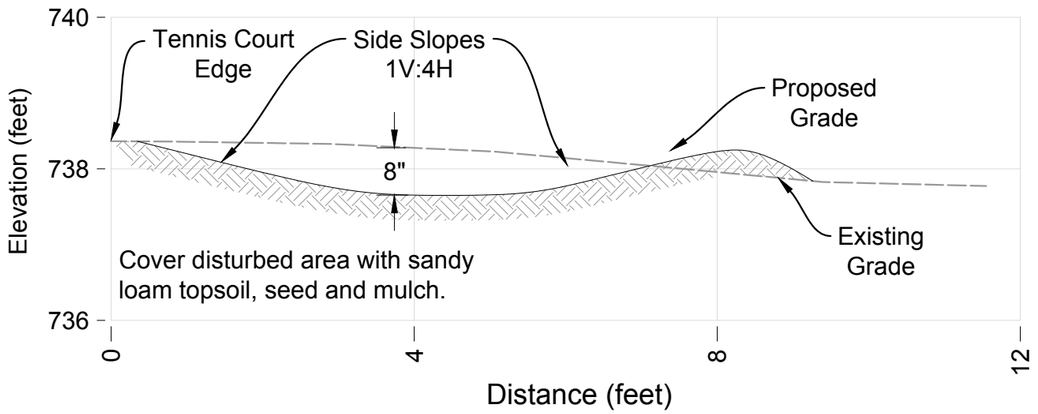
EHB	EPF
Map By	Checked By

1" = 60'
Scale

December 3, 2019
Date

SW-9 & 10
SHEET 1
SHEET NO.

Detail A: Basketball Court Infiltration Cross-Section (1" = 2')



Preliminary Cost Opinion

Parking and Court Area Improvements

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 500	$ 500
New/Upgrade Culvert (12" to 15")	1	Each	$ 750	$ 750
Install Sediment Trap	2	Each	$ 750	$ 1,500
Common Excavation and Trucking	10	CY	$ 40	$ 400
Topsoil	4	CY	$ 50	$ 200
Grass Seed (1lb/200 sq ft)	4	LBS	$ 20	$ 80
8" Minus Stone	15	CY	$ 50	$ 750
Labor	8	HR	$ 40	$ 320
ECORASTER E30 Materials & Installation	1	LS	$ 4,000	$ 4,000
			Subtotal	$ 8,500
			Contingency (20%)	$ 1,600
			Total	**$ 10,100**

Soccer Field Area Constructed Wetland

Item	Quantity	Unit	Unit Price	Cost
Mobilization/Demobilization	1	LS	$ 500	$ 500
Common Excavation and Trucking	80	CY	$ 40	$ 3,200
Topsoil	35	CY	$ 50	$ 1,750
Native Wetland Seed (1lb/1250 s qft)	2	LBS	$ 34	$ 68
2" Minus Stone for Culvert Cover	4	CY	$ 50	$ 200
Laborer	8	HR	$ 40	$ 320
			Subtotal	$ 6,038
			Contingency (20%)	$ 1,108
			Total	**$ 7,146**

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Notes: Existing profile based on 0.7 meter LiDAR Digital Elevation Model for Bennington County (2017).

Shaftsbury Stormwater Master Plan
30% Concept Design
Howard Park (SW-9 & 10)
Shaftsbury, VT

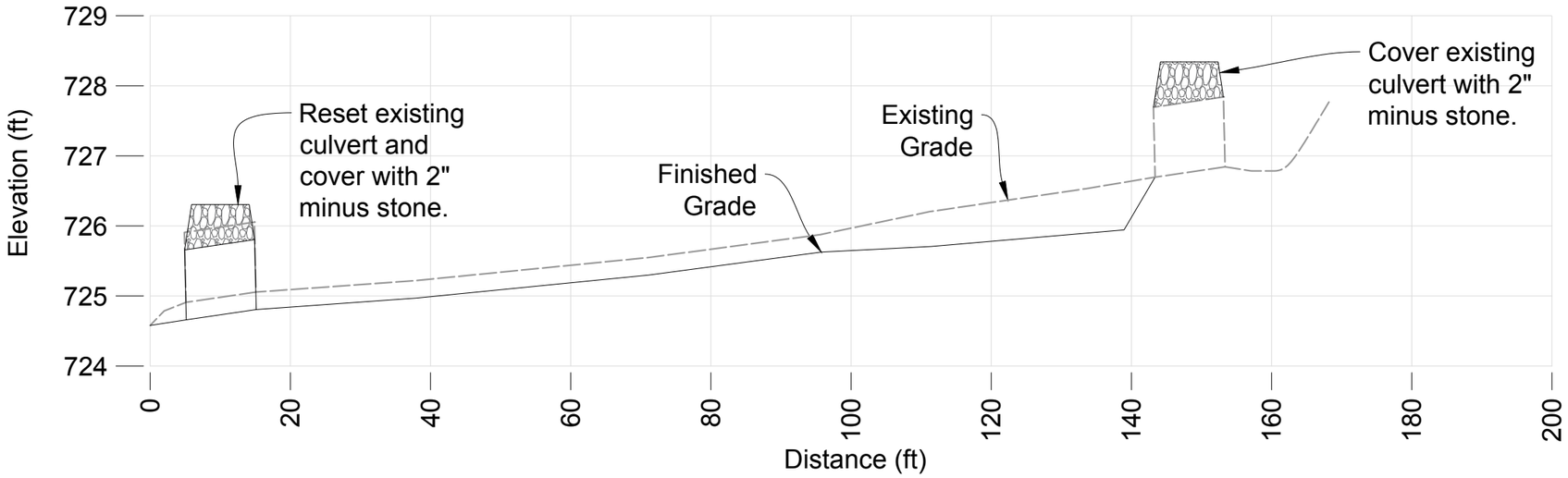
EHB	EPF
DRAWN	CHECKED

As Shown
SCALE

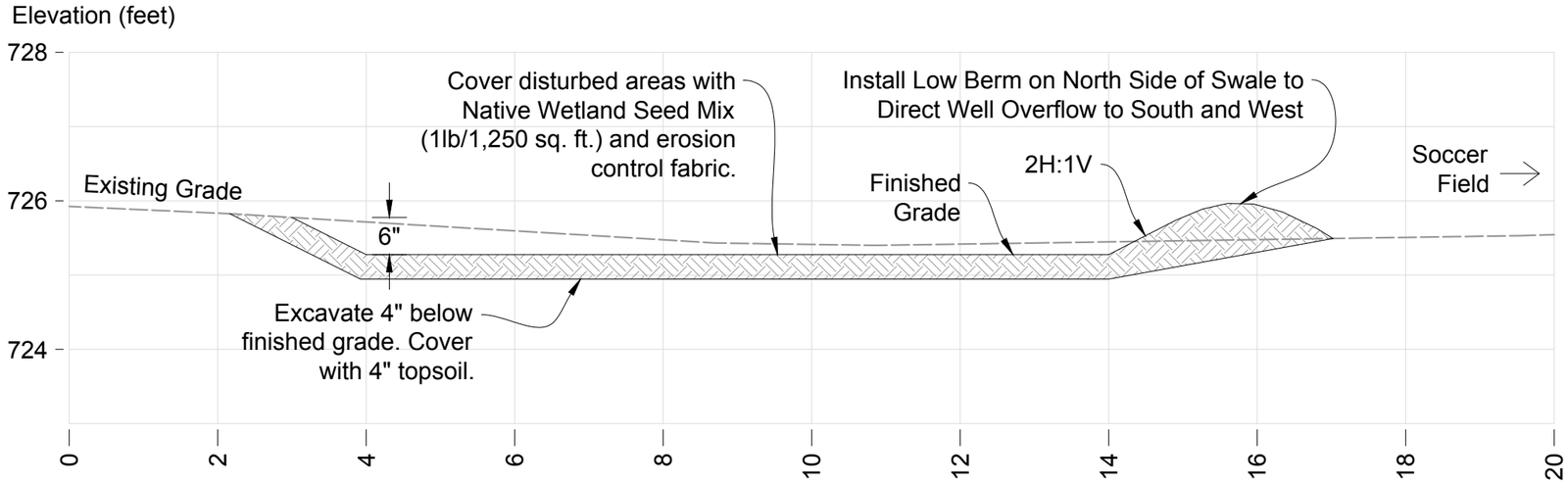
December 3, 2019
DATE

SW-9 & 10
SHEET 2
SHEET NO.

Detail B: Soccer Field Swale Profile (1" = 20' H; 1" = 2' V)



Detail C: Soccer Field Swale Cross-Section (1" = 2')



Suggested Construction Sequence:
1. Following excavation, install 4" topsoil. Ensure there is no berm on the south side to allow sheet flow into the feature.
2. Seed with wetland seed mix.
3. Install erosion control fabric.

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Notes: Existing profile based on 0.7 meter LiDAR Digital Elevation Model for Bennington County (2017).

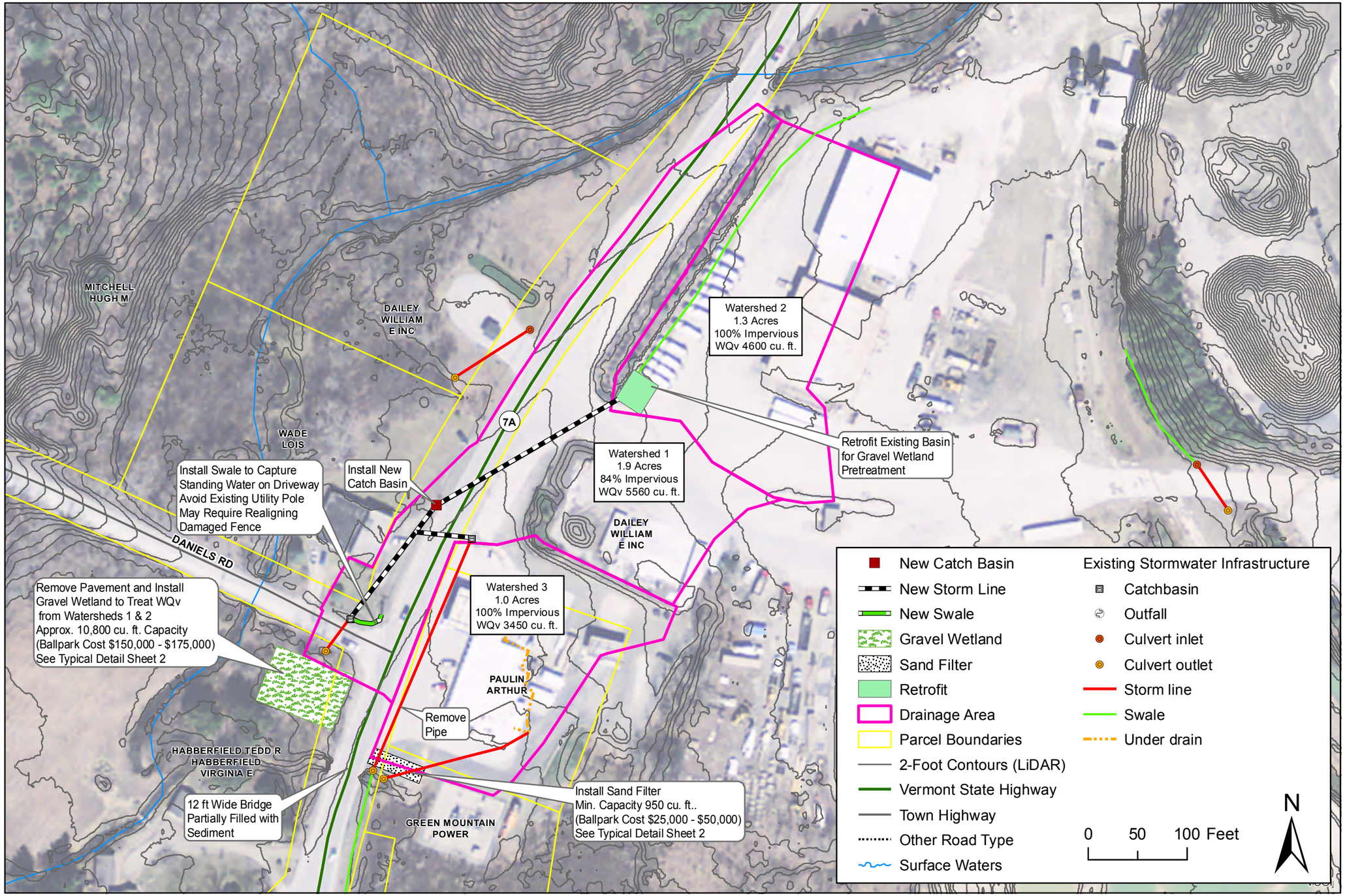
Shaftsbury Stormwater Master Plan
30% Concept Design
Howard Park (SW-9 & 10)
Shaftsbury, VT

EHB	EPF
DRAWN	CHECKED

As Shown
SCALE

December 3, 2019
DATE

SW-9 & 10
SHEET 3
SHEET NO.



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Notes
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Shaftsbury Stormwater Master Plan
30% Concept Design
Route 7 Corridor (SW-1)
Shaftsbury, VT

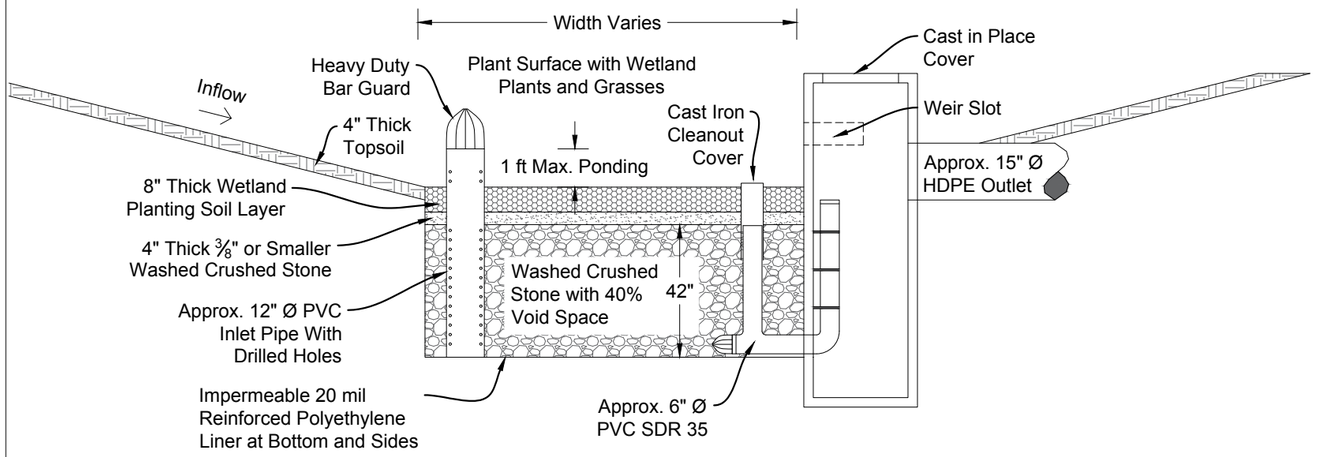
EHB	EPF
Map By	Checked By

1" = 60'
Scale

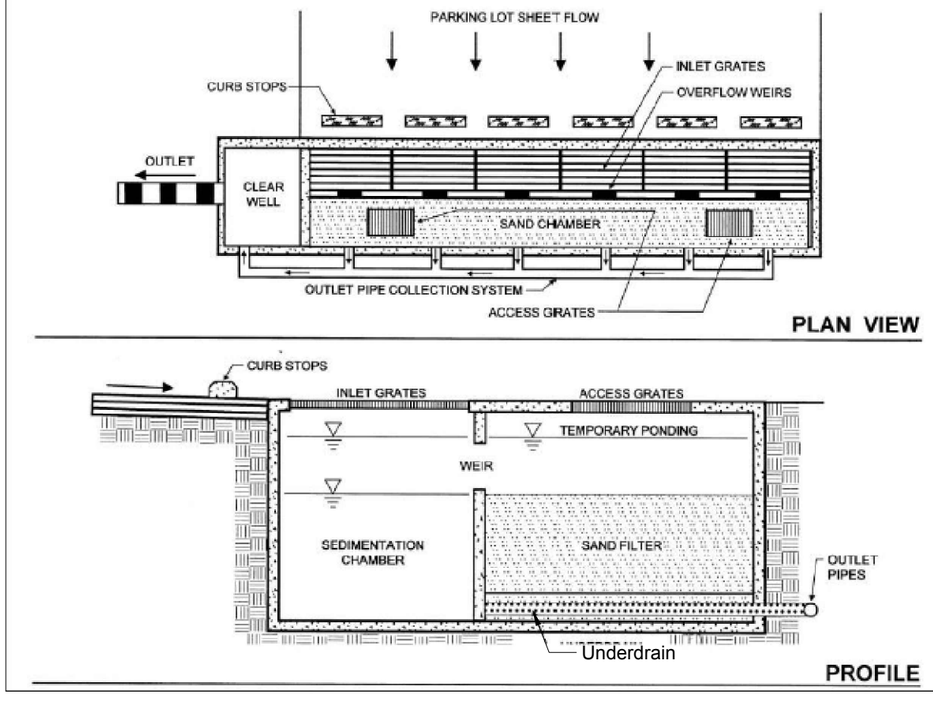
December 3, 2019
Date

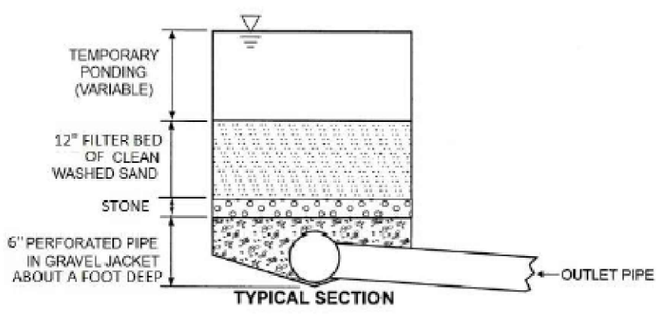
SW-1
SHEET 1
SHEET NO.

Detail A: Gravel Wetland Typical N.T.S



Detail B: Sand Filter Typical (VT Stormwater Treatment Standards Fig. 4-17) N.T.S.





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Notes:

Shaftsbury Stormwater Master Plan
30% Concept Design
Route 7A (SW-1)
Shaftsbury, VT

EHB	EPF
DRAWN	CHECKED

As Shown
SCALE

December 3, 2019
DATE

SW-1
SHEET 2
SHEET NO.