Alternate Calculation for Pollutant Removal in Channel Stabilization and Implications for MS4 Permittees

East of Hudson Watershed Corporation

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Presentation Overview

- East of Hudson Watershed Corporation
  - Who are we?
- Channel Stabilization as a Stormwater Retrofit Project
  - Cost effective source of pollution prevention
  - Previously approved method and shortcomings
  - New modelling approach
- NYSDEC Approved MS4 Applications of the New Method
  - How does this help you meet the Minimum Control Measures of the MS4 Permit?
- Proper Operation and Maintenance
- Questions

EOHWC – Who and Why?

- Formed to address heightened P-Reduction
  - Regional Stormwater Entity (RSE).
  - 460 kg over a 5-year period.
  - Bubble compliance for the members

- Carmel (T)
- Putnam Valley (T)
- Kent (T)
- Southeast (T)
- Patterson (T)
- Bedford (T)
- Cortlandt (T)
- Lewisboro (T)
- Mt. Kisco (T/V)
- New Castle (T)
- North Castle (T)
- North Salem (T)
- Pound Ridge (T)
- Somers (T)
- Yorktown (T)
- Brewster (T)
- Pawling (T/V)
- Putnam County

Channel Stabilization

- Why should I care about Channel Stabilization?
  - Eroded soils carry pollutants
    - Phosphorus: typ. 300 mg/kg of soil
  - Sediment deposits from stormwater runoff fill in rivers and wetlands after every storm
  - Highway Departments regularly are addressing road side stabilization in everyday practices
  - Cost effective MS4 Permit solution
    - Minimal piping and catch basins
    - Minimal clearing and demolition
    - Minimal maintenance in comparison to treatment ponds

EAST OF HUDSON WATERSHED CORPORATION

Channel Stabilization

- Increase in soil bulk unit (specific) weight.
- Decrease or complete loss of matric suction, and, therefore, apparent cohesion.
- Generation of positive pore-water pressures, and reduction or loss of frictional strength.
- Entrainment of in situ and failed material at the bank toe.
- Loss of confining pressure during recession of runoff.

Channel Stabilization

Previously Approved
Channel Stabilization Calculation

$$P_{load} = (0.4536)\ ((R-1)(A)(L)(BD)(Ptest))\ /\ ((RP)(1{,}000{,}000))$$

Where:

P_{load} = Total Phosphorus Loading (Kg/yr).

R = 0.0012(i^2) + 0.0239(i) + 1.

i = Imperviousness (%), (Chapter 2, Figure 2.5 of the NYSDEC SWMDM).

A = existing channel cross sectional area (SF).

L = channel or stream length (ft).

BD = bulk density (typ. 95 lb/CF).

Ptest = phosphorus level in soil (typ. 300 mg/kg).

RP = relaxation period (typ. 67 years for alluvial streams);

Drawbacks From the Previously Approved Channel Stabilization Calculation

- Method favors high percent impervious areas versus large basin areas with small impervious contributions.
- This empirical method was created from 2 studies where the slope of the channels were <1 % and <2.5%. These slopes generated a "Relaxation period of 67 years to achieve equilibrium."
- CSM receives no credit for phosphorus removal from stormwater runoff, only addressing the soil content itself.

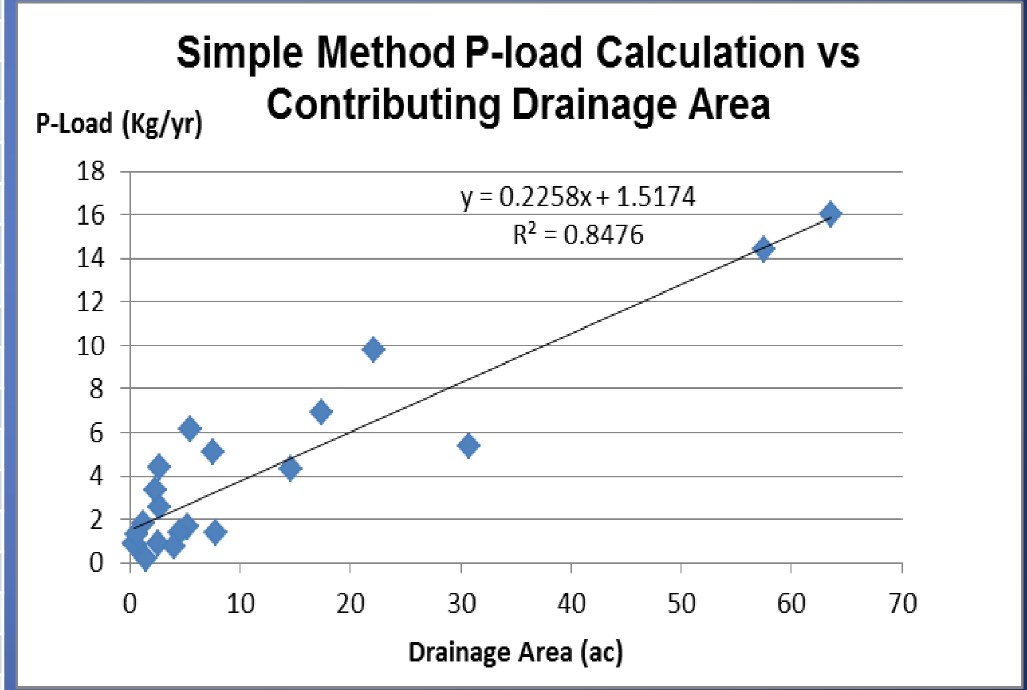
Calculating Phosphorus Loading in Stormwater Runoff

Simple Method: L = 0.103(R)(C)(A)

Where: L = Annual load (kg/yr)
R = Annual Runoff (in)
C = Pollutant Concentration (mg/L)
A = Contributing Area (ac)
0.103 = Unit Conversion factor
And where: R = (P)(Pj)(Rv) = Annual Runoff (in)
P = Annual Rainfall (in)
Pj = Fraction of rainfall producing Runoff = 0.9
Rv = Runoff Coefficient where Rv = 0.05 + 0.9(Ia) (Rv minimum = 0.2)
Where Ia = Impervious area as a percentage

Existing Phosphorus Loading
Simple Method Data

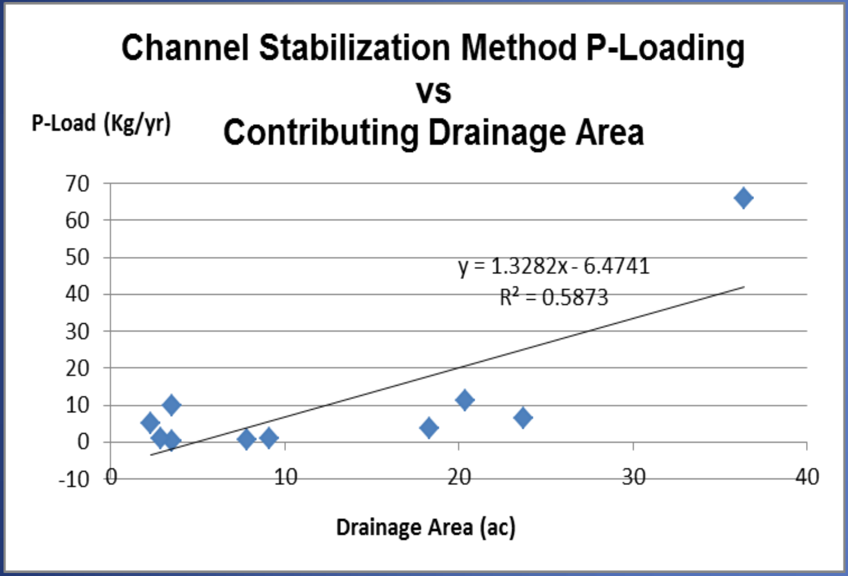
Project ID	Contributing Drainage Area (ac)	Simple Method P-load (Kg/yr)
S-MU-09D	2.53	0.92
S-MU-09F	5.19	1.65
Kent-MB-Add-5	4.5	1.4
Pat-MB-06	4.0	0.78
B-MU-07	30.8	5.34
Y-MU-17A	1.24	1.8
Kent-MB-Add-4	1.5	0.2
S-MU-09A	0.51	0.79
S-MU-09B	0.42	0.9
Carmel-AM-116	2.71	2.6
NS-MU-05	22.2	9.8
Kent-MB-Add-3	7.8	1.4
S-MU-01	0.66	1.29
S-MU-09C	2.28	3.35
Y-MU-17B	14.6	4.3
SE-POT-01	57.5	14.4
PC-1	2.7	4.4
Patterson-PA-11	5.43	6.11
Carmel-AM-112	7.5	5.12
PC-1A	63.6	15.98
Southeast-PA-23	17.4	6.93

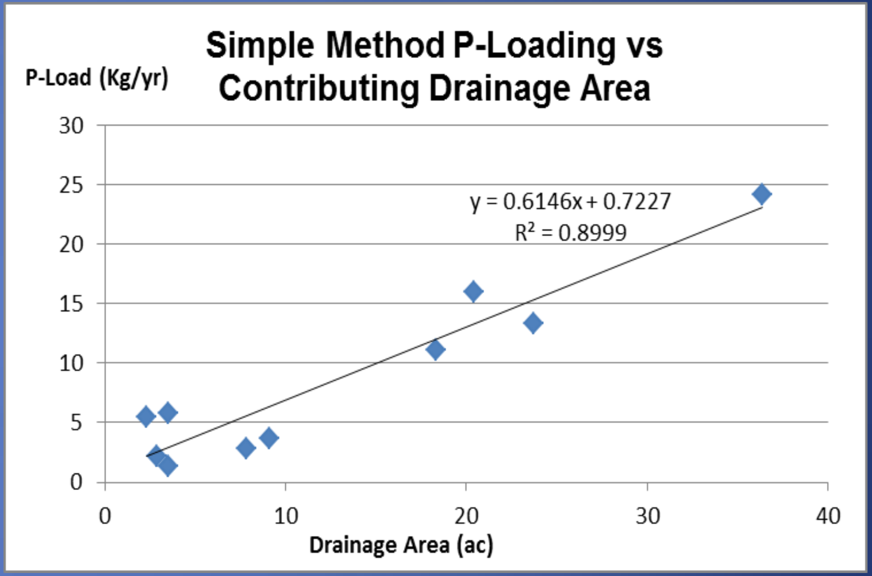


Phosphorus Loading
Simple Method vs. Channel Stabilization

Project ID	Contributing Drainage Area (ac)	SM (Theoretical Kg/yr)	Imp %	R	Approximate Channel Length (ft)	CSM (Kg/yr)
NewC-NCR-33a	7.8	2.87	13.14	1.52	130	0.71
NewC-NCR-33b	9.1	3.64	15.18	1.64	130	0.96
B-MU-34	3.5	1.29	16.29	1.71	500	0.27
Kent-MB-311B	23.7	13.32	29.11	2.71	900	6.51
B-MU-32	18.3	11.13	32.40	3.03	220	3.65
L-CR-11C	20.4	15.99	42.08	4.90	700	11.29
B-MU-33A	2.9	2.14	40.35	3.92	900	0.85
S-MU-03	36.4	24.20	23.31	9.60	2,500	65.98
MK-NC-20	3.5	5.74	79.67	10.72	100	9.76
Carmel-CF-102A	2.3	5.52	80.63	11.54	280	5.15

Phosphorus Loading
Simple Method vs. Channel Stabilization





Phosphorus Loading
Simple Method vs. Channel Stabilization

- Impervious area that drives the R value.
- Method skews calculation at the low and high end of curve.
- This empirical method was developed using flat channels of <1 % and <2.5% generating a 67 year equilibrium period.
- CSM receives no credit for phosphorus removal from stormwater runoff in Simple Method.
- The SM and CSM calculate completely different P-load contributing sources.
- The Total P-Load should reflect appropriate portions of both methods.

Alternate Approach to Channel Stabilization

***"A Practical Method of Computing Streambank Erosion Rate"*, By David L. Rosgen, PhD., Wildland Hydrology, Inc., Pagosa Springs, Colorado.**

Utilized in various Federal and Local Agencies

*NRCS

*USA EPA

*Chesapeake Bay Watershed

Alternate Approach to Channel Stabilization

<u>"A Practical Method of Computing Streambank Erosion Rate"</u>,
By David L. Rosgen, PhD., Wildland Hydrology, Inc., Pagosa Springs, Colorado.

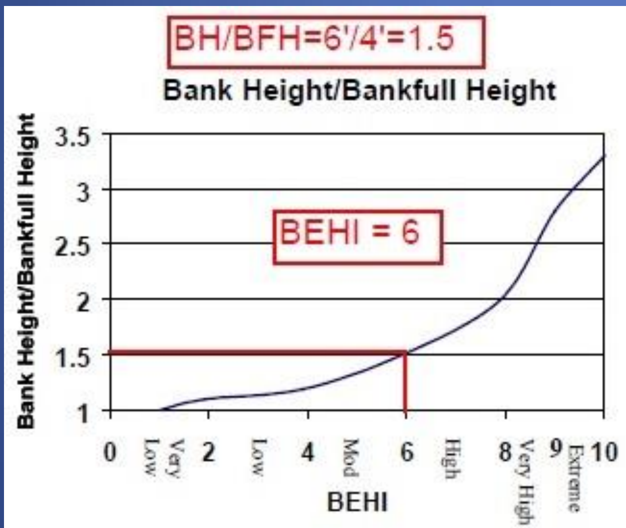
<u>Model Development</u>

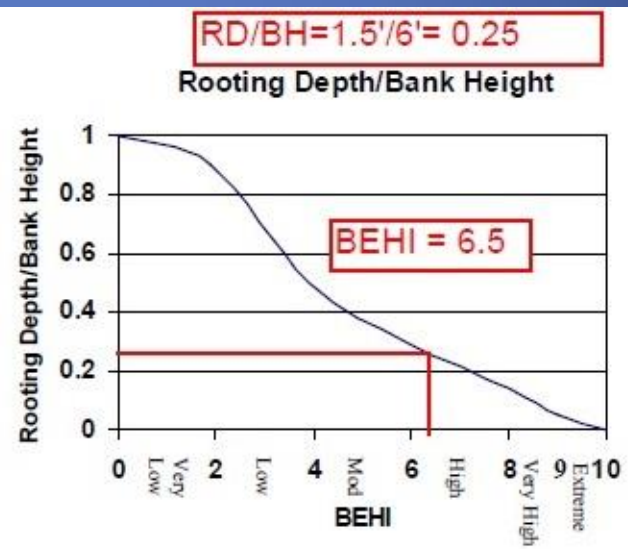
- Bank height ratio (stream bank height/maximum bankfull depth).
- Ratio of rooting depth/bank height.
- Rooting density. Percent surface area of bank protected.
- Bank angle (slope).

Alternate CSM P-Load Component Analysis

Component One
Bank Height

Component Two
Rooting Depth

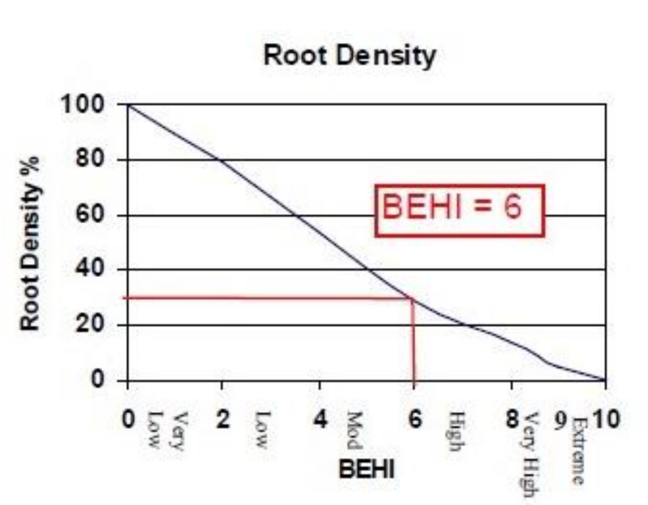




Alternate CSM P-Load Component Analysis

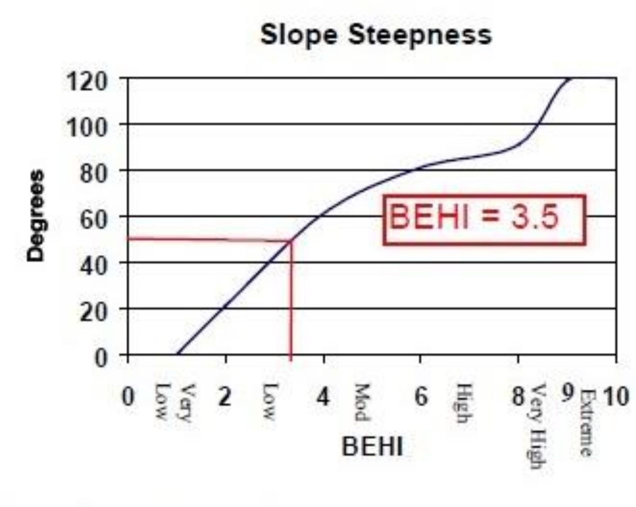
Component Three

Root Density



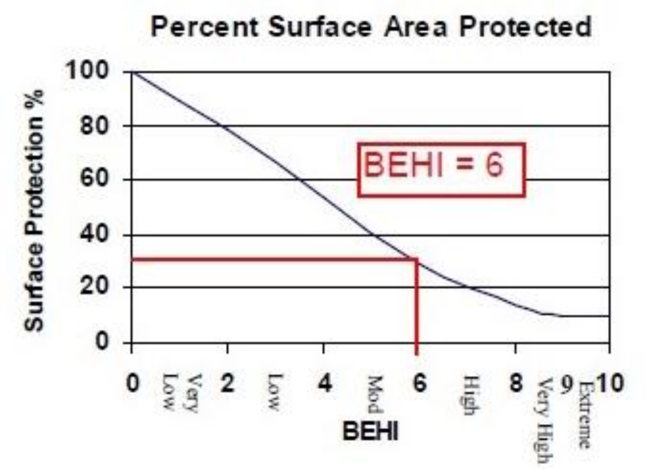
Component Four

Slope Steepness



Component Five

Surface Protection



Alternate CSM P-Load Component Analysis

Table 1. Streambank characteristics used to develop Bank erosion Hazard Index (BEHI)

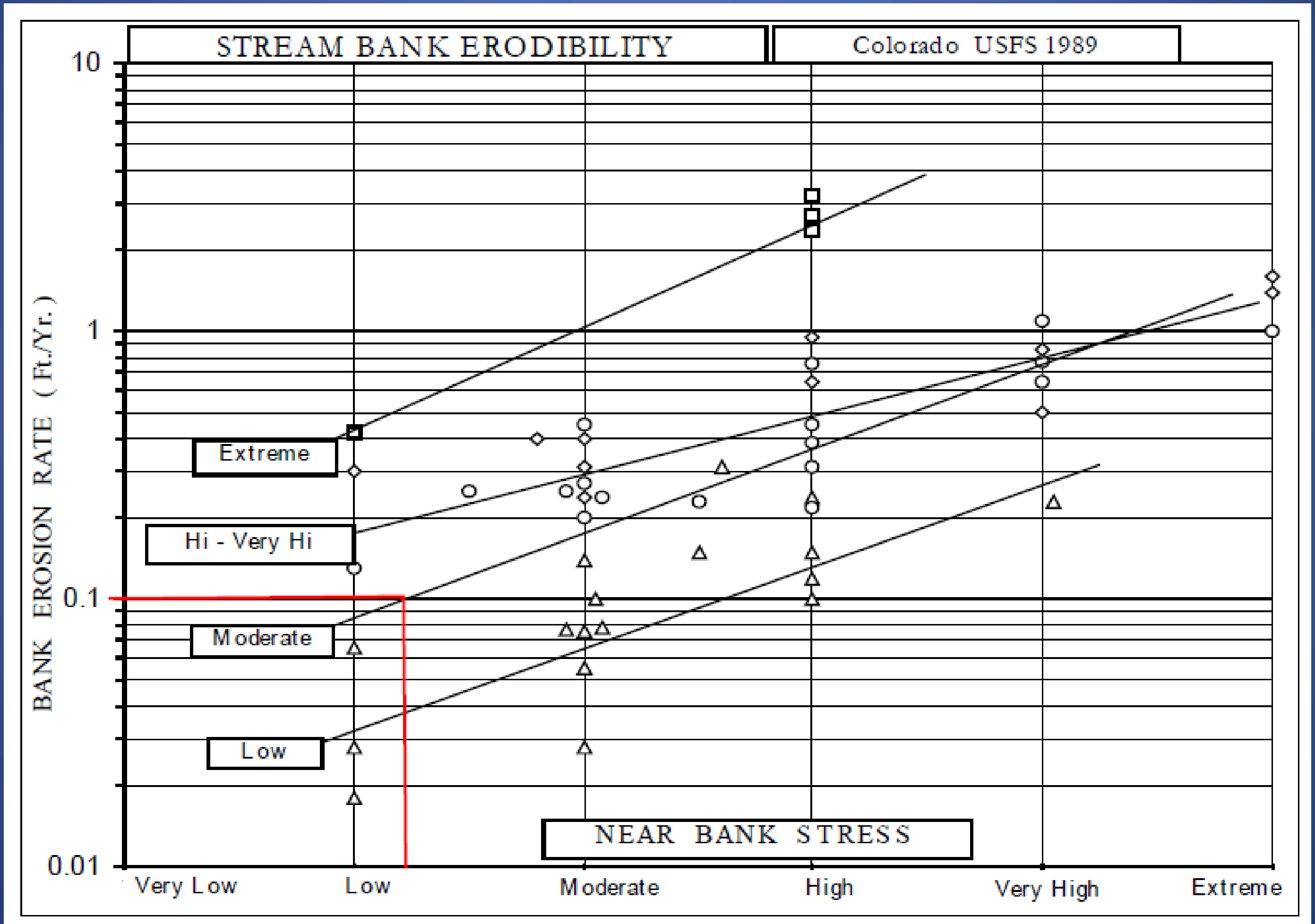
Adjective Hazard or risk rating categories		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%	Totals
VERY LOW	Value	1.0-1.1	1.0-0.9	100-80	0-20	100-80	
	Index	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	5-9.5
LOW	Value	1.11-1.19	0.89-0.5	79-55	21-60	79-55	
	Index	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	10-19.5
MODERATE	Value	1.2-1.5	0.49-0.3	54-30	61-80	54-30	
	Index	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	20-29.5
HIGH	Value	1.6-2.0	0.29-0.15	29-15	81-90	29-15	
	Index	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	30-39.5
VERY HIGH	Value	2.1-2.8	0.14-0.05	14-5.0	91-119	14-10	
	Index	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	40-45
EXTREME	Value	>2.8	<0.05	<5	>119	<10	
	Index	10	10	10	10	10	46-50

For adjustments in points for specific nature of bank materials and stratification, the following is used:
Bank Materials: Bedrock (very low), Boulders (low), cobble (subtract 10 points unless gravel/sand>50%, then no adjustment), gravel (add 5-10 points depending on % sand), sand (add 10 points), silt/clay (no adjustment).
Stratification: Add 5-10 points depending on the number and position of layers.

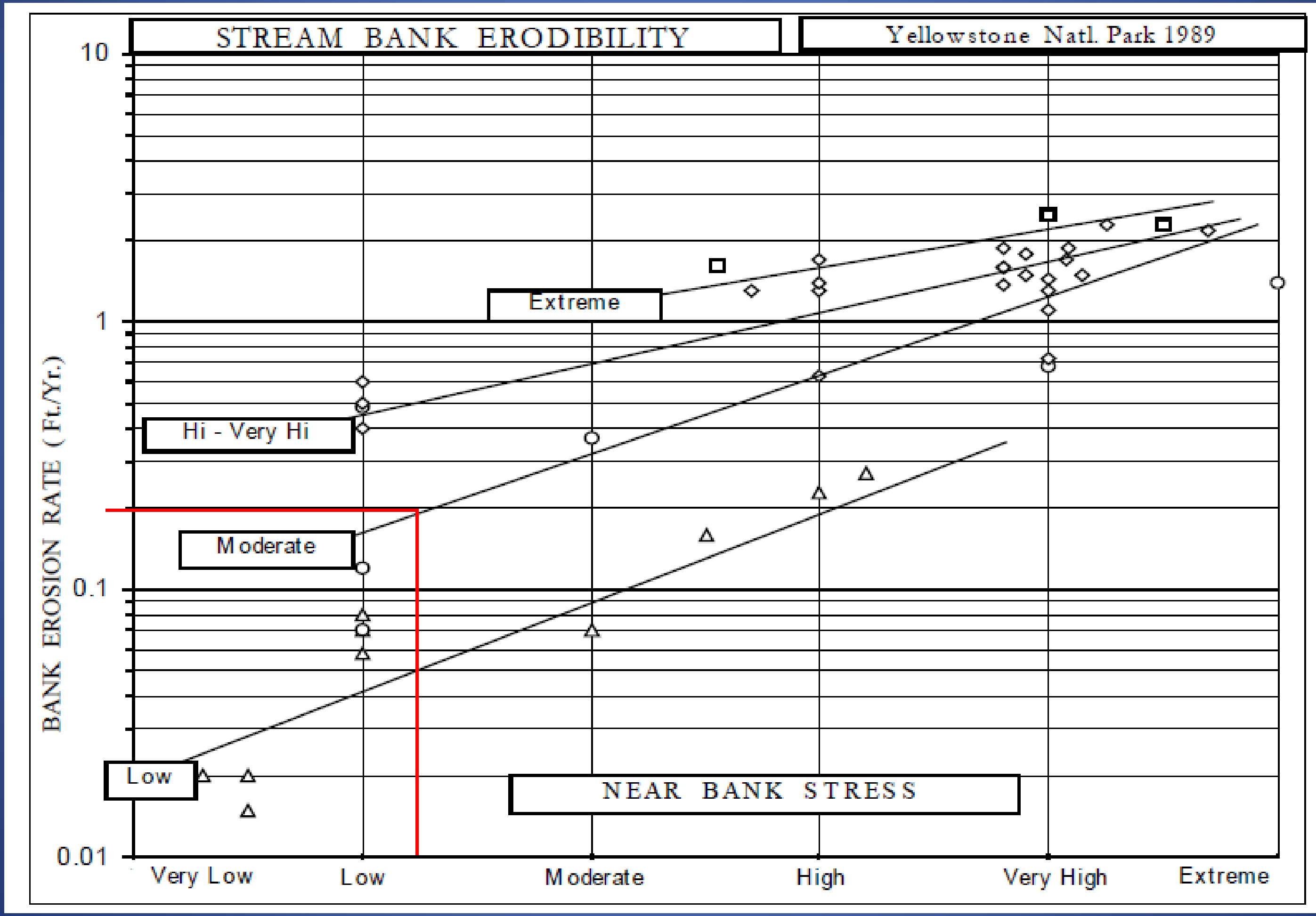
Table 2. Velocity gradient and near-bank stress indices

Bank Erosion Risk Rating	Velocity gradient	Near-bank stress/shear stress
Very low	Less than 0.5	Less than 0.8
Low	0.5 -1.0	0.8 -1.05
Moderate	1.1 -1.6	1.06 -1.14
High	1.61 - 2.0	1.15 - 1.19
Very High	2.1 -2.4	1.20 -1.60
Extreme	Greater than 2.4	Greater than 1.60

Alternate CSM P-Load Component Analysis



Alternate CSM P-Load Component Analysis



Engineering P-Load Evaluation Process

- Develop HydroCad Model using contributing area, slope, and channel characteristics,
- Find the WQv flowrate.
- Using Alternate CSM five model process and calculated velocity, determine annual channel erosion depth.
- Apply channel erosion depth using the following relationship:
- **Alt $CSM_{P\text{-}Load}$= Channel (L*W*D)*BD*Ptest = P-Load Kg/yr**.
- Where: BD = bulk density (typ. 95 lb/CF).
- Ptest = phosphorus level in soil (typ. 300 mg/kg).
- Calculate P-load and WQv for Treatment using Existing Simple Method.
- Determine the percent of WQv treated (V_t) in the stabilized channel.
- Calculate the Simple Method P-Load
- **$P\text{-}Load_{Total}$ = Alt $CSM_{P\text{-}Load}$ + [($SM_{P\text{-}Load}$*V_t)*Efficiency(%)]**

Alternate Channel Stabilization Method

$$P\text{-}Load_{Total} = Alt\ CSM_{P\text{-}Load} + [(SM_{P\text{-}Load} * V_t) * Efficiency(\%)]$$

NYSDEC MS4 Minimum Control Measures

1. **Public Education and Outreach:** *Distribution of educational materials and outreach activities.*

2. **Public Participation/Involvement:** *Encouraging citizens participate in the stormwater management program process.*

3. **Illicit Discharge Detection and Elimination:** *Develop, implement and enforce a plan to detect and eliminate illicit discharges.*

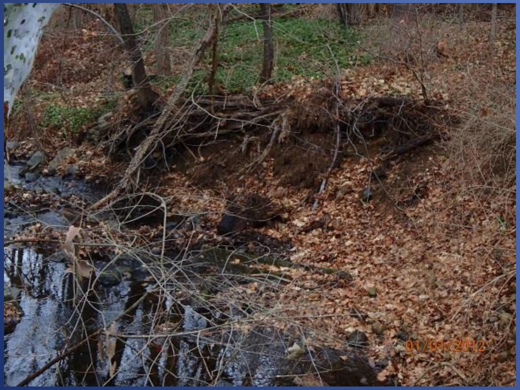
4. **Construction Site Runoff Control :***Enforce an erosion and sediment control program for construction activities.*

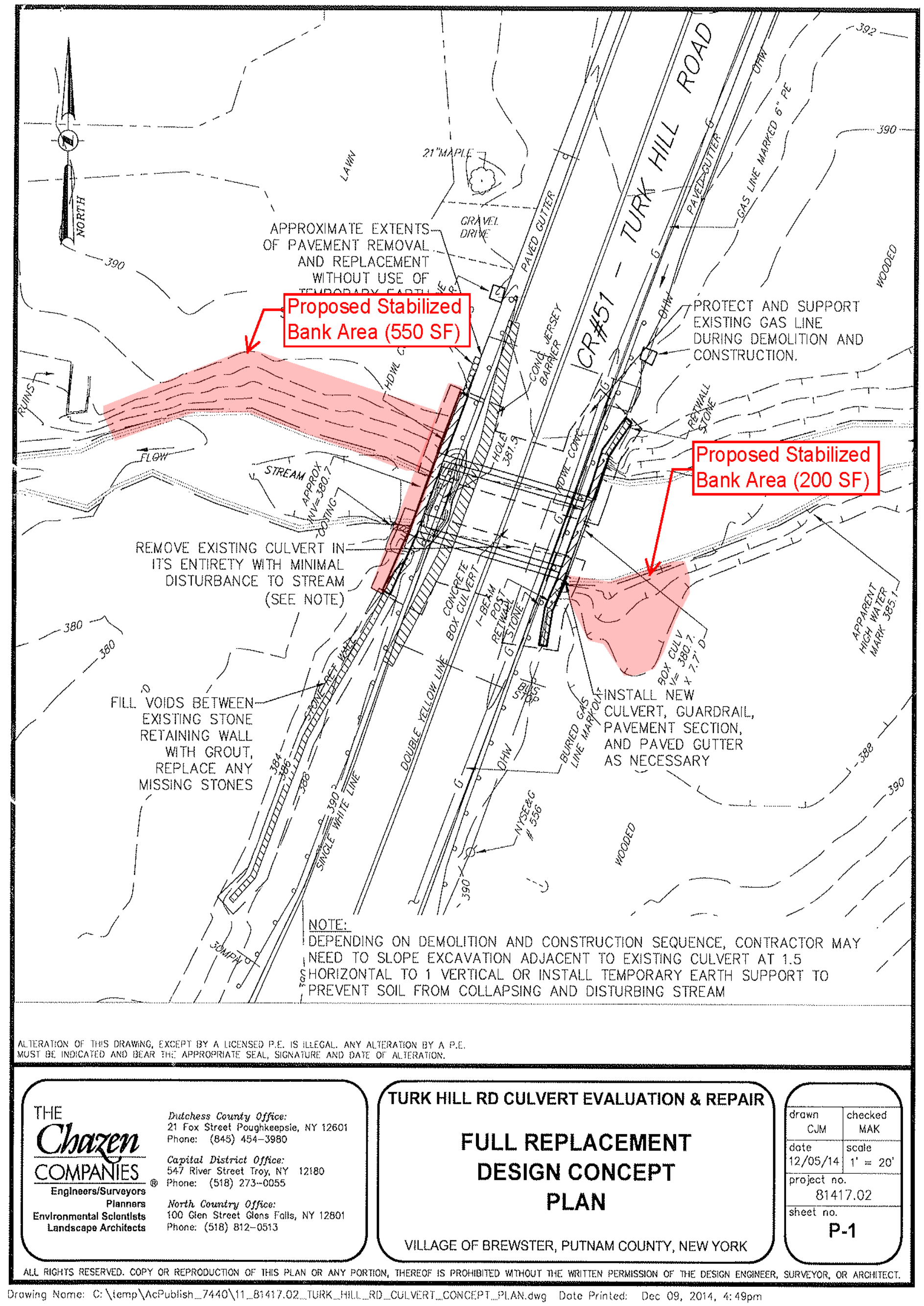
5. **Post-construction Runoff Control:** *Enforce a plan that addresses stormwater runoff from new development and redevelopment projects.*

6. **Pollution Prevention/Good Housekeeping:** *Implement a program to prevent or reduce pollutant runoff.*

Additional Soil Stabilization Applications

- Culvert Repair
- Roadside Soil Stabilization
- Streambank Stabilization





NORTH
APPROXIMATE EXTENTS OF PAVEMENT REMOVAL AND REPLACEMENT WITHOUT USE OF TEMPORARY EARTH
Proposed Stabilized Bank Area (550 SF)
Proposed Stabilized Bank Area (200 SF)
PROTECT AND SUPPORT EXISTING GAS LINE DURING DEMOLITION AND CONSTRUCTION.
CR#51 - TURK HILL ROAD
21"MAPLE
LAWN
GRAVEL DRIVE
PAVED GUTTER
CONC JERSEY BARRIER
GAS LINE MARKED 6" PE
WOODED
RUINS
FLOW
STREAM
REMOVE EXISTING CULVERT IN ITS ENTIRETY WITH MINIMAL DISTURBANCE TO STREAM (SEE NOTE)
CONCRETE BOX CULVERT
I-BEAM POST RETWALL STONE
INSTALL NEW CULVERT, GUARDRAIL, PAVEMENT SECTION, AND PAVED GUTTER AS NECESSARY
APPARENT HIGH WATER MARK 385.1
FILL VOIDS BETWEEN EXISTING STONE RETAINING WALL WITH GROUT, REPLACE ANY MISSING STONES
DOUBLE YELLOW LINE
SINGLE WHITE LINE
BURIED GAS LINE MARKOUT
NYSE&G # 536
30MPH
NOTE:
DEPENDING ON DEMOLITION AND CONSTRUCTION SEQUENCE, CONTRACTOR MAY NEED TO SLOPE EXCAVATION ADJACENT TO EXISTING CULVERT AT 1.5 HORIZONTAL TO 1 VERTICAL OR INSTALL TEMPORARY EARTH SUPPORT TO PREVENT SOIL FROM COLLAPSING AND DISTURBING STREAM
ALTERATION OF THIS DRAWING, EXCEPT BY A LICENSED P.E. IS ILLEGAL. ANY ALTERATION BY A P.E. MUST BE INDICATED AND BEAR THE APPROPRIATE SEAL, SIGNATURE AND DATE OF ALTERATION.
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North Country Office: 100 Glen Street Glens Falls, NY 12801 Phone: (518) 812-0513
TURK HILL RD CULVERT EVALUATION & REPAIR
FULL REPLACEMENT DESIGN CONCEPT PLAN
VILLAGE OF BREWSTER, PUTNAM COUNTY, NEW YORK
drawn CJM
checked MAK
date 12/05/14
scale 1" = 20'
project no. 81417.02
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Roadside Stabilization
Stabilized Channel with Check Dams

Streambank Stabilization

Stormwater Management Practice Operation and Maintenance

- Proper Operation and Maintenance of SMP will:
  - Extend the life of the practice.
  - Ensure effective stormwater treatment.
  - Minimize long term O & M costs.
  - Minimize the effects of large storm events.

Conclusions

- Where does the old method fall short?
- How does this new method propose a clearer representation of pollutant loading?
- Can this method be applied to everyday activities by a traditional MS4 entity?
- How efficient is this type of retrofit for phosphorus reduction?

Questions?