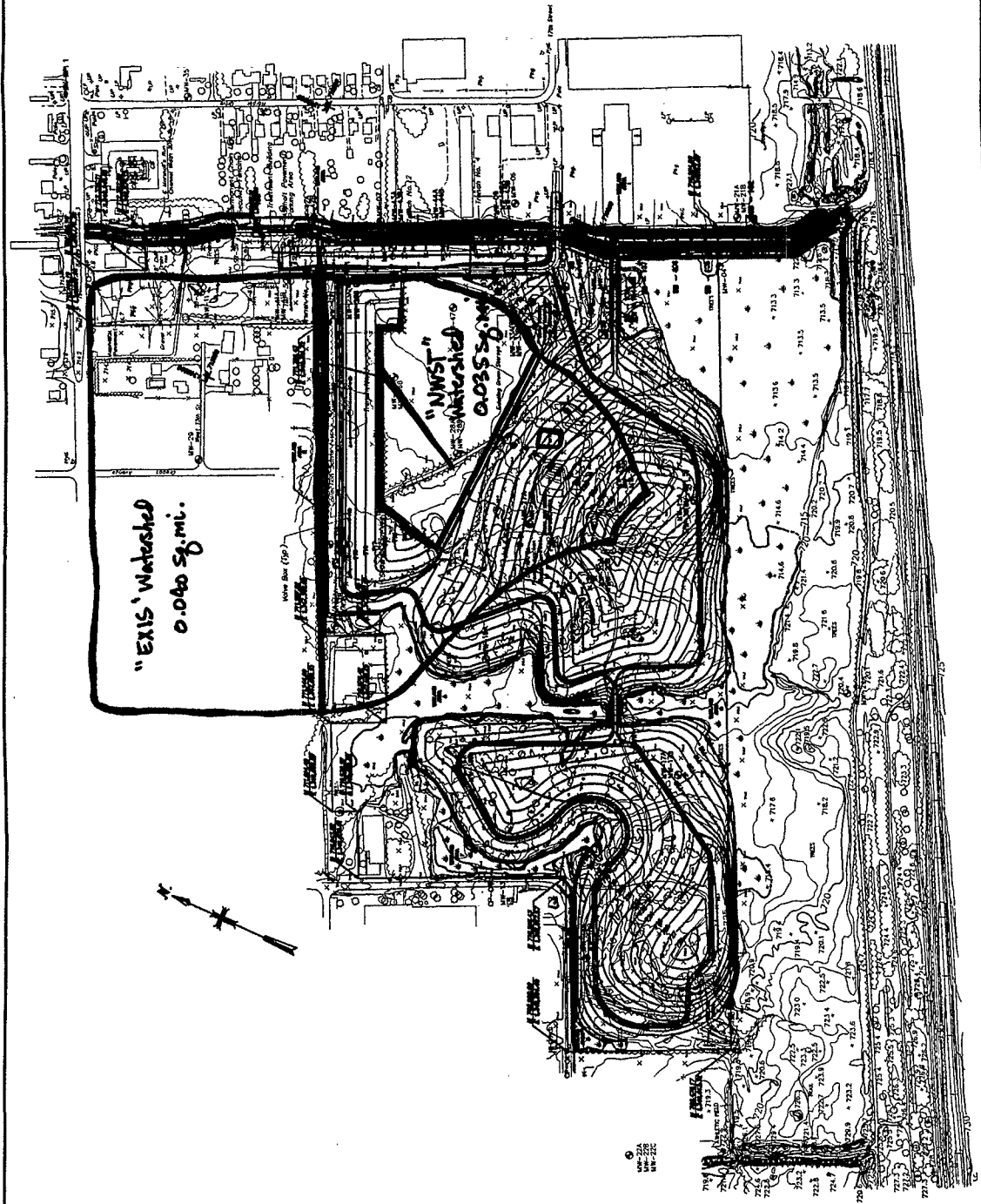


APPENDIX J

NORTH DITCH HYDROLOGIC ANALYSIS MAPS



**MALCOLM
PIRNIE**

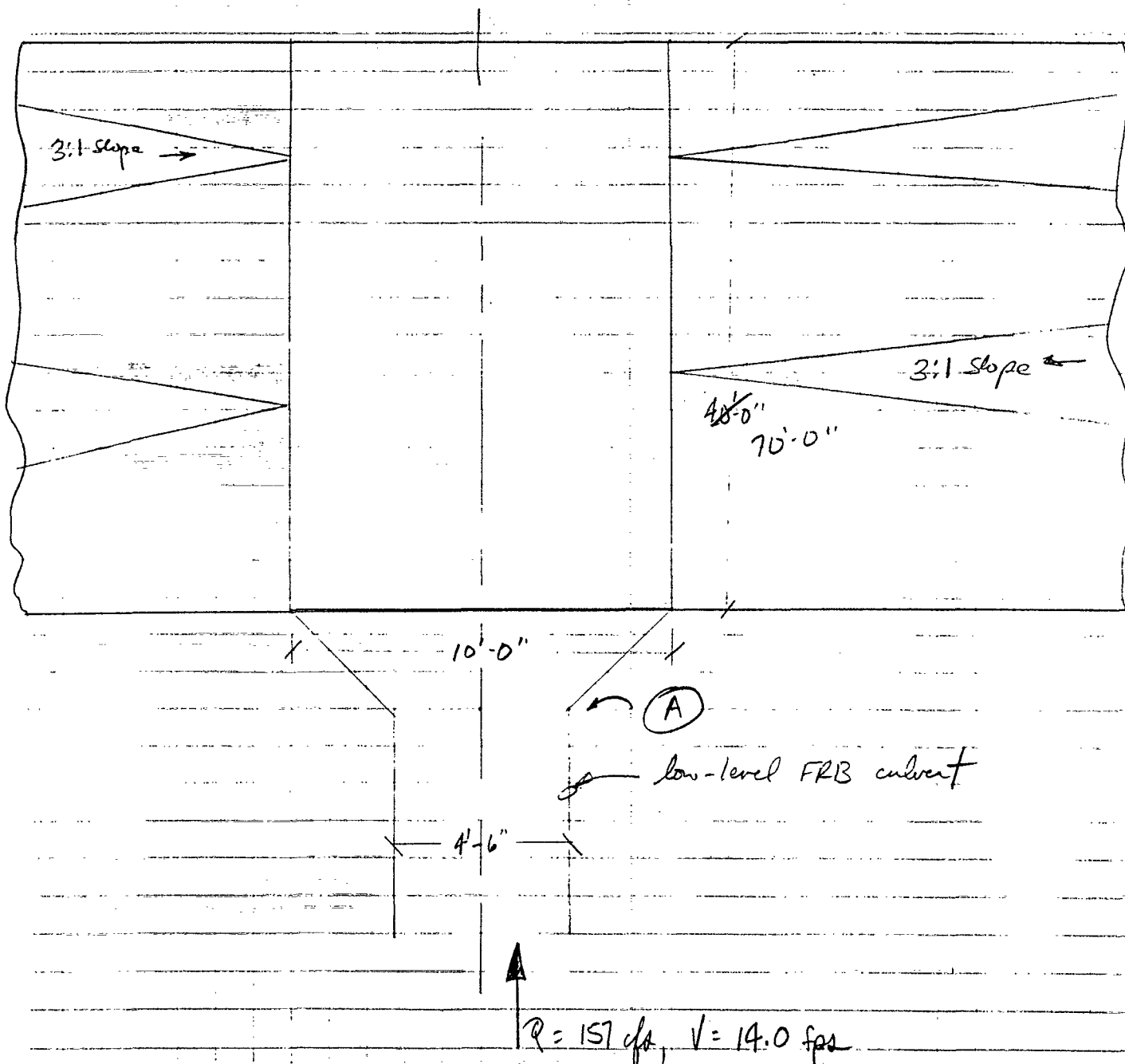
APPENDIX K

RIPRAP AND ENDWALL CALCULATIONS

0285-33-2

AR004606

Reference: "Design & Erosion-Control Structures for Airfields and Helipads" TM 5-820-3



AR004607

I. Section 10-2.2 "Estimating Erosion"

$$\text{minimum tailwater: } L_{sm} = D_o \cdot 2.40 \left(\frac{Q}{D_o^{5/2}} \right)^{0.71} \cdot t^{0.125} \quad \checkmark$$

 where L_{sm} = maximum length of scour (ft)

 D_o = ϕ of culvert (ft)

Our culvert is 11.25 sf.

$$\sqrt{\frac{11.25}{\pi}} = r = 1.89$$

 $\therefore$ Equivalent $\phi = 2r = 3.78'$

$$Q = 154 \text{ cfs } 159 \quad \checkmark$$

$$t = 90 \text{ min.}$$

$$L_{sm} = 3.78 \cdot 2.40 \left(\frac{154}{3.78^{5/2}} \right)^{0.71} \cdot 90^{0.125} = 54' \quad \checkmark$$

 - THIS SOL'N GIVES AN APPROXIMATION OF SCOUR.

FOR DETAILED ENDWALL APRON DESIGN, REFER TO

CALC'S BELOW -

II. Chpt. 4 - Headwalls

Section 4-3 "Apron"

"e" (see attached Xerox).

TW = tailwater

Refer to attached nomograph Fig. 4-2 for solution, where

$$\frac{Q}{D_o^{5/2}} = \frac{157 \text{ cfs}}{3.78^{5/2}} = 5.65, \rightarrow \text{max } Q/D_o^{5/2} \text{ 's listed in Table 4-1}$$

 where D_o = equivalent ϕ
 $\therefore$ Apron req'd

$$\frac{TW}{D_o} = \frac{3.5}{2.5} = 10\text{-yr tailwater} / \text{height of culvert} = 1.4 \quad \checkmark$$

$$= 6.0 / 2.5 = 50\text{-yr flow} / \text{height culvert} = 2.4 \quad \checkmark$$

AR004608

BY SM DATE 10/1/91

SHEET NO. 3 OF 3

CHKD. BY 99 DATE 10/3/91

JOB NO. _____

SUBJECT _____

$$\frac{L}{D_0} = \approx H = 19.0$$

$$\therefore \text{length of Apron} = D_0 \times H = 3.78 \times 19 = \overset{72'}{42'} \text{ from pt "A"}$$

(see sheet 1/3).

use 40' from downstream dam face.
70'

dissipators or erosion protection works, or for reasons such as right-of-way restrictions and, occasionally, esthetics.

b. Failure of the system will take place if there is inadequate endwall protection. Normally the end sections may be damaged first, thus causing flow obstruction and progressive undercutting during high runoff periods which will result in washout of the structure. For corrugated metal (pipe or arch) culvert installations, use of prefabricated end sections may well prove desirable and economically feasible. When a metal culvert outfall projects from an embankment fill at a substantial height above natural ground, either a cantilevered free outfall pipe or a pipe downspout will probably be required. In either case the need for additional erosion protection requires consideration.

c. Various designs of energy dissipators, flared transitions and erosion protection for culvert outfalls are discussed in detail in subsequent sections of this manual. See paragraphs 7-1 through 7-4, and paragraph 10-3.

4-6. Structural Stability

The proposed structure will be adequate to withstand soil and hydrostatic pressures, and in areas of seasonal freezing the effects of frost action. The structure will be designed to preclude detrimental heave or lateral displacement as the result of frost action. The most satisfactory method of preventing such damage is to restrict frost penetration beneath and behind the wall to nonfrost-susceptible materials. Positive drainage behind the wall is also essential. Bedding requirements will be determined in accordance with procedures outlined in note 4, table 2-3. Criteria for determining the depth of backfill behind walls are given in TM 5-818-1.

4-7. Sloughing

The proposed structure will be large enough to preclude the partial or complete stoppage of the drain by sloughing of the adjacent soil. This can best be accomplished by a straight headwall or by wingwalls. Typical erosion problems result from uncontrolled local inflow around the endwalls. The recommended preventive for this type of failure is the construction of a berm behind the endwall (outfall headwall) to intercept local inflow and direct it properly to protected outlets such as field inlets and paved or sodded chutes that will conduct the water into the outfall channel. The proper use of solid sodding will often provide adequate headwall and channel protection.

4-8. Apron

a. Paved aprons are probably the oldest and simplest form of culvert protection. Protection is provided to the local area covered by the apron and a portion of the kinetic energy of flow is reduced or converted to potential energy because of the hydraulic resistance provided by the apron.

b. The necessity for an apron or stilling basin is determined largely by the soil characteristics of the adjacent open channel and by the anticipated maximum velocities and turbulence at the pipe outlet. Most culverts operate under free outfall conditions, i.e. controlling tailwater is absent, and the discharge possesses kinetic energy in excess of that naturally occurring in the waterway. This excess kinetic energy often must be dissipated to control damaging erosion. The extent to which protective works are required for energy dissipation depends on the amount of excess kinetic energy and the characteristics of the material in the outlet channel. The soil type will indicate the maximum permissible velocities for open channels. These velocities are given in table 2-1. The velocity may be regulated so far as it is feasible to vary the hydraulic gradient of the storm drain or outfall ditch. If excessive discharge velocities do occur, an apron (or stilling basin) of adequate design will be provided to reduce the velocities to permissible values. As an additional precaution, a cutoff wall will be provided to minimize the possibility of undermining the structure. Concrete aprons will be designed to preclude structural damage from differential movement caused by frost action during no-flow periods or by expansive subgrade soils.

c. Recent studies give generalized results of tests for determining the extent of localized scour anticipated in cohesionless soils downstream of circular storm-drain outlets as well as the size and extent of a horizontal blanket of protective stone to prevent localized scour. Investigators have also reported on the maximum or limiting discharges for which an adequate performance was maintained with various types of energy dissipators.

d. There is a need for simpler protective works for those field installations where conditions of headwater, tailwater and discharges are such that excessive scour is not anticipated and where the more elaborate and commonly used energy dissipators are not justified. Tests were conducted to determine the maximum values of the discharge parameters considered satisfactory for various conditions of tailwater and flared outlet transitions.

e. Test results of these simple outlet transitions with the apron at the same elevation as the culvert

invert are shown in Figure 4-1. The maximum discharge parameter for a given culvert length of transition and tailwater can be calculated by the following equation

$$\frac{Q}{D_n^{5/2}} = 1.60 \frac{TW}{D_n} \left(\frac{L}{D_n} \right) 0.4 (D_n/TW)^{1/2}$$

Similarly, the length of transition for a given situation can be selected by the interrelations shown in Figure 4-2, which is calculated by the following equation

$$\frac{L}{D_n} = 0.30 \left(\frac{D_n}{TW} \right)^2 \left(\frac{Q}{D_n^{5/2}} \right) 2.5 (TW/D_n)^{1/2}$$

Variables are defined in appendix C and figure 4-1 shows that this type of protection is satisfactory only for limited values of $Q/D_n^{5/2}$ and TW/D_n . Arbitrary extent of scour depth equal to or less than

$0.5D_n$ was used to classify satisfactory conditions.

f. Figure 4-3 indicates that recessing the apron and providing an end sill at the downstream end did not significantly improve energy dissipation or increase the applicable maximum value of the discharge parameter, $Q/D_n^{5/2}$. The limiting values of the discharge parameter for various outlet transitions and tailwater elevations are listed in table 4-1.

g. Numerous endwall failures have occurred as a result of improper consideration of the relative elevation of the apron and outfall channel. If practicable, the apron elevation will be selected to insure that sufficient depth of backwater occurs over the apron during design flow conditions to prevent undesirable erosion, otherwise positive erosion protection measures will be required. Newly excavated channels erode slightly during the aging process, and proper allowance for this action must be included in establishing the apron elevation.

Table 4-1. Limiting Values of $Q/D_n^{5/2}$

L/D_n	H/D_n	TW/D_n	$Q/D_n^{5/2}$
3	0	0.25	0.88
3	0	0.5	1.78
3	0	1.00	2.56
3	0.25	0.25	1.28
3	0.25	0.50	1.78
3	0.25	1.00	2.56
3	0.50	0.25	1.58
3	0.50	0.50	2.00
3	0.50	1.00	2.56
5	0	0.25	1.20
5	0	0.50	2.40
5	0	1.00	3.20
5	0.25	0.25	1.58
5	0.25	0.50	2.78
5	0.25	1.00	3.47
5	0.50	0.25	1.47
5	0.50	0.50	2.77
5	0.50	1.00	3.46
8	0	0.25	1.68
8	0	0.50	2.40
8	0	1.00	3.75
8	0.25	0.25	2.17
8	0.25	0.50	3.36
8	0.25	1.00	4.44
8	0.50	0.25	2.46
8	0.50	0.50	3.65
8	0.50	1.00	4.55

4-5.6!

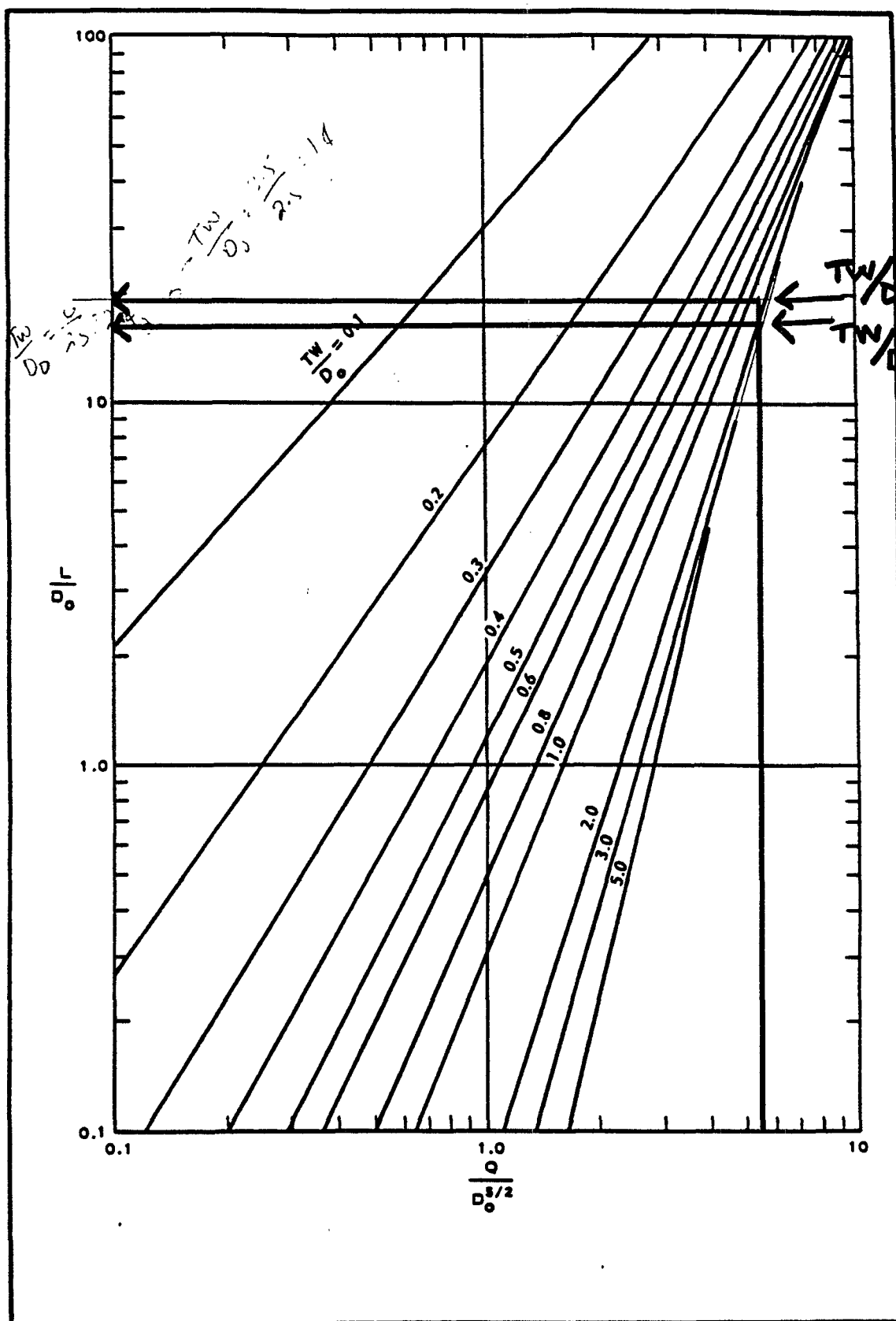


Figure 4-2. Length of flared outlet transition relative to discharge, tailwater, and conduit size.

AR004612

BY SM DATE 10/1/91 SHEET NO. 1 OF 1
 CHKD. BY JTC DATE 10/3/91 JOB NO. 0285-33-2
 SUBJECT Rip Rap Size - Mill Creek Cap + FRB
(McShall's Run)

Reference: Drainage & Erosion Control Structures for Airfields - Helipad to
TM 5-820-3

Fig. 10-8, p. 10-9

$$F_c = \bar{V} / \sqrt{gD} \quad \checkmark$$

where $g = 32.2 \text{ ft/s}^2$

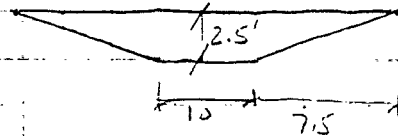
$D = 2.5'$ (10-yr flow, 157 cfs) $\checkmark$

$5.0'$ (50-yr. flow, 327 cfs) $\checkmark$

given via computer
calc's.

$$\bar{V}_{10\text{-yr}} = Q/A$$

where $Q = 157 \text{ cfs}$ $\checkmark$
 $A =$



$$= (10 \cdot 2.5) + (7.5 \cdot 2.5) = 43.75 \text{ sf}_{10\text{-yr}} \quad \checkmark$$

$$= 157 / 43.75 = \underline{3.6 \text{ fps}} \quad \checkmark$$

$$\bar{V}_{50\text{-yr}} = Q/A$$

where $Q = 327 \text{ cfs}$

$A =$



$$= (10.5) + (5 \cdot 1.5) = 12.5 \text{ sf} \quad \checkmark$$

$$= 327 / 12.5 = \underline{2.6 \text{ fps}} \quad \checkmark$$

$$F_{c10\text{-yr}} = \bar{V} / \sqrt{gD} = 3.6 / \sqrt{32.2 \cdot 2.5} = \underline{0.40} \quad \checkmark$$

$$F_{c50\text{-yr}} = 2.6 / \sqrt{32.2 \cdot 5} = \underline{0.20} \quad \checkmark$$

AR004613

From fig. 10-B (checked), req'd d_{50} size is:

10-yr

$$d_{50} \text{ (around hydraulic structures)} = D \cdot 0.062 \checkmark$$

where $D = \text{depth flow} = 2.5'$

$$\therefore d_{50} = 0.155' = \underline{1.9" \phi}$$

$$d_{50} \text{ (in open channel)} = D \cdot 0.022 \checkmark$$

where $D = 2.5'$

$$\therefore d_{50} = 0.055' = \underline{0.7" \phi} \checkmark$$

50-yr

NOT Required

$$d_{50} \text{ (around hydraulic structures)} = D \cdot 0.028$$

where $D = 5.0'$

$$\therefore d_{50} = 0.14' = \underline{1.7" \phi}$$

$$d_{50} \text{ (in open channel)} = \underline{\text{not req'd}}$$

solution: choose min ϕ rip rap $2" \phi$.

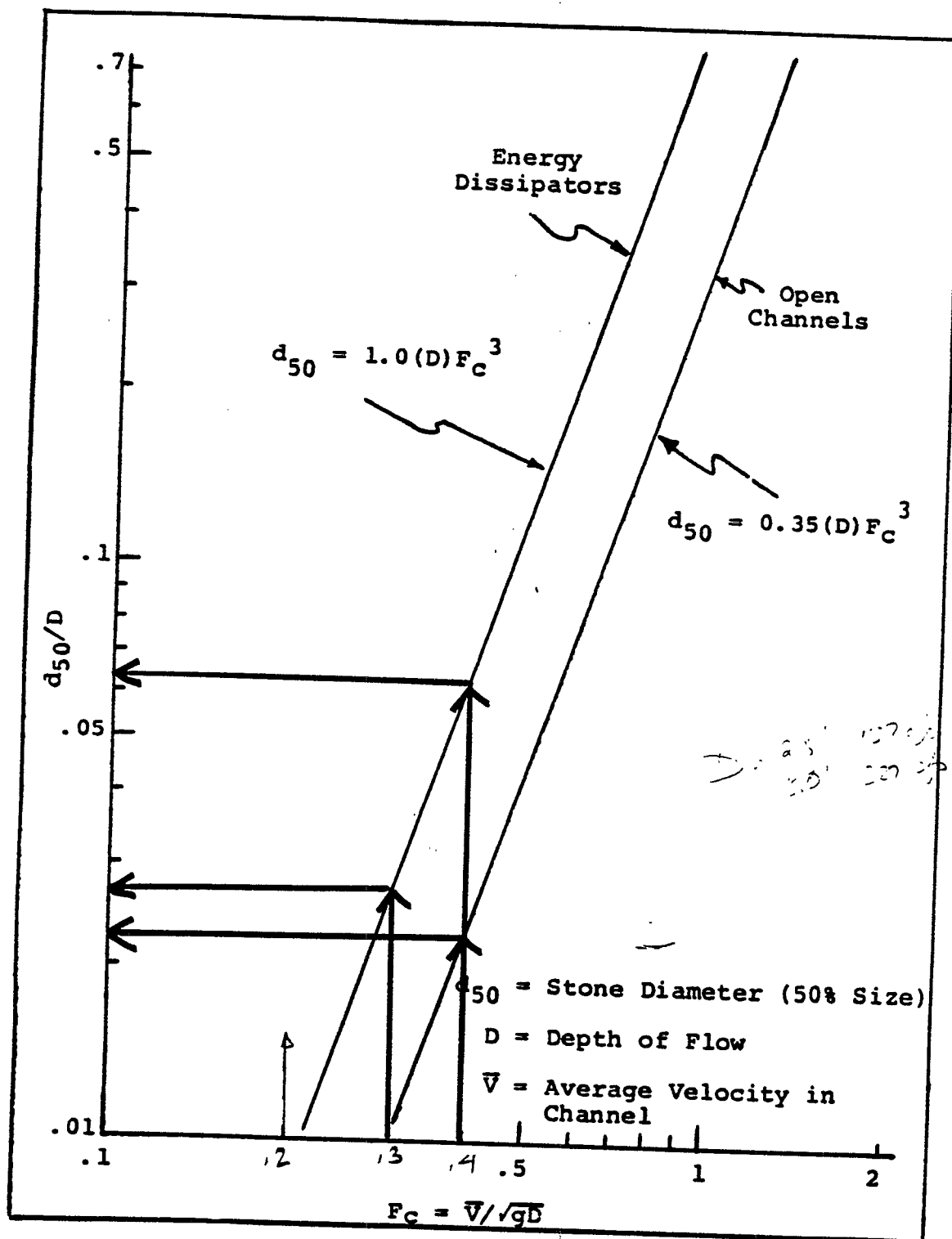
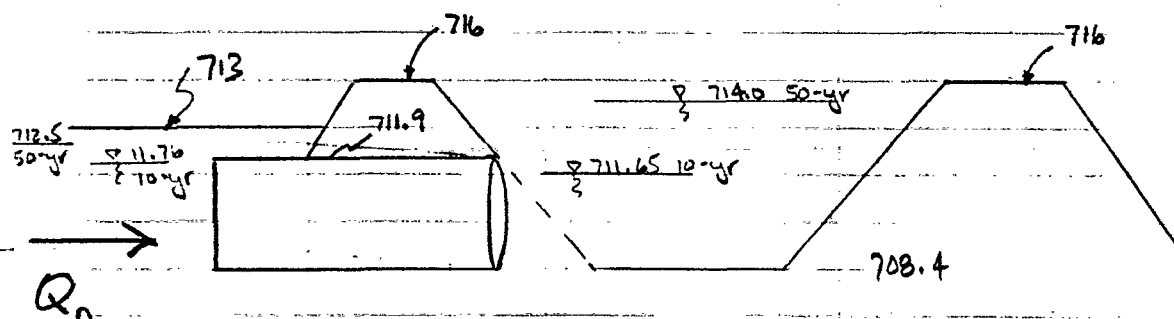


Figure 10-8. Recommended riprap sizes.

BY SJM DATE 10/2/91 SHEET NO. 1 OF 2
 CHKD. BY RCV DATE 10/3/91 JOB NO. 0295-33-2
 SUBJECT Determination of Reg'd Riprap
downstream of N. Channel culverts @
Marshall's Run

Ref: TM 5-820-3 p. 10-10 "Riprap Protection", Fig. 10-9 "Recommended Riprap Sizes".



$Q_n = Q_{10} = 49 \text{ cfs}$
 $Q_{50} = 94 \text{ cfs}$) Per computer Run

$F = \bar{V} / \sqrt{gD}$

where D = depth in channel
 = 5.6' (50-yr) X Per computer Run
 = 3.25' (10-yr) -

$q = 32.2$
 $\bar{V} = Q/A$

where $Q_{10} = 49 \text{ cfs}$
 $Q_{50} = 94 \text{ cfs}$

$A = \pi \cdot r^2 = \pi \cdot 1.75^2 = 9.62 \text{ sf}$ ✓
 ? 3.5' ϕ pipe

$\bar{V}_{10} = 5.1 \text{ fps}$ ✓
 $\bar{V}_{50} = 9.8 \text{ fps}$ ✓

$F_{10-yr} = 5.1 / \sqrt{g \cdot 3.25} = 0.50$ ✓

$F_{50-yr} = 9.8 / \sqrt{g \cdot 5.6} = 0.73$ ✓

AR004616

In fig. 10-9, use horizontal scar hole (invert el. of pipe = invert of receiving channel).

$$d_{50 \text{ 10-yr storm}} = D_0 \cdot 0.018 \quad \checkmark$$

$$= \text{where } D_0 = \phi \text{ culvert} = 42" \\ = \underline{0.76"} \phi \quad \checkmark$$

$$d_{50 \text{ 50-yr storm}} = D_0 \cdot 0.06 \quad \checkmark$$

$$= \underline{2.5"} \phi \quad \checkmark$$

solution: use 3" ϕ rip rap in Marshall's run adjacent to North Ditch culverts.

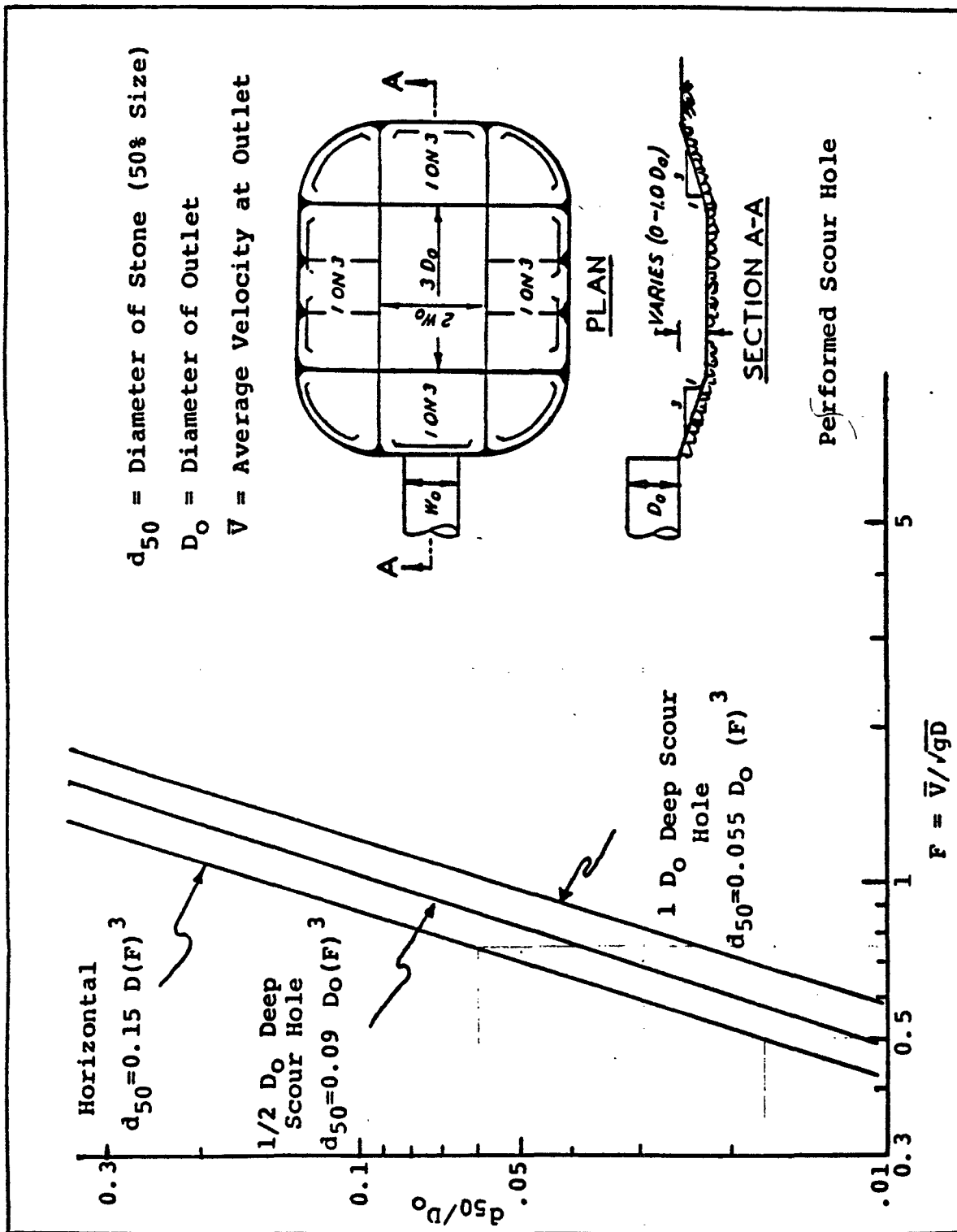


Figure 10-9. Recommended riprap sizes.

**MALCOLM
PIRNIE**

APPENDIX L

PADER DAM REVIEW CRITERIA

0285-33-2

AR004619



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

Post Office Box 8554
Harrisburg, Pennsylvania 17105-8554
September 17, 1991

717-541-7902

Bureau of Dams and Waterway Management

Mr. Steve Miller
Malcolm Pirnie, Inc.
P.O. Box 1938
Buffalo, NY 14127

Re: DER File No. D 25-47

Dear Mr. Miller:

Reference is made to information recently referred to this office by Nancy Snyder of the Department's Northwest Regional Office concerning the proposed construction of a storm water detention dam in conjunction with the Millcreek Superfund Site. The dam is to be located across Marshall Run in Millcreek Township, Erie County.

Although Federal regulations do not require state permits to be issued for work involved at a Superfund clean up site, the design is required to meet all design criteria that would normally apply. This office will conduct a standard review of the proposed design and request comments from other involved State and Federal agencies.

Upon completion of our technical review we will forward any comments directly to you.

Sincerely yours,

Dennis R. Dickey, P.E.
Chief, Project Review and
Evaluation Section
Division of Dam Safety

Enclosures: Dam Applications (2)
Checklist
Environmental Assessment

AR004620

Recycled Paper





COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
FIELD OPERATIONS - WASTE MANAGEMENT
1012 Water Street
Meadville, Pennsylvania 16335
Telephone: A. C. 814/332-6848
November 7, 1991

Subject: Millcreek Superfund Site
Erie County

Mr. Anthony Koller (3HW21)
Remedial Project Manager
U.S. Environmental Protection Agency
Region III
841 Chestnut Building
Philadelphia, PA 19107

Dear Mr. Koller:

The Pennsylvania Department of Environmental Resources (PA DER) has completed its review of the portions of the Millcreek Superfund Site Construction and Flood Retention Basin (FRB) Design Report that would be regulated by the Pennsylvania Dam Safety & Encroachments Act. The following comment is a State Applicable or Relevant and Appropriate Requirement (ARAR):

- The Department's Chapter 105 Rules & Regulations would require a minimum design storm of 100-year return period for a dam with this classification. The dam may be able to safely pass the 100-year storm, but the information submitted does not demonstrate this. No calculations are shown for the 100-year flood. Since the dam is being built as a flood retention basin, the probable downstream hazard potential classification is 2.

The following comments are not State ARARs but should be considered in the FRB design:

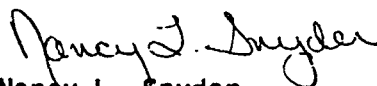
- There is a discrepancy in the invert of this 2.5/ft. by 4.5/ft. low-level outlet. It is given as 709.5 in Table 2 on Page 15 of the 100% Submittal Design Analysis Report and is shown as 709.5 on the "FRB CONTROL STRUCTURE PLAN" on Sheet C-16, but 709.0 is used in the routing (See HEC-1 input, line 171). It is acknowledged that the effect of this discrepancy on the routing would be negligible.
- The degradation of filter material versus the specified perforation of the pipe is questionable according to U.S. Bureau of Reclamation (USBR) and U.S. Army Corps of Engineers (USACOE) guidelines. The following criteria are not met:
 - ° D85f/Max. pipe opening > 2 (USBR, 1987)
 - D50f/Slot width > 1.2 (USACOE, 1986)

AR004621

- The design of the geotextile selected for the toe drain should be based on the embankment fill material properties regardless of source.
- A fine grained soil should be specified for structural backfill along the FRB control structure.

If you have any questions, please contact me at this office.

Sincerely,



Nancy L. Snyder
Project Manager
Hazardous Sites Cleanup Program
Northwest Region

NLS/sn

cc: Mr. Japp
Mr. Miller ✓
Mr. Leaver
Mr. Gorman

AR004622

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

APPLICATION FOR DAM PERMIT

....., 19

In compliance with the provisions of the Act of November 26, 1978, P.L. 1375, *as amended* (32 P.S. §693.1 *et seq.*) known as the "Dam Safety and Encroachments Act"; Act of October 4, 1978, P.L. 851 (32 P.S. §679.101 *et seq.*), known as the "Flood Plain Management Act"; and the Administrative Code, Act of April 9, 1929, P.L. 177, *as amended*, which empowers the Department of Environmental Resources to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania, and the Water and Power Resources Board.

.....
(Applicant)

hereby makes application for the consent or permit of the Department of Environmental Resources to ☐construct, ☐repair, ☐modify, ☐enlarge, ☐operate and maintain, ☐breach, ☐abandon

.....
(State the name of the dam or reservoir if known)

in, along, or across
(State name of stream or other body of water.)

at a point
(Give location, by distance from mouth of stream, county, township, or municipal boundary; also give city, town or township and county in which located.)

for the purpose of
(State fully the purpose, necessity, and description of the dam.)

in accordance with the complete maps, plans, profiles, and specifications filed with this application and made a part hereof.

MUST BE COMPLETED BY APPLICANT

Drainage Area _____ acres or square miles

Maximum Depth to Top of Dam _____ feet

Surface Area: at normal pool _____ acres

Storage Volume: at normal pool _____ acre-feet

at top of dam _____ acres

at top of dam _____ acre-feet

Size and Hazard Classification _____

Justification for Hazard Classification _____

FOR DEPARTMENT USE ONLY

Application Fee _____

Application No. _____

Check No. _____

Date Received _____

Amount _____

Municipal Notification _____

Check Date _____

County Notification _____

(Continued on other side)

AR004623

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

APPLICATION FOR DAM PERMIT

....., 19 ...

In compliance with the provisions of the Act of November 26, 1978, P.L. 1375, *as amended* (32 P.S. §693.1 *et seq.* known as the "Dam Safety and Encroachments Act"; Act of October 4, 1978, P.L. 851 (32 P.S. §679.101 *et seq.* known as the "Flood Plain Management Act"; and the Administrative Code, Act of April 9, 1929, P.L. 177, *as amended* which empowers the Department of Environmental Resources to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania, and the Water and Power Resources Board

.....
(Applicant)

hereby makes application for the consent or permit of the Department of Environmental Resources to ☐construct, ☐repair ☐modify, ☐enlarge, ☐operate and maintain, ☐breach, ☐abandon

.....
(State the name of the dam or reservoir if known)

in, along, or across
(State name of stream or other body of water.)

at a point
(Give location, by distance from mouth of stream, county, township, or municipal boundary; also give city, town or township and county in which located

for the purpose of
(State fully the purpose, necessity, and description of the dam.)

in accordance with the complete maps, plans, profiles, and specifications filed with this application and made a part hereof

MUST BE COMPLETED BY APPLICANT

Drainage Area _____ acres or square miles

Maximum Depth to Top of Dam _____ feet

Surface Area: at normal pool _____ acres
at top of dam _____ acresStorage Volume: at normal pool _____ acre-feet
at top of dam _____ acre-feetSize and Hazard Classification _____
Justification for Hazard Classification _____-----
FOR DEPARTMENT USE ONLY

Application Fee _____

Application No. _____

Check No. _____

Date Received _____

Amount _____

Municipal Notification _____

Check Date _____

County Notification _____

(Continued on other side)

AR004624

APPLICATION CHECKLIST FOR DAM PERMIT

- _____ Permit application correctly signed, sealed and witnessed, with corporate or municipal seals in accordance with Section 105.13.
- _____ Application fee in accordance with Section 105.13(b).
- _____ Evidence of municipal and county notification. (See reverse side)
- _____ The location, type, size, height, and purpose of the proposed dam and reservoir and appurtenant works.
- _____ The storage capacities and reservoir surface areas for normal pool and maximum high water.
- _____ The size and hazard classification of the dam in accordance with Section 105.91 and justification for hazard classification.
- _____ Proof of title or adequate flowage easements for all land area below the top of the dam elevation that is subject to inundation.
- _____ Data concerning subsoil and rock foundation conditions and the physical properties of the materials entering into the construction of the dam in accordance with Section 105.81(c).
- _____ Design drawings, technical construction specifications and design report in sufficient detail that a determination of the adequacy of the proposed facility can be made.
- _____ Registered professional engineer's seal and certification affixed to all plans, specifications and design reports accompanying the application in accordance with Section 105.13(h).
- _____ An Erosion and Sedimentation Pollution Control Plan and a copy of a letter of approval from the appropriate County Conservation District(s).
- _____ Hydrologic and hydraulic analyses.
- _____ The method and schedule of operation of the dam, including an emergency warning system in accordance with Section 105.134.
- _____ Proof of financial responsibility in accordance with Section 105.20.
- _____ An environmental assessment in accordance with Section 105.15.
- _____ Information concerning the chemical content, viscosity, and other pertinent physical characteristic of fluids or semi-fluids other than water.
- _____ A plan for monitoring performance of the dam in accordance with Section 105.81(a)(5).
- _____ The proposed time for commencement and anticipated completion of construction.
- _____ Reports of the most recent inspection of existing dams.
- _____ A letter from the municipality indicating that the project is consistent with their floodplain and stormwater management programs.

AR004625

ENVIRONMENTAL ASSESSMENT UNDER SECTION 105.15

GUIDELINES FOR PREPARATION

The following guidelines are intended to provide direction in the fulfillment of the environmental assessment criteria in section 105.15 of the Departments Chapter 105 Rules and Regulations, 25 Pa. Code Chapter 105, 32 P.S. Section 693.1.

Each application for construction of the following categories of activities shall include an environmental assessment:

- (1) Any dam or reservoir for the storage of water of size classification A or B or hazard classification 1 as defined in §105.91 (relating to classifications of dams and reservoirs).
- (2) Any dam or reservoir for the storage of fluids or semifluids other than water, the escape of which may result in air, water, or land pollution or may result in danger to persons or property.
- (3) Any dam, bridge, culvert, stream crossing, stream enclosure, dike, levee, flood wall, or stream relocation located in, along, or across a stream identified as a candidate for or included in the Federal or State wild and scenic river systems.
- (4) Any stream enclosure, stream relocation, or any other activity or facility which the Department determines may have a significant impact on the environment.

The criteria outlined on the following pages are intended to serve as a guide in identifying any adverse environmental impacts which may occur as the result of the project. Upon review of the assessment, the Department may require the submission of additional data pertaining to any of the information provided.

The Department may further require the submission of additional information regarding the project. Included are alternatives to the proposed action including alternative locations, routings or designs to avoid or reduce any significant adverse environmental impacts. Furthermore, information concerning any actions that may be taken through design, location or operation of the proposed structure or other activities to mitigate any unavoidable significant environmental impacts which would occur as the result of the project may also be required. The Department reserves the right to request additional analysis of any one or more of the alternatives submitted, and to require further assessment of additional alternatives which it deems necessary.

For the purposes of these guidelines and this chapter, any proposed activity which reduces, degrades, eliminates or stresses any of the functions, values or uses as listed in the following categories shall be deemed to constitute a significant adverse environmental impact.

Each application for a permit under this chapter that requires an environmental assessment must contain a narrative addressing the impacts of the proposed activity on the following factors:

AR004626

- (b) Will the project alter stream flow in the primary stream or receiving stream?
- (c) Will the project have an affect on upstream or downstream water users?
- (d) Is the stream identified as a candidate for, or included in the Federal or State wild or scenic river system?
- (e) Is the stream identified as, or known to be a naturally reproducing wild trout stream?
- (f) Is the stream classified as a stocked or stockable trout stream by the Pa. Fish Commission?
- (g) Is the stream classified as high quality or exceptional value, or is it located in a watershed classified as such?

Identify and explain all alternatives which were considered to avoid or reduce adverse impacts to any of the functions, values or uses identified above, and why each of those alternatives were considered feasible or infeasible.

Identify and explain any actions taken through operation, location or design to mitigate any of the adverse effects to any of the functions, values or uses as identified above.

3. Other relevant significant environmental factors.

Identify any impacts which will occur as a result of the project on each of the following environmental factors. Explain fully each answer, and provide any supporting documentation necessary.

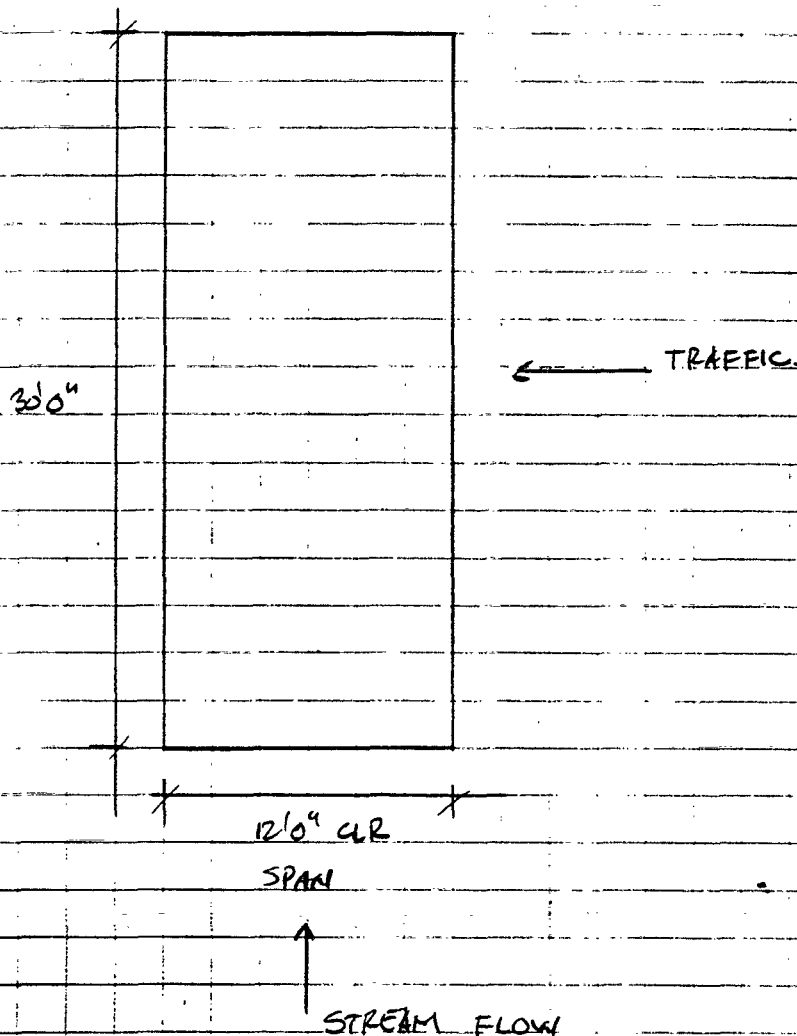
- (a) Federal and State Forests
- (b) Parks
- (c) Recreation, recreation areas
- (d) Prime Farmlands
- (e) Sites, areas or structures of historic, cultural or archaeological significance, including those having federal, state or local designation.
- (f) Threatened and endangered plant, animal and other species.
- (g) Sites listed on the National Registry of Natural Landmarks.
- (h) Public or private water supplies, supply intakes or reservoirs.
- (i) Coastal Zone Management Program area; is the project within the Coastal Zone, and what impact, if any, will the project have upon the coastal resources?

APPENDIX M

STRUCTURAL DESIGN CALCULATIONS

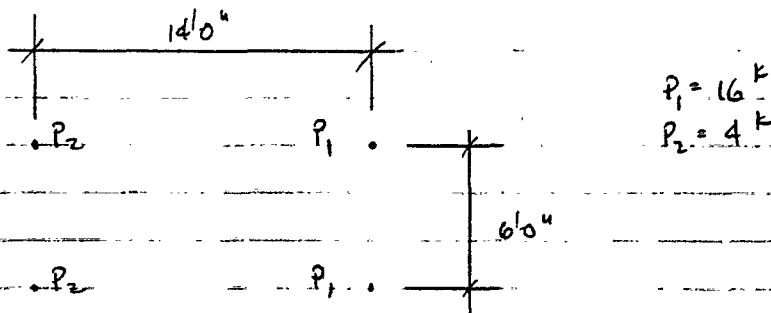
BY RDC DATE 7/9/91 SHEET NO. 1 OF 1
 CHKD. BY AH DATE 7/9/91 JOB NO. 0285-33-2
 SUBJECT MILLCREEK ACCESS R.D. CULVERT

PROPOSED PLAN - ACCESS RD BOX CULVERT



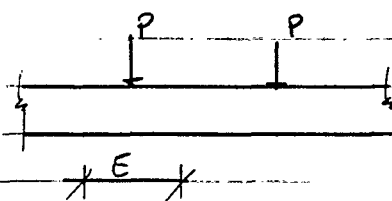
AR004629

DESIGN TRUCK - H20



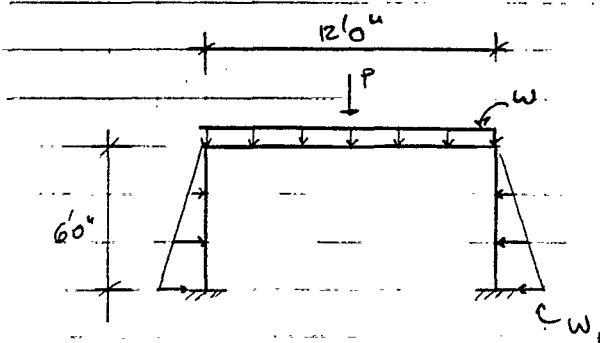
MAIN REINF. IS PARALLEL TO DIRECTION OF TRAFFIC

WHEEL LOADS ARE DISTRIBUTED AS FOLLOWS.



$$\begin{aligned} E &= \text{EFFECTIVE BEAM WIDTH} \\ &= 4 + .06 (\text{CLEAR SPAN}) \\ &= 4 + .06 (12) \\ &= 4.72' \end{aligned}$$

CULVERT LOADING & REINFORCING



$$\begin{aligned} P &= 16 / 4.72' \\ &= 3.39 \text{ k/1} \end{aligned}$$

$$\begin{aligned} W &= .15 + .04 \quad (12" \text{ CONC} + 3" \text{ FILL}) \\ &= .19 \text{ k/1} \end{aligned}$$

$$\begin{aligned} W_1 &= .065 (6) \\ &= .39 \text{ k/1} \end{aligned}$$

AR004630

BY PDC DATE 7/9/91 SHEET NO. 3 OF
 CHKD. BY AK DATE 7/9/91 JOB NO.
 SUBJECT MILL CREEK ACCESS R.D. - CULVERT

DISTRIBUTE MOMENTS & SELECT ROOF SLAB REINF.

			4 SYM			
0	.67	.33		.33	.67	0
-70	+47	-737				
+23	+4.6	+23				
		-115				
+39	+77	+39				
1.99	5.84	-5.83				

DISTRIBUTION FACTORS
FIXED END MOMENTS

$$M_{max}^- = 5.83 \text{ K/1}$$

$$P_{xu} = .5(3.39) + .19(6) = 2.84 \text{ K}$$

$$M_{max}^+ = -5.83 + .19 \frac{(144)^2}{8} + \frac{3.39(12)}{4} = 7.79 \text{ K/1}$$

$$d^+ = \sqrt{\frac{7.79}{.204}} = 6.18 \text{ in}$$

$$d^- = \sqrt{\frac{5.83}{.204}} = 5.35 \text{ in}$$

$$d_{shear} = \frac{2.84(1000)}{12(60)} = 3.94 \text{ in}$$

USE 12" SLAB W/ 3" COVER ON TOP & 2" ON BTM.

$$d^- = 8.54$$

$$d^+ = 9.54$$

$$A_s^- = \frac{5.83}{1.76(8.5)} = .39 \text{ in}^2/\text{1}$$

$$A_s^+ = \frac{7.79}{1.76(9.5)} = .47 \text{ in}^2/\text{1}$$

$$\text{DISTRIBUTION STEEL } A_{sd} = \frac{.47}{12} = .14 \text{ in}^2$$

$$\text{or } A_{sd} = .0033(6 \times 12) = .24 \text{ in}^2 \leftarrow \text{CONTROLS}$$

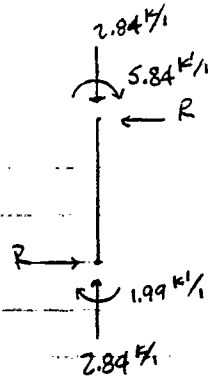
⇒ USE #6 @ 12" T & #5 @ 6" BTM, #5 @ 12" DISTRIB. STEEL

$$z_{BTM} = \frac{7.79(12)}{(.62 \times 90 \times 9.5)} \left(2(2.5)(6) \right)^{1/3} = 75 \text{ OK}$$

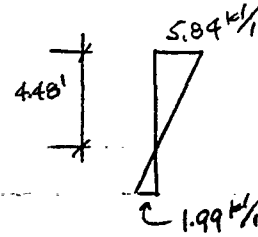
$$z_{TOP} = \frac{5.83(12)}{.44(.92 \times 8.5)} \left(2(2.5)(12) \right)^{1/3} = 109 \text{ OK}$$

AR004631

SELECT WALL REINF @ BASE.



$$R = \frac{1.99 + 5.84}{6} = 1.31 \text{ k/ft}$$



MOMENT DIAG.

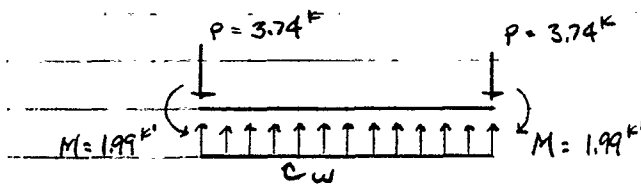
USE 12" SLAB W/ 2" COVER TYP.

$$d = 9.5" \quad A_s^+ = \frac{1.99}{1.76(9.5)} = .12 \text{ in}^2$$

$$A_s^+, \text{min} = .0019(6)(12) = .13 \text{ in}^2$$

⇒ USE #5 @ 12" DOWNELS EACH FACE.

SELECT BASE SLAB THICKNESS & REINF



$$P = 2.84 + 1(1)(.15)(6) = 3.74 \text{ k}$$

$$M = 1.99 \text{ k-ft}$$

$$w = \frac{2(3.74)}{15} = .50 \text{ k/ft}$$

$$M_{\text{max}} = 1.99 + .5 \frac{(12)^2}{8} = 11.0 \text{ k-ft}$$

$$d = \sqrt{\frac{11}{.204}} = 9.8 \text{ in}$$

⇒ USE 15" SLAB $d = 12.5 \text{ in}$

AR004632

BY RDC DATE 7/12/91 SHEET NO. 5 OF
 CHKD. BY AT DATE 7/9/1 JOB NO.
 SUBJECT MILL CREEK ACCESS RD CULVERT

$$A_s = \frac{11.0}{1.76(12.5)} = .50 \text{ in}^2/\text{ft} \quad \text{TOP}$$

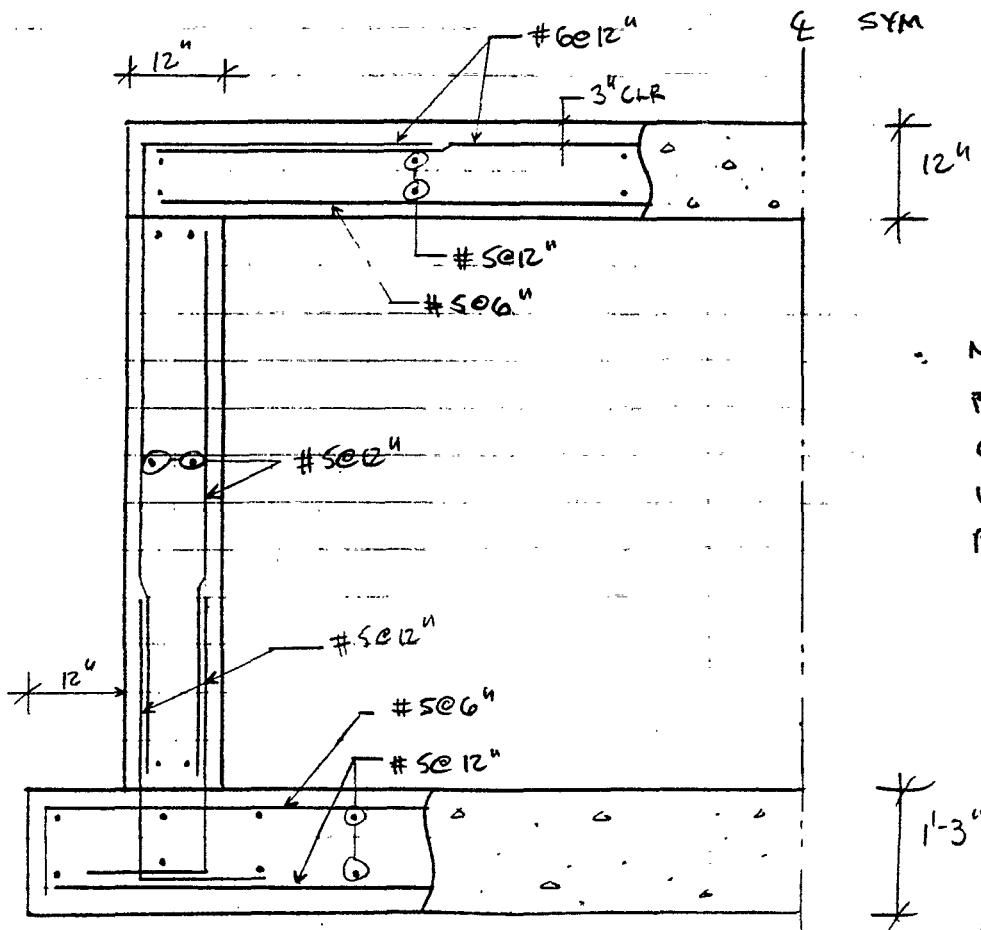
$$A_{s, \text{min}} = 7.5(12)(.0012) = .16 \text{ in}^2/\text{ft}$$

$$A_{s, \text{TEMP}} = .0033(7.5)(12) = .30 \text{ in}^2/\text{ft}$$

⇒ PROVIDE #5@6" TOP, #5@12" BTM, #5@12" TCB TEMP.

$$Z = \frac{11(12)}{.60(421)(12.5)} \left(2(2.5)(12) \right)^{1/3} = 102 < 145 \quad \text{OK.}$$

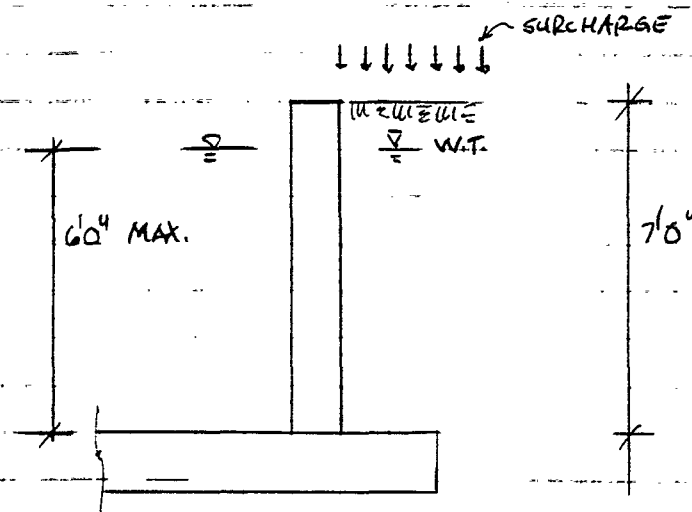
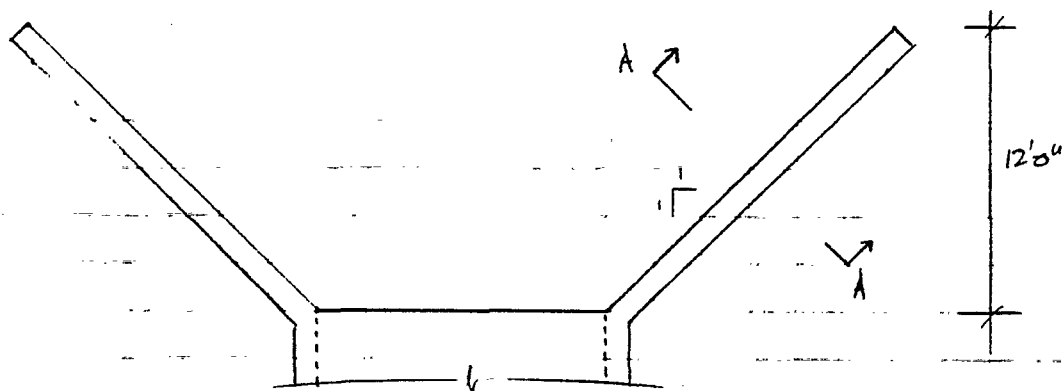
SUMMARY



NOTE: DETAILING FOR ACCESS RD CULVERT WILL BE UTILIZED FOR THE BYPASS CULVERT

AR004633

PROPOSED PLAN - FOR ACCESS RD & BYPASS CULVERTS



SECTION A-A

DESIGN ASSUMPTIONS

ASSUME: WATER TABLE AT SAME ELEV. AS CHANNEL WATER SURFACE
300 PSF SURCHARGE
DESIGN FOR "AT REST" CONDITION. $F_0 = .50$
EQUV. FLUID = 90 PCF BELOW WATER TABLE
EQUV. FLUID = 60 PCF ABOVE WATER TABLE

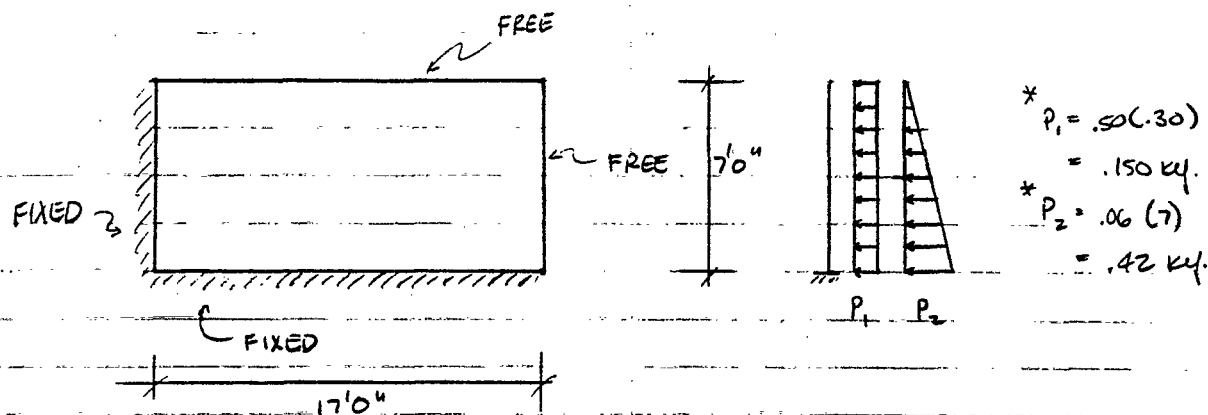
AR004634

BY RDC DATE 7/12/91 SHEET NO. 7 OF

CHKD. BY AT DATE 7/91 JOB NO.

SUBJECT MILLCREEK - CULVERT RET. WALLS.

WALL LOADING / BOUNDARY CONDITIONS & REINF.



$a = 17'0"$ $a/b = 2.42$ $* \text{WORST CASE} = \text{CHANNEL EMPTY w/ 300 PSF SURCHARGE ON WALL.}$
 $b = 7'0"$

$a/b > 1.0 \therefore$ VERTICAL WALL FIXITY HAS NO AFFECT ON BASE MOMENTS.

$$M_{\max} @ \text{BASE} = \frac{.15(7)^2}{2} + \frac{.42(7)^2}{6} \quad V_{\max} = .15(7) + .42(7)(.5)$$

$$= 7.11 \text{ k'/ft} \quad = 2.52 \text{ k'/ft}$$

$$d = \sqrt{\frac{7.11}{.204}} \quad \text{OR} \quad d = \frac{2.52(1000)}{12(60)}$$

$$= 5.9 \text{ in} \quad = 3.5 \text{ in}$$

$\Rightarrow$ USE 12" WALLS $d = 9.5 \text{ in}$

$$A_s = \frac{7.11}{1.76(9.5)} \quad z = \frac{7.11(12)}{921(9.5)(.44)} \left(\frac{2(2.5)^2(12)}{3} \right)^{1/3}$$

$$= .43 \text{ in}^2/\text{ft} \quad = 118 < 145 \text{ OK.}$$

$$= \#6 @ 12"$$

$\Rightarrow$ PROVIDE #6 @ 12" DWLS FACING SOIL. #5 @ 12" ALL OTHER PLACES.

AR004635

BY RDC DATE 7/12/91 SHEET NO. 8 OF
 CHKD. BY MT DATE 7/91 JOB NO.
 SUBJECT MILLCREEK - CULVERT RET. WALLS

BASE SLAB LOADING & REINF



$$M = 7.11 @ 45^\circ \text{ TO REINF}$$

$$\Rightarrow M_{\text{design}} = 7.11 \cos 45$$

$$= 5.03 \text{ k'}$$

$$d = \sqrt{\frac{5.03}{2.04}}$$

$$= 5.0 \text{ in}$$

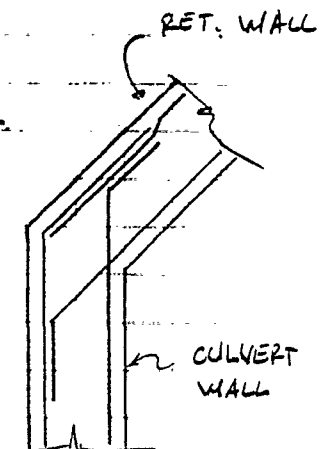
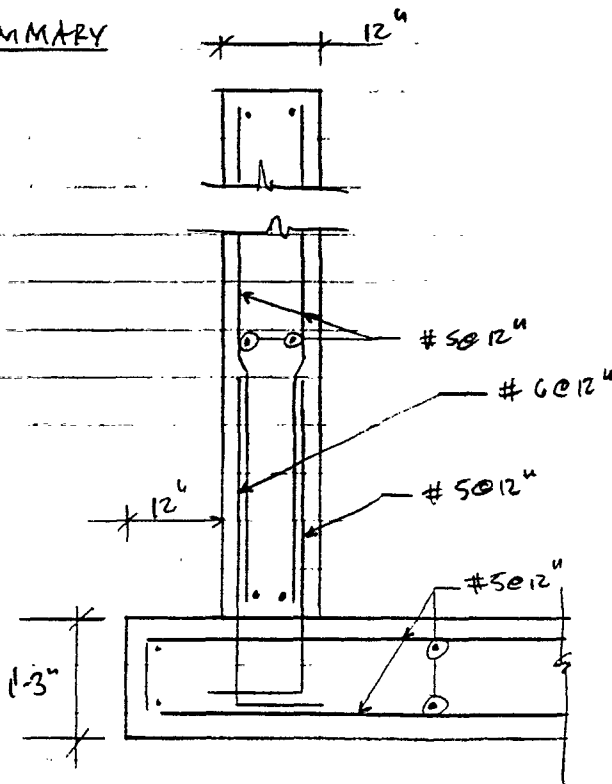
USE 15" SLAB TO MATCH CULVERT BASE SLAB
 $d = 11.5 \text{ in}$

$$A_s = \frac{5.03}{1.76(11.5)}$$

$$= .25 \text{ in}^2$$

$\Rightarrow$ USE #5 @ 12" E.W.E.F.

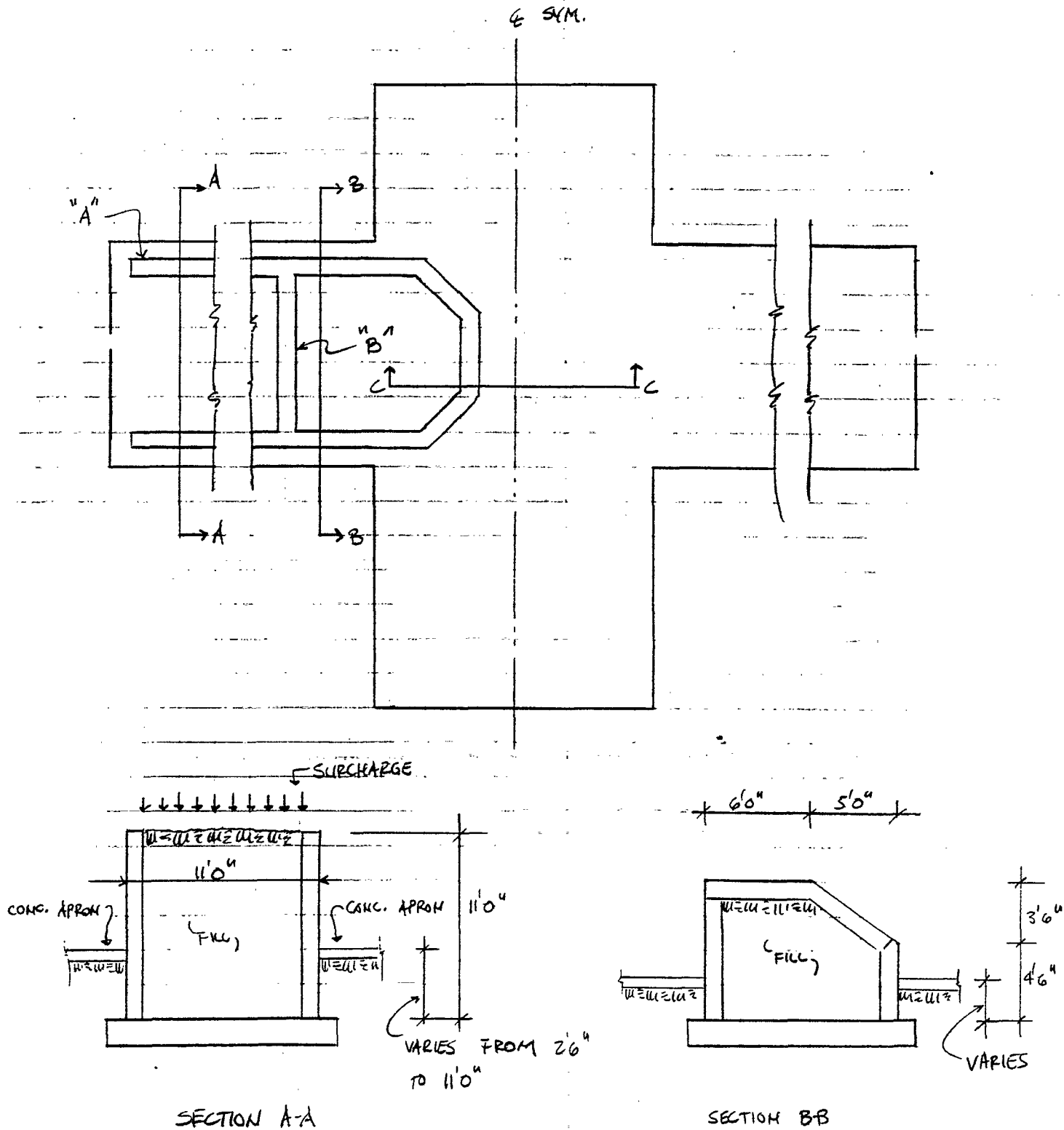
SUMMARY



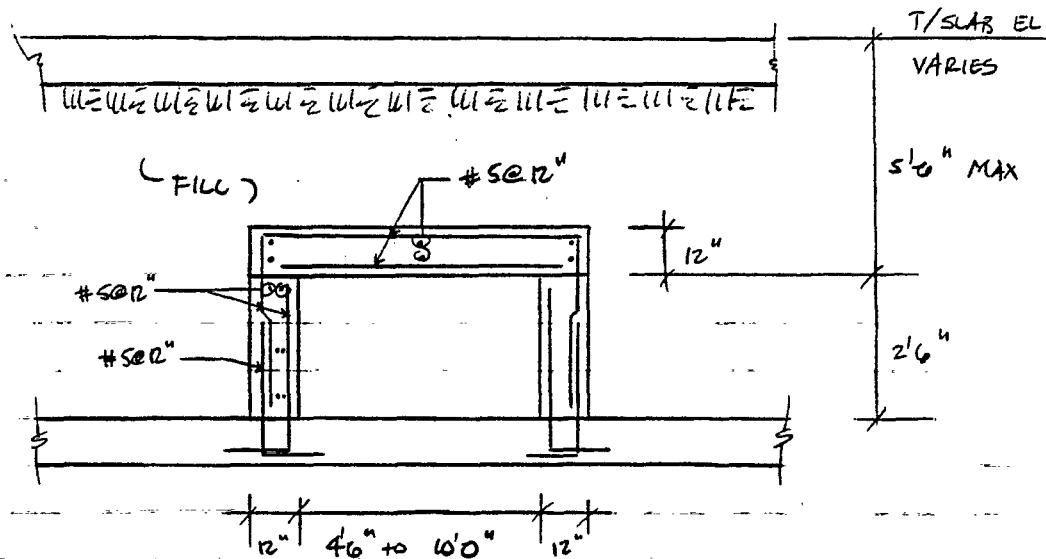
TRANSITION DETAIL

AR004636

PROPOSED FOUNDATION PLAN & SECTIONS



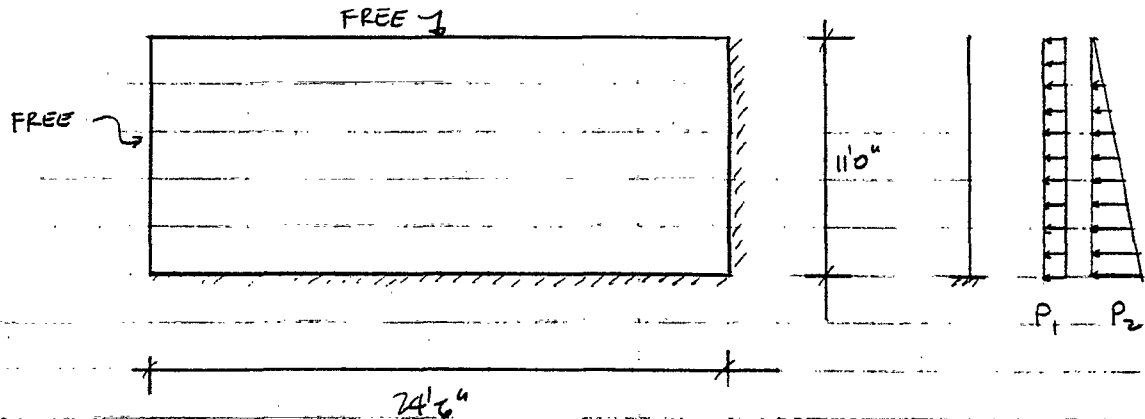
AR004637



SECTION C-C

BY RDC DATE 7/15/91 SHEET NO. 11 OF
CHKD. BY AH DATE 7/91 JOB NO.
SUBJECT MILLCREEK - FBR STRUCTURE

WALL "A" LOADING, BOUNDARY CONDITIONS & REINF.



WORST CASE LOADING - CHANNEL EMPTY W/ 300 PSF SURCHARGE

DESIGN FOR "AT REST" CONDITION $K_0 = .50$

$$P_1 = .50(.300) = .150 \text{ k/ft}$$

$$P_2 = .06(11) = .66 \text{ k/ft}$$

$$a = 24'6" \quad a/b = 2.23$$

$$b = 11'0"$$

$a/b > 1.0$ ∴ VERTICAL WALL FIXITY HAS NO AFFECT ON BASE MOMENT.

$$M_{\text{max @ BASE}} = \frac{.15(11)^2}{2} + \frac{.66(11)}{6}$$

$$V_{\text{max}} = .15(11) + .66(11)(.50)$$

$$= 22.4 \text{ k/ft}$$

$$= 5.28 \text{ k/ft}$$

$$d = \sqrt{\frac{22.4}{.204}} \quad \text{OR} \quad d = \frac{5.28(1000)}{12(600)}$$

$$= 10.5 \text{ in} \quad = 1.33 \text{ in}$$

AR004639

BY RDC DATE 7/15/91 SHEET NO. 12 OF
CHKD. BY AH DATE 7/91 JOB NO.
SUBJECT MILLCREEK - FBR STRUCTURE

⇒ USE 14 in WALLS $d = 11.5$ in

$$A_s = \frac{22.4}{1.76(11.5)} = 1.11 \text{ in}^2/\text{ft}$$

$$z = \frac{22.4(12)}{1.20(.892)(11.5)} = 92 < 145 \text{ OK}$$

$$= \#7 @ 6"$$

MINIMUM LAP FOR $\#7 @ 6" = 42"$ ∴ EXTEND $3'6"$ FROM BASE.

$$M @ 3'6" \text{ FROM BASE} = \frac{.15(7.5)^2}{2} + \frac{.5(.12)(7.5)^3}{6}$$

$$= 8.44 \text{ K'/ft}$$

$$A_s = \frac{8.44}{1.76(11.5)} = .42 \text{ in}^2/\text{ft}$$

$$z = \frac{8.44(12)}{.44(.929)(11.5)} = 115 < 145 \text{ OK}$$

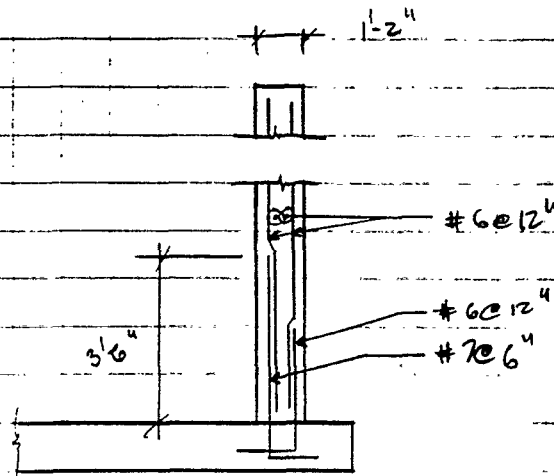
$$= \#6 @ 12"$$

$$A_{s, \text{TEMP}} = .004(7)(12)$$

$$= .34 \text{ in}^2$$

$$= \#6 @ 12" \text{ E.F.}$$

SUMMARY



AR004640

BY RDC DATE 7/15/91

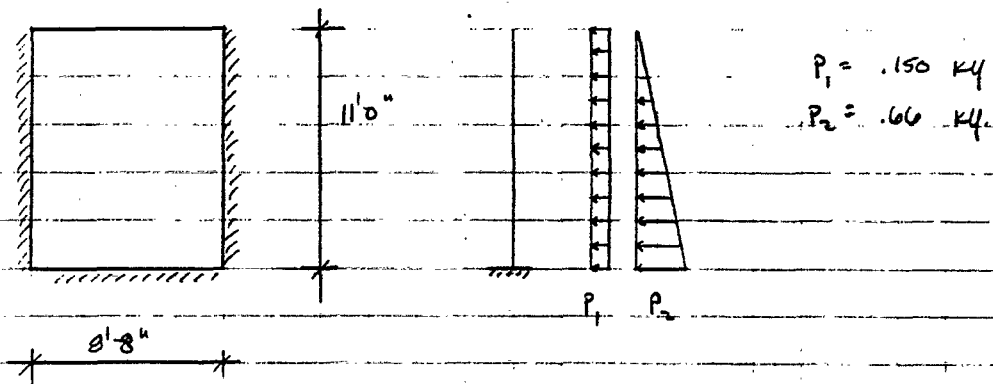
SHEET NO. 13 OF

CHKD. BY AH DATE 7/91

JOB NO.

SUBJECT MILLCREEK - FBR STRUCTURE

WALL "B" LOADING, BOUNDARY CONDITIONS & REINF.



$$a = 4'-4" \quad a/b \approx 3/8$$

$$b = 11'-0"$$

$$M_{\text{MAX @ BASE}} = .02 (.66 \times 11)^2 + .0288 (.15)(11)^2$$

$$= 2.12 \text{ K'} / \text{ft}$$

$$M_{\text{WALL @ 4.4' FROM BASE}} = .0208 (.66 \times 11)^2 + .0379 (.15)(11)^2$$

$$= 2.35 \text{ K'}$$

$$M_{\text{WALL @ 6.6' FROM BASE}} = .0176 (.66 \times 11)^2 + .0442 (.15)(11)^2$$

$$= 2.21 \text{ K'}$$

BY INSPECTION - 12" WALL w/ #5 @ 12" C.W.-EF. ADEQUATE.

AR004641

BY ROC DATE 7/15/91

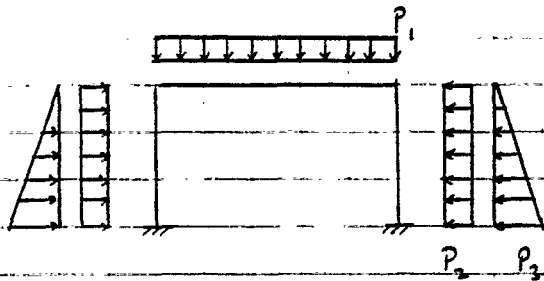
SHEET NO. 14 OF

CHKD. BY AH DATE 7/91

JOB NO.

SUBJECT MILLCREEK - FBR STRUCTURE

TUNNEL LOADING & REINF. - SEE SECTION C-C



$$P_1 = .15 + .15 + .12(3.5) \quad \text{SLABS & SOIL}$$

$$= .72 \text{ k/ft}$$

$$P_2 = .15(.90) + .06(4.5) \quad \text{SURCHARGE (12" SLAB)}$$

$$= .35 \text{ k/ft} \quad + \text{ACTIVE SOIL}$$

$$P_3 = .06(2.5)$$

$$= .15 \text{ k/ft}$$

6 SYM.

0	.80	.20		.20	.80	0
-.20	+.20	-6.00				
+2.32	+4.64	+1.16				
+2.12	+4.84	-4.84				

$$M_{\text{max}}^+ = -4.84 + \frac{.72(100)}{8}$$

$$= 4.16 \text{ k'}$$

$$d = \sqrt{\frac{4.84}{.204}} \quad \text{USE 12" WALL } d = 9 \frac{1}{2}"$$

$$= 4.87 \text{ in}$$

$$A_s = \frac{4.84}{1.76(9.5)}$$

$$= .29 \text{ in}^2/\text{ft}$$

$$= \#5 @ 12"$$

$$z = \frac{4.84(12)}{31(.934)(9.5)} \left(2(2.5)^2(12) \right)^{1/3}$$

$$= 112 \quad \text{OK}$$

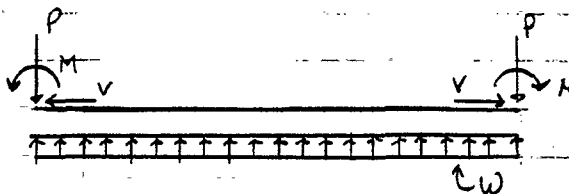
SEE SECTION CC FOR REINF SUMMARY

AR004642

BY PDC DATE 7/15/91 SHEET NO. 15 OF

CHKD. BY AH DATE 7/91 JOB NO.

SUBJECT MILLCREEK - FBR STRUCTURE

BASE SLAB LOADING & REINF

$$P = .03(14/12)(1)(11)$$

$$= .39 \text{ K}$$

$$M = 22.4 \text{ K'}$$

$$V = 5.28 \text{ K}$$

$$W = 2(.39)$$

$$8.67$$

$$= 10 \text{ K'}$$

MIN. SLAB THICKNESS = EMBEDMENT FOR WALL DOWELS + 3" COVER

$$= 12" (\#7 @ 6") + 3"$$

$$= 15"$$

$$M_{max} = 22.4 + 10 \frac{(8.67)^2}{8}$$

$$= 23.3 \text{ K'}$$

$$d = \sqrt{\frac{23.3}{.204}}$$

$$= 10.7 \text{ in}$$

USE 15" SLAB $d = 12.5"$

$$A_s = 23.3$$

$$1.76(12.5)$$

$$= 6.06 \text{ in}^2/\text{ft}$$

$$= \#6 @ 12" \text{ w/ } \#7 @ 12" \text{ ADDL.}$$

DISTRIBUTE 1/2 TENSILE FORCE TO MAIN REINF
AND REMAINING FORCE TO TEMP STEEL

$$A_{s, \text{TEMP}} = .0018(7.5 \times 12) + \frac{5(5.28)}{24}$$

$$= .127 \text{ in}^2/\text{ft}$$

$$= \text{SAY } \#6 @ 12" \text{ BTM.}$$

$$A_{s, \text{TEMP}} = .004(7.5 \times 12)$$

$$= .36 \text{ in}^2/\text{ft}$$

$$= \#6 @ 12"$$

+ TO MAIN STEEL

AR004643

BY RDC DATE 7/15/91

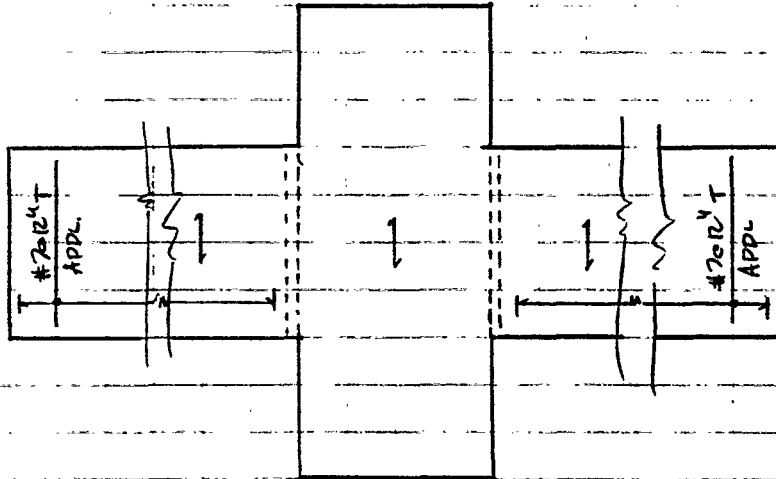
SHEET NO. 16 OF

CHKD. BY AH DATE 7/91

JOB NO.

SUBJECT MILLCREEK - FBR STRUCTURE

SUMMARY



15" SLAB

12" SLAB

15" SLAB

NOTES

1. INDICATES OUTERMOST LAYERS OF REINF.
2. 12" SLAB REINF. #5 @ 12" EW-EF
3. 15" SLAB REINF. #6 @ 12" EW-EF
4. SEE PLAN FOR ADDL. REINF.

AR004644

**MALCOLM
PIRNIE**

APPENDIX N

MISCELLANEOUS DESIGN CALCULATIONS

0285-33-2

AR004645

MALCOLM PIRNIE
MILL CREEK
SLOPE STABILITY

20179-40
11/20/91
RMT
checked by SJM 11/24/91

REFERENCE — DUNCAN & BUCHIGNANI (1975)

IF COHESIVE —

CONSERVATIVELY ASSUME $c = 250$ PSF
 $\phi = 0^\circ$

$$P_0 = \gamma H \approx (120 \text{ PCF})(10') = 1200$$

$$L = P/H = 0$$

$$N_0 \approx 10.5$$

$$\text{SAFETY FACTOR} = \frac{N_0 c}{P_0} = \frac{(10.5)(250)}{1200} = 2.19$$

IF GRANULAR —

ASSUME $\phi = 27^\circ$
 $c = 0$

$$L = \cot \beta = 3$$

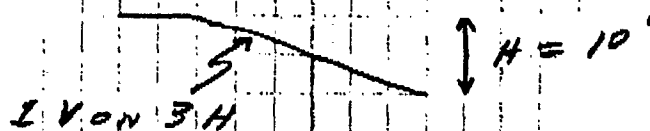
$$\text{SAFETY FACTOR} = \frac{\tan \phi}{\tan \beta}$$

$$= \frac{1}{3} \tan \phi$$

$$= 1.53$$

(NO SEEPAGE ASSUMED, BECAUSE OF
NATURE OF FACILITY AND PRESENCE
OF DRAINAGE.)

NOTE — BOTH COHESIVE AND GRANULAR
CASES BASED ON THE FOLLOWING
GEOMETRY —



AR004646

BY S.J.M. DATE 11/20/91 SHEET NO. 1 OF 5
CHKD. BY EWM DATE 11/22/91 JOB NO. 0285-33-2
SUBJECT Millcreek CAP + FRB Project - 1Improved Marshall's Run Channel Liner AnalysisLINER ANALYSISProblem Statement

Determine the adequacy of the proposed liner design arrangements under the anticipated loadings. Analysis shall include the following components:

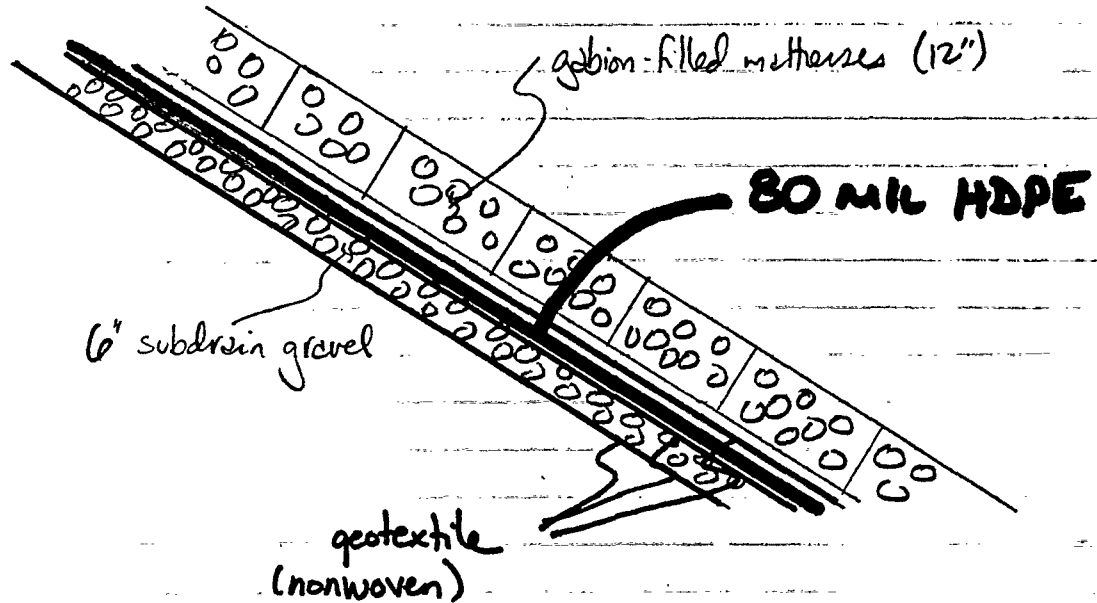
- ① geotextile, flexible membrane, and gabion mattresses for tensile strength;
- ② riprap and gravel bedding for side slope stability; and ③ subdrain pipe and bedding layer for hydraulic transmissivity and protection from uplift.

Design Assumptions

- The slope is 34:1V (18.4°)
- The friction angle between the soil and geotextile would be 26°.
- For design checks of liner stresses, all FML-geotextile interfaces will be assumed to have a friction angle of 90° (i.e. a "fixed component" liner "scenario").
- Angle of repose for gravel bedding layer = 36°
angle of repose for riprap = 30°
- Interface strength parameters:
 - stone or soil - geotextile (Ref. 1 p. 41) Non-woven = 26°
 - geotextile - smooth HDPE = 9°
- Minimum tensile strength:
 - Gundlach HDPE 80 mil liner = 320 #/in. width (min)
 - geotextile (Mirafi 1120N) = 145 #/in. width (minimum)

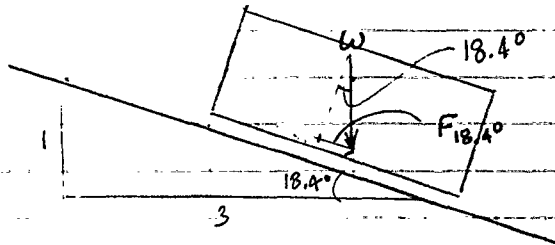
AR004647

① Tensile strength of components



Design weights for 1 sq. ft.:

• subdrain gravel: $120 \text{ #/cf} \times (\frac{6}{12})' \text{ thick} \times \text{length slope} = w$
 where length = $\frac{6'}{\sin 18.4^\circ} = 19'$
 $\therefore w = 1140 \text{ #/ft.}$



component of gravel stress acting along the plane:

$$\sin 18.4^\circ = \frac{w}{F_{18.4}} = \frac{1140}{F_{18.4}}$$

$$\therefore F_{18.4} = 360 \text{ #/ft.}$$

• Total shear on geotextile: $360 \text{ #/ft.} \times \tan(26^\circ) = 175 \text{ #/ft.}$

• geotextile, milti = $\frac{1602 \text{ #/yd} (\text{#/16 oz})}{9 \text{ ft.}^2/\text{yd}} = 0.111 \text{ #/ft.}^2 \times 19' = 2.1$
 $F_{18.4} = 0.66 \text{ #/ft.}$

• HDPE, 80 mil: $\frac{2,240 \text{ #/roll}}{5625 \text{ ft.}^2/\text{roll}} = 0.40 \text{ #/ft.}^2 \times 19' = 7.6$

AR004648

$F_{18.4} = 2.40$

BY S.J.M. DATE 11/20/91

SHEET NO. 3 OF 5

CHKD. BY EWM DATE 11/22/91

JOB NO. 0285-33-2

SUBJECT MILLCREEK CAP & FFB DESIGN

• gabion mattress:

1) stone

$$120 \text{ #/cf} \times (17\frac{1}{2})' \text{ thick} \times 19' \text{ L} = 2,280 \text{ #/LF}$$

$$F_{18.4^\circ} = \sin 18.4^\circ \times 2,280 = 720 \text{ #/LF}$$

$$\text{total shear on geotextile} = 720 \text{ #/LF} \cdot \tan(26^\circ) = 350 \text{ #/LF}$$

TOTAL STRESS ON BOTTOM geotextile is:

$$= F_{18.4^\circ}(\text{gravel}) + F_{18.4^\circ}(2 \text{ geotextile layers}) + F_{18.4^\circ}(\text{HDPE}) + F_{18.4^\circ}(\text{gabion mattress})$$

$$= 175 \text{ #/LF} + (0.66 \text{ #/LF} \times 2) + 2.4 \text{ #/LF} + 350 \text{ #/LF}$$

$$= 529 \text{ #/LF} = 44 \text{ #/inch}$$

TOTAL STRESS ON HDPE is:

$$= F_{18.4^\circ}(\text{geotextile}) + F_{18.4}(\text{mattresses})$$

$$= 2.4 \text{ #/LF} + 350 \text{ #/LF} = 354 \text{ #/LF} = 30 \text{ #/inch}$$

Factors of safety:

$$\text{For geotextile (bottom layer)}: 175 / 44 = 3.3$$

$$\text{For HDPE (80 mil)}: 320 / 30 = 11$$

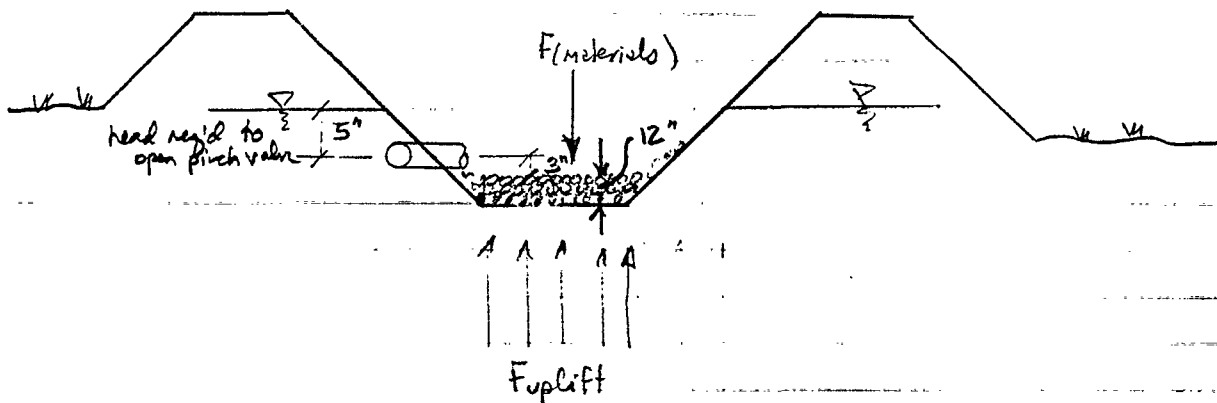
OK

2. Stability of riprap and gravel bedding.

the angle of repose is equal to the angle of internal friction ϕ at the loose surface. For cohesionless soils, Sowers (Geotechnical Engineering, 1970) lists ϕ values of 29° to 45° .

Since the slope of the channel embankment is $18.4^\circ < (29^\circ)$ the material is stable. Reference calculations a factor of safety by H. A. Inc.

3. Uplift Analysis (assuming empty channel)



For prevention of uplift of the HDPE liner, the net force acting down on the liner " $F_{materials}$ " must exceed the buoyant forces

$$F_{uplift} = \gamma \cdot h \cdot A$$

$$\text{where } \gamma = 62.4 \text{ #/cf}$$

$$h = 12" + 3" + 5" = 20" = 1.67'$$

$$A = 10'W \times 1' \text{ length}$$

$$= 62.4 \times 1.67 \times 10' = 1,040 \text{ #/ft length of channel}$$

$$F_{materials} = \text{Gravel materials} \times \text{gravel thickness}$$

$$\text{Gravel: } 120 \text{ #/cf} \times 1' \text{ thickness} \times 10' \text{ width} \times 1' \text{ length} \\ = 1,260 \text{ #/ft length of channel.}$$

AR004650

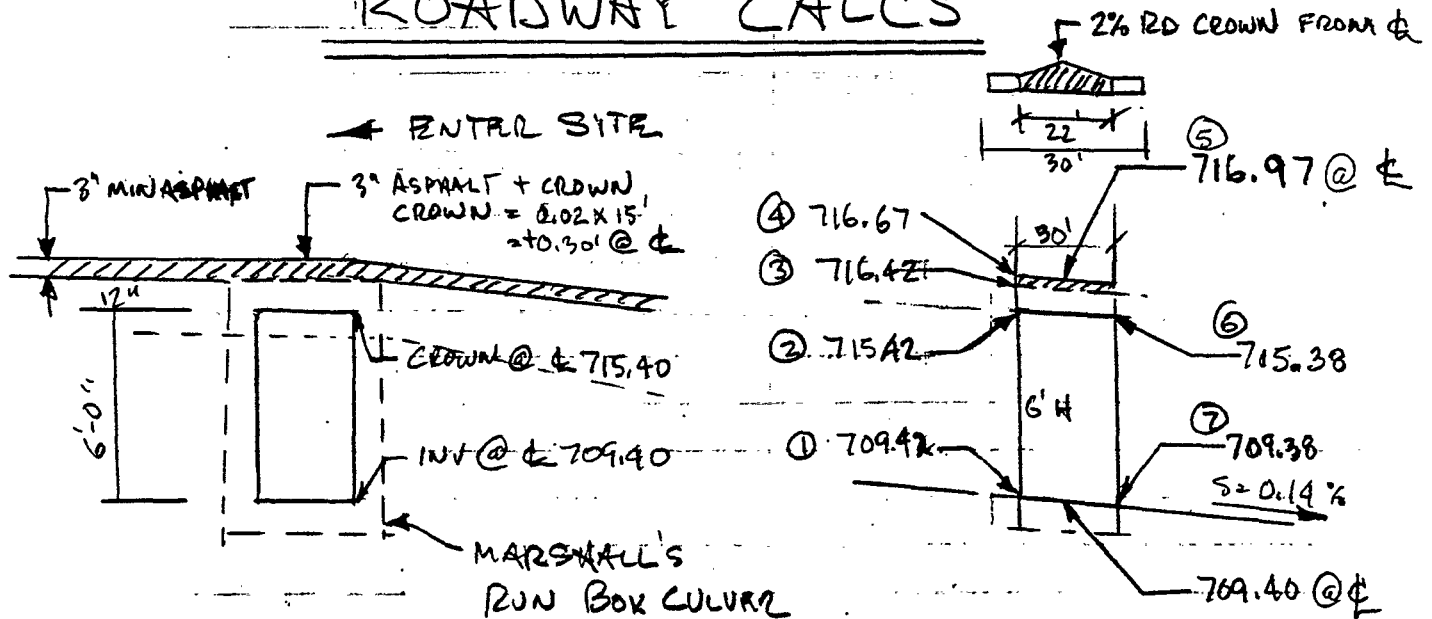
* 5" = head req'd to open pinch valve; by direct AR004650
** add 5' to net a short mound

BY SLM DATE 11/20/91 SHEET NO. 5 OF
CHKD. BY SWM DATE 11/22/91 JOB NO. 0285-33-2
SUBJECT MILLREEL CAP & FRB DESIGN

$$\text{Factor of Safety against uplift} = \frac{1260}{1040} = \underline{\underline{1.21}}$$

AR004651

ROADWAY CALCS



RD. PROFILE

CHANNEL PROFILE

— FROM WATER TREATMENT PLANT ROAD PROFILE —
EXISTING CONDITIONS
 $S = \pm 0.58\%$ From Sta 13+00 to 12+50
ELEV @ 13+00 714.1 ±

$$\therefore \text{ELEV @ } 12+50 = 714.1 - (0.58 \times 50) = 713.81$$

ELEV @ 10+83 (EAST SIDE OF PROPOSED BOX CULVERT)
716.97

$$S \text{ Between } 12+50 \text{ \& } 10+83 = \frac{713.81 - 716.97}{(12+50) - (10+83)} = -1.89\%$$

ELEV @ 0+65 (ENTRANCE TO TREATMENT PLANT)
713.50

AR004652

BY EWM DATE 10/2/91SHEET NO. 2 OF 2

CHKD. BY _____ DATE _____

JOB NO. 0285-33-2SUBJECT MILLCREEK CAP DESIGNELEV @ 10+68 (WEST SIDE OF PROPOSED BOX CULVERT)
716.97

$$S \text{ Between } 10+68 \text{ \& } 0+65 = \frac{716.97 - 713.50}{(10+68) - (0+65)} = +0.34\%$$

VC Between EXIST 17th St. Entrance \& Box Culv.

$$g_1 = -1.89\% \quad g_2 = +0.88\%$$

Intersection @ Station 12+50
elev 713.81

$$L = 100'$$

$$BVC = 713.81 + (0.5 \times 1.89) = 714.76$$

$$EVC = 714.10$$

$$ELEV @ P.I. = \left[\frac{(714.76 + 714.10)}{2} + 713.81 \right] = 714.12$$

BY JPR DATE 10/1/91 SHEET NO. 1 OF 12
CHKD. BY EMM DATE 10/3/91 JOB NO. 0285-33-2
SUBJECT ROADWAY STABILIZATION FABRIC DESIGN
MILLCREEK CAT DESIGN

DESIGN RATIONALE OF FILTER FABRIC FOR ROAD BASE STABILIZATION

There are three major uses for permeable membranes in the field of road construction

1. water drainage
2. Sub-base/sub grade separator in "temporary road" construction
Such as mine haul roads
Site access roads, farm roads etc
3. AS separator at sub-base/sub grade interface or at another interface.

As a separator, the permeable membrane acts to prevent the upward migration of soft subgrade material into the crushed stone of the base course which is caused by dynamic pumping action of vehicles passing over the road. The soft cohesive subgrade materials separates the granular soil particles and effectively reduces the depth of the sub-base course.

Using the combined action of separation and filtration at a membrane/soil interface

AR004654

can result in a reduction in the water content of the original soil resulting in increased shear strength. The filtering action of the membrane allows water to escape from the soil but resists unwanted migration of fines.

One object of laying granular material on top of a wet cohesive sub-grade is that the granular layer spreads the point load of a vehicle tire over a large surface area by means of frictional energy dissipation.

In terms of selection of a particulate type of fabric to accomplish both filtration and separation by use of a fabric membrane, the two general categories of fabric to select from are woven and non-woven fabrics. Woven fabrics generally display the highest strength and lowest extensibility. Non-woven fabrics of the thin film variety have the same strength properties in two directions and have a wide range of pore sizes which is useful in building an effective filter.

From DESIGN STANDPOINT / FABRIC SELECTION
 "DESIGNING WITH GEOSYNTHETICS"
 DERIVES THE FOLLOWING FOR USE OF
 GEOSYNTHETIC MEMBRANE ON "REASONABLY
 FIRM" SOILS BELOW AND STONE
 BASE COURSE ABOVE TO DEMONSTRATE
 SEPARATION DESIGN: FOUR FACTORS IN
 SELECTION

① BURST RESISTANCE

$$p_{\text{test}} = 0.33 d_a p' \text{ in/lb/in}^2$$

p' = pressure forcing geotextile into
voids in the stone base

d_a = average aggregate diameter

p_{test} = burst test pressure

$p' = 0.75 p_a$

p_a = truck tire inflation pressure

for solved example

100#/in² truck tire, 3 in

Stone size (maximum) and

factor of safety of 3.0

from figure 2.14 (attached) burst

strength = 225 psi

② GRAB STRENGTH

$$T = p'(e)^2$$

T = mobilized force

p' = pressure

e = strain of geotextile between
contact points

AR004656

for 100 #/in² inflation pressure, 3" stone
and assuming no slippage and factor
of safety of 2.0, ($e = 75\%$)

$$T = p' (e)^2$$

$$= 0.75 (100 \text{ psi}) (0.75)^2$$

$$T = 42 \text{ lb}$$

$$T_{\text{required}} = 84 \text{ lb grab strength}$$

3) Puncture (Tear) resistance

Tear resistance

$$T_{\text{req'd}} = \pi (d_i - d_a) P' S'$$

$T_{\text{req'd}}$ = required tensile force
in fibers

d_a = average diameter of stone

d_i = initial average void diameter
of geotextile

S' = shape factor = $(1 - S)$ for aggregate

$S = 0.7$ for R.O.B. gravel

$S = 0.4$ crushed stone

$S = 0.3$ for shot rock

$p' = 0.75 p_a$ tire inflation pressure
 $p_a = 135 \text{ psi}$

$F_s = 2.0$

AR004657

Area of No 30 sieve AR004657 in opening

BY JPR DATE 10/1/91SHEET NO. 5 OF 12CHKD. BY gwm DATE 10/2/91JOB NO. 0285-33-2

SUBJECT _____

$$T = (\pi d_i d_e) p' s'$$
$$= \pi (0.0232)(12) 101 (1.0 - 0.7)$$

$$= 26^\#$$

$$T_{ry} = 26^\# (2)$$

$$T = 52^\# \text{ puncture strength}$$

Comparison of values obtained for

①, ②, and ③ above to manufacturers literature indicates the correct geotextile selection for a particular application

	DESIGN	MIRAFI 300X	SUPAC 4WS(UV)
① <u>BOLST RESISTANCE</u>	225 psi	450 psi OK	450 psi OK
② <u>GRAB STRENGTH</u>	84 lb.	200 lbs OK	N/A
③ <u>PUNCTURE (TEAR) RESISTANCE</u>	52 lb.	83 lbs OK	80 lb OK

AR004658

2.3 DESIGNING FOR SEPARATION

2.3.1 Overview of Applications

Specific application areas for geotextiles being used in the separation function were given in Section 1.2.3. There are indeed many specific uses, and one could say in a general sense that geotextiles always serve a separation function. Indeed, if they do not serve this function, the other, usually primary, function will not be served properly. This should not give the impression that geotextiles as separators always play a secondary role. Many situations call for separation only, and in such cases the fabrics do indeed serve a noble function.

Perhaps the target application which can best illustrate the use of geotextiles as separators is its placement between reasonably firm soils below it and stone base course, aggregate, or ballast above it. We say "reasonably firm" because it is assumed that the subgrade deflection is not sufficient to mobilize significant tensile stress in the fabric. (The application of geotextiles in unpaved roads on soft soils wherein membrane-type reinforcement is developed is treated in Section 2.4.1.) Thus for the separation function the fabric has only to be placed on the site and the stone dumped, spread, and compacted above it. A number of scenarios can be developed showing what required fabric properties are required for a given situation.

2.3.2 Burst Resistance

Consider a geotextile on a soil subgrade with stone of average particle diameter (d_s) placed above it. If the stone is uniformly sized, there will be voids within it that will be available for the fabric to enter into. This entry is caused by the simultaneous action of the traffic loads being transmitted to the stone, through the fabric, and into the underlying soil. The stressed soil then tries to intrude the fabric up into the voids in the stone. The situation is shown schematically in Figure 2.13. The analogy is quite similar to the (Mullen) burst test (ASTM D774) which has the fabric being stressed into a gradually increasing hemispherical shape until it fails in radial tension. The test is described more fully in Section 2.1.3.4.

Using the scenario shown in Figure 2.13, the following relationship can be developed:

$$p'd_v = p_{\text{test}}d_{\text{test}} \quad (2.18)$$

where p' = pressure forcing the geotextile into the void

d_v = maximum void diameter

p_{test} = burst test pressure

d_{test} = burst test diameter (= 1.2 in. in the Mullen burst test)

In equation (2.18) we use the tire inflation pressure (p_s) as the driving force in the equation and reduce it slightly as it is dissipated through the thickness of the stone base course (e.g., $p' \sim 0.75p_s$). If the stone base thickness is known, this can be more accurately treated using layered elasticity theory [30]. Also needed for a solution is the void diameter, which will be assumed to be $d_v = 0.4d_s$, where d_s is the average aggregate

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SOURCE: "DESIGNING WITH GEOSYNTHETICS"
Robert M. Koerner, PhD, P.E.
Prentice Hall, 1986

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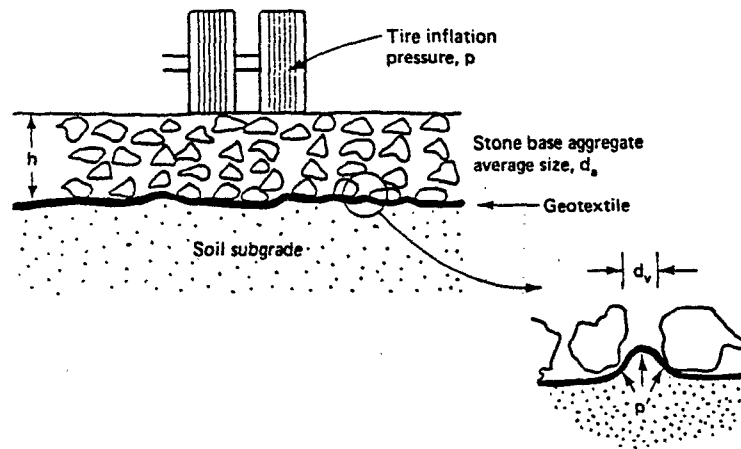


Figure 2.13 Geotextile being forced up into voids of stone base by traffic tire loads.

diameter. Thus the equation above can be rewritten as follows:

$$p'(0.4d_s) = p_{\text{test}}(1.2)$$

$$p_{\text{test}} = 0.33d_s p' \quad (\text{in lb/in.}^2)$$

This equation has been solved for a number of pressure values (from 50 to 150 lb/in.²) and for a number of stone aggregate sizes (from 0.5 to 12 in.) as shown in Figure 2.14. The following example illustrates the use of the curve in a design manner.

Example: Given a 100-lb/in.² truck tire inflation pressure on a uniformly graded stone base course consisting of 3-in. maximum-size stone. What is the required burst strength of the geotextile assuming a factor of safety of 3.0?

Solution: Using the approximate relationship of $p' = 0.75p_s$ gives $p' = 75 \text{ lb/in.}^2$. Now from the intersection of the 75 lb/in.² tire inflation and 3-in. aggregate size curve, one obtains a burst pressure of 75 lb/in.². For a factor of safety of 3.0, the required burst pressure is 225 lb/in.². Geotextile manufacturer's literature must be consulted to compare this to the actual value.

Note that the example assumes uniformly sized stone. With well-graded stone the aggregate voids become much smaller and the required burst pressure becomes proportionately reduced.

2.3.3 Tensile Strength Requirement

Continuing the general problem just addressed, there is another action also acting on the fabric at the same time as a tendency to burst. This is one of tensile stress being mobilized by in-plane deformation. The geotextile is locked into position by the aggregate above it and the soil below it. As an upper piece of aggregate is forced between two lower pieces (these being adjacent to the fabric), a lateral, or in-plane, stress will be imposed. See Figure 2.15, where an analogy to the grab tension test can readily be visualized. Here one can estimate the maximum strain that the fabric will undergo as the

AR004660

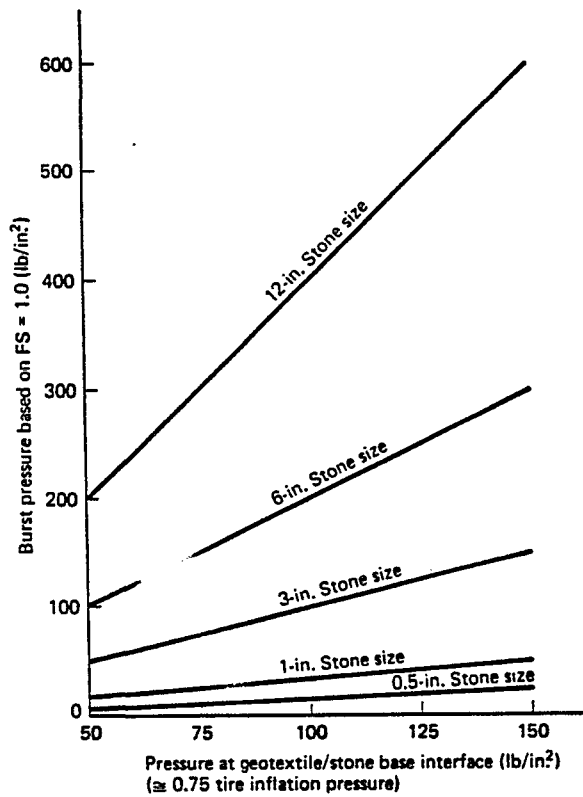


Figure 2.14 Design guide for burst analysis of geotextile used in a separation function.

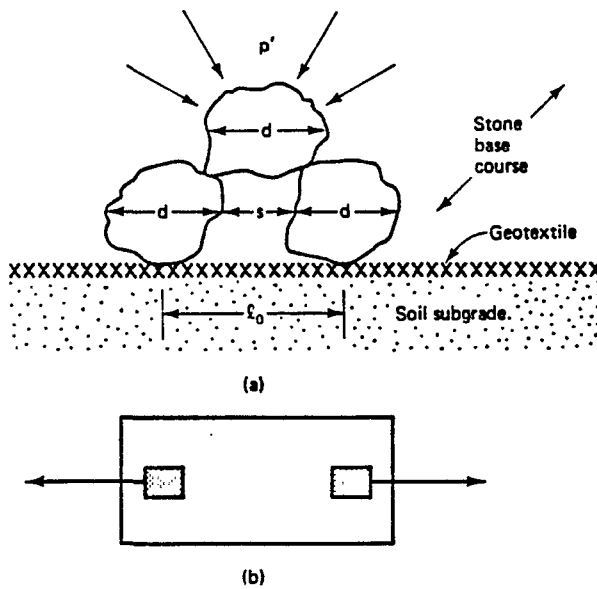


Figure 2.15 Geotextile being subjected to tensile (grab) stress as surface pressure is applied and stone base tends to spread laterally. (a) Actual situation; (b) analogous grab tension test.

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upper stone wedges itself down to the fabric. Using the dimensions shown (where $S \sim d/2$), the strain can be

$$\begin{aligned}\epsilon &= \frac{l_0}{l_f} \left(\frac{d/2}{2(d/2)} \right) (100) \\ &= \frac{1.5d}{2.0d} (100) \\ &= 75\%\end{aligned}\quad (2.19)$$

Note that the assumptions above result in a strain that is independent of particle size. Thus the strain in the fabric could be as high as 75%, assuming no stone-to-fabric slippage of the two stones being wedged aside as the upper stone forces its way between them. Now the tensile force being mobilized is related to the pressure exerting on the stone as follows [31]:

$$T = p'(\epsilon)^2 \quad (2.20)$$

where T = mobilized tensile force

p' = pressure

ϵ = strain of the geotextile between contact points

To illustrate the design procedure of the situation above, the following example is given.

Example: Given a 100-lb/in.² truck tire inflation pressure on a stone base course of 3-in. maximum size with a geotextile beneath it. Calculate the maximum grab tensile stress on the geotextile assuming that no slippage between the fabric and stone will occur. Since this is a very conservative assumption, a factor of safety of 2.0 is adequate.

Solution: As shown, the strain in the fabric will be 75% and using $p' = 0.75p_s$,

$$\begin{aligned}T &= p'(\epsilon)^2 \\ &= (0.75)(100)(0.75)^2 \\ &= 42 \text{ lb}\end{aligned}$$

and for FS = 2.0,

$$T_{\text{required}} = 84 \text{ lb}$$

For the problem chosen with a 3-in.-diameter stone size, the "grip" on the fabric will be in the center third, or approximately 1 in., which is exactly the dimensions of the grab test itself (recall Section 2.1.3.2). Thus one needs a fabric of grab strength 84 lb or greater.

If smaller stone had been used and the "grip" on the fabric was less than 1 in., the required grab strength would have had to be proportionately larger. Conversely, with larger stone there is a reduction in required grab strength.

2.3.4 Puncture (Tear) Resistance

Although not only related to the separation function, the geotextile during its placement must survive the installation process. Indeed, fabric survivability is critical in all types of applications; without it, the best of designs are futile. In this regard, sharp stones, tree stumps, roots, miscellaneous debris, and so on, on the ground beneath the geotextile present a problem for puncturing through the fabric after stone base and traffic loads are imposed above it. The design method suggested for this situation is shown schematically in Figure 2.16. For these conditions, the vertical force exerted on the geotextile

AR004662

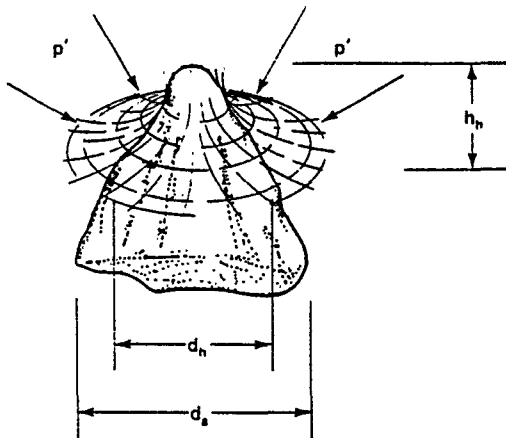
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Figure 2.16 Visualization of a stone puncturing a geotextile as pressure is applied from above.

(which is gradually tightening around the object) is as follows:

$$F_{\text{vert}} = [(\pi d_h)(h_h)p']S' \quad (2.21)$$

where F_{vert} = total vertical force imposed on the fibers adjacent to the puncture

d_h = average diameter of the hole, where $d_h(\text{maximum}) = d_s$

d_s = average diameter of the aggregate (or stump, etc.)

h_h = propagation height ($\approx d_s$)

p' = pressure exerted on the geotextile (≈ 0.75 tire inflation pressure or equal to the embankment pressure)

S' = shape factor varying from zero for rounded blunt objects to 1.0 for sharp angular objects [For aggregate particles it can be assumed to be $(1.0 - S)$, where S is the sphericity, from $S = A_p/A_c$, A_p is the projected area of the particle, and A_c is the area of the smallest circumscribing circle around the particle; typical values of S are 0.8 for Ottawa sand, 0.7 for run-of-bank gravel, 0.4 for crushed rock, and 0.3 for shot rock]

This vertical force must now be converted into a tensile force in the fibers of the geotextile. To be sure, it is a complex problem, since both radial friction and axial rotation of the fibers against the protrusion are involved. As an approximation, however, we can use

$$\frac{F_{\text{vert}}}{T_{\text{reqd}}} = \frac{d_s}{d_i} \quad (2.22)$$

where F_{vert} = total vertical force on fibers

T_{reqd} = required tensile force in fibers

d_s = average diameter of the stone

d_i = initial average void diameter of geotextile

Combining equations, with the assumptions noted above, one obtains

$$\begin{aligned} T_{\text{reqd}} \left(\frac{d_s}{d_i} \right) &= (\pi d_s^2 p') S' \\ T_{\text{reqd}} &= (\pi d_i d_s) p' S' \end{aligned} \quad (2.23)$$

AR004663

This value of T_{reqd} can be compared to the puncture test (if the object is blunt, causing puncture) or to the tear test (if the object is sharp, causing tear). Both types of tests were described in Section 2.1.3.

Using some assumptions (which can be modified as described) a design guide can be developed as shown in Figure 2.17. It was developed on the basis that the geotextile had an initial opening size of 0.06 mm (= 0.00236 in.) and the protruding stones had a sphericity of 0.4. Thus

$$T_{\text{reqd}} = (0.00236\pi d_a)p'(1 - 0.4) \\ = 0.00445d_ap'$$

Example: What is the required puncture resistance of a woven geotextile of AOS = No. 30

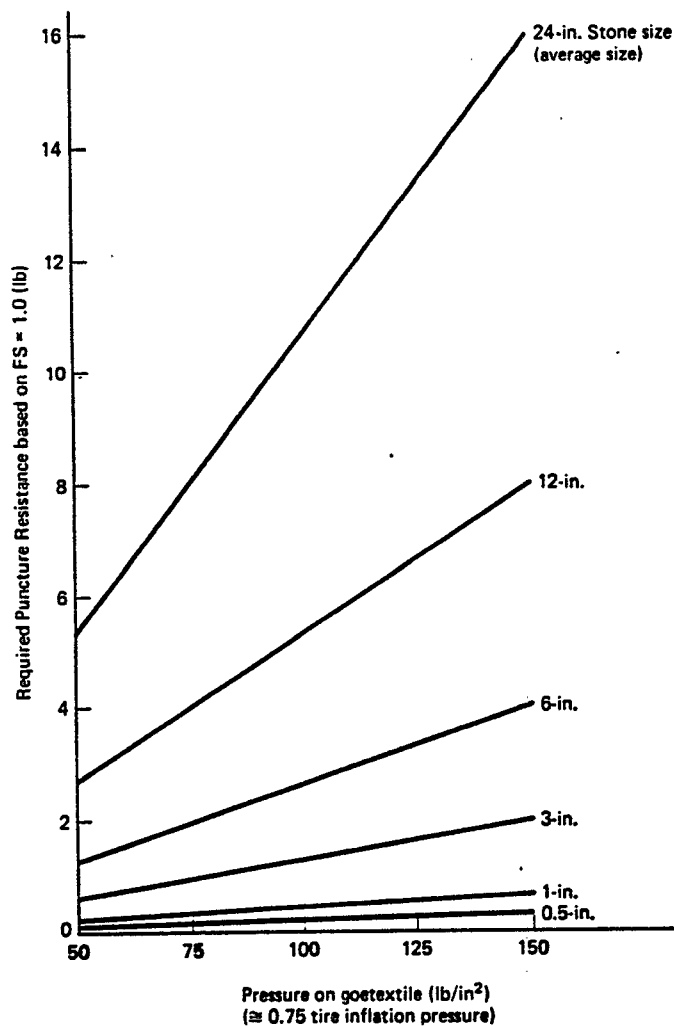


Figure 2.17 Typical puncture resistance design guide.

AR004664

12/15

sieve, on a 12-in. rock of sphericity 0.32? Trucks with tire inflation pressure of 135 lb/in.² will be on the stone base above the fabric. Use FS = 2.0.

Solution: Using the stress on the fabric of $p' = 0.75p_s$,

$$\begin{aligned} p' &= 0.75(135) \\ &= 101 \text{ lb/in.}^2 \end{aligned}$$

and a No. 30 sieve = 0.0232-in. openings,

$$\begin{aligned} T_{\text{reqd}} &= (\pi d_s) p' S' \\ &= \pi(0.0232)(12)(101)(1.0 - 0.32) \\ &= 60 \text{ lb} \\ T_{\text{reqd}} &= 60(2.0) \\ &= 120 \text{ lb} \end{aligned}$$

This value is now to be compared to the puncture strength of the candidate geotextile. It should be noted that many geotextiles do not have 120 lb puncture resistance, thus illustrating the severity of this example.

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**MALCOLM
PIRNIE**

APPENDIX O

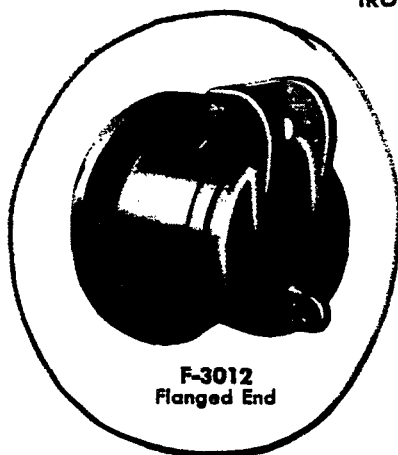
MISCELLANEOUS CATALOG INFORMATION

0285-33-2

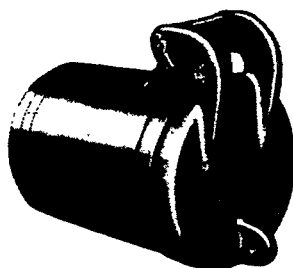
AR004666

FLAP VALVES

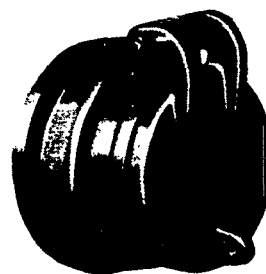
IRON BODY, BRONZE MOUNTED
4' THRU 30'



F-3012
Flanged End



F-3014
Spigot End

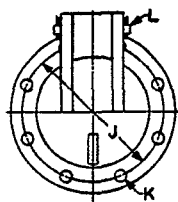


F-3016
Hub End

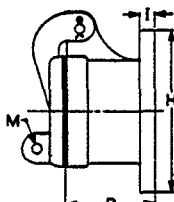
Eddy-Iowa Flap Valves are used for end closure of outfall lines, or in manholes, to prevent entrance of backwater. They swing open under direct pressure to release the outfall fluid and close tightly when the direct pressure is relieved. Back pressure serves to hold the valve tightly against its seat.

Eddy-Iowa Flap Valves are used in filtration and sewage disposal plants and in various industrial installations. 4- thru 12-inch valves may be of all iron construction, but are regularly furnished fully bronze mounted, with bronze hinge pin, flap ring, and seat ring. Flap valves are available in sizes 4 thru 30 inches.

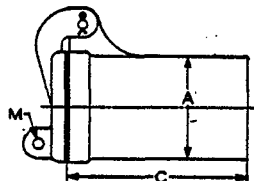
DIMENSIONS



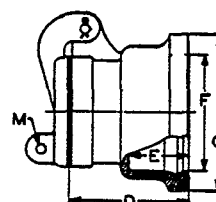
End
View



F-3012
Flanged End



F-3014
Spigot End



F-3016
Hub End

Dimensions—Inches

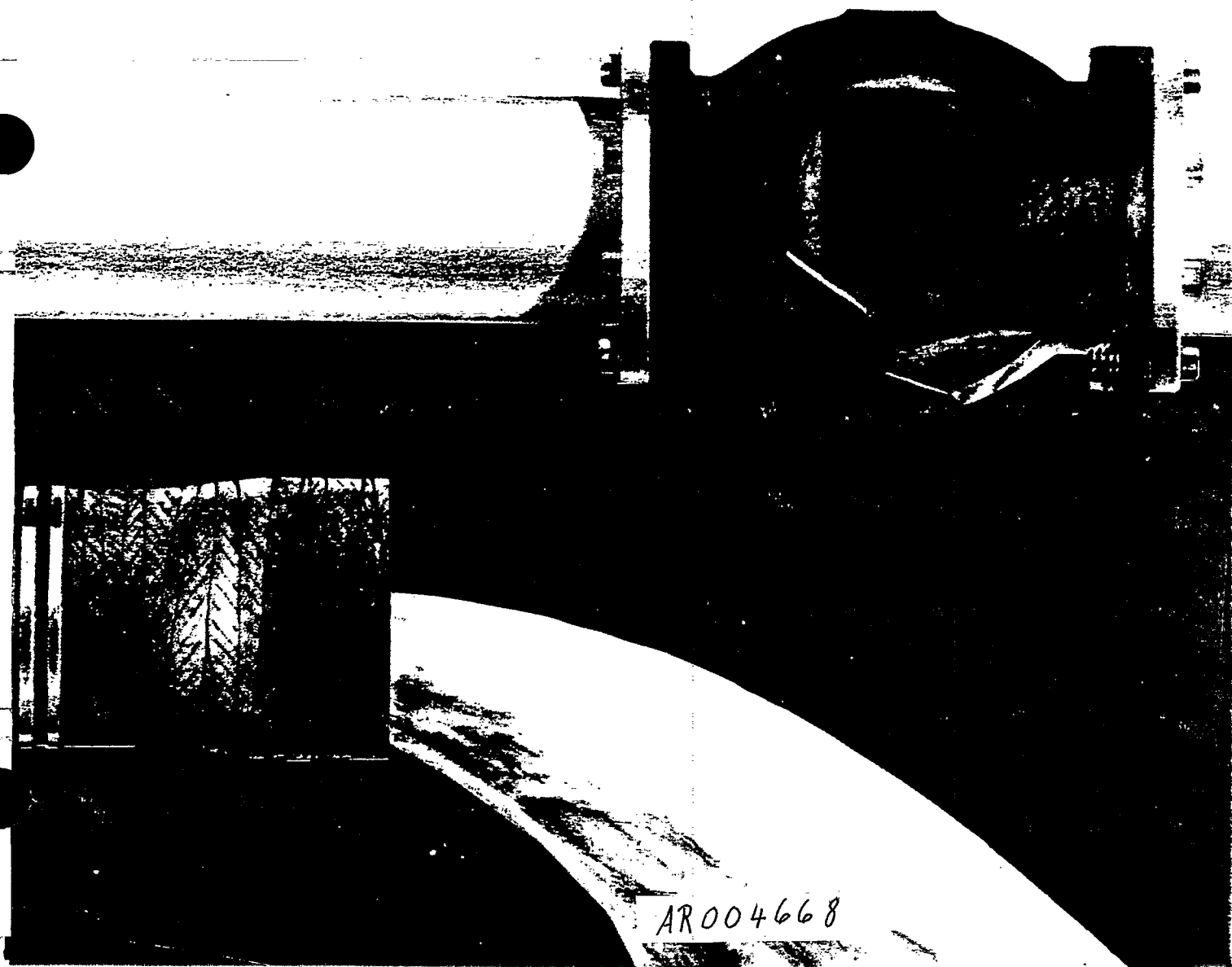
Valve Size.....Inches	4	6	8	10	12	14	16	18	20	24	30
A Outside diameter of spigot	4 7/8	7	9	11 1/4	13 3/8	15 3/8	17 1/2	19 1/2	21 1/2	25 3/4	31 3/4
B Face of seat to face of flange	4	6	8	8	8	10	10	10	10	10	10
C Face of seat to end of spigot	12	12	12	12	12	12	12	12	12	12	11
D Face of seat to end of hub...	8	8	8	8	8	10	12	12	12	15	...
E Depth of hub.....	4	4	4	4	4	4	4	4	4	4	...
F Inside diameter of hub.....	5 3/4	7 7/8	10	12 1/8	14 1/4	16 3/8	18 1/2	20 1/2	23	27 1/4	...
G Outside diameter of hub...	8	10 3/4	12 7/8	15	17 1/2	19 1/2	21 3/4	23 3/4	27 1/4	31 1/8	...
H Diameter of end flange....	9	11	13 1/2	16	19	21	23 1/2	25	27 1/2	32	38 3/4
I Thickness of end flange....	3/4	7/8	1	1	1 1/8	1 1/4	1 1/4	1 1/4	1 1/8	1 1/2	1 1/2
J Diameter of bolt circle....	7 1/2	9 1/2	11 3/4	14 1/4	17	18 3/4	21 1/4	22 3/4	25	29 1/2	36
K Number and size of bolts...	8-5/8	8-3/4	8-3/4	12-7/8	12-7/8	12-1	16-1	16-1 1/8	20-1 1/8	20-1 1/4	28-1 1/4
L Diameter of flap pin (bronze)	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1	1	1 1/4
M Diameter of flap lug hole...	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1	1	1

Flanges are faced and drilled to ANSI 125 pound template, unless otherwise instructed.

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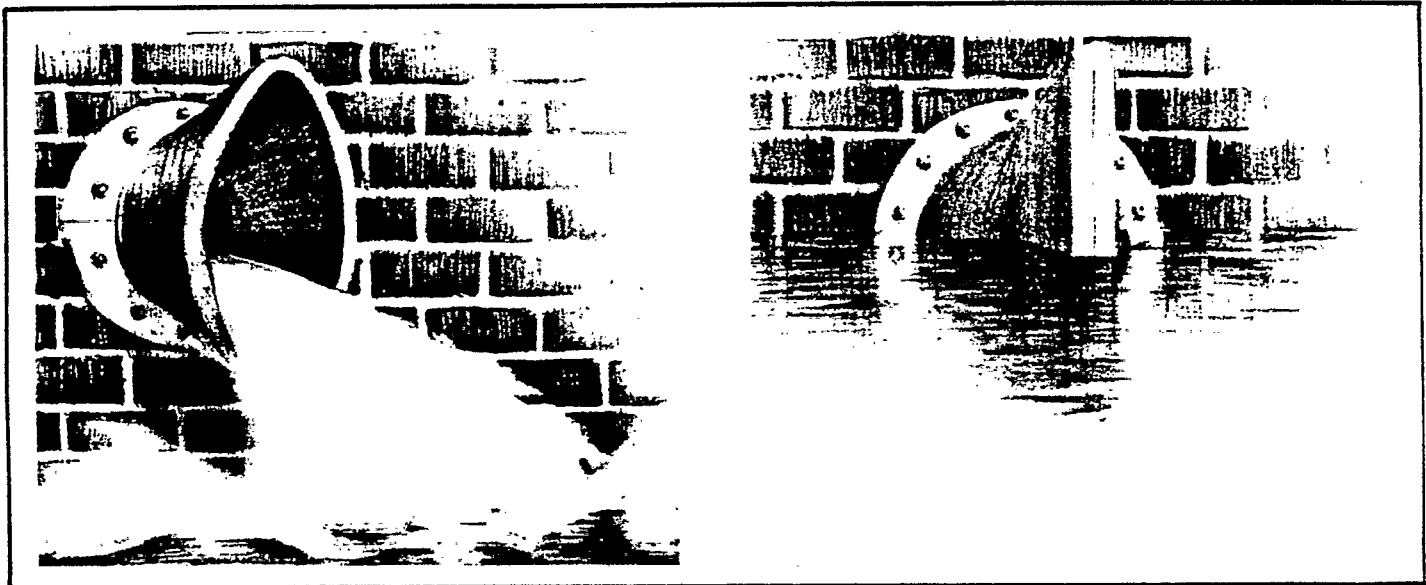
RED VALVE

Check Valves



CHECK VALVES

CHECK VALVES THAT REVOLUTIONIZE BACKFLOW PREVENTION

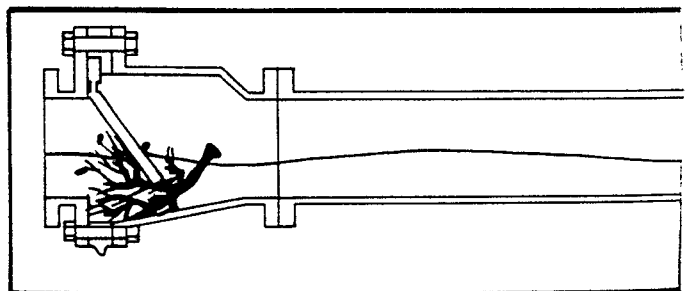


TIDE-FLEX® AND SERIES "33" Red Valve's Check Valves are designed for handling the backflow of liquids, slurries, and gases. The valves are totally passive devices requiring no outside energy source for operation or maintenance. Red Valve Check Valves operate solely on line back pressure. Sliding, rotating, swinging, springs, and plunging parts are not needed. The valves are constructed entirely of rubber enabling them to seal around debris in the line. The unique one piece design of Red Valve Check Valve sleeves enables the valve to open with low line pressure, yet withstand great amounts of back pressure without slamming. Red Valve Check Valves are the most effective method of preventing backflow from entering combined sewer systems.

LOW MAINTENANCE Advantages are endless with Red Valve Check Valves. Any industry needing the prevention of backflow can benefit from Red Valve's rubber check valve design. Since the rubber check sleeve allows closure over debris caught in the line, blockage, common to conventional gate valves, is eliminated. Red Valve Check Valves have no metal parts that can freeze open or shut making them excellent replacement parts for ineffective tide gate and flapper style check valves. Overall, Red Valve Check Valves require **no maintenance** or repair and are substantially more cost efficient.

LOW HEAD LOSS Pumping dollars are reduced with Red Valve Check Valves. In a recent independent laboratory study, Red Valve Check Valves tested as having significantly lower head loss than the best swing check valve. Low head loss allows for substantial savings in pumping costs. (See graphs on page 7)

NON-SLAMMING Loud slamming generally occurs with typical swing check valves because of rapid flow reversal. Regardless of valve size and flow velocity, Tide-Flex Valves are silent due to their unique duck-billed rubber design. They are flexible enough to open on 2 inches of line pressure, yet able to withstand up to 150 psi of back pressure and the turbulent waters of high tides or flash floods.



Conventional check valves clog.

TESTING A critical phase of manufacturing this unique product is testing. Each valve is hydraulically tested prior to shipment to verify that the valve will open with the stated line pressure and will withstand the required back pressure. Due to the operating principle of this valve, it is therefore imperative that when ordering, both the line and back pressure required are stated.

APPLICATIONS Because of the unique all-rubber construction, Red Valve Check Valves are able to handle a wide variety of applications and many diverse media:

Media

- Heavy Slurry
- Raw Sewage
- Industrial Waste
- Brine and Salt Water
- Lime Systems
- Ash Handling
- Mud Slurry
- Bottom Ash
- Caustic Slurry

Applications

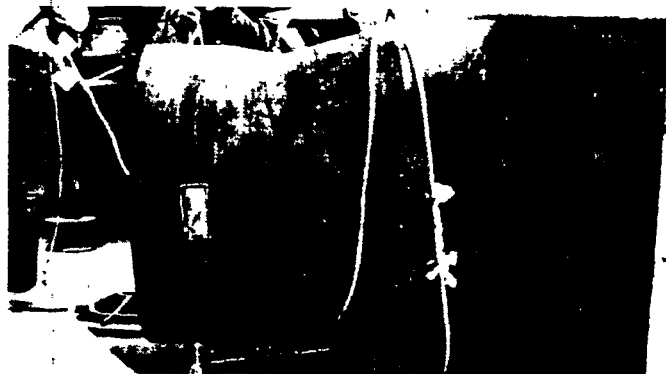
- Municipal Sewer Interceptors
- Industrial Outfall Lines
- Discharge Side of Pumps
- Wet Wells
- Wet/Dry Wells
- Tailing Systems
- Scrubber Systems
- Water Dredging

FEATURES

- Seal on Entrapped Solids
- Lowest Head Loss
- Full Flow
- 100% Shut-off at 1 PSI
- Installed in any position
- Silent, Non-slamming; Energy Absorbing
- Maintenance Free; Only 1 Part
- Wide Variety of Materials for Abrasive and Corrosive Environments

Each Red Valve Check Valve is built to customer specifications. Through choice of elastomers and hardness variations, valves can be contoured to accommodate a wide range of sizes and back pressures. Valves can be installed in any horizontal or vertical position. Red Valve manufactures two styles of check valves; the Tide-Flex for outfall lines, and the Series "33" for in-line service.

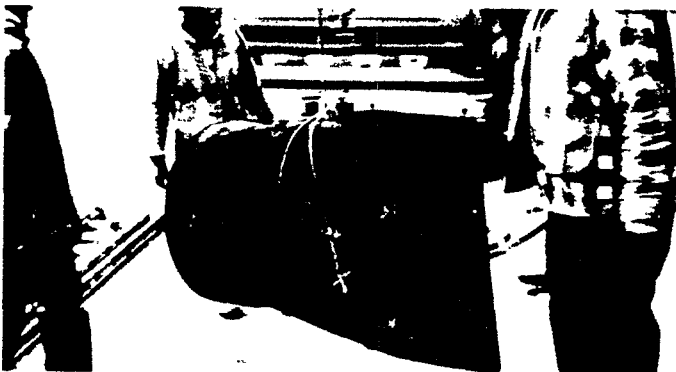
The basic function of a check valve is quite simple: to allow flow through in one direction and to "check" flow in the other. Red Valve Check Valves accomplish this role expertly and cost effectively due to their sleeve design. Problems such as slamming, high head loss, and high maintenance costs inherent of hinged valve designs, are all eliminated with Red Valve's revolutionary Check Valves; the Tide-Flex and Series "33".



Tide-Flex Check Valve being installed in Boston.



New York's 54" Tide-Flex as interceptor discharge valve.



Installation of Fort Lauderdale's Red Valve Tide-Flex.



Installed Tide-Flex in Vancouver.

AR004670

TIDE-FLEX[®]

Tide-Flex[®] CHECK VALVE

The Tide-Flex Check Valve is Red Valve's slip-on rubber check valve manufactured in sizes 1/2" to 120". A three year development program resulted in this revolutionary back-flow prevention device.

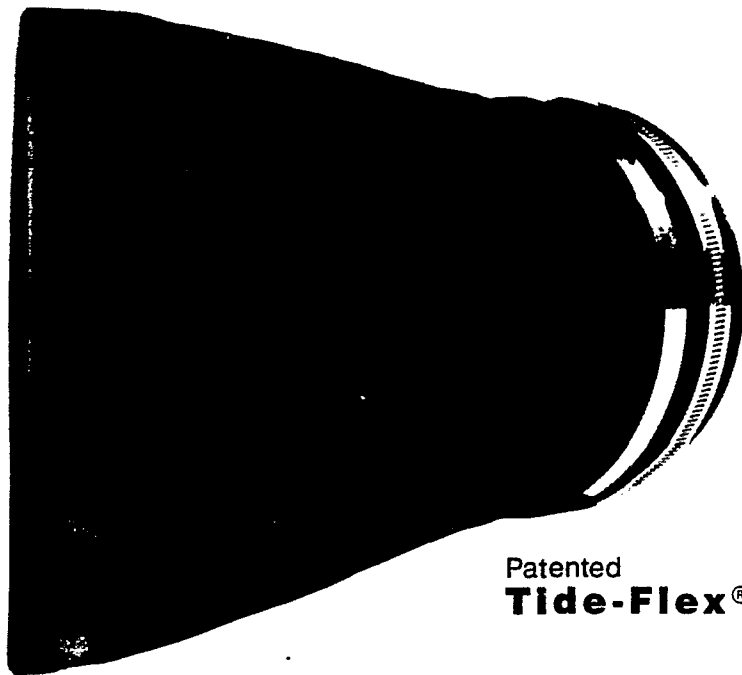
The Tide-Flex is maintenance free and is able to seal tightly around entrapped solids. It can open with as little as 2 inches of water in a combined sewer. Yet the Tide-Flex is sturdy enough to withstand up to 150 feet of back pressure from tides and the pounding of ocean waves.

Traditionally, tide gate valves were employed to protect collector sewers and interceptors from the inflow of tidal or high river-stage waters. Without such control devices, backflows surcharge collector sewers causing flood conditions, flooding of interceptors, pumping stations, and treatment plants. This adversely affects the sewage treatment process and the capacity of the drainage system.

There are several problems with the types of tide or flood gates currently in use such as failure to close tight (because of debris blockage, warpage, and corrosion), a tendency to get stuck in one position, and the need for regular maintenance. Poor tide gate performance results in higher treatment costs, treatment plant upsets, greater pollutional loads due to downstream overflows and plant bypassing, and flooding in upland tributary drainage areas. Municipalities try to maintain them, but maintenance is expensive and time consuming. Therefore, there is a genuine need for Red Valve Company's all rubber Tide-Flex Check Valve to overcome the problems described.

The Red Valve Company's Tide-Flex Check Valve is a totally passive device requiring no outside energy source to operate and is virtually maintenance free.

The all rubber construction of the Tide-Flex allows the valve to operate in this fashion. Neoprene with an EPDM cover is normally furnished. Pure Gum Rubber, Hypalon, Butyl, Buna N, Food Grade Elastomers, and Viton can also be supplied. The Tide-Flex utilizes two metal clamps to connect it to the outfall line.



Patented
Tide-Flex[®]

Specifying information on line pressure to open the valve in the direction of flow as well as the back pressure the valve will withstand, must be stated when ordering.

Available Elastomers

NEOPRENE is non-deteriorating when exposed to oil and grease and is also resilient to moderate chemicals, ozone, fats, and hydrocarbons.

EPDM is effective on steam, water, and diluted acids.

PURE GUM RUBBER has excellent resiliency, tensile strength, and is abrasive resilient. Effective on weak chemicals, organic acids, alcohols, and ketones.

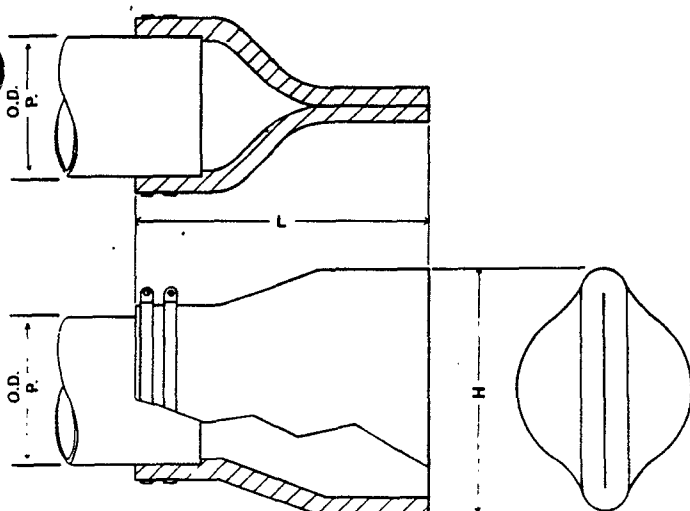
HYPALON is resistant to heat, ozone, weathering, oxidizing chemicals, and strong acids.

BUTYL is resistant to animal and vegetable fats, oils, greases, strong and oxidizing chemicals, and heat.

BUNA N is resistant to many hydrocarbons, fats, oils, grease, kerosene, and moderate chemicals.

VITON resists ozone, oils, chemicals, solvents and halogenated hydrocarbons, oxygen, and weathering.

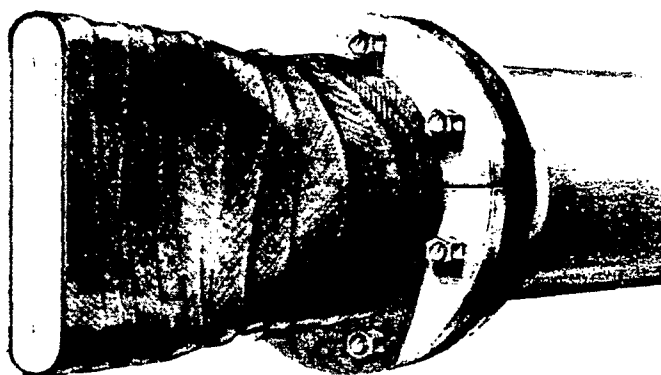
SPECIFICATIONS Series ~~FP-2~~ Tideflex Check Valves are to be all rubber and of the flow operated check type with a slip-on end connection. Inlet port areas shall be 100% of the mating pipe port size. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. The check valve is designed to slip over the specified pipe outside diameter. The flexible duckbill sleeve shall be one piece rubber construction with fabric reinforcement. The check valve shall also have a protective EPDM exterior wrapping for protection against sunlight attack. Check valves shall be attached to the pipe outside diameter by means of vendor furnished clamps. Company name, plant location, and valve size and serial number shall be bonded to the check valve.



SIZE (NOM.)	PIPE O.D. P.	MAXIMUM LENGTH L	MAXIMUM HEIGHT H
1/2"	.840	2 1/2"	1 5/32"
3/4"	1.050	2 3/4"	1 7/8"
1"	1.315	3"	2"
1 1/4"	1.660	3 1/4"	2"
1 1/2"	1.900	4"	2 13/16"
2"	2 3/8"	6"	3 3/4"
2 1/2"	2 7/8"	6 1/2"	4 9/16"
3"	3 1/2"	7"	5 1/4"
4"	4 1/2"	13"	7 1/8"
6"	6 5/8"	16"	10 3/8"
8"	8 5/8"	18"	13"
10"	10 3/4"	20"	13 3/4"
12"	12 3/4"	21 3/4"	17 7/8"
14"	14"	19"	19"
16"	16"	24"	22 7/8"
18"	18"	27 1/4"	26 3/4"
20"	20"	27 1/4"	26 3/4"
24"	24"	41 1/4"	36"
30"	30"	36"	43 3/4"
36"	36"	46"	52"
42"	42"	48"	52"
48"	48"	54"	71 3/8"
54"	54"	90 1/2"	70 3/4"
60"	60"	72"	78"
72"	72"	75"	106"
84"		96"	114"
96"		108"	130"
108"		124"	148"
120"		140"	164"

Series 35

For applications requiring a flanged construction, The Series "35" is available. Identical in design to the Tide-Flex, dimensions and price information can be obtained by consulting the Factory. (See page 6)



AR004672

SERIES 33

Series 33 CHECK VALVE The Red Valve Series "33" Check Valve is designed for handling the backflow of fluids, solids, and slurries.

The in-line Series "33" Check Valve is simple in design. There are only two parts; body and rubber check sleeve. Sliding, rotating, swinging, and spring parts are not required. The valve is maintenance-free.

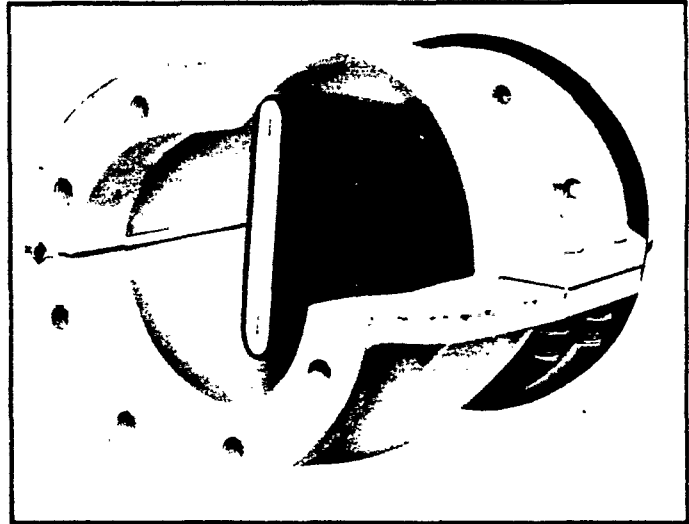
Series "33" Check Valves can be installed in any horizontal or vertical position. There is no slamming when the valve closes against backflow. The Valve seals completely around solid objects making it ideal for handling fly ash, raw sewage, and sludge applications.

Series "33" check sleeves are available in Neoprene, Pure Gum Rubber, Hypalon, Butyl, EPDM, Buna N, Food Grade Elastomers, and Viton. Standard valve bodies are Cast Iron or Aluminum. Stainless Steel and Ductile Iron are also available. Bodies can be rubber lined for more severe applications.

Flange size, facing, and drilling conform to the ANSI B 16.1, Class 125# Cast Iron Fittings. Flushing connections are furnished on both top and bottom.

Available in sizes 1' to 36", Red Valve Series "33" Check Valves have been in service for over 17 years, and are finding wider applications in all industries.

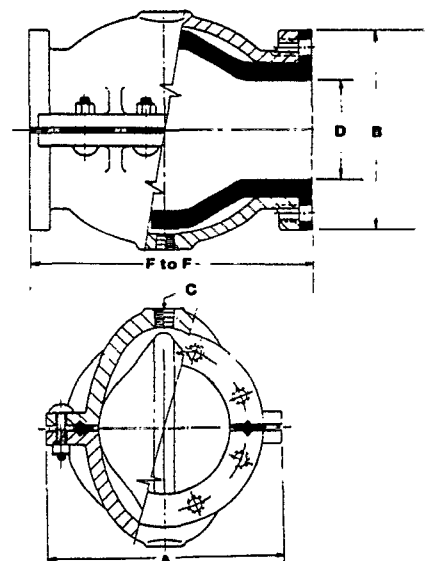
Series 35 CHECK VALVE The Series "33" can be furnished without a housing for applications where the check valve is either discharging into a tank or an open stream. It can be furnished complete with steel backup rings for bolting to the adjoining pipe. Flanges, working pressures, and sleeve materials are identical to those shown for the Series "33" Check Valve.



SPECIFICATIONS Valves are to be of the flow operated check type with flanged joint ends on both check sleeve and metal body. Port areas shall be 100% of the mating pipe port area. The port area shall contour down to a duckbill which shall allow passage in one direction of flow and prevent reverse flow. The flexible duckbill sleeve shall be one piece construction with one flange drilled to ANSI 125# standard. The duckbill check tube shall also be Nylon reinforced with an exterior wrapping of 1/8" thick Neoprene. Valve body shall be drilled and tapped for a flushing connection on top and bottom of the housing. Valve body shall be two piece split body construction. The two halves shall be sealed by diamond shaped cross section rubber gasket permanently locked by a groove machined in the valve body. Company name and location shall be cast onto the valve body.

VALVE SIZE "D"	LENGTH F TO F	WIDTH "A"	HEIGHT "B"	FLUSH CONN. "C" (N.P.T.)	WORKING PRESSURE (P.S.I.)	MAXIMUM BACK PRESSURE (P.S.I.)	WEIGHT CAST IRON (LBS.)
1"	4 1/2"	5 3/4"	4 1/4"	1/4"	125	100	8
1 1/2"	6 1/2"	6 1/2"	5"	1/4"	125	100	16
2"	8 1/2"	7 3/8"	6"	1/4"	125	100	30
2 1/2"	9 1/2"	8"	7"	1/4"	125	100	38
3"	11 1/4"	8 1/2"	7 1/2"	1/4"	125	100	53
4"	11 3/4"	9 7/8"	9"	1/4"	100	100	80
6"	19"	15 1/4"	11"	1/4"	75	75	163
8"	21"	16 1/4"	13 1/2"	1/4"	75	75	233
10"	23"	19 3/8"	16"	1/4"	75	50	425
12"	25"	22 3/4"	19"	1/4"	75	50	640
14"	29"	24"	21"	1/2"	50	50	780
16"	33"	25"	23 1/2"	1/2"	50	50	910
18"	37 1/2"	28 3/4"	25"	1/2"	50	25	1275
20"	41 1/2"	31 1/2"	27 1/2"	1/2"	50	25	1704

- Consult factory for sizes 24" through 36"
- All flanges have A.N.S.I. 125/150 Flange Drilling Dimensions



AR004673

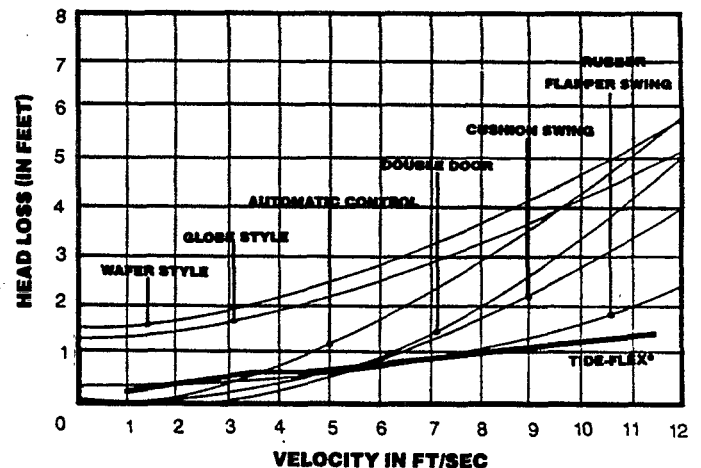
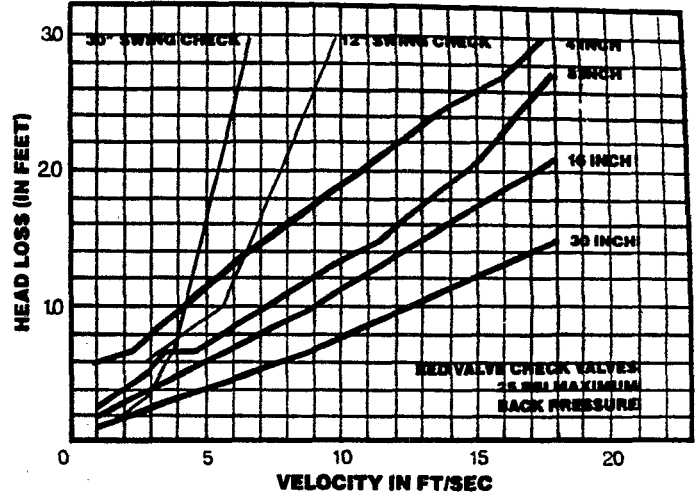
ENGINEERING DATA

RED VALVE CHECK VALVES HAVE LOWEST HEAD LOSS

HEAD LOSS Low head loss is an inherent benefit of all Red Valve Check Valves. Flow tests conducted by an independent research laboratory resulted in the head loss graph at top right. For all velocities and all flow rates, Red Valve Rubber Check Valves prove to have significantly lower head loss than conventional check valves. Plotted are Red Valve's 4", 8", 16", and 30" check valves shown in reference to conventional 12" and 30" swing check valves. Not only is head loss consistently lower with all Red Valve Check Valves, but as valve size increases, head loss decreases.

When compared to a variety of conventional check valves, Red Valve Check Valves continue to have the lowest reported head loss. The bottom right chart illustrates this. It is based on 6" size valves.

Red Valve's maintenance free, non-slamming, rubber Check Valves are cost efficient due to their low head loss. Less pumping is required of valves with low head loss. Therefore, pumping costs are substantially reduced with Red Valve Check Valves.



TEAR HERE

ORDERING INFORMATION MUST INCLUDE BACK PRESSURE

Maximum Back Pressure _____

Flow Rate _____

Line Pressure _____

Please Quote to me on: _____

SIZE

Name _____

Title _____

Company _____

Address _____

City _____

☐ Have salesman call

☐ Please send me complete information in:

CATALOGS

☐ Control Pinch Valves

☐ Manual Pinch Valves

☐ Knife Gate Valves

☐ WWTP Valve

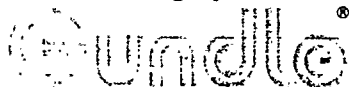
☐ Engineering Handbook

☐ Other _____

Phone _____

State _____

Zip **AR004674**



GUNDLIN[®] HD is a high quality formulation of High Density Polyethylene containing approximately 97.5% polymer and 2.5% of carbon black, anti-oxidants and heat stabilizers. The product was designed specifically for exposed conditions. It contains no additives or fillers which can leach out and cause embrittlement over time.

GUNDLIN[®] HD SPECIFICATIONS

TYPICAL PROPERTIES*	TEST METHOD	GAUGE (NOMINAL)							
		30 mil (0.75 mm)	40 mil (1.0 mm)	50 mil (1.25 mm)	60 mil (1.5 mm)	80 mil (2.0 mm)	100 mil (2.5 mm)	120 mil (3.0 mm)	140 mil (3.5 mm)
Density, g/cc. (Min.)	ASTM D1505	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Melt Flow Index, g/10 min. (Max.)	ASTM D1238 Condition E (190°C, 2.16 kg.)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Tensile Properties (Typical)	ASTM D 638 Type IV Dumb-bell at 2 ipm.								
1. Tensile Strength at Break (Pounds/inch width)		120	160	200	240	320	400	480	560
2. Tensile Strength at Yield (Pounds/inch width)		70	95	115	140	190	240	290	340
3. Elongation at Break (Percent)		700	700	700	700	700	700	700	700
4. Elongation at Yield (Percent)		13	13	13	13	13	13	13	13
Tear Resistance Initiation, lbs. (Typical)	ASTM D1004 Die C	22	30	37	45	55	65	80	95
Low Temperature Brittleness, °F (Typical)	ASTM D746 Procedure B	-112	-112	-112	-112	-112	-112	-112	-112
Dimensional Stability, % Change Each direction. (Max.)	ASTM D1204 212°F 1 hr.	±2	±2	±2	±2	±2	±2	±2	±2
Resistance to Soil Burial, Percent change in original value. (Typical)	ASTM D3083 using ASTM D638 Type IV Dumb-bell at 2 ipm.								
Tensile Strength at Break and Yield	% Change	±10	±10	±10	±10	±10	±10	±10	±10
Elongation at Break and Yield	% Change	±10	±10	±10	±10	±10	±10	±10	±10
Environmental Stress Crack, Hours. (Min.)	ASTM D1693 (10% Igepal, 50°C)	1500	1500	1500	1500	1500	1500	1500	1500
Puncture Resistance, Pounds. (Typical)	FTMS 101 Method 2065	30	52	65	80	105	130	150	169
Coefficient of Linear Thermal Expansion, $\times 10^{-4} \frac{\text{cm}}{\text{cm}^\circ\text{C}}$ (Typical)	ASTM D696	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Thermal Stability Oxidative Induction Time (OIT), Minutes. (Min.)	ASTM D3895 130°C, 800 psi O ₂	2000	2000	2000	2000	2000	2000	2000	2000

*Note: All values except when specified as minimum or maximum are typical test results.

SPECIFICATIONS

Mirafi Construction Products: Typical Property Values

The product specifications are average values. For minimum certifiable values contact your local Mirafi Representative or the Mirafi Technical Department at 1-800-438-1855.

SR = SOIL REINFORCEMENT
D = DRAINAGE

SC = SEDIMENTATION CONTROL
L = LANDSCAPING

EC = EROSION CONTROL
PU = POND UNDERLINING

Property	Unit	Test Method	Mira-drain 6000 (D)	Mira-grid (SR)	Miramat 2400 (EC)	100X (SC)	140NSL (D,EC)	140NL (D,EC)	140NS (D,EC)	140N (D,EC)	500X (SR)	600X (SR,EC)	700X (D,EC)	1200HP (SR,EC)	2120HP (SR)	160NS (P,UEC)	180N (P,UEC)
Weight	oz/sy	ASTMD-3776-79	8	24	18 x 6'	3.0	3.5	3.5	4.3	4.5	4.0	6.0	6.5	12.0	14.0	60	8.0
Grab Strength	lbs	ASTMD-4632-86	2900 x 1700*	21 x 26'	150 x 100	120	100	100	145	120	200	300	425 x 250	600	1300 x 550	240	240
Grab Elongation	%	ASTMD-4632-86				30 (max)	60	50	70	55	30 (max)	35 (max)	35 (max)	30 x 30	25 x 15	> 70	50
Trapezoid Tear Strength	lbs	ASTMD-4533-85				65	40	40	75	50	115	120	110 x 55	250 x 250	400 x 275	90	75
Mullen Burst Strength	psi	ASTMD-3786-87				280	150	200	180	265	450	600	525	1500 +	1000 +	270	450
Puncture Strength	lbs	ASTMD-3787-80*					45		50	70	85	130	130	350	75 x 150	75	125
Wide Width Strip Tensile	lbs/in	ASTMD-4595-86	220 x 134								150 x 150	200 x 180	250 x 180	400 x 400	1000 x 500		
Wide Width Strip Elongation	%	ASTMD-4595-86	15 x 20								20 x 20	20 x 15	20 x 18	20 x 20	18 x 20		
Thickness	mil	ASTMD-1777-64			250	17	57			60	23	30	19	50	40		105
Permittivity	sec	ASTMD-4491-85*				.5	1.3	2.2	1.0	0.35	.3	.4	.3	.2	1.0	.3	1.8
Water Flow Rate	gal/min/ft	ASTMD-4491-85*				40	110	180	95	170	35	50	60	95	80	25	100
Apparent (AOS)																	
Opening Size (EOS) U.S. Std Sieve		ASTMD-4751-87				20-35	50-100	70-100	70-100	100 +	30-50	30-50	70-100	50-120	40 x 70	100 +	100 +
Efficiency	%	VTM-51				75											
Slurry Flow Rate	gal/min/ft	VADHVTM-51				0.5											
Ultraviolet																	
Stability	%	ASTMD-4355-84*				90					90	90	90	90	90		
Porosity	%	Calculated			85-90												
Flexibility	mg-cm	ASTMD-1388-64			2000												
Core Compressive Strength	psi	ASTMD-1621 (Modified)															
Lateral Flow Rate	gpm/ft width	PDS Flow Test*	15,000														
Core Amplitude	in	Measured	38														

1. 1600 testing machine with ring clamp, steel ball replaced with a 2 1/2 inch diameter solid steel cylinder centered within the ring clamp (I)

2. ASTMD-4632-86 after 250 cycles in an Xenon-arc Weatherometer (Type BH or C). One cycle consists of 102 minutes of light followed by 18 minutes of light with water spray

3. Flow rate measured in Mirafi flow tester

a) = (IV1 = 1 at 3500 psi confining soil pressure)

b) = (IV1 = 1 at 10,800 psi confining soil pressure)

c) = (IV1 = 80 at 10,000 psi confining soil pressure)

4. Two-inch strip method (lbs/in)

5. 5 cm Constant head

6. Modified for geogrid using sample size 1 strand

by 4 junctions with two junctions between jaws

Results reported in lbs/foot

MIRAFI INC

800-438-1855

(704) 523-7477

TELEX: 216903MRFI

Mirafi's family of geotextile and related products continues to grow, more than 15 years after our company introduced the first commercial geotechnical products in the United States.

As "the company that started an industry," we take pride in our heritage of innovation and our commitment of service to the construction industry. Our product groupings focus on five main areas of concern to engineers, architects and contractors:

1. Sedimentation control;
2. Soil reinforcement;
3. Drainage & Waterproofing;
4. Erosion control
5. Specialty applications.

Sedimentation Control

Proper control of sediment run-off can be achieved with silt fence structures that act as a filter to let storm water run off while trapping sediment. *Envirofence™* and *Mirafi 100X* are two sedimentation control products that Mirafi offers to handle sediment retention. These products are typically used to protect waterways from sediment deposits by securing the perimeter of construction sites.



Sedimentation Control

Soil Reinforcement

Mirafi makes two levels of stabilization fabrics to deal with soil reinforcement. The standard stabilization fabrics, *500X* and *600X*, are high modulus woven fabrics that increase the allowable stress on road subgrades and reduce the aggregate requirements. In applications where installation stresses are excessive and critical properties such as extremely high

abrasion resistance and high soil-fabric friction are needed, Mirafi's high performance fabrics can do the job. *2120HP* is used in such applications as embankments, containment dikes, vertical soil walls, pond capping and dredge spoil containment.

Drainage and Waterproofing

Subsurface drainage problems can be handled with woven and non-woven drainage fabrics as well as prefabricated drainage composites. In the fabric line, Mirafi offers the *140N Series* to provide soil stability around drains and *700X*, a woven geotextile, where very high hydraulic gradients or gap-graded soils are present.

The *Miradrain™* line of prefabricated drainage composites provides drainage for subterranean walls and horizontal plaza decks. These products feature a high-impact polymeric core and a Mirafi filter fabric which allow water to pass freely into the molded drain core where it flows to the discharge system. These products eliminate the need for expensive aggregate systems and require minimum manpower and time to install.

Miradrain™ is a self-adhered sheet membrane with two waterproofing components. This composite product consists of a specially-formulated rubberized asphalt laminated to a polyethylene film in a minimum 60-mil thick membrane. The product is marketed as a complete Mirafi Waterproofing System in conjunction with a primer for wall preparation, a liquid membrane for hard-to-reach areas, and a mastic to seal termination points. The product has a history of excellent performance in providing waterproofing protection for below grade foundation walls, slabs, parking decks, plaza decks, tunnels, and similar structures.



Soil Reinforcement

Erosion Control

Mirafi provides both fabrics and a special matting to control erosion problems. As a fabric liner under rip rap, Mirafi's products protect slope, channel, and embankment soil from erosion. Among the fabrics used in these applications are: the *140N Series*, *600X*, *700X*, and *1200HP*.



Subsurface Drainage

Miramat™, an erosion control revegetation mat, is a synthetic web that provides a flexible ground cover that retards erosion while allowing natural vegetation to take root and grow. It has proved particularly effective in roadway ditches, storm and irrigation channels, pond and lake banks, and outlets for pipes and culverts.

Specialty Applications

In addition to the basic area outlined already, Mirafi continues to develop specialty products for applications such as landscaping and heavy duty soil reinforcement. *Mirascope™* is a fabric used to provide weed control, separation, and drainage in landscape applications.



Erosion Control

Miragrid™ provides a great advance in soil reinforcement with its ability to reinforce any soil type, maintain its physical properties under high stress and load, and offer superior long term durability. This woven fiber geogrid has openings large enough to allow soil-to-soil contact while providing a reinforced soil matrix with much greater load carrying capacity.

All of Mirafi's products are backed by the most comprehensive team of geotechnical experts in the business. By having the technology, manufacturing, service, and marketing expertise in one organization, Mirafi can offer the largest geotextile marketing organization of its kind in North America.

Trevira® Spunbonds are highly needed nonwoven engineering fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

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TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1135	1145	1155
Fabric Weight	oz/yd ²	ASTM D-3776	3.6	4.2	6.0	7.4	10.5	13.5	16.2
Thickness, t	mils	ASTM D-1777	60	65	90	110	150	175	210
Grab Strength (MD/CD) ¹⁾	lbs	ASTM D-4632	110/90	135/110	205/175	270/225	390/330	500/425	625/560
Grab Elongation (MD/CD)	%	ASTM D-4632	70/85	70/85	75/85	75/85	75/85	90/95	90/95
Trapezoid Tear Strength (MD/CD)	lbs	ASTM D-4533	50/40	60/50	80/75	105/95	135/120	175/170	205/200
Puncture Resistance ($\frac{1}{16}$ " hemispherical tip)	lbs	ASTM D-3787	50	60	90	115	155	175	240
Mullen Burst Strength	psi	ASTM D-3786	180	210	315	390	550	625	840
Water Flow Rate	gpm/ft ²	ASTM D-4491	150	140	130	120	100	80	55
Permittivity, ψ	sec ⁻¹	ASTM D-4491	2.04	1.90	1.77	1.63	1.36	1.09	0.75
Permeability, k	cm/sec	k = ψ /1	0.31	0.31	0.40	0.46	0.52	0.48	0.40
AOS	Sieve Size mm	CW-02215 Mod. to 10 Min.	70-100 210-149	70-100 210-149	70-100 210-149	70-120 210-125	70-120 210-125	100-140 149-105	100-170 149-088
Standard Roll Widths ²⁾	ft		400	400	300	300	300	300	300
Standard Roll Length ³⁾	ft		400	400	300	300	300	300	300

¹⁾MD = Machine Direction, CD = Cross Machine Direction.

²⁾Other width and length rolls are available upon request.

MINIMUM AVERAGE ROLL VALUES (WEAKEST PRINCIPAL DIRECTION) OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1135	1145	1155
Fabric Weight	oz/yd ²	ASTM D-3776	3.4	4.0	5.7	7.1	10.0	13.0	16.0
Thickness, t	mils	ASTM D-1777	50	55	80	100	135	160	200
Grab Strength	lbs	ASTM D-4632	80	100	155	200	290	375	500
Grab Elongation	%	ASTM D-4632	60	60	65	60	65	80	80
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	100	140	170
Puncture Resistance ($\frac{1}{16}$ " hemispherical tip)	lbs	ASTM D-3787	35	45	75	95	130	155	200
Mullen Burst Strength	psi	ASTM D-3786	160	190	285	360	500	575	765
Water Flow Rate ³⁾	gpm/ft ²	ASTM D-4491							
Permittivity, ψ ³⁾	sec ⁻¹	ASTM D-4491							
Permeability, k ³⁾	cm/sec	k = ψ /1							
AOS ⁴⁾	Sieve Size mm	CW-02215 Mod. to 10 Min.	70 210	70 210	70 210	70 210	70 210	100 149	100 149

³⁾Insufficient testing has been performed to statistically establish "minimum average values" at the time of this printing. Please contact your Trevira Distributor or Hoechst Fibers for additional information. ⁴⁾AOS "minimum average roll value" is a measure of the largest opening size in the fabric.

TYPICAL ROLL PROPERTIES

PROPERTY	TEST PROCEDURE	UNIT	POLYFELT										PGM		
			420	500	550	600	650	700	750	800	900	1000	13	15	20
PHYSICAL															
Weight	ASTM D3776	oz/yd ²	3.8	4.5	5.5	6.0	7.0	8.3	10.3	12.0	14.0	16.2	3.6	4.2	6.0
Thickness	ASTM D1777	mils	55	60	70	80	90	105	120	130	150	160	55	60	80
Spinnat Retention	TF25, Meth. 8	gal/yd ²											0.22	0.27	0.33
MECHANICAL															
Grab Tensile	ASTM D4632	lbs	110	125	150	170	190	225	280	325	*380/320	*470/350	100	120	160
Grab Elongation	ASTM D4632	%	>50	>50	>50	>50	>50	>50	>50	>50	>60	*85/90	>50	>50	>50
Width Tensile	ASTM D4595	lb/in	45	50	65	75	85	100	120	135	145	150			
Elongation at Break	ASTM D4595	%	>50	>50	>50	>50	>50	>50	>55	>55	>80	>80			
Puncture Resistance	ASTM D4833	lbs	55	65	70	85	100	115	130	150	155	170	55	60	85
Trapezoidal Tear	ASTM D4533	lbs	50	60	70	75	85	100	115	130	*150/135	*170/140	50	55	75
Mullen Burst	ASTM D3786	psi	155	185	230	255	295	345	425	450	470	490			
HYDRAULIC															
Water Flow Rate	ASTM D4491	gpm/ft ²	250	220	190	170	140	130	100	90	80	65			
Permittivity	ASTM D4491	sec ⁻¹	2.9	2.7	2.3	2.0	1.8	1.6	1.3	1.2	0.9	0.8			
Permeability, Kv	ASTM D4491	cm/sec	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.35	0.35			
Transmissivity at	ASTM D4716	gpm/ft (x10 ⁻³)													
0.3 psi			6.7	7.0	8.5	9.5	10.0	11.0	11.5	12.7	13.0	15.0			
14.5 psi			2.7	3.0	3.8	4.0	5.0	7.0	7.0	7.0	7.0	7.0			
29.0 psi			1.6	2.0	2.5	3.0	3.5	4.0	4.0	4.0	4.0	4.0			
A.O.S.	ASTM D4751	sieve size	70-35	80-40	80-45	100-60	100-70	120-80	140-100	140-100	>140	>140			
		mm	0.2-0.5	0.18-0.42	0.18-0.35	0.15-0.25	0.15-0.21	0.12-0.18	0.10-0.15	0.10-0.15	<0.10	<0.10			
ENDURANCE															
U.V. Resistance (500 hours)	ASTM D4355	% str. ret.	>85	>85	>85	>85	>85	>85	>90	>90	>90	>90	2-13	2-13	2-13
pH Resistance															

MINIMUM AVERAGE ROLL PROPERTIES

PROPERTY	TEST PROCEDURE	UNIT	POLYFELT										PGM		
			420	500	550	600	650	700	750	800	900	1000	13	15	20
PHYSICAL															
Weight	ASTM D3776	oz/yd ²	3.8	4.5	5.5	6.0	7.0	8.3	10.3	12.0	14.0	16.2	3.6	4.2	6.0
Thickness	ASTM D1777	mils	55	60	70	80	90	105	120	130	150	160	55	60	80
Spinnat Retention	TF25, Meth. 8	gal/yd ²											0.22	0.27	0.33
MECHANICAL															
Grab Tensile	ASTM D4632	lbs	110	125	150	170	190	225	280	325	380/320	*470/350	100	120	160
Grab Elongation	ASTM D4632	%	>50	>50	>50	>50	>50	>50	>50	>50	>60	*85/90	>50	>50	>50
Width Tensile	ASTM D4595	lb/in	45	50	65	75	85	100	120	135	145	150			
Elongation at Break	ASTM D4595	%	>50	>50	>50	>50	>50	>50	>55	>55	>80	>80			
Puncture Resistance	ASTM D4833	lbs	55	65	70	85	100	115	130	150	155	170	55	60	85
Trapezoidal Tear	ASTM D4533	lbs	50	60	70	75	85	95	105	110	120	130	50	55	75
Mullen Burst	ASTM D3786	psi	155	185	230	255	295	345	425	450	470	490			
HYDRAULIC															
Water Flow Rate	ASTM D4491	gpm/ft ²	250	220	190	170	140	130	100	90	80	65			
Permittivity	ASTM D4491	sec-1	2.9	2.7	2.3	2.0	1.8	1.6	1.3	1.2	0.9	0.8			
Permeability, Kv	ASTM D4491	cm/sec	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.35	0.35			
Transmissivity at	ASTM D4716	gpm/ft (x10 ⁻³)													
0.3 psi			6.7	7.0	8.5	9.5	10.0	11.0	11.5	12.7	13.0	15.0			
14.5 psi			2.7	3.0	3.8	4.0	5.0	7.0	7.0	7.0	7.0	7.0			
29.0 psi			1.6	2.0	2.5	3.0	3.5	4.0	4.0	4.0	4.0	4.0			
A.O.S.	ASTM D4751	sieve size	70-35	80-40	80-45	100-60	100-70	120-80	140-100	140-100	>140	>140			
		mm	0.2-0.5	0.18-0.42	0.18-0.35	0.15-0.25	0.15-0.21	0.12-0.18	0.10-0.15	0.10-0.15	<0.10	<0.10			
DURABILITY															
U.V. Resistance (500 hours)	ASTM D4355	% str. ret.	>85	>85	>85	>85	>85	>85	>90	>90	>90	>90	2-13	2-13	2-13
pH Resistance															

PACKAGING

MD/CD

polyfelt

ROLL																	
Width, ft	15	15	15	15	15	15	15	14	13	10	10	12 5	12 5	12 5	12 5	12 5	12 5
Length, ft	360	360	360	360	360	360	360	300	300	300	300	400	575	360	360	360	360
Area, yd ²	600	600	600	600	600	600	600	467	433	333	333	556	799	500	500	500	500
Weight, lbs	150	180	215	235	275	320	310	335	335	300	345	148	231	200	200	200	200

polyfelt

*MD/CD

AR004679

AR004680

**MALCOLM
PIRNIE**

FINAL SITE-SPECIFIC QUALITY MANAGEMENT PLAN

**CAP CONSTRUCTION AND FLOOD RETENTION BASIN
HAZARDOUS WASTE CLEAN-UP
MILLCREEK SUPERFUND SITE
ERIE COUNTY, PENNSYLVANIA**

**U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
CONTRACT NO. DACW45-89-C-0190
PROJECT 0285-33-2**

NOVEMBER 1991

MALCOLM PIRNIE, INC.

**S-3515 Abbott Road
P. O. Box 1938
Buffalo, New York 14219**

**SITE SPECIFIC QUALITY MANAGEMENT PLAN
MILLCREEK SUPERFUND SITE**

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1.0 GENERAL

1.1 PURPOSE

This Site Specific Chemical Quality Management Plan (SSQMP) outlines the respective U.S. Army Corps of Engineers (USACE) and Construction Contractor quality assurance (QA) and quality control (QC) interactions and related responsibilities, and describes the project data collection requirements including sampling, sample handling, custody, documentation and analytical procedures. This SSQMP, in conjunction with chemical quality management contract specifications, is intended to assure that the Construction Contractor collects, analyzes and documents chemical data during the project duration that is legally and scientifically defensible.

1.2 PROJECT SCOPE AND DESCRIPTION

1.2.1 Scope

This SSQMP is considered a working document for internal use by USACE construction personnel during the construction of the cap and flood retention basin (FRB) at the Millcreek Superfund Site, Erie County, Pennsylvania. Sampling of excavated drums encountered during grading operations and soils contaminated from leaking drums may be required during the construction period.

The Contractor shall prepare a Chemical Data Acquisition Plan (CDAP) which describes the QA/QC procedures and QM program which will be utilized by the Contractor and its subcontractors during cap and FRB construction and for the first year following completion of construction activities.

1.2.2 Site Description

The Millcreek site is an 78.4-acre tract of land located in Millcreek Township, Erie County, Pennsylvania. The site was formerly a freshwater wetland. Between 1941 and 1981, all but 4 acres were filled with foundry sand and industrial and municipal waste. Beginning

in the mid-1970s, waste oils containing PCBs were bulk-disposed in the fill, along with liquid wastes containing phthalates, phenols, polynuclear aromatic hydrocarbons (PAHs), and heavy metals. The Pennsylvania Department of Environmental Resources (PADER) first advised the landfill operator to cease operations in August 1980. In July 1982, at the request of PADER, five monitoring wells (MW-1 - MW-5) were installed by the Millcreek Township on the Township's 4-acre parcel of land. A hazard ranking score was determined after a USEPA Technical Assistance Team performed a site assessment in August 1982. USEPA Region III's Remedial Investigation, completed in 1985, discovered extensive soil, sediment, and surface water contamination. The major classes of compounds detected included:

- VOCs such as vinyl chloride, trichloroethene, 1,2-dichloroethene, 1,1,1-trichloroethane, 1,2-dichloroethane and 1,1-dichloroethene in the ground water;
- semi-volatile organic chemicals such as bis (2-ethylhexyl) phthalate, naphthalene and benzo(a)pyrene in on-site fill materials;
- PCBs in the fill and in some sediment samples, and;
- lead in the fill.

In addition to the contaminants listed, numerous other metals, PAHs and phthalates were detected in the fill materials.

On May 1, 1986 the USEPA issued a Record of Decision (ROD) which proposed remedial actions for the site based on the RI/FS. In 1989, a pre-design study was completed in which remedial actions were recommended to:

- prevent the air dispersion and off-site transport of contaminants;
- prevent direct contact with contaminants by humans and wildlife; and
- reduce soil, sediment, surface water and ground water contaminant concentrations to levels acceptable to the USEPA and the PADER.

The selected remedial actions for the site included:

- site grading/placing a vegetated topsoil cover;
- construction of a flood retention basin and improved surface water drainage system; and
- extraction and treatment of contaminated ground water.

1.2.3 References

Additional information concerning the site history and contaminants can be found in the following reports:

- Remedial Investigation and Feasibility Study, Millcreek Superfund Site, Erie County, Pennsylvania, dated August 1985.
- Record of Decision, Remedial Alternative Selection, Millcreek Superfund Site, Erie County, Pennsylvania, dated 7 May 1986.
- Draft Engineering Report, Remedial Clean-up Treatability Study, Millcreek Superfund Site, Erie County, Pennsylvania, June 1989.
- Soil Gas Survey Report, Remedial Clean-up Treatability Study, Millcreek Superfund Site, Erie County, Pennsylvania, August 1988.
- Field Investigation Report, Remedial Clean-up Treatability Study, Millcreek Superfund Site, Erie County, Pennsylvania, August 1988.
- Ground Water Treatability Testing Report, Remedial Clean-up Treatability Study, Millcreek Superfund Site, Erie County, Pennsylvania, February 1989.
- Wetlands Sediment Sampling Report, Remedial Clean-up Treatability Study, Millcreek Superfund Site, Erie County, Pennsylvania, August 1989.
- Exploratory Soil Borings Investigation, Millcreek Superfund Site, Erie County, Pennsylvania, August 1989.

The following references also describe procedures for chemical quality data management and shall be used in the preparation of the CDAP:

- Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste, Appendix F, ER1110-1-263, U.S. Army Corps of Engineers, October 1990.

- Test Methods for Evaluating Solid Waste, USEPA Office of Solid Waste, SW-846, 3rd Edition, published November 1986, revised December 1987.
- Federal Register Vol. 51, No. 114, 06/13/86, 40 CFR Part 261.
- Methods for Chemical Analysis of Water and Wastes, USEPA Environmental Monitoring and Support Laboratory, USEPA 600/4-79-020, Revised March 1983.
- Standard Methods for the Examination of Water and Wastewater, 16th Ed., 1985.
- Procedures for Handling and Chemical Analysis of Sediment and Water Samples, USEPA/USACE-81-1, May 1981.

1.3 CHEMICAL HAZARD IDENTIFICATION

Field investigations performed on behalf of PADER (1982), USEPA (1982, 1984, and 1987) and the USACE (1987-1989) have identified a variety of contaminants in the soils, sediments and ground water at the site. A summary of the occurrence of contaminants detected in various media during field investigations for the USACE are presented in Tables QM-1 through QM-4. The health and safety considerations for the contaminants of concern are discussed in the Health and Safety Design Analysis prepared in conjunction with the SSQMP.

PARAMETER	FREQUENCY	CONCENTRATION		PARAMETER	FREQUENCY	CONCENTRATION	
		MAXIMUM	MINIMUM			MAXIMUM	MINIMUM
VOLATILE ORGANICS (ug/l)				TOTAL METALS (mg/l)			
1,1,1-Trichloroethane	3	510	63	Aluminum	29	26	0.18
1,1,2-Trichloroethane	0			Antimony	0		
1,1-Dichloroethane	6	420	9	Arsenic	16	0.10	0.005
1,1-Dichloroethene	2	7	4	Barium	28	1.1	0.06
1,2-Dichloroethane	1	3		Cadmium	24	0.017	0.005
1,2-Dichloroethene (total)	14	4900	1	Calcium	29	230	0.49
Acetone	26	8100	28	Chromium	10	0.036	0.007
Benzene	15	4	0.1	Copper	21	1.25	0.006
Chloroethane	0			Iron	29	80	0.06
Chloroform	0			Lead	15	0.17	0.05
Ethylbenzene	0			Magnesium	29	140	0.21
Methylene Chloride	8	690	2	Manganese	29	2.8	0.096
Tetrachloroethene	0			Mercury	0		
Toluene	1	0.2		Nickel	3	0.10	0.07
Total xylenes	2	110	2	Silver	4	0.009	0.005
Trichloroethene	6	1000	0.9	Sodium	29	340	13
t-1,2-Dichloroethene	0			Zinc	29	0.46	0.025
Vinyl chloride	8	470	30				
ACID EXTRACTABLES (ug/l)				SOLUBLE METALS (mg/l)			
2,4-Dimethylphenol	1	2		Aluminum	29	3	0.03
				Antimony	0		
BASE/NEUTRAL EXTRAC. (ug/l)							
Acenaphthene	1	0.4		Arsenic	13	0.027	0.005
Bis (2-ethylhexyl) phthalate	6	81	0.8	Barium	28	0.56	0.05
Diethylphthalate	1	0.2		Cadmium	7	0.010	0.006
Di-n-butyl phthalate	1	0.4		Calcium	29	170	0.12
Fluorene	1	0.2		Chromium	1	0.010	
Isophorone	4	180	1	Copper	12	0.073	0.006
Naphthalene	2	4	1	Iron	29	21	0.02
N-Nitrosodiphenylamine	11	1	0.2	Lead	4	0.07	0.05
Phenanthrene	1	0.2		Magnesium	29	86	0.13
				Manganese	29	1.7	0.006
PCBs (ug/l)				Mercury	0		
Aroclor-1260	2	0.44	0.24	Nickel	1	0.06	
				Silver	4	0.011	0.006
TRPH (mg/l)	5	1.30	1	Sodium	29	300	11
				Zinc	26	0.15	0.006

NOTES:

-
1. Number of detections does not include QC duplicate samples.
 2. Total number of samples collected: 29
 3. List includes parameters detected during previous RI.

AR004689

PARAMETER	FREQUENCY	CONCENTRATION		PARAMETER	FREQUENCY	CONCENTRATION	
		MAXIMUM	MINIMUM			MAXIMUM	MINIMUM
VOLATILE ORGANICS (ug/kg)				BASE/NEUTRAL EXT (ug/kg)			
1,1,1-Trichloroethane	4	99	43	2-Chloronaphthalene	1	430	
1,1,2,2-Tetrachloroethane	1	1		2-Methylnaphthalene	85	20,000	3
1,1-Dichloroethane	2	55	52	Acenaphthene	37	83,000	17
1,2-Dichloroethene(total)	8	6,800	5	Acenaphthylene	1	530	
2-Butanone	1	32		Anthracene	39	180,000	31
2-Hexanone	0			Benzidine	17	1,800,000	1000
4-Methyl-2-pentanone	1	19,000		Benzoic acid	1	140	
Acetone	50	51,000	14	Benzo (b) anthracene	0		
Benzene	28	190	0.3	Benzo(a)anthracene	82	220,000	57
Bromodichloromethane	1	1		Benzo(a)pyrene	85	190,000	27
Carbon disulfide	2	41	4	Benzo(b)fluoranthene	86	590,000	90
Chloroform	13	510	0.3	Benzo(g,h,i)perylene	70	97,000	110
Ethylbenzene	8	150,000	0.6	Benzo(k)fluoranthene	0		
Methylene Chloride	107	5,700	6	Bis (2-ethylhexyl) phthalate	41	16,000	64
Tetrachloroethene	12	470	0.9	Butyl benzyl phthalate	1	120	
Toluene	56	38,000	0.3	Chrysene	91	140,000	77
Total xylenes	11	1,600,000	4	Dibenzo(a,h)anthracene	51	39,000	90
Trichloroethene	27	19,000	0.6	Dibenzofuran	52	39,000	1
t-1,2-Dichloroethene	5	18	1	Diethylphthalate	2	9	8
Vinyl acetate	1	1		Dimethyl phthalate	0		
Vinyl chloride	0	0		Di-n-butyl phthalate	56	7,600	69
				Di-n-octylphthalate	16	1,400	5
ACID EXTRACTABLE (ug/kg)				Fluoranthene	82	510,000	94
2,4-Dimethylphenol	13	12,000	64	Fluorene	13	82,000	50
2-Methylphenol	19	810	57	Indeno(1,2,3-cd)pyrene	70	110,000	94
4-Chloro-3-methylphenol	1	4,800		Isophorone	4	83,000	540
4-Methylphenol	24	8,200	4	Naphthalene	72	49,000	100
Phenol	21	14,000	420	N-Nitrosodiphenylamine	40	7,200	37
Benzyl alcohol	2	66	20	Phenanthrene	80	300,000	5
				Pyrene	83	390,000	90
METALS (TOTAL) (ug/g)							
Antimony	16	100	0.69	PCBs (ug/kg)			
Arsenic	108	38	1.3	Arochlor-1248	14	18,000	50
Barium	110	51,000	6.1	Arochlor-1254	11	1,600	50
Cadmium	50	790	0.58	Arochlor-1260	7	8,200	50
Chromium	110	5,290	3.5				
Copper	108	19,000	0.45				
Iron	110	209,000	150	NOTES:			
Lead	103	2,400	4.8	-----			
Manganese	110	32,500	74				
Mercury	24	1.5	0.11	1. Frequency of detection based field samples only.			
Nickel	110	3,010	3.4	2. Total number of samples collected: 110			
Selenium	21	11	0.66	3. Parameter list includes only those chemicals detected in			
Silver	67	33	0.55	1988 field investigation and 1985 RI.			
Zinc	89	12,300	8.9	4. Minimum concentration listed includes estimated (J)			
				values.			
TRPH (ug/g)	102	27,000	22				

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SAMPLE NUMBER	SD-A1	SD-A2	SD-A4	SD-B3	SD-C1	SD-A-COMP	SD-B-COMP	SD-C-COMP	SD-A1D	SD-A1M	TB-SD	R-QC
SAMPLE DATE	2/23/89	2/23/89	2/24/89	2/24/89	2/23/89	2/24/89	2/24/89	2/24/89	2/23/89	2/23/89	2/23/89	2/23/89
SAMPLE TYPE	Discrete	Discrete	Discrete	Discrete	Discrete	Composite	Composite	Composite	Duplicate	Matrix SpkTrip	Blk	Rinsate
VOLATILE ORGANICS (ug/kg)												
Acetone		52 DJ	76	480 D	1100 D	NA	NA	NA	70			480 D
Methylene Chloride						NA	NA	NA		2 BJ		21 DJ
Tetrachloroethene				5 DJ		NA	NA	NA				
Toluene		2 DJ	0.4 J	2 DJ		NA	NA	NA	0.2 J		0.2 BJ	3 DBJ
BASE/NEUTRAL EXTRAC. (ug/kg)												
2-Methylnaphthalene	310 J	NA	80 J	NA	NA	25 J	10 J				NA	(ug/L)
3,3-Dichlorobenzidine	14 J	NA		NA	NA					14 J	NA	
Acenaphthene	22 J	NA	12 J	NA	NA						NA	
Anthracene	42 J	NA	36 J	NA	NA				51 J	48 J	NA	
Benzo(a)anthracene	130 J	NA	150 J	NA	NA				120 J	110 J	NA	
Benzo(a)pyrene	160 J	NA	230 J	NA	NA	70 J	12 J		120 J	120 J	NA	
Benzo(b)fluoranthene	210 J	NA	260 J	NA	NA	97 J	17 J		180 J	160 J	NA	
Benzo(g,h,i)perylene	99 J	NA	120 J	NA	NA	30 J			71 J	58 J	NA	
Benzo(k)fluoranthene	190 J	NA	260 J	NA	NA	72 J	16 J		120 J	140 J	NA	
Bis (2-ethylhexyl) phthalate	150 BJ	NA	300 BJ	NA	NA	440 BJ	110 BJ		720 B	720 B	NA	3 J
Butyl benzyl phthalate	22 J	NA	13 J	NA	NA						NA	0.3 J
Chrysene	190 J	NA	200 J	NA	NA		21 J		170 J	160 J	NA	
Dibenz(a,h)anthracene	28 J	NA	27 J	NA	NA				29 J	16 J	NA	
Dibenzofuran	94 J	NA		NA	NA	7 J			110 J	110 J	NA	
Diethylphthalate	25 J	NA		NA	NA						NA	
Di-n-butyl phthalate	450 BJ	NA	330 BJ	NA	NA	240 BJ	280 BJ		350 BJ	320 BJ	NA	
Di-n-octylphthalate	9 J	NA		NA	NA						NA	
Fluoranthene	180 J	NA	280 J	NA	NA	49 J			170 J		NA	
Fluorene	23 J	NA		NA	NA				31 J	28 J	NA	
Indeno(1,2,3-cd)pyrene	97 J	NA	130 J	NA	NA	33 J			77 J	56 J	NA	
Naphthalene	410 J	NA	120 J	NA	NA	77 J				460 J	NA	
Phenanthrene	250 J	NA	220 J	NA	NA	24 J	20 J		300 J	260 J	NA	
Pyrene	150 J	NA	190 J	NA	NA	41 J					NA	

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MILLCREEK

TABLE QM-3: SUMMARY OF RESULTS: WETLAND SEDIMENT

QM3 (PAGE 2)

PARAMETER	SAMPLE NUMBER	SD-A1 2/23/89	SD-A2 2/23/89	SD-A4 2/24/89	SD-B3 2/24/89	SD-C1 2/23/89	SD-A-COMP 2/24/89	SD-B-COMP 2/24/89	SD-C-COMP 2/24/89	SD-A1D 2/23/89	SD-A1M 2/23/89	TB-SD 2/23/89	R-QC 2/23/89	
SAMPLE DATE	2/23/89	2/23/89	2/23/89	2/24/89	2/24/89	2/23/89	2/24/89	2/24/89	2/24/89	2/23/89	2/23/89	2/23/89	2/23/89	
SAMPLE TYPE	Discrete	Discrete	Discrete	Discrete	Discrete	Discrete	Composite	Composite	Composite	Duplicate	Matrix	SpkTrip	Blnk	Rinsate
PCBs (ug/kg)												(ug/l)	(ug/l)	
Aroclor-1248	280	NA	NA	2300	NA	NA	130	140		83		NA		
Aroclor-1254	220	NA	NA		NA	NA						NA		
JACID EXTRACTABLES (ug/kg)												(ug/l)	(ug/l)	
2,4-Dichlorophenol		NA	NA		NA	NA				44 J		NA		
2,4-Dimethylphenol	31 J	NA	NA		NA	NA					36 J	NA		
2-Methylphenol	61 J	NA	NA		NA	NA	100 J			73 J	70 J	NA		
4-Methylphenol	480 J	NA	NA		NA	NA				470 J	490 J	NA		
Phenol		NA	NA		NA	NA	510 J					NA		
TOTAL METALS (ug/g)												(mg/l)	(mg/l)	
Antimony		NA	NA	3.0	NA	NA						NA		
Arsenic	6.6	NA	NA	1.7	NA	NA	6.3	9.8	6.4			NA		
Barium	65	NA	NA	15	NA	NA	130	170	160			NA		
Cadmium	0.035	NA	NA	2.7	NA	NA	2.6	1.7	1.6			NA	0.006	
Chromium	99	NA	NA	13	NA	NA	17	12	11			NA	0.016	
Copper	89	NA	NA	7900	NA	NA	2900	290	33			NA		
Iron	21000	NA	NA	7600	NA	NA	8900	9700	9400			NA		
Lead	46	NA	NA	150	NA	NA	74	9.7	2			NA		
Manganese	1200	NA	NA	91	NA	NA	180	150	130			NA		
Mercury	0.11	NA	NA	0.23	NA	NA	0.15	0.13				NA		
Nickel	84	NA	NA	120	NA	NA	130	22	11			NA	0.04	
Silver	1.6	NA	NA	3.2	NA	NA	2.0	0.49	0.44			NA		
Zinc	250	NA	NA	4600	NA	NA	2100	290	79			NA		
Dry Weight (%)		78	58	79	52	53	56	55	58			NA		

B: Analyte detected in lab blank D: Analyte detected at secondary dilution of sample J: Estimated concentration of analyte
 NA: Sample not analyzed for this analyte.

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TABLE QN-4: SUMMARY OF VOC RESULTS - SATURATED SOILS

Sample Number	B-2	B-6	B-9	B-9DL	B-10	B-14	B-14MS	B-14MSD	B-15	B-15MS	B-15MSD	B-150
Sample Date	5/22/89	5/23/89	5/17/89	5/17/89	5/17/89	5/18/89	5/18/89	5/18/89	5/23/89	5/23/89	5/23/89	5/23/89
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
VOLATILE ORGANICS												
Acetone	31 B	93 B	20 B	65 BD	3 BJ				93 B	61 B	80 B	38 B
Carbon disulfide	4 J		0.5 J									
Chlorobenzene			2 J									
Chloroform									0.8 BJ			16
1,1-Dichloroethane												
1,1-Dichloroethene			0.9 J									
1,2-Dichloroethene (total)		780	1500 E	1200 D	230	2800	2700	2600	7	5 J	4 J	30
Ethylbenzene									0.3 J	0.08 J		
Methylene Chloride	5 J	5 BJ	2 BJ	5 BDJ	12 B	73 J	350 J	330 J	2 J	2 J	2 J	4 J
Toluene	1 BJ	4 BJ	4 BJ	4 BDJ	1 BJ	140 BJ			1 BJ			2 BJ
1,1,1-Trichloroethane									3 J			
Trichloroethene		150	3 J	6 DJ	0.9 J				2 J			1 J
Vinyl chloride		8 J	10 J									3 J
Xylenes (total)												0.1 J
Percent Moisture	17	17	13	13	21	14	14	14	13	13	13	19

ABBREVIATIONS:

- B - Analyte detected associated blank
 D - Analyte detected in secondary dilution of sample
 J - Estimated concentration
 E - Exceeded calibrated linear range of instrument
 MS - Matrix spike
 MSD - Matrix spike duplicate
 150 - Duplicate sample boring 15

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2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The Construction Contractor is responsible for chemical quality control, while the government is responsible for quality assurance.

2.1 GOVERNMENT

Chemical data quality management responsibilities for the USACE are discussed below.

2.1.1 Contracting Officer

The Contracting Officer will have the following responsibilities:

- Approving the Contractor's Chemical Data Acquisition Plan (CDAP).
- Arranging meetings, if necessary, between appropriate USACE representatives and the Contractor to clarify or discuss required QA/QC practices.
- Receiving Daily Quality Control (DQC) Reports from the Contractor when samples for chemical analysis are collected, handled or analyzed.
- Receiving analytical results from the Contractor.
- Coordinating government review of the DQC reports, records, or analytical/QC problems on a daily basis with the QA Laboratory or as soon as possible after a problem arises.
- Ensuring that the Contractor furnishes duplicate or split samples and field blanks to the QA Laboratory in accordance with the requirements of the applicable Drum Handling and Chemical Data Management Specifications.
- Furnishing performance audit samples (from Design Division or QA Laboratory) to Contractor promptly.
- Furnishing analytical results (from the Contractor) to the QA Laboratory.
- Ensuring (with the assistance from QA Laboratory) that contract Specifications and CDAP requirements are met for number, quality and type of QA/QC field samples (duplicates and splits and appropriate blanks, one set

for QC and another set for QA), minimum sample sizes, sample handling and preservation, etc.

- Ensuring (with QA Laboratory assistance) that QC provisions described in the CDAP are executed by the Contractor.
- Ensuring (with QA Laboratory assistance) that instrument calibrations, preventive maintenance, etc., are satisfactorily performed and recorded.
- Ensuring (with QA Laboratory assistance) that all documentation regarding sampling, analysis, chain-of-custody and transportation manifests (if applicable) is thoroughly and properly recorded.

2.1.2 QA Laboratory

The QA laboratory will have the following responsibilities:

- Furnishing performance audit samples to the Contracting Officer promptly.
- Reviewing in a timely fashion Contractor validation sample results.
- Reviewing analytical results (from Contractor) promptly.
- Analyzing duplicate or split samples and blanks promptly.
- Assisting the Contracting Officer to ensure that contract Specifications and CDAP requirements are met.
- Reviewing on a timely basis Contractor DQC Reports.
- Assisting the Contracting Officer in solving laboratory and chemical problems as they occur.

2.2 CONTRACTOR

As part of the CDAP, the Contractor shall prepare a description of his quality control organization including assigned individuals for prime contractor and any subcontractors. A discussion of corresponding QC responsibilities and related qualifications shall also be provided; channels of interaction between the Contractor and subcontractors should be identified. The QC organization shall be independent of the project management organization and QC personnel shall report to a senior officer within the Contractor's firm. Quality management provisions shall be in accordance with USACE ER 1110-1-263.

General descriptions of key QC personnel responsibilities and qualifications are provided for guidance in Sections 2.2.1 through 2.2.3.

2.2.1 Project Manager

It should be the Contractor's policy that a Project Manager (supervisor or equivalent) be responsible for the quality of all work performed under his direction. The Project Manager (PM) shall, therefore, direct Contractor's personnel to comply with the specified quality requirements of the CDAP and the Specifications. He shall assure that site personnel have access on-site to all procedures, plans, and specifications pertaining to quality requirements for on-site work activities. The PM may delegate authority to expedite and facilitate the implementation of the CDAP.

2.2.2 Quality Control Manager

The Quality Control Manager (or equivalent) has the responsibility for independently monitoring project activities for compliance with any specified chemical quality requirements. It is not anticipated that the QC Manager needs to be present on site at all times during performance of the contracted work for this project. The QC Manager reports directly to an officer of the Contractor's firm responsible for Quality Control. This officer shall provide a signed letter to the QC Manager describing his responsibilities and authorities. The QC Manager's responsibilities include:

- ensuring that field personnel are familiar with and adhering to proper sampling procedures, field measurement techniques, and sample identification and chain-of-custody procedures;
- coordinating with the analytical laboratories for the receipt of samples, the reporting of analytical results, and recommending corrective actions to correct deficiencies in the analytical protocol or sampling;
- reviewing all chemical quality management submittals to the USACE by the Contractor and documenting this review by signing the applicable copy;
- monitoring and auditing of quality control procedures for chemical analysis;
- completing the chemical quality management portion of the DQC on a daily basis and submitting these reports to the Contracting Officer within five work days of when the work was performed; and

- assuring compliance with the Specifications and implementing the approved CDAP.

The QC Manager must be authorized and have the ability to determine the acceptability or non-acceptability of laboratory work with respect to specified quality requirements. His determinations are directly conveyed to his project management and the Contracting Officer's representative. He is authorized to specify the required steps to resolve any work he finds non-acceptable. The Contractor must submit the resume of the person who will be the Quality Control Manager to the USACE. The QC Manager must have at least one year of experience with the review of HTW chemical data. The QC Manager will assess the data quality and implement corrective actions in situations when unacceptable data has been generated.

2.2.3 Laboratory Personnel

Chemical analysis will be performed at a qualified USACE-validated off-site laboratory. The Contractor's laboratory personnel shall be experienced in the type of testing to be done. A list of key individuals for various project components shall be compiled. The project-related qualifications of the Contractor's analytical laboratory in terms of equipment, facilities, and assigned scientific personnel (supervisors, chemists, and technicians) shall be provided. The Contractor shall include qualifications of assigned scientific personnel with complete chronological resumes listing appropriate education and experience. The minimum education requirement for supervisors and chemists is a BS in Chemistry or equivalent. Appropriate education and experience required for analytical techniques may vary from one year (for inorganic extractions) to as much as five years (for Gas Chromatography/Mass Spectrometry (GC-MS) spectral interpretation).

Staff with degrees in other areas of science or engineering shall prove equivalency in education and experience in terms of the number and types of chemistry courses necessary to fulfill a BS in Chemistry. A MS degree in Chemistry or related field may be equivalent to one year of experience. Technicians shall have a minimum of 2 years of college science or the equivalent and shall work under the close and continuous supervision of a chemist.

3.0 LABORATORY AND EQUIPMENT

3.1 PROVISIONS AND SELECTION

For any chemical analysis, the contractor will be required to provide and coordinate the services of testing laboratories to perform specified analyses and services. Where on-site laboratories are utilized, the on-site laboratory must be validated by the USACE. The contractor must notify the Contracting Officer in advance as to any laboratory or subcontractor laboratory which will be used. Any changes, such as the laboratory, instrumentation, personnel, or delegation of laboratory work must be approved by the USACE in advance. The Contractor should provide a Laboratory Quality Management Manual (LQMM) describing laboratory facilities, list of analytical instrumentation (manufacturer, model, years of purchase), and complete personnel qualifications, including appropriate education and experience, QC program, sample handling and storage, chain-of-custody procedures, sample analysis and tracking system, etc.

3.2 INSPECTION AND APPROVAL

The Resident Engineer (RE) of the local USACE Construction District/Division should be aware that the laboratory evaluation process can be time consuming and that the RE plays an active role in the initiation procedure. Appendix A at the end of the section, Chemical Quality Management in the specifications, outlines the initiation procedures as well as the three implementation steps of the USACE Commercial Laboratory Validation process. The implementation steps for validation of the Contractor's laboratory by CEMRD-EP-EC are: submittal of the lab LQMM, completion of performance evaluation samples and laboratory inspection. Ordinarily each step in the implementation procedures is completed before the subsequent step is initiated. If the capabilities of the laboratory appear adequate to meet project requirements based on review of the LQMM by CEMRD-EP-EC and the QA Laboratory, matrix-specific and analyte-specific performance audit (PA) samples will be provided through CEMRD-EP-EC for analysis by the laboratory. Upon

successful completion of the PA samples, a representative of CEMRD-EP-EC and/or the QA Laboratory (acting as an agent for CEMRD-EP-EC) will inspect the Contractor's laboratory and organization. The inspection will concentrate on project-related analyses and procedures. If the inspection reveals deficiencies, the Contractor shall rectify them. If necessary, additional scheduled inspections will be made. The Contractor's laboratory and organization must be approved by the Contracting Officer (assisted by QA Laboratory and the Design Division) prior to receiving any samples for analysis. Satisfactory completion of the entire laboratory validation process and approval of the CDAP in accordance with this document and the provisions of Appendix C of ER1110-1-263 are required. All laboratories must be validated and approved by the Contracting Officer prior to receiving any samples for analysis.

4.0 SAMPLING AND SAMPLE CUSTODY PROCEDURES

Sampling and sample custody procedures shall be consistent with United States Environmental Protection Agency (USEPA) and COE guidelines (NIOSH for air monitoring) unless otherwise specified. Normally, sample handling and chain-of-custody procedures shall follow the latest COE Sample Handling Protocol. In some cases, special COE procedures or American Society for Testing and Materials (ASTM) procedures (or NIOSH for air monitoring) recommended by the USEPA can be used. Guidelines to be followed include:

- Sampling Manual for the Investigation of Hazardous Waste Disposal Sites; Characterization of Hazardous Waste Sites - A Methods Manual Volume II — Available Sampling Methods (USEPA-600/4-04-076), December 1984;
- RCRA Ground Water Monitoring Technical Enforcement Guidance Document, USEPA OSWER-9950.1, September 1986;
- Preparation of Soil Sampling Protocol: Techniques and Strategies, USEPA-600/54-83-020, August 1983; and
- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846, 3rd edition).
- Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste, U.S. Army Corps of Engineers, Draft September 1988.

4.1 SAMPLING PLAN

The Contractor shall prepare a sampling plan which thoroughly addresses the procedures to be used to obtain representative soil, drum contents and air monitoring samples, descriptions of sampling equipment, containers and sample site. The Contractor shall provide in the CQCP a description of the techniques to be used (random, stratified, etc.) to select sampling sites. This description shall include the selection rationale and criteria to be employed for each matrix or phase.

Any air quality sample sites shall be selected with respect to wind direction, site configuration, work activity, and locations of nearby residences or places of employment. Air quality sampling (time-weighted average) shall include on-site portable (personnel monitoring) and perimeter air monitoring for particulates. These procedures shall be in accordance with the COE "Interim Standard Air Monitoring Guide for Hazardous Waste Sites," June 1984, and appropriate NIOSH methods. For perimeter air monitoring, USEPA methods may be appropriate.

The Contractor shall institute appropriate sampling procedures to collect representative samples. The Contractor is required to provide a description of the technique, the rationale, and the criteria to be employed for selecting locations and sampling each matrix. Specific sampling procedures to be used (USEPA, NIOSH, ASTM) shall be referenced. For non-standard or modified sampling methods, detailed procedures with appropriate references will be required. Examples of procedures for the collection of drum content and soil samples contaminated by leaking drums are described below.

4.1.1 Drum Sampling Methods

All sampling of liquids and solid materials from excavated drums shall be performed by the Contractor. Sampling procedures shall be in accordance with procedures set forth in the USEPA document EPA/600/2-86/013 "Drum Handling Procedures at Hazardous Waste Sites." The Contractor shall provide all sample containers and be responsible for sample compositing, packing, preservation and transport. The Contractor shall maintain field log documentation of all drum sampling and chain-of-custody for sample handling. Split samples shall be made available to the Contract Officer or representatives of regulatory agencies upon request.

The Contractor shall include in its proposal a detailed, site-specific sampling and analytical program for excavated drums. The objective of this program shall be to characterize the wastes as required to:

- determine waste compatibility to insure safe drum staging and segregation, waste bulking, or recontainerization (screening);
- determine if drummed material is hazardous;

- determine treatment and disposal requirements; and
- allow transportation of wastes in accordance with regulatory requirements.

Except for hazardous waste determination, the referenced drum handling procedures list all necessary parameters to be tested for to achieve the above objectives. Hazardous waste shall be characterized by the following RCRA hazardous waste characteristics:

- TCLP metals, volatiles, semi-volatiles, pesticides, PCBs, and herbicides;
- corrosivity;
- ignitability; and
- reactivity.

4.1.2 Soil Sampling Methods

Soil surrounding excavated drums suspected to be contaminated by leaking drum contents will be collected for screening and RCRA hazardous waste characterization. Collected soil shall be placed in drums for staging. All sampling of drummed soil shall be performed by the Contractor. Sampling procedures shall be in accordance with procedures set forth in the USEPA document EPA/600/2-86/013 "Drum Handling Procedures at Hazardous Waste Sites." The Contractor shall provide all sample containers and be responsible for sample collection, packing, preservation and transport. The Contractor shall maintain field log documentation of all soil sampling and chain-of-custody for sample handling. Split samples shall be made available to the Contract Officer or representatives of regulatory agencies upon request.

The Contractor shall include in its proposal a detailed, site-specific sampling and analytical program for drummed soil suspected to be contaminated. The objective of this program shall be to characterize the suspected contaminated soil as required to:

- determine waste compatibility to insure safe staging and segregation, waste bulking, or recontainerization (screening);
- determine if collected soil is hazardous;
- determine treatment and disposal requirements; and

- allow transportation of wastes in accordance with regulatory requirements.

Except for hazardous waste determination, the referenced drum handling procedures list all necessary parameters to be tested for to achieve the above objectives. Hazardous waste shall be characterized by the following RCRA hazardous waste characteristics:

- TCLP metals, volatiles, semi-volatiles, pesticides, PCBs, and herbicides
- corrosivity;
- ignitability; and
- reactivity.

4.2 SAMPLE CONTAINERS AND PRESERVATION METHODS

Samples will be collected in precleaned bottles as supplied by the analytical laboratory. All sample containers provided by the analytical laboratories will be properly cleaned for the appropriate trace analysis using USEPA-approved methods. All sample bottles utilized for sample splitting and duplicates will be subjected to the same cleaning procedures. Examples of sample container cleaning procedures are listed below:

- All polyethylene bottles (for inorganic analysis) are to be:
 1. washed using a non-phosphate laboratory grade detergent
 2. tap water rinsed
 3. nitric acid washed 25% v/v nitric acid/deionized water
 4. rinsed with copious quantities of deionized water (at least four rinsings)
- All glass bottles except volatile vials (for organic analysis) are to be:
 1. washed using a non-phosphate laboratory grade detergent
 2. tap water rinsed
 3. rinsed with acetone (pesticide grade)
 4. rinsed with copious quantities of deionized water (at least six rinsings and two complete fillings of bottle to overflowing).
- All volatile vials are to be:
 1. washed using a non-phosphate laboratory grade detergent
 2. rinsed with copious quantities of deionized water (at least six rinsings)
 3. dried for one hour in a 103°C oven (without caps and septa)

4. cooled and capped with precleaned septa (washed with non-phosphate laboratory grade detergent and rinsed with deionized water, dried at 103°C for 1 hour.)

All glassware shall be thoroughly dried before use.

Samples should be placed in the sample containers, preserved and analyzed within the holding times as listed in Table QM-5. The Contractor shall specify the sample containers, preservatives and holding times in his CQCP using appropriate USEPA guidelines (e.g. Publication SW-846, 3rd Edition).

4.3 SAMPLE HANDLING

4.3.1 Packaging and Shipping

Environmental samples collected at the site will be considered low concentration samples, where the hazards are thought to be significantly reduced by normal environmental processes. In accordance with the COE Sample Handling Protocol, the following procedures should be implemented for packaging and shipping low concentration samples.

- Waterproof metal or equivalent strength plastic ice chests or coolers only should be used.
- After collecting the sample and filling out the pertinent information on the sample label and tag, secure the sample lid with strapping tape on all sample bottles other than VOA bottles, secure the string from the numbered approved tag around the lid.
- Mark volume level on bottle with grease pencil.
- Place about 3 inches of inert cushioning material, such as vermiculite, in the bottom of the cooler.
- Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.
- Ensure that the cooler will not exceed shipper's weight limit.
- Put in additional inert packing material to partially cover sample bottles (more than half way). Place sealed bags of ice around, among, and on top of the sample bottles.

TABLE QM-5
CONTAINERS, PRESERVATIVES AND HOLDING TIMES
SOIL AND DRUM CONTENT SAMPLES

Parameter	Container*	Preservative**	Holding Time (Days) TCLP Prep Collection - Extraction - Analysis	
TCLP	Two (2) 40-ml VOA vials (glass, Teflon septa) full, no headspace. Two (2) 8-oz wide-mouth glass jars, 3/4 full, Teflon-lined lids.			
Volatiles		Cool to 4°C/pH < 2 (HCL or NaHSO ₄)	14	NA
Semi-Volatiles		Cool to 4°C/NA	14	7
Mercury		Cool to 4°C/pH < 2 (HNO ₃)	28	NA
Metals (w/o Hg)		Cool to 4°C/pH < 2 (HNO ₃)	180	NA
Transportation/Disposal Requirements				
• Total metals	One (1) 8 oz. wide-mouth glass jar 3/4 full, Teflon-lined lids	Cool to 4°C/pH < 2 (HNO ₃)	28 days mercury, 6 months others	
• Percent Solids	Aqueous only: 100 mL polyethylene or glass bottle	None required	7 days	
• Settable Solids	Aqueous only: One (1) 1-liter polyethylene or glass bottle	None required	24 hours	
• Phenols	One (1) 500 mL polyethylene or glass bottle	Cool to 4C H ₂ SO ₄ to pH < 2	28 days	
• Oil and Grease	One (1) 1-liter amber glass bottle	Cool to 4C H ₂ SO ₄ to pH < 2	28 days	
• Free Cyanide	One (1) 500 mL polyethylene or glass bottle	Cool to 4C Add Na ₂ S ₂ O ₃	14 days	
• Total Cyanide	One (1) 500 mL polyethylene or glass bottle	Cool to 4C NaOH to pH > 12	14 days	
• Percent Moisture (solids only)	4 oz. glass jar	Prevent contact with direct sunlight	ASAP	

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TABLE QM-5
CONTAINERS, PRESERVATIVES AND HOLDING TIMES
SOIL AND DRUM CONTENT SAMPLES

Parameter	Container*	Preservative**	Holding Time (Days) TCLP Prep Collection - Extraction - Analysis
• Specific Gravity	4 oz. glass jar (solids) 100 mL plastic or glass bottle (aqueous)	None required	ASAP
• Hydrocarbon composition • Sulfur Content • Thermal Content • Organochlorine Percentage	8 oz. wide-mouth glass jar (solids) 500 mL glass bottle (aqueous)	None required	ASAP
• Viscosity (aqueous samples only)	To be determined	To be determined	To be determined
• Solubility in Water	To be determined	To be determined	To be determined
• Physical State @ 70F • Phases/Layering	Direct observation?	None required	Field Parameter?

* If sample is solid material, replace polyethylene or glass bottle with 8 oz. wide-mouth jar.

** Preservative refers to aqueous samples only. No preservative except cooling to 4°C is required for soil (solid) samples unless specified.

TCLP as described in 40 CFR, Part 261, Appendix II, 7-1-90 Edition.

See also Federal Register, Vol. 55, 11862, 3-29-90, and revision thereafter Vol. 55, 26987, 6-29-90.

NA = Not applicable.

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- Fill cooler with cushioning material.
- Put paperwork (chain-of-custody record) in a waterproof plastic bag and tape it with masking tape to the inside lid of the cooler.
- Tape the cooler drain shut.
- Secure cooler lid by taping. Wrap the cooler completely with strapping tape at a minimum of two locations. Do not cover any labels.
- Attach completed shipping label to top of the cooler.
- Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.
- Affix numbered and signed custody seals on front side, and back left of cooler. Cover seals with wide, clear tape.

For samples from drums, direct discharges, chemical spills or areas where there is little or no evidence of environmental dilution, the packaging and shipping procedures for "high concentration" samples should be followed. These procedures are detailed in the COE Sample Handling Protocol.

4.3.2 Sample Labeling

All samples will be carefully identified using waterproof labels and indelible ink. The labels will be covered with clear plastic waterproof tape after all sample identification information has been recorded. Labels will contain the following information: sample number, date and time of sampling, source, sampling location, required analysis and sampler's name. Each sample will receive a unique number to allow for the retrieval of information pertaining to a particular sample.

4.3.3 Chain-of-Custody

Chain-of-custody records begin in the field at the time of sampling. A person is in custody of a sample if the sample is:

- in that person's physical possession;
- in view after being in that person's physical possession;
- placed in a locked repository by that person, or;
- placed in a secure, restricted area by that person.

A chain-of-custody record will be maintained for all refuse, soil, liquid, and air samples obtained in the field. The person obtaining the samples in the field initiates the chain-of-custody record by reporting the following minimum data as the samples are collected:

- Name of person obtaining sample.
- Sample number.
- Sample type.
- Date collected.
- Time collected.
- Amount collected.
- Containers collected.

Other information such as preservatives added, analyses required, laboratory destination, description, and conditions shall be added as appropriate.

Chain-of-custody forms will be completed for each sample at the time of collection and will be maintained while shipping the sample to the laboratory. At each change of possession, the form must be signed by the person relinquishing the samples and the person receiving the samples. This could occur as the samples are transferred from the contaminated portion of the site to a designated clean area, as the samples are transported to the lab, or when the samples are received at the analytical laboratory. All records will be attached to the sample container. Chain-of-custody tapes will be used to seal the container to prevent tampering and to ensure sample integrity is maintained during shipment. If for any reason, samples on a chain-of-custody log are split and sent to separate destinations, multiple copies of the logs will be generated with a clear indication of which sample went to which destination.

When the sample arrives at the laboratory following shipment, the sample is received by the sample custodian. Any inconsistencies between the samples and the custody record and the condition of the samples and shipping package should be noted at the time of sample receipt. The sample handling procedures utilized by the analytical laboratory should be described in the laboratory QA/QC Procedures Manuals.

4.4 RECORD-KEEPING PROCEDURES

The following information shall be recorded in a bound field notebook at the time of sampling:

- Unique sample designation, location, sketch
- Name of sampler
- Weather
- Method of collection
- Time and date of sampling
- HNU meter readings (if applicable)
- Sample matrix, volume
- Analyses required and sample container types
- Field measurements and calibration (if applicable)
- Observations and remarks
- Sample transport

A bound field log book shall be maintained in which to record the daily activities. All entries shall be made in indelible ink. Incorrect entries will be corrected by a single stroke through the error and shall be verified with the recorder's initials. Entries to the log book shall include:

- Date
- Start and finish times
- Summary of work performed (inc. samples collected)
- Name of personnel present
- Names of visitors
- Weather
- Level of personnel protection used during various activities
- Observations and remarks
- Signature of person making entry

A sufficient amount of information should be recorded so that the field activities can be reconstructed without relying on an individual's memory.

4.5 DECONTAMINATION OF EQUIPMENT

The Contractor is required to submit a detailed description of decontamination procedures for sampling equipment as part of the CQCP. Decontamination techniques are described in applicable USEPA guidance documents. Sampling methods and equipment shall be chosen so as to minimize decontamination requirements and the possibility of cross contamination between samples and sample locations. Sample tubing, rope, rods, etc., shall be disposed of after sampling. Any sampling equipment used at more than one location will be decontaminated between locations by following these basic steps:

- The equipment can initially be steam-cleaned with spray from a portable steam generator.
- The equipment shall then be scrubbed with brushes and non-phosphate laboratory grade detergent and rinsed with potable tap water (minimum three rinses).
- The equipment should be rinsed with a solvent as determined by the required chemical analysis.
- The equipment will then be triple rinsed with deionized analyte-free water.
- The equipment will be wrapped with foil or other material to prevent contamination during storage.

4.6 FIELD SAMPLE STORAGE

Field storage of samples shall be adequate to prevent damage, loss, or unacceptable deterioration. Samples shall not be subjected to excessive moisture and the temperature shall be maintained at 4°C. All items shall be stored so that ready access for maintenance is possible without excessive handling. Samples should not be stored on site for more than 24 hours.

Site storage of samples prior to and after testing shall follow the above requirements. Storage supervision is the responsibility of the laboratory supervisor. All samples stored on site will be recorded on an inventory record with copies on file in the laboratory and the storage facility, if separate from the laboratory. Sample chain-of-custody procedures shall

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be maintained. At the end of the project, the Contracting Officer will decide on long-term sample storage.

5.0 ANALYTICAL PROCEDURES

5.1 ANALYTICAL METHODS/PROCEDURES

The Contractor shall specifically state in the CDAP the analytical procedures which are proposed. The CDAP shall fully describe and provide references for the specific analytical methods which will be used to determine sample characteristics, transportation and disposal of wastes. Analytical methods used shall be USEPA-approved standard methods (e.g. SW-846) wherever practical.

Where alternate standard methods are available, normally the most cost-effective method will be used provided it satisfies project requirements for precision, accuracy, specificity and sensitivity, and has received approval from the Contracting Officer, QA Laboratory and USACE Design Division.

Specific sampling procedures and the related extraction procedures and analytical methods (e.g., USEPA, ASTM, NIOSH) selected for chemical analyses shall be submitted by the Contractor. These include field sampling techniques and laboratory procedures. For non-standard or modified sampling methods, detailed method write-ups with appropriate references are required. Specific references shall be cited for selection of sample size, sampling containers, sample container cleaning, sampling apparatus, procedures to prevent sample contamination, sample preservation and holding times (in accordance with USEPA and USACE guidelines). Application of a method shall be limited to specific chemicals or classes of chemicals and appropriate concentration ranges and matrices to which it is appropriate.

5.1.1 Analytical Instrumentation

The apparatus to be used for all analyses shall be identified including:

- Specific field and laboratory instrumentation, including manufacturers, model and detectors.
- Operating parameters of the instruments and identification of any applicable accessories, such as chromatography columns.

- Laboratory chemicals necessary to perform analyses, including list of sources and purity of analytical reference materials.
- Standards needed for calibration.

5.1.2 Analytical Methodology Details

Published analytical methods used for this contract shall be properly referenced. Any method proposed which is not published shall be described in such detail as to provide the following information:

- Applicability of the method (specific chemicals or classes of chemicals and appropriate concentration ranges and matrices).
- Sensitivity and detection limits of each method which must be sufficient for the objectives of the analysis (e.g. proposed action levels).
- Possible matrix or chemical interferences.

5.1.3 Analytical Procedures

The analytical procedures which will be used shall be referenced or described in sufficient detail, including:

- A detailed step-by-step procedure for analyzing samples, as well as instrument calibration procedures, or a reference to the appropriate published method.
- The procedures used to validate the method used when they are not specified in or differ from those described in the method. These procedures may include method blank analysis, calibration checks, surrogate recoveries, matrix spike recoveries, and duplicate sample analysis.

5.1.4 Calculations

The Contractor shall describe in detail the manner used to obtain sample concentrations in the original matrix from responses obtained in the analysis as they appear in the raw data. The Contractor shall provide equations, units, and formats to be used for the standardization of the data.

5.2 ANALYTICAL/STATISTICAL/CONTROL PARAMETERS

The Contractor shall provide in the CDAP the procedures, or reference to standard procedures, which will be used to determine analytical/statistical/control parameters to establish technically sound criteria for each measurement. As part of the analytical quality control (QC) program, the Contractor's laboratory should determine precision and accuracy for each parameter analyzed. The requirements for precision and accuracy shall be no less stringent than the guidelines listed in SW-846. As the number of samples which may be analyzed is relatively small, the use of project-specific precision and accuracy limits may not be appropriate; therefore, USEPA QC acceptance criteria specific to the analytical methods selected may be used. The following definitions will be used for this project:

- Replicate (duplicate) samples are essentially identical samples collected at the same time, in the same way, and contained, preserved and transported in the same manner.
- Split samples are replicate samples given to the Contracting Officer for analysis. In the SSQMP, QA samples are field split samples that are analyzed by the USACE through their QA Laboratory.
- QC samples are replicate samples that are analyzed by the Contractor.

Criteria for data acceptance shall address the items discussed in the following sections in a concise manner.

5.2.1 Accuracy of Each Analytical Method

Discussion shall include the accuracy of each analytical method as applied to a given analytical instrument for given analytes in given matrices and the degree of accuracy required for this project. Analytical methods shall be validated for the same or similar matrix. This may require discussion of instrumentation, reference standards or spiked samples, sample collection, analytical procedures, calibration procedures and performance evaluation samples. Requirements of accuracy shall be no less stringent than the guidelines listed for each method in SW-846.

5.2.1.1 Matrix Spikes

To determine the accuracy of an analytical method and/or laboratory analyst, a program of sample spiking is carried out. Spiking frequency is based on the reference method; generally one of every 20 samples is spiked. The results of sample spiking are used to calculate the quality control parameter (i.e., the Percent Recovery [%R]) for accuracy evaluation. Field blanks are not to be used as a spiked sample.

The percent recovery is defined as the observed spiked sample concentration, minus the sample concentration, divided by the true concentration of the spike multiplied by 100.

5.2.1.2 Quality Assurance (QA)

Quality assurance samples are evaluated to assess quantitative data systematically and independently, determining if analytical results are within acceptable control limits. The CDAP, with guidance from the Contracting Officer, will delineate the types and percentages of samples to be supplied by the Contractor to the government (e.g., the QA Laboratory) for external QA checks.

Quality assurance checks normally comprise a percentage of total samples collected/analyzed by the Contractor, (e.g., 5-10%) consisting of duplicates, splits and blanks which are collected along with QC samples. Exceptions to the percentage specified in the CDAP can be made by the Contractor only after receiving approval from the Contracting Officer or Contracting Officer's representative.

The Contractor shall develop a schedule of field and laboratory inspections to be conducted and shall support any additional government inspections. The Contractor shall develop a method of performing, documenting, and monitoring quality control operations of the prime contractor and any subcontractors, including frequency of inspections/checks.

The Contractor shall provide to NED Laboratories QA samples to be supplied to the government (NED Laboratories) for external QA checks. QA samples are to be collected by the Contractor and shipped to:

USACE
New England Division (NED)
Environmental Laboratory
Barre Falls Dam
Hubbardston, MA 01452
POC Brian Condike (508)928-4238

5.2.2 Sensitivity of Each Analytical Method

Discussion shall include the sensitivity of each proposed analytical method in each matrix involved at this site and the sensitivity required for this project. Sensitivity shall be related to detection levels required for this project. Calibration methods for determining detection levels shall be addressed, as well as a discussion of the appropriate detection limits.

5.2.3 Precision of Each Analytical Method

Discussion shall include the analytical methodology used to determine the precision of each analytical method using duplicate samples and instrumentation checks, and the degree of precision necessary for this project. In determining the precision of the analytical method for given analytes, the exact sample matrix shall be taken into account. Precision requirements shall exceed or be equivalent to the guidelines listed in SW-846.

5.2.4 Quality Control Samples

The Contractor shall provide a system of internal quality control checks designed to establish technically sound criteria for each measurement parameter which will serve to accept or reject data in a uniform and systematic manner. The Contractor shall perform the QC procedures specified by the referenced method. If the method does not specify a frequency, the QC procedures shall be conducted at a 5% frequency. These checks are designed to insure accuracy in the sampling procedure and the analytical methods and include laboratory blanks, laboratory duplicates, matrix spikes, matrix spike duplicates, calibration verification samples and surrogate standards, reference standards and performance evaluation samples. Note that some construction-related sampling does not require QA/QC samples.

5.2.4.1 Surrogate Standards

In addition to sample spiking, surrogate standards will be added to all samples and blanks for organic analyses. The surrogates and acceptable percent recovery ranges for GC/MS methods are listed in the USEPA-approved methods. These ranges are to be used as guidelines in evaluating results because sample matrix effects may present unique

problems outside the control of the laboratory. The evaluation of the data will be based on the surrogate recovery and other quality control parameters.

5.2.4.2 Field Blank

A field blank is an artificial sample designed to monitor the introduction of artifacts into the sampling and analytical process. Generally, one field blank will be analyzed for each ten to twenty samples. One such field blank, the equipment rinsate, is to be prepared in the field by passing Type II Reagent Water through sampling equipment after decontamination and prior to sample collection to assure that proper decontamination was performed. However, if dedicated sampling equipment is used or the sample is collected directly into the sample container, then no equipment rinsate blank is required. The Type II Reagent Water shall be supplied by the Contractor's laboratory. Equipment rinsate samples apply to liquid samples only.

Trip blanks will be required for VOC analysis. Trip blanks accompany other sample containers through sample collection, handling and transportation to identify possible sources of contamination. Trip blanks are to be prepared using Type II Reagent Water at the Contractor's laboratory. Trip blanks are not to be opened on-site, but shall be exposed to the same field conditions as the field samples collected for volatile organic analysis (i.e., trip blanks should not be kept in a sealed container separate from field sample). Trip blanks are applicable only to liquid samples. The frequency for both the QC and the QA lab for trip blanks shall be one set (two 40 ml VOA vials) with every batch of volatile organic samples sent to the respective QC or QA lab. Trip and field blanks will be submitted to USACE for analysis with QA samples.

5.2.4.3 Method Blank

A method blank will be analyzed with each set of samples. The method blank is defined by following the analytical method step by step, including the addition of all reagents and solvents in the quantity required by the method. If the cumulative method blank interferes with the determination, steps must be taken to eliminate or reduce the interference to a level that will permit this combination of solvents and reagents to be used. If the method blank interference cannot be eliminated, the magnitude of the interference

must be considered when calculating the concentration of specific constituents in the sample analyzed by the method.

The number of method blanks analyzed is determined by the method of analysis and the number of samples analyzed at a given time. At a minimum, there should be a method blank analyzed every 20 samples or for any batch of less than 20 samples.

5.2.5 Data Comparability

The Contractor's CDAP shall include the methodology for data comparison, listing specific units, equations and data formats to be used, including:

- Checks for transmittal, data reduction and reporting errors.
- Any process used for data validation must be close to the origin of the data, while being independent of the data production process.
- Supportive rationale that samples are representative of the matrix being analyzed or the site location.

5.2.6 Data Validation

As part of the analytical quality control program, the laboratory must apply precision and accuracy criteria to each parameter analyzed. When analysis of a sample set is completed, the quality control data are reviewed and evaluated to validate the data set. All data must be reviewed and checked independently by an individual familiar with the test procedure who has not generated the data.

Quality control limits for surrogate percent recovery and matrix spikes results as referenced by standard USEPA methods will be used in validating the data. Complexity of sample matrix, blanks and methodology are also considered in evaluating the project data.

The CDAP shall also include a discussion of the corrective action to be taken if values are questionable or outside the established control limits. The following items shall be addressed in this section of the CDAP:

- Limits of data acceptability for each analytical parameter and sample matrix along with the corrective action to be taken when these limits are exceeded.

- Information regarding the poor precision shall be documented if the limits are exceeded.
- Personnel responsible for initiating and performing the corrective action shall be indicated.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 GENERAL

Calibration procedures and frequency should be consistent with the standard USEPA methods referenced in the CDAP. Nonstandard calibration will be described for all field and laboratory instrumentation. The Contractor must describe the daily calibration or calibration check of the selected air monitoring instruments. Information shall be provided on the manufacturer, model and accessories which will be used.

Analytical balances should be calibrated on a daily basis with Class S weights. All standards, weights, and other reference materials shall be traceable to National Bureau of Standards (NBS), USEPA, ASTM, NIOSH, or another appropriate independent organization.

7.0 PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

7.1 GENERAL

The Contractor shall provide and describe in the CDAP a system for the preventive maintenance of all analytical equipment and instrumentation to be used either in the laboratory or on site (including the frequency of these maintenance operations). Equipment maintenance procedures shall be documented for all analytical, testing, and measuring instruments requiring routine maintenance. This equipment should be tagged with maintenance labels indicating the date of required maintenance, the person maintaining equipment, and the next maintenance date. Detailed records of these operations shall be maintained and must be available for inspection by the Contracting Officer on request. Information pertaining to life histories of equipment maintenance shall be stored in individual logs for each instrument requiring routine maintenance.

Routine maintenance should be performed according to manufacturer's recommendations defined in the operation and maintenance manuals accompanying the instrument. Major laboratory instrumentation must be maintained under service contract with the respective manufacturers. Scheduled maintenance shall be performed by qualified factory personnel so that laboratory instrumentation is maintained in good condition.

8.0 DATA ANALYSIS AND REPORTING

For each analytical method and major parameter, the Contractor shall provide in the CDAP the following information:

- The data analysis scheme, including units and equations, required to calculate concentrations or the value of the measured parameter.
- The principal criteria that will be used to assure data integrity during collection and reporting.
- Plans for treating outliers.
- Description of the data management systems, including but not limited to, the collection of raw data, data storage and data quality assurance documentation.
- Identification of raw data, data storage and data quality control and assurance documentation with appropriate units (e.g., ug/g, ug/l, mg/m³).
- Identification of individuals to be involved in the reporting sequence.

9.0 GOVERNMENT AND CONTRACTOR REPORTS

9.1 GOVERNMENT REPORTS

9.1.1 QA Result Reports

The QA Laboratory should submit QA results to the Contracting Officer in a timely fashion. This will permit rapid result evaluation and problem identification. Initial notification may be verbal but written documentation should be submitted in a timely fashion.

Since understanding of these documents requires trained chemical personnel, the QA Laboratory should compare their results of duplicate or reference samples to those of the Contractor and make appropriate recommendations to the Contracting Officer regarding any corrective actions required by the Contractor's laboratory. Significant problems and possible solutions should also be included in this report and reported within two working days or sooner.

9.1.2 Chemical Quality Assurance Report

The CQAR is written by the USACE Quality Assurance Laboratory and sent to the Contracting Officer within 30 days of receipt of the Contractor's data and completion of the quality assurance data. This report should address the following concerns:

- overall performance of the laboratory — commercial or USACE — that analyzed the site primary samples;
- detailed evaluation of the Contractor's data — laboratory blanks, replicate analyses, agreement between duplicates/splits, acceptability of spike and surrogate recoveries;
- comparison of the quality assurance analytical results with those of the project laboratory;
- any other problems or issues encountered such as packing and shipment errors, chain-of-custody failures, etc.
- lessons learned.

Tables should be prepared which compare the results for duplicates, splits and blanks sent to both laboratories. The quality assurance data with internal quality control results should be appended.

Guidance provided herein is based on Appendix E of USACE ER1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities, October 1990.

9.2 CONTRACTOR REPORTS

9.2.1 Contractor Chemical Data Acquisition Plan (CDAP)

The Contractor must submit a CDAP in conformance with the contract specifications and as noted herein. The CDAP must be submitted to the USACE and approved by the USACE prior to the Contracting Officer issuing notice to proceed for any activities which involve chemical QA/QC requirements or for the Contractor to receive any samples for analysis. In addition to the elements detailed herein (SSQMP), the CDAP shall address the following items:

- The Contractor's quality control organization, including the role of any subcontractor(s).
- A copy of the letter notifying the Contractor personnel responsible for quality control about exact duties and responsibilities. The letter should be signed by a responsible executive/manager of the company.
- Authorities and responsibilities of all quality control personnel.
- Schedule of field or laboratory inspections.
- Proposed sample collection, handling, storage, transfer, and recording protocols, including chain-of-custody procedures; names of personnel collecting samples; monitoring equipment used (brand, model, serial number); calibration of monitoring equipment; names of work personnel wearing monitoring equipment; description of work site and any unusual conditions.
- Selection and testing of replicate and split samples, blanks and standard (known) samples.

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- Provision of performance audit samples to the Contractor's laboratory, if appropriate, and provision of split/replicate samples and field blanks to the USACE for QA purposes.
- Procedures to assess the precision, accuracy and completeness of all measurement parameters. The Contractor shall also report precision based on standards and known additions.

The CDAP shall include a protocol describing corrective actions to be taken by the Contractor and specifically defined feedback systems. Limits of data acceptability shall be included with the corrective action to be taken when these limits are exceeded. Information justifying the poor recovery or precision will be documented when limits are exceeded. The USACE QA Laboratory will then decide what further corrective action, if any, need be taken. Personnel responsible for initiating and executing corrective action shall be indicated in the protocol. Those individuals responsible for the corrective actions shall sign the bound laboratory log books and all documentation citing the corrective action.

9.2.2 Contractor Daily Quality Control (DQC) Reports

At the conclusion of each day of work on site involving sampling or chemical QA/QC requirements, the Contractor shall prepare and complete a DQC Report which summarizes the activities completed that day. The DQC Report, at a minimum, shall contain:

- Location of work.
- Weather information.
- Work performed, including analytical and QC results.
- Specific inspections performed and results (e.g., check for truck decontamination).
- Quality control problems and corrective actions required (if any).
- Written instructions from the government personnel for retesting.
- Samples collected, types of test performed, personnel involved and results of tests.
- Calibration documentation (procedures and recording)

- Contractor's certifications
- General remarks.

The DQC Reports shall be submitted weekly to the Contracting Officer during sampling activities.

This report shall be dated and signed by the Contractor's Chemical Data Acquisition Manager. It is the responsibility of the Contractor to report to the Contracting Officer in writing within two working days any significant problems with analytical procedures, instrument calibrations or QC along with corrective actions that have been taken to solve the problem. The Contracting Officer should coordinate the Contractor DQC reports on a weekly basis with the QA Laboratory. Reports generated by the Contractor regarding significant problems, such as those stated above, should be forwarded promptly to the QA Laboratory when received by the Contracting Officer. It is essential that qualified chemical personnel review these reports for both their validity and accuracy.

9.2.3 Contractor Quality Control Summary Report (CQCSR)

The CQCSR shall be prepared by the Contractor at the completion of remedial activities at the site. This report shall be submitted to the Contracting Officer for approval. The report will include, at a minimum, the following items:

- A brief summary of sampling procedures, noting any deviations from procedures proposed in the CDAP.
- A consolidation and summary of Contractor DQC reports.
- An outline of QC practices employed, including problems encountered and corrective actions taken.

In addition, the Contractor shall ensure that at the end of the project all temporary on-site facilities have been demobilized. Prior to leaving the site, all equipment, facilities (trailers), and temporary utilities which have entered the Exclusion Zone or are suspected to be contaminated shall be decontaminated. This final decontamination must be documented and signed by the Contractor and submitted as part of the Chemical Data Acquisition Project Summary Report.

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FINAL HEALTH AND SAFETY DESIGN ANALYSIS

**CAP CONSTRUCTION AND FLOOD RETENTION BASIN
HAZARDOUS WASTE CLEAN-UP
MILLCREEK SUPERFUND SITE
ERIE COUNTY, PENNSYLVANIA**

**U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
CONTRACT NO. DACW-45-89-C-0190**

MPI PROJECT 0285-33-2

NOVEMBER 1991

MALCOLM PIRNIE, INC.

**S-3515 Abbott Road
P. O. Box 1938
Buffalo, New York 14219**

**HEALTH AND SAFETY DESIGN ANALYSIS
CAP CONSTRUCTION AND FLOOD RETENTION BASIN
MILLCREEK SUPERFUND SITE**

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**HEALTH AND SAFETY DESIGN ANALYSIS
CAP CONSTRUCTION AND FLOOD RETENTION BASIN
MILLCREEK SUPERFUND SITE**

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1.0 INTRODUCTION

1.1 PURPOSE

This site specific Health and Safety Design Analysis (HSDA) has been developed as a basis for hazard identification, assessment, and evaluation for the construction of the cap and flood retention basin (FRB) at the Millcreek Superfund Site, Erie County, Pennsylvania. This HSDA is intended for internal use by the U.S. Army Corps of Engineers (USACE) to evaluate the Contractor's health and safety protocols.

Recommended safety, health and emergency response procedures are outlined for use while construction and remediation activities are ongoing at the site. Included in this HSDA are the recommended assignment of responsibilities, personnel protection minimum requirements, safe work practices and emergency response procedures which the Contractor should describe in the Safety, Health and Emergency Response Plan (SHERP). USACE approval of the SHERP is required prior to the commencement of any remedial activities. The document includes historical information germane to remediation activities associated with this site.

1.2 REGULATORY REQUIREMENTS AND GUIDELINES

Site activities conducted by the Contractor are to be in compliance with the Occupational Safety and Health Administration (OSHA) requirements contained in 29 CFR 1910 and 1926 including the final rule contained in 29 CFR 1910.120. Procedures must also be consistent with the guidance contained in the **USACE Safety and Health Requirements Manual** (EM 385-1-1), the **Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities** jointly prepared by the National Institute for Occupational Safety and Health (NIOSH), OSHA, USCG and USEPA and USEPA Standard Operating Safety Guides. While this HSDA references these requirements and guidelines in general, it is the responsibility of the Contractor to meet all applicable laws and regulations.

1.3 SITE DESCRIPTION AND BACKGROUND

The Millcreek Site comprises approximately 78.4 acres of a former wetland located adjacent to a highly developed residential area within the Town of Millcreek, Erie County, Pennsylvania. The topography is relatively flat, with sparse vegetative growth in the central portion of the site. A wetland of approximately four acres lies southeast of the site, and the eastern corner of the site lies within the 100-year floodplain of Marshall's Run, an intermittent stream bordering the east side of the site. The average fill depth on-site is reported to be seven feet, and the depth to ground water in the center of the site during the Remedial Investigation was approximately seven feet.

The Millcreek Site was used in the past for the disposal of a variety of waste materials. Information available on disposal practices indicates that most liquid wastes were bulk disposed within the fill materials. The types of wastes known to be on-site include:

- Foundry sand, apparently contaminated with polynuclear aromatic hydrocarbons (PNAs), phenolic compounds and metals;
- Waste oils containing PCB's and phthalates;
- Drums of solvents which could be the source for the numerous volatile organic compounds (VOCs) and other tentatively identified compounds (TICs) detected on-site;
- Construction and demolition debris, including creosote-treated railroad ties;
- Municipal refuse; and
- Other wastes such as polyester resins, ink wastes, caustics, paint wastes and slag which may also be the source of the numerous TICs detected in on-site media.

In addition, junk vehicles and pieces of abandoned equipment are scattered throughout the site.

2.0 HAZARD ASSESSMENT

2.1 HAZARDOUS SUBSTANCE CHARACTERISTICS AND TOXICOLOGY

The surface and subsurface soils in the southeast and south central portions of the site are contaminated with elevated levels of polychlorinated biphenyls. Polynuclear aromatic hydrocarbons (PNAs) were detected in soil samples collected throughout the southern portion of the site. Trace metals, such as lead, copper and zinc, were detected at elevated concentrations throughout the site, but are concentrated in the southern portion of the site. Ground water in the eastern portion of the site is contaminated with volatile organic chemicals (VOCs), specifically, chlorinated ethanes and ethenes. Marshall's Run, a small stream running adjacent to the east side of this site, has been contaminated with VOCs in the past. The on-site pond and lowland wet area sediments are contaminated with PCBs and heavy metals.

The contaminants of concern were selected based upon data collected during previous site investigations, after review of relative concentrations, frequency of detection, background levels, and toxicity. The contaminants of concern are representative of the various classes of compounds detected above background at the Millcreek Site (volatile organics, semivolatiles, PCBs, metals, etc.) and can be used as indicator compounds which are modeled to simulate the physical behavior and health effects of other compounds in their classes.

The following selected contaminants of concern are believed to represent the chemical hazards most prevalent at the site. Summary appraisals of each compound of concern are given below.

- Benzene

The most significant health effects of benzene are toxicity to the blood, immune system, and nervous system. Inhalation of benzene has been associated with a decrease in various cells of the circulating blood resulting from bone marrow depression, which may lead to myelogenous leukemia. Benzene metabolites are believed to be the source of the hematological effects as agents known to alter benzene metabolism (toluene, Aroclor-1254, phenobarbital, ethanol) have also altered benzene toxicity. Ethanol generally increases benzene toxicity. Aplastic anemia has also been associated with

benzene exposure. Benzene alters the immune system; symptoms of immune stimulation (allergy) have been reported as a result of occupational exposures. Central nervous system effects such as drowsiness, dizziness, headache, vertigo, delirium have been associated with benzene exposure. Benzene has been classified as a known human carcinogen, by the USEPA.

- Isophorone

Isophorone is an unsaturated cyclic ketone used in the formulation of lacquers. Inhalation exposures of guinea pigs and rats at concentrations between 300 and 4600 ppm resulted in irritation of eyes and nose, lacrimation, swelling of the nose, instability, respiratory difficulty or irregularity, diarrhea, and light narcosis. An increased heart rate was observed when exposure was continued over 12 hours. The vapor is highly irritating to the eyes, nose and throat of humans. Transitory conjunctivitis has also been reported at concentrations of 300 ppm for a few minutes. It is reported to be a weak irritant to the skin of rabbits. Isophorone has a relatively low acute oral toxicity in experimental animals.

- Methylene Chloride

High levels of methylene chloride in air (above 500 ppm) can irritate the eyes, nose and throat. On the skin, methylene chloride usually evaporates quickly and causes only mild irritation. However, if it is trapped against the skin by gloves, shoes or clothing it can cause a burn. If it gets into the eyes, it could cause severe but temporary eye irritation. Methylene chloride can also affect the central nervous system. If it is inhaled at levels above 500 ppm, it may cause sluggishness, irritability, lightheadedness, nausea and headaches. Some effects have been observed at levels as low as 300 ppm. These effects disappear quite rapidly after the exposure ends.

The results of animal studies suggest that frequent or lengthy exposures can cause serious changes in the liver and kidney. However, based on these studies and those of exposed workers, it appears unlikely that methylene chloride will cause serious liver or kidney damage in humans unless exposure is very high. In certain laboratory experiments animals exposed to high concentrations of this chemical throughout their lifetime developed cancer. Methylene chloride has not been shown to cause cancer in humans exposed at occupational levels; however, based on animal tests, it should be treated as a potential cancer-causing agent.

- Tetrachloroethene

The effects of tetrachloroethene on humans have been established primarily from individuals accidentally or occupationally exposed to very high concentrations. Exposure to high concentrations of tetrachloroethene causes a variety of toxicological effects in humans. Effects upon the central nervous system

are generally the most noticeable following acute or excessive occupational exposures. Effects upon the kidney and liver have been observed and generally occur after an elapsed period of exposure to high concentrations. Liver effects attributed to exposure to tetrachloroethene at high levels include cirrhosis of the liver, toxic hepatitis, liver cell necrosis and enlarged liver. Symptoms of renal dysfunction include diminished excretion of urine, uremia, elevated serum creatinine, proteinuria and hematuria. Overexposure to high but unknown concentration of tetrachloroethene have also been associated with pulmonary damage.

- Vinyl Chloride

Vinyl chloride is a synthetic chlorinated organic chemical used in the manufacture of polyvinyl chloride (PVC). Its presence in site-specific circumstances may be attributable to breakdown of the halogenated aliphatic hydrocarbons TCE and 1,2-trans-dichloroethene to vinyl chloride.

Acute inhalation exposure to vinyl chloride results in central nervous system effects such as dizziness, giddiness, euphoria, ataxia, headache and narcosis. Skin contact with undiluted vinyl chloride results in frostbite by rapid evaporation and subsequent freezing. It is unlikely that these acute effects would be observed at the concentrations and site-specific exposure scenarios expected. Chronic exposure to vinyl chloride through inhalation has been associated with liver toxicity, fatty deposition in particular. Vinyl chloride is considered to be a suspect carcinogen. "Vinyl Chloride Disease" is the name given to a syndrome observed as a result of occupational exposure, which is characterized by dissolution of the fingertips, circulatory disturbance in the extremities, Raynaud syndrome, scleroderma, liver, kidney and lung damage. Inhalation exposures to vinyl chloride have been associated with impaired liver function or liver damage. Symptoms and signs of liver disease have included pain in the abdomen, evidence of fibrosis and cirrhosis, and hepatomegaly. Severity of the disease appears to correlate with duration of exposure. Subtle neurotoxicity may be associated with occupational exposure. paternal occupational exposure may be associated with fetal loss. Several reports link liver cancer with occupational exposure to vinyl chloride. USEPA has designated vinyl chloride as a known human carcinogen.

At the Millcreek Site, vinyl chloride was detected in the ground water at concentrations up to 470 ug/l. Inhalation of volatilized vinyl chloride gas and direct skin contact with vinyl chloride contaminated ground water and saturated soil are potential exposure routes.

- 1,2-Dichloroethene

In humans, the most significant impact of 1,2-dichloroethene is on the central nervous system. Inhalation of the chemical has been reported to cause dizziness, drowsiness, vertigo, and intracranial pressure. Exposure to trans-

1,2-dichloroethene in air can also cause eye irritation. The symptoms subside upon removal from the exposure. The long-term health effects following exposure to low concentrations of 1,2-dichloroethene are unknown. Animals exposed to 1,2-dichloroethene via inhalation experienced lung and heart damage. Animals fed 1,2-dichloroethene developed pathological lesions in the liver and kidney. 1,2-dichloroethene is not known to have reproductive or teratogenic effects in humans or animals.

Exposure to 1,2-dichloroethene has been associated with nausea, drowsiness, fatigue, intracranial pressure and ocular irritation. No association between increased cancer incidence in humans and exposure to 1,2-dichloroethene is reported. USEPA classifies 1,2-dichloroethene as a probable human carcinogen.

- Trichloroethene (TCE)

Trichloroethene is a common industrial solvent used primarily in dry cleaning and metal degreasing. Trichloroethene exposure at levels of 200 ppm has been associated with mild behavioral and psychomotor effects, including vertigo, fatigue and headache. TCE is a suspected human carcinogen. TCE was detected in the ground water at concentrations up to 1000 ug/l. TCE was detected in unsaturated soil samples at concentrations up to 19 mg/kg. The major potential exposure to TCE in site-specific circumstances is by inhalation of volatilized TCE.

Inhalation exposure to trichloroethene is associated with central nervous system effects including depression (narcosis). Other symptoms include drowsiness, headache, dizziness, nausea, confusion, facial numbness and blurred vision. Effects attributed to long-term exposure include decreased appetite and sleep disturbances. Liver damage, including necrosis, has resulted from acute occupational exposure. The USEPA has concluded, however, that chronic exposure to trichloroethene at concentrations found or expected in ambient air, are unlikely to result in liver damage. Kidney dysfunction and failure have also been associated with acute occupational and intentional exposure. Anorexia, nausea, vomiting and intolerance of fatty foods have been associated with long-term occupational exposures. Trichloroethene may also be associated with mild eye irritation and dry throats. Skin contact may result in irritation, burns and rashes; it may also act as a sensitizer as well as a primary irritant. Available evidence indicates that trichloroethene is carcinogenic in animals. The USEPA has classified it as a possible human carcinogen.

- 1,2-trans-dichloroethene

1,2-trans-dichloroethene is a synthetic organic chemical used in industry as a solvent and as a chemical intermediate. It is also believed to be a product of the anaerobic reductive-dehalogenation breakdown sequence of chlorinated

ethenes. It is often found in ground water contamination situations involving halogenated aliphatic hydrocarbon solvents. One concern over the presence of 1,2-trans-dichloroethene in the ground water is the potential for being transformed into the more toxic compound, vinyl chloride. 1,2-dichloroethene occurs in cis-and trans- forms; commercial mixtures are generally a combination of the two. The cis- form has an acrid, ethereal odor and may be narcotic or irritating at high concentrations. 1,2-dichloroethene is not believed to be carcinogenic.

1,2-trans-dichloroethene was the most frequently detected VOC found in the ground water at the Millcreek site. Acute toxic effects from short-term exposure to 1,2-trans-dichloroethene at the maximum reported concentration (29,000 ug/l) in ground water would be unlikely under site-specific circumstances. Concentrations in the soil ranged up to 6800 ug/kg.

- 1,1,1-Trichloroethane

1,1,1-Trichloroethane (methyl chloroform) is a colorless, synthetic chemical widely used as a degreasing and dry cleaning solvent. At airborne concentrations of 350-500 ppm, there may be slight changes in perception, and methyl chloroform odor would be pronounced. At higher concentrations, dizziness, throat irritation and narcosis may occur.

The principal health effect of overexposure to 1,1,1-trichloroethane involves the central nervous system. While thresholds for such effects are difficult to characterize, levels around 1000 ppm may result in coordination problems. At much higher levels, anesthesia becomes apparent and death may occur at 1 to 3 percent due to anesthesia and/or cardiac toxicity. Unlike other chlorinated hydrocarbons, 1,1,1-trichloroethane has not been associated with clearly evident liver or kidney damage. Exposure via inhalation is a potential exposure scenario, however, the levels encountered are expected to be lower than those associated with perceptible health effects.

Detections of methyl chloroform were observed in the ground water at concentrations up to 960 ug/l and in the soil up to 99 ug/kg.

- 1,2-Dichloroethane

1,2-Dichloroethane, commonly known as ethylene dichloride (EDC), is a chlorinated hydrocarbon used primarily as a component of leaded fuel and as an intermediate in the production of several chlorinated hydrocarbons, including vinyl chloride, trichloroethylene, and perchloroethylene. Little is known about EDC's potential toxic effects other than by inhalation. Subtle neurological effects, including fatigue, irritability and sleeplessness, may be experienced at levels below 100 ppm. 1,2-Dichloroethane is considered to be a suspect human carcinogen. Acute health effects from ingestion of EDC are not well documented.

Ethylene dichloride was infrequently detected in the ground water at concentrations of 3 ug/l, 6.0 ug/l and 7.6 ug/l.

- 1,1-Dichloroethene

1,1-dichloroethene (vinylidene chloride) is a synthetic halogenated aliphatic hydrocarbon and is used as a copolymer in the production of synthetic materials including Saran. Vinylidene chloride is also used in the production of adhesives and synthetic fibers. It is highly reactive and, in the presence of air, can form explosive, complex peroxides. Formaldehyde, phosgene and hydrochloric acid may be produced from such an explosion.

The health effects of dichloroethene (vinylidene chloride) in humans are generally unknown. In animal studies at high concentrations, dichloroethene has caused liver, kidney, heart and lung damage. It has also caused nervous system disturbances and death after brief exposures. After prolonged exposure at lower concentrations, liver damage has been observed. Exposure through inhalation appears to be the route in which the most harm occurs in animals. After brief exposures to high levels of dichloroethene, similar effects can be expected to occur in humans. The potential for inhalation is the most important route of exposure.

Detections of vinylidene chloride in the ground water were limited, with concentrations ranging up to 16 ug/l.

- Naphthalene

Naphthalene is a chemical derived from the refining of petroleum and coal tar distillation. It has various uses including the production of mothballs, pesticides, fungicides, and detergents.

The main acute effect of naphthalene is the formation of cataracts, resulting from oral exposures of experimental animals. Hepatic changes, including increased liver weight, elevated alkaline phosphatase and aniline hydroxylase activity, and increased lipid peroxidation, may also result from oral exposure to naphthalene. No evidence of immunotoxicity was found in mice administered naphthalene by gavage. Naphthalene has been shown to inhibit mitochondrial respiration. In humans, dermal and ophthalmological changes have been observed in workers occupationally exposed to naphthalene.

The occurrence of naphthalene at the Millcreek Site is limited to the surface and subsurface soils. Naphthalene will bind tightly to soil particle organic constituents and, therefore, will tend not to mobilize into the ground water. Consequently, the exposure modes for naphthalene in the site-specific setting are through inhalation of contaminated airborne soil particles and through direct skin contact.

- Benzo(a)pyrene

Polynuclear aromatic hydrocarbons (PAHs) are a diverse class of compounds derived from both natural and man-made sources. Benzo(a) pyrene (BaP), one of the most hazardous of the PAHs, causes cancer in mice and rats. (BaP) is readily absorbed by all routes of exposure. Absorbed (BaP) is distributed rapidly throughout the body, metabolized to conjugated derivatives, and eliminated. (BaP) is a well-studied, well-established experimental carcinogen. Its carcinogenicity has been demonstrated in laboratory animals by all routes for which humans would normally expect to be exposed. Few reports are available on the noncarcinogenic systemic effects of (BaP) in humans or experimental animals following inhalation, oral, or dermal exposures. Occupational exposures to complex mixtures and industrial processes that include PAHs have resulted in toxic effects including a variety of skin lesions and non-cancer lung diseases such as bronchitis. However, it is not possible to determine from those studies the effect of individual PAHs. Results from studies in rodents indicate that in-utero exposure to (BaP) either by the oral route or by injection is associated with developmental toxicity and adverse reproductive effects.

- Bis (2-Ethylhexyl) Phthalate

Subacute administration of high doses of bis (2-ethylhexyl) phthalate can produce hepatomegaly, hepatic peroxisome proliferation, and induction of peroxisomal enzymes in the rat. It also has effects on lipid metabolism in the liver and other tissues, and has been shown to induce hepatic mixed function oxidase activity in the rat. The evidence for the genotoxicity of bis (2-ethylhexyl) phthalate is very weak. The International Agency for Research on Cancer (IARC) indicates that there is sufficient evidence to substantiate the carcinogenicity of bis (2-ethylhexyl) phthalate in experimental animals, but insufficient evidence in humans. Bis (2-ethylhexyl) phthalate has been shown to induce liver tumors in rats and mice. It has been hypothesized that this compound is a non-genetic carcinogen; its ability to produce tumors may relate to proliferation of peroxisomes. There is evidence that compounds which induce peroxisome proliferation in the liver of rodents do not have the same activity in humans, and hence the hepatocarcinogenicity observed in rodents may not be indicative of a carcinogenic potential in humans.

Several species of phthalate compounds were detected at the Millcreek Site. Their occurrence is mainly confined to the soils and sediments on the site. Bis(2-ethylhexyl)phthalate has been selected as an indicator substance to describe the hazards associated with exposure to the phthalates as a class. Bis(2-ethylhexyl)phthalate poses the most serious health hazard of the phthalates because of its potential for carcinogenic health effects. The primary exposure routes for bis(2-ethylhexyl)phthalate in the site-specific circumstances are via inhalation of contaminated airborne particulate matter and through direct skin contact with contaminated ground water.

- Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are highly stable, nonflammable compounds formerly used in capacitors and transformers and in the manufacture of plasticizers, hydraulic and lubricating fluids, as well as in paints and inks. PCBs are toxic to humans through ingestion, inhalation, and direct skin contact. The general population is exposed to PCBs, primarily through consumption of fish. Dermal absorption of PCBs may occur, but there is not adequate data to determine rates of absorption. Due to their lipophilicity, PCBs are distributed to the fat, skin, and other fat-containing organs. Occupational exposure to PCBs has been associated with reversible skin lesions and subclinical alterations of serum enzymes suggestive of liver enzyme induction and possible hepatocellular damage. The USEPA has determined that the positive evidence for carcinogenicity in animals, along with inadequate evidence in humans, place PCBs in probably human carcinogen.

Four different species of Aroclors (1242, 1248, 1254, 1260) were identified at the Millcreek Site. Their occurrence is limited to the soils and to the on-site sediments. PCBs bind firmly to the organic constituents of soil particles and are, therefore, largely immobile or will migrate very slowly, except in the case of erosion transport. To facilitate discussion of the PCBs as a class, Aroclor-1248, the most prevalent species observed, will be used as an indicator compound.

Concentrations of Aroclor-1248 in the soils at the site ranged up to 18 mg/kg. The primary modes of exposure to Aroclor-1248 are via inhalation of contaminated soil particles and direct skin contact with contaminated soils. Acute health impacts from exposure to Aroclor-1248 are unlikely because of the low probability of exposure. The probability of a chronic PCB exposure is very low, based on the contaminant's absence from any completed long-term exposure pathway such as daily skin contact, ingestion, or inhalation. Any non cancer chronic health impacts would be overshadowed by the potential carcinogenic effects of PCB exposure.

- Lead

Lead is found throughout the environment at variable concentrations, depending upon local geological circumstances. Human-caused sources of lead contamination include its use in paint pigments, dyes, and inks. Frequent, low-level exposure to lead in the ambient air may result in hematologic, neurobehavioral and kidney effects.

High exposures to lead may result in kidney and brain damage. Low-level exposure may result in neurobehavioral deficits and growth retardation in young children and hypertension in middle-aged men. Effects on heme (a constituent of hemoglobin) synthesis also occurs at very low exposure levels.

In addition, low-level exposure to lead decreases the circulating levels of an active form of Vitamin D in children. This form of Vitamin D is largely responsible for calcium homeostasis in the body. Lead exposure of a mother during pregnancy may result in preterm birth, reduced birth weight, and decreased intelligence quotient (IQ) for the infant. USEPA has determined that data were sufficient to consider lead an animal carcinogen, but inadequate for derivation of an estimate of carcinogenic potency in humans. Therefore, lead is classified as a probable human carcinogen by the USEPA.

Lead was observed in the surface soils, sediments, ground and surface waters at the Millcreek Site. Its inclusion as a contaminant of concern in this assessment is based on its detection in the surface water (the swamp area on the southcentral side) in concentrations greater than the primary drinking water standard and its presence in a TCLP extract from a soil sample at greater than USEPA recommendations.

2.2 SUMMARY OF PROJECTED RISKS

Due to both the disposal practices and the variety of wastes allegedly disposed of at the Millcreek Site, the potential exists that, during the field activities, workers will be exposed to hazardous substances.

Although no work at a site containing chemical contamination can be considered completely risk-free, logical and reasonable precautions can be implemented to provide an adequate level of protection for workers. The integration of medical evaluations, worker training relative to chemical hazards, safe work practices, proper personal protection, environmental monitoring, work zones and site control, appropriate decontamination procedures and contingency planning into the project approach minimizes the chances for unnecessary exposures and physical injuries, thereby ensuring the health and welfare of on-site workers.

Workers will potentially be exposed to both physical and chemical hazards during cap construction. Potential physical hazards will exist while working around heavy earthwork equipment such as excavators, dozers, and backhoes. Potential chemical hazards may involve exposure to contaminants of concern during intrusive site construction activities.

Chemical health and physical characteristics for chemicals detected above background at the Millcreek site are presented in Tables 2.1A and 2.1B. A detailed summary of potential hazards associated with specific construction activities is presented in Table 2.2.

TABLE 2.1A
CHEMICAL HEALTH
AND
PHYSICAL CHARACTERISTICS TABLE
Ground Water Results

Parameter	Frequency	Concentration Maximum Minimum	TLV	Vapor Pres.	Ionization Pot.
VOLATILE ORGANICS (ug/l)					
1,1,1-Trichloroethane	3	510 63	350 ppm	100 mm	
1,1-Dichloroethane	6	420 9	100 ppm	182 mm	
1,1-Dichloroethene	2	7 4			
1,2-Dichloroethane	1	3	50 ppm	62 mm	9.64 ev
1,2-Dichloroethene (total)	14	4900 1			
Acetone	26	8100 28	1000 ppm	266 mm	6.69 ev
Benzene	15	4 0.1	10 ppm	75 mm	9.25 ev
Methyl Chloride	8	690 2	500 ppm	350 mm	11.35 ev
Toluene	1	0.2	200 ppm	22 mm	8.82 ev
Total xylenes	2	110 2	100 ppm	7	8.56 ev
Trichloroethene	6	1000 0.9	100 ppm	58	9.47 ev
Vinyl chloride	8	470 30	1ppm	2580	9.995 ev
ACID EXTRACTABLES (ug/l)					
2,4-Dimethylphenol	1	2			
BASE/NEUTRAL EXTRAC. (ug/l)					
Acenaphthene	1	0.4			
Bis (2-ethylhexyl) phthalate	6	81 0.8			
Diethylphthalate	1	0.2			
Di-n-butyl phthalate	1	0.4			
Fluorene	1	0.2	.1 ppm	71 atm	19.69
Isophorone	4	180 1	25 ppm	.2 mm	
Naphthalene	2	4 1	10 ppm	.05 mm	8.14 ev
N-Nitrosodiphenylamine	11	1 0.2			
Phenanthrene	1	0.2			
PCBs (ug/l)					
Aroclor-1260	2	0.44 .024			
TRPH (mg/l)	5	1.30 1			

TABLE 2.1A						
CHEMICAL HEALTH AND PHYSICAL CHARACTERISTICS TABLE Ground Water Results						
Parameter	Frequency	Concentration		TLV	Vapor Pres.	Ionization Pot.
		Maximum	Minimum			
TOTAL METALS (mg/l)						
Aluminum	29	26	0.18			
Arsenic	16	0.10	0.005			
Barium	28	1.1	0.06			
Cadmium Dust	24	0.017	0.005			
Calcium	29	230	0.49			
Chromium	10	0.036	0.007			
Copper	21	1.25	0.006			
Iron	29	80	0.06			
Lead Dust/Fumes	15	0.17	0.05			
Magnesium Fume	29	140	0.21			
Manganese	29	2.8	0.096			
Nickel	3	0.10	0.07			
Silver	4	0.009	0.005			
Sodium	29	340	13			
Zinc	29	0.46	0.025			
SOLUBLE METALS (mg/l)						
Aluminum	29	3	0.03			
Arsenic	13	0.027	0.005	10 ug/m ³		
Barium	28	0.56	0.05	.5 mg/m ³		
Cadmium	7	0.010	0.006	.2 mg/m ³		
Calcium	29	170	0.12			
Chromium	1	0.010		1 mg/m ³		
Copper	12	0.073	0.006	1 mg/m ³		
Iron	29	21	0.02			
Lead	4	0.07	0.05	.05 mg/m ³		
Magnesium	29	86	0.13			
Manganese	29	1.7	0.006	5 mg/m ³		
Nickel	1	0.06		1 mg/m ³		
Silver	4	0.011	0.006	.01 mg/m ³		
Sodium	29	300	11			
Zinc Oxide Fume	26	0.15	0.006	5 mg/m ³		
NOTES:						
1. Number of detections does not include QC duplicate samples.						
2. Total number of samples collected: 29						
3. List includes parameters detected during previous RI.						

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TABLE 2.1B
CHEMICAL HEALTH
AND
PHYSICAL CHARACTERISTICS TABLE
Unsaturated Soil Samples

Parameter	Frequency	Concentration Maximum Minimum	Exposure Limit/ TLV	Vapor Pres.	Ionization Pot.
VOLATILE ORGANICS (ug/kg)					
1,1,1-Trichloroethane	4	99	43	1900 mg/m ³	100 mm
1,1,2,2-Tetrachloroethane	1	1		35 mg/m ³	8 mm
1,1-Dichloroethane	2	55	52	400 mg/m ³	182 mm
1,2-Dichloroethene (total)	8	6,800	5	790 mg/m ³	180
2-Butanone	1	32		590 mg/m ³	70 mm
4-Methyl-2-pentanone	1	19,000			
Acetone	50	51,000	14	2400 mg/m ³	266 mm
Benzene	28	190	0.3	10 ppm	75 mm
Bromodichloromethane	1	1			
Carbon disulfide	2	41	4	20 ppm	300 mm
Chloroform	13	510	0.3	240 mg/m ³	160 mm
Ethylbenzene	8	150,000	0.6	435 mg/m ³	7.1 mm
Methylene Chloride	107	5,700	6	500 ppm	350 mm
Tetrachloroethene	12	470	0.9	100 ppm	14 mm
Toluene	56	38,000	0.3	200 ppm	22 mm
Total xylenes	11	1,600,000	4	435 mg/m ³	7 mm
Trichloroethene	27	19,000	0.6	100 ppm	58 mm
t-1,2-Dichloroethene	5	18	1	790 mg/m ³	180 -
				265 mm	
Vinyl acetate	1	1			
ACID EXTRACTABLES (ug/kg)					
2,4-Dimethylphenol	13	12,000	64		
2-Methylphenol	19	810	57		
4-Chloro-3-methylphenol	1	4,800			
4-Methylphenol	24	8,200	4		
Phenol	21	14,000	420	19 mg/m ³	.36 mm
Benzyl alcohol	2	66	20		
METALS (TOTAL) (ug/g)					
Antimony	16	100	0.69	.5 mg/m ³	
Arsenic	108	38	1.3	10 mg/m ³	
Barium	110	51,000	6.1	.5 mg/m ³	
Cadmium	50	790	0.58	.2 mg/m ³	
Chromium	110	5,290	3.5	1 mg/m ³	
Copper	108	19,000	0.45	1 mg/m ³	
Iron	110	203,000	150		
Lead	103	2,400	4.8	.05 mg/m ³	
Manganese	110	32,500	74	5	
Mercury	24	1.5	0.11	.1	
Nickel	110	3,010	3.4	1	
Selenium	21	11	0.66	.2	
Silver	67	33	0.55	.01	
Zinc Oxide Fume	89	12,300	8.9	5	

**TABLE 2.1B
CHEMICAL HEALTH
AND
PHYSICAL CHARACTERISTICS TABLE
Unsaturated Soil Samples**

Parameter	Frequency	Concentration Maximum Minimum	Exposure Limit/ TLV	Vapor Pres.	Ionization Pot.
TRPH (ug/g)	102	27,000 22			
BASE NEUTRAL EXT (ug/kg)					
2-Chloronaphthalene	1	430			
2-Methylnaphthalene	85	20,000 3			
Acenaphthene	37	83,000 17			
Acenaphthylene	1	530			
Anthracene	39	180,000 31			
Benidine	17	1,800,000 1000			
Benzoic acid	1	140			
Benzo(a)anthracene	82	220,000 57			
Benzo(a)pyrene	85	190,000 27			
Benzo(b)fluoranthene	86	590,000 90			
Benzo(g,h,i)perylene	70	97,000 110			
Bis (2-ethylhexyl) phthalate	41	16,000 64			
Butyl benzyl phthalate	1	120			
Chrysene	91	140,000 77			
Dibenzo(a,h)anthracene	51	39,000 90			
Dibenzofuran	52	39,000 1			
Diethylphthalate	2	9 8			
Di-n-butyl phthalate	56	7,600 69	5 mg/m ³	<0.01 mm	
Di-n-octylphthalate	16	1,400 5			
Fluoranthene	82	510,000 94			
Fluorene	13	82,000 50	.2 mg/m ³	>1ATM	15.69 ev
Ideno(1,2,3-cd)pyrene	70	110,000 94			
Isophorone	4	83,000 540	140 mg/m ³	.2 mm	
Naphthalene	72	49,000 100	50 mg/m ³	.05 mm	8.14
N-Nitrosodiphenylamine	40	7,200 37			
Phenanthrene	80	300,000 5			
Pyrene	83	390,000 90			
PCBs (ug/kg)					
Arochlor-1248	14	18,000 50			
Arochlor-1254	11	1,600 50			
Arochlor-1260	7	8,200 50			

NOTES:

1. Frequency of detection based on field samples only.
2. Total number of samples collected: 110
3. Parameter list includes only those chemicals detected in 1988 field investigation and 1985 RI.
4. Minimum concentration listed includes estimated (J) values.

TABLE 2.2
SUMMARY OF PROJECTED RISKS

Task	Activity	Potential Hazard	Prevention
1. Field Engineering & Surveying	Monitoring progress of cap and FRB construction	1. Slip, trip and fall hazards. 2. Possible exposure to site contaminants via inhalation and skin contact.	1. Safe work practices (see Sec. 6) 2. Air monitoring (see Sec. 7)
2. Clearing, Grubbing, Brush Removal, and Grading	Site FRB construction and areas to be cleaned.	1. Falling trees and limbs. 2. Equipment running over or crushing personnel. 3. Equipment backing over personnel. 4. Chain saw injuries. 5. Overturning equipment. 6. Uncovering buried drums and containers. 7. Possible exposure to site contaminants via inhalation and skin contact. 8. Damage to hearing.	1. Wear hard hat. Stay away from areas being cleared of trees and limbs. Equipment to be provided with canopies, guards and ropes. 2. Be alert to moving construction vehicles. Bucket shouldn't obstruct operator's view when traveling. 3. Ascertain construction vehicle back-up alarms are working and listen for their activation while working. 4. Chain saw guards in place at all times. Avoid getting saw into vines or small limbs which may pull saw into operator. Use safety can for fuel mix supply. 5. Check equipment for mechanical defects. Provide proper operator training. 6. Notify appropriate persons. (See Drum Handling & Removal Section.) 7. See Sections 6 and 7. Wet down areas. 8. Wear hearing protection. 9. Air monitoring (see Sec. 7). Stop work when reaching Action Levels and take proper precautions noted in Chapter 7.

AR004746

TABLE 2.2

SUMMARY OF PROJECTED RISKS

Task	Activity	Potential Hazard	Prevention
3. Temporary Construction Facilities	Building, fabricating and setting up facilities including required fencing.	1. Swinging loads over personnel. 2. Transporting soil to various areas. 3. Possible exposure to site contaminants via inhalation and skin contact. 4. Entangled in auger.	1. Avoid standing under overhead loads. 2. Cover truck loads with tarps. 3. Wet down dusty areas. 4. Avoid wearing loose or hanging clothing.
4. Unloading Incoming Materials	Loading and unloading materials from trucks and vehicles (i.e., soils, fencing, pipes, general supplies, etc.)	1. Swinging loads over personnel. 2. Cables under tension. 3. Material slipping or rolling. 4. Vehicle movements to/from unloading area. 5. Unloading of soil onto site personnel. 6. Back/lifting injuries.	1. Avoid standing under overhead loads. Know proper hand signals when hoisting. 2. Stay clear of cables and strapping under tension. 3. Unload onto level areas. 4. Provide spotter when moving equipment. 5. Stay clear and away from tailgate/dump truck unloading operation. 6. Provide training in proper lifting procedures. Request assistance if load is too heavy.
5. Site Preparation	Similar to site FRB construction and areas to be cleared. Includes hauling and heavy construction equipment usage.	Similar hazards as Item #2 (Clearing, Grubbing, Brush Removal and Grading). ADD: 1. Transporting soils/materials to various areas. 2. Unanticipated movement of equipment. 3. Sudden equipment start-up or activation while surveying or maintenance is being performed.	Similar Preventions as Item #2. ADD: 1. Wet down dusty areas. Cover truck loads with tarps. Segregate any contaminated soils. 2. Secure equipment to prevent it being started or moved after it is parked or by unauthorized persons. 3. Lock out and tag out equipment before servicing. Maintenance person to isolate all energy sources and secure ignition key in their pocket.

AR004747

TABLE 2.2
SUMMARY OF PROJECTED RISKS

Task	Activity	Potential Hazard	Prevention
6. Dewatering	Pumping out ground water. Discharging ground water into on-site pond.	1. Inhalation of off-gases and vapors/mists from agitated ground water. 2. Splashing from discharge hose into worker's eyes, mouth, or onto skin. 3. Slips, trips and falls when setting up lengths of hose.	1. Avoid areas of agitated ground water causing off-gassing. Wear required PPE when working in these areas. 2. Direct discharge hose to eliminate potential for splashing. Secure hose to prevent movement. Wear PPE if splashing or misting occurs. Try to avoid area. 3. Wear proper safety shoes with good gripping surfaces and tread. Soles should not be worn smooth. Special care and precautions needed in wet, slippery conditions around hoses.
7. Drum Excavation & Handling	Uncovering of buried drums and containers during routine site clearing, grading and preparation activities.	1. Toxic exposure. 2. Potential for fire or explosion. 3. Spills and contaminated soils. 4. Movement of drums/containers causing potential for leaks, spills, and exposure to workers.	1, 2 & 3. See sections on Drum Excavation and Handling; Air Monitoring. In general, notify authorities and isolate area to prevent worker exposure. Contain any leakage and safely remediate. Segregate contaminated soils. 4. Inspect drums and containers prior to being moved. Notify all employees potentially exposed to drums/containers being transferred of hazards associated with contents.
8. Backfilling	Movement of soils for "filling-in" and stabilizing.	1. Construction equipment movement. 2. Possible exposure to site contaminants via inhalation.	1. Stay clear of moving equipment and surface openings. 2. See Sections 6 and 7. Wet down areas when dusty.

AR004748

2.3 DESCRIPTION OF REMEDIATION FIELD ACTIVITIES

The Contractor shall fully describe each of the major categories of construction activities planned to be used and assess both the potential hazards and minimum protection levels required. The Contractor shall assess the following work activities, at a minimum, in detail as part of the Contractor's Safety, Health and Emergency Response Plan (SHERP). The levels of protection described below are minimum levels of protection; the Contractor may need more stringent protection depending upon the specific construction activities to be undertaken and/or the results of work area air monitoring.

The rationale for levels of protection is based upon the potential for generating dust or releasing vapors during the course of remedial activities. Respirable dust levels at 5 mg/m³ are not expected at the outset of activities. Level D will be required initially with an option for wearing a dust mask. At respirable dust concentrations of 5 mg/m³ and above, respiratory protection will be upgraded to, at minimum, a half face respirator equipped with disposable cartridges approved containing high efficiency particulate filters (NIOSH/MSHA approved) (see full description of standard personal protective equipment triggered by this action level in "Level C-Particulates" as described in Section 2.4.3). If volatile organic vapor levels exceed 5 ppm greater than background persistently in the breathing zone of the worker who has the potential for greatest exposure, the respiratory protection will be upgraded to a full facepiece respirator equipped with appropriate cartridges for toxic dusts, fumes and mists (see full description of standard personal protective equipment triggered by this action level in "Level C-Vapors" as described in Section 2.4.2). For organic vapor concentrations in excess of 5 ppm persistently above background, supplied air will be required (see full description of standard personal protective equipment triggered by this action level in "Level B" as described in Section 2.4.1).

Air monitoring results will form the basis for determining levels of respiratory protection during site activities, as follows:

Particulates - The action level for upgrading to a half-face respirator is 5 mg/m³ respirable particulate. For concentrations below 5 mg/m³, dust masks will be available to workers as optional equipment. For concentrations above 5 mg/m³, a full facepiece air purifying respirator will be required. The rationale for the selection of 5 mg/m³ respirable particulate as the action level is provided in Section 2.4.

Organic Vapors - The action level for upgrading to a full facepiece air purifying respirator equipped with combination organic vapor/particulate cartridges will be persistent organic vapor readings above background to 5 ppm above background in the breathing zone of the most exposed worker. For persistent readings greater than 5 ppm above background, supplied air respirators will be required.

Protective clothing will be worn to limit skin contact, and safety gear will protect against physical hazards, as determined based on site conditions by the Site Safety Officer. Minimum levels of protection will be as specified below. The Contractor has the option of incorporating more stringent guidance as conditions warrant. Table 2.3 lists levels of protection and the corresponding exposure limits.

TABLE 2.3	
Protective Level	Allowable Exposure Limits
D	0-1 ppm volatile organics (above background) 0-5 mg/m ³ particulates
C	1-5 ppm volatile organics (above background) >5 mg/m ³ particulates
B	5-500 ppm volatiles (above background)

Field Engineering and Surveying

Field engineering and surveying will be performed in all areas of the site. These activities will include monitoring the progress of cap and FRB construction, and various other site tasks. The level of protection for each activity will depend on the likelihood of exposure to contaminants. In general, surveying work will take place above ground, without appreciable risk of coming in contact with contaminated soil. This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades. Most field engineering will also take place above ground and may require Level C-Particulate protection.

Clearing, Grubbing and Brush Removal

Clearing, grubbing and brush removal prior to proposed cap and FRB construction activities will be the first task performed. The clearing of all trees will take place above the

ground surface. Clearing, grubbing and brush removal may result in the disturbance of some soil. Whenever the ground surface is disturbed, proper air monitoring will be required. This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades. It may be necessary to upgrade to Level C Particulate or Vapor personal protective levels should airborne contaminants be detected. Since these tasks will require the use of motorized equipment, the hearing protection requirements as contained in 29 CFR 1926.52 shall be met, as appropriate.

Temporary Construction Facilities

Electricity, telephone, water, sanitary facilities, first aid, fire protection, site security, access roads and parking, field offices, staging area, decontamination area and temporary and chain link fences will be installed on the site. The level of protection for each activity will depend on the likelihood of exposure to contaminants. This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades. Any activities which involve excavation or augering will require air monitoring and Level C-Particulate protection. It may be necessary to upgrade to Level C-Vapor respiratory protection if volatile vapors are detected. Electrical work performed shall be in accordance with requirements contained in 29 CFR 1926.400.

Unloading Incoming Materials

Materials such as imported fill (soil), topsoil, seed, filter fabric, select backfill, fencing, equipment, etc. will be delivered during the course of the project. This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades. If unloading of the materials disrupts waste fill or contaminated surfaces, Level C-Particulate personal protective equipment will be required along with air monitoring. Vehicles leaving a contaminated area shall be decontaminated. Vehicles that did not come in contact with waste fill or contaminated areas will not require decontamination. The drivers shall remain in the vehicles during the entire time which the vehicle is within project limits, otherwise the driver shall undergo personal decontamination.

Site Preparation/Grading

Site preparation will involve numerous activities such as heavy equipment operations and on-site hauling of the excavated material. Each activity may require a different level of protection, dependent on the risk of exposure to contaminants. Excavation of fill and native soils will potentially expose workers to both contaminated soil and contaminated ground water. This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades. Real-time air monitoring will also be required. Hauling and redistribution of the excavated material on-site to achieve desired grades may require Level C particulate or vapor protective equipment. The redistributed on-site soils/waste fill should be compacted as soon as possible.

Dewatering

Ground water may be encountered during cap and FRB construction activities. This water will be pumped out and discharged into the on-site pond or depressions. The water being pumped may be contaminated and therefore all personnel involved in this activity will be required to wear Level D protective equipment, using the guidance outlined above for respiratory/personal protective upgrades. Real-time air monitoring will also be required.

Drum Excavation and Handling

The Contractor may encounter drums and containers containing unknown substances during site grading and preparation. The Contractor will be required to place exhumed drums in overpacks as necessary, log and field screen them using an appropriate hazardous material field screening kit, and immediately transport them to the on-site drum accumulation area for sampling and analysis prior to final disposition. If buried drums and containers are damaged in-place or during removal and materials are released, the Contractor will be required to collect those materials to the maximum extent practical and place the released materials in clean drums. The Contractor will also be required to transfer the drummed materials to the on-site accumulation area for subsequent sampling prior to final disposition.

In general, drum excavation will proceed from the downwind end of the area towards the upwind end. The excavation area will be monitored for volatile organic vapors using a flame ionization detector (FID), and/or a photoionization detector (PID). At this time a

USACE representative may also log materials and collect samples for chemical analysis. The Contractor's foreman will direct the Contractor's personnel and equipment during the drum excavation. Other personnel, with the exception of the USACE representative will stand clear of the immediate area during the drum excavation. All work will proceed in a slow controlled manner so as to minimize the potential dangers associated with excavation and extraction of buried drums or other forms of waste materials.

Level C-Vapor protective equipment will be required if the total organic vapor reading in the breathing zone is between 1 ppm to 5 ppm above background.

All drum excavation work shall be conducted in accordance with OSHA interim standard, 29 CFR 1910.120, (Hazardous Waste Site Operation and Emergency Response).

Backfilling

This work will, at minimum, require all personnel to wear Level D health and safety protection, using the guidance outlined above for respiratory/personal protective upgrades.

2.4 LEVELS OF PERSONAL PROTECTIVE EQUIPMENT

The Contractor shall provide all on-site personnel including the Contracting Officer and visiting USACE, USEPA and PADER personnel with appropriate personal safety equipment and protective clothing. The Contractor shall provide up to four sets of equipment for Contracting Officer's Use. The Contractor shall ensure that all safety equipment is used properly and protective clothing is kept clean and well maintained. The Contractor's certified Industrial Hygienist shall establish "action levels" at which the specified minimum levels of protection are either upgraded or downgraded based upon air monitoring results and direct contact potential. Protocols for formally changing the level of protection and the communication network for doing so shall be described in the SHERP.

The action level for dust is protective for exposure to PAHs, which have been detected at high concentrations in unsaturated soil samples on-site. The action level for volatile organics is based on USEPA's rationale for total organic vapors. This method was adopted as a conservative measure, because of the variety of construction activities planned, including intrusive activities at various locations on-site.

The high concentration of PAHs in unsaturated soil samples is of concern from an inhalation standpoint, on the site. The OSHA permissible exposure limit (PEL) which is

applicable for these compounds is the PEL for coal tar pitch volatiles. Coal tar pitch is composed almost entirely of PAHs consisting of anthracene, benzo(a)pyrene, phenanthrene, acridine, chrysene and pyrene. Five of these PAHs were detected in unsaturated soil samples collected on-site:

Anthracene	31 - 180,000 ug/kg
Benzo(a)pyrene	27 - 190,000 ug/kg
Phenanthrene	5 - 300,000 ug/kg
Chrysene	77 - 140,000 ug/kg
Pyrene	90 - 390,000 ug/kg

The sum of the maximum values is 1,200 mg/kg. If it is assumed that, during dusty conditions of 5 mg/m³, the airborne concentrations of coal tar pitch volatiles is in the same proportion as is found in the soil (using the maximum values), the level would be 0.006 mg/m³ coal tar pitch volatiles, which is 3% of the coal tar pitch volatiles PEL. Therefore, an action level of 5 mg/m³ respirable dust is protective regarding likely exposure to these PAHs in airborne dust.

The standard USEPA levels of protection are described as follows. While the respiratory protection shall be determined by the action levels, the needs for upgrading protective clothing shall be determined by the Site Safety Officer based upon the potential for inhalation or other opportunity for skin contact; safety gear will also be determined based upon safety hazards.

2.4.1 Level B

Level B protection should be selected when the highest level of respiratory protection is needed. The following equipment comprises Level B protection:

- Pressure-demand SCBA or supplied air respiratory system (OSHA/NIOSH approved), operated in the positive pressure mode and equipped with an emergency escape cylinder.
- Hooded, one-or two-piece chemical-resistant suit, Saranex-coated Tyvek or equivalent.
- Gloves - Outer (Neoprene, nitrile or equivalent).
- Gloves - Inner (latex).

- Boots - Outer (Neoprene).
- Boots - Inner (steel toe and shank).
- Two-way radio communications.
- Hard hat.

Level B protection will be used for the following conditions:

- Total vapor levels exceeding 5 ppm above background in the breathing zone as indicated on a volatile organic vapor analyzer [i.e., Flame Ionization Detector (FID) or Photoionization Detector (PID)].
- Confined space entry.

2.4.2 Level C-Vapor

Level C-Vapor protection shall be selected when the types and concentrations of respirable material are known, when appropriate air purifying cartridges are available for the known contaminants, and continuous air monitoring of the site and individual work areas has been established.

The following equipment comprises Level C protection:

- Full-face piece, air-purifying respirator with disposable combination organic vapor, and high efficiency particulate air (HEPA) cartridges (MSHA/NIOSH approved).
- Hooded one-or two-piece chemical resistant suit, Tyvek or equivalent (Saranex coated if splash hazard exists).
- Gloves - Outer (Neoprene, nitrile or equivalent).
- Gloves - Inner (latex).
- Hard hat.
- Boots - Outer (Neoprene); Inner (steel toe and shank); or combination.
- Two-way radio communications (for remote operations).
- Escape air mask [for imminent danger to life or health (IDLH) conditions].

Level C-Vapor protection will be utilized under the following conditions:

- The types of hazards encountered on-site are well known and are compatible with Level C protective equipment.
- Total organic vapor reading in the breathing zone of between 1 ppm above background to 5 ppm above background as indicated on an PID or a FID.
- Limited contact with soils and ground water in contaminated areas, such as trench excavation, dewatering, soils removal and monitoring well installation.

Air purifying respirators shall not be used in IDLH atmospheres or in atmospheres containing less than 19.5% or greater than 22% oxygen by volume.

2.4.3 Level C-Particulate

Level C-Particulate will be required when dust levels in the work zone exist at equal to or greater than 5 mg/m³ and total organic vapor levels are below upgrade action levels. The following equipment comprises Level C protection:

- Half-face piece air purifying respirator with disposable high-efficiency particulate air (HEPA) cartridges (NIOSH/MSHA approved), as appropriate relative to detected contaminants.
- Gloves - Outer (Neoprene, nitrile or equivalent).
- Gloves - Inner (latex).
- Hooded one- or two-piece chemical resistant suit, tyvek or equivalent (saranex coated if splash hazard exists).
- Hard hat.
- Boots - Outer (Neoprene); Inner (steel toe and shank); or combination.
- Two-way radio communications (for remote operations).

When dust levels in the work zone exist at equal to or greater than 5 mg/m³, as indicated by a respirable dust monitoring instrument, a half-face air purifying respirator with disposable HEPA cartridges shall be worn. Air purifying respirators shall not be used in IDLH atmospheres or in atmospheres containing less than 19.5% or greater than 22% oxygen by volume. Level C-Particulate will be utilized where there is limited potential contact with soils in contaminated areas. General activities include Contaminant Reduction

Zone activities or Exclusion Zone activities such as clearing and grubbing, sheet pile installation and removal and backfilling.

2.4.4 Level D

Level D is the basic work uniform and should be worn only outside the Contaminant Reduction Zone and Exclusion Zone at this site. The following equipment comprises minimum Level D protection:

- Coveralls (Tyvek).
- Boots/shoes - steel toe and shank.
- Hard hat (face shield optional).
- Gloves.
- Safety Glasses.
- Two-way Radio Communications.

Level D protection will be utilized under the following conditions:

- No total toxic materials are known to exist as indicated by no readings above background levels on volatile organic vapor analyzers (i.e., PID and/or FID) and dust levels of less than 5 mg/m³.
- General work activities such as in the Support Zone, namely reconnaissance, traffic control, equipment transfer and construction of Support Zone activities.
- Oxygen levels are at least 19.5% or less than 22% oxygen by volume.

3.0 MEDICAL SURVEILLANCE AND EXPOSURE MONITORING

3.1 MEDICAL SURVEILLANCE

Contractor and subcontractor personnel, whose work may involve potential chemical exposure or present unusual physical parameters, will have initial employment, annual, and employment termination examinations. Medical evaluations will be performed by an occupational physician designated by the Contractor.

Purpose - The purposes of the medical evaluation are to: 1) determine fitness for duty on hazardous waste sites, and 2) establish baseline data for future reference. Such an evaluation is based upon the employee's occupational and medical history, a comprehensive physical examination, and an evaluation of the ability to work while wearing protective equipment.

Supplemental Examinations - Supplemental examinations may be performed whenever there is an actual or suspected excessive exposure to chemical contaminants or upon experience of exposure symptoms, or following injuries or temperature stresses.

Medical Records - In conformance with OSHA regulations, the Contractor will maintain and preserve medical records for a period of 30 years following termination of employment. Employees or their designated representative are the only persons who shall have access to the results of medical testing and medical records and analysis. Medical records will not be released to any person without express written consent of the employee.

Contractor - The Contractor must supply medical certification for all Contractor and subcontractor personnel who will work at the Millcreek site. All Contractor and subcontractor personnel involved in site activities will undergo a baseline medical examination at the expense of the Contractor, conducted by a board certified physician practicing occupational medicine. Contents of the examination must be determined by the Contractor or subcontractor's medical consultants, who will have been provided by the Contractor or subcontractor with adequate information on the site hazards to enable an evaluation of fitness to be made. The examination must include an OSHA-type evaluation of the workers' ability to use respiratory protective equipment. Personnel who have undergone the medical examination and analyses within the past year may not need to be re-examined. A medical

approval is required prior to the start of work from the Contractor's or subcontractor's medical consultant to the USACE Contracting Officer certifying the medical fitness of each person to perform his duties and to wear respiratory protection.

Medical Examinations - Medical surveillance protocol is the physician's responsibility but shall meet applicable OSHA the requirements contained in standard 29 CFR 1910.

3.2 EXPOSURE MONITORING

Whenever feasible, the level of protection established for workers will be based upon quantitative determinations of the chemical agents and physical stresses present in the work environment.

Heat Stress Monitoring - Heat stress is probably one of the most common and potentially serious illnesses at hazardous waste sites. The potential for heat stress is dependent on a number of factors, including environmental conditions, clothing, workload, physical conditioning, and age. The effects of heat stress can range from mild symptoms, such as fatigue, irritability, and decreased mobility, to death. The body's responses to heat stress include the following:

- **Heat Rash:** A result of continuous exposure to heat and humidity, heat rash decreases the body's ability to tolerate heat.
- **Heat Cramps:** A result of profuse perspiration with inadequate fluid intake and chemical replacement, heat cramps are signaled by muscle spasms and pain in the abdomen and the extremities.
- **Heat Exhaustion:** A result of increased stress on various organs. The signs of heat exhaustion include shallow breathing; pale, cool, moist skin; profuse sweating; dizziness and lassitude.
- **Heat Stroke:** The most severe form of heat stress, heat stroke must be relieved immediately to prevent severe injury or death. The signs of heat stroke are red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; coma. The body must be cooled and medical attention sought immediately.

Measures to prevent heat stress include regular work breaks during field activity, regular fluid replenishment, and the availability of shelter (i.e. shaded area). All personnel

will be made aware of the symptoms of heat stress. Should one or more symptoms be detected, the affected worker will be assisted to seek shade, drink plenty of fluids, and seek medical attention, if required.

Heat stress monitoring of all personnel will commence when the ambient temperature in the work areas is above 70°F. Monitoring of heat stress conditions for persons wearing impermeable clothing shall comply with current ACGIH TLV's for heat stress. The frequency of heat stress monitoring shall depend initially on the air temperature adjusted for solar radiation and the level of physical work. A standard mercury-in-glass thermometer shall be available on site to measure air temperature. The frequency of heat stress monitoring shall govern the length of each work cycle.

Several screening techniques can be used to detect early warning signs of heat stress. The following method, based on body temperature measurements, is simple and straightforward and may be conducted by the Site Safety and Health Officer as indicated. Body temperature may be measured with a digital-readout clinical thermometer with disposable tips.

Body temperature may be measured orally (3 minutes under the tongue) with a clinical thermometer at the end of each work period and before drinking. Oral temperature and the end of the work period should not exceed 99.6°F. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. However, if the oral temperature exceeds 99.6°F at the beginning of the next rest period, the following work cycle should be further shortened by 33%. Oral temperature should be measured again at the end of the rest period to make sure that it has dropped below 99°F. No worker may be permitted to continue wearing semipermeable or impermeable garments when his/her oral temperature exceeds 100.6°F.

Cold Exposure - Field personnel may be required to work under conditions at or below freezing which could contribute to frostbite. Extreme cold for a short time may cause severe injury to the surface of the body or result in profound generalized cooling, causing death. Areas of the body that have a high surface-area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible to frostbite.

Two factors influence the development of a cold injury: ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in

combination with low temperature. For instance, 10°F with a wind of 15 mph is equivalent in chilling effect to still air at -18°F.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of five mph increases to ten mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is soaked with perspiration.

Some conditions of cold stress:

1. **Frost nip or incipient frostbite.** The condition is characterized by sudden blanching or whitening of the skin.
2. **Superficial frostbite.** Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
3. **Deep frostbite.** Tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: (1) shivering, (2) apathy, listlessness, sleepiness and (sometimes) rapid cooling of the body to less than 95°F, (3) unconsciousness, glassy stare, slow pulse and slow respiratory rate, (4) freezing of the extremities, and finally, (5) death.

SYSTEMIC HYPOTHERMIA

Risk Factors

- medications/drugs
- alcohol
- wetting
- wind
- medical conditions (circulatory problems)
- age

Recognition

- mild hypothermia
 - subtle behavioral changes
 - decreased worker efficiency
 - decreased level of communication
 - forgetfulness
 - repetitive behavior
 - poor motor skills
 - poor judgement

- distraction
- denial
- most thermoregulatory mechanisms intact
- shivering
- goose flesh
- peripheral vasoconstriction (cold pale skin)
- person feels cold

- moderate hypothermia
- conscious
- incapable of functioning effectively
- grossly disoriented mental function
- behavioral changes
- stupor
- disorientation
- hallucinations
- inappropriate affect
- bizarre behavior
- some loss of thermoregulatory mechanisms
- shivering absent
- goose flesh disappears
- slowed heart rate
- dilated peripheral blood vessels
- diminished feeling of cold

Treatment

All Stages

- rewarming
- passive - conservation of body heat
- active - applying heat

COLD STRESS

Types

- Systemic hypothermia
- Local hypothermia

Consider

- Air temperature
- wind speed
- equivalent chill temperature

Warning Signs

- Systemic - maximum severe shivering
- Local - pain in the extremities

HYPOTHERMIA: Prevention/Recommendations

- loose fitting, dry clothing; outer windbreak garment
- high calorie diet
- avoid bare metal
- avoid exposure to moisture
- adequate work/rest periods
- avoid/limit risk factors
- availability of enclosed, heated environment
- availability of dry changes of clothes
- conduct body temperature monitoring
- availability of hypothermia packs
- fluid replacement (warm drinks, soup)
- buddy system

LOCAL HYPOTHERMIA

Types

- frostnip
- superficial frostbite
- deep frostbite
- trench foot - non-freezing
- immersion foot - non-freezing

Risk Factors

- duration of exposure
- ambient temperature
- wind
- contact with cold metal or moisture
- clothing
- race
- acclimatization
- previous cold injury
- host factors (medications, smoking)

Recognition

- frostnip
 - whitened area of skin
 - slightly burning or pain
- superficial frostbite
 - waxy, white skin; firm sensation; some resiliency
 - feels warm to victim without pain
- deep frostbite
 - skin cold, numb, pale, firm or hard

Treatment

frostnip

simple rewarming

frostbite

transport rather than definitive care as thawing and refreezing

can cause severe damage

institute basic measures, as follows:

DO

prevent further heat loss and protect from further damage (cover); get victim to protected environment

DO NOT

allow victim to smoke or drink alcohol, rub skin with anything; thaw with warm water or dry heat; walk on thawed foot/use thawed hand; break any blisters; apply heat

4.0 HAZARD COMMUNICATION AND TRAINING

4.1 HEALTH AND SAFETY ORIENTATION TRAINING

All Contractor and Subcontractor personnel involved with the remediation activities will have completed the health and safety training requirements of 29 CFR 1910.120. This training, designed to orient personnel potentially exposed to hazardous substances, health hazards, or safety hazards, includes the following:

- Safety and health risk analysis;
- Use of personal protective clothing;
- Work practices by which the employee can minimize risks from hazards;
- Safe use of engineering controls and equipment;
- Medical surveillance requirements including recognition of symptoms and signs which might indicate overexposure to hazards;
- General safety concepts; and
- Emergency response plans.

4.2 SPECIALIZED TRAINING

All Contractor and subcontractor field personnel will be knowledgeable in the particular hazards that may be encountered during this project and shall be familiar with all safe operating procedures. They shall be trained to a level that will be consistent with the worker's particular job function and responsibilities. Field personnel shall also be familiar with all emergency response procedures outlined in the SHERP.

4.3 PRE-REMEDIATION HEALTH AND SAFETY BRIEFING

All Contractor and subcontractor personnel involved with the project shall attend a site-specific health and safety training program. The topics to be discussed include:

- Characteristics and potential hazards of chemicals and other contamination known to be present at the site;
- Personal protective clothing: function, donning/doffing, demonstrations;
- Respirators: selection, use, care;
- Personal hygiene;
- Environmental monitoring;
- Decontamination procedures;
- Work zone designations;
- Heat stress;
- General safety concepts; and
- Site contingency plans.

4.4 SAFETY MEETINGS

Safety and health briefings will be conducted at least weekly by the Site Safety and Health Officer as designated by the Contractor. Problems relative to respiratory protection, inclement weather, heat stress, or the interpretation of newly available environmental monitoring data are examples of topics which might be covered during these briefings. An outline report of meetings giving the date, time, attendees, subjects discussed, and instructor shall be maintained and copies furnished to the designated authority on request. Visitors shall be properly oriented to existing site conditions, planned activities, levels of personal protection and other procedures outlined in the Contractor's SHERP.

4.5 POST-REMEDIATION HEALTH AND SAFETY BRIEFING

A post-remediation health and safety briefing shall be conducted by the Site Health and Safety Officer to review, discuss, and evaluate past project activities. The effectiveness of the Safety Program Plan shall be evaluated. An outline report of the meeting shall be submitted to the Contracting Officer.

5.0 SITE CONTROL

A log containing the names of personnel, site entry and exit times and their levels of personal protection will be maintained by the Site Safety and Health Officer.

5.1 ACCESS/EGRESS

Access and emergency egress routes will be shown on the Contractor's drawings.

5.2 WORK ZONES

Work Areas or Zones shall be designated by the Contractor. The Contractor shall clearly layout and identify these Zones in the field and shall limit equipment, operations and personnel in the Zones as described in USEPA Standard Operating Safety Guides.

Exclusion Zone(s) (Hazardous Work or Hot Zone). Initially the entire site shall be designated the Exclusive Zone. After establishing the Support and Contamination Reduction Zones, the remaining portions of the Site shall be the Exclusion Zone as designated on the drawings. The level of personnel protective equipment required in this Zone shall be in accordance with the requirements of Section 2.4 as a minimum or as determined by the Safety Officer after monitoring and on-site inspection.

- **Contamination Reduction (Buffer) Zone(s).** This Zone will occur at the interface of Exclusion and Support Zones and will provide for the transfer of construction materials from clean areas to site dedicated equipment, the decontamination of waste transport vehicles prior to entering the Support Zone, the decontamination of personnel and clothing prior to entering the Support Zone, and for the physical segregation of the Support and Exclusion Zones. The level of personnel protective equipment required in this Zone shall be in accordance with the requirements of Section 2.4 as a minimum or as determined by the Safety Officer after monitoring and on-site inspection.
- **Support (Safe or Clean) Zone(s).** This Zone will be established on the Site and is defined as the area outside the zone of significant contamination. The Support Zone shall be clearly delineated and shall be secured against active or passive contamination from the work site. Eating, drinking and smoking will be allowed only in this Zone. The level of personnel protective equipment required in this Zone shall be in accordance with the requirements of Section 2.4 as a minimum or as determined by the Safety Officer after

monitoring and on-site inspection. The function of the Support zone is to provide:

- An entry area for personnel, material and equipment to the Exclusion Zone of site operations.
- An exit area for decontaminated personnel, materials and equipment from the Contamination Reduction Zone of site operations;
- An area for location of Support Area facilities; and
- A storage area for clean safety and work equipment.

Examples of other "clean zones" on the site include areas which have been regraded and covered with clean soil, and new roadways not used for hauling potentially contaminated spoil.

Decontamination of personnel will be performed as outlined in Section 8.0 before entering the Support Zone. Access of non-essential personnel to the Exclusion and Contamination Reduction Zones will be strictly controlled. Only personnel who are essential to the completion of the task will be allowed access to these areas and only if they are wearing the prescribed level of protection. Entrance of non-contractor or subcontractor personnel must be approved by the Site Safety and Health Officer or the Contracting Officer.

6.0 SAFE WORK PRACTICES

The understanding of basic, precautionary concepts regarding personal health and safety is essential for field personnel assigned to sites where chemical contamination is known or suspected to be present. The Contractor should elaborate in his SHERP all safe work practices. At a minimum, the safe work practices to be detailed include:

- The number of personnel and equipment on the site should be minimized, consistent with effective site operations.
- On-site personnel will use the "buddy" system. No one may work alone, i.e., out of earshot or visual contact with other workers.
- Site activities will be performed to minimize dust production and soil disturbance. The maximum on-site vehicle speed will be 5 mph.
- Contact with surfaces/materials either suspected or known to be contaminated will be avoided to minimize the potential for transfer to personnel, the need for decontamination and cross contamination.
- All work areas will be lighted to not less than 5 foot candles. While most work will be conducted outdoors, portable lighting may be required to support work in the dawn or dusk hours.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice which increases the probability of hand-to-mouth transfer of contaminated material should be strictly prohibited on the site outside of the clean zone.
- The hands and face must be thoroughly washed upon leaving the work area and prior to engaging in any activity indicated above. Each individual must shower as soon as possible after the removal of protective clothing and equipment after the completion of the daily field activities.
- Medicine and alcohol can potentiate the effects of exposure to toxic chemicals. Due to possible contraindications, use of prescribed drugs should be reviewed with the contractor or subcontractor occupational physician. Alcoholic beverage and illegal drug intake are strictly forbidden during site work activities and is to be avoided during off-hours for the duration of field activity.
- Any respiratory protective equipment and clothing **must** be worn by personnel as outlined in the Contractor's SHERP. Excessive facial hair (i.e., beards, long mustaches or sideburns), which interferes with the satisfactory respirator-to-face seal is prohibited.

- When it is necessary for a visitor to observe the field work, that person will be issued appropriate personal protective equipment, briefed on potential hazards, safety practices, decontamination procedures and site communications by the Contractor. Respiratory equipment and proof of training/fit testing must be supplied by all site visitors to the Site Safety Officer. Site access will be denied those who do not have current medical clearance, training and fit test results.
- All employees have the obligation to correct or report unsafe work conditions.
- Use of contact lenses on-site will not be permitted. Workers wearing eyeglasses will be required to have a spectacle kit provided with their full-face respirator.

7.0 ENVIRONMENTAL MONITORING

7.1 AIR MONITORING INSTRUMENTATION

The following monitoring instruments are recommended for air monitoring during remediation activities:

- Foxboro Analytical Century Model OVA-128 Portable Organic Vapor Analyzer.
- HNU Model PI 101 photoionization detector fitted with a 11.7 eV lamp.
- MSA Portable Indicator and Alarm (Combustible Gas and Oxygen) Model 261.
- MIE, Inc. Miniram Model PDM-3 (Miniature Real-Time Aerosol Monitor).
- Four high volume particulate sampling stations.
- Wind sock.

The Contractor shall have the option of selecting equipment. If the Contractor selects an HNU volatile organic vapor analyzer for monitoring, a 11.7eV lamp will be required as the primary monitoring instrument. The OVA-128 shall be used as secondary monitoring instrument.

All monitoring instruments will be protected from surface contamination during use to allow easy decontamination. All instrumentation will be calibrated before use; periodic calibration checks will be made and documented in the field over the duration of the field activities.

Action levels will apply to persistent readings in the breathing zone of personnel conducting field remediation activities. Organic vapor action levels will be based on EPA's rationale for relating total atmospheric vapor concentrations to the selection of the level of personal protection as provided in the EPA 1988 Standard Operating Safety Guides.

7.2 AIR MONITORING REQUIREMENTS

Real-time air monitoring will be required near each active work zone in the Exclusion Zone and in the Contaminant Reduction Zone. Real-time monitoring of the work zone is required continuously during all activities in which the potential for exposure to contaminated soils or water exists, including monitoring well installation, excavation, staging or loading of potentially-contaminated soils and handling of contaminated liquids.

Background air concentrations for VOCs and particulates will be determined prior to the start of work each day. Instrument readings will be obtained at the site perimeter both downwind and upwind of the active work zone(s). The wind direction will be determined with the aid of a wind sock.

Real-time air monitoring for explosive atmospheres and for oxygen shall be performed in each work zone. For atmospheres at less than 10% of the lower explosive limit (LEL), work may be performed without additional precautions. For atmospheres between 10% and 25% LEL, work zone monitoring shall be continued, with extreme caution as higher levels are encountered. At greater than 25% LEL, an explosion hazard exists and workers should be withdrawn from the area immediately.

Oxygen levels at less than 19.5% oxygen by volume shall require continuous monitoring and self-contained breathing apparatus for workers. Oxygen levels between 19.5% and 25% by volume are acceptable to continue work. Deviations from the normal level may be due to the presence of other substances. Oxygen levels greater than 25% by volume present a fire hazard potential. Work should be discontinued and the fire department or other fire safety specialist should be consulted.

Recommended action levels for VOCs in the work zone are described in Section 2.4, with appropriate respiratory protection requirements. An action level of 5 mg/m³ for the respirable fraction of particulates in the work zone will be acceptable for determining when respiratory protection against dusts will be required. This limit is consistent with OSHA Permissible Exposure Limits (8-hour time-weighted average) in 29 CFR 1910.1000.

Real-time air monitoring of VOCs at the site perimeter will be required any time that respiratory protection from VOCs is in use in the work zone (e.g., Level B or Level C). VOC concentrations will be recorded hourly at both the upwind and the downwind site perimeters. To protect the health and welfare of the community, the Contractor will be

required to implement preventive measures if real-time site perimeter monitoring indicates that VOCs are persistently greater than background at the downwind site perimeter.

Real-time respirable particulate monitoring will be required continuously near the work zone during all earth-moving activities, including excavation, hauling and grading. A personal monitoring device (such as a Miniram) should be used for work zone monitoring; attaching the device to a fixed location near the work zone will be an acceptable particulate monitoring method. An action level of 5.0 mg/m^3 in the work zone will require respiratory protection for workers in the work zone or will necessitate dust source control by the Contractor to reduce work zone concentrations to acceptable levels. In the event that respirable dust concentrations in the work zone exceed 5.0 mg/m^3 , real-time air particulate monitoring will be required at the downwind site perimeter. If this real-time monitoring indicates respirable particulate concentrations in excess of 5.0 mg/m^3 at the site perimeter, the Contractor shall implement preventive measures (viz. dust source control) to protect the health of the community. The Contractor shall reposition particulate monitoring stations, as required or as necessary, when wind directions change.

Continuous (time-weighted) air particulate monitoring will be required at the site perimeter during all earth-moving activities. Monitoring stations shall be established at two locations at the site perimeter, upwind and downwind of the potential dust source. Respirable dust concentrations at the downwind site perimeter in excess of the OSHA Permissible Exposure Limit (5.0 mg/m^3 , 8-hour time-weighted average) will require the Contractor to implement preventive measures to protect the community health.

7.3 SAMPLING REQUIREMENTS

Remediation activities may generate dusts containing PAHs, PCBs and lead. In addition to the direct reading instrument used for determining respirable particulate levels for personal protection during site activities, integrated air samples will be collected to determine time-weighted average concentrations over the duration of workshifts. This information will be used to identify contaminant concentrations at the perimeter of the site, during site activities, and to determine need for engineering controls to limit exposures to these contaminants as work proceeds.

Particulate samples shall be collected with high-volume samplers, using the EPA Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method, 40 CFR 50, Appendix B). Monitoring stations shall be established at four locations, one upwind and the remainder downwind of the potential dust source. The Contractor shall reposition particulate monitoring stations, as required or as necessary, when wind directions change. At the initiation of the project, three samples from each station will be submitted for analysis of total suspended particulates, lead, and total PAHs. Levels will be compared against applicable standards such as ambient air quality guidelines and adjusted permissible exposure limits. As work proceeds, samples will be submitted for analysis of these parameters, at minimum, once a month. Analytical results will be reported to the Contractor within two weeks of sample collection.

8.0 DECONTAMINATION

8.1 PERSONAL DECONTAMINATION

The degree of decontamination required is a function of both a particular activity and the physical environment within which it takes place. Decontamination procedures will be according to Contractor's SHERP. Further, all on-site activities will be carried out in such a manner as to avoid undue contamination of personnel, protective equipment, tools and machinery.

Decontamination activities for the remediation activities will take place in an area designated as the Contamination Reduction Zone. The area is accessible by vehicle, facilitating decontamination efforts; the area will be clearly marked to segregate it from the Support Zone and the Exclusion Zone. Personnel egress to and from these sites shall be limited. This will minimize the potential spread of contaminated material to clean areas. Under no circumstances is a potentially-contaminated person to exit the site by any means other than through the Contaminant Reduction Zone. Upon leaving the site for lunch break or at the end of each work shift, personnel will be required to remove all contaminated protective clothing/equipment.

Upon completion of remediation activities at each break or at the end of each work shift, the work crew will proceed toward the designated decontamination area. Equipment (i.e., shovels, tools, etc.) will remain at the sites. A large plastic sheet will be placed on the ground in the Contaminant Reduction Zone. Disposable towels will be used to contain spilled and splashed water. Prior to removal, boot covers or boots, aprons and outer gloves will be washed in large tubs with a soap and water solution (i.e. Alconox), rinsed with fresh water, and removed. A bristle brush will be used to remove gross soil contamination. A pump sprayer will be utilized for each rinse station.

Unsoiled or decontaminated disposable protective equipment will be disposed of as trash. Wash and rinse water will be disposed of by the Contractor on-site at an on-site pond. Grossly contaminated equipment will be disposed of as fill under the topsoil cap.

8.2 DECONTAMINATION OF FIELD EQUIPMENT

Decontamination procedures are to be provided by the contractor for all remediation activities. These procedures shall be performed in the Contamination Reduction Zone.

8.3 DECONTAMINATION FOR MEDICAL EMERGENCIES

In the event of a minor, non-life threatening injury, personnel should follow the decontamination procedures as outlined above, and then administer first-aid.

In the event of a major injury or other serious medical concern, immediate first-aid is to be administered in lieu of further decontamination efforts unless the environmental conditions would be considered "Immediately Dangerous to Life or Health," in which case all personnel shall evacuate the area.

9.0 EMERGENCY EQUIPMENT AND COMMUNICATIONS

9.1 EMERGENCY EQUIPMENT

Emergency equipment will be readily accessible and distinctly marked. Contractor and subcontractor personnel will be familiar with the location and trained in the use of emergency equipment. Emergency equipment that will be available on-site includes:

Fire Extinguishers

- Fire extinguishers will be provided by contractor and subcontractors.
- Two Class A, B dry chemical fire extinguishers will be located on site. One will be located in field vehicles and one will be located within each on-site temporary facility. In addition fire extinguishers shall be located in the Contamination Reduction Zone.
- Fire extinguishers will be inspected, serviced, and maintained in accordance with the manufacturer's instructions. As a minimum, all extinguishers shall be checked monthly and weighed semi-annually, and recharged if necessary.
- Immediately after each use, fire extinguishers will be either recharged or replaced.
- Fire extinguishers will be suitably placed, distinctly marked, and readily accessible.

First Aid Kits - First Aid Kits will conform to Red Cross and other applicable good health standards, and will consist of a weatherproof container with individually-sealed packages for each type of item. First Aid Kits will be fully equipped before being sent out on each job and will be checked weekly by the Site Safety Officer to ensure that the expended items are replaced. First Aid Kits will be suitably placed, distinctly marked, and readily accessible.

Eye Wash - In the event of contamination by dust particles during any remedial activities, an emergency eye wash will be available on-site during all field activities. In such an emergency, the eye will be immediately flushed with large amounts of water, occasionally lifting the lower and upper lids. Professional medical attention should be sought

immediately. Emergency eye wash containers will be distinctly marked and located in areas known to all field personnel. The emergency eye wash will meet minimum requirements of ANSI Z358.1.

Emergency Sprayer/Shower - In the event that any part of the body comes in contact with contaminants during remedial activities, flushing facilities will be provided in the work area for immediate emergency use. Emergency flushing containers will be distinctly marked and located in areas known to all field personnel. If necessary, emergency medical attention will be sought.

In addition to the emergency equipment, portable sanitary facilities will be provided on site for use by Contractor personnel.

9.2 COMMUNICATIONS

Provisions for on-site communication will be available. Mobile CB radios, FM transceivers or other portable communication devices may be used to enable personnel to maintain contact with the Contracting Officer and Site Safety Officer during remedial activities.

In addition, a telephone will be maintained on site to allow for immediate contact with response personnel in the event of an emergency.

10.0 EMERGENCY INFORMATION/RESPONSE

10.1 EMERGENCY MEDICAL TREATMENT

In the event of a serious medical emergency, victims should be treated at an emergency-room equipped medical facility in Erie, PA. The Emergency Room Supervisor should be contacted in the case of a serious medical emergency for determination of the appropriate mode of transportation (i.e., by personal vehicle, ambulance, or ambulance after on-site treatment by paramedics). The hospital will be contacted and briefed on the situation, the potential hazards, and the substances involved. In addition, the Millcreek Police Department will be fully apprised of the proposed remediation activities. Written directions and map of the route to the hospital will be posted at the site during all activities.

10.2 PERSONAL INJURY

In the event of personal injury, emergency first-aid will be applied on site as deemed necessary. The individual will be decontaminated as appropriate and transported to the nearest medical clinic if needed. During all field activities, at least one person on the site shall be certified in First Aid.

10.3 RECOMMENDED ACTIONS FOR PERSONNEL EXPOSURE

- **Skin contact:** If appropriate, based on chemical-specific information, use copious amounts of soap and water. Wash affected area for at least 15 minutes. Decontaminate and provide medical attention. Eyewash stations will be provided on site. If necessary, transport to appropriate emergency facility as determined by emergency response personnel.
- **Inhalation:** Move to fresh air and, if necessary, transport to appropriate emergency facility as determined by emergency response personnel.
- **Ingestion:** Decontaminate and transport to appropriate emergency facility as determined by emergency response personnel.

10.4 ENVIRONMENTAL ACCIDENT (SPREAD OF CONTAMINATION)

If an IDLH atmosphere does not exist and adequate personal protective equipment is being used, secure spread of contamination whenever possible. The Contracting Officer and the Site Safety Officer will be notified. Other appropriate emergency response groups and management will be notified as necessary by the Site Safety Officer. The Site Safety Officer or Contracting Officer will also determine whether an evacuation of the immediate areas is necessary and will announce that decision. If possible, personnel should leave the area through the Contamination Reduction Zone. If this is not possible, personnel should leave via the shortest route.

10.5 ADVERSE WEATHER CONDITIONS

In the event of adverse weather conditions, the Site Safety Officer will determine if work can continue without sacrificing the health and safety of contractor and subcontractor workers. Some of the items to be considered prior to determining if work should continue are:

- Potential for heat stress or cold stress;
- Inclement weather-related working conditions;
- Limited visibility;
- Potential for electrical or dust storms.

10.6 FIRE PROTECTION AND PREVENTION

- Recommended practices and standards of the National Fire Protection Association (NFPA) and other applicable regulations will be followed in the development and application of Project Fire Prevention Programs.
- The Contractor will prepare and submit a Fire Prevention Plan for the approval of the Contracting Officer.

- Essential considerations for the Fire Prevention Plan will include:
 - Proper site preparation and safe storage of combustible and flammable materials.
 - Availability of the coordination with private and public fire authorities.
 - Adequate job-site fire protection and inspections for fire prevention.
 - Adequate indoctrination and training of employees.
- All storage, handling, or use of flammable and combustible substances will be under the supervision of qualified persons.
- All tanks, containers, and pumping equipment, portable or stationary, used for the storage or handling of flammable and combustible liquids, will meet the recommendations of the National Fire Protection Association.

10.7 EMERGENCY NUMBERS

Emergency telephone numbers will be available on site at all times in case of emergency.

11.0 RECORDKEEPING

It will be the responsibility of the Contractor to establish and assure adequate records of all:

- Exposure work-hours and a log of occupational injuries and illness.
- Accident investigations.
- Daily record of all first-aid treatments not otherwise reportable.
- Reports to insurance carrier or state compensation agencies.
- Reports required by the client.
- Record and reports required by Local, State, and Federal agencies.
- Related correspondence.
- Safety training.

In the event of any accident/incident, the Site Safety Officer will immediately notify the Contracting Officer. All accidents will be investigated, reported, and analyzed. Within two working days of any reportable accident, the Site Safety Officer will complete and submit to the Contracting Officer in Accident Report on ENG Form 3394 in accordance with AR 385-40 and USACE Supplement 1 to that regulation. Injured persons are responsible for reporting all injuries as soon as possible to the Site Safety Officer.

12.0 SAFETY AND HEALTH PERSONNEL ORGANIZATION

12.1 CONTRACTOR'S PERSONNEL

The Contractor's health and safety personnel organization will be comprised of the following key individuals having the responsibilities discussed.

12.1.1 Safety Officer/Industrial Hygienist

The Contractor's employee or Subcontractor with overall responsibility for the preparation, implementation and enforcement of the Site SHERP. The Safety Officer shall also conduct the initial site specific training on site and provide regular support for all health and safety activities, including upgrading or downgrading the level of personnel protection, as needed and only with documented approval by the Contracting Officer. The Safety Officer shall be a Certified Industrial Hygienist (American Board of Industrial Hygiene) with a minimum of three years of specialized experience on sites with hazardous wastes or hazardous materials with hazards similar to those anticipated on this project. This person shall also have demonstrable expertise in air monitoring techniques and development of respiratory protection programs for working in potentially toxic atmospheres. The Safety Officer shall have a broad working knowledge of State and Federal occupational safety and health regulations and formal educational training in occupational safety and health. The Safety Officer may delegate the implementation and enforcement of the SHERP to the Safety and Health Specialist/Industrial Hygiene Technician defined below, with regular on-site supervision and continued evaluation of effectiveness of the plans to be performed by the Safety Officer.

12.1.2 Safety and Health Specialist/Industrial Hygiene Technician

The Contractor's or subcontractor's employee assigned to the site on a full time basis for the duration of the project with functional responsibility for implementation and enforcement of the Site SHERP. The Safety and Health Specialist shall have authority to stop work any time unsafe work conditions are determined. The Safety and Health Specialist shall complete a daily diary of activities with Health and Safety relevance including

references to maintenance and calibration of Health and Safety equipment and shall maintain a written log containing the names of personnel, site entry and exit times and names of visitors. The Safety and Health Specialist/Industrial Hygiene Technician shall have a minimum of 6 months working experience on sites with hazardous wastes or hazardous materials with hazards similar to those anticipated on this project, and shall have a sound working knowledge of State and Federal occupational safety and health regulations. In addition the Safety and Health Specialist/Industrial Hygiene Technician shall have specialized training in personal and respiratory protective equipment program implementation and in the proper use of air monitoring instruments, air sampling methods and procedures and have current certification in first aid and CPR as provided by a recognized approved organization such as the American Red Cross or the American Heart Association. Name, qualifications and work experience shall be submitted to the Contracting Officer prior to commencement of work at the site.

12.1.3 Project Manager

The Contractor's employee responsible for conducting the work and for assuring that the work is conducted in accordance with the requirements of the Contract Documents. The Project Manager shall be site-dedicated for the duration of the Contract, and shall be experienced in and familiar with the management and day-do-day activities of hazardous waste clean-up operations.

12.1.4 Custodian

The Contractor's employee or subcontractor responsible for keeping all health and safety equipment clean and all facilities properly equipped and maintained.

12.1.5 Security Officer

The Contractor's employee responsible for maintaining the security of the Site.

12.1.6 Physician

A licensed physician, Board Certified Occupational Medicine by the American Board of Preventive Medicine, with experience in the practice of occupational medicine, and provided by the Contractor.

12.1.7 First Aid Technician

The Contractor shall have at least one certified First Aid Technician on the site at all times. This person may perform other duties, but shall be immediately available to render first aid when needed. The First Aid individual should be certified in First Aid and CPR by the American Red Cross or equivalent.

12.2 GOVERNMENT

The following key individuals should be identified as part of the government's health and safety organization.

12.2.1 Contracting Officer (CO)

Any person chosen by U.S. Army Corps of Engineers who has been delegated authority and responsibility for day-to-day surveillance activities.

12.2.2 On-Scene Coordinator (OSC)

Any person designated by the State Government for field surveillance duties. The Contractor shall take direction only from the Contracting Officer. Any responses or directives from the OSC will be directed only to the Contracting Officer.