



ASTM D 6460

STANDARD TEST METHOD FOR DETERMINATION OF ROLLED EROSION CONTROL PRODUCT (RECP) PERFORMANCE IN PROTECTING EARTHEN CHANNELS FROM STORM-INDUCED EROSION

Project: **ASTM D 6460 modified (single replicate)**

Product: **ClosureTurf® with ArmorFill® (Emulsion)**

Client: **Watershed Geosynthetics**

Test Dates: **2/27/2018**

Shear Range: **2 - 5 psf**

Flume: **2-ft wide x 40-ft long; 20% Bed**

Event: **30 minutes at each shear**

Test Scenario	Shear Level	depth (in)	velocity (fps)	Flow (cfs)	Manning's roughness, n	Max Bed Shear Stress (psf)	CSLI (in)	Cumulative CSLI, (in)
ClosureTurf® with ArmorFill® (Emulsion)	1	2.11	5.95	2.09	0.035	2.19	0.02	0.02
	2	4.95	12.86	10.61	0.029	5.06	0.05	0.08

Product	Geomembrane	Infill	Infill Thickness	Binder Mixing Rate	Binder Application Rate	Permissible Shear	Permissible Velocity
ClosureTurf®	Agro Drain Liner® (with studs facing up)	ArmorFill® (Emulsion) (C33 Sand + Binding Agent + Water)	0.5 Inches	6:1 (water: emulsion)	3400 gals per acre	10.3+ psf	23.3+ ft/sec

The testing is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose

CJS 3/2/18

Quality Review / Date



Installation of Erosion Control Product in Test Channel

As noted, the submitted erosion control product is installed as directed by the client. For the tests reported herein, the erosion control product was installed in the rectangular wall channel. Agru Drain Liner® geomembrane was installed on the subgrade soil with the studs facing up. The geomembrane was covered with a layer of synthetic turf. ASTM C33 sand was raked uniformly in the turf component of the Closure Turf® system to achieve a uniform in-fill rate of $0.04 \text{ ft}^3/\text{ft}^2$, producing a nominal uniform thickness of 0.5 inches. A proprietary binding agent was mixed with water at a 6:1 ratio and applied with a backpack sprayer to achieve a uniform application rate of 3400 gallons per acre of the binding agent / water mixture (ArmorFill-E).



Closure Turf® with ArmorFill® (Emulsion) - Unvegetated



ClosureTurf® Installed in Channel (typical)



ClosureTurf® Installed (close-up)



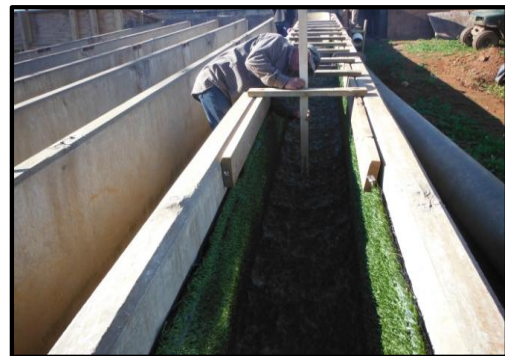
Medium Flow



Infill Loss Measurement



High Flow



Flow Depth Measurement



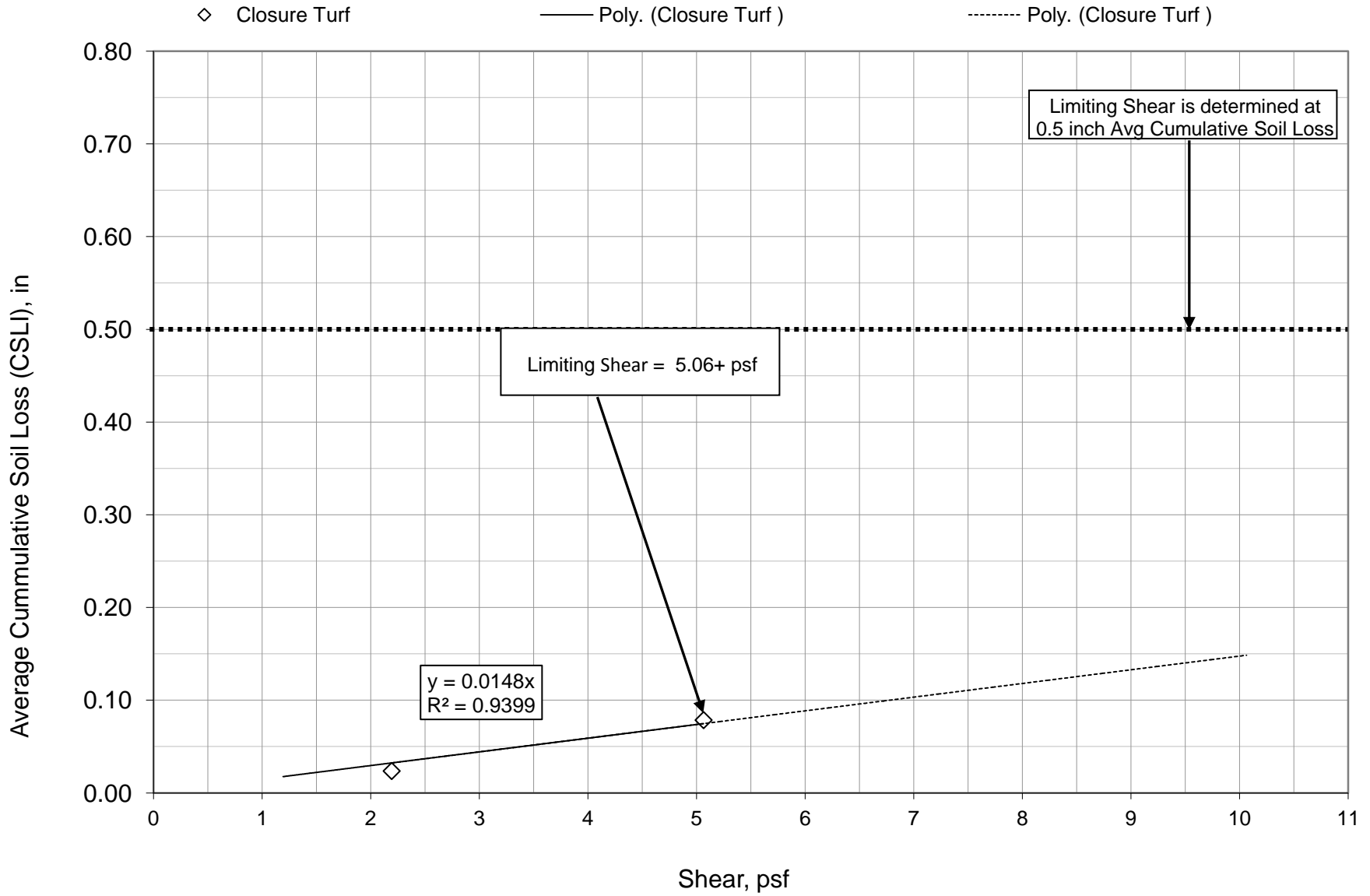
After High Flow - ClosureTurf® Close-up



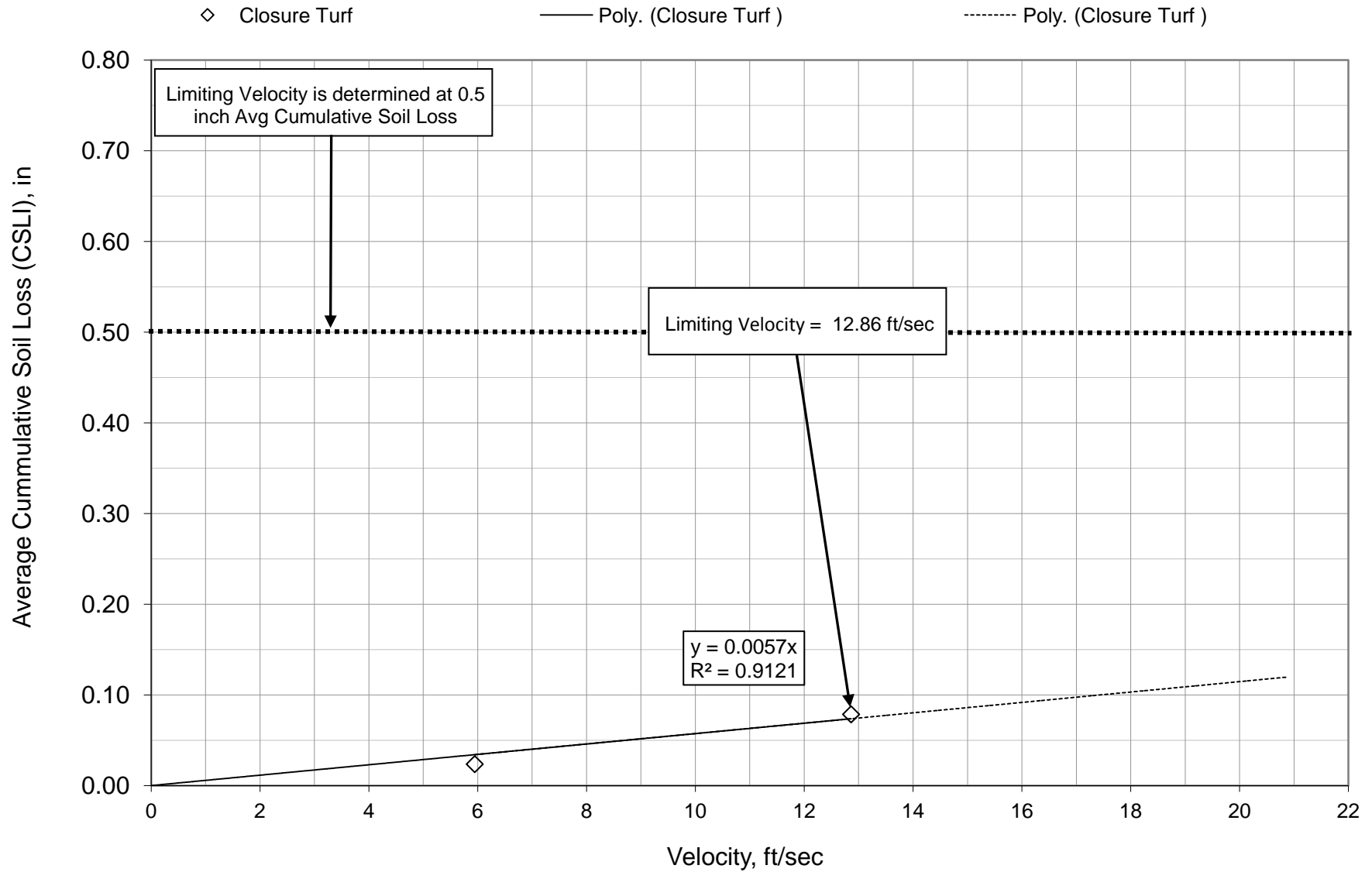
After Test Completion

Limiting Shear via ASTM D 6460

ClosureTurf with ArmorFill Emulsion

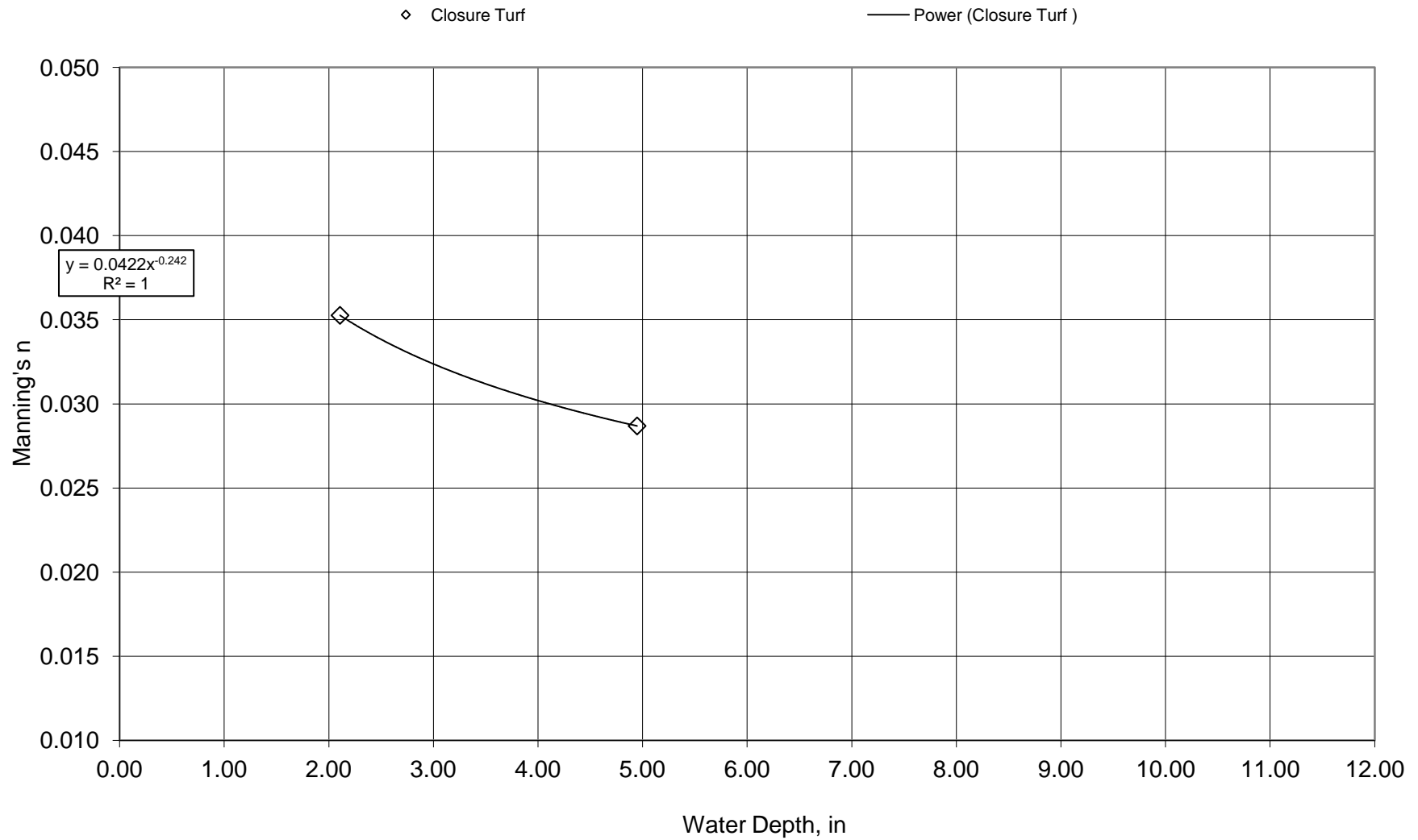


Limiting Velocity via ASTM D 6460 ClosureTurf with ArmorFill (Emulsion)



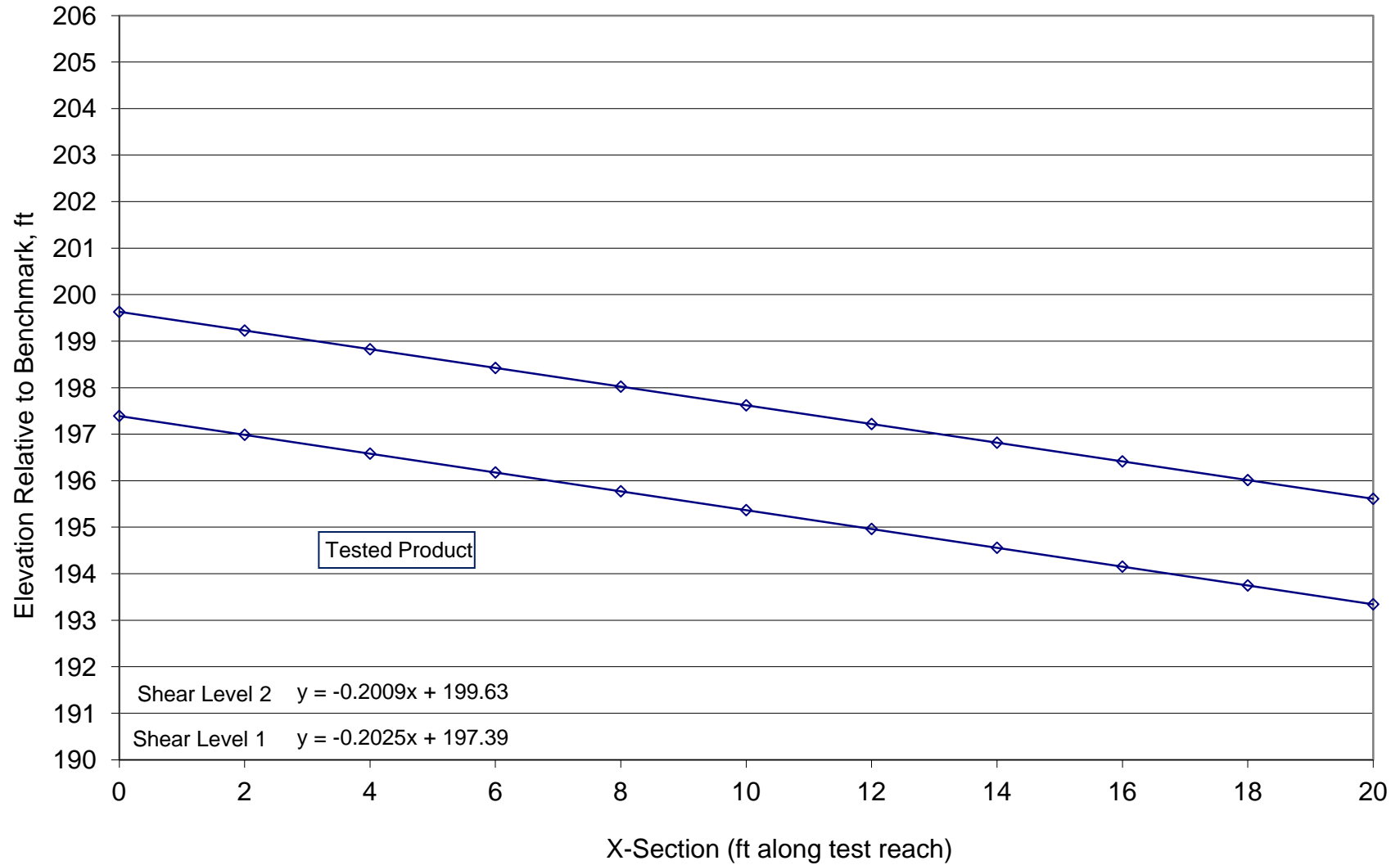
Manning's n vs. Water Depth

ClosureTurf with ArmorFill (Emulsion)



Energy Grade Lines - All Shear Levels

ClosureTurf with ArmorFill (Emulsion)



Date:	2/27/18	RECP:	Closure Turf			Anchorage:	Armor Fill - E						
Slope:	20%	Start Time:	9:48 AM	Channel #	1	Shear #	1	Start Time:	10:32 AM	Channel #	1	Shear #	2
Width:	2	End Time:	10:18 AM	1	1	End Time:	11:02 AM	1	2				
Cross-Section Measurements													
		Measured Volumetric Flow, cfs:				Measured Volumetric Flow, cfs:							
1	To original Surface Elev, cm	70.6	70.8	70.6	Avg.								
	To eroded Surface Elev, cm	70.6	70.9	70.6	70.7	70.6	70.9	71.1	70.9				
	Loss/Gain, sq.in./in. width	0.00	-0.04	0.00	-0.01	0.00	-0.04	-0.20	-0.07				
	CSLI, sq.in./in. width	0.00	-0.04	0.00	-0.01	0.00	-0.04	-0.20	-0.07				
	Velocity, ft/s		0.0		5.8				0.0			12.6	
	Distance to Water Surface, cm			65.2		65.2			58.0			58.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.17			10.61	5.07						
2	To original Surface Elev, cm	70.8	70.8	70.4	Avg.								
	To eroded Surface Elev, cm	70.8	70.8	70.5	70.7	70.8	71.0	70.6	70.8				
	Loss/Gain, sq.in./in. width	0.00	0.00	-0.04	-0.01	0.00	-0.08	-0.08	-0.04				
	CSLI, sq.in./in. width	0.00	0.00	-0.04	-0.01	0.00	-0.08	-0.08	-0.04				
	Velocity, ft/s		0.0		6.1				0.0			12.6	
	Distance to Water Surface, cm			65.5		65.5			58.0			58.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.05			10.61	5.04						
3	To original Surface Elev, cm	70.8	71.2	70.7	Avg.								
	To eroded Surface Elev, cm	70.9	71.2	70.8	71.0	71.0	71.2	71.1	71.1				
	Loss/Gain, sq.in./in. width	-0.04	0.00	-0.04	-0.03	-0.08	0.00	-0.16	-0.08				
	CSLI, sq.in./in. width	-0.04	0.00	-0.04	-0.03	-0.08	0.00	-0.16	-0.08				
	Velocity, ft/s		0.0		5.6				0.0			13.4	
	Distance to Water Surface, cm			65.3		65.3			59.0			59.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.23			10.61	4.76						
4	To original Surface Elev, cm	70.1	70.5	70.3	Avg.								
	To eroded Surface Elev, cm	70.2	70.5	70.3	70.3	70.3	70.7	70.5	70.5				
	Loss/Gain, sq.in./in. width	-0.04	0.00	0.00	-0.01	-0.08	-0.08	-0.08	-0.07				
	CSLI, sq.in./in. width	-0.04	0.00	0.00	-0.01	-0.08	-0.08	-0.08	-0.07				
	Velocity, ft/s		0.0		5.5				0.0			12.9	
	Distance to Water Surface, cm			64.6		64.6			58.0			58.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.26			10.61	4.92						
5	To original Surface Elev, cm	69.0	68.3	68.0	Avg.								
	To eroded Surface Elev, cm	69.2	68.5	68.2	68.6	69.4	68.9	68.4	68.9				
	Loss/Gain, sq.in./in. width	-0.08	-0.08	-0.08	-0.07	-0.16	-0.24	-0.16	-0.14				
	CSLI, sq.in./in. width	-0.08	-0.08	-0.08	-0.07	-0.16	-0.24	-0.16	-0.14				
	Velocity, ft/s		0.0		6.2				0.0			12.5	
	Distance to Water Surface, cm			63.5		63.5			56.0			56.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.02			10.61	5.08						
6	To original Surface Elev, cm	70.2	69.8	69.3	Avg.								
	To eroded Surface Elev, cm	70.2	70.0	69.4	69.9	70.5	70.3	69.7	70.2				
	Loss/Gain, sq.in./in. width	0.00	-0.08	-0.04	-0.03	-0.12	-0.20	-0.16	-0.12				
	CSLI, sq.in./in. width	0.00	-0.08	-0.04	-0.03	-0.12	-0.20	-0.16	-0.12				
	Velocity, ft/s		0.0		6.7				0.0			13.5	
	Distance to Water Surface, cm			65.1		65.1			58.2			58.2	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	1.88			10.61	4.71						
7	To original Surface Elev, cm	70.0	69.8	69.1	Avg.								
	To eroded Surface Elev, cm	70.0	69.8	69.2	69.7	70.0	69.8	69.6	69.8				
	Loss/Gain, sq.in./in. width	0.00	0.00	-0.04	-0.01	0.00	0.00	-0.20	-0.07				
	CSLI, sq.in./in. width	0.00	0.00	-0.04	-0.01	0.00	0.00	-0.20	-0.07				
	Velocity, ft/s		0.0		5.6				0.0			12.8	
	Distance to Water Surface, cm			64.0		64.0			57.2			57.2	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.23			10.61	4.96						
8	To original Surface Elev, cm	70.0	69.8	69.3	Avg.								
	To eroded Surface Elev, cm	70.0	69.8	69.6	69.8	70.0	69.8	70.1	70.0				
	Loss/Gain, sq.in./in. width	0.00	0.00	-0.12	-0.04	0.00	0.00	-0.31	-0.10				
	CSLI, sq.in./in. width	0.00	0.00	-0.12	-0.04	0.00	0.00	-0.31	-0.10				
	Velocity, ft/s		0.0		6.1				0.0			12.5	
	Distance to Water Surface, cm			64.6		64.6			57.0			57.0	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.05			10.61	5.10						
9	To original Surface Elev, cm	70.4	70.5	70.2	Avg.								
	To eroded Surface Elev, cm	70.5	70.6	70.4	70.4	70.5	70.6	70.5	70.5				
	Loss/Gain, sq.in./in. width	-0.04	-0.04	0.00	-0.02	-0.04	-0.04	-0.12	-0.06				
	CSLI, sq.in./in. width	-0.04	-0.04	0.00	-0.02	-0.04	-0.04	-0.12	-0.06				
	Velocity, ft/s		0.0		5.6				0.0			12.4	
	Distance to Water Surface, cm			64.8		64.8			57.5			57.5	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.22			10.61	5.13						
10	To original Surface Elev, cm	70.8	70.8	70.8	Avg.								
	To eroded Surface Elev, cm	70.8	70.9	70.9	70.9	71.0	70.9	71.0	71.0				
	Loss/Gain, sq.in./in. width	0.00	-0.04	-0.04	-0.02	-0.08	-0.04	-0.08	-0.06				
	CSLI, sq.in./in. width	0.00	-0.04	-0.04	-0.02	-0.08	-0.04	-0.08	-0.06				
	Velocity, ft/s		0.0		6.3				0.0			13.3	
	Distance to Water Surface, cm			65.8		65.8			58.8			58.8	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	1.99			10.61	4.79						
11	To original Surface Elev, cm	71.0	70.8	70.8	Avg.								
	To eroded Surface Elev, cm	71.0	70.9	70.8	70.9	71.0	71.0	70.8	70.9				
	Loss/Gain, sq.in./in. width	0.00	-0.04	0.00	-0.01	0.00	-0.08	0.00	-0.01				
	CSLI, sq.in./in. width	0.00	-0.04	0.00	-0.01	0.00	-0.08	0.00	-0.01				
	Velocity, ft/s		0.0		6.0				0.0			13.1	
	Distance to Water Surface, cm			65.6		65.6			58.6			58.6	
	Calculations		Flow, cfs	Depth, in			Flow, cfs	Depth, in					
		2.09	2.09			10.61	4.86						