B&L Woodwaste Site
Pierce County, Washington

Engineering Design Report (EDR) Addendum 1

Phase 1 Part 1 Remediation Design Report

Barrier Wall and Interceptor Trench

Appendix 1C
Engineering Calculations

FINAL

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Memorandum

To: Dom Reale, Washington Department of Ecology

Copies: D. Silver. T. Floyd

From: Miao Zhang, Koorus Tahghighi

Date: June 16, 2009

Project No: 13488

Re: **List of Engineering Calculations in Appendix 1C for EDR Addendum 1**

Phase 1 Part 1 Cleanup Action
B&L Woodwaste Site
Pierce County, Washington

Appendix 1C of EDR Addendum 1 consists of the following engineering calculations.

1. Spacing and Size of Construction Stormwater Conveyance Pipe

This calculation estimated the stormwater runoff flow rate during construction, and determined the spacing and size of pipe to convey the stormwater runoff across the disturbed area.

2. Slope Stability of Outer Berm for the Western Infiltration Pond

This calculation assessed the slope stability of the outer berm for the western infiltration pond as designed.

3. Capacity of Geosynthetic Cap to Withstand Tearing Force

This calculation assessed the ability of the specified geomemebrane to resist the tearing force due to weight of access road on the Landfill and anticipated truck traffic.

4. Total Head Loss in Active Drain Pipe

This calculation estimated the total head loss in the active drain pipe between a lift station and discharge point, as designed. This head loss is the minimum lifting requirement for the pump.

5. Peak Stormwater Runoff Rate on Restored Landfill Cap; Size of Final Stormwater Drainage Ditch

This calculation estimated the peak stormwater runoff rate on the restored Landfill cap for a 25-year storm event, and determined the size of the final stormwater drainage ditch.

6. Infiltration Capacity of Infiltration Ponds

This calculation estimated the infiltration capacity of the two infiltration ponds as designed.

DESIGN MEMORANDUM (METRIC)

amec

Client: Floyd/Snider
Sheet 1 Of 3
Project: B&L Woodwaste Site
Date: 3/17/09
Data For: Construction Stormwater
Work Order:
Prepared By: DLS
Checked By: MZ 6/12/09
File No:

Note: This form must be used for project calculations and original filed in project files

APPROX. CALCS.

Worse Case Scenario

Rational Method using intensity of 2 in/hr

Pick Largest area

Rational Method

Consider Landfill as Pasture, Hilly, Tight Clay C = 0.60

pg. 85, Table 3.24 Design Hydrology and Sedimentology for Small Catchments, Haan et al.

Rational Method

$Q = CIA$

$C = 0.60$

$I = 2$ in/hr assumed, worse case scenario, cummulative summer rainfall of 2 inch storm

$A = 53{,}568\,ft^2 / 43560\,ft^2 = 1.23$ acres

$Q = 1.48$ cfs

4 inch hose

slope over road 1ft vertical, 20ft horizontal

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$

$n = 0.025$ corrugated hose (used value for corrugated metal)

pg. 109 Table 4.1 Design Hydrology, Haan et. al

$R = D/4 \quad D = 0.33\,ft$

$S = 1/20 = 0.05$

$Q = \frac{1.49}{0.025}\left(\frac{0.33}{4}\right)^{2/3}(0.05)^{1/2}\frac{\pi(0.33)^2}{4} = 0.216$ cfs

6 inch hose

$Q = \frac{1.49}{0.025}\left(\frac{0.5}{4}\right)^{2/3}(0.05)^{1/2}\frac{\pi(0.5)^2}{4} = 0.65$ cfs

DESIGN MEMORANDUM (METRIC)

amec

Client: _____ Sheet 2 Of 3

Project: _____ Date: _____

Data For: _____ Work Order: _____

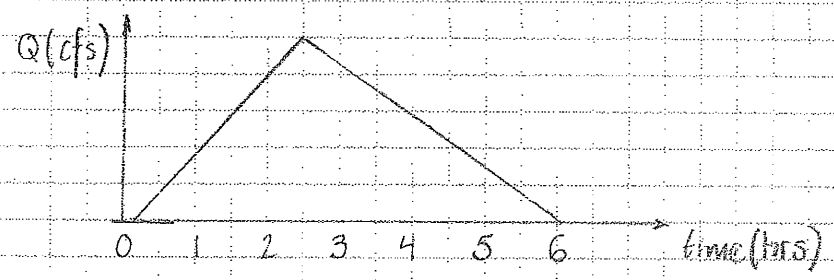
Prepared By: _____ Checked By: MZ File No: _____

Note: This form must be used for project calculations and original filed in project files

APPROX CALCS

Hypothetical Unit Hydrograph / w/ total rainfall of 2 inches

Rainfall over 6 hour storm



Area under the curve is equivalent to cumulative runoff volume

$t = 6\text{hrs}\left(\frac{60\text{ min}}{\text{hr}}\right)\left(\frac{60\text{s}}{\text{min}}\right) = 21{,}600\text{s}$

$Q_p = X$ cfs

Area $= \frac{1}{2}bh$

Area should be $2\text{inchs}\left(\frac{\text{ft}}{12\text{in}}\right) 38{,}840\text{ft}^2 = 6473\text{ft}^3$ for average area

$\frac{1}{2}(21{,}600\text{s})h = 6473\text{ft}^3$

$h = 0.59$ cfs

$Q_p = 0.59$ cfs

Area $= \frac{1}{2}(21{,}600\text{ sec})(0.59\text{ cfs}) = 6473\text{ ft}^3$

Assume 20% losses, 80% runoff (Grassy, landfill with cap)

$\frac{1}{2}(21{,}600\text{s})h = 5178\text{ ft}^3$

$h = 0.48$ cfs

$Q_p = 0.48$ cfs

DESIGN MEMORANDUM (METRIC)

amec

Client: _____ Sheet _____ Of _____

Project: _____ Date: _____

Data For: _____ Work Order: _____

Prepared By: _____ Checked By: MZ File No: _____

Note: This form must be used for project calculations and original filed in project files

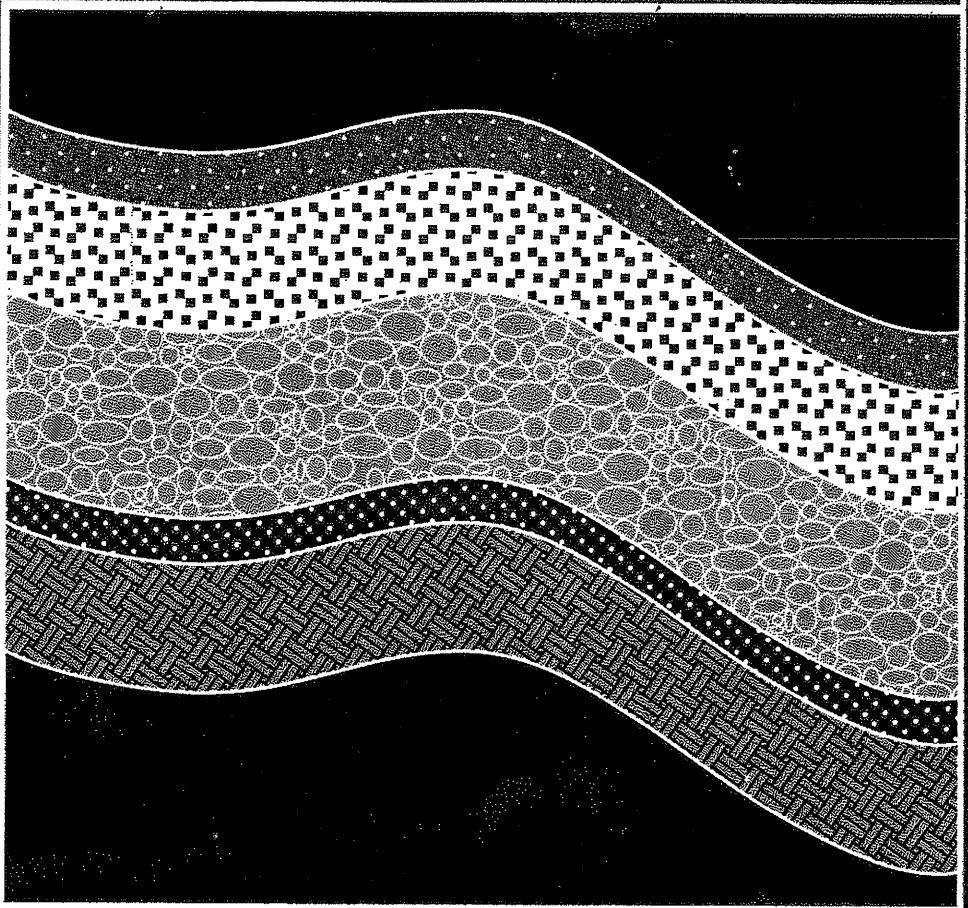
APPROX CALCS

So, use a 6-inch hose every 200ft or 4-inch hose 100ft

Capacity for 6-inch pipe 0.65cfs

Capacity for 4-inch pipe 0.22cfs

Design Hydrology and Sedimentology for Small Catchments



C. T. Haan • B. J. Barfield • J. C. Hayes

Table 3.24—*Continued*

Rural areas

Topography and vegetation	Soil texture: Open sandy loam	Clay and silt loam	Tight clay
Woodland			
Flat 0–5% slope	0.10	0.30	0.40
Rolling 5–10% slope	0.25	0.35	0.50
Hilly 10–30% slope	0.30	0.50	0.60
Pasture			
Flat	0.10	0.30	0.40
Rolling	0.16	0.36	0.55
Hilly	0.22	0.42	0.60
Cultivated			
Flat	0.30	0.50	0.60
Rolling	0.40	0.60	0.70
Hilly	0.52	0.72	0.82

the impervious area is next to the outlet, while in case B the grass area is next to the outlet. Straightforward application of the Rational Equation would result in the same flow estimate for both cases since t_c and the weighted C would be the same.

A closer look at case A, however, shows that it is possible that the peak flow from the impervious area alone could exceed the peak estimated for the whole area based on a weighted C. Using Eq. (3.49), a flow time of 10 min is estimated for the 500 ft of grass. Using a similar procedure, a flow time of only about 5 min is estimated for the impervious area. Thus, the

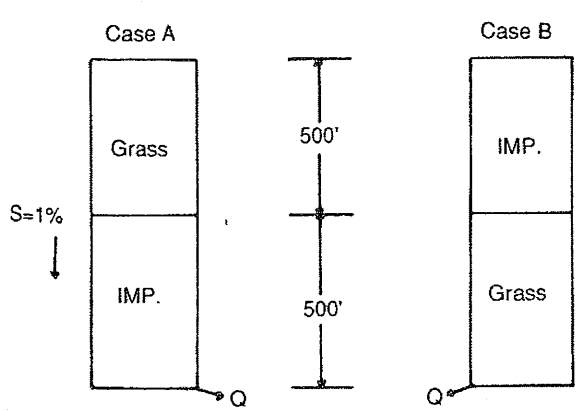


Figure 3.39 Hypothetical runoff situations.

total flow time is 15 min. A weighted C is

$$\bar{C} = 0.5(0.9 + 0.2) = 0.55.$$

A 10-year, 15-min rain at Stillwater, Oklahoma, has an i of 6.29 iph. Thus,

$$q_{\text{total}} = 0.55(6.29)A = 3.15A.$$

Considering only the impervious area, C is 0.9 and t_c is 5 min. The corresponding i is 10.15 iph

$$q_{\text{imp}} = 0.9(10.15)A/2 = 4.56A,$$

or the 10-year flow peak from the lower impervious area would exceed the original estimate for the entire area. This illustrates the need to carefully consider the location of impervious or high runoff-producing areas. Of course, this same high flow rate would be estimated to occur at the lower end of the impervious part of case B. Here, however, the flow through the pervious area would at least partially attenuate this peak.

Finally, it must be kept in mind that this is a method of peak flow estimation only. The t_c bears no relation to the time from the beginning of a rainfall. One cannot predict from this method when the peak will occur. The t_c applies to the time from the beginning of an intense rainfall with a duration equal to t_c. This intense rainfall may occur anytime during the rainstorm. The use of the Rational Equation to develop runoff hydrographs carries the method well beyond its original intent. Tabulated values of the Rational C have generally been derived based on peak flows, not entire hydrographs, and thus may not be valid when used to develop hydrographs.

SCS-TR55 Method

The Soil Conservation Service (1986) presents a method for estimating peak flows from small catchments based on an analysis of a large number of computer runs with their TR20 computer program (SCS, 1983). This program computes runoff hydrographs in a manner analogous to the procedure detailed earlier in this chapter and attributed to the SCS. The results of the peak flow analysis can be expressed as

$$q_p = q_u A Q F_p, \tag{3.72}$$

where q_p is the peak discharge in cfs, q_u is the unit peak discharge in cfs per inch of runoff per square mile, A is the drainage area in square miles, Q is the runoff in inches from a 24-hr storm of the desired

An Irish engineer named Manning found that the equation

$$v = KR^{2/3}S^{1/2}$$

fit experimental data quite nicely. This equation is known as Manning's equation and differs from Chezy's equation only in the exponent on R. So that the factor related to the channel roughness would increase as roughness increased, Manning's equation is generally written as

$$v = (1/n)R^{2/3}S^{1/2}$$

in the metric system with v in meters per second and R in meters. The coefficient n is known as Manning's n. In the English system of units, Manning's equation is

$$v = \frac{1.49}{n}R^{2/3}S^{1/2}, \qquad (4.23)$$

where v is in fps, R is in feet, and S is in feet per foot. Tables of Manning's n are widely available. Table 4.1 is such a table taken from several sources, drawing heavily on Schwab *et al.* (1966, 1971). Manning's n is influenced by many factors, including the physical roughness of the channel surface, the irregularity of the channel cross section, channel alignment and bends, vegetation, silting and scouring, and obstruction within the channel. Chow (1959) displays some photographs of typical channels and the associated values for Manning's n.

Figure 4.9 contains some useful relationships for calculating the hydraulic properties of A, P, R, and top width, T, for three common channels. For natural channels, these properties are best determined from measurements based on the actual cross sections of the channel.

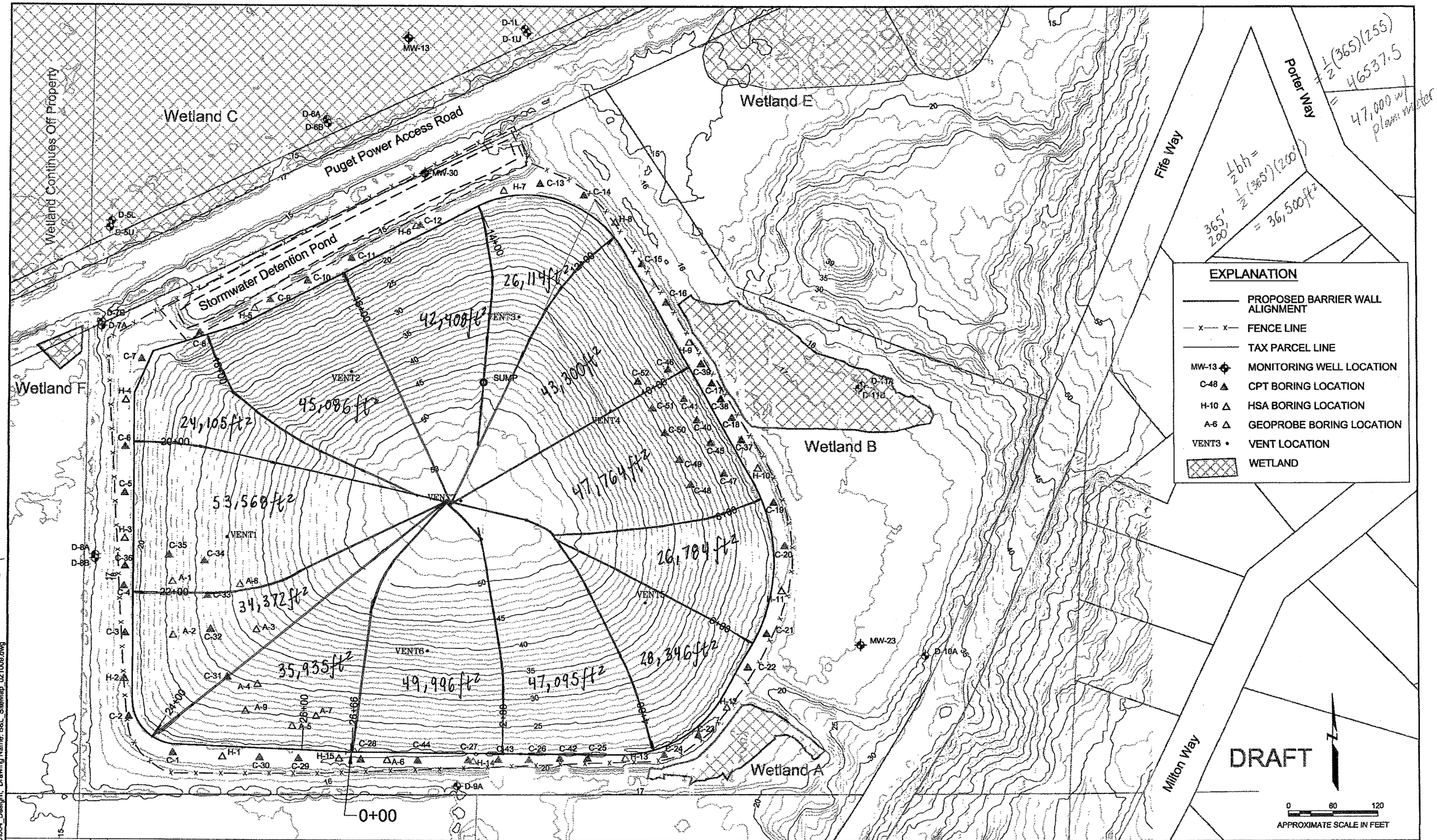
Table 4.1 Typical Values for Manning's n

Type and description of conduits	n Values[a] Min.	Design	Max.
Channels, lined			
Asphaltic concrete, machine placed		0.014	
Asphalt, exposed prefabricated		0.015	
Concrete	0.012	0.015	0.018
Concrete, rubble	0.016		0.029
Metal, smooth (flumes)	0.011		0.015
Metal, corrugated	0.021	0.024	0.026
Plastic	0.012		0.014
Shotcrete	0.016		0.017
Wood, planed (flumes)	0.009	0.012	0.016
Wood, unplaned (flumes)	0.011	0.013	0.015
Channels, earth			
Earth bottom, rubble sides	0.028	0.032	0.035
Drainage ditches, large, no vegetation			
(a) < 2.5 hydraulic radius	0.040		0.045
(b) 2.5–4.0 hydraulic radius	0.035		0.040
(c) 4.0–5.0 hydraulic radius	0.030		0.035
(d) > 5.0 hydraulic radius	0.025		0.030
Small drainage ditches	0.035	0.040	0.040
Stony bed, weeds on bank	0.025	0.035	0.040
Straight and uniform	0.017	0.0225	0.025
Winding, sluggish	0.0225	0.025	0.030
Channels, vegetated			
(See subsequent discussion)			

Type and description of conduits	n Values[a] Min.	Design	Max.
Natural Streams			
(a) Clean, straight bank, full stage, no rifts or deep pools	0.025		0.033
(b) Same as (a) but some weeds and stones	0.030		0.040
(c) Winding, some pools and shoals, clean	0.035		0.050
(d) Same as (c), lower stages, more ineffective slopes and sections	0.040		0.055
(e) Same as (c), some weeds and stones	0.033		0.045
(f) Same as (d), stony sections	0.045		0.060
(g) Sluggish river reaches, rather weedy or with very deep pools	0.050		0.080
(h) Very weedy reaches	0.075		0.150
Pipe			
Asbestos cement		0.009	
Cast iron, coated	0.011	0.013	0.014
Cast iron, uncoated	0.012		0.015
Clay or concrete drain tile (4–12 in.)	0.010	0.0108	0.020
Concrete	0.010	0.014	0.017
Metal, corrugated	0.021	0.025	0.0255
Steel, riveted and spiral	0.013	0.016	0.017
Vitrified sewer pipe	0.010	0.014	0.017
Wood stave	0.010	0.013	
Wrought iron, black	0.012		0.015
Wrought iron, galvanized	0.013	0.016	0.017

[a]Selected from numerous sources.

24,105
45,086
42,408
26,114
43,300
47,764
26,784
28,346
47,095
49,996
35,935
34,372
53,568
504,873
AVG - 38,836



$\frac{1}{2}(365)(255) = 46537.5$

47,000 w/ planimeter

$\frac{1}{2}bh = \frac{1}{2}(365)(200) = 36,500 ft^2$

365'
200'

REFERENCES:
PLANS

DATUM
HORIZONTAL: WASP-NAD83-S FEET
VERTICAL: NAVD88 FEET

NO.	REVISION	DATE	APRVD

DRAWN A.S.
DESIGNED K.T.
CHECKED ??
REVIEWED ??

FLOYD | SNIDER
AMEC Geomatrix

SITE MAP

B&L WOODWASTE SITE
PIERCE COUNTY, WASHINGTON

DATE: 02/09/2009
PROJECT NO.: 13488

FIGURE 1

Plot Date: 02/10/09 - 10:08am, Plotted by: adam.stenberg
Drawing Path: S:\13488\004_Design\, Drawing Name: B&L_SiteMap_021009.dwg

Subject SLOPE STABILITY
B&L LANDFILL

Project No. 13488.131.1
Task No. 1
File No.
Sheet 1 of 10

By Carlo Evangelisti Checked By KT

Date 6/16/09 Date 6/16/09

THE SLOPE STABILITY ACROSS THE WESTERN CROSS SECTION, WHERE EXISTING GRADES WILL BE CHANGED TO CREATE THE WESTERN INFILTRATION POND.

THREE CASES WERE EVALUATED FOR THREE SCENARIOS. THE THREE CASES ARE: 1_ DRY WEST POND, 2_ FULL WEST POND, 3_ FULL WEST POND UNDER SEISMIC CONDITION.

THE THREE SCENARIOS ARE: 1_ BASE FAILURE, 2_ SLOPE FAILURE, 3_ SURFACE FAILURE.

UNDER ALL CASES AND SCENARIOS THE FACTOR OF SAFETY EXCEEDS 1. UNDER FULL POND WITH SEISMIC CONDITION, THE F.S. IS THE LOWEST FOR SURFACE FAILURE AT F.S. = 1.08