WehranEnviroTech

FINAL ENGINEERING DESIGN REPORT FOR THE CLOSURE ACTION

OF THE BROOME COUNTY COLESVILLE LANDFILL

REMEDIAL DESIGN

Prepared for

BROOME COUNTY
DIVISION OF SOLID WASTE MANAGEMENT
Broome County, New York
and
GAF CORPORATION
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1.0 INTRODUCTION

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This Final Engineering Design Report was developed in accordance with the September 1991 Design Statement of Work for the Broome County Colesville Landfill Remedial Design and is based on comments received from NYSDEC and USEPA on the Preliminary Design Report submitted August 1992, and Pre-Final Engineering Design Report submitted February 1993. This work has been performed by Wehran-New York, Inc. for the Broome County Division of Solid Waste Management (Broome County, New York), and GAF Corporation (Wayne, New Jersey).

The Colesville Landfill site is located in Broome County, New York (see Figure 1-1). It is a Superfund site that has been the subject of a Remedial Investigation/Feasibility Study performed by Wehran-New York, Inc. The remedy for this site includes the following major components:

- Landfill final cover
- Collection of contaminated groundwater in the glacial outwash aquifer downgradient of the landfill using wells outside of the landfill and within the landfill
- Seep collection
- Collected water (groundwater and seep) treatment
- Discharge of treated effluent to surface water

This Engineering Design Report addresses the general features of the Remedial Design and related design criteria of the final cover. The areas related to design of the final remedy of the Colesville Landfill site included in this report are:

- Final Cover
- Limit of Waste
- Borrow Areas
- Stormwater Management

The design of the pumping and treatment systems are described in separate documents titled, Engineering Design Report for Groundwater Treatment System, also prepared by Wehran-New York, Inc.

The Final Engineering Design Report should be reviewed in conjunction with the Post-Closure Operations and Maintenance Plan, Construction Plans, and Final Technical Specifications for the Colesville Landfill prepared by Wehran-New York, Inc., dated April 1994.

The Landfill Closure Design also incorporates site data and information from the Remedial Investigation Report, dated April 1988; and the Conceptual Design Report, dated June 1992, both prepared by Wehran-New York, Inc.

2.0 SITE INFORMATION

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2.1 LAND USE

The Colesville Landfill site is situated within an area characterized as rural, with large tracts of undeveloped woodlands. Developed lands include large-scale agricultural tracts and scattered residential parcels. The largest, and nearest grouping of residential development is found in Doraville, located approximately one-half mile south of the site.

2.2 TOPOGRAPHY AND SURFACE DRAINAGE PATTERNS

Surface elevations within the Colesville landfill site range from approximately 1,400 feet above mean sea level (msl) in the undeveloped eastern section, to about 970 feet above msl along the western site boundary. Elevations on the Susquehanna River lowland vary between approximately 940 feet msl to 970 feet msl. The Susquehanna River in the vicinity of the site is at an elevation of approximately 940 feet msl.

Site drainage is primarily westward toward the Susquehanna River. However, the terrace upon which the landfill has been developed is dissected by streams on the north, east, and south. Accordingly, a dendritic pattern of surface water runoff has been developed. Drainage to the south occurs by overland flow shortly after the streams enter the lowland.

3.0 WETLAND IMPACTS AND MITIGATION

3.0 WETLAND IMPACTS

Remedial construction activities, including capping and borrow operations, discharge of treated effluent, stormwater discharge, and groundwater withdrawal, will affect the wetlands on and around the Colesville Landfill.

The impact to affected wetlands and the wetland mitigation are included in the Colesville Landfill Wetland Mitigation Compensation Wetlands Plan, prepared by Wehran-New York, Inc. and Wetlands Research Associates, Inc., dated March 1994 (see Appendix A).

The Plan describes the proposed action and has been approved by USEPA.

4.0 LANDFILL DESIGN

4.0 LANDFILL DESIGN

4.1 GENERAL

A final cover system is to be utilized in the remediation of the Colesville Landfill. The final cover system will incorporate gas venting, flexible membrane liner, barrier protection layer, topsoil, and stormwater controls.

The gas venting system will intercept, collect, and passively vent landfill gas to the atmosphere.

The flexible membrane liner, barrier protection layer, topsoil, and the stormwater controls will minimize the infiltration and percolation of stormwater through the waste. This will minimize the release of contaminants into the groundwater.

4.2 CONSTRUCTION LIMITS

A determination of the limit of waste was performed based upon interpretation of aerial photographs for visible disturbance. To more accurately define the limit of waste placement, a test pit investigation was performed by Wehran-New York, Inc., between July 22 and July 24, 1992.

The extent of waste placement was verified by excavating test pits across the site. The test pits were performed under the supervision of Wehran-New York, Inc. field personnel. Approximately 100 test pits were excavated and those that represented the edge of waste are shown on Figure 4.2.1. For areas not represented by test pits, visual observation of waste and historical data was relied on to define the limit of waste placement.

Interpretation of the data collected during this investigation has moderately changed the boundary of the proposed final cover. The new boundary is shown on Sheet 2 of 9 of the Construction Plans.

4.3 FINAL COVER DESIGN

4.3.1 General

The goal of the final cover construction is to reduce leachate generation within the landfill. The final cover and associated stormwater management features will greatly reduce the amount of water infiltrating into the waste by providing an impermeable barrier in addition to reducing surface ponding.

The final cover system proposed for this site is designed to fulfill the requirements of 6 NYCRR Part 360-2.13(p-s), effective December 31, 1988, revised May 28, 1991. The final cover system, from top to bottom includes a 6-inch topsoil layer, 24-inch barrier protection layer, 40 mil flexible membrane liner (FML), and a gas venting layer.

Two alternatives are presented in the Construction Plans for the barrier protection layer. Alternative 1 has a 12-inch drainage layer consisting of granular material, and a 12-inch soil layer of clean fill material with geotextile separating the two layers.

In Alternative 2, the 12-inch drainage layer has been replaced by a geosynthetic drainage layer. The geosynthetic drainage layer will be a geocomposite drain comprised of HDPE netting with geotextile bonded to each side. For this alternative, the barrier protection layer would be 24 inches thick and consist of fill material obtained from the on-site borrow.

The two final cover options are considered equivalent in function. Since the two alternatives are equivalent, the decision of which option to choose is basically economic. As such, the final cover alternative will be effectively determined by the option chosen by the successful low bidder for the project.

4.3.2 Subgrade Preparation

The existing cover soils will require regrading to provide a smooth, uniform surface to facilitate placement of the low permeability barrier cover (FML) and to effect positive drainage. Fill will be required to eliminate existing depressions or to contour slopes, as necessary. Cutting into the existing soil will be limited as much as possible to eliminate the risk of exposing any in-place waste. Once a suitable surface is prepared, the remainder of the construction will proceed.

4.3.3 Gas Venting Layer

The final cover system includes a gas venting layer beneath the FML barrier. The Colesville site has been dormant since 1984 and the average age of the in-place waste is estimated to be approximately 14 years old. As a result of the relatively long period since waste was deposited, gas generation at the site is expected to have diminished significantly.

Combustible gas migration surveys performed around the perimeter of the landfill indicate combustible gas is not currently migrating laterally from the landfill. As such, the 12-inch layer of granular gas venting material over the entire site is not necessary.

In recognition of the reduced amount of gas production at the site and the continued need for collection, various alternatives were investigated. The alternatives were evaluated on the basis of equivalency for the requirements found in 6 NYCRR Part 360, as well as for economical reasons.

Two alternatives for the gas venting (collection) layer have been proposed in place of the 12-inch soil layer required in 6 NYCRR Part 360. Since each alternate differs from the requirements of 6 NYCRR Part 360, a variance application is required (see Appendix E). The variance application discusses the equivalency of the alternates in relation to Part 360.

Alternate 1 consists of a geocomposite venting layer, a geonet with filter fabric bonded to both sides, and 6-inch slotted pipes trenched into the existing grade; Alternate 2 consists of 6-inch soil layer with 6-inch slotted pipes trenched into the existing grade. In order to determine the equivalency of the proposed alternatives to Part 360-2.13(p) requirements, equivalency calculations have been performed. Calculations are based upon the hydraulic transmissivity of each of the layers. The equivalency calculations performed are attached (see Appendix G).

The equivalency calculations for Alternate 1 shows the ability of the geocomposite layer to significantly exceed the capabilities of the required 12-inch soil layer in regard to transmissivity. The geocomposite in Alternate 1 is manufactured from polyethylene and resists degradation from chemical breakdown uniformly with the proposed 40 mil flexible membrane liner (FML). The geocomposite will be placed directly beneath the FML. As such, clogging of this layer is not anticipated. The liquid flow required as the mechanism for fines transport is away from this interface and not towards it. The relatively thick cross-section (fabric/net/fabric) of the geocomposite drain will perform as a cushion between the prepared landfill subgrade and the FML.

The equivalency calculations for Alternate 2 shows the 6-inch soil layer with increased minimum permeability requirements, 2×10^{-3} cm/sec, to be equivalent to the required 12-inch soil layer. The addition of collection pipes trenched within the layer will increase the layer's ability to control and collect gas. Due to the layer's similarity with the required soil venting layer, performance of the alternative in regard to chemical degradation, performance under loading, and impact on FML placement will be consistent with the required soil venting layer.

For these reasons, the gas venting layer alternatives will provide equivalent performance to the required 12-inch gas venting layer.

Each of the alternates will also include the installation of passive vents, as shown in the Construction Plans. The passive vents will consist of 6-inch diameter Schedule 40 PVC pipe which is placed vertically into the refuse to a depth of 3 feet. The vertical pipe will be connected to the slotted corrugated polyethylene pipe within the trench. The passive vents will be fitted with a gooseneck cap and extend a minimum of 8 feet above final grade.

4.3.4 Flexible Membrane Liner

The low permeability barrier cover for the landfill will be constructed of a flexible membrane liner (FML). The FML will consist of a 40 mil geomembrane in conformance with Part 360-2.13(r). The FML will be very low density polyethylene (VLDPE). This material is resistant to the constituents routinely found in the leachate and decomposition gases of municipal solid waste landfills.

4.3.5 Barrier Protection Layer

The barrier protection layer will consist of 24 inches of soil material suitable to protect the integrity of the low permeability barrier cover. In addition, the barrier protection layer will remove excess head buildup by draining the cover soils, thereby enhancing the stability of the final cover system. Drainage from above the low permeability barrier cover will be achieved by two different means, depending on the final cover alternative selected.

Final Cover Alternative 1 incorporates a 12-inch drainage layer as the lower portion of the 24-inch barrier protection layer. This material will most likely be a sand with a transmissivity on the order of 1 x 10^{-3} cm/sec.

The barrier protection layer for Alternative 2 includes a geosynthetic drainage layer overlain by 24 inches of soil. The geosynthetic drainage layer with a high in-plane transmissivity will be placed above the low permeability barrier cover.

Drainage pipes will be placed near the low permeability barrier cover. These pipes will be placed incrementally across the slope and spaced approximately 50 feet apart. The pipes will intercept water flowing through the drainage layer and discharge it to stormwater channels at the surface. The pipes will be slotted corrugated polyethylene pipe wrapped by a woven geotextile. The geotextile maintains filter separation between the protection layer soil and the pipe slots, reducing potential sedimentation and enhancing long-term performance.

The barrier protection layer will be capable of supporting root growth but has no specific requirements in terms of permeability or gradation. However, it must be free of material which will damage the geosynthetic components of the final cover system.

Details of the final cover alternatives are shown on the Construction Plans.

4.3.6 Topsoil

The topsoil layer will be six inches thick and will be of the proper pH and nutrient content to sustain the growth of perennial grasses. The topsoil will be spread in a single lift and vegetation will be established. Landfill vegetation is described in detail in Section 4.5 this report.

4.4 STRUCTURAL INTEGRITY OF THE LANDFILL

4.4.1 Stability Analysis

A stability analysis was performed to assess the integrity of the final cover system. The analysis was performed on a typical cross-section through the the final cover on a maximum 33 percent slope. The interface between the barrier protection layer and the geomembrane is considered critical because of the lower interface friction angle.

The stability analysis was performed utilizing a $\phi = 23.5$ degrees, $C = 200$ psf shear strength of the geotextile/textured membrane interface and $\phi = 30$ degrees for the barrier protection layer soils. Given the use of drains in combination with a high "in plane" permeability geosynthetic, no accumulation of water over the membrane was included in the model. The resulting factor of safety is 1.7.

4.4.2 Settlement Analysis

The proposed grading plan for the site utilizes slopes shallower than four percent as required by 6 NYCRR Part 360-2.13(r)(2)(ii). The proposed grading plan depicts a minimum slope of two percent in the western portion of the site.

The proposed shallower slopes are utilized in order to preclude excavation of the in-place waste and minimize filling to achieve design grades. Excavation or relocation of waste at the site was deemed undesirable due to the nature of the materials deposited and prohibitive cost associated with waste relocation. Filling of the existing grades was limited in order to minimize the off-site impact of developing a borrow area.

Calculations were performed in order to assess the long-term effect of settlement on the proposed grades. The settlement of the waste was estimated at two stages - immediately after placing the final cover (short-term), and 30 years following the capping (long-term settlement of the waste). The immediate settlement is a combination of elastic and consolidation settlements due to weight of the equipment or fill soil which comprises the final cap. The long-term settlement occurs due to the decomposition of waste with time.

The settlements were computed using a computer program developed by Wehran. Parameters for the immediate and long-term settlement of waste were obtained from published values and Wehran's previous work on landfill settlement prediction.

The critical areas were identified in the western portion of the site in regard to settlement. The first location (Cross-section AA) represents the minimum proposed slope, the second location (Cross-section BB) represents the largest thickness of waste in the area of slopes shallower than those required. Settlement calculations for these two areas are included in Appendix B, along with figure drawings showing the orientation of the cross-sections.

As shown by the settlement calculations included with the cross-sections, the expected settlement is relatively minor. The values are 1.1 feet and 0.7 feet for short-term settlement and 1.0 feet and 1.9 feet for long-term settlement across Cross-sections AA and BB, respectively. The expected settlement for Cross-section AA will result in a grade effecting positive drainage. The calculations for Cross-section BB depict differential settlement developing over the existing waste trench in the southwestern portion of the site; however, due to the orientation of the slope, positive drainage will still be maintained. Therefore, due to the limited differential settlement predicted for the areas of slopes shallower than those required, overfilling at this time is not recommended. If localized depressions are identified by the long-term site inspection and maintenance program, regrading of the final cover soils in the localized areas will be performed.

Since the proposed grading over a portion of the site is less than 4 percent as required by NYSDEC Part 360 regulations, a variance application has been prepared and is included in Appendix E. Additionally, an annual survey will be performed to document the cap slope. If the annual survey identifies areas which have settled and are ponding water, the affected area will be prepared and regraded.

4.5 STORMWATER MANAGEMENT

4.5.1 General

Construction of the landfill final cover and development of the on-site soil borrow area will require the construction of surface water drainage controls to manage stormwater runoff and sediment transport.

Runoff from the site will be enhanced during construction as a result of the disturbance to cover soils and existing vegetation. To prevent uncontrolled runoff from leaving the site, a surface drainage control system is proposed. The surface drainage system will consist of drainage swales and a sediment basin.

The sediment basin receives the drainage from the eastern one-third of the landfill and from the entire borrow area. The basin traps sediment, and provides a controlled discharge of runoff into existing stream channels. The western two-thirds of the site is collected into drainage swales which discharge to an existing stream channel via a step (tumbling flow) downchute. The discharge from both drainage areas will provide discrete points for future monitoring of off-site stormwater discharge.

Design of the basin is in accordance with the New York Guidelines for Urban Erosion and Sediment Control, October 1991, Section 5A.33. Due to both topographic and available property limitations the sediment basin, in the location shown in the Construction Plans, can collect runoff from approximately 9 of the 28 acres within the area to be capped. The basin will collect all runoff from the borrow area. The more favorable location for the basin at the western end of the site is limited by available property and existing steep terrain. These constraints only allow the sediment basin to be located at the high (east) end of the site, limiting its tributary area.

In developing the borrow area, the existing surface drainage will be affected. Presently, there are two intermittent streams existing within the limits of the proposed borrow area. These streams will have to be redirected in order to allow for removal of the borrow material.

A third existing stream located between the capping and borrow area will be cordoned off during construction with silt fence to prevent silt from entering the water course. The stream will flow through a culvert along the western edge of the sediment basin and discharge into the existing stream bed.

The surface drainage system is principally required for the control of sediment during construction. Upon completion of construction and establishment of vegetation, sediment controls will not be required. The sediment basin will be retained after construction as a component of on-site wetland mitigation.

In addition to the sediment basin and drainage channel modifications, other sediment barriers will be implemented during construction. These barriers will include hay bales and/or silt fence, and will be used to limit sediment transport from the 21 acres of shallow sloped areas not draining to the sediment basin.

4.5.2 Landfill Vegetation

The primary purposes for establishment of vegetation on the landfill final cover are to protect slopes from erosion, enhance evapotranspiration, and improve aesthetics. If efforts to establish vegetation needed for adequate erosion protection are successful, then the vegetation requirements for evapotranspiration and aesthetics are also satisfied.

Three general varieties of vegetation for erosion protection are as follows:

1. Temporary vegetation
2. Permanent vegetation
3. Drainage channel vegetation

Temporary vegetation is established with winter rye grass in topsoiled areas where permanent cover cannot be established until the following planting season. Temporary vegetation should be employed on all areas that will remain uncovered, with no ongoing activity in excess of 30 days to control runoff and prevent soil erosion. Permanent vegetation should be placed on all areas as soon as possible after they reach final grades.

Permanent vegetation has been selected based upon localized specialization factors including slope steepness and orientation, the physical and chemical properties of the topsoil to ensure that the species of vegetation best suited for a particular environment may be established, and for aesthetic reasons.

Two suggested seed mixtures for vegetation of the proposed site are as follows:

Temporary Seedings	
Type	**Amount (lbs/acre)**
Ryegrass (annual or perennial)	30
Certified Arostock	100
Winter Rye (use winter rye if seeding in October/November	
Permanent Seedings	
Type	**Amount (lbs/acre)**
Empire Birdsfoot Trefoil[1] or Common White Clover[1]	8
Tall Fescue	20
Redtop or Ryegrass	5
[1] Inoculate legume seeds immediately prior to seeding. [2] Source: New York State Guidelines for Urban Erosion Control. October 1991.	

Permanent vegetation should be planted between March 15 to May 15 or from August 15 to October 15.

Drainage channel vegetation protects the channel bottom and sides by increasing the roughness coefficients of the channel thereby reducing the flow velocity. Additionally, the root mat of the vegetation will hold the underlying soil in place. Vegetation planted in drainage channels is the same as species noted for permanent vegetation. Drainage channel vegetation should be placed in all drainage channels as soon as possible after final grading.

Seed will be hydraulically planted with mulch applied on steeper slopes. A binder will be applied with the mulch to hold it in place while seed is germinating.

4.5.3 Surface Drainage Controls

The diversion swales, downchutes, stilling basins, perimeter channels, and culverts are designed to accommodate stormwater runoff from the 25-year, 24-hour, Type II storm as determined using methods from the Soil Conservation Service, Technical Release No. 55. The sediment basin and basin outlet channel are designed for the 10-year, 24-hour, Type II storm using methods from the same reference. The proposed surface drainage system will minimize leachate generation and soil erosion, and will control sediment transportation and peak runoff rates. The final landfill grades have been designed to provide diversion of overland runoff through swales and downchutes to minimize soil erosion.

Diversion Swales

Diversion swales have been designed to convey runoff to the downchutes, as shown in the Construction Plans. The diversion swales are grass-lined if the design flow is less than 3 fps.. If the design flow is between 3 fps and 4 fps, grass lining with an erosion control mat will be utilized. In reaches of the diversion channels with flow velocities in excess of 4 fps, rip-rap lining shall be utilized.

Culverts

Culverts are provided for routing stormwater under the access roads. The culvert inlets and outlets are protected with rip-rap or gabions, as shown in the Construction Plans.

Downchutes

Downchutes are trapezoidal in section and are rip-rap-lined, as shown in the Construction Plans. Downchutes convey runoff from the diversion swales down the sideslope of the landfill or borrow area. The downchutes will discharge into existing streams. Step gabions are used to dissipate energy, reduce the flow velocity, and limit the potential for scouring at the discharge points.

Sediment Basin

The sediment basin has been designed to accommodate sediment storage volume and detention storage during construction, and become a component of the required wetland mitigation after construction. The sediment storage volume has been designed in accordance with the New York Guidelines for Urban Erosion and Sediment Control. The combined principal/emergency spillway has been sized to pass the 100-year, 24-hour, Type II peak storm event and consists of a trapezoidal gabion-lined channel.

The spillway is designed as a trapezoidal gabion-lined channel. This supersedes the spillway referenced in the Wetland Mitigation Plan, which includes a spillway with an adjustable weir to modify the water level. If the water level within the basin requires adjustment, the spillway will be reconstructed to raise or lower the standing water elevation.

4.6 ON-SITE SOIL BORROW EVALUATION

Planimetric calculations were performed to determine if an adequate volume of soil borrow materials exist on Broome County property adjacent to the landfill. In order to determine the amount of fill required for site regrading, the grading plan was prepared assuming the following requirements:

- No cutting of in-place materials
- Fill will be minimized
- Final slopes will vary between a minimum of 2 percent and a maximum of 33 percent.

The resultant grading plan shows filling to both smooth out irregularities in the landfill surface and to effect positive drainage without surface ponding.

For the purpose of performing an estimate of the quantity of soils required to be borrowed from on site, the assumption that no cutting will be performed within the limit of landfilling represents a conservative approach. The actual quantity required may be less if in-place soil material is moderately regraded. Based upon a comparison of the proposed grading plan to the existing topography, approximately 65,000 cy of material will be required to bring the site to grade.

Construction activity on site is expected to induce settlement of the surface topography. Additional fill will be required to offset any settlement. Settlement calculations were performed to estimate the effect of loading the in-place waste with the final cover system. Assuming fill is required in only the shallow portions of the site where settlement may affect drainage results in approximately 50,000 cy of material. These areas would be principally those with slopes of less than four percent. The anticipated settlement within areas with surface slopes of four percent or greater is not expected to significantly affect drainage.

It is anticipated that settlement will occur differentially across the site with most areas requiring no fill while some areas will require concentrated filling. The geophysical investigation performed for the site identified the waste to be shallowest in the areas of existing shallow slopes, therefore significant settlement is no longer a concern. Subsequently, the amount of fill required to offset settlement effects is reduced.

The total quantity of soils required for subgrade fill are estimated to be 115,000 cy including 65,000 cy of fill for regrading and 50,000 cy of fill to offset settlement.

The other component of the final cover system which may be obtained from on-site borrow is the material for the barrier protection layer. The amount of material required will depend upon the actual final cover alternative chosen. For Alternative No. 1, 46,000 cy of material will be required, whereas 92,000 cy of material will be required to complete Alternative No. 2. It is anticipated that the on-site soils will require screening before being used as barrier protection material. It is also anticipated that, in the screening process, the useable fraction of borrowed soil will be reduced, possibly by as much as 50 percent. However, at least a portion of the screenings may be used as subgrade fill, particularly for the unfilled trench located in the south center portion of the site.

To summarize the volume needs, Alternative No. 1 requires 46,000 cy of barrier protective layer soil, 65,000 cy of subgrade fill and 50,000 cy of fill to offset settlement. Assuming all screenings can be used as subgrade fill, approximately 161,000 cy of soil need to be borrowed.

Alternative No. 2 requires 92,000 cy for barrier protection layer soil, 65,000 cy of subgrade fill and 50,000 cy of fill to offset settlement. Again, assuming all screenings may be used as subgrade fill, approximately 207,000 cy of soil need to be borrowed.

To determine the quantity of borrow material available, the logs of test pits located on the eastern portion of the property were reviewed. Test pits TP-1 through TP-8 consistently report 15 to 18 feet of glacial till extending down from the surface. This is considered acceptable soil for the cap's barrier protection soil and subgrade fill. The groundwater table was also examined and found to be an average of 25 feet below existing grade. A proposed grading plan for the borrow area was developed based upon the need to obtain 207,000 cy of material. Grading of the borrow area was held to maximum slopes of 3 horizontal to 1 vertical as shown on Sheet 4 of 11 on the Construction Plans. The assumption that slopes may be cut to 3 horizontal to 1 vertical based upon our observation of similar existing features proximate to the proposed borrow.

The borrow area is currently forested and will require clearing and grubbing in association with borrow area development. Topsoil will be stripped and stockpiled. Upon completion of the capping activities, the site will be reclaimed. Reclamation will entail grading of the site, replacement of topsoil, and revegetation.

As a result of the investigation, it appears the volume of soil available from on-site borrow is adequate for a portion of the site final cover needs, assuming capping to the limits shown. Table 4.4-1 indicates the soils required for final cover construction, the estimated quantity of each soil type, and whether the soil is available on site or would need to come from off site.

Material requirements for the various soil layers are discussed in the Technical Specifications.

TABLE 4.4-1
COLESVILLE LANDFILL REMEDIAL DESIGN
ENGINEERING DESIGN REPORT
CAPPING MATERIAL REQUIREMENTS

Cap Component	*Alt 1*	*Alt 2*	*Available On Site*
Topsoil	23,000 cy	23,000 cy	0
Barrier Proection Soil	46,000 cy	92,000 cy	92,000 cy
Drainage Sand	46,000 cy	N/A	0
Geosynthetic Drainage	N/A	1,250,000 sf	0
40 mil FML	1,250,000 sf	1,250,000 sf	0
Gas Venting Soil Layer	N/A	23,000 cy	0
Gas Venting Geocomposite Drain Layer	1,250,000 sf	N/A	0
Fill for Site Regrading	65,000 cy	65,000 cy	65,000 cy
Fill to Offset Settlement	50,000 cy	50,000 cy	50,000 cy

5.0 LANDFILL CONSTRUCTION

5.0 LANDFILL CONSTRUCTION

5.1 GENERAL

As a component of the closure design for the existing landfill, Construction Plans and detailed Technical Specifications have been prepared jointly with this report and submitted to the department for approval and issuance of a permit to construct.

The Construction Plans detail the closure of the site at the level of detail suitable for implementation of the approved design.

The materials and methods of construction are fully described in the Technical Specifications. The specifications present the acceptance criteria for all construction materials including all testing requirements for conformance to the established design parameters and testing frequency in accordance with the solid waste regulations. Acceptance criteria are based upon the certification requirements stated within the 6 NYCRR Part 360 for the individual components of construction.

The Quality Assurance and Quality Control (QA/QC) Plan provides procedures to assure and document that design and regulatory requirements are properly implemented during construction. The QA/QC Plan presents the management organization, personnel and laboratory requirements as well as requirements for documentation to demonstrate that construction of the landfill closure will be performed in accordance with the applicable regulatory requirements.

5.2 CONSTRUCTION PROCEDURES

The components of the final cover design are described in Section 4.3. The construction will involve preparing the existing cover soil in preparation for final cover. A gas venting system, comprised of vents and collection piping, will be installed. The installation of 40 mil textured FML will then commence. FML panels will be deployed over the area and overlapped in the downslope direction a minimum of 4 inches.

Adjacent panels will be welded together either by an extrusion or hot-air welding device. The FML will be temporarily anchored down by the use of sandbags. Additionally, the FML edges, at the limit of the landfill cap, will be placed in a trench and anchored by soil.

Drainage control features, including diversion swales, downchutes, culverts and a sediment basin, will be utilized to handle the stormwater runoff. Rip-rap, gabions, and filter fabric will be installed as shown in the drawings to the required depths. The materials used will conform to the specifications.

Pipe culverts will be installed as shown on the drawings, with the required bedding material. Pipe trenches will be carefully backfilled with clean granular material, and hand-tamped around the pipe to ensure it is compact and free of voids. Backfill will be placed in a maximum of 6-inch lifts to the top of the pipe, and 12-inch lifts thereafter. Backfill over the pipe will be clean compacted material, free of material over 8 inches in any dimension. Headwalls and inflow/outfall protection will be constructed as shown in the drawings.

Erosion protection will be installed as soon as possible after construction of the drainage structure. Any damage caused by delay will be rectified prior to placement of protection.

Fertilization and seeding will be in accordance with the specifications, and will be protected and maintained until a good vegetative stand is developed.

All drainage structures will be protected from the inflow of sediment during construction by use of hay bales, silt fences or diversion ditches, and will be left clean and clear of sediment following completion of construction.

5.3 DEVELOPMENT OF THE BORROW AREA

As shown on the Construction Plans, a portion of the property directly east of the landfill is a proposed borrow area. As discussed in Section 4.6, closure of the landfill will require a significant quantity of soil. It is anticipated that a mined land use plan and a mining permit will be required.

Before excavation of material, the proposed borrow area will need to be cleared. Topsoil stripping may then commence with the material being stockpiled on-site. The underlying layers will be excavated to the grades shown on the Construction Plans. The recovery of material will need to be staged along with the progress of closure construction such that the material amounts are provided in a continuous manner. The borrow area will be reclaimed and seeded in accordance with the provisions of the mined land use plan and the mining permit.

5.4 SCHEDULE

A schedule has been prepared for the implementation of the closure construction activities. Figure 5-1 shows the overall schedule for closure of the site while Figure 5-2 shows the anticipated schedule for completion of individual construction items.

FIGURE 5-1

COLESVILLE LANDFILL REMEDIAL DESIGN

CONTRACT NO. 1 PROJECT SCHEDULE

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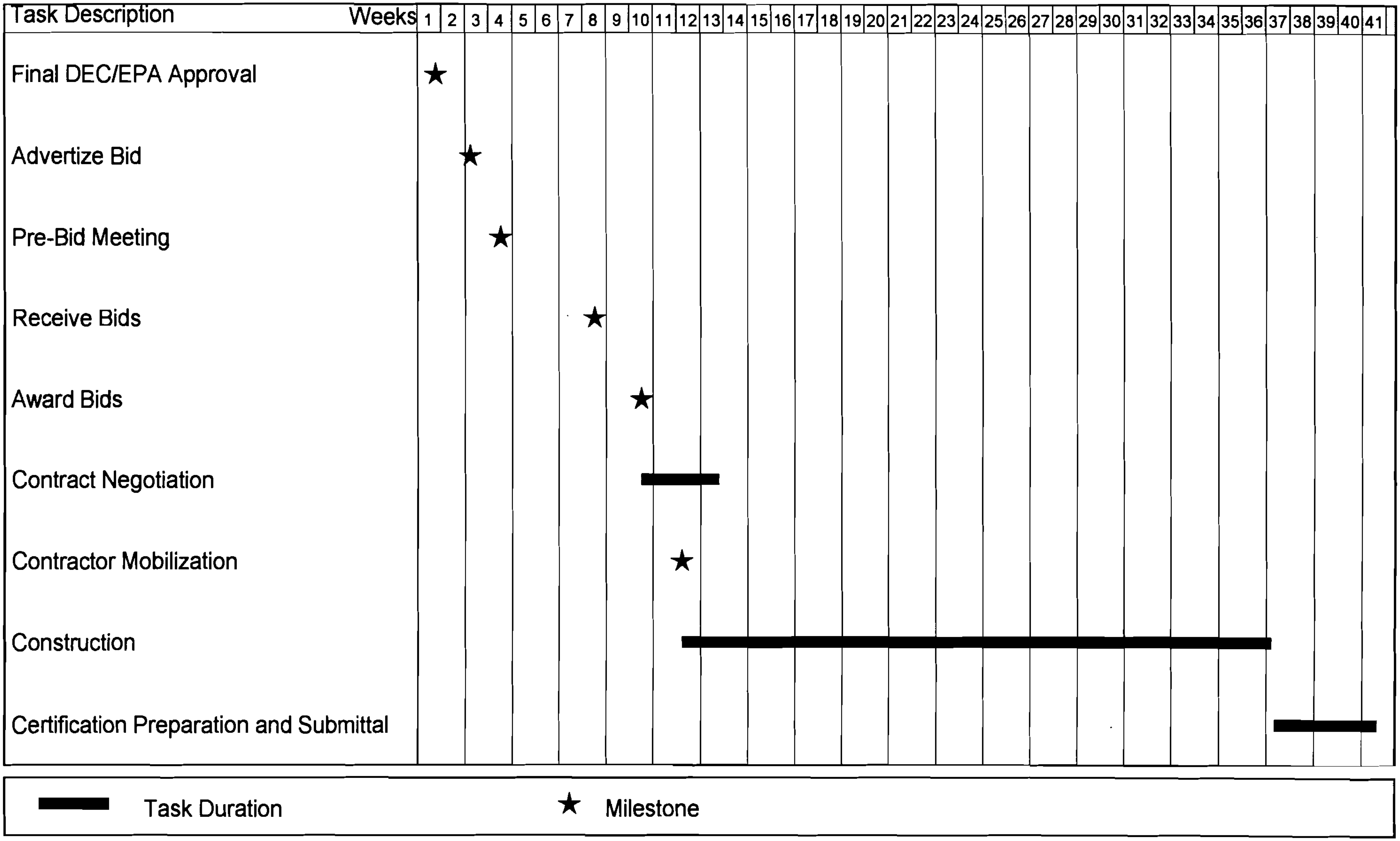

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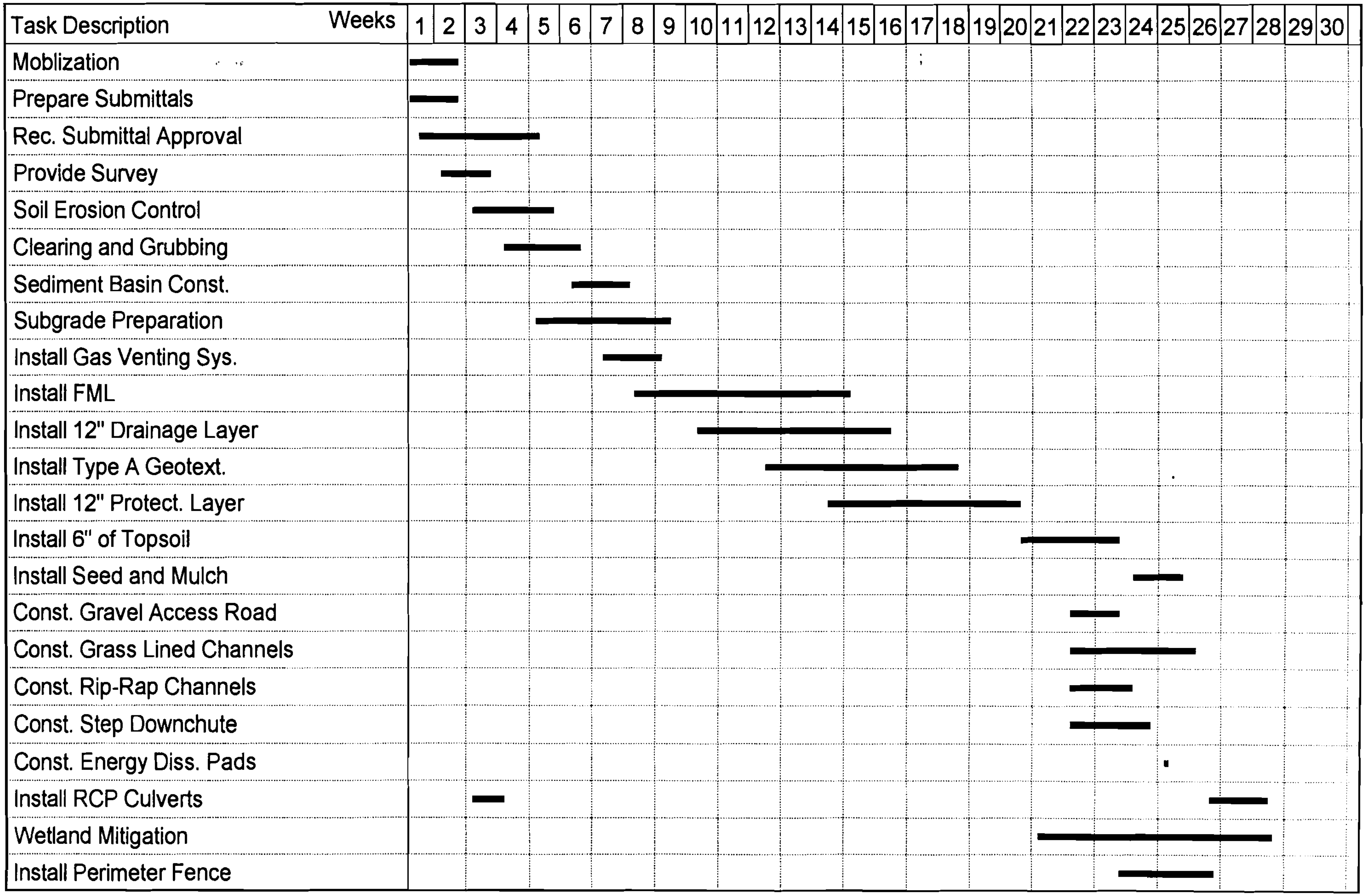
FIGURE 5-2

COLESVILLE LANDFILL FINAL COVER

CONTRACT NO. 1 PROPOSED CONSTRUCTION SCHEDULE

Page 1 of 1



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6.0 PERMITS AND EQUIVALENCIES

6.0 PERMIT EQUIVALENCY REQUIREMENTS

Table 6-1 shows the permit equivalency application status related to this Contract.

TABLE 6-1
COLESVILLE LANDFILL
REGULATORY PERMIT EQUIVALENCY REQUIREMENTS FOR REMEDIAL ACTIVITIES
(Based on Final Design)

Agency	*Regulatory Compliance Requirement/ Permit Compliance*	*Remediation Activity*	*Permit Equivalency Status*
NYSDEC – Solid Waste	Facility Closure/Post-Closure Requirements	Closure Post-Closure	Engineering Design Plans, Specifications, Design Report, and O&M Plan will address this requirement
NYSDEC – Water Resources	State Pollutant Discharge Elimination System (SPDES) Permit Equivalencies	Stormwater runoff (Construction/Post-Closure)	The Notice of Intent to apply for this permit equivalency is under preparation
NYSDEC – Water Resources	Protection of Waters Permit Equivalency	Construction affecting protected stream	It is currently understood that this permit equivalency will be required due to the NYSDEC C(T) designation of the North Stream
NYSDEC – Water Resources	Water Quality Certificate Equivalency	Construction affecting protected stream/wetlands	Water Quality Certificate equivalency will be sought in conjunction with the Notification made to the ACOE regarding Nationwide Permit #38

TABLE 6-1
COLESVILLE LANDFILL
REGULATORY PERMIT EQUIVALENCY REQUIREMENTS FOR REMEDIAL ACTIVITIES
(Based on Final Design)

Agency	*Regulatory Compliance Requirement/ Permit Compliance*	*Remediation Activity*	*Permit Equivalency Status*
ACOE	Nationwide Permit #38 (Cleanup of Hazardous and Toxic Waste)	Construction affecting wetlands	A Notification Package is being prepared for the ACOE District Engineer which will consist of a brief letter of notification identifying the project, appropriate drawings/plans (i.e., site plan, remedial design drawings, grading plan for borrow area), a copy of the wetland delineation and mitigation plans

Notes:

- A determination was made by the NYSDEC that the permit equivalencies originally identified for the removal of borrow area soils would not be necessary.

7.0 QUALITY ASSURANCE AND QUALITY CONTROL PLAN

7.0 QUALITY ASSURANCE AND QUALITY CONTROL PLAN

The Quality Assurance and Quality Control (QA/QC) Plan for the Colesville Landfill addresses the requirements for construction of the landfill. The Plan has been prepared to meet the requirements of 6 NYCRR Part 360, Section 2.8, effective December 31, 1988, last revised May 28, 1991.

Quality Assurance and Quality Control have been defined in 6 NYCRR Part 360, as follows:

- Quality assurance means the application of standards and procedures to ensure that a product or facility meets or exceeds desired performance criteria and documentation to verify the results obtained. Quality assurance includes quality control, and refers to actions taken to assure conformity of the construction with the department-approved quality assurance plan, engineering plans, reports, and specifications.
- Quality control means those actions which provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements. Quality control includes those actions taken before construction to ensure that the materials chosen and workmanship comply with the department-approved quality control plan, engineering plans, reports, and specifications.

The purpose of the Quality Assurance/Quality Control Plan is to develop systematic procedures to assure and document that design and permit requirements are properly implemented during construction. The QA/QC Plan presents procedures that will be used during the construction of the following elements:

- Landfill final cover
- Landfill gas venting layer
- Groundwater collection system
- Borrow area
- Final cover stormwater control

- Sediment basin
- Access roads
- Culverts
- Maintenance facilities

The QA/QC Plan presents the management organization, personnel and laboratory requirements, testing protocols, and requirements for documentation and recordkeeping to demonstrate that construction of the landfill will be completed in conformance with 6 NYCRR, Part 360 Section 360-2.13 of the Solid Waste Management Facilities Regulations.

During construction of the Landfill, a number of quality control measures will be employed by the Construction Contractor and any subcontractors to provide self-monitoring of construction activities. These self-monitoring activities are not addressed in this Plan. The QA/QC Plan for construction of the Landfill addresses the procedures that will be employed by the Project Engineer and other parties independent of the Contractor and subcontractors to assure and document that the design and permit requirements are properly implemented. The Quality Control measures for the construction of the above-listed items will be outlined and described in the Technical Specifications for construction, submitted under separate cover.

QA/QC procedures related to environmental monitoring activities are outlined in the Environmental Monitoring Plan, submitted under separate cover.

7.1 MANAGEMENT ORGANIZATION

The Owner will retain a licensed professional engineering firm knowledgeable in landfill design and construction to serve as the Project Engineer for the construction. In accordance with Section 360-1.2(b)(111) of 6 NYCRR Part 360, the Project Engineer shall be licensed to practice engineering in the State of New York and will be responsible for observing, documenting, and certifying that activities related to the quality assurance of the construction of the landfill and related facilities conform to approved construction plans and specifications, and conditions of the permit to construct.

Representatives of the Project Engineer will be responsible for implementing the requirements of the QA/QC Plan. The Project Engineer will also be responsible for supervising the activities of the QA/QC laboratories.

The Quality Assurance and Quality Control management organization to be used for construction at the Landfill is shown in Figure 7-1 and described below.

The party responsible for implementing the QA/QC Plan will be the Project Engineer.

7.1.1 Project Engineer

The Project Engineer will provide qualified personnel to serve in the following capacities:

- The ***Project Principal*** will serve as the official representative of the Project Engineer, and will have overall responsibility for the implementation of the QA/QC Plan.
- The ***Project Manager*** will report directly to the Project Principal, and will be responsible for overall coordination of construction and QA/QC activities with the Owner, the Contractor, any subcontractors, QA/QC Laboratories, and the other representatives of the Project Engineer.
- The ***Construction Coordinator*** will report directly to the Project Manager, and will be responsible for coordination of the activities of the Geotechnical and Geosynthetic Construction Observers, and the QA/QC laboratories.
- The ***Geosynthetic and Geotechnical Construction Observers*** will report to the Construction Coordinator, and will be responsible for observing, testing, and documenting construction activities on a daily basis.

The responsibilities of these personnel are described in further detail in Section 8.2.

7.1.2 Quality Assurance and Quality Control Laboratories

The services of Quality Assurance and Quality Control Laboratories will be secured by the Project Engineer to complete the testing requirements presented in the Technical Specifications. The QA/QC laboratories may be affiliated with the Project Engineer or subcontracted by the Project Engineer. If the services of the Geotechnical QA/QC laboratory are subcontracted, the laboratory must be independent of the Contractor, subcontractors, or material suppliers. If the services of the Geosynthetic QA/QC laboratory are subcontracted, the laboratory must be independent of the manufacturer, fabricator, or installer of geosynthetics at the site.

The Geotechnical QA/QC laboratory will complete the required geotechnical testing as directed by the Project Engineer.

The Geosynthetic QA/QC laboratory will complete the required geosynthetic testing as directed by the Project Engineer.

7.2 QUALITY ASSURANCE AND QUALITY CONTROL PERSONNEL

The Project Engineer will have responsibility for implementation of the QA/QC Plan for construction at the Landfill. The qualifications and experience requirements and responsibilities of each representative of the Project Engineer, are presented below.

The project personnel will have construction-related responsibilities in addition to the QA/QC responsibilities listed below. Additional responsibilities, and qualifications and experience requirements have not been included for work activities to be performed in addition to the implementation of the QA/QC Plan.

7.2.1 Project Principal

Qualifications and Experience

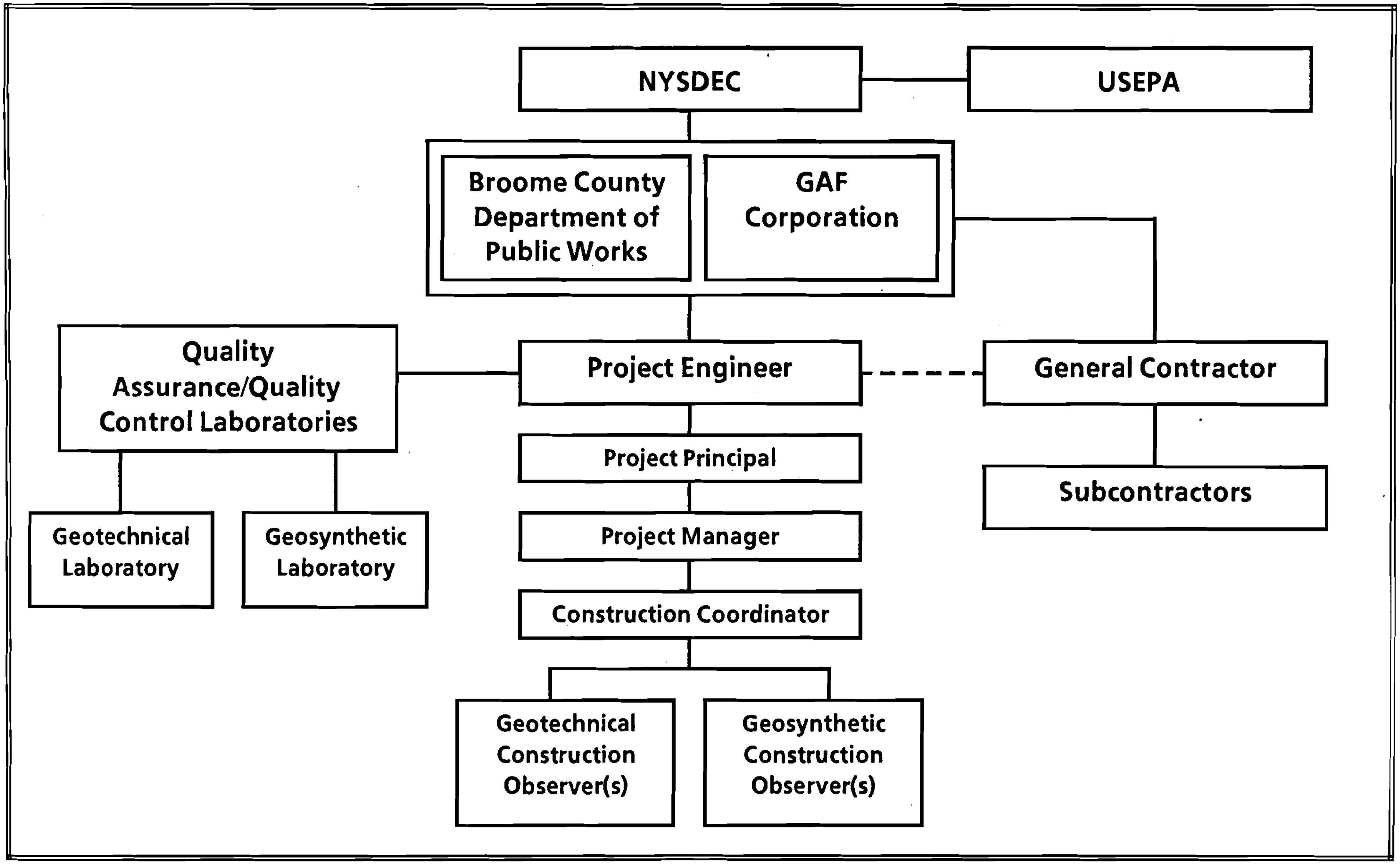
The Project Principal must be a Professional Engineer registered in New York State. The Project Principal must demonstrate past experience in a position of significant responsibility for landfill construction projects of similar magnitude and complexity to this landfill project and must be knowledgeable of the project requirements and objectives, and must be familiar with the Construction Plans and Technical Specifications.

Responsibilities

The Project Principal will have the following responsibilities in the implementation of the QA/QC Plan:

- Serve as the official representative of the Project Engineer.
- Has ultimate responsibility for the implementation of the QA/QC Plan.
- Ensure that appropriate technical review is completed by qualified representatives of the Project Engineer for Construction Plans, Technical

Figure 7-1
COLESVILLE LANDFILL
QUALITY ASSURANCE AND QUALITY CONTROL MANAGEMENT ORGANIZATION



Specifications, any modifications to the Plans and Specifications and the Construction Certification Report.

- Review and approve all design documentation, including the Construction Plans and Technical Specifications.
- Review and approve modifications to the Construction Plans and Technical Specifications during construction.
- Review and endorse the Construction Certification Report.

7.2.2 Project Manager

Qualifications and Experience

The Project Manager must be a registered Professional Engineer. The Project Manager must have extensive experience with construction projects of similar magnitude and complexity to this Landfill project. The Project Manager must have a thorough familiarity with the project, and be familiar with the Construction Plans and Technical Specifications.

Responsibilities

The Project Manager will have the following responsibilities in the implementation of the QA/QC Plan:

- Serve as the primary contact person for the Project Engineer. Maintain contact with the Owner, Contractor and subcontractors regarding conformance with the requirements of this Plan.
- Provide overall coordination of the activities of the Geotechnical and Geosynthetic Construction Observers and the Construction Coordinator.
- Provide assistance to the Construction Coordinator in the review and interpretation of field and QA/QC laboratory quality control testing results.
- Provide assistance to the Construction Coordinator in the review of shop drawings and other submittals from Contractors and subcontractors.
- Perform periodic site visits to review progress and QA/QC procedures.
- Determine acceptance of installed portion of work to permit further construction

- Ensure that the Construction Coordinator and Construction Observers are notified of any noted deficiencies in quality control testing results or procedures so that corrective actions can be taken.
- Review the Weekly Construction Summary Reports.
- Compile the Construction Certification Report with the Construction Coordinator, and the Geotechnical and Geosynthetic Construction Observers.

7.2.3 Construction Coordinator

Qualifications and Experience

The Construction Coordinator must have a Bachelor of Science Degree in Engineering or an Associates Degree in Engineering Technology. The Construction Coordinator must have previous experience with landfill construction activities of similar magnitude and complexity to this Landfill project. The Construction Coordinator must have a thorough familiarity with the project, and have a thorough familiarity with the Construction Plans and Technical Specifications. The Construction Coordinator must also have a working knowledge of the quality control testing procedures included in the Technical Specifications.

Responsibilities

The Construction Coordinator will have the following responsibilities in the implementation of the QA/QC Plan:

- Serve as the daily contact person for the Project Engineer. Maintain routine contact with the Owner, Contractor, and subcontractors regarding conformance with quality control testing requirements.
- Coordinate the daily activities of the Geotechnical and Geosynthetic Construction Observer.
- Review all shop drawings and other submittals from the Contractors and subcontractors for conformance with the Technical Specifications.
- Review all field and QA/QC laboratory quality control testing results for conformance with the Technical Specifications and provide interpretation of data to determine areas to be reworked or repaired.

- Organize all field quality control testing data to facilitate preparation of weekly Construction Summary Reports, and the Construction Certification Report.
- Review all Daily Construction Reports prepared by the Construction Observers.
- Prepare the Weekly Construction Summary reports.
- Monitor delivery of appropriate samples to the QA/QC laboratory for quality control testing.
- Coordinate with Project Manager and Construction Observers to establish proper sampling procedures including proper sample location, sample size, sample collection protocol, and sample numbering system.
- Receive and organize all quality control testing results from the QA/QC laboratories and check for compliance with specifications. Notify Project Manager and Construction Observers of results and review test results with Project Manager to make determination of areas to be reworked or repaired.
- Perform routine site visits to review progress and QA/QC procedures.
- Notify Construction Observers, Contractors and subcontractors of acceptance of installed portion of work to permit further construction.
- Prepare Construction Certification Report

7.2.4 Geotechnical Construction Observer

Qualifications and Experience

Through a combination of formal education, training and experience, the Geotechnical Construction Observer must have a demonstrated knowledge of landfill construction including earthwork, installation of granular fills, aggregates, low permeability soil liners, and applicable testing methods. The Geotechnical Construction Observer must also have a demonstrated knowledge of installation of manholes, pumping and piping systems.

The Geotechnical Construction Observer must be familiar with and trained in the use of nuclear moisture-density meters.

Responsibilities

The Geotechnical Construction Observer will have the following responsibilities in the implementation of the QA/QC Plan:

- Visually observe construction materials such as soils and piping delivered to the site to determine general conformance with material specifications.
- Observe and record procedures used for site preparation clearing and grubbing.
- Observe and record procedures used for excavation and filling of subgrade to required elevations.
- Observe and record procedures for placement of fill, groundwater collection system drainage soil, barrier protection soil and top soil, including:
  - Compacted lift thickness
  - Method of moisture addition
  - Proofrolling
  - Fine grading

- Perform moisture and density testing, as established in the Technical Specifications.
- Assign locations and collect samples of other soils for quality control testing.
- Provide for delivery of samples to the QA/QC laboratory or the Construction Coordinator.
- Record any on-site activities that could result in damage to any earthwork or site improvements, such as compacted subgrade, and report these activities to the Contractor, Subcontractor and the Construction Coordinator.
- Prepare daily construction report as described in Section 7.5.

7.2.5 Geosynthetic Construction Observer

Qualifications and Experience

Through a combination of formal education and experience, the Geosynthetic Construction Observer must have a demonstrated knowledge of landfill construction including manufacturing, installation, and testing of geosynthetics.

Responsibilities

The Geosynthetic Construction Observer will have the following responsibilities in the implementation of the QA/QC Plan:

- Visually observe construction materials such as geomembranes, geotextiles, geonet, and geocomposite drain delivered to the site to determine general conformance with the material specifications.
- Observe and record condition of subgrade prior to placement of all geomembranes.
- Observe and record procedures for stockpiling, storage and handling.
- Observe and record procedures used for installation of geosynthetics.
- Visually observe all geosynthetics after installation for failure to comply with the Technical Specifications.
- Observe and record procedures used for installation of all liner penetrations.
- Conduct final inspection of membranes prior to drainage layer placement.
- Observe that panel placement is in accordance with the approved panel plan.
- Observe that permanent and temporary anchoring procedures are followed.
- Observe and record procedures used for seaming. Observe and record that the area of seam is clean, supported, and overlap and seam width are in accordance with the Technical Specifications.
- Observe and record that all required field seaming tests are performed. Observe and record that all areas with deficient seams are marked for repair.
- Observe and record procedures used for all repairs.
- Assign locations for collection of all samples for quality control testing.
- Observe and record procedures used to repair areas where samples are taken.
- Provide for delivery of samples to the QA/QC laboratory or the Construction Coordinator.
- Record any on-site activities that could result in damage to the various geosynthetics and report these activities to the Contractor, Subcontractor, and the Construction Coordinator.
- Prepare daily construction report.

7.3 QUALITY ASSURANCE AND QUALITY CONTROL LABORATORIES

7.3.1 Geotechnical Quality Assurance and Quality Control Laboratory

Experience and Qualifications

The Geotechnical QA/QC Laboratory shall have experience in testing granular fills and aggregates, and shall be familiar with ASTM test standards and Army Corps of Engineers test procedures as required in the Technical Specifications. The Geotechnical QA/QC Laboratory shall be capable of providing permeability test results within 48 hours of receipt of sample. The laboratory shall be capable of providing all other test results within four days of receipt of samples.

The Geotechnical QA/QC laboratory must submit an acceptable QA/QC Plan to the Project Manager to demonstrate that the laboratory has the capability to complete the quality control testing required in the Technical Specifications.

Responsibilities

The Geotechnical Quality Assurance Laboratory is responsible for performing all tests and formally submitting results to the Project Engineer as required in the Technical Specifications.

7.3.2 Geosynthetic Quality Assurance and Quality Control Laboratory

Experience and Qualifications

The Geosynthetic QA/QC Laboratory shall have experience in testing geosynthetics, and must conform with ASTM, NSF, GRI, and other applicable test standards. The Geosynthetic QA/QC Laboratory shall be capable of providing test results within 48 hours of receipt of samples.

The Geotechnical QA/QC laboratory must submit an acceptable QA/QC Plan to the Project Manager to demonstrate that the laboratory has the capability to complete the quality control testing required in the Technical Specifications.

Responsibilities

The Geosynthetic Quality Assurance Laboratory is responsible for performing all test procedures in accordance with the Technical Specifications and formally submitting results to the Project Engineer.

7.4 QUALITY ASSURANCE AND QUALITY CONTROL TESTING PROTOCOLS

The Quality Assurance and Quality Control Testing Protocols to be used during construction of this Landfill will be presented in the Technical Specifications. The Specifications will address the following elements of construction:

- Earthwork and related soil materials
- Geosynthetics
- Piping and appurtenances
- Mechanical equipment
- Electrical requirements

Where applicable, the Specifications describe the following testing requirements for each of the elements of construction:

- Field testing procedures to be used
- Field testing equipment to be used
- Frequency of field testing
- Sampling procedures to be used
- Sampling equipment to be used
- Frequency of sampling for laboratory testing
- Procedures to be used for laboratory testing
- Acceptable limits for field and laboratory testing

7.5 DOCUMENTATION AND RECORDKEEPING

Records of construction progress and quality control activities will be maintained throughout the construction at the Landfill. The following reports will be prepared by the Project Engineer retained to oversee these activities:

- Daily Construction Report
- Weekly Construction Summary Report
- Construction Certification Report

7.5.1 Daily Construction Report

Daily construction reports will be prepared by the Geotechnical Construction Observers and the Geosynthetic Construction Observers at the conclusion of every day construction activities occur at the site.

The daily construction reports will include the following:

- Date.
- Weather conditions, including daily high and low temperature, wind conditions, and precipitation, if any.
- General description of work activities at the site.
- List of personnel and equipment operating on site, number of hours worked, number of hours on standby, and work activities completed. Include names of key QA/QC and construction personnel.
- Description of work completed for the day, referencing stationing and grid coordinates.
- Identification of areas worked including lift number, panel number, and seam number.
- Drawings, sketches, and maps showing work completed.
- Summary of QA/QC procedures used for the day.
- Results of all quality control testing.
- Drawings, sketches, and maps showing all quality control testing areas. Passing and failing areas of the geomembrane panels and seams will be recorded.
- Reworked and repair areas will be recorded with all quality control testing results.
- Identification of all samples collected for quality control testing at the QA/QC laboratories, including sample number, location, and testing to be performed.
- Identify any in-field modifications.
- Documentation of discussions, decisions or recommendations involving the Contractor, Subcontractor, the Owner, NYSDEC, and representatives of the Project Engineer.

The Daily Construction Report will be submitted to the Construction Coordinator for review and inclusion in the project file.

7.5.2 Weekly Construction Summary Report

Weekly construction summary reports will be prepared by the Construction Coordinator at the end of every working week. The weekly reports will summarize construction progress and quality control testing based on the following:

- Daily construction reports for the work.
- Results from the geotechnical and geosynthetic QA/QC laboratories.
- Shop drawings and other submittals from the Contractor and subcontractors.

The weekly construction summary reports will include the following:

- General description of work activities completed at the site for the week.
- Specific description of work completed for the week, referencing stationing and grid coordinates.
- Identification of areas worked for the week, lift thickness, panel number, and seam number.
- Drawings, sketches, and maps showing work completed for the week.
- Summary of QA/QC procedures used for the week.
- Summary of quality control testing results for the week.
- Summary of reworked areas and repairs completed for the week.
- Summary of shop drawings and submittals received from the Contractor and subcontractors during the week, and disposition of same.
- Summary of results received from the geotechnical and geosynthetic QA/QC laboratories during the week.
- Summary of in-field modifications.
- Summary of decisions and recommendations as a result of discussions with the Contractor, subcontractors, the Owner, NYSDEC, and representatives of the Project Engineer.

The Weekly Construction Summary Report will be included in the project file.

7.5.3 Construction Certification Report

Upon completion of construction activities, the Project Engineer will prepare a construction certification report. The report will be prepared under the direction of, and endorsed by, the Project Principal.

The certification report will document construction in accordance with construction plans and specifications, with any exceptions noted. The certification report will include the following:

- Narrative description of the construction completed at the site.
- Description of deviations from construction plans and specifications and reasons for such changes.
- Description of quality control testing procedures.
- Summary of quality control test data.
- Drawings showing quality control test locations.
- Descriptions of procedures used to rework or repair areas with failing quality control test results.
- As appropriate, raw data sheets and worksheets related to quality control testing.
- QA/QC Plans submitted to the Project Engineer by the Geotechnical and Geosynthetic QA/QC laboratories.
- A series of color photographs of major project features.
- Record drawings of the completed construction.
- Certification statement of completion of construction in accordance with the Construction Plans and Technical Specifications.

8.0 CONTINGENCY PLAN

8.0 CONTINGENCY PLAN

8.1 GENERAL

The purpose of this Contingency Plan is to present an organized, planned, coordinated, as well as technically and financially feasible course of action to be taken in responding to contingencies during the closure of the landfill. This plan should be carried out whenever emergency situations develop which endanger human health and safety or the environment.

8.2 PERSONNEL AND USER SAFETY

An emergency response program will be established for the Colesville Landfill to address safety in the event of the occurrence of emergency situations. The program will include:

- Identification of Emergency Coordinators
- Identification of Duties and Responsibilities of the Emergency Coordinator
- Identification of Communication Systems
- Development of Evacuation Plan
- Summary of First Aid Available for Selected Medical Emergencies
- Summary of Available Emergency Services

8.2.1 Emergency Coordinators and Chain-of-Command

Prior to commencement of closure at the landfill, the Owner, Engineer, and Contractor will appoint emergency coordinators to direct an organized response to emergency situations. If an emergency situation occurs at the landfill, field personnel must contact the designated Emergency Coordinators.

At all times during hours of site construction, there will be at least one Emergency Coordinator on site or on call, with the authority to commit the necessary resources of to carry out the provisions of this Contingency Plan.

8.2.2 Duties and Responsibilities of the Emergency Coordinator

Contingency Plan Implementation

The decision to implement the Contingency Plan at the landfill will depend upon whether or not a fire, explosion, or other emergency incident could potentially endanger human health and safety, or the environment. The following information provides the Emergency Coordinator with criteria to assist in making this decision.

The Contingency Plan should be implemented in the following situations:

Fire or Explosion

- The fire spreads and could possibly ignite materials at other locations on site or could cause heat-induced explosions.
- The fire could possibly spread to off-site areas.
- Use of water and/or chemical fire suppressant could result in contaminated runoff.
- An imminent danger exists that an explosion could occur, causing a safety hazard.
- An imminent danger exists that an explosion could ignite other materials at the facility.
- An explosion has occurred.

Material Release or Spill

- The material release spill could result in release of flammable, ignitable, or combustible liquids or vapors, thus causing fire or gas explosion hazard.
- The material release spill can be contained on site, but the potential exists for groundwater contamination.
- The material release spill cannot be contained on site, resulting in off-site soil contamination and/or ground or surface water pollution.

Emergency Response Procedures

Whenever there is any type of incident at the landfill, the Emergency Coordinator must immediately notify field personnel, identify and assess the source and extent of the emergency, and take action to control the situation.

Notification

In the event of an imminent or actual emergency occurrence, the first person on the scene should notify the Emergency Coordinator, who, in turn will initiate a proper response to the situation in question. Notification of the Emergency Coordinator may be performed second only to notification of on-site personnel and/or site evacuation, depending on the emergency situation.

Having been apprised of the situation, the Emergency Coordinator will proceed to notify all facility personnel by initiating the internal communications system, (if not previously initiated), and aid in evacuation, if necessary. Progression of notification will continue to any local, State, and Federal response agencies deemed appropriate by the Emergency Coordinator.

A list of the Designated Emergency Coordinators will be posted in a conspicuous location at the site office. In addition, a list of the Emergency Response Agencies and Contacts is included in Appendix F and will be posted conspicuously at the same location.

Identification

Whenever there is a fire and/or explosion, spill or release, or other incident presenting a potential threat to the human health and safety or the environment, the Emergency Coordinator must immediately identify the source and extent of the emergency.

Assessment

In case of an emergency situation, an assessment of the possible hazard must be made. If the Emergency Coordinator determines that the facility has had a fire and/or explosion, spill or release, or other incident that presents a possible hazard to public health and safety, and/or the environment, and initiates the Contingency Plan, contact with local authorities must be made informing them of situations when an evacuation of the surrounding area is necessary. The New York State Department of Environmental Conservation (NYSDEC) should also be advised of all the pertinent facts regarding the incident.

When making a report to the NYSDEC, the following information must be provided:

- Name and telephone number of person making the report
- Name of the facility
- Type and time of incident occurrence
- Name and quantity of material(s) involved, to the extent known

- Extent of any injuries
- Possible hazards to public health and safety, and/or the environment surrounding the facility

Control Procedures

The nature of work carried out during landfill closure makes the occurrence of emergency situations a possibility, no matter how infrequently they may actually happen. Emergencies can happen quickly and unexpectedly, requiring immediate response.

In the event of any emergency situation, the Emergency Coordinator must take all reasonable measures to prevent the occurrence, recurrence, or spread of a fire or explosion or unplanned releases to other portions of the facility.

A broad-based emergency response network will be established to respond to any incidents at the facility. If an emergency occurs, fully trained response personnel should be contacted as soon as possible.

Requests for assistance should always include:

- Name, address, and telephone number of the facility
- Type and time of incident occurrence
- Extent of any injuries
- Possible hazard to public health and safety, and/or the environment surrounding the facility
- Type and quantities of materials involved, if known

Immediate action by on-site personnel should concentrate on preventing any fire/explosion, or spill/leak situation that occurs from spreading to other areas of the facility, and immediate emergency medical attention should be given to injured personnel, if possible. Any possible sources of ignition should be removed from the incident area, if this can be done without risk, and vehicular traffic should be suspended and work ceased until the fire or incident can be safely contained or controlled.

Storage and Disposal of Released Materials

Immediately after an emergency situation, the Emergency Coordinator must make arrangements for the storage, or disposal of any recovered wastes, water, or any contaminated materials resulting from the incident.

Post-Emergency Equipment Maintenance

Following an emergency incident, all emergency response equipment used must be cleaned and made fit for reuse, or replaced as necessary, so that the equipment will be available when construction operations resume. An inspection of all equipment must take place before operations resume to ensure that each item is in proper working condition. Remedial activities as a result of this inspection may include recharging of fire extinguishers, restocking first aid kits, replacement of personal protective gear, and restocking of disposable items.

8.2.3 Internal Communication/Warning System

An internal communication system consisting of telephones and two-way radios will be available at the landfill for notifying field personnel in the event of an emergency episode. Units are located in readily accessible areas at the site office, in vehicles, and in the equipment. In addition, units may be carried by field personnel. This system provides facility personnel with immediate emergency notification and necessary instructions in the event of an incident.

8.2.4 External Communication/Warning System

A network of emergency response agencies are available and field personnel that can be contacted in the event of an incident at the landfill. Designated Emergency Coordinators and Emergency Response Agencies and Contacts will be notified by telephone for assistance in an emergency.

Lists including these names and telephone numbers will be displayed prominently at site office for easy employee accessibility in the event of an emergency.

8.2.5 Evacuation Plan for Facility Personnel

In an emergency situation, and when time permits, the Emergency Coordinator will be the individual responsible for determining when evacuation of the facility is required. Imminent or actual dangers that constitute a situation requiring evacuation include:

- A generalized fire or threat of generalized fire that cannot be avoided.
- An explosion or the threat of explosion that cannot be averted.
- A major spill or leak that cannot be contained and constitutes a threat to human health.

When time permits and evacuation is required, the following procedures should be followed:

- Alert all field personnel and support personnel using the telephone and/or two-way radio system.
- Alert and request assistance from local emergency response agencies.
- Shut down all facility equipment.
- All field personnel should proceed to a designated meeting point. Once assembled at this designated meeting point, a determination and identification of any missing persons should be made. In the event that any personnel cannot be accounted for, assembled personnel should not reenter the facility. Instead, all personnel should await the arrival of local emergency response agencies and standby to afford assistance, if and as needed.

8.2.6 Emergency Equipment

Various emergency equipment is available at the landfill facility as described below.

Firefighting Equipment

The landfill facility will maintain several types of equipment on site that may be used in firefighting efforts. Earth-moving equipment that is utilized on a regular basis for landfill closure may be used to move and apply material for fire control. A tank truck will be available for use in controlling fires.

The facility will also maintain a supply of fire extinguishers that may be used in the event of an emergency incident. These extinguishers will be located at strategic points at the site. Fire extinguishers will also be located on the construction equipment for use in cases of field emergencies. Extinguishers will be maintained in conformance with State and local fire codes and regulations.

First Aid/Safety Equipment

First aid and safety equipment will also be located in strategic locations on the site, and some items may be kept in construction equipment. First aid kits will be located in the landfill site office and will contain a full range of items necessary to care for minor injuries needing prompt attention. First aid kits will be easily and immediately accessible to personnel.

8.2.7 Medical Emergencies/First Aid

In cases of medical emergency, trained medical response personnel should be contacted immediately. First aid administered by on-site facility personnel should continue until professional assistance arrives.

First aid is the immediate care of a person who has been injured or has suddenly taken ill. It is intended to prevent death or further illness and injury, and to relieve pain until additional, professional medical aid can be obtained. The objectives of first-aid are:

- To control conditions that might endanger life.
- To prevent further injury.
- To relieve pain, prevent contamination, and treat for shock.
- To make the patient as comfortable as possible.

The initial responsibility for first-aid rests with the first person at the scene who must react quickly, but in a calm and reassuring manner. The person assuming responsibility should immediately summon medical assistance, being as explicit as possible in reporting suspected types of injury or illness. The injured person should not be moved, except where necessary, to prevent further injury.

8.2.8 Available Emergency Services

In the event of an emergency at the landfill, the agencies listed in Appendix F – Emergency Contact Listing, are available.

8.3 POTENTIAL REMEDIAL ACTIONS DURING CLOSURE OPERATIONS

Conditions may be encountered at the site during normal landfilling activities that will require response actions that are not included as part of typical daily site operations.

8.3.1 Fires

The possibility of a fire, whether in the landfilled waste or within a piece of equipment, is a potential hazard associated with the closure operation of the landfill.

The earth-moving equipment to be used in the closure activity will be capable of moving and applying the amount of material needed.

Water can be used to supplement the use of cover soil or serve as an alternative means of controlling fires. The Contractor will have a water truck available for use during emergency situations. Water can be obtained from the sediment basin or on-site water supply. For larger or more serious outbreaks, the local fire department would be contacted. Additionally, portable fire extinguishers will be kept in all vehicles and buildings as a precautionary measure.

The contingency programs described below should be followed when encountering a ground fire and below cover fire:

- The application of cover soil by landfill earth-moving equipment, or the application of water by the on-site water tank truck to extinguish the blaze, can be carried out.
- Any vehicles and any equipment in the fire zone should be sprayed with water, while working to quench the fire.
- Precaution should be taken throughout the entire firefighting operation.
- If, at any time, additional assistance is required, local firefighting units should be contacted as soon as possible.

8.3.2 Landfill Gas

Decomposition of organic waste is generally accompanied by the production of landfill gas. Landfill gas produced at municipal solid waste disposal sites is generally composed of approximately 50 percent methane and 50 percent carbon dioxide and when mixed with oxygen at the proper proportion and exposed to an ignition source can present a fire and/or explosion hazard. Recognizing the potential explosive hazard, a plan will be developed to identify the source, extent of impact, and outline remedial actions to protect landfill personnel and the environment. In the event of combustible gas detection in any enclosed structures, the structure will be immediately evacuated, the emergency coordinator notified, and a plan developed to identify the source of the combustible gas, and outline remedial actions.

8.3.3 Dust Control

During dry periods, fugitive dust may be a nuisance resulting from the landfill closure operation. The access roads and working areas of the site are generally removed from residential areas. Under these conditions, dust problems are typically localized and can generally be managed with on-site equipment. The following measures may be employed wherever a potential problem exists:

- Applying water on haul roads.
- Wetting equipment and excavation faces.
- Spraying water on buckets during excavation and dumping.
- Hauling materials in properly tarped or watertight containers.
- Restricting vehicle speeds to 10 mph.
- Covering excavated areas and material after excavation activity ceases.
- Reducing the excavation size and/or number of excavations.

8.3.4 Litter Control

The tasks of excavation for the gas collection trenches or cover regrading may expose the waste to wind and potentially produce litter. Every practicable measure will be taken to contain litter as close to the working area as possible. Activities which have the potential to expose waste will be restricted to as small an area as possible. The Contractor's employees will manually pick up litter as required. If activities begin to distrub waste, the work will be evaluated and modified, if possible, to avoid further waste disturbance.

8.3.5 Odor Control

Odors from closed landfills generally result from the generation of landfill gas and upon exposure of waste. Due to the limited quantity and age of the waste, the amount of landfill gas expected to be generated is minimal. If odors become an off-site problem, the source must be determined and proper mitigative actions taken. The following contingency steps can be taken:

- Application of additional cover soils
- Use of odor masking agents
- Modification of landfill gas control system

Waste disturbance is anticipated only during gas vent installation. Therefore, any odor associated with this activity will be of limited and controlled time duration.

8.3.6 Noise Control

The major source of noise in the area of the landfill during closure will be the construction equipment. Since the construction will occur during daylight hours and will be generally removed from local residences, the noise generated from landfill operations are not expected to be an off-site problem. All landfill equipment working at the site will have muffler systems to further diminish any potential nuisance from noise.

If noise conditions present a problem, mufflers on all landfill vehicles should be inspected and replaced if inadequate. If unsatisfactory conditions persist and noise levels are detected in violation of the effective solid waste management or local regulations, operational procedures will be modified or appropriate noise barriers should be constructed.

8.3.7 Vector Control

As in the case of litter control, the amount of waste exposed during any time will be kept to the smallest area practical. Prompt covering of the waste should eliminate problems with insect, bird, and animal pests. Vectors are greatly discouraged when waste materials are not easily available.

If vector control presents a problem at the site, waste exposure will be more closely controlled and monitored. However, if a problem persists with vectors such as insects or rodents, an extermination program can be initiated. This program would be in strict accordance with requirements of the New York State Departments of Health and Environmental Conservation.

9.0 COST ESTIMATES

9.0 COST ESTIMATES

9.1 GENERAL

Closure and post-closure estimates have been prepared to reflect the anticipated cost of closure and post-closure monitoring and maintenance for the final cover action of the Colesville Landfill Remedial Design. The closure cost estimate has been prepared based upon the construction items necessary for closure as detailed in the Construction Plans, prepared by Wehran-New York, Inc., dated April 1994. The post-closure cost estimate is based on maintenance schedules obtained from other landfill projects.

All costs are presented in 1993 dollars without adjustment for cost escalation with time. Where possible, unit prices for materials have been obtained from quotes received from suppliers or material manufacturers. Where actual costs were not readily available, costs from cost estimating guides were used. These costs are based upon the best information available at the present time. These estimates are subject to change based upon market conditions at the actual time of closure construction and post-closure activity.

9.2 CLOSURE COST ESTIMATE

A description of the closure construction items that are addressed in this report are presented below.

9.2.1 Mobilization and General Conditions

This cost has been estimated as 10 percent of the total project cost and includes Contractor mobilization, site facilities, insurance, bonds and other administrative costs.

9.2.2 Survey

The survey cost reflects the cost for survey work required for layout of the work and survey-associated payment requests, and layer thickness determinations.

9.2.3 Clearing and Grubbing

The cost for clearing and grubbing reflects the cost for clearing the on-site areas of woody vegetation in preparation for soil borrow and final cover construction.

9.2.4 Soil Erosion and Sediment Control

The cost for soil erosion and sediment control includes the installation of hay bales and silt fence, construction of temporary sediment impoundments and flexible pipe downslope drain, as well as other temporary soil erosion and sediment control measures throughout construction.

9.2.5 Subgrade Preparation

The cost for subgrade preparation includes regrading of the existing landfill cover to provide a surface suitable for placement of the final cover materials and to achieve the grades depicted on the Construction Plans once all appropriate layers are placed. Fill for subgrade preparation is assumed to come from the on-site borrow area.

9.2.6 Gas Venting Layer

The gas venting layer will consist of either 6 inches of drainage sand or a geocomposite layer. Both alternatives include 18-inch deep collection trenches. Additionally, crushed recycled glass may be substituted for the subangular stone within the collection trenches. The estimated cost for this layer includes cost for material purchased from an off-site source and placement,

Gas vent risers will be constructed at a frequency of one vent riser per area as shown in the Plans. The vents will extend above the final cover a minimum of 6 feet, and in the waste a minimum of 3 feet.

9.2.7 Flexible Membrane Liner

A 40 mil VLDPE flexible membrane liner (FML) will be installed as a low permeability barrier layer over an area of approximately 28 acres. The estimated cost for this item includes material and installation costs for both the smooth and textured FML components.

9.2.8 Drainage Layer

The drainage layer will consist of a minimum of 12 inches of drainage sand over the geomembrane layer. Alternately, a geocomposite may be substituted for the sand drainage layer. The 12-inch sand drainage layer is assumed to be more expensive and therefore more conservative from the perspective of cost. The estimated cost for this layer includes cost for material purchased from an off-site source and placement.

4-Inch diameter slotted corrugated polyethylene pipe wrapped in geotextile will be placed within the drainage layer across the slope, and spaced approximately every 50 feet across the slope, with drain pipe outlets spaced every 50 feet apart. The pipes will intercept water in the drainage layer and discharge it to stormwater channels at the surface. The estimated cost for this item includes material and installation costs.

9.2.9 Geotextile

Geotextile Type A, may be included if the drainage sand the barrier protection layer do not demonstrate filter compatibility.

9.2.10 Barrier Protection Layer

A 12-inch soil layer, along with the 12-inch drainage layer, completes the requirement for the 24-inch protective barrier protection layer required by Part 360. (Alternately, if a geocomposite drain is substituted for the soil drainage layer, then the barrier protection layer will be 24 inches thick.) Cost for placement of a 12-inch soil layer to accompany the 12-inch sand drainage layer includes placement and purchase of material from an off-site source.

9.2.11 Topsoil

Soil suitable to sustain vegetation (i.e., topsoil) will be placed in a 6-inch lift and will cover approximately 28 acres. Material is assumed to be required from off-site.

9.2.12 Seeding and Mulch

Cost includes seeding and mulching of the 28 acres of soil suitable to sustain vegetation as well as other disturbed areas.

9.2.13 Gravel Access Road

This item represents the cost to build the gravel access road on-site to provide access for post-closure maintenance and monitoring activities.

9.2.14 Grass-Lined Drainage Channels

Construction of the diversion swales includes placement of a soil berm lined with geomembrane, filter fabric, and a seeded topsoil layer. The quantity of 4,270 linear feet for this item includes diversion swales as shown in the Construction Plans. The topsoil and seeding costs are not included under this item but are included elsewhere in the Closure Construction Cost Estimate.

9.2.15 Rip-Rap-Lined Drainage Channels

The cost for rip-rap-lined drainage channels includes all earthwork to form the channels and the placement of geotextile and rip-rap, as shown on the Plans.

9.2.16 Gabion-Lined Channels

This item includes the cost for earthwork to form the channels, gabion basket assembly and placement, and stone filling.

9.2.17 Step Downchute

The cost for downchute construction includes the placement of a geomembrane lining, filter fabric, concrete elements, and rip-rap stone. The quantity for this item includes the step downchute to the North Creek, as shown on the Construction Plans.

9.2.18 Energy Dissipator Pads

The cost for this item includes all earthwork, gabion basket assembly and placement, and stone filling.

9.2.19 Culverts

Pipe culverts will be installed to allow access to the borrow area and the treatment plant. The estimated cost for these items include trench excavation, supply, and installation of the pipe as well as backfill.

9.2.20 Sediment Basin

The cost for this item includes the earthwork required to excavate, and build the basin embankment and basin spillway.

9.2.21 Wetland Mitigation

This item includes the preparation of the wetland mitigation portion of borrow area, including placement of low permeability soil liner in the sediment basin, spreading of topsoil outside of the basin, and planting of wetland vegetation.

9.2.22 Perimeter Fence

The cost for this item includes construction of perimeter fence and gates around the final covered areas, as shown on the Plans.

9.2.23 Inspection and Certification

During construction, an engineering firm will be employed to observe construction and document compliance with the approved Construction Plans and NYSDEC regulations. Upon completion of the closure construction, an engineering certification report will be prepared describing the landfill closure construction. The report will be submitted to NYSDEC. The estimated cost for this item assumes that all closure construction will be completed in one nine-month construction season. This item includes the cost for required on-site construction observation, daily record keeping, and appropriate geosynthetic and geotechnical testing.

9.3 POST-CLOSURE COST ESTIMATE

Post-closure activities at the site will include routine inspection and maintenance, as well as remedial activities. Anticipated post-closure activities that will be conducted during the 30-year post-closure period are summarized in the following sections.

9.3.1 Final Cover/Vegetative Maintenance

Regular inspections will be conducted to determine the need to repair the final cover and vegetation. Repairs will be conducted, as necessary to ensure the integrity of the landfill cover. Based on observations of similar landfill sites, it is estimated that approximately 1/8 of the final cover will require maintenance over the closure period. It is estimated that 3 percent will be repaired the first year, 2 percent the second through fourth years, 1 percent for the fifth year, and ½ percent for the sixth through the tenth year of the post-closure period.

9.3.2 Fertilizing

During the initial 10 years of vegetation establishment, fertilizer will be applied annually.

9.3.3 Mowing

Mowing of vegetation, approximately two times per year, will be completed to prevent the establishment of deep-rooted vegetation.

9.3.4 Drainage System Inspection and Repair

The surface water system composed of diversion swales, access road swale, downchutes and energy dissipators, will be inspected on a regular basis. Repair, including cleaning, revegetation and regrading, will be conducted as necessary. Based upon observations of similar projects, it is assumed that maintenance will be equivalent to the replacement of approximately 1/3 of the drainage system. The repair schedule is similar to the schedule for final cover maintenance.

9.3.5 Annual Survey

An annual survey will be performed to verify the final cover slope, and identify any areas of differential settlement or ponding. The annual survey will assist in the determination of which areas of final cover will require repair.

9.3.6 Wetland Mitigation Inspection and Repair

The wetland mitigation area will be inspected semi-annually (spring and fall) for the first two years, starting from the completion of the first planting, to assess the effectiveness of the wetland mitigation. Vegetation will be replanted and sediment basin water elevation will be adjusted as necessary, to comply with the Wetland Mitigation Plan.

9.3.7 Inspection and Certification

Engineering inspections and certifications will be completed and summarized in engineering reports that will be prepared by a professional engineer registered in New York. It is estimated that the reports will be prepared annually for the first 5 years, and then the equivalent of once every other year for the remainder of the 30-year closure period.

FINAL COVER CONSTRUCTION COST ESTIMATE

BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORP.
BROOME COUNTY COLESVILLE LANDFILL
CLOSURE ACTION OF THE REMEDIAL DESIGN

Item No.	Item	Approximate Quantities		ESTIMATED COST	
		Quantity	Unit	UNIT PRICE	COST
1	Mobilization and General Conditions	1	LS	500,000.00	500,000.00
2	Survey	1	LS	100,000.00	100,000.00
3	Clearing and Grubbing				
	a. First 13 Ac	13	Ac	2,500.00	32,500.00
	b. Over 13 Ac	2	Ac	2,500.00	5,000.00
4	Soil Erosion and Sediment Control	1	LS	20,000.00	20,000.00
5	Subgrade Preparation, Fill Soils, and Fine Grading				
	a. First 158,000 SY	158,000	SY	2.20	347,600.00
	b. Over 158,000 SY	16,000	SY	2.20	35,200.00
6.1	Alternate 1 Gas Venting Layer (6 inches Sand)				
	a. First 139,000 SY	139,000	SY	3.50	486,500.00
	b. Over 139,000 SY	14,000	SY	3.50	49,000.00
6.2	Alternate 2 Gas Venting Layer (Geocomposite Drain)				
	a. First 1,250,000 SF	1,250,000	SF	0.70	875,000.00
	b. Over 1,250,000 SF	125,000	SF	0.70	87,500.00
7	Slotted Corrugated Polyethylene Gas Pipe, Subangular Stone, Geotextile Type B, and Gas Vents	1	LS	45,000.00	45,000.00
8	40 mil Flexible Membrane Liner				
	a. First 1,250,000 SF	1,250,000	SF	0.46	575,000.00
	b. Over 1,250,000 SF	125,000	SF	0.46	57,500.00

FINAL COVER CONSTRUCTION COST ESTIMATE
BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORP.
BROOME COUNTY COLESVILLE LANDFILL
CLOSURE ACTION OF THE REMEDIAL DESIGN

Item No.	Item	Approximate Quantities		ESTIMATED COST	
		Quantity	Unit	UNIT PRICE	COST
9.1	Alternate 1 Drainage Layer (12 inches Sand)				
	a. First 139,000 SY	139,000	SY	7.50	1,042,500.00
	b. Over 139,000 SY	14,000	SY	7.50	105,000.00
9.2	Alternate 2 Drainage Layer (Geocomposite Drain)				
	a. First 1,250,000 SF	1,250,000	SF	0.70	875,000.00
	b. Over 1,250,000 SF	125,000	SF	0.70	87,500.00
10.1	Alternate 1 Geotextile Type A				
	a. First 1,250,000 SF	1,250,000	SF	0.10	125,000.00
	b. Over 1,250,000 SF	125,000	SF	0.10	12,500.00
11.1	Alternate 1 Barrier Protective Layer (12 inches)				
	a. First 139,000 SY	139,000	SY	1.30	180,700.00
	b. Over 139,000 SY	14,000	SY	1.30	18,200.00
11.2	Alternate 2 Barrier Protective Layer (24 inches)				
	a. First 139,000 SY	139,000	SY	2.60	361,400.00
	b. Over 139,000 SY	14,000	SY	2.60	36,400.00
12	Topsoil (6 inches)				
	a. First 139,000 SY	139,000	SY	3.40	472,600.00
	b. Over 139,000 SY	14,000	SY	3.40	47,600.00
13	Seeding and Mulch				
	a. First 42 AC	42	AC	3,200.00	134,400.00
	b. Over 42 AC	5	AC	3,200.00	14,400.00

FINAL COVER CONSTRUCTION COST ESTIMATE
BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORP.
BROOME COUNTY COLESVILLE LANDFILL
CLOSURE ACTION OF THE REMEDIAL DESIGN

Item No.	Item	Approximate Quantities Quantity	Unit	ESTIMATED COST UNIT PRICE	COST
14	Gravel Access Road				
	a. First 4,300 LF	4300	LF	19.00	81,700.00
	b. Over 4,300 LF	430	LF	19.00	8,170.00
15	Grass–Lined Drainage Channel				
	a. First 4,300 LF	4,300	LF	14.50	62,350.00
	b. Over 4,300 LF	430	LF	14.50	6,235.00
16	Rip–Rap Lined Drainage Channel				
	a. First 260 LF	260	LF	20.00	5,200.00
	b. Over 260 LF	30	LF	20.00	600.00
17	Gabion–Lined Channel				
	a. First 120 LF	120	LF	110.00	13,200.00
	b. Over 120 LF	12	LF	110.00	1,320.00
18	Step Downchute				
	a. First 130 LF	130	LF	145.00	18,850.00
	b. Over 130 LF	15	LF	145.00	2,175.00
19	Energy Dissipator Pads	2	EA	250.00	500.00
20	Dual 36–Inch Diameter RCP Culvert				
	a. First 150 LF	150	LF	200.00	30,000.00
	b. Over 150 LF	15	LF	200.00	3,000.00

FINAL COVER CONSTRUCTION COST ESTIMATE

BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORP.

BROOME COUNTY COLESVILLE LANDFILL

CLOSURE ACTION OF THE REMEDIAL DESIGN

Item No.	Item	Approximate Quantities		ESTIMATED COST	
		Quantity	Unit	UNIT PRICE	COST
21	18-Inch Diameter RCP Culvert				
	a. First 70 LF	70	LF	50.00	3,500.00
	b. Over 70 LF	10	LF	50.00	500.00
22	Sediment Basin	1	LS	25,000.00	25,000.00
23	Wetland Mitigation	1	LS	57,200.00	57,200.00
24	Perimeter Fence				
	a. First 5,200 LF	5,200	LF	14.75	76,700.00
	b. Over 5,200 LF	520	LF	14.75	7,670.00
25	Engineering Inspection & Certification	1	LS	150,000.00	150,000.00

FINAL COVER CONSTRUCTION COST ESTIMATE
BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORP.
BROOME COUNTY COLESVILLE LANDFILL
CLOSURE ACTION OF THE REMEDIAL DESIGN

Item No.	Item	Approximate Quantities		ESTIMATED COST	
		Quantity	Unit	UNIT PRICE	COST
1/1	Final Cover Alternate 1 & Gas Venting Layer Alternate 1				
	Base Items ____________________				4,586,000.00
	Overages ____________________				374,070.00
	Total Bid ____________________				4,960,070.00
1/2	Final Cover Alternate 1 & Gas Venting Layer Alternate 2				
	Base Items ____________________				4,974,500.00
	Overages ____________________				412,570.00
	Total Bid ____________________				5,387,070.00
2/1	Final Cover Alternate 2 & Gas Venting Layer Alternate 1				
	Base Items ____________________				4,474,200.00
	Overages ____________________				362,270.00
	Total Bid ____________________				4,836,470.00
2/2	Final Cover Alternate 2 & Gas Venting Layer Alternate 2				
	Base Items ____________________				4,862,700.00
	Overages ____________________				400,770.00
	Total Bid ____________________				5,263,470.00

Notes:

1 Overages are approximately 10% of the Estimated Quantities.

2 Mobilization based on 10% of Base Item and Overage costs.

3 Alternative 1/1 includes all Item Nos. exclusive of Item Nos. 6.2, 9.2 and 11.2
Alternative 1/2 includes all Item Nos. exclusive of Item Nos. 6.1, 9.2 and 11.2
Alternative 2/1 includes all Item Nos. exclusive of Item Nos. 6.2, 9.1, 10.1 and 11.1
Alternative 2/2 includes all Item Nos. exclusive of Item Nos. 6.1, 9.1, 10.1 and 11.1

4 Units are as follows:
AC – Acre
CY – Cubic Yard
EA – Each
LF – Linear Foot
LS – Lump Sum
SF – Square Foot
SY – Square Yard

BROOME COUNTY DIVISION OF SOLID WASTE MANAGEMENT / GAF CORPORATION
BROOME COUNTY COLESVILLE LANDFILL REMEDIAL DESIGN
POST–CLOSURE COST ESTIMATE
APRIL 1994

Item	CLOSURE COST ($)											
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11 to 30	TOTAL COST
Final Cover Repair	60,123	40,082	40,082	40,082	20,041	10,021	10,021	10,021	10,021	10,021	0	250,515
Vegetative Repair	4,512	3,008	3,008	3,008	1,504	752	752	752	752	752	0	18,800
Fertilizing	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	0	28,500
Mowing	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	42,000
Drainage System Inspection and Repair	3,236	2,158	2,158	2,158	1,079	539	539	539	539	539	0	13,484
Wetland Mitigation Inspection and Repair	7,750	7,750	2,000	2,000	2,000	0	0	0	0	0	0	21,500
Survey	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	105,000
Engineering Inspection and Certification	6,100	6,100	6,100	6,100	6,100	3,050	3,050	3,050	3,050	3,050	3,050	106,750
TOTALS ($)	89,471	66,848	61,098	61,098	38,474	22,112	22,112	22,112	22,112	22,112	7,950	586,549

NOTES: (1) All costs are in 1993 dollars.
(2) Costs are constant from year 11 to 30.

APPENDICES

APPENDIX A
WETLAND MITIGATION PLAN

COLESVILLE LANDFILL WETLAND MITIGATION

COMPENSATION WETLANDS PLAN

Prepared For

BROOME COUNTY
DIVISION OF SOLID WASTE MANAGEMENT
Broome County, New York

and

GAF CORPORATION
Wayne, New Jersey

March 1994

Wehran-New York, Inc.
Middletown, New York

and

Wetlands Research Associates, Inc.
Newark, Delaware

Environmental Engineers • Scientists • Constructors

TABLE OF CONTENTS

1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to provide a conceptual plan for the creation of compensation wetlands as part of permit requirements for remedial actions at the Colesville Landfill, Broome County, New York.

These plans have been based on wetlands information provided in Remedial Design – Conceptual Design Report (June 1992), Pre-Final Engineering Design Report – Remedial Design of Final Cover and Groundwater Collection Systems (February 1993), correspondence documents with USEPA, and a brief site reconnaissance (November 1993).

It is the goal of Broome County and GAF Corporation to maintain the integrity of the compensation site and the environmental benefits provided by this site. Therefore, the County will not allow farming, silviculture or ranching activities to occur on the compensation site. However, the compensation site may be used in the future for educational purposes and non-intrusive features. Roads and structures will not be constructed in the compensation sites, unless a permit under Section 404 of the Clean Water Act is first obtained.

2.0 EXISTING CONDITIONS

2.0 EXISTING CONDITIONS

2.1 SITE CONDITIONS

The Colesville Landfill site is located 1,400 feet from the eastern bank of the Susquehanna River, 18 miles east of Binghamton, in eastern Broome County (Figure 1). Elevations on the landfill vary from 1,150 to 960 feet above sea level, while the river elevation is 930 feet above sea level. Two streams, on the east and west sides of the landfill, drain directly into the river. Soils in the landfill area are predominantly Braceville, Chenango and Howard, and Mardin channery series (Figure 2). Unadilla and Wayland series are the dominant soils of the floodplain along the river.

Vegetation on the landfill is a mixture of herbaceous weed and grass species. Some areas are sparsely vegetated with barren soil and rock fragments visible. Species included asters (Aster spp.), goldenrods (Solidago spp.), sweet fern (Comptonia peregrina), ragweed (Abrosia artemisiifolia), foxtail (Alopecurus spp.), broomsedge (Andropogon virginicus), and various grasses.

Upland forest occurs along the eastern and southern sides of the site. Species encountered in the forested areas include oaks (Quercus spp.), shagbark hickory (Carya ovata), beech (Fagus grandifolia), sugar maple (Acer saccharum), white pine (Pinus strobus), and black cherry (Prunus serotina). Areas along streams and seeps (i.e., wetlands) were dominated by hemlock (Tsuga canadensis), red maple (Acer rubrum), and hornbeam (Carpinus caroliniana). Agricultural fields are located along the northern landfill boundary (hayfield) and approximately 200 feet southeast of the landfill (plowed field adjacent to East Windsor Road).

2.2 SITE WETLANDS

Landfill and Vicinity Wetlands

The following description of site wetlands is from the Remedial Design – Conceptual Design Report (June 1992).

The March 1991 Record of Decision for the site required that a wetlands survey, based on the "three-parameter method", be conducted during the remedial design phase. Wehran conducted a wetland delineation to identify and map wetland areas occurring on

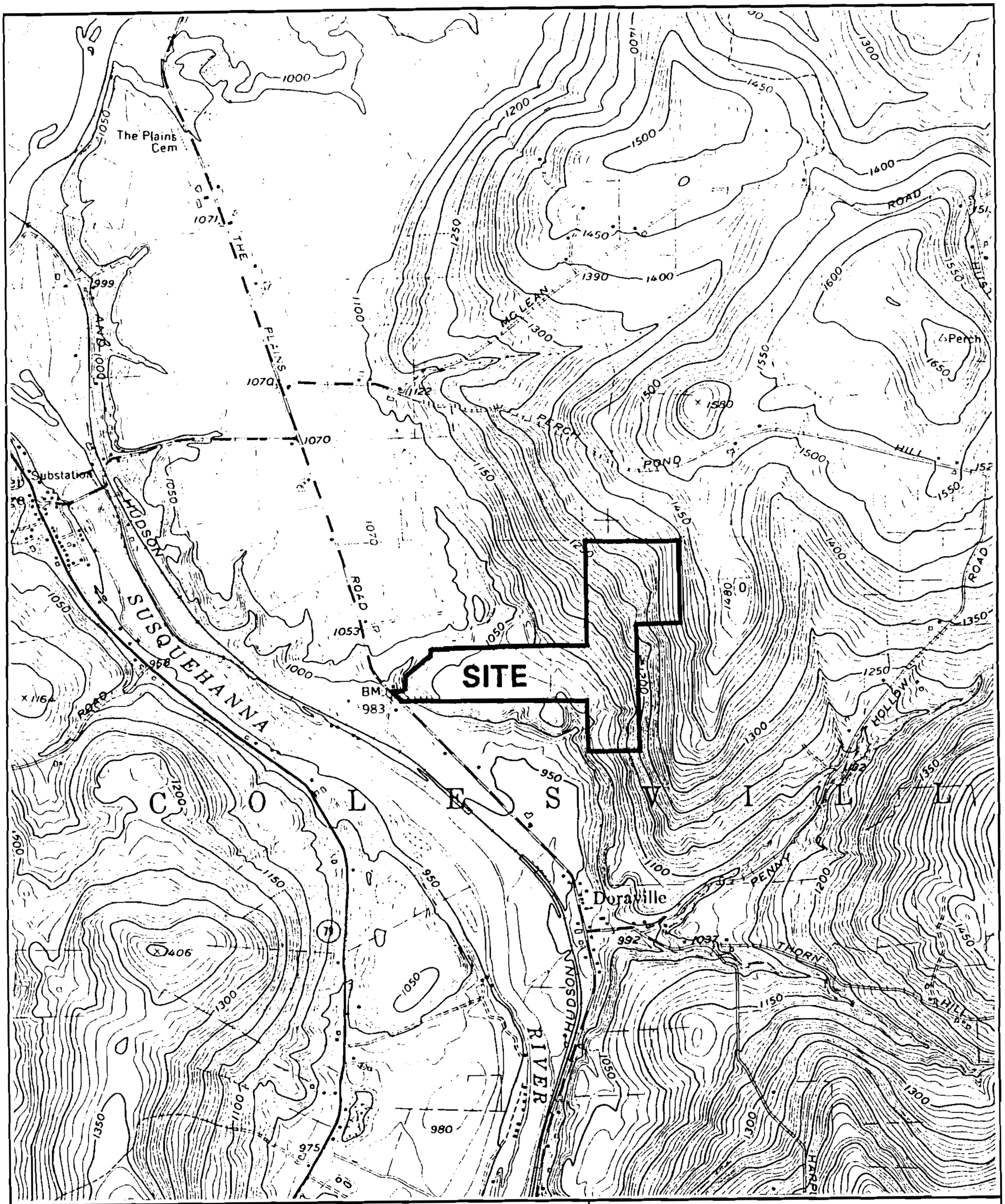


Figure 1. Site Location Map
Afton, NY, USGS
Scale: 1" = 2000'

Wetlands Research Associates, Inc.

the site, and in the immediate vicinity of the site, which could potentially receive impact by remedial construction activities.

On April 6 and 7, 1992 and December 14, 1993, biologists from Wehran flagged the wetland boundaries in the field using the three-parameter approach described in the Wetland Delineation Manual (Corps of Engineers, January 1987). Surveying of the wetland boundaries was performed by Wehran on April 9 and 10, 1992, and in December 1993.

Review of NYSDEC00 Freshwater Wetland Maps for the Colesville area indicate that there are no State-regulated wetlands on or near the site (see Figure 3). A review of National Wetland Inventory Maps indicates that three wetlands occur within the study area (Figure 4). These include two palustrine, unconsolidated bottom excavations (PUBH; i.e., ponds), and one palustrine forested wetland (PFO1).

Wetland Descriptions

Several wetlands were flagged within the study area (see Sheet 1 of 1). These wetlands range in size from 0.04 to 0.84 acres. Wetland A is a small depression. Wetlands B and H are associated with the streams previously described. Others originate as groundwater or leachate seeps (Wetlands C, D, E, F, G). All of the wetlands along the southern side of the study area are part of a larger wetland located further south. Only the upper portions of these areas, which originate as seeps and which may be impacted by remedial activities, were flagged as part of this study.

Several small wetland microhabitats were also noted on the landfilled section of the site. These microhabitats are all isolated depressions less than 0.1 acre in size and were not included in the mapping presented on Sheet 1 of 1. Although hydrophytic vegetation was present in these areas, standing water and saturated soil conditions are believed to be present only after storm events.

Following is a description of each wetland area flagged as part of this study. Data sheets and photographs of each wetland are included in Appendix B.

Wetland A

This wetland is located on adjacent property near the north central landfill border. The wetland is a small depressional area which receives drainage from the east, south, and west. A small outlet is located to the north. The wetland consists of an open water area,

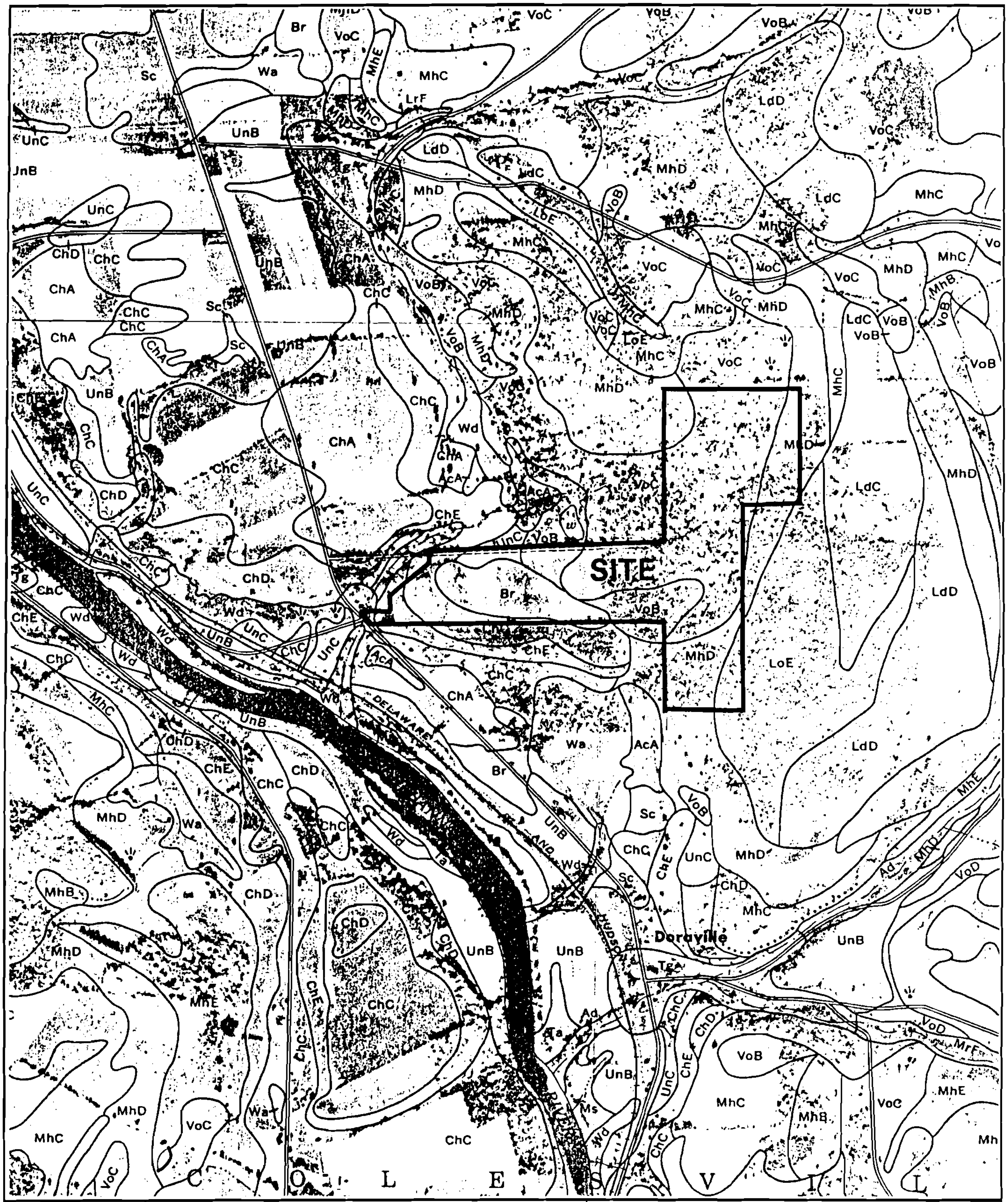


Figure 2. Site Soils Map
Soil Survey of Broome County, New York
USDA, SCS, 1971, pp.46,36 Scale: 1" = 1320'

Wetlands Research Associates, Inc.

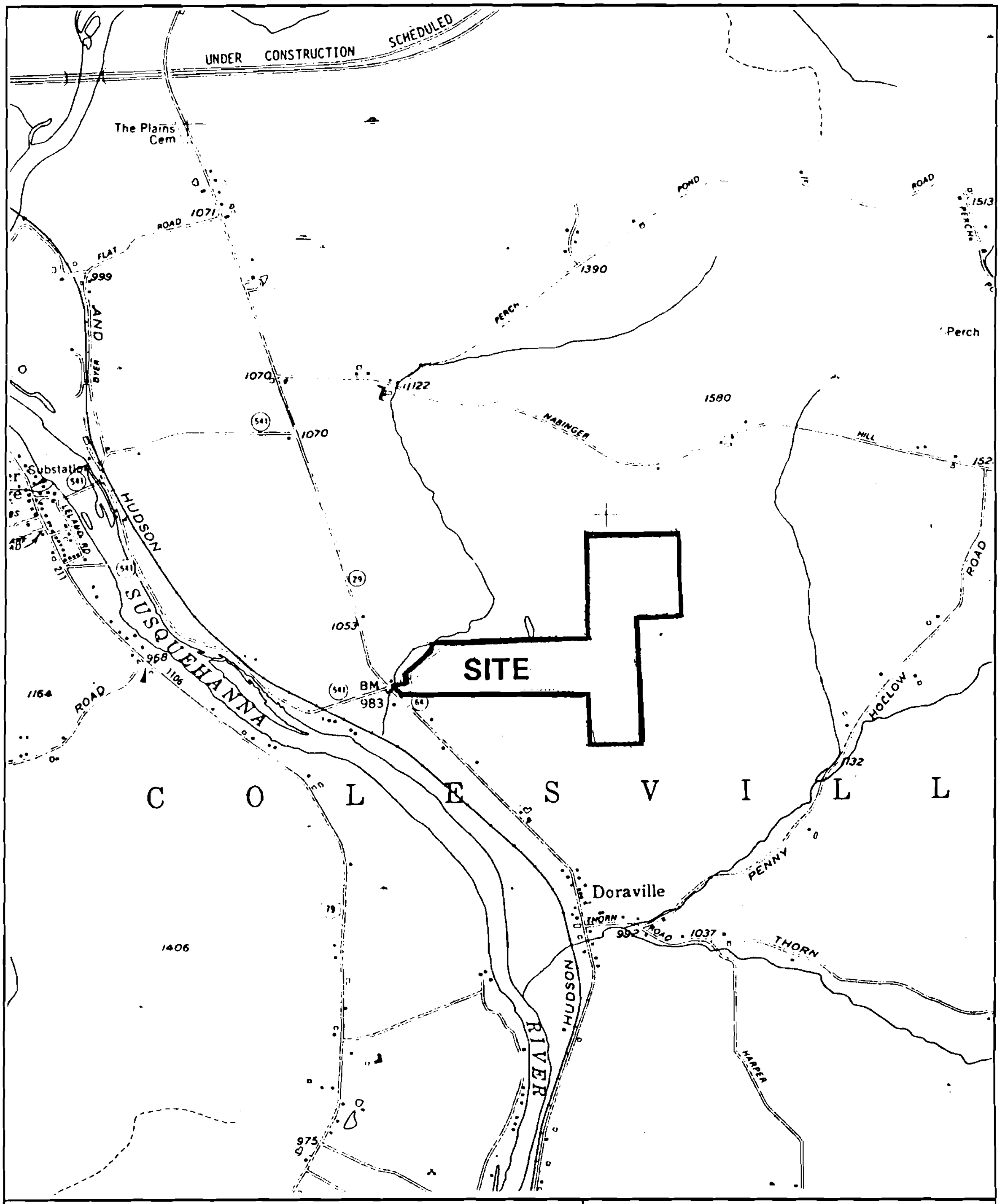


Figure 3. NYSDEC Freshwater Wetlands Map

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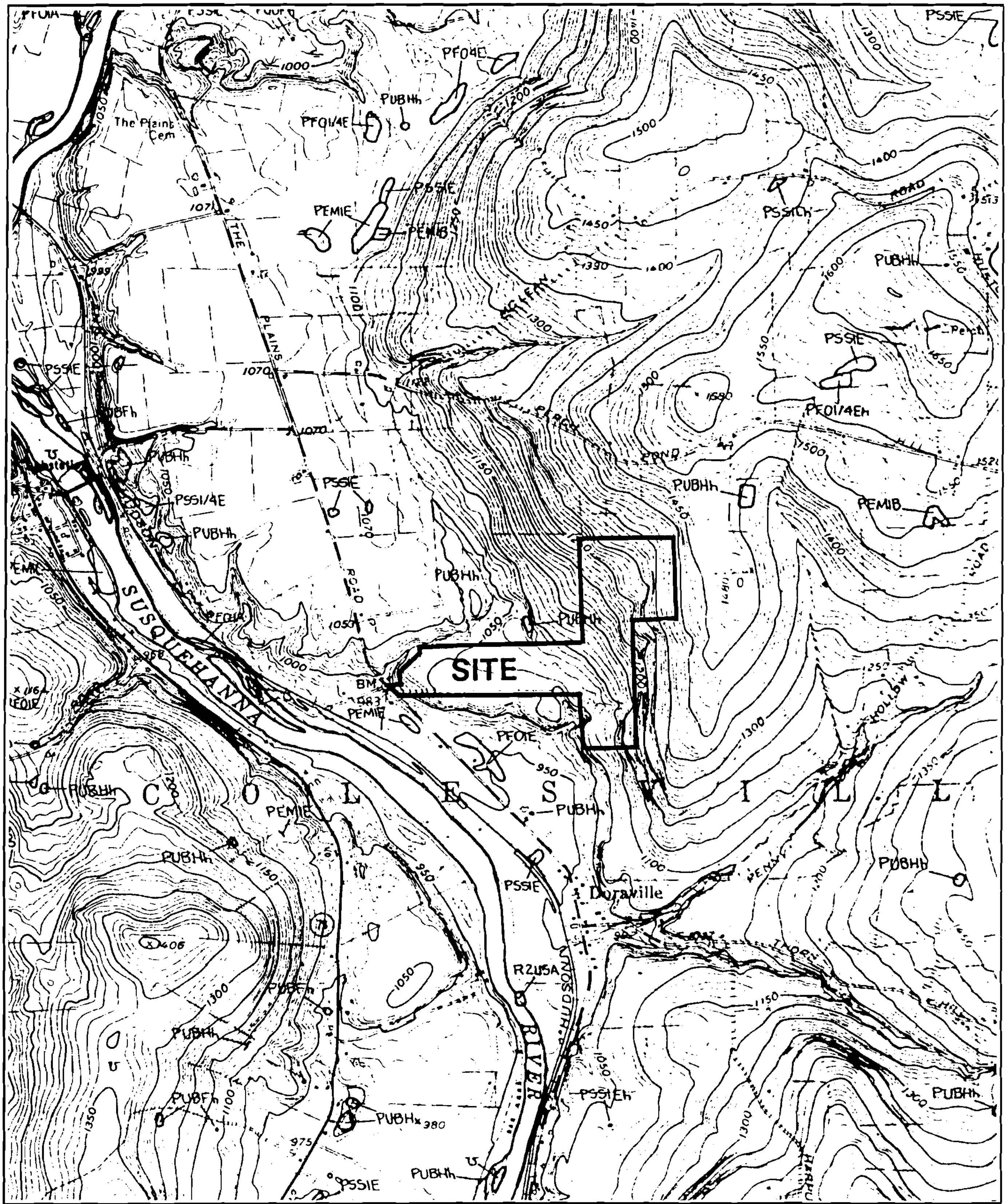

Figure 4. National Wetlands Inventory Map
Afton, NY, USFWS
Scale: 1" = 2000'

Wetlands Research Associates, Inc.

1 to 2 feet deep; surrounded by a concentric ring of emergent vegetation 5 to 20 feet wide. Some hydrophytic shrubs and trees are located adjacent to the emergent zone. These shrub species include witch-hazel (Hamamelis virginiana, FAC-), speckled alder (Alnus rugosa, FACW+), hornbeam (FAC), buttonbush (Cephalanthus occidentalis, OBL) and red maple (FAC). Herbaceous species noted in the emergent zone consist of wool grass (Scirpus cyperinus, FACW+), soft rush (Juncus effusus, FACW+), tearthumb (Polygonum sagittatum, OBL), and sensitive fern (Onoclea sensibilis, FACW).

Soils in the vicinity of Wetland A are mapped by the Soil Conservation Service (SCS) as Volusia channery silt loams. These soils consist of deep, poorly drained, loamy soils formed in dense till. Soil samples retrieved within the wetland boundary from depths up to 12 inches were both mottled and gleyed. Mottle colors were generally found to range from orange to red (2.5 YR 4/8 to 2.5 YR 5/8). Gley colors were typically 5GY 7/1. Soils within the wetland boundary were inundated or saturated to the surface. This wetland is 0.76 acres in size.

Wetland B

This wetland is a small (0.2169 acres) linear wetland associated with a ditched tributary on the east side of the landfill. The wetland ranges from approximately 2 to 10 feet wide in certain areas. Characteristic plants include willow, rush, and sedge along the stream channel. Flowing water (2 to 3 inches deep) was present in the drainage channel.

Wetlands C, D, E, F, and G

Wetlands C through G originate as groundwater seeps on the south facing slope, approximately 400 to 500 feet south (below) of the landfill. Several of these wetlands have visible leachate discharges in the upper sections of the wetlands. All of these areas start out as small linear rivulets or seeps, and drain south into a larger wetland complex. The areas flagged represent fingers of the same wetland which extend up the hillside. All wetland flagging was terminated at an access road which runs along the base of the hill. No physical wetland impacts are expected below this road; subsequently, these areas will not be disturbed.

not flagged because no impacts are anticipated in this area. As the stream proceeds west, steep hemlock covered banks are encountered. The wetland area in this section is limited to the rock covered stream bottom. Further along the stream, deciduous trees become dominant in more of a floodplain type environment.

Soil samples were only obtained in the upper sections of Wetland H due to the prevalence of rock in the stream bed. Also, the wetland was typically defined as the stream channel in the lower reaches.

Borrow Area Wetlands Y, Z, and BWA

The wetlands occurring in the borrow area are predominantly streamside corridor wetlands. They are generally linear and narrow, sometimes only 3 to 4 feet wide. Near the streams, dominant woody vegetation consists of red maple (Acer rubrum, FAC), hornbeam (Carpinus caroliniana, FAC), yellow birch (Betula alleghaniensis, FAC), and witch hazel (Hamamelis virginiana, FAC-). Areas of more moderate elevation change where the stream corridor and wetland widened included hawthorn (Crataegus spp.), red-osier dogwood (Cornus stolonifera, FACW+), and elderberry (Sambucus canadensis, FACW).

While no formal evaluation of wetland functions and values has been conducted, the value of much of the delineated wetlands is restricted to stormwater conveyance and microhabitat for amphibians.

Other wetland functions typically identified as occurring in wetlands are of unknown, or at least minimal, value for the wetlands in the borrow area. Characteristics of the subject wetlands which contribute to the lesser importance of their functions include the following:

- Small aerial extent of wetland acreage. (The larger the wetland, the greater the potential to store stormwater and reduce flooding.)
- Linear shape, with some cross-sections 3 to 4 feet. (Wide wetlands allow greater dissipation of storm flow and increased frictional resistance of vegetation to filter sediments.)
- Position in the landscape. (Wetlands high in the watershed have limited opportunity for many of the documented wetland functions.)
- No receptors of function. (No downstream development.)

3.0 WETLANDS IMPACTS

3.0 WETLANDS IMPACTS

3.1 IMPACTS

Remedial construction activities at the Colesville Landfill which will potentially affect on-site and nearby wetlands will include: capping of the waste areas, groundwater withdrawal and treatment, disturbance of borrow areas, discharge of treated effluent, and discharge of non-contact stormwater from the capped areas.

Precise conclusions concerning the impacts of drawdown are difficult given the complexity of wetland/groundwater interactions. However, impacts to wetland environments around the landfill will be offset by the enhanced protection of water resources and by remediation of the site.

Wetlands found on the landfill and in the surrounding area are identified on the Wetland Delineation Map (see Sheet 1 of 1). Presented below is a description of potential impacts to each wetland.

Wetland H (North Stream)

Wetland H consists of small fringe wetlands located along the North Stream. This stream and associated wetlands are currently fed by surface water flowing from higher topographic areas and from discharging groundwater. Current remedial design plans call for the placement of several pumping wells and an impermeable cap along the western end of the landfill, which will reduce the amount of discharging groundwater to the stream. The result of this loss to the stream hydrology may decrease the flow rates in the lower section of the stream. Drawdown in that same area also raises the potential for the water way to become a losing stream (i.e., contributing to groundwater).

Leachate Seeps 1 and 3, located adjacent to the North Stream, will be intercepted by a collection system. The collection system, consisting of geosynthetic clay, composite, subangular stone, slotted polyethylene pipe, and a pump station will be located in those positions currently occupied by the seeps. Construction of the seep collection system is expected to physically impact the stream bank. However, backfilling of the collection system excavation upon completion will mean that the physical disturbance will be temporary. Further, Leachate Seeps 1 and 3 should dry up over a period of time resulting in an overall improvement in water quality for the North Stream.

The stream's losing water balance may be compensated by the addition of treated effluent and non-contact stormwater runoff that will be directed to it from the landfill cap. Runoff will enter the stream via a step downchute located off the western end of the landfill. The step downchute can reduce the velocity of the flow by approximately 25 percent and allow some suspended particles associated with the stormwater to settle out.

Based on the pre-final design for the groundwater treatment system, treated effluent will be discharged to the North Stream. The effluent will enter DC-1-3 (diversion swale) from the treatment plant and enter the stream via the energy dissapating downchute. This discharge will be at a maximum rate of 80 gpm (gallons per minute), and an average temperature of 50 to 55°F. A hydrological evaluation of the waterway utilizing the Soil Conservation Service's Technical Release No. 55 method, indicates that the peak discharge rate is far greater than the treated effluent discharge rate of 80 gpm (0.18 cfs) and will therefore not impact the existing drainage capacity of the North Stream.

Wetland A

Wetland A is an isolated wetland on the north side of the landfill. This wetland receives surface flow and groundwater discharge from higher topographic areas. Drainage from the wetland flows to the west into the North Stream. This wetland is not expected to be impacted by capping and borrow activities because it is essentially upgradient or cross-gradient of all operations. Drawdown should also have little affect since the wetland is underlain by a highly impermeable till and receives overland flow from an upslope origin that will not be affected by remedial construction activities. Accordingly, the vertical leakage from Wetland A has been calculated at 0.07 gallons/day per square foot (22,194 gallons/day) based upon a 20-year model of groundwater drawdown of 4 feet in the vicinity of Wetland A. This vertical leakage will be an increase of 7.8 percent from the present day vertical leakage of 20,583 gallons/day (see Appendix B). These numbers equate to a loss of approximately 1,611 gallons/day to the surface water flow leaving the wetland and entering the North Stream.

Wetland B

Wetland B is comprised of a small narrow ditch corridor on the eastern (uphill) side of the site. In order to protect the integrity of the cap in that area, the stream corridor (Wetland B) will be rip-rapped along its length on the eastern end of the landfill and pass through a culvert near the southeast corner of the landfill.

Drainage from the sediment basin will be discharged to this drainage corridor following the removal of sediment.

Wetlands C, D, E, F, and G

Wetland Areas C, D, E, F, and G will likely be affected by drawdown along the southerly portion of the landfill. These wetlands occur as seeps which are driven by the hydraulic head from that area. Drawdown is necessary in the southern portion of the landfill to help control flow from Leachate Seep 2 located immediately upslope of Wetlands C, D, E, F, and G. It is anticipated that these wetland areas will be lost as a result of remedial activities.

Wetlands I, J, K, L, M, N, O, P

Capping activities will also require the filling of several small wetlands located directly on top of the landfill. Wetlands I, J, K, L, M, N, O, P, and Q currently exist as small, depressional, emergent wetlands, of which some originate as leachate seeps. The loss of these areas is unavoidable as capping is required to reduce the infiltration of precipitation into underlying waste strata.

Remedial construction activities, including capping and borrow operations, discharge of treated effluent, stormwater discharge, and groundwater withdrawal, will affect the wetlands on and around the Colesville Landfill. Those wetlands expected to be impacted minimally include Wetland Areas A and H. These wetlands comprise 1.60 acres. Wetland B comprising 0.22 acres, will receive impacts by construction activities that include placing rip-rap in the stream channel and passing the stream through a culvert. Wetland Areas C, D, E, F, and G, totaling 0.39 acres, are expected to be eliminated as a result of drawdown. Wetland Areas I, J, K, L, M, N, O, P, and Q, on top of the existing landfill and comprising 0.48 acres, will be lost because of capping operations.

Borrow Area Wetlands Y, Z, and BWA

Wetlands within the borrow area will be removed during material excavation (Figures 5 and 6). Stream corridors will be re-established according to the mitigation plan, and may have wetland characteristics. All wetland impacts are addressed in the following compensation plan.

EPA has required that wetland impacts be compensated as follows:

TABLE 1
IMPACT AND COMPENSATION SUMMARY

Wetland Impact Areas	***Acres***	***Replacement Ratio***	***Compensation Acres***
Landfill Surface and Southern Slope	1.1	1.0	1.1
Borrow Area	0.992	2.0	1.98
Total	***2.092***		***3.08***

Compensation Wetland Community Types	***Acres***
Open Water and Emergents	0.55
Emergents	0.85
Scrub/Shrub	0.6
Forested	1.1
Total	***3.08***

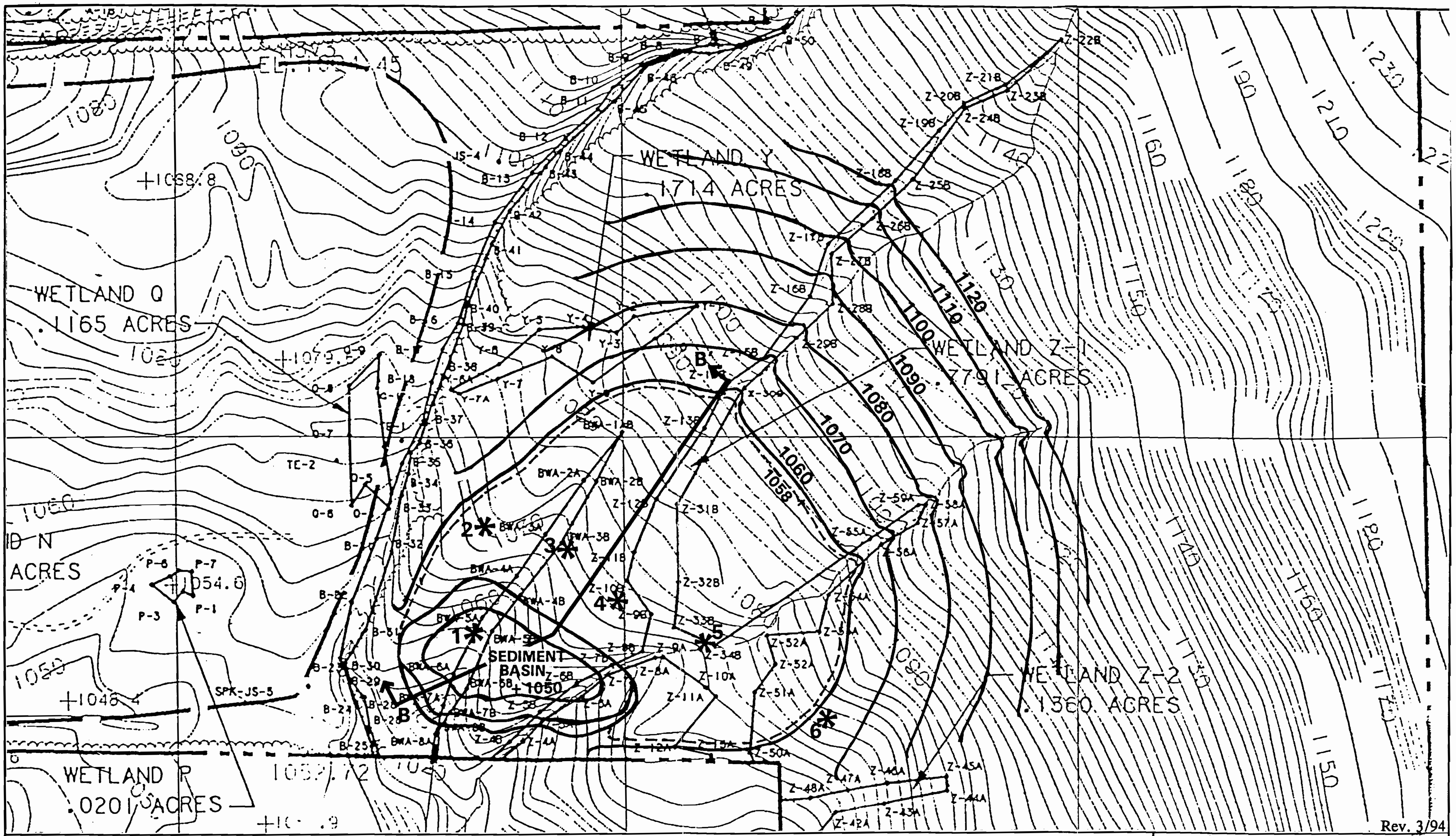

Figure 5. Grading Plan and Soil Boring Locations
Scale: 1" = 100'

0 100'

LEGEND
SOIL BORING LOCATION 1✱

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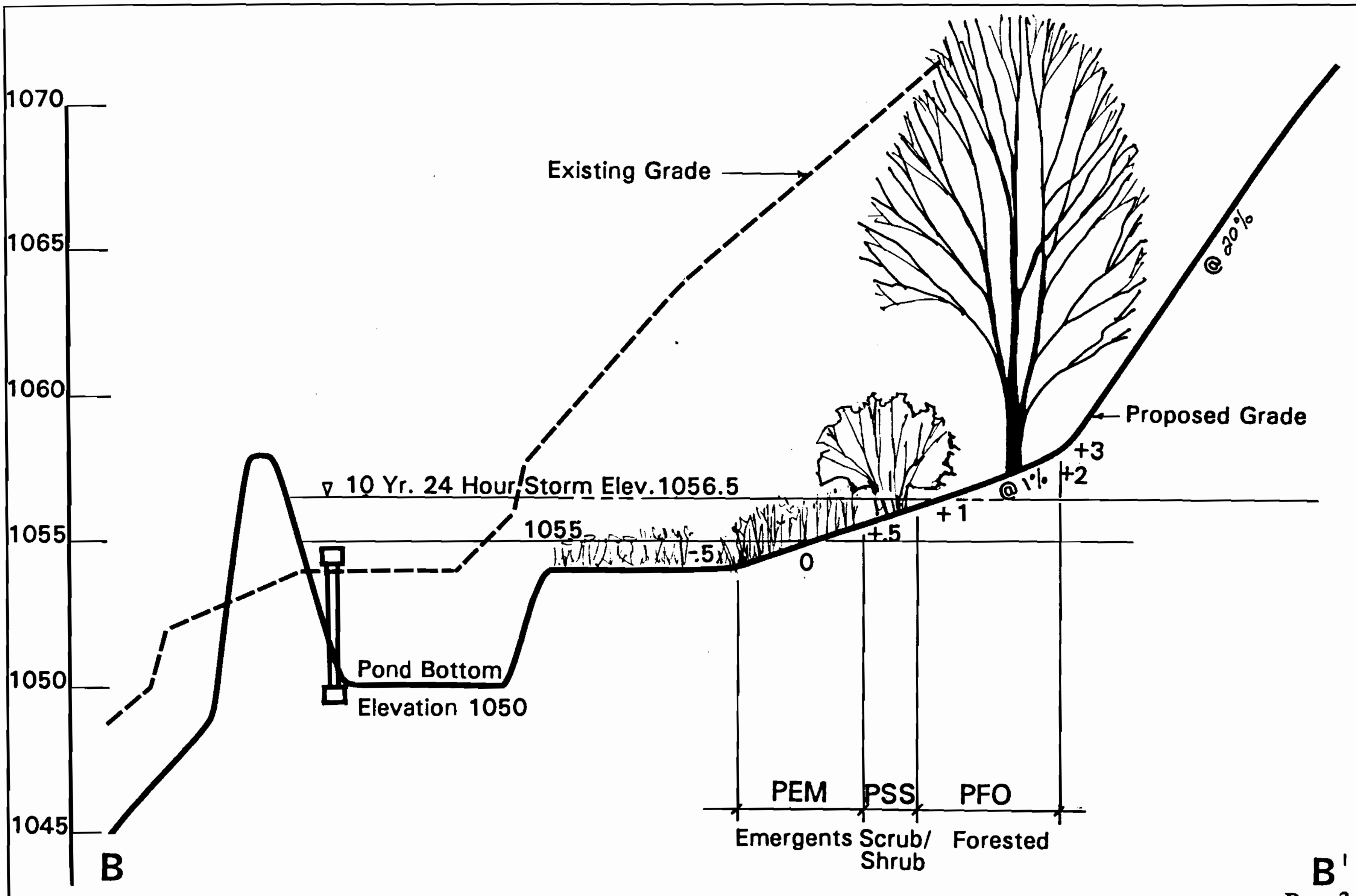

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Figure 6. Sediment Basin Cross-Section B-B'
Not to Scale

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4.0 PROPOSED CONCEPTUAL PLAN

4.0 PROPOSED CONCEPTUAL PLAN

The restoration plan for the mitigation site includes the following elements:

1. Topographic map of existing conditions and proposed contours for grading/excavation.
2. Revegetation plan describing species to be planted, density, and distribution throughout the mitigation area.
3. Monitoring as necessary to determine the success of the grading and revegetation plan.

4.1 RESTORATION PLAN OBJECTIVES

The restoration plan seeks to replace wetland habitat lost as a result of the remedial actions on the landfill site. Wetlands receiving impacts from the remedial actions consist of emergent wetlands located on the existing landfill surface and forested wetlands on the slope woodland, south of the landfill and in the borrow area. These wetlands serve to improve water quality, desynchronize flood flows, moderate base flows, and provide wildlife habitat. The proposed compensation program seeks to mitigate for these losses by restoring a greater acreage of wetland habitat on the site within the borrow area.

Specifically, the restoration plan will:

1. Create emergent, scrub shrub and forested wetlands in the lower area of the borrow area, adjacent to the sediment basin.
2. Revegetate the upper borrow area with an assemblage of forest tree species.
3. Increase wildlife habitat in the restored borrow area through increasing habitat diversity to include open water, emergent marsh, scrub shrub, forested wetlands, and restored upland forest.
4. Permanently preserve and protect wetlands through site ownership and maintenance.

The success of the restoration effort will be measured against these objectives.

4.2 CONCEPTUAL DESIGN

The current wetland design is based upon a pond for dependable hydrology in the margin wetland and a mixture of emergent, scrub/shrub, and forested wetland community types as commensurate in-kind replacement for the wetland impact areas on site.

The creation of wetland hydrology on site may be achieved immediately adjacent to the proposed sediment basin in the borrow area on the eastern edge of the landfill (Figure 5). Specifically, wetland hydrology may be created on a expanded shoreline margin on the north and eastern borders of the sediment basin. It is anticipated that approximately up to 30 feet of soils and glacial till will be removed throughout the borrow area in order to provide sufficient material for the new landfill cap. Approximately 0.5 acre of pond margin will be created by excavation into the hillside in addition to the sediment basin area. The compensation wetland area will be comprised of the 0.55 acre permanent pond (initial sediment basin), 0.85 acre emergent wetland, 0.6 acre scrub/shrub wetland, and 1.1 acre palustrine forested wetland.

The primary source of water will be the stream within the borrow area and the surface runoff from the southern portion of the new landfill cap area. Groundwater elevations within the borrow area have not been determined, but may be assumed from boring data to be at streambed elevations in the stream between the landfill and borrow area or about 20 feet below the existing land surface. Water elevation within the basin and wetland margin will be set by a riser or weir and discharge structure.

The final construction specifications will describe the over-excavation (1 foot deeper) of the wetland margin area. This will allow for the addition of ½-foot depth of hydric soils from the stream and swale corridors of the borrow area, to bring the surface of the wetland up to the desired elevations. Hydric soils in the created wetland will enhance the growth of wetland plants through their associated soil moisture capacity, nutrients, and seed bank.

It is anticipated that the elevation of saturation in the margin wetland will be higher than the pond water elevation due to both capillary rise within the soil and the downgradient subsurface flow of water from the upper borrow area. Capillary rise even in pure sands may constitute 6 inches and the site till should exhibit greater capillary rise. These factors are expected to bring about saturated soil conditions (at least seasonally) within the root zone of the forested wetland area. Forested wetland community soils characteristically display a significant drawdown over the growing season. Four channels (two intermittent stream channels and two ditches) will cross the wetland area. In the event that sufficient wetland hydrology is not achieved during the monitoring period, check dams may be placed in these channels to back up flow and increase soil saturation in adjacent areas.

The wetland margin will include shallow water habitat, emergent marsh, scrub/shrub and forested wetland areas. Wetland communities within the area are: shallow water and emergent marsh (-0.5 to +0.5 feet above pond water elevation), scrub shrub (+0.5 to 1.0 feet), and wetland forest (1.0 to 2.0 feet). Figure 7 presents a diagrammatic layout of the planting area. The actual borders between communities will be blended and irregular as in natural communities. Calculations for the 10-year, 24-hour storm event indicate that basin elevations will extend to the mid elevations of the forested wetlands (1056.5 feet). The basin/pond discharge structure will be developed to allow for the adjustment of basin water elevation. The proposed water control structure is not active in nature. A dam or weir is proposed with a wooden plank face. Adjustment to the pond water level could be made as warranted by removing, adding, or changing the size of planks. At the end of the monitoring period the overflow level would be permanently set by either rip rap or fill. The permanent basin elevation will be set to achieve the desired hydrology within the margin wetland communities.

Plant species suggested for the wetland area are given in Table 1. All species are native plants either commonly found on-site or within the region. All plant material may be purchased from regional wetland nurseries.

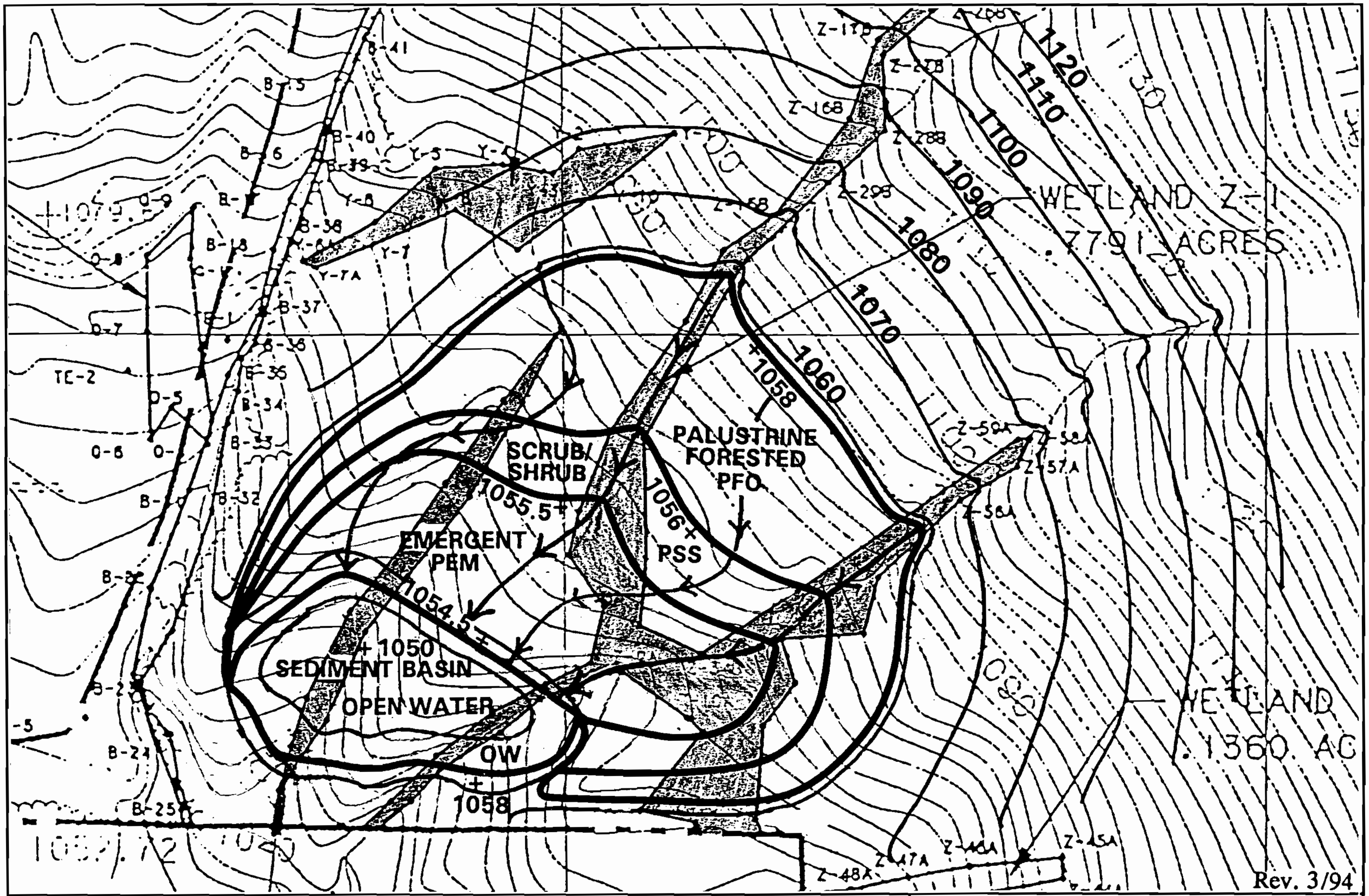

Figure 7. Wetland Compensation Planting Plan
Scale: 1" = 100'

0 100'

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LEGEND
EXISTING WETLANDS ▨

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5.0 COMPENSATION SITE FEASIBILITY

5.0 COMPENSATION SITE FEASIBILITY

5.1 TOPOGRAPHY AND DRAINAGE

The sediment basin, compensation wetland, and borrow area is located adjacent to the east end of the landfill. The site lies on a hillside that slopes moderately to the southwest, and is heavily wooded. The area is drained by a swale and two streams that eventually drain into the Susquehanna River, approximately one-half mile to the west. The elevation at the upper end of the proposed borrow area is 1,150 feet above sea level, and the lower elevation (near the proposed sediment basin) is 1,040 feet.

5.2 SOILS

The soil mapped in the borrow/compensation wetland area is Volusia channery silt loam, a deep, somewhat poorly drained, loamy soil. The Volusia series is listed as a soil with potential hydric inclusions. Hydric soil types in the vicinity that may occur as inclusions in Volusia soil at the site include Alden-Chippewa complex and Wayland soils.

AcA	Alden and Chippewa	Hydric	Deep, very poorly drained in depressions and along drainage ways
Wd	Wayland	Hydric	Deep, poorly to somewhat poorly drained
Unc	Unadilla silt loam	Non-Hydric	
Chc	Chenango and Howard	Non-Hydric	
Wa	Wallington silt loam	Hydric Inclusions	Deep, acid, somewhat poorly drained in slight depressions, sometimes ponded
MhD	Mardin	Non-Hydric	
Sc	Scio silt loam	Non-Hydric	
Vo	Volusia	Hydric Inclusions	

Soil data collected in the area of the sediment basin are presented below with auger locations given in Figure 5.

Auger	Depth	Description (Value/Chroma)
1	0-5" 5-10" 10-15" 15-20"	5/1, 4/1 10YR, Fe Ox roots 5/1, 4/1, 6/2 10YR 5/1, 6/1 5Y, Fe Ox Ag. 6/1 5Y, 6/8 10YR, Fe Ox Ag.
2	0-5" 5-20"	3/1 10YR 3/1, 5/3 10YR, 6/1 5Y, Fe Ox Ag.
3	0-5" 5-10" 10-20"	5/5, 4/2 10YR 5/4 2.5Y 5/4, 6/4 2.5Y
4	0-5" 5-10" 10-20"	5/5, 4/2 10YR 5/4 2.5Y 5/4, 6/4 2.5Y
5	0-5" 5-20"	3/1 10YR 3/1, 5/3 10YR, 6/1 5Y, Fe Ox Ag.
6	0-5" 5-10" 10-20"	5/5, 4/2 10YR 5/4 2.5Y 5/4, 6/4 2.5Y

5.3 HYDROLOGY

The area of the proposed sediment basin and compensation wetland is heavily influenced by surface flow from the upper watersheds to the north and east. Stream B, which flows in a channelized ditch west of and adjacent to the proposed basin and wetland, does not presently contribute directly to the surface flow. There are two swales and a small stream that converge in the southwest corner of the area, then join Stream B and flow south. Although the drainage area is moderately steeply sloped, the entire area is forested with adequate cover to stabilize surface flows.

Limited information is available on groundwater in the borrow area. Groundwater elevations as shown in drawing details are based on one boring log and the assumption that groundwater elevations are near the streambed of Stream B or about 1,050 feet in elevation, between the landfill and the borrow area. The boring log record from the borrow area indicates groundwater at about 20 feet below the surface. One may assume that in the vicinity of the proposed sediment basin, groundwater may seasonally reach the bottom of the basin at an elevation of 1,050 feet. Water budget calculations suggest wetland hydrology will usually be achieved (Appendix C).

5.4 VEGETATION

The proposed sediment basin and compensation wetland area is now predominantly second growth, mixed hardwood and pine forest. The upper elevations are dominated by white oak (Quercus alba), shagbark hickory, (Carya ovata), and white pine (Pinus strobus) with a sparse understory including black cherry (Serotina Prunus). The lower elevations are dominated by red oak (Quercus rubra), white pine (Pinus strobus), and red maple (Acer rubrum). Throughout the study area in lesser amounts were American beech (Fagus grandifolia), poplar (Populus sp.), birch (Betula sp.), hornbeam (Carpinus carolinianus), and red osier dogwood (Cornus stolonifera).

5.5 WILDLIFE

As second growth deciduous forest, the study area presumably supports diverse wildlife populations. During the November site visit, tracks and signs were observed for white-tailed deer, wild turkey, eastern cottontail, and canids. Red-tailed hawks and many passerine birds including, nuthatch, chickadee, fox sparrow, white throated sparrow, cardinals, and crow were observed on the site.

5.6 SITE FEASIBILITY

The sediment basin in the borrow area will be designed as a permanent wet basin or pond with a 5-foot water depth overall. This open water area, with associated water control structure, can provide a stable hydrology for the establishment of a wetland margin along the water's edge.

Grading of the margin around the north and east of the basin can easily be achieved assuming the representation of the Boring Log 9 data to this location. Slightly steeper slopes will be required immediately upslope of the wetland border to achieve the original borrow area contours and cut volumes. Grading in the margin wetland will require a 1 percent slope, from 0.5 below to 2.0 above, the design water elevation.

The source of water for the margin wetland will be the surface water stream through the borrow area, subsurface soil moisture flow in the borrow area, and runoff from the southeastern portion of the new cap landfill surface. Diversion of the adjacent stream (Wetland B) could be considered. The relocation of hydric topsoil from the borrow area to the margin wetland will ensure greater and enhanced growth of wetland plants.

6.0 PLANTING DESIGN AND SPECIFICATIONS

6.0 PLANTING DESIGN AND SPECIFICATIONS

The objective of the re-vegetation plan is to introduce species that can initiate the re-establishment of a diverse wetland and surrounding upland ecosystem. This will be achieved through:

1. Use of hydric soils from the impact areas to provide a seed source for "volunteer" wetland plant colonizers.
2. Planting with emergent and woody plants.

6.1 PALUSTRINE FORESTED WETLANDS

The dominant tree species of the area forested wetlands are red maple, green ash and hemlock, with an understory of spice bush and ironwood. The compensation site plan will emphasize these dominants and add select species found elsewhere to enhance diversity. Site diversity will also increase as the dominants mature providing greater shade and protection. Dominant species, such as red maple tend to be hardier, have wider moisture tolerances, and may survive better than less common species during the initial stages of the restoration. Additional wetland species will be selected both for being fast growing or otherwise less susceptible to grazing. A relatively rapidly formed canopy will allow for colonization by the shade tolerant wetland species not easily established in the open early stages of the compensation wetland development.

6.2 SCRUB-SHRUB WETLANDS

Shrub species will be planted within the forested areas at a equal density to tree species (Planting Specifications). The scrub/shrub wetland has been included in anticipation of the formation of a natural scrub/shrub community in this zone as a transition between the forested and emergent wetland communities. Shrub species will be planted in clumps on the border of the forested wetland areas; therefore, preference will be for shade intolerant species. Willow cuttings and clumps of alder will be located along banks or the waters edge wherever possible.

6.3 EMERGENT WETLANDS

A portion of the compensation wetland area will be planted with emergent species. The wettest of these areas may remain in solely emergent species, but in most areas there will probably be an invasion of tree and shrub species. In time these areas may develop into forest communities.

Emergent wetland species will be located in areas where soils are probably saturated throughout the growing season. Although selected species will be planted from bare root stocks and seeding, many species of sedges, rushes and broadleaved plants will invade and colonize these areas. It is expected that seeds and rootstocks in the hydric soils used as backfill will also provide a source of plant propagules.

Many emergent wetland plant species can tolerate considerably dry, as well as wet conditions. These more hardy and facultative species will be located on berm slopes of the lower elevations, which will experience greater extremes in conditions.

6.4 BERM AREAS

Facultative grass species available in seed stock for basin berm areas include: Agrostis alba (redtop), Agrostis tenuis, Agrostis palustris (bentgrasses), Poa trivalis (rough bluegrass), and Alopercus pratensis (meadow foxtail). All exposed soil will be seeded with this mixture.

6.5 UPLAND FOREST

Well drained, higher elevations of the sites will be planted with trees to establish an upland buffer to the wetland. Trees planted will be representative of adjacent uplands with an added emphasis on mast crops for enhanced wildlife value.

6.6 PLANTING SPECIFICATIONS

Plant species to be used are shown in Table 1. Planting details for trees and shrubs are discussed below. Trees to be used will be purchased at a height of 1 to 2 feet, and planted in density equivalent to 10 feet on center; although planting location will be on a random basis. Species will be chosen randomly in each community group. Shrubs will be purchased at 1 to 2 feet in height and planted in groups of 3, 5, and 7, of the same species.

In the case of a scrub-shrub community, these groupings will be in a density equivalent to 10 feet on center.

The plan is based on the use of native "wet-cultured" plants grown especially for wetland conditions. Nurseries that specialize in native wetland species should be contacted. Other nurseries tend to grow trees and shrubs for landscaping in upland conditions and the plants from these companies will not have been adapted to wetland conditions. If suitable plants are not available, it may be necessary to have them grown by nurseries under contract. All trees should be at least one year old prior to planting.

The location for the installation of various plant species will be shown on a detailed planting plan to accompany the final engineering drawings and specifications. These habitat and wetland types are shown in Figure 7. Emergent wetland species will be planted at the lowest elevation, where ponding is expected to occur the longest or soil saturation the longest throughout the year. Forested wetland species will be planted in the area having a seasonally wet hydroperiod, generally from December to late May. FACW species will be distributed in wetter areas than FAC species. Upland species will be planted in areas that have a water table generally below 24 inches or, when higher, it only saturates the upper soil profile for brief periods of time.

Assuming that the cap construction is completed in 1994, emergent species will be planted in the spring of 1995. Although seeding with facultative grasses is most needed to stabilize erodible surfaces, seeding may be carried out over the entire compensation site to hasten ground cover development with wetland species. A rapid natural colonization of the areas of hydric soils should be expected from the transported seed bed and wind born seeds. No additional watering is anticipated.

TABLE 1
WETLAND SPECIES FOR PLANTING

Species Name	Common Name	Number[1]	Indicator Status
EMERGENTS			
Carex stricta	tussock sedge	415 b.r.	OBL
Juncus effusus	soft rush	415 b.r.	FACW+
Onoclea sensibilis	sensitive fern	200 qt.	FACW

TABLE 1
WETLAND SPECIES FOR PLANTING

Species Name	Common Name	Number[1]	Indicator Status
Sagittaria latifolia	duck potato	200 qt.	OBL
Scirpus cyperinus	wool grass	415 b.r.	FACW+
Sparganium americanum	eastern bur-reed	200 qt.	OBL
	SHRUBS		
Alnus rugosa	speckled alder	6	FACW+
Cephalanthus occidentalis	button bush	6	OBL
Cornus stolonifera	red-osier dogwood	6	FACW+
Salix purpurea	streamco willow	6	-
Sambucus canadensis	elderberry	6	FACW+
	TREES		
Acer rubrum	red maple	40	FAC
Fraxinus pennsylvanicus	green ash	20	FACW
Salix nigra	black willow	10	FACW+

[1] Plant material type: b.r. = bare root, qt. = quart container

7.0 PROPOSED SCHEDULE

7.0 PROPOSED SCHEDULE

7.1 PLANTING SCHEDULE

General Schedule

Planting of aquatic or emergent wetland species will occur between April 1 and June 1, preferably during April. Fall planting of trees and shrubs will occur between September 1 and October 30. Planting will not occur when the ground is frozen, snow-covered, or in an otherwise unsuitable condition for planting. Propagules will be planted in the proportions determined above in this plan. All balled, burlapped, and container grown plants will be handled and moved only by the ball or container.

Holes for planting will be dug to produce vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed and smooth, the glazed surfaces will be scarified. The depth of the holes will be 6 inches deeper than the root ball. The width of the holes will allow a minimum distance between the ball, and the sides of the hole of 6 inches for shrubs and 12 inches for trees. Loosen the bottom 4 inches of the hole with a shovel prior to planting. One part peat moss with four parts soil should be mixed to use as a soil amendment to support the root ball in the hole.

Plants will be set plumb and manually held in position until sufficient soil has been firmly placed around roots or ball. Plants are to be set at the same depth at which they were grown in the nursery or container.

Balled and burlapped stock will be backfilled with soil to approximately half the depth of the ball, then tamped and watered. Burlap and tying materials will be carefully removed or opened and folded back. Plastic wrap will be completely removed before the placement of backfill. The remainder of backfill will be tamped and watered.

Willow and alder cuttings may be made in winter to early spring and transplanted along the water's edge of the compensation wetland before leaf out. Willow cuttings can be planted on 2-foot centers. Emergent plant species rhizomes can be planted in early spring as available from the supplier.

7.2 WATERING

All plants will be watered by flooding the backfilled hole within the same working day upon which they were planted. During and immediately after watering, all plants will

8.0 MONITORING

8.0 MONITORING

8.1 GOALS OF THE MONITORING PROGRAM

The monitoring program will be conducted to document the Permit Special Conditions. These permit conditions will be documented over a period of 2 years, starting from the completion of the first planting within the compensation wetlands.

Monitoring will be conducted during each year of the monitoring period. Progress and formal reports will document the status of wetland site conditions using the following monitoring methodology. The final monitoring report will provide a summary of monitoring data trends and compare current wetland status with compensatory wetland goals.

8.2 MONITORING PROGRAM COMPONENTS

8.2.1 Photographs

The compensatory wetland will be documented through fixed point photos with range poles or objects for scaling and reference. Location and number of photographs will be sufficient to cover the entire compensation site. Photographs will be taken from the same point and in the same direction each sampling period. Significant changes in the wetland structure, including events such as storm damage, will be documented by these photos.

8.2.2 Precipitation Gauge

Local recording precipitation gauges will be located near the mitigation area to provide better estimates of watershed precipitation than distant weather station records. Daily records of precipitation will be maintained during the period of monitoring and these data will be included in the annual monitoring reports.

8.2.3 Surface and Groundwater Monitoring

Shallow groundwater piezometers will be maintained in the compensatory wetland. Reference will be made to other groundwater elevation records. Groundwater and surface water records will be continued for the duration of the monitoring program and data summaries provided in the annual reports.

8.2.4 Base Map

A base map or plan view will be provided illustrating the location of photo points, piezometers, and sampling areas.

8.2.5 Vegetation Assessment

Vegetation is generally indicative of the structure of wetlands and a quantitative assessment of vegetative cover and survival is required by the permit conditions. The composition of each wetland vegetation community will be adequately characterized. The following general methods will be followed with an allowance for site or minor modifications. Sampling will be conducted during late spring and early fall periods of each monitoring year to best identify dominant plant species and assess seasonal biomass.

Forested Wetlands – A belt transect or line intercept method will be employed for sampling areas where tree species (with a secondary shrub layer) are to be dominant. Transects will be positioned so that each vegetation zone or category is sampled. Transects will also be located along wetland basin moisture gradients, extend into forest buffer vegetation and into undisturbed upland vegetation adjacent to the compensatory wetland.

Scrub/Shrub Wetlands - Replicate quadrat sampling will be used in areas to be dominated by shrub species. The number and average height of woody individuals within quadrats and the DBH of the largest individuals of each taxa recorded. Paired 3-meter by 3-meter quadrats are recommended.

Emergent Wetlands – Emergent vegetation areas to be dominated by herbaceous plant species are to sampled using replicate quadrats. The percent cover and average height of individuals of each taxa within the major height strata will be recorded. Each major herbaceous plant zone will be sampled. Seven replicate 1-meter by 1-meter quadrats are recommended.

8.2.6 Habitat Enhancement

Observational data will be collected on wildlife observed during seasonal vegetation assessments in the compensatory wetland area. Notes will also be kept on the grazing or predation of wetland vegetation.

8.3 IDENTIFICATION OF PROBLEMS AND RECOMMENDATIONS

As indicated through the monitoring program or otherwise noted by monitoring and facility staff, problems arising during the monitoring period will be communicated by the applicant to the District Corps of Engineers. Recommendations will be developed to compensate for problems or otherwise direct site management toward the goals of the wetland compensation program.

8.4 MAINTENANCE OF DOMINANT WETLAND VEGETATION

Wetland compensation program goals are the establishment and limited maintenance of forested and emergent wetland plant communities. Compensatory Wetland Plan specifications have been developed to enhance the establishment of such communities as quickly as possible. The persistence of these wetland communities may not depend upon a consistency of wetland community species composition as initially established on the site. Rather, wetlands are among the most dynamic of landscape features and their plant community assemblages reflect such temporal change. The influence of climatic variation, the natural colonization by native plants, and the natural development of site wetland hydrology and nutrient regimes may likely lead to a wetland that differs in community structure, but adequately meets program goals. Maintenance and management of the site will be directed towards establishing a natural wetland community over time.

APPENDICES

APPENDIX A
DATA SHEETS AND PHOTOGRAPHS

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____ Application Number: ____ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: A-1 wetland Section: ____

Vegetation [list the three **dominant** species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1.		7. Polygonum sagittatum	OBL
2.		8. Scirpus cyperinus	FACW+
3.		9. Juncus effusus	FACW+
Saplings/shrubs		**Woody vines**	
4. Salix discolor	FACW	10. Rubus hispidus	FACW
5. Cephalanthus occidentalis	OBL	11.	
6. Spirea latifolia	FAC+	12.	

% of species that are OBL, FACW, and/or FAC: >50%. Other indicators: ____.

Hydrophytic vegetation: Yes X No ____. Basis: >50% FAC or wetter.

Soil

Series and phase: Volusia On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: 2.5YR 5/8; Matrix color: ____.

Gleyed: Yes X No ____ Other indicators: 5 GY 7/1.

Hydric soils: Yes X No ____; Basis: Mottling and saturated condition.

Hydrology

Inundated: Yes X; No ____. Depth of standing water: at surface.

Saturated soils: Yes X; No ____. Depth to saturated soil: At surface.

Other indicators: ____.

Wetland hydrology: Yes X; No ____. Basis: ____.

Atypical situation: Yes ____; No ____.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland Yes; Nonwetland ____.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: N.Y. County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: TA1 Upland Section: ______

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Quercus alba	FAC U-	7. Lycopodium clavatum	FAC
2. Carya ovata	FAC U-	8.	
3. Pinus strobus	FAC U	9.	
Saplings/shrubs		**Woody vines**	
4. Ostrya virginiana	FAC U	10.	
5. Pinus strobus	FAC U	11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: <50% Other indicators: ______.

Hydrophytic vegetation: Yes ___ No X. Basis: <50% of Plants FAC or wetter on Indicator List.

Soil

Series and phase: Volusia Channery silt loam On hydric soils list? Yes ____; No X.

Mottled: Yes ____; No X. Mottle color: ______; Matrix color: ______.

Gleyed: Yes ____ No X Other indicators: ______.

Hydric soils: Yes ____ No X; Basis: No hydric soil indicators.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: none observed.

Saturated soils: Yes ____; No X. Depth to saturated soil: none observed

Other indicators: ______.

Wetland hydrology: Yes ____; No X. Basis: No saturated soil evidence.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes ____. No X.

Wetland Determination: Wetland ______; Nonwetland Yes.

Comments: Transect point located in upland north of wetland A on a 10% slope.

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____ Application Number: ____ Project Name: Colesville Landfill

State: N.Y. County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: TA2 Section: ____

Wetland Transect

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Acer rubrum	FAC	7. Juncus effusus	FACW+
2. Betula lenta	FACU	8. Sphagnum spp.	NA
3.		9. Onoclea sensibilis	FACW
Saplings/shrubs		**Woody vines**	
4. Alnus rugosa	FACW+	10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: >50% Other indicators: ____.

Hydrophytic vegetation: Yes X No ____. Basis: Greater than 50% FAC or wetter Species.

Soil

Series and phase: Volusia, Channery silt loam On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: 2.5YR 5/8; Matrix color: ____.

Gleyed: Yes ____ No X Other indicators: ____.

Hydric soils: Yes X No ____; Basis: Mottling and saturated soil.

Hydrology

Inundated: Yes X; No ____. Depth of standing water: at surface.

Saturated soils: Yes X; No ____. Depth to saturated soil: Surficial.

Other indicators: ____.

Wetland hydrology: Yes X; No ____. Basis: ____.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland YES; Nonwetland ____.

Comments: Part of transect for wetland A

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: TA3 (wetland) Section: ______

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1.		7. Polygonum sagittatum	OBL
2.		8. Onoclea sensibilis	FACW
3.		9. Scirpus cyperinus	FACW+
Saplings/shrubs		**Woody vines**	
4. Hamamelis virginiana	FAC-	10. Rubus hispidus	FACW
5. Alnus rugosa	FACW+	11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: >50%. Other indicators: ______.

Hydrophytic vegetation: Yes X No ____. Basis: Greater than 50% FAC species or wetter.

Soil

Series and phase: Volusia channery silt loam On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: 25YR 4/8; Matrix color: ______.

Gleyed: Yes X No ____. Other indicators: Gley Color 5GY 6/1.

Hydric soils: Yes X No ____; Basis: Mottled soil.

Hydrology

Inundated: Yes X; No ____. Depth of standing water: at Surface.

Saturated soils: Yes X; No ____. Depth to saturated soil: at Surface

Other indicators: ______.

Wetland hydrology: Yes X; No ____. Basis: Soil Saturated.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland YES; Nonwetland ______.

Comments: Transect point in wetland A.

Determined by: Dave Tompkins / Joe Kopalek

TA4 - uplandarea west of wetland A

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____ Application Number: ____ Project Name: Colesville Landfill

State: N.Y. County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: TA4 Section: ____

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Pinus strobus	FACU	7. Lycopodium clavatum	
2. Acer rubrum	FACU-	8.	
3. Quercus rubra	FACU-	9.	
Saplings/shrubs		**Woody vines**	
4. Hamamelis virginiana	FAC-	10.	
5.		11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: <50%. Other indicators: ____.

Hydrophytic vegetation: Yes ____ No X. Basis: Less than 50% of species FAC or wetter on plant list.

Soil

Series and phase: Volusia, silt loam On hydric soils list? Yes ____; No X.

Mottled: Yes ____; No X. Mottle color: None; Matrix color: 10YR 4/4.

Gleyed: Yes ____ No X Other indicators: ____.

Hydric soils: Yes ____ No X; Basis: No indicators of hydric soils.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: ____.

Saturated soils: Yes ____; No X. Depth to saturated soil: None observed

Other indicators: ____.

Wetland hydrology: Yes ____; No X. Basis: ____.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes ____ No X.

Wetland Determination: Wetland ____; Nonwetland Yes.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____________ Application Number: ____________ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: A-6 Wetland Section: ____________

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Carpinus caroliniana	FAC	7. Sphagnum spp	—
2.		8. Scirpus cyperinus	FACW+
3.		9. Pteridium aquilinum	FACU
Saplings/shrubs		**Woody vines**	
4. Tsuga canadensis	FACU	10. Rubus hispidus	FACW
5.		11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: ≥50% Other indicators: ________.

Hydrophytic vegetation: Yes X No ____. Basis: >50% species FAC or wetter on plant list.

Soil

Series and phase: Volusia channery silt loam On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: 2.5YR/5/8; Matrix color: ________

Gleyed: Yes X No ____ Other indicators: 5GR 7/1.

Hydric soils: Yes X No ____; Basis: Mottled and gleyed soil conditions.

Hydrology

Inundated: Yes X; No ____. Depth of standing water: At surface.

Saturated soils: Yes X; No ____. Depth to saturated soil: At surface.

Other indicators: ________________.

Wetland hydrology: Yes X; No ____. Basis: Standing water present.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland Yes; Nonwetland ____________.

Comments: — area may represent an abandoned farm pond.

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: C-7B wetland. Section: ______

Vegetation [list the three **dominant** species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Acer rubrum	FAC	7. Symplocarpus foetidus	OBL
2.		8. Polystichum acrostichoides	FACU-
3.		9.	
Saplings/shrubs		**Woody vines**	
4. Carpinus caroliniana	FAC	10.	
5. Hamamelis virginiana	FAC-	11.	
6. Lindera benzoin	FACW-	12.	

% of species that are OBL, FACW, and/or FAC: >50%. Other indicators: ______.

Hydrophytic vegetation: Yes X No ___. Basis: >50% of Plants listed or FAC or wetter.

Soil

Series and phase: Chenango On hydric soils list? Yes ___; No X.

Mottled: Yes X; No ___. Mottle color: 2.5YR 4/8; Matrix color: 2.5Y 4/2.

Gleyed: Yes x No ___ Other indicators: Gley color 5Y 4/1.

Hydric soils: Yes X No ___; Basis: Sample is mottled and gleyed.

Hydrology

Inundated: Yes X; No ___. Depth of standing water: 1 to 3 inches.

Saturated soils: Yes X; No ___. Depth to saturated soil: surface.

Other indicators: Stream channel present.

Wetland hydrology: Yes X; No ___. Basis: Standing water/saturated soils.

Atypical situation: Yes ___; No X.

Normal Circumstances? Yes X No ___.

Wetland Determination: Wetland Yes; Nonwetland ______.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: N.Y. County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: Upland between C and D Section: ______

Vegetation [list the three **dominant** species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Quercus rubra	FACU-	7. Lycopodium clavatum	FAC
2. Acer rubrum	FAC	8.	
3. Carya ovata	FACU-	9.	
Saplings/shrubs		**Woody vines**	
4. Carpinus caroliniana	FAC	10.	
5. Pinus strobus	FACU	11.	
6. Fagus grandifolia	FACU	12.	

% of species that are OBL, FACW, and/or FAC: <50% Other indicators: ______.

Hydrophytic vegetation: Yes x No X. Basis: <50% of plant species listed as FAC or wetter.

Soil

Series and phase: Chenango - Silty Clay loam On hydric soils list? Yes ____; No X.

Mottled: Yes ____; No X. Mottle color: None; Matrix color: ______.

Gleyed: Yes ____ No X Other indicators: NO.

Hydric soils: Yes ____ No X; Basis: No hydric soil indicators.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: None.

Saturated soils: Yes ____; No X. Depth to saturated soil: None observed

Other indicators: No.

Wetland hydrology: Yes ____; No X. Basis: ______.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes ____ No X.

Wetland Determination: Wetland ______; Nonwetland Yes.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: N.Y. County: Broome Legal Description: Township: ____ Range: ____

Date: 4/6/92 Plot No.: D2A Section: ______

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Acer rubrum	FAC	7. Symplocarpus foetidus	OBL
2. Betula alleghaniensis	FAC	8.	
3. Tsuga canadensis	FACU	9.	
Saplings/shrubs		**Woody vines**	
4. Lindera benzoin	FACW-	10.	
5. Carpinus caroliniana	FAC	11.	
6. Hamamelis virginiana	FAC-	12.	

% of species that are OBL, FACW, and/or FAC: >50% Other indicators: ______.

Hydrophytic vegetation: Yes X No ____. Basis: ______.

Soil

Series and phase: Chenango On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: 2.5Y 4/2, Matrix color: 5YR 6/8

Gleyed: Yes X No ____ Other indicators: ______.

Hydric soils: Yes X No ____; Basis: Mottled and gleyed Soil indicators

Hydrology

Inundated: Yes ____; No X. Depth of standing water: Some in depressions.

Saturated soils: Yes X; No ____. Depth to saturated soil: ______.

Other indicators: None.

Wetland hydrology: Yes X; No ____. Basis: Standing water and Saturated Soil.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland Yes; Nonwetland ______.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1
WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ______ Range: ______

Date: 4/6/92 Plot No.: E 7 Section: ______

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Fraxinus americana	FACU	7. Symplocarpus foetidus	OBL
2.*Acer rubrum	FAC	8. Viola spp.	
3. Tsuga canadensis	FACU	9.	
Saplings/shrubs		**Woody vines**	
4. Carpinus caroliniana	FAC	10.	
5. Lindera benzoin	FACW-	11.	
6. Hamamelis virginiana	FAC-	12.	

% of species that are OBL, FACW, and/or FAC: >50%. Other indicators: ______.

Hydrophytic vegetation: Yes X No ___. Basis: >50% of plant species are FAC or wetter.

Soil

Series and phase: Chenango-Silty Sand On hydric soils list? Yes ___; No X.

Mottled: Yes X; No ___. Mottle color: 2.5YR 4/8 red-brown; Matrix color: 7.5YR 5/3.

Gleyed: Yes ___ No X Other indicators: ______.

Hydric soils: Yes X No ___; Basis: Mottled soil condition.

Hydrology

Inundated: Yes X; No ___. Depth of standing water: 0 - 1".

Saturated soils: Yes X; No ___. Depth to saturated soil: Surface.

Other indicators: Flowing water (Slow).

Wetland hydrology: Yes X; No ___. Basis: ______.

Atypical situation: Yes ___; No X.

Normal Circumstances? Yes ___ No ___.

Wetland Determination: Wetland Yes; Nonwetland ______.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____________ Application Number: ____________ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: _____ Range: _____

Date: 4/6/92 Plot No.: Upland between E and F wetlands. Section: ____________

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Acer rubrum	FAC	7.	
2. Quercus rubra	FACU-	8.	
3. Fraxinus americana	FACU	9.	
Saplings/shrubs		**Woody vines**	
4. Carpinus caroliniana	FAC	10. Gaultheria procumbens	FACU
5. Fagus grandifolia	FACU	11.	
6. Pinus strobus	FACU	12.	

% of species that are OBL, FACW, and/or FAC: <50% Other indicators: None.

Hydrophytic vegetation: Yes ____ No X. Basis: <50% of plant species are FAC or wetter.

Soil

Series and phase: Chenango-Sandy loam On hydric soils list? Yes ____; No X.

Mottled: Yes ____; No X. Mottle color: ________; Matrix color: Yellow-Brown

Gleyed: Yes ____ No X Other indicators: ____________.

Hydric soils: Yes ____ No X; Basis: No mottling or gleyed condition.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: None observed.

Saturated soils: Yes ____; No X. Depth to saturated soil: None observed

Other indicators: ____________.

Wetland hydrology: Yes ____; No X. Basis: ____________.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes ____ No X.

Wetland Determination: Wetland ____________; Nonwetland Yes.

Comments: Area is a southern slope.

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____ Application Number: ____ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/1/92 Plot No.: G9A Wetland Section: ____

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	**Indicator Status**	**Species**	**Indicator Status**
Trees		**Herbs**	
1. Carpinus caroliniana	FAC	7. Symplocarpus foetidus	OBL
2. Acer rubrum	FAC	8. Juncus effusas	FACW+
3. Sassafras albidum	FACU-	9. Carex spp.	
Saplings/shrubs		**Woody vines**	
4. Carpinus caroliniana	FAC	10.	
5. Ilex verticula	FACW+	11.	
6. Cormus stolinifera	FACW+	12.	

% of species that are OBL, FACW, and/or FAC: >50% Other indicators: Hummock vegetat

Hydrophytic vegetation: Yes X No ____. Basis: > 50% of vegetation is listed as FAC or wetter.

Soil

Series and phase: Braceville On hydric soils list? Yes ____; No X.

Mottled: Yes X; No ____. Mottle color: Red; Matrix color: ____.

Gleyed: Yes X No ____ Other indicators: Gray gleying.

Hydric soils: Yes X No ____; Basis: Soil Mottled & Gleyed.

Hydrology

Inundated: Yes X; No ____. Depth of standing water: 1-2".

Saturated soils: Yes X; No ____. Depth to saturated soil: Surface.

Other indicators: ____.

Wetland hydrology: Yes X; No ____. Basis: Saturated soil and Standing water.

Atypical situation: Yes X; No ____.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland Yes; Nonwetland ____.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ____ Application Number: ____ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/7/92 Plot No.: H-2 (wetland) Section: ____

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		Herbs	
1.		7. Solidago spp.	
2.		8.	
3.		9.	
Saplings/shrubs		Woody vines	
4. Salix discolor	FACW	10.	
5. Cornus stolonifera	FACW+	11.	
6. Spirea alba	FACW+	12.	

% of species that are OBL, FACW, and/or FAC: >50% Other indicators: edge of stream

Hydrophytic vegetation: Yes X No ____. Basis: >50% plant species listed as FAC or wetter

Soil

Series and phase: Alden and Chippewa (Ac A) On hydric soils list? Yes X; No ____.

Mottled: Yes X; No ____. Mottle color: Red; Matrix color: ____.

Gleyed: Yes ____ No X Other indicators: ____.

Hydric soils: Yes X No ____; Basis: hydric soils list and mottling.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: None.

Saturated soils: Yes X; No ____. Depth to saturated soil: 6 inches.

Other indicators: area adjacent to flowing stream.

Wetland hydrology: Yes X; No ____. Basis: Saturated soils.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes X No ____.

Wetland Determination: Wetland X; Nonwetland ____.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

DATA FORM 1

WETLAND DETERMINATION

Applicant Name: ______ Application Number: ______ Project Name: Colesville Landfill

State: NY County: Broome Legal Description: Township: ____ Range: ____

Date: 4/7/92 Plot No.: East of H-2 Upland Section: ______

Vegetation [list the three dominant species in each vegetation layer (5 if only 1 or 2 layers)]. Indicate species with observed morphological or known physiological adaptations with an asterisk.

Species	Indicator Status	Species	Indicator Status
Trees		**Herbs**	
1. Acer rubrum	FAC	7. Solidago spp.	
2. Betula lenta	FACU	8. Asters spp.	
3.		9.	
Saplings/shrubs		**Woody vines**	
4. Quercus alba	FACU-	10.	
5. Cornus stolonifera	FACW+	11.	
6.		12.	

% of species that are OBL, FACW, and/or FAC: <50% Other indicators: None.

Hydrophytic vegetation: Yes ___ No X. Basis: <50% of species are FAC or wetter.

Soil

Series and phase: Chenango On hydric soils list? Yes ____; No X.

Mottled: Yes ____; No X. Mottle color: ______; Matrix color: ______.

Gleyed: Yes ____ No X Other indicators: None.

Hydric soils: Yes ____ No X; Basis: No hydric indicators present.

Hydrology

Inundated: Yes ____; No X. Depth of standing water: None.

Saturated soils: Yes ____; No X. Depth to saturated soil: None observed.

Other indicators: None.

Wetland hydrology: Yes ____; No X. Basis: No standing water or saturated soil conditions.

Atypical situation: Yes ____; No X.

Normal Circumstances? Yes ____ No X.

Wetland Determination: Wetland ______; Nonwetland Yes.

Comments:

Determined by: Dave Tompkins / Joe Kopalek

Figure 1: North-facing view of Wetland A shows open water area, emergent zone, and scrub/shrub area (left).

Figure 2: East-facing view of Wetland A. Dominant herbaceous plants in the emergent zone include wool grass, sensitive fern, and soft rush.

Figure 3: Close-up of small tributary comprising Wetland B. Shrubs are pussy willow and red-osier dogwood. This wetland ranges from two to several feet wide.

Figure 4: Photograph shows Wetland B descending down the Landfill along tree line.

Figure 5: Part of Wetland E. This area is similar to photo described below. Shade in foreground is caused by dense hemlocks which prevail further down the slope.

Figure 6: Part of Wetland F located on south-facing slope below the Landfill. Surface soils are black muck. The most common herbaceous plant is skunk cabbage. Dominant trees are red maple and hornbeam.

Figure 7: Soil sample showing commonly encountered gleyed and mottled colors. This soil sample was retrieved from Wetland A.

BORROW AREA WETLANDS
PHOTOGRAPH DESCRIPTION

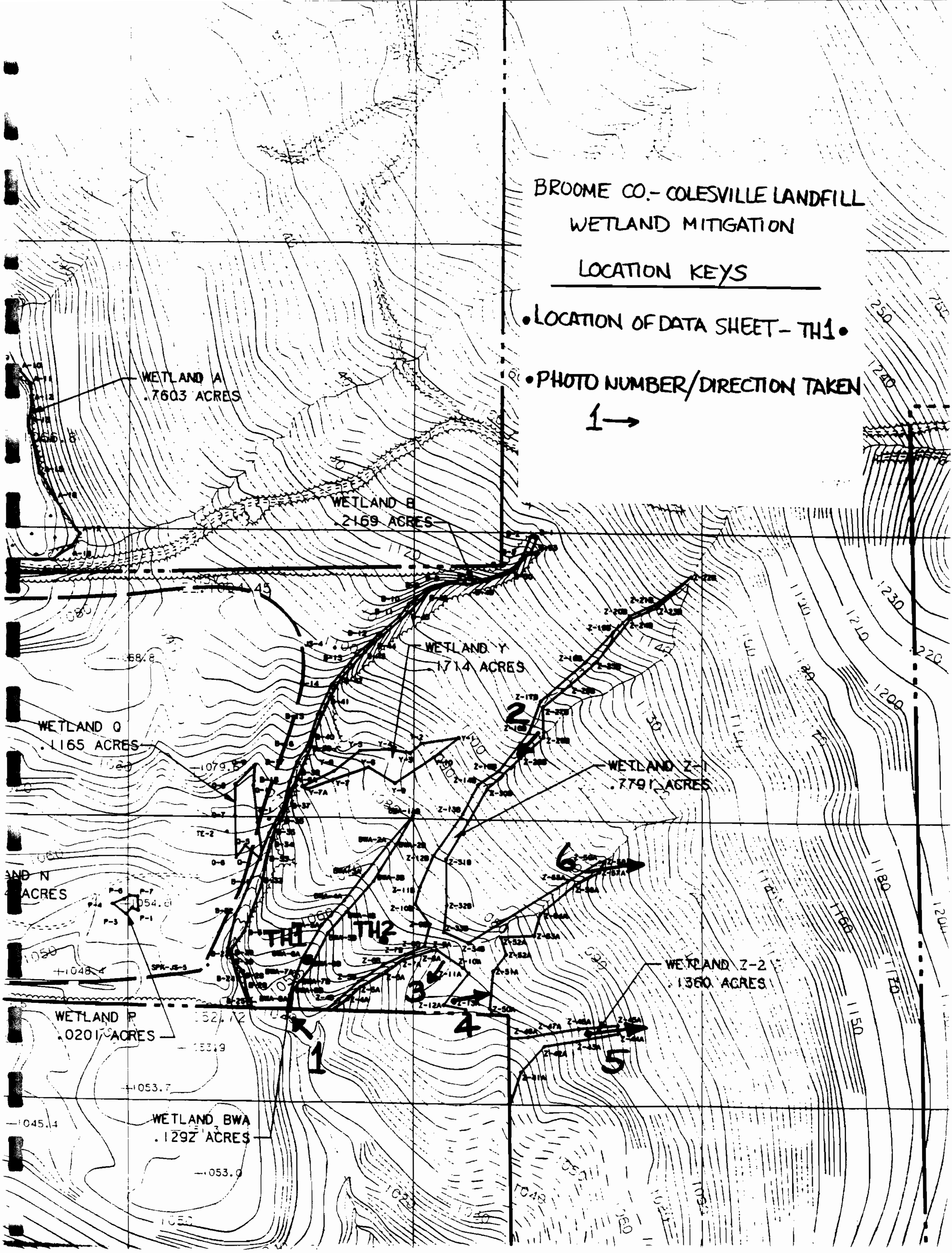
#1. Continuation of stream corridor (facing north) from wetland B. Location of outlet from wetlands BWA and Z on right.

#2. Photo taken near flag Z6B (east). Wetland in this area is restricted to just stream channel. Shrub area in background is a larger wetland area.

#3. Upland area facing south from flag Z9A.

#4. Larger flat wetland area near flag Z12A. This is the only area where significant herbaceous vegetation is present. Some disturbance (test pits) is visibly nearby.

#5. Upgradient section of wetland Z-2.



BROOME CO.- COLESVILLE LANDFILL
WETLAND MITIGATION

LOCATION KEYS

- LOCATION OF DATA SHEET - TH1 •
- PHOTO NUMBER/DIRECTION TAKEN

1→

Photo #2

Photo #3

Photo #4

Photo 5

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Colesville - Borrow Area
Applicant/Owner:
Investigator: D. Tompkins
Date: 12/14/93
County: Broome
State: NY

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID:
Transect ID:
Plot ID: TH 1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	OS	FAC	9.		
2. Pinus strobus	US	FACU	10.		
3. Hamamelis virginiana	Shr	FAC –	11.		
4. Betula lenta	Shr	FACU	12.		
5. Cornus stolonifera	GL	FACW+	13.		
6. Onoclea sensibilis	GL	FACW	14.		
7. Solidago spp.	GL	–	15.		
8. unidentified grass	GL	–	16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 4/6 = 67%

Remarks: No woody vegetation within 3-5 meters. Goldenrod and grass (clear dominant species) not identifiable in present condition, but only seen to be in wetland.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
  ___ Stream, Lake, or Tide Gauge
  ___ Aerial Photographs
  ___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)

Depth to Free Water in Pit: 1-2 (in.)

Depth to Saturated Soil: at Surface (in.)

Wetland Hydrology Indicators:
Primary Indicators:
  X Inundated
  X Saturated in Upper 12 Inches
  ___ Water Marks
  ___ Drift Lines
  ___ Sediment Deposits
  X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
  ___ Oxidized Root Channels in Upper 12 Inches
  ___ Water-Stained Leaves
  ___ Local Soil Survey Data
  ___ FAC-Neutral Test
  ___ Other (Explain in Remarks)

Remarks: Ice present on ground surface

SOILS

Map Unit Name
(Series and Phase): ____________________ Drainage Class: __________

Field Observations

Taxonomy (Subgroup): ____________________ Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8	A	10YR 3/1	na	na	silty clay
8-19	B	10YR 4/2	7.5 YR 5/8	common throughout	sandy clay

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- X Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks: difficult to accurately assign Munsell Color, too cloudy roots present to approx 8" depth

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)

Wetland Hydrology Present? [✓ Yes] No

Hydric Soils Present? [✓ Yes] No

(Circle)

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: wetland represents a thin corridor occurring on a sloping landscape.

Approved by HQUSACE 3/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Colesville - Borrow Area
Applicant/Owner:
Investigator: D. Tompkins

Date: 12/14/93
County: Broome
State: NY

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID:
Transect ID:
Plot ID: TH2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	OS	FAC	9.		
2. Pinus strobus	US	FACU	10.		
3. Fraxinus americana	Shr	FACU	11.		
4. Fagus grandifolia	Shr	FACU	12.		
5. Rubus flagellaris	GL	NI	13.		
6. Lycopodium clavatum	GL	FAC	14.		
7. Lycopodium obscurum	GL	FACU	15.		
8. Dryopteris spinulosa	GL	FAC+	16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 3/8 = 38%

Remarks: Higher elevations (ie: upland) are dominated by Acer saccharum (FACU) Fairly developed woody groundlayer, herb. groundlayer nonexistent.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
  ___ Stream, Lake, or Tide Gauge
  ___ Aerial Photographs
  ___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: ______ (in.)
Depth to Free Water in Pit: >21 (in.)
Depth to Saturated Soil: >21 (in.)

Wetland Hydrology Indicators:
Primary Indicators: None
  ___ Inundated
  ___ Saturated in Upper 12 Inches
  ___ Water Marks
  ___ Drift Lines
  ___ Sediment Deposits
  ___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required): None
  ___ Oxidized Root Channels in Upper 12 Inches
  ___ Water-Stained Leaves
  ___ Local Soil Survey Data
  ___ FAC-Neutral Test
  ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name
(Series and Phase): ____________________ Drainage Class: __________

Field Observations

Taxonomy (Subgroup): ____________________ Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
O	0-2"	10YR 2/1			organic
A	2-5	10YR 4/2			clayey silt
B	6-19	" 5/4			silty clay
B	19>21	" 5/4	5YR 5/8	slight	clay

Hydric Soil Indicators:

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)

Wetland Hydrology Present? Yes [✓ No]

Hydric Soils Present? Yes [✓ No]

(Circle)

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

APPENDIX B
WETLAND A VERTICAL LEAKAGE ESTIMATE

By GHM Date 1/26 **WEHRAN ENGINEERING** Job No. 02260 EC
Chkd. by Date 1/29 Engineers & Scientists Sheet No. 1 of 2
Subject Colesville - Pre Final Engineering Report

Appendix , Vertical Leakage in Wetland A

I An estimate of the vertical leakage in Wetland A can be determined based on Darcy's Law and information obtained from on-site monitoring wells W-2 and W-10 as follows,

$$Q = K \frac{H_2 - H_1}{L} A$$

where:

Q = vertical leakage through upper glacial till

K = average permeability of upper glacial till measured in on-site monitoring wells W-2 and W-10
= 3.5×10^{-5} ft/min

H_2 = present day water table elevation in on-site monitoring well W-10
= 1015.71 ft

H_1 = water surface elevation in Wetland A
= 1066.80 ft

L = thickness of glacial till layer underlying Wetland A as determined from boring log of monitoring well W-10
= 31 ft

A = surface area of Wetland A
= 33,119 sq. ft.

Accordingly:

$$Q_{\text{present day}} = \frac{3.5 \times 10^{-5}\ \text{ft/min}\,(1015.71 - 1066.80\ \text{ft})(33,119)}{31}$$

~~= 20,583 gallons/day~~

= 0.62 gallons/day/ft^2

By [illegible] Date [illegible]

WEHRAN ENGINEERING
Engineers & Scientists

Job No. [illegible]
Sheet No. 2 of 2

Chkd. by [illegible] Date 1/89

Subject Colesville - Pre Final Engineering Report

II An estimate of the leakage rate in 20-years based upon an average model predicted drawdown of 4-ft in Wetland A is given by:

$$Q = K\frac{\left((H_2 - d) - H_1\right)}{L}A$$

Where:

d = drawdown
= 4 ft

Accordingly:

$$Q_{20\text{-}year} = 3.5\times10^{-5}\,\text{ft/min}\,\big((1015.71-4) - 1066.80\,\text{ft}\big)(33,115)\,/\,3$$

= 22,194 gallons/day
= 0.67 gallons/day/ft²

III Therefore, the total effect that the pumping of the ground water recovery system for 20-years will have on the leakage rate from Wetland A is given by,

$$Q_{20\text{-}year} - Q_{\text{present day}} = \Delta$$

where: Δ = change in leakage rate

Accordingly: Δ = 22,194 - 20,583

= 1611 gallons/day
= 0.049 gallons/day/ft²
= 7.8% increase in leakage rate

APPENDIX C
WATER BUDGET FOR COLESVILLE, NEW YORK

Water Budget Estimate
Colesville Landfill Compensation Wetlands Site

Water budget estimates were developed for the proposed Compensation Wetlands adjacent to the Colesville Landfill, Broome County, NY. Monthly water budget values were calculated based on temperature and precipitation data from Binghamton, NY. Estimates of potential evapotranspiration used in the budget were calculated by the Thornthwaite and Mather method (Thornthwaite and Mather, 1957). The budget form calculates monthly output values for: soil moisture storage, surplus, actual evapotranspiration and soil moisture deficit.

Water budget calculations require assumptions on the amount of water in the soil available for loss to the atmosphere (soil moisture capacity) and the ease with which this water may be withdrawn from the soil (soil moisture depletion function). The estimate of soil moisture capacity was based on data on typical bulk density and porosity data for hydric soils. Generally hydric soils have about 45% of their volume available for water storage at saturation. Rooting depth in wetland soils is typically limited to within the upper 15 inches of soil and this therefore corresponds to 6.85 inches of soil moisture storage from saturation. This corresponds to the available soil moisture capacity of 36 inches of Volusia soils (data from the Broome County Soil Survey) for unsaturated conditions. The soil moisture depletion function for heavy silty soils was used as an approximation of the Volusia soils.

Water budgets were run for average weather conditions of the last 20 years and the wettest (1976) and driest year (1964) within this period. Under average conditions there is a surplus of water (for runoff) through April. Then there is a drawdown of soil moisture reaching a maximum of 10 inches in soil depth in August. Recharge begins in September and is completed by October, when there is again a surplus of water. Under the wettest year conditions, the maximum soil moisture drawdown was to a depth of 1.5 inches. In contrast the driest year brought a drawdown of 11.8 inches in August. The estimated drawdown from this range of climatic extremes can be seen to be within an acceptable rooting depth range for wetland forest and shrub species.

The water budget estimates above **do not account** for an input of surface water from the watershed above the proposed wetland compensation area. The compensation wetland plan calls for the input of surface water to the wetland basin, whose elevation is set by the basin outfall elevation. Monthly estimates were made of stream flow for the project area watershed (borrow area and a portion of the landfill) from stream flow data for Newtown Creek at Elmira, NY (provided by USGS). These data suggest that under average conditions, 13.1, 7.1, and 6.0 ft. of water (for a 1 acre wetland/pond basin) is available each month during June, July and August respectively. During the driest year (1964) these months were estimated to have corresponding values of 4.2, 2.9, and 1.8 ft. for the months June July and August.

It can be seen from these estimates of soil moisture drawdown from the water budget and stream flow input additions, that sufficient hydrology should be available for wetland conditions. This is also based on the assumption that infiltration rates for the wetland/pond basin will be sufficiently low.

WATER BUDGET CALCULATIONS

Colesville, NY

YEAR IS AVERAGE

MO	TEMP	UPE	APE	PREC	DIFF	ST	DST	AE	DEF	SURP
1	-3.6	0	0	65	65	174	0	0	0	65
2	1.3	2	2	59	57	174	0	2	0	57
3	4.8	14	14	75	61	174	0	14	0	61
4	11.9	46	52	78	26	174	0	52	0	26
5	20.2	94	118	81	-37	141	-33	114	4	0
6	20.6	96	122	91	-31	118	-23	114	8	0
7	21.8	104	133	88	-45	91	-27	115	18	0
8	22.1	106	126	85	-41	72	-19	104	22	0
9	20.1	93	96	84	-12	67	-5	89	7	0
10	12.1	47	45	76	31	98	31	45	0	0
11	4.7	13	11	77	66	164	66	11	0	0
12	1.2	2	2	74	72	174	10	2	0	63
YEARLY TOTALS			720	933				661	59	272

TERMS

UPE = UNADJUSTED POT. EVAPO

APE = POTENTIAL EVAPOTRANSPIRATION

AE = ACTUAL EVAPOTRANSPIRATION

DST = CHANGE IN SOIL STORAGE

ST = SOIL MOISTURE STORAGE

PREC = PRECIPITATION

SURP = SURPLUS (RUNOFF)

TEMP = TEMPERATURE

DIFF = PREC-APE

DEF = DEFICIT (APE-AE)

WATER BUDGET CALCULATIONS

Colesville, NY

YEAR IS 1976

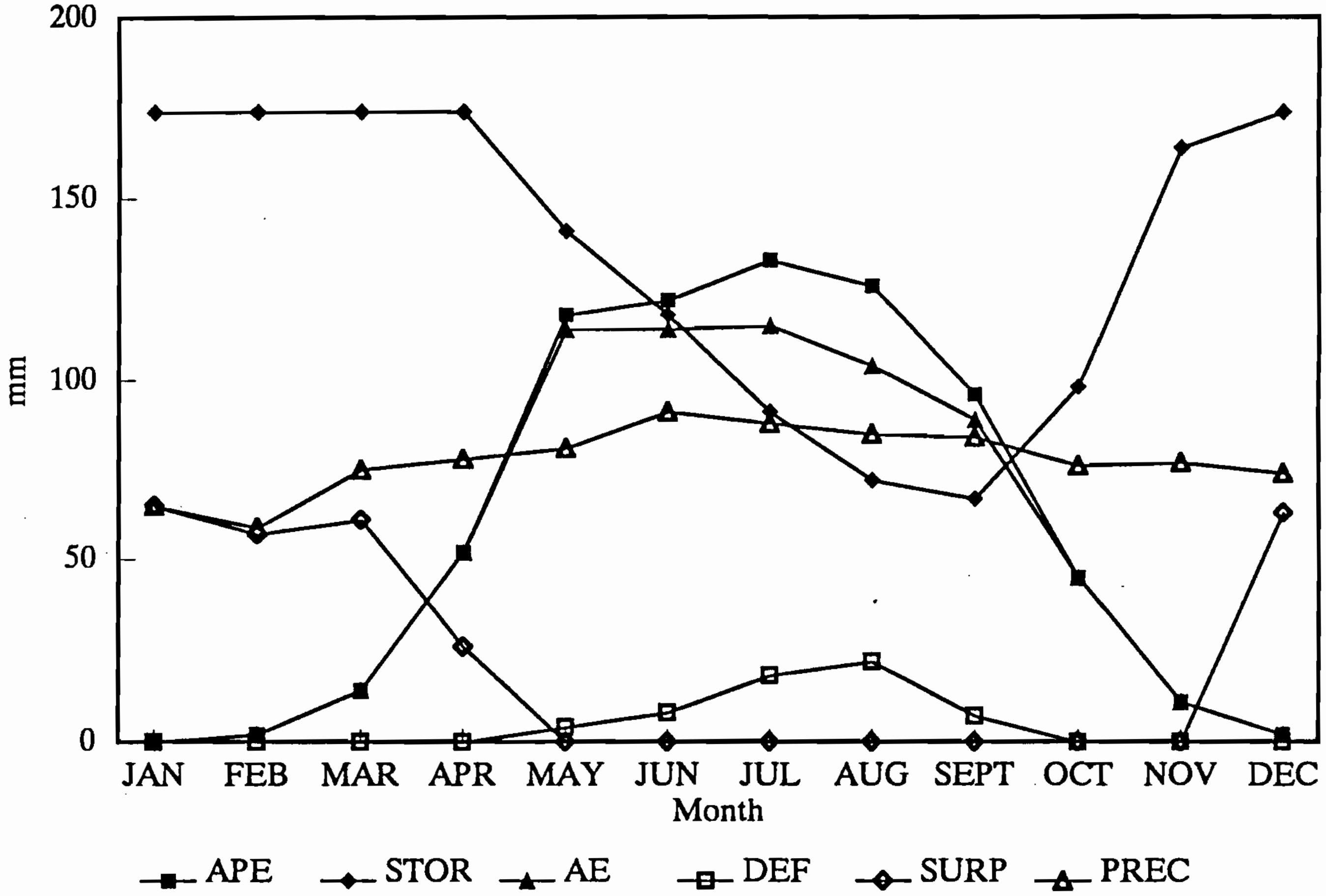
MO	TEMP	UPE	APE	PREC	DIFF	ST	DST	AE	DEF	SURP
1	-8.4	0	0	94	94	174	0	0	0	94
2	-.9	0	0	73	73	174	0	0	0	73
3	1.9	9	9	71	62	174	0	9	0	62
4	8.3	40	44	68	24	174	0	44	0	24
5	11.6	57	71	64	-7	167	-7	71	0	0
6	19.4	97	123	112	-11	157	-10	122	1	0
7	18.7	93	120	163	43	174	17	120	0	26
8	18.6	93	110	172	62	174	0	110	0	62
9	14.1	69	72	98	26	174	0	72	0	26
10	6.5	31	29	160	131	174	0	29	0	131
11	-.5	0	0	28	28	174	0	0	0	28
12	-6.5	0	0	43	43	174	0	0	0	43
YEARLY TOTALS			578	1146				577	1	569

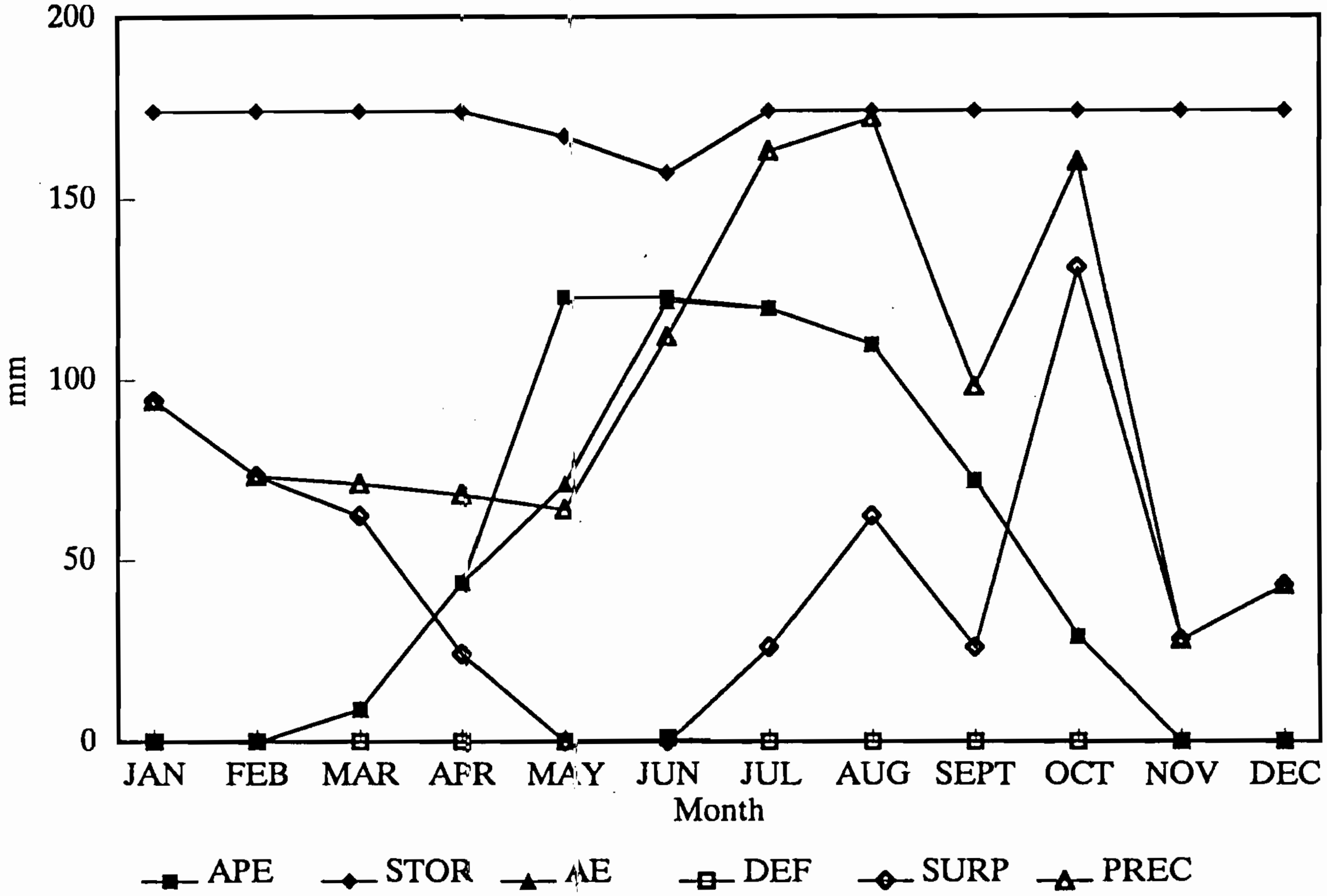
YEAR IS 1964

MO	TEMP	UPE	APE	PREC	DIFF	ST	DST	AE	DEF	SURP
1	-4.4	0	0	76	76	174	27	0	0	49
2	-7.3	0	0	51	51	174	0	0	0	51
3	-.1	0	0	116	116	174	0	0	0	116
4	6.1	27	30	129	99	174	0	30	0	99
5	14.7	70	88	51	-37	141	-33	84	4	0
6	16.7	81	102	31	-71	93	-48	79	24	0
7	21.3	106	136	122	-14	86	-7	129	7	0
8	18.4	90	107	47	-60	61	-25	72	35	0
9	16.2	78	80	17	-63	42	-19	36	45	0
10	9.1	41	39	27	-12	39	-3	30	9	0
11	6.1	27	21	48	27	66	27	21	0	0
12	-2.2	0	0	81	81	147	81	0	0	0
YEARLY TOTALS			603	796				481	123	315

Water Budget

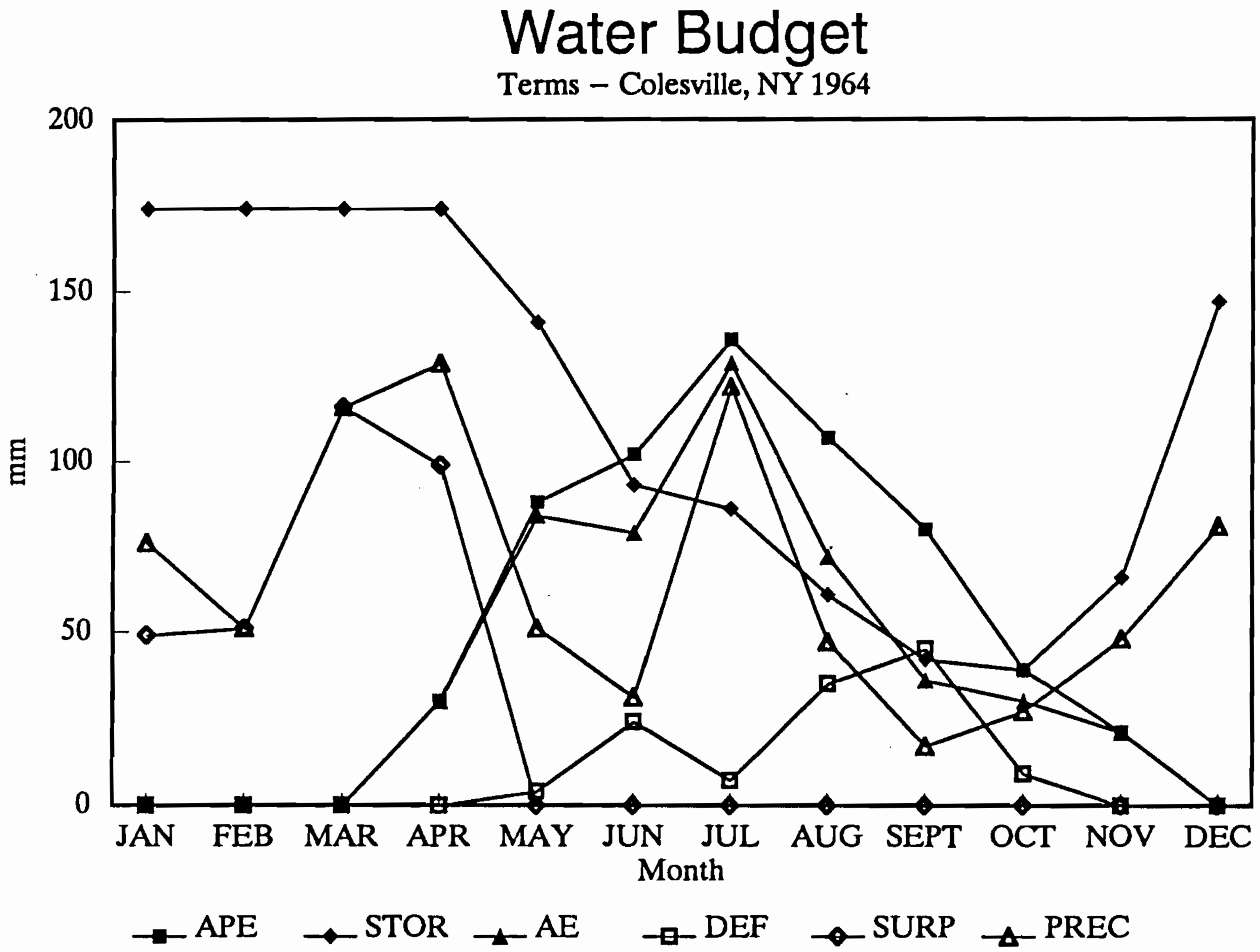
Terms – Colesville, NY AVERAGE

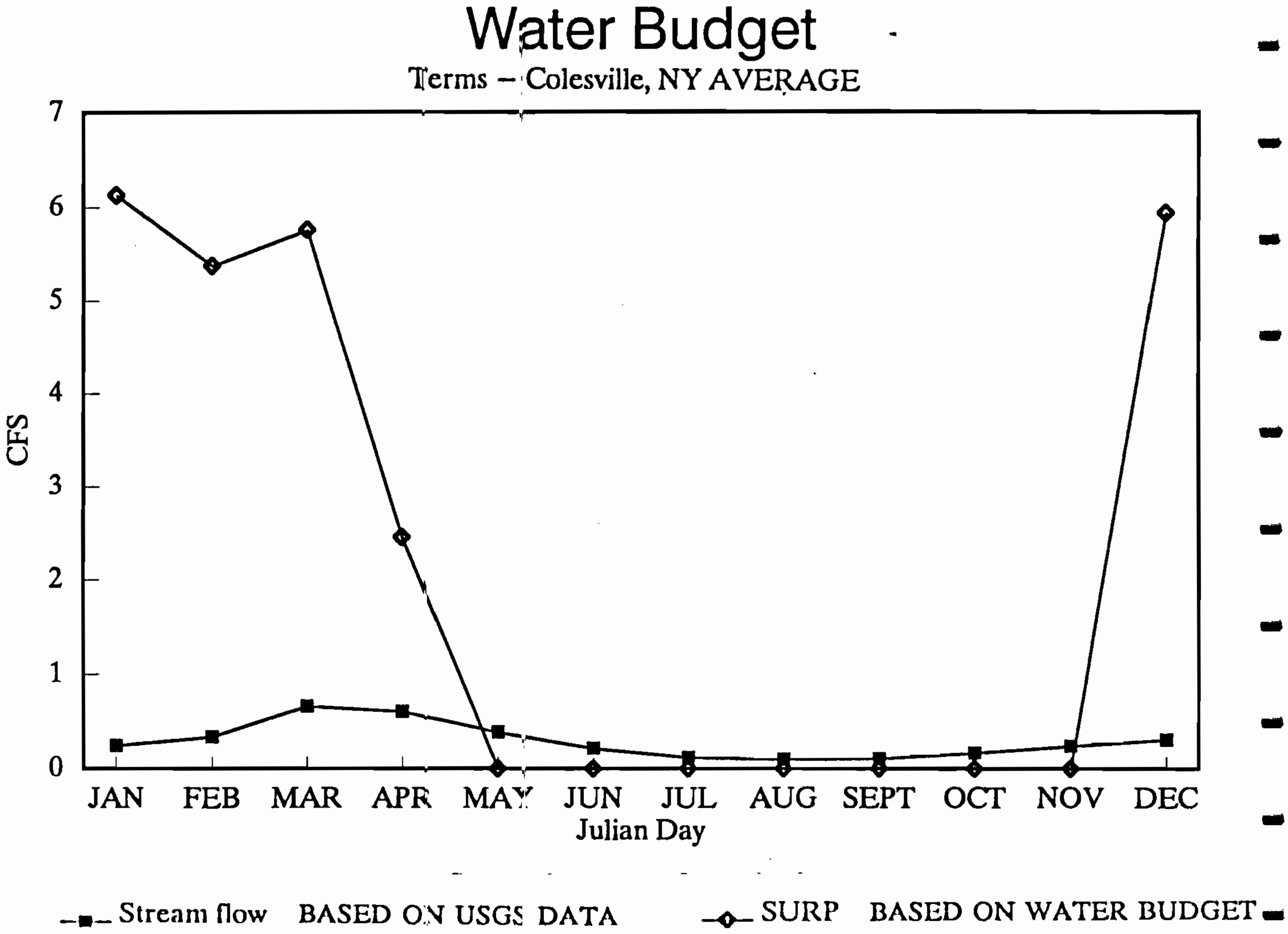


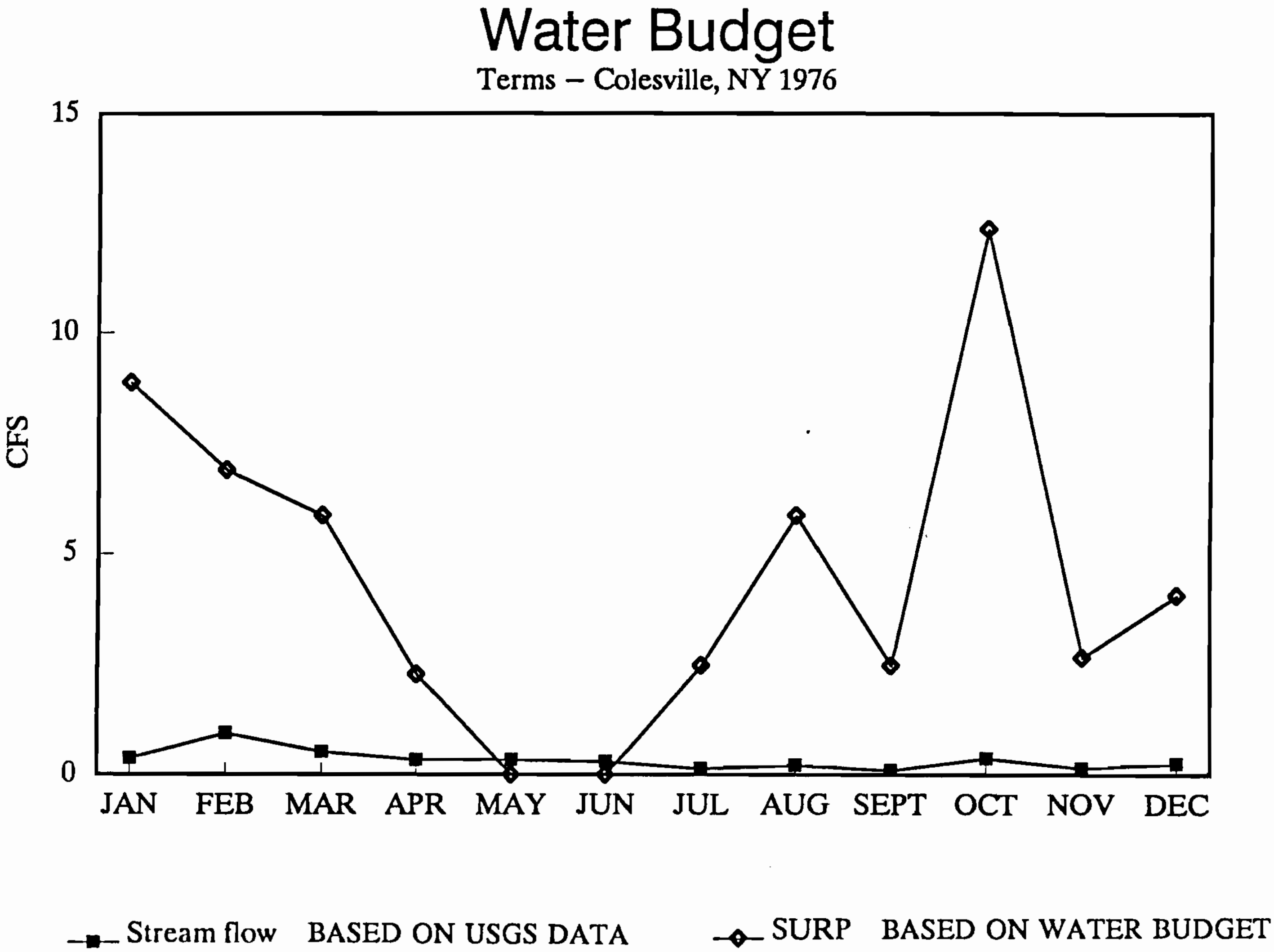


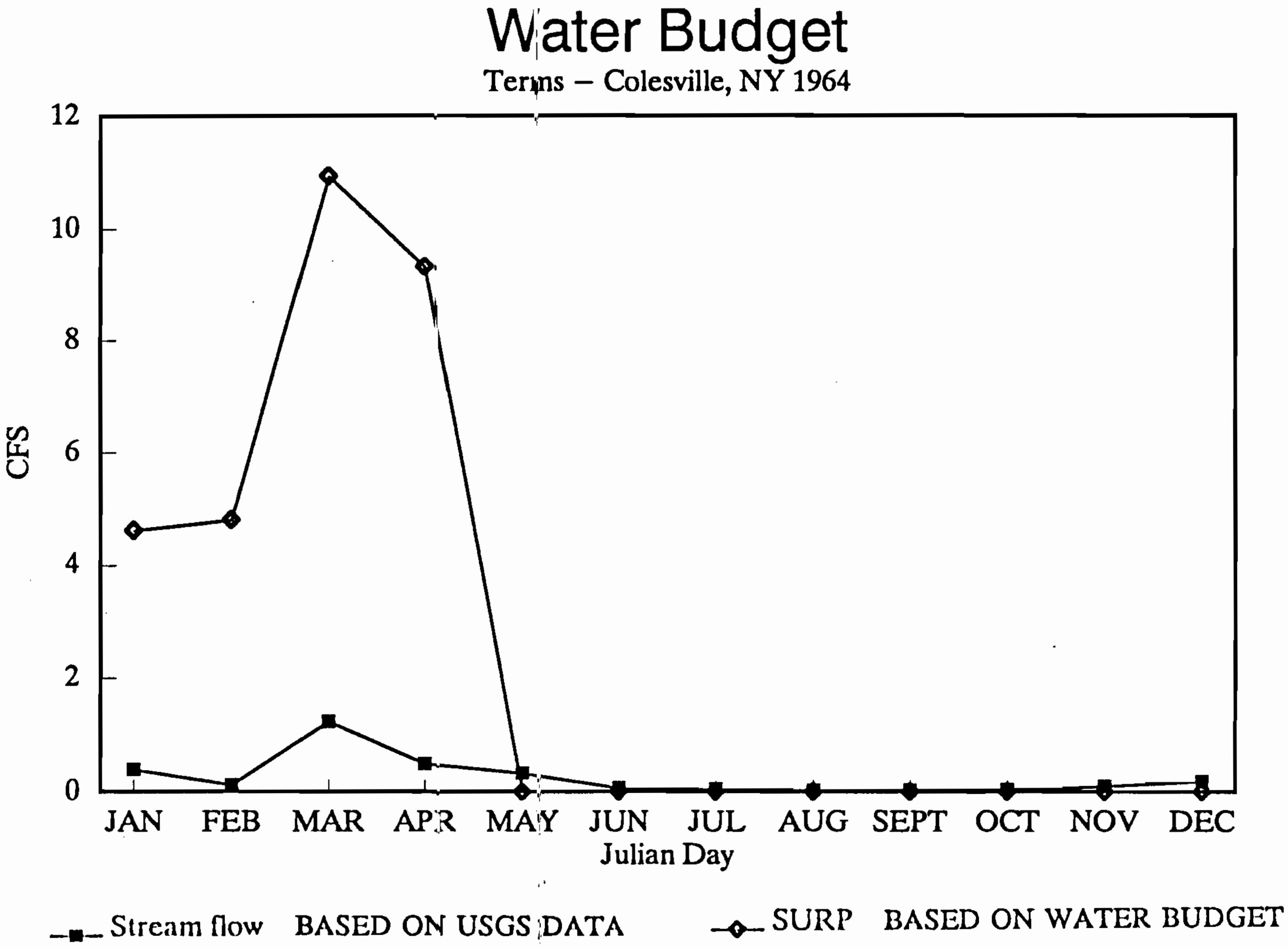
Water Budget

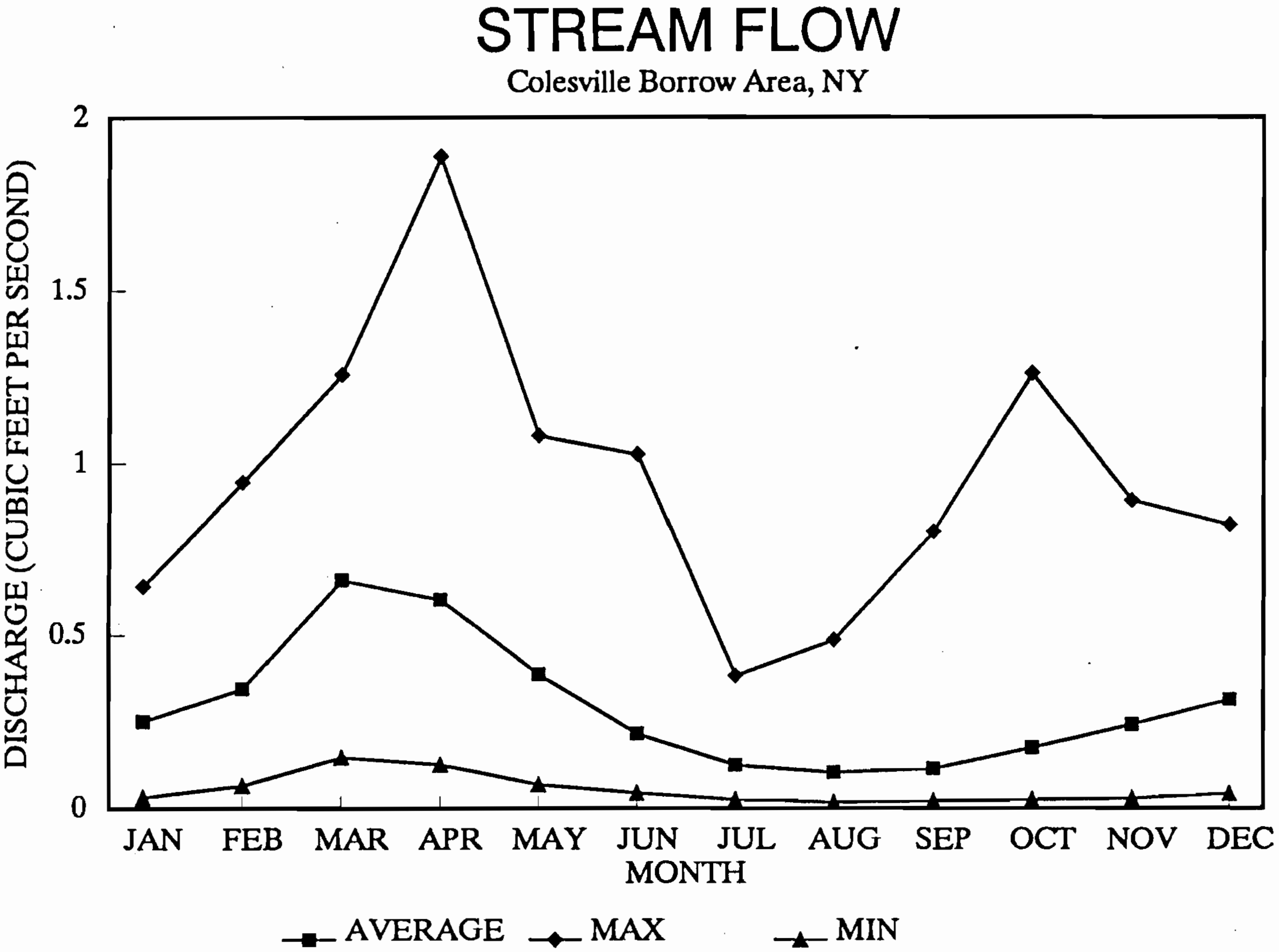
Terms – Colesville, NY 1976


Water Budget
Terms – Colesville, NY 1964
200
150
100
50
0
mm
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC
Month
APE
STOR
AE
DEF
SURP
PREC


Water Budget
Terms – Colesville, NY AVERAGE
CFS
0
1
2
3
4
5
6
7
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC
Julian Day
Stream flow BASED ON USGS DATA
SURP BASED ON WATER BUDGET


Water Budget
Terms – Colesville, NY 1976
15
10
5
0
CFS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC
Stream flow BASED ON USGS DATA
SURP BASED ON WATER BUDGET


Water Budget
Terms – Colesville, NY 1964
12
10
8
6
4
2
0
CFS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEPT
OCT
NOV
DEC
Julian Day
Stream flow BASED ON USGS DATA
SURP BASED ON WATER BUDGET


STREAM FLOW
Colesville Borrow Area, NY
DISCHARGE (CUBIC FEET PER SECOND)
2
1.5
1
0.5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH
AVERAGE
MAX
MIN

WehranEnviroTech

COLESVILLE LANDFILL

REMEDIAL DESIGN PROJECT

Wetland Survey Coordinates

Location	Northing	Easting
Z27B	788697.2720	771226.6785
Z17B	788707.8619	771222.8570
Z26B	788735.1807	771271.7693
Z18B	788775.6505	771297.8734
Z19B	788829.5800	771346.7255
Z24B	788852.5495	771375.6420
Z20B	788858.0126	771374.5358
Z21B	788872.0310	771422.4086
Z21B	788926.0068	771480.7839
Z23B	788872.4279	771422.4881
Z25B	788777.3791	771318.3158
SPKJC	788773.6623	771140.8853
T\W	788742.4969	771155.0083
Y1	788642.9432	771079.5897
Y2	788632.0721	771012.5161
Y3	788614.9089	770993.0040
TPPK8	788607.2083	770998.1730
Y10	788608.5638	771034.7033
Y9	788561.7428	770966.4230
Y8	788589.4258	770920.1916
Y7	788566.2290	770859.3101
Y7A	788550.5900	770816.8879
Y6A	788554.7737	770807.0686
Y6	788581.5962	770860.9848
Y5	788618.3780	770906.2643
Y4	788620.9374	770955.8878
P-1	788992.9323	771216.9462
P-2	788992.7925	771204.9661
P-53	788966.5759	771215.5280
P-52	788962.6878	771216.3855
P-54	788966.4190	771205.9183
P-51	788962.0628	771200.2625
P-3	788961.3400	771192.6956
P-4	788953.2300	771188.1027
P-5	788937.0096	771173.1735
P-50	788932.5036	771175.3975
P-49	788915.2811	771127.6853
P-6	788918.3110	771125.8609
P-7	788918.1292	771096.1902
P-48	788908.8537	771093.4828

NOTE: Location with P designation corresponds to Wetland B locations shown on the Wetland Delineation Map

COLESVILLE LANDFILL

REMEDIAL DESIGN PROJECT

Wetland Survey Coordinates

Location	Northing	Easting
P-47	788911.3039	771067.2462
P-8	788912.3267	771056.9424
P-9	788899.0547	771022.2258
P-46	788896.3326	771025.8280
P-10	788874.0610	770990.5684
P-45	788859.5648	770991.7980
P-11	788850.7973	770973.4876
P-12	788819.3616	770936.4771
P-44	788805.8310	770930.2823
P-43	788789.7016	770914.1590
P-13	788784.2731	770899.2714
P-42	788743.6460	770873.4670
P-14	788732.3860	770857.2007
P-41	788708.2185	770853.4793
P-15	788680.0596	770833.1042
P-40	788644.3280	770825.9919
P-39	788623.3379	770820.8942
P-16	788625.3124	770815.2067
P-17	788597.6059	770797.6080
P-18	788562.3295	770785.1546
P-38	788569.4720	770798.7770
P-37	788535.7885	770785.2855
P-19	788518.2380	770775.2852
P-36	788494.0447	770771.6455
P-35	788483.1380	770760.9295
P-34	788461.3044	770757.9936
P-20	788471.8354	770750.5726
P-33	788438.8686	770749.8306
P-21	788392.3107	770720.6886
P-32	788378.8648	770737.6713
P-22	788324.4647	770692.5633
P-31	788296.1777	770707.8103
P-23	788265.4221	770679.2749
P-30	788260.7530	770685.0857
P-29	788241.8895	770689.3702
P-28	788225.1700	770705.5158
P-24	788219.8391	770695.5805
P-28	788192.7565	770710.9973
P-25	788173.1403	770712.8768

NOTE: Location with P designation corresponds to Wetland B locations shown on the Wetland Delineation Map

COLESVILLE LANDFILL

REMEDIAL DESIGN PROJECT

Wetland Survey Coordinates

Location	Northing	Easting
Z49A	788113.1723	771160.7974
Z50A	788164.8692	771135.0989
Z51A	788229.7370	771140.4222
Z52A	788259.7418	771163.0827
Z53A	788293.8852	771212.2412
Z54A	788332.6990	771222.6832
Z55A	788391.6227	771269.5053
Z56A	788385.9821	771282.1589
Z57A	788408.6676	771322.9941
Z58A	788428.7123	771331.9578
Z59A	788427.6400	771323.2036
Z52A	788290.6447	771153.8355
Z34B	788279.8007	771096.5845
Z33B	788298.5817	771053.9602
Z9B	788312.1600	771028.8600
TPPK5	788391.0528	770994.4595
Z32B	788346.8163	771058.8375
Z31B	788428.9124	771057.5064
Z30B	788554.6964	771129.8973
Z14B	788561.8676	771113.8063
Z13B	788509.3933	771086.7602
Z12B	788434.6293	771035.1426
~~Z11B~~	~~788378.5254~~	~~771011.2799~~
Z10B	788348.2218	771003.3478
BWA3B	788387.6414	770929.8443
BWA4B	788332.4938	770883.8282
BWA5A	788308.5431	770840.5705
BWA4A	788352.6429	770879.4976
BWA3A	788396.9745	770912.1005
BWA2A	788454.3665	770955.5700
BWA2B	788454.1029	770969.6375
BWA1AB	788504.9583	770998.5367
TPPK6	788640.8562	771172.7430
TPPK7	788690.9086	771204.7614
Z15B	788579.6598	771154.2251
Z29B	788609.1210	771187.8261
Z28B	788644.8206	771227.6745
Z16B	788653.2364	771202.4554
Z27B	788697.2720	771226.6785

NOTE: Location with P designation corresponds to Wetland B locations shown on the Wetland Delineation Map

COLESVILLE LANDFILL

REMEDIAL DESIGN PROJECT

Wetland Survey Coordinates

Location	Northing	Easting
BWA8B	788193.3181	770791.5978
BWA7B	788208.8139	770803.7244
BWA7A	788216.8646	770796.2558
BWATH1	788240.6462	770814.5802
BWA6B	788234.1729	770822.6612
BWA6A	788248.6808	770807.7144
BWA5B	788294.3576	770851.7477
TPTJ1	788164.0645	770892.8449
BWA9A	788133.2057	770776.7330
BWA8A	788185.7365	770786.4822
Z2B	788137.0169	770828.0312
Z2A	788141.1484	770841.2602
Z3A	788150.3856	770848.5149
Z3B	788155.9508	770843.3578
Z4B	788178.0139	770870.1902
Z4A	788178.3451	770885.5214
Z5B	788209.3830	770904.3965
Z5A	788199.9401	770907.1175
Z6B	788238.9912	770946.3911
Z6A	788224.1403	770950.6684
Z7A	788247.5727	770980.6479
Z7B	788258.0401	770985.5309
Z8B	788272.7570	771019.1868
Z8A	788265.8564	771033.0281
TPTJ2	788177.0662	771087.0290
Z9A	788266.4353	771041.7466
Z10A	788234.8925	771087.3906
Z11A	788225.5664	771097.7529
Z12A	788169.9858	771053.1700
Z13A	788162.0899	771092.1788
Z14A	788100.3500	771127.7697
Z40A	787985.8933	771165.3752
Z41A	788055.8294	771189.6080
Z42A	788101.0392	771229.6728
Z45A	788139.5868	771354.6973
Z44A	788124.8956	771354.9728
Z46A	788132.4825	771288.6653
Z43A	788110.6034	771284.8364
Z47A	788124.4617	771243.5911
Z48A	788116.3483	771200.6375

NOTE: Location with P designation corresponds to Wetland B locations shown on the Wetland Delineation Map

COLESVILLE LANDFILL

REMEDIAL DESIGN PROJECT

Wetland Survey Coordinates

Location	Northing	Easting
P-27	788158.7475	770722.8278
P-26	788155.8519	770714.0058

NOTE: Location with P designation corresponds to Wetland B locations shown on the Wetland Delineation Map

APPENDIX B
STABILITY AND SETTLEMENT ANALYSIS

CROSS-SECTION AA

SETTLEMENT CALCULATIONS

```
****  INPUT DATA  ****

  NUMBER OF SETTLEMENT POINTS                          =          4
  LIFT THICKNESS OF PROPOSED CAP                       =        4.0 FT
  TIME ASSUMED FOR PRIMARY COMPRESSION                 =        .25 YRS
  TIME ELAPSE BETWEEN THE PRIOR CLOSURE
   AND PROPOSED CAPPING                                =       8.00 YRS
  TIME REQUIRED FOR CAPPING                            =        .00 YRS

BEYOND THE OPERATIONAL LIFE OF EXPANSION:

  SETTLEMENTS COMPUTED UPTO                            =      30.00 YRS
  TIME INTERVALS SETTLEMENTS COMPUTED                  =      30.00 YRS

WASTE PARAMETERS:

  STRAIN FACTOR                                        =       .055 PER TSF
  COEFFICIENT OF PRIMARY COMPRESSION                   =       .100
  COEFFICIENT OF SECONDARY COMPRESSION                 =       .050
  UNIT WEIGHT OF EXISTING SOLID WASTE                  =       65.0 PCF
  UNIT WEIGHT OF EXISTING FINAL COVER                  =         .0 PCF
  UNIT WEIGHT OF PROPOSED CAPPING                      =      120.0 PCF

PEAT PARAMETERS:

  COEFFICIENT OF COMPRESSION                           =       .000
  UNIT WEIGHT                                          =         .0 PCF

THICKNESSES OF DIFFERENT LAYERS:

POINT     PEAT       EXISTING     EXISTING     PROPOSED
 NO.    THICKNESS     WASTE       F. COVER       CAP
                    THICKNESS    THICKNESS    THICKNESS
          (FT)        (FT)         (FT)         (FT)

  1         .0         5.0           .0          4.0
  2         .0        13.0           .0          4.0
  3         .0        21.0           .0          4.0
  4         .0        29.0           .0          4.0
```

SETTLEMENT CALCULATIONS

```
*** SETTLEMENTS DURING CAPPING    ****

POINT    PEAT      ELASTIC    PRIMARY    SECONDARY     TOTAL
 NO.  CONSOLD.   SETTLMT.   COMPRES.   COMPRES.    SETTLEMENT
         (FT)      (FT)       (FT)        (FT)        (FT)

  1      .00       .10        .29        .00          .40
  2      .00       .27        .42        .00          .69
  3      .00       .44        .48        .00          .91
  4      .00       .60        .51        .00         1.11

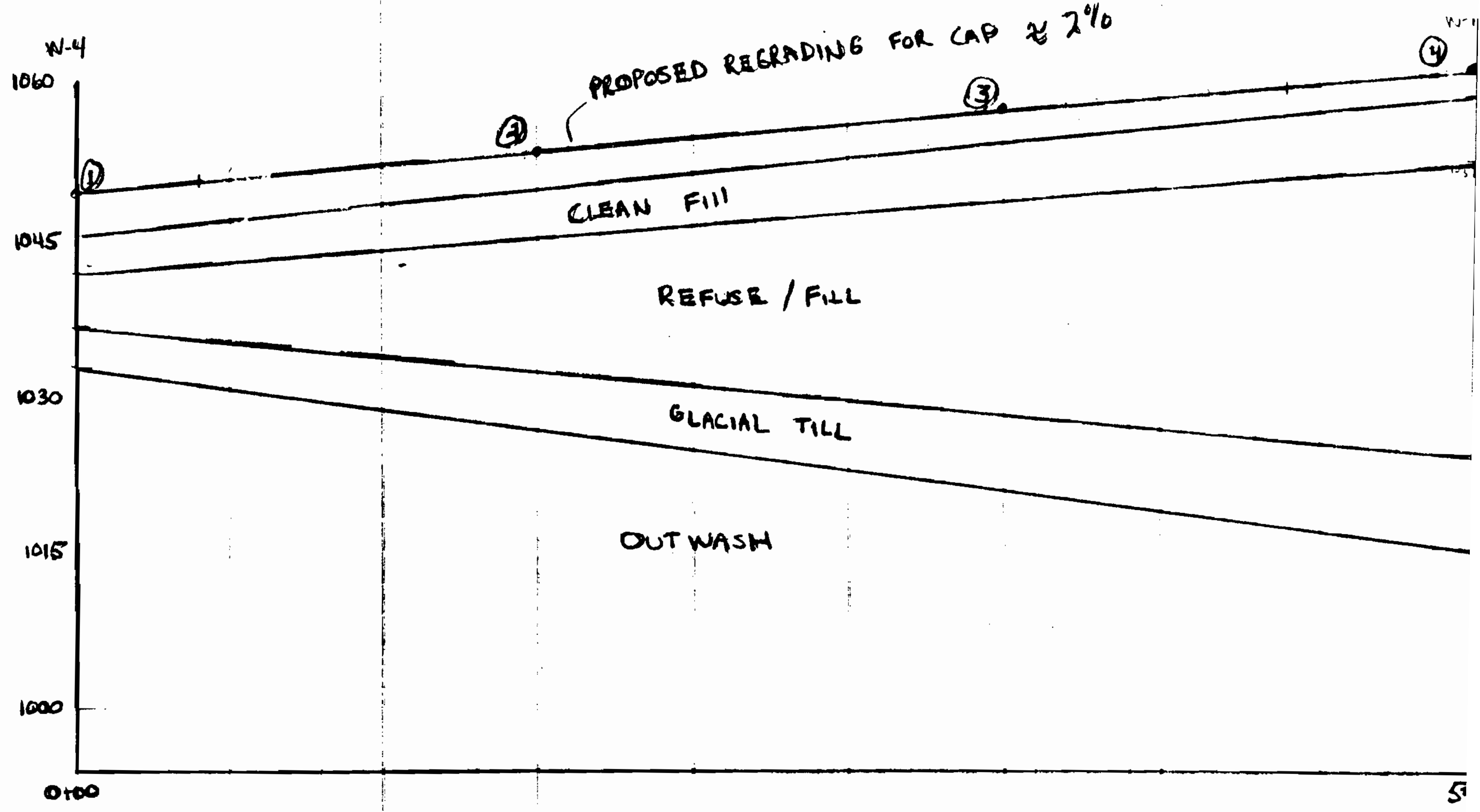

*** SETTLEMENTS 30.0 YEARS AFTER CAPPING ****

POINT     SETTLEMENTS          SETTLEMENTS       TOTAL
 NO.        DURING              FOLLOWING      SETTLEMENT
            CAPPING              CAPPING
             (FT)                 (FT)             (FT)

  1           .40                 .13              .53
  2           .69                 .35             1.04
  3           .91                 .58             1.49
  4          1.11                 .80             1.91
```

Chkd. by ______ Date ______ Sheet No. ______ of ______

Subject ______



CROSS-SECTION - AA

SCALE

VERTICAl 1" = 15'
HORIZONTAl 1" = 61'

NOTE: POINTS ①, ②, ③ AND ④ ARE
LOCATIONS WHERE
SETTLEMENTS WERE COMPUTE

CROSS-SECTION BB **SETTLEMENT CALCULATIONS**

```
****  INPUT DATA  ****

  NUMBER OF SETTLEMENT POINTS                         =          3
  LIFT THICKNESS OF PROPOSED CAP                      =        4.0 FT
  TIME ASSUMED FOR PRIMARY COMPRESSION                =        .25 YRS
  TIME ELAPSE BETWEEN THE PRIOR CLOSURE
   AND PROPOSED CAPPING                               =       8.00 YRS
  TIME REQUIRED FRO CAPPING                           =        .00 YRS

BEYOND CAPPING:

  SETTLEMENTS COMPUTED UPTO                           =      30.00 YRS
  TIME INTERVALS SETTLEMENTS COMPUTED                 =      30.00 YRS

WASTE PARAMETERS:

  STRAIN FACTOR                                       =       .055 PER TSF
  COEFFICIENT OF PRIMARY COMPRESSION                  =       .100
  COEFFICIENT OF SECONDARY COMPRESSION                =       .050
  UNIT WEIGHT OF EXISTING SOLID WASTE                 =       65.0 PCF
  UNIT WEIGHT OF EXISTING FINAL COVER                 =         .0 PCF
  UNIT WEIGHT OF PROPOSED CAP                       =      120.0 PCF

PEAT PARAMETERS:

  COEFFICIENT OF COMPRESSION                          =       .000
  UNIT WEIGHT                                         =         .0 PCF

THICKNESSES OF DIFFERENT LAYERS:

POINT      PEAT        EXISTING      EXISTING    PROPOSED
 NO.    THICKNESS       WASTE        F. COVER      CAP
                      THICKNESS     THICKNESS   THICKNESS
           (FT)          (FT)          (FT)        (FT)

  1          .0          14.0            .0          4.0
  2          .0          21.0            .0          4.0
  3          .0          12.0            .0          4.0
```

SETTLEMENT CALCULATIONS

```
*** SETTLEMENTS CAPPING ****

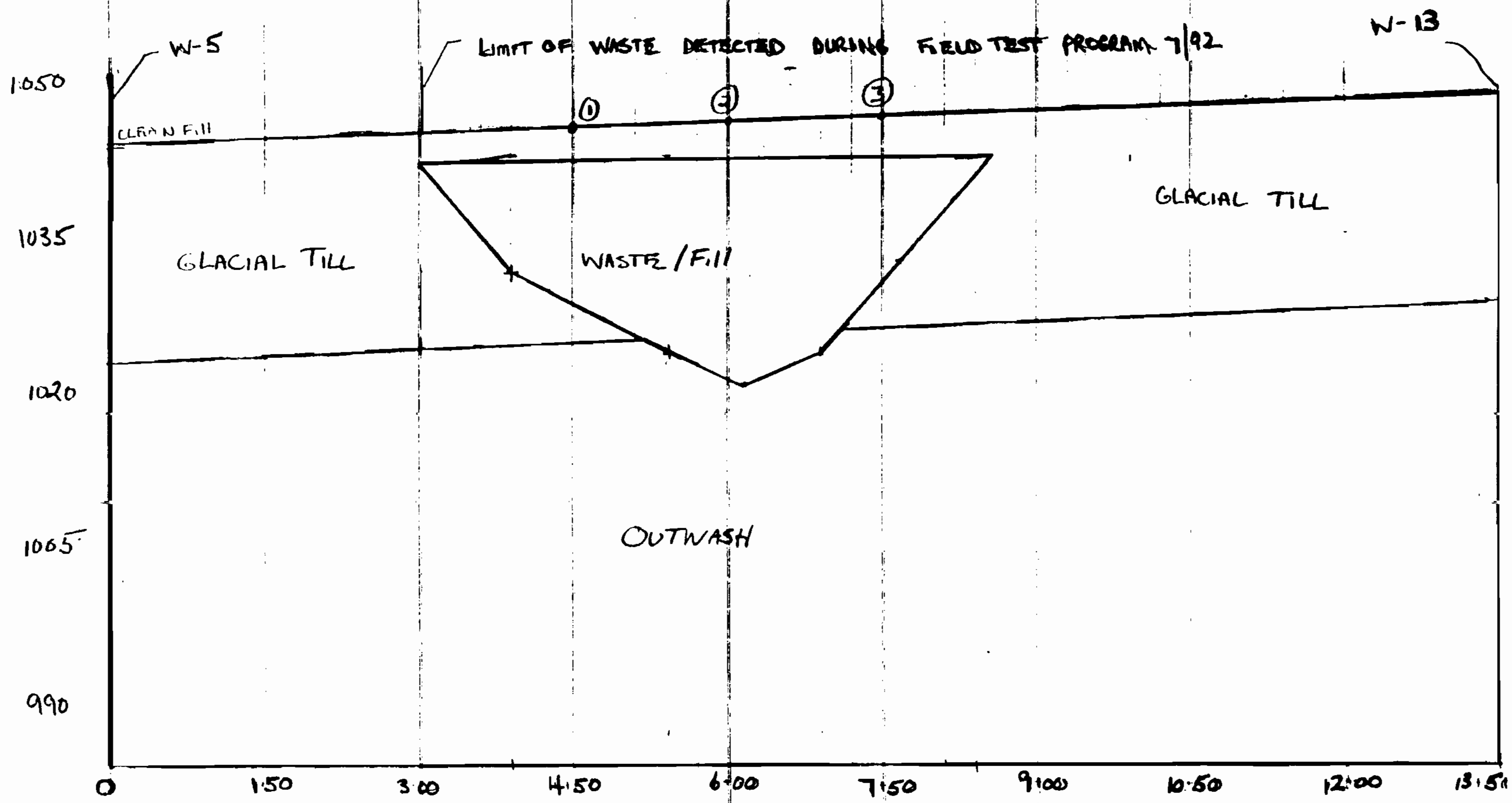
POINT    PEAT      ELASTIC     PRIMARY     SECONDARY     TOTAL
 NO.  CONSOLD.   SETTLMT.    COMPRES.    COMPRES.    SETTLEMENT
        (FT)       (FT)        (FT)        (FT)         (FT)

  1      .00        .29         .43         .00          .72
  2      .00        .44         .48         .00          .91
  3      .00        .25         .41         .00          .66


*** SETTLEMENTS 30.0 YEARS BEYOND REACHING FINAL GRADES ****

POINT       SETTLEMENTS              SETTLEMENTS        TOTAL
 NO.           DURING                 FOLLOWING       SETTLEMENT
              CAPPING                  CAPPING
               (FT)                     (FT)             (FT)

  1             .72                      .38             1.10
  2             .91                      .58             1.49
  3             .66                      .33              .98
```



CROSS SECTION BB

SCALE HORIZONTAL 1" = 150'
VERTICAL 1" = 15'

NOTE: POINTS ①, ②, AN ③ ARE LOCATIONS WHERE SETTLEMENTS WERE COMPUTED

By NKK Date 12/16/92 **WehranEnviroTech** Job No. ____
Chkd. by ____ Date ____ Sheet No. ____ of ____
Subject ____

CROSS-SECTION AA

POINT	WASTE THICKNESS (FT)	COVER SOIL THICKNESS (FT)	TOTAL SETTLEMENT (FT)
1	5	4	0.53
2	13	4	1.04
3	21	4	1.49
4	29	4	1.91

CROSS-SECTION BB

POINT	WASTE THICKNESS (FT)	COVER SOIL THICKNESS (FT)	SETTEMENT (FT)
1	14	3	1.10
2	21	4	1.49
3	12	4	0.98

NOTE: WASTE FILLING BETWEEN 1969-84

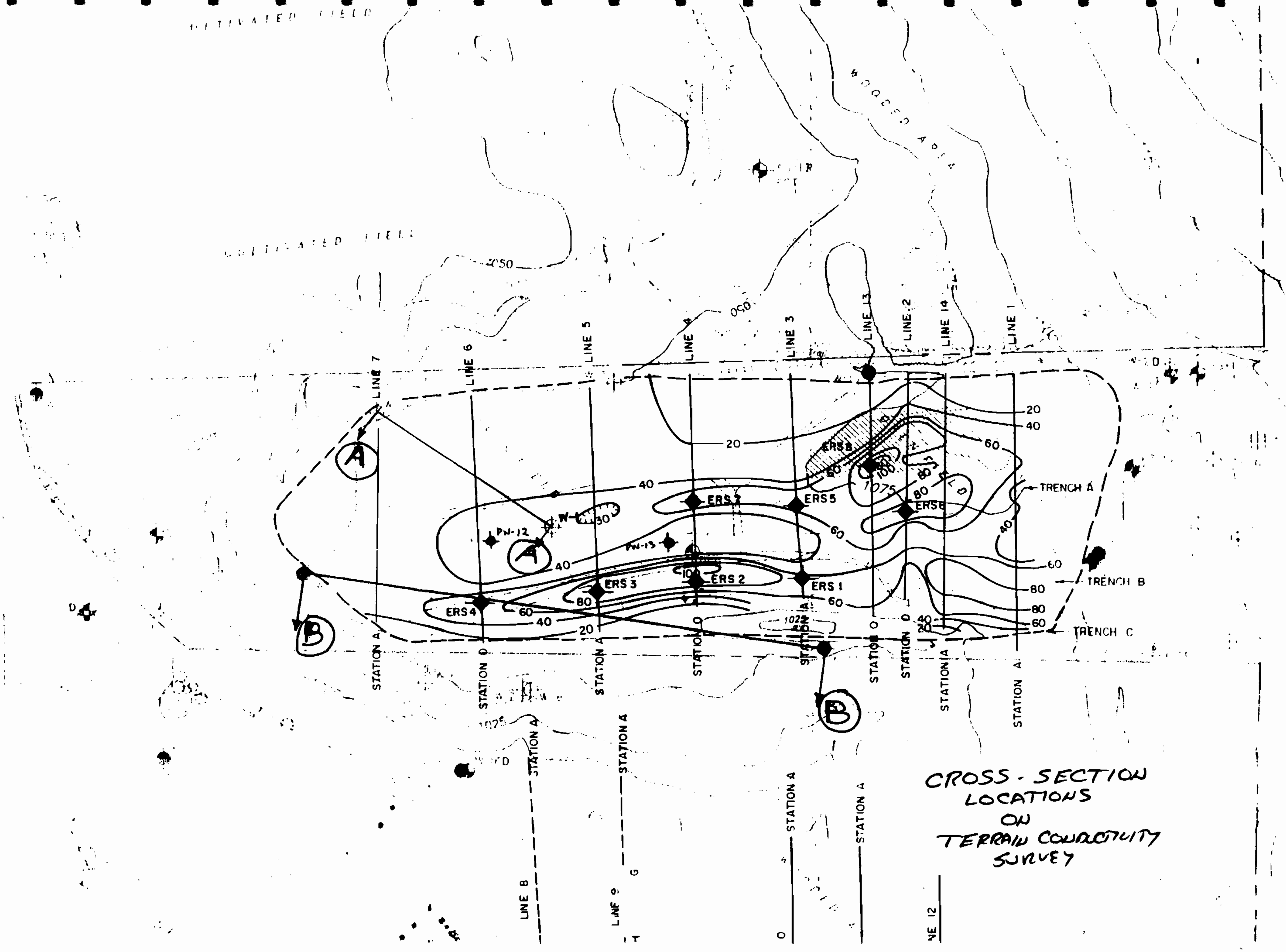
SETTLEMENT — Δ ELEVATIONS

CROSS-SECTION AA

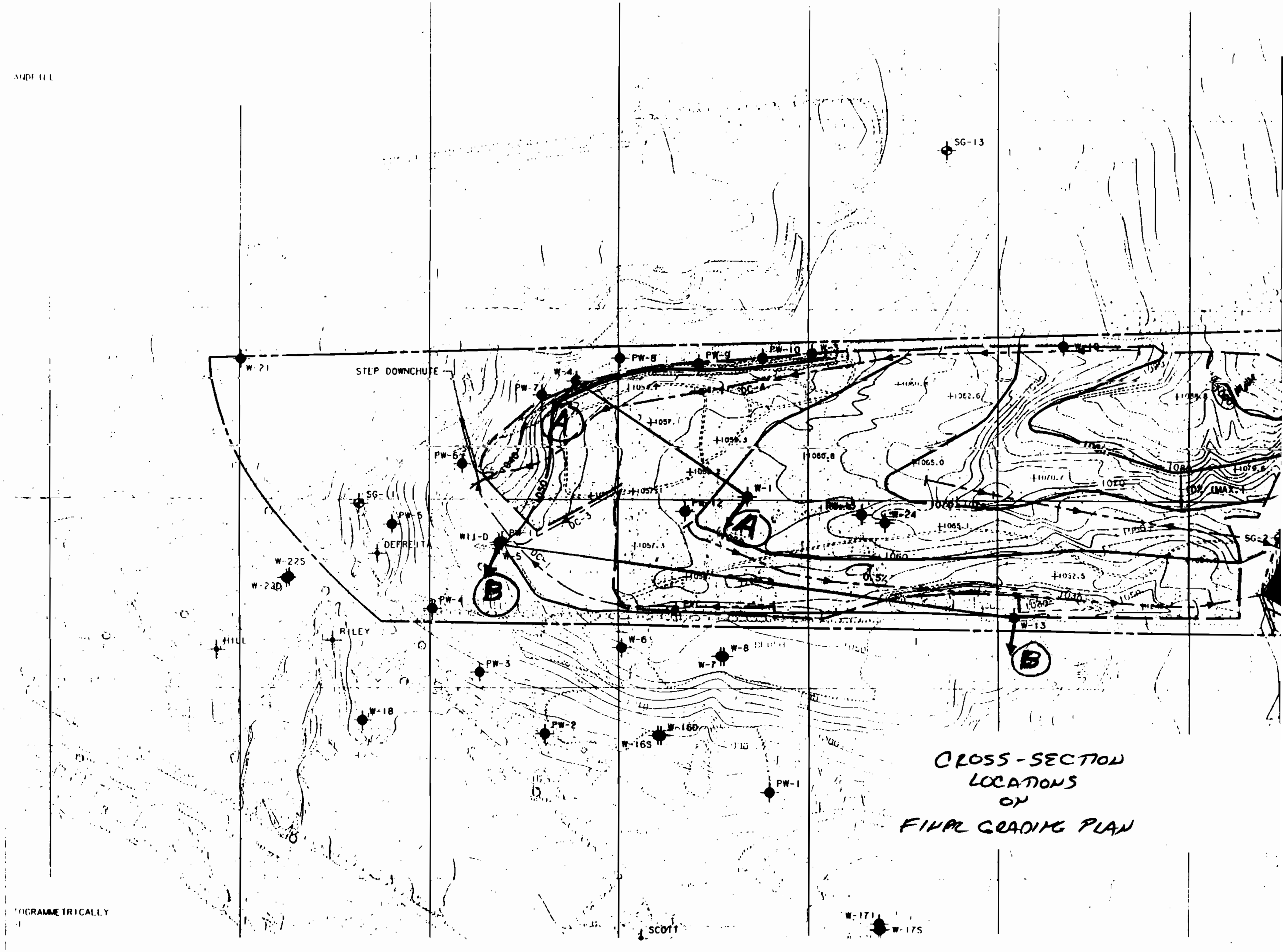
POINT	INITIAL ELEV.	EXPECTED SETTLEMENT	END ELEV
1	1046	0.53	1045.47
2	1054	1.04	1052.96
3	1058	1.49	1056.51
4	1061	1.91	1059.09

CROSS-SECTION BB

1	1055	1.10	1053.90
2	1055	1.49	1053.51
3	1055	0.98	1054.02



CROSS-SECTION
LOCATIONS
ON
TERRAIN CONDUCTIVITY
SURVEY



CROSS-SECTION LOCATIONS ON FINAL GRADING PLAN

DRAFT

COLESVILLE LANDFILL

REMEDIAL INVESTIGATION REPORT

Prepared For

BROOME COUNTY DEPARTMENT OF PUBLIC WORKS

BROOME COUNTY, NEW YORK

And

GAF CORPORATION

WAYNE, NEW JERSEY

VOLUME 1 – REPORT

APRIL 1988

WE WEHRAN ENGINEERING
Consulting Engineers

3.0 SITE HISTORY

3.1 OVERVIEW

The Colesville Landfill is located in the Town of Colesville, Broome County, New York, just north of Doraville (see Figure 3.1.1). The area evaluated as part of this remedial investigation report is generally bounded by East Windsor Road to the west, and by unnamed streams to the north, east and south, and consists of approximately 113 acres. Of this area, only about 35 acres have been used for disposal of solid waste. A detailed description of the environmental setting of this area is presented in Section 5.0.

3.2 LANDFILL OPERATIONS

Waste disposal operations commenced at the Colesville site in 1969. The landfill was owned and operated by the Town of Colesville between 1969 and 1971. Broome County took ownership of the site in 1971, and operated the landfill from 1971 to 1984. The landfill has been closed since 1984. Waste placement occurred primarily within excavated three trenches. Area landfilling was also performed in the northeastern portion of the site.

As part of this remedial investigation report, a review of available aerial photographs of the Colesville site was performed. This evaluation considered the extent and progression of historic landfill operations. The following photographs were analyzed utilizing stereoscopic projections, which allowed for a three-dimensional evaluation of site grading as related to onsite landfilling methods.

Photo Date	Scale	Approximate Disturbed Area (%)	Figure Number
July 4, 1955	1:1000	0	Figure 3.2.1
October 19, 1965	1:1000	6	Figure 3.2.2
May 26, 1977	1:1000	69	Figure 3.2.3
April 28, 1982	1:1000	96	Figure 3.2.4
November 23, 1987	1:500	100	Figure 3.2.5

All photos were obtained from the United States Department of Agriculture (USDA), Aerial Photograph Field Office, Salt Lake City, Utah, with the exception of the 1987 photos, which were obtained from R. M. Keddal and Associates, Inc., Library, Pennsylvania.

A general description of site conditions over time based on these photographs, is as follows:

July 4, 1955

Pre-landfill conditions existed; open fields without scattered trees and no sign of excavations. This photograph indicates the fields were utilized for agricultural purposes (see Figure 3.2.1)

October 19, 1965

Some form of construction and/or disturbance had occurred. An access road had been built on western and northern perimeter of property. Excavations and stockpiling of material was evident along the north-central property line. The areal extent of disruption activities encompassed just over two acres. The farm fields were fallow, and it appeared that farming activities had ceased (see Figure 3.2.2).

May 26, 1977

The landfill was in full operation. The first active disposal trench is identified, running east to west through the center of the landfill property, with refuse piled at the western end. An active borrow area was located at the northeastern corner of the site. Access roads existed throughout the site with the major road ending at the refuse pile. The associated landfill area had increased to 24 acres (see Figure 3.2.3).

April 28, 1982

Landfill operations had continued. A second trench, running east to west, existed along southern border of property. The primary borrow area still appeared to be located on the northeast section. Disposal activities appeared contained only within the trench (see Figure 3.2.4).

November 23, 1987

The landfill is closed (see Figure 3.2.5). Remnant access roads exist across site. A third, open trench exists running east to west along the southern border of landfill. Refuse is exposed on the north face of the trench (based on visual field examination). Borrow areas are now covered with vegetation.

In summary, landfill operations at the Colesville site began along the northern property border of the site, with refuse disposed of in east to west trending trenches. As trenches were filled, new trenches were excavated to the south, adjacent to active filling. A total of three trenches were identified. Borrow areas were identified on the north-central area during early landfill stages and in the northeast corner in later stages. Wastes appeared to be dumped in the trenches and then covered with borrow material from onsite sources. At no time did it appear that the limits of refuse exceed the property boundary. No major facility, such as an office or maintenance garage, was identified on the landfill property, although a small, shed-like structure exists along the western edge of the property. Overall, approximately 35 acres were used for landfilling purposes.

3.3 WASTE DISPOSAL PRACTICES

Throughout its operational life, the Colesville Landfill was used for the disposal of municipal solid waste (MSW). Between 1973 to 1975, industrial wastes were also disposed of at the facility with concurrence of the NYSDEC.

Table 3-1 lists the nature of industrial wastes disposed of at the site along with the estimated amount of each waste type received per month.

Interviews conducted with site personnel familiar with landfill procedures at the time of operation, indicate that disposal practices were quite varied. For example, it has been reported that wastes received in drums were randomly codisposed of with MSW and disposed in segregated areas. Moreover, depending upon the particular operator on duty at the time the wastes were received, the drums were either buried intact, or punctured and crushed prior to burial.

By KPH Date 12/16/92
Chkd. by ______ Date ______
Subject Collinsville Landfill

WehranEnviroTech

Job No. ______
Sheet No. ______ of ______

SETTLEMENT CROSS SECTIONS

USING BORING LOGS DEVELOP RELATIONSHIP BETWEEN RECORDED CONDUCTIVITY LEVELS AND ACTUAL WASTE THICKNESS.

BORING LOCATION	CONDUCTIVITY LEVEL	WASTE DEPTH	CONDUCTIVITY/WASTE DEPTH mmhos/m / FT
PW-12	36	7.0	5.1
PW-13	33	15	2.2
W-1	42	27	1.6

= 3 MMHOS / FT OF WASTE

* EXAMPLE CONDUCTIVITY LEVEL OF 60 ⇒ 20' WASTE

Wehran EnviroTech

BORING/WELL NO. PW-13

SHEET 1 of 2

PROJECT: COLESVILE LF Remedial Design
CLIENT: BROOME COUNTY/GAF
CONTRACTOR: EMPIRE SOILS

PROJECT NO: 02260HG
RIG: CME-75

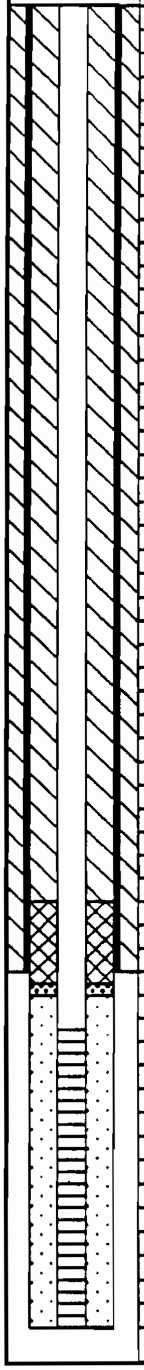
GS ELEV: 1062.5ft.
N-S COORD: 788,462.54
E-W COORD: 769,640.70
WL REF ELEV: 1064.37ft.
DATE STARTED: 1/7/92
DATE FINISHED: 1/13/92
OPERATOR: L. Pech
GEOLOGIST: D.R.L./B.A.O.

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	HSA/steel	SS		
DIAM.	4"	2"		
WEIGHT		140#		
FALL		30"		

WELL CONSTRUCT



DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (feet)	N-VALUE	LOG	UNIFIED	FIELD DESCRIPTION (Modified Burmister)	REMARKS
	1		0.7	8			SOIL FILL Brown cf SAND, little Silt & Clay, trace (+) fm Gravel, loose, moist.	
5	2		0.8	40				
10	3		0.0	27				
	4		0.3	100				
15	5		0.0	50			15.0' REFUSE w/ FILL, tire, plastic, wood, paper, glass, slight odor, wet.	
	6		0.5	17				
20	7		0.4	20			@ 20' Saturated.	
	8		0.6	54				
25	9		0.0	9				
	10		0.2	28				
30	11		1.0	28			30.0' TILL Grayish-brown SILT & Clay and cf Sand, little mf Gravel, m dense, moist.	
	12		0.8	24				
35	13		0.0	28				
	14		1.8	24			@ 37.0' Grayish-brown fc SAND, little f Gravel, trace (-) Silt, dry.	
40	15		1.3	20			40.0' GLACIAL OUTWASH Gray fc SAND, little (-) fm Gravel, trace (+) Silt, m dense, dry.	Permanent 6" steel casing to 41ft.g.s. Switched from 4" Augers to 4" casing @ 41'.
	16		1.0	20				
45	17		1.0	17			@ 44.5' Becomes moist.	
	18		0.7	25				
	19		1.2	27				
50	20		0.9	24			@ 50' Becomes Grayish-brown f SAND and Silt, m dense, moist.	
	21		1.8	21				
55	22		2.0	39				
	23		1.3	17			55.0' GLACIOLACUSTRINE DEPOSIT ~~Brown Clayey SILT, little f Sand, dense, moist, saturated~~	

Wehran EnviroTech

BORING/WELL NO. PW-13

SHEET 2 of 2

PROJECT: COLESVILE LF Remedial Design	PROJECT NO: 02260HG	GS ELEV: 1062.5ft.
CLIENT: BROOME COUNTY/GAF		N-S COORD: 788,462.54
CONTRACTOR: EMPIRE SOILS	RIG: CME-75	E-W COORD: 769,640.70

WELL CONSTRUCT	DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (feet)	N-VALUE	LOG	UNIFIED	FIELD DESCRIPTION (Modified Burmister)	REMARKS
		24	☒	1.1	57				
	60	25	☒	1.4	39			@ 60' becomes Brown laminated SILT and f Sand, soft.	
		26	☒	1.3	50				
	65	27	☒	1.6	39			@ 64' Brown f SAND and Silt grading to Light Green-brown SILT and f Sand, w/ f Sand partings.	
		28	☒	1.5	52				
		29	☒	1.5	39				
	70	30	☒	1.3	61			@ 70' Brown SILT and f Sand, soft, dense, layered, w/<0.25" Clay seam @ 71.5'.	
		31	☒	1.4	26				
	75	32	☒	1.6	36				
		33	☒	1.7	39				
		34	☒	1.9	53			@ 78.0' Green-brown SILT, some (+) f Sand, soft, w/ 0.75" Red Clay seam @ 79.5'.	
	80							80.0' @ 80' End Of Boring.	
	85								
	90								
	95								
	100								
	105								
	110								
	115								
	120								

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BORING/WELL NO. PW-12

SHEET 1 of 2

PROJECT: COLESVILE LF Remedial Design
PROJECT NO: 02260HG
CLIENT: BROOME COUNTY/GAF
CONTRACTOR: EMPIRE SOILS
RIG: CME-850

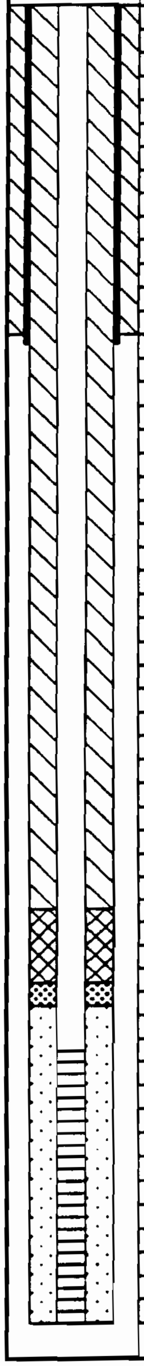
GS ELEV: 1058.4ft.
N-S COORD: 788,469.78
E-W COORD: 769,177.32
WL REF ELEV: 1060.42ft.
DATE STARTED: 1/6/92
DATE FINISHED: 1/10/92
OPERATOR: S. Ereeds
GEOLOGIST: J. Gilbert

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

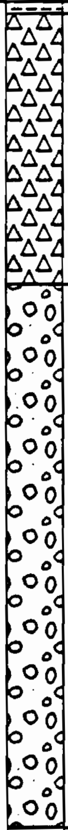
	CASING	SAMPLE	TUBE	CORE
TYPE	HSA/steel	SS		
DIAM.	4"	2"		
WEIGHT		140#		
FALL		30"		

WELL CONSTRUCT



DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (feet)	N-VALUE	FIELD DESCRIPTION (Modified Burmister)	REMARKS
	1	☒	0.8	13	TOPSOIL/SOIL FILL Brown SILT, some (+) fmc Sand, little (-) fm subangular Gravel, organic, wet	
5	2	☒	0.5	25	5.0' REFUSE Plastics, wood, odorous, wet.	
10	3	☒	1.0	18		
	4	☒	1.3	28	12.0' TILL Red-Brown Clayey SILT, some (-) fmc Gravel, little fmc Sand, dense, dry to damp.	
15	5	☒	1.0	31	@ 15.0' Brown Clayey SILT and (-) fmc Gravel, some (-) fmc Sand, plasticity, loose, chemical odor, wet.	20', 6.5"O.D. Permanent Casing set @ 14.4'. Switched from 4" Augers to 4" casing @ 14'.
20	6	☒	1.4	44	@ 20' m dense.	
25	7	☒	1.0	53		
30	8	☒	0.8	58	@ 30.0' Brown Clayey SILT, some (+) fmc Gravel, some (-) fmc Sand, wet.	
35	9	☒	1.4	42	35.0' OUTWASH Brown cmf SAND, trace (+) Silt, trace fm Gravel, wet.	
	10	☒	1.3	35		
40	11	☒	1.4	24		
	12	☒	1.2	29		
	13	☒	1.6	26	@ 43' Gray-black fmc SAND, trace (-) Gravel, sl. chemical odor, wet.	
45	14	☒	1.2	26		
	15	☒	0.0	32		
50	16	☒	0.5	38		
	17	☒	1.6	22		
	18	☒	1.6	35		
55	19	☒	1.6	29	@ 55' Dark Gray fm SAND, some (-) Silt, w/ Silt sorted, wet.	

LOG



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BORING/WELL NO. PW-12

SHEET 2 of 2

PROJECT: COLESVILE LF Remedial Design
CLIENT: BROOME COUNTY/GAF
CONTRACTOR: EMPIRE SOILS

PROJECT NO: 02260HG
RIG: CME-850

GS ELEV: 1058.4ft.
N-S COORD: 788,469.78
E-W COORD: 769,177.32

DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (feet)	N-VALUE	LOG	UNIFIED	FIELD DESCRIPTION (Modified Burmister)	REMARKS
	20	☒	2.0	35			@ 58' Silt seams w/ Red Silty Clay seam.	
60	21	☒	1.7	26				
	22	☒	2.0	40				
	23	☒	1.0	18			@ 63.0' Dark Brown f SAND, some (+) Silt, laminated. @ 64.6' Red Silty Clay seam, high dilatancy, wet.	
65	24	☒	2.0	34				
	25	☒	1.8	32				
70	26	☒	1.7	34				
	27	☒	2.0	30			@ 71' becomes dense.	
	28	☒	1.7	36				
75	29	☒	1.7	44			75.0' GLACIOLACUSTRINE DEPOSIT Brown SILT and f Sand, dense, w/ <0.25" Red Clay seam @ 75.5'.	
	30	☒	2.0	39				
80	31	☒	1.5	48			@ 79' high dilatanty, wet, w/ 0.25" Red Silty Clay seam.	
	32	☒	1.8	41			@ ~83' 0.5" Red Silty Clay seam w/ silt seams.	
85							83.0' @ 83.0' End Of Boring.	
90								
95								
100								
105								
110								
115								
120								

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TEST BORING LOG

BORING NO. W-5

SHEET NO. 1 **OF** 2

JOB NO. 0127 2290

ELEVATION 1249.57

DATE STARTED 6/10/83

DATE FINISHED [illegible]

DRILLER Jeff Thom[illegible]

INSPECTOR T Hooper

PROJECT: COLESVILLE LANDFILL

CLIENT: BROOME COUNTY

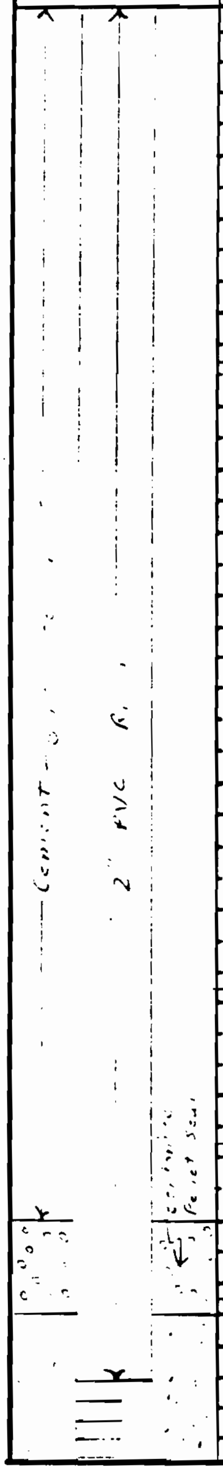
BORING CONTRACTOR: NORTHSTAR [illegible] Inc

GROUND WATER 17.2'

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		SS		
DIA.		2		
WT.		140 lb		
FALL		30		

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0				CLEAN FILL	
7'				GLACIAL TILL brown SILT and f SAND little(+) f Gravel	
10	1	SS	4 7 11		
11.0				OUTWASH @11' becomes brown m-f SAND Trace(+) silt	
13.0				GLACIAL TILL F-m SAND, some F Gravel little(+) silt + clay	
15	2	SS	8 8 10		
20	3	SS	9 17 12	SILT + CLAY, some f-m sand, little f-m gravel	
25	4	SS	12 13 10	F-m SAND some silt + clay little(+) F Gravel	Frequent cobbles and Boulders To 28'
28'				OUTWASH	
30	5	SS	8 7 6	m-f SAND, little SILT	
35	6	SS	6 9 8	F SAND little(+) [illegible]	
40	7	SS	6 7 9		
45					

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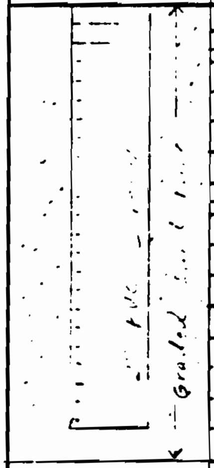
TEST BORING LOG
BORING NO. W-[illegible]
SHEET NO. 2 **OF** 2
JOB NO. 01273290

PROJECT : COLESVILLE LANDFILL
CLIENT : BROOME COUNTY

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
45	8	SS	10 12 13		
					[illegible]
50	9	SS	8 11 11	Sandy [illegible] SAND [illegible]	Saturated
55	10	SS	7 10 11		
60	11	SS	7 7 13		
				END OF BORING at 61.5'	Well Fully developed with air upon completion
65					
70					
75					
80					
85					
90					
95					

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TEST BORING LOG
BORING NO. W-13

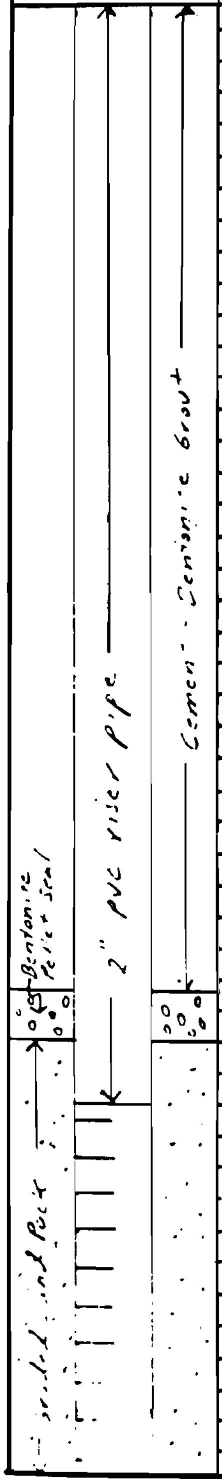
PROJECT: Colesville Landfill	**SHEET NO.** 1 **OF** 2
CLIENT: [illegible] County	**JOB NO.** 01273270
BORING CONTRACTOR: North Star Drilling Inc	**ELEVATION** 1051.4
	DATE STARTED [illegible]
	DATE FINISHED [illegible]
	DRILLER Harry
	INSPECTOR [illegible]

GROUND WATER

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE	H.S.A	S.S.		
DIA.	8"	2"		
WT.		140 lbs		
FALL		30"		

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	SAMPLE BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	1	S.S.	8 6 6 4	GLACIAL TILL med brown SILT & CLAY Some F-m Gravel, little F-c Sand	
5	2	S.S	30 51 46 37	F-m GRAVEL, Some Silt & Clay little F-c Sand	
10	3	S.S.	14 18 19 13	grading to med brown F-C SAND little(+) F-m Gravel, little Silt & Clay layer of cobbles 6-8'	
15	4	S.S	2 10 8 2		evidence of perched water
20	5	S.S.	6 5 6 9	GLACIAL OUTWASH @ 20.3' F-C SAND, Trace Silt, Trace F Gravel, grading to very F SAND Some Silt	20
25	6	S.S.	6 6 7 10	med brown F SAND, Trace Silt	
30	7	S.S.	10 8 10 10	grading to F SAND, Some Silt Thin laminations, grading to F SAND Trace Silt	
35	8	S.S	8 6 8 4	@ 35'-36' med brown SILT, little(+) F-C SAND, Trace F Gravel @ 36' becomes F SAND, little Silt	
40	9			med brown SILT and F SAND with lense of thick brown F-m SAND little Silt Saturated	1st encountered Saturation in Sample 9
45					

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TEST BORING LOG

BORING NO. W-13

PROJECT: Colesville Landf

CLIENT: Broome County

SHEET NO. 2 **OF** 2

JOB NO. [illegible]

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	45	10	S.S.	10 9 15 21	GLACIAL OUTWASH med. brown SILT and F SAND irregular varves Saturated	
[illegible]	50	11	S.S	9 11 13 20		
					END OF Boring at 52'	
	55					
	60					
	65					
	70					
	75					
	80					
	85					
	90					
	95					

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TEST BORING LOG

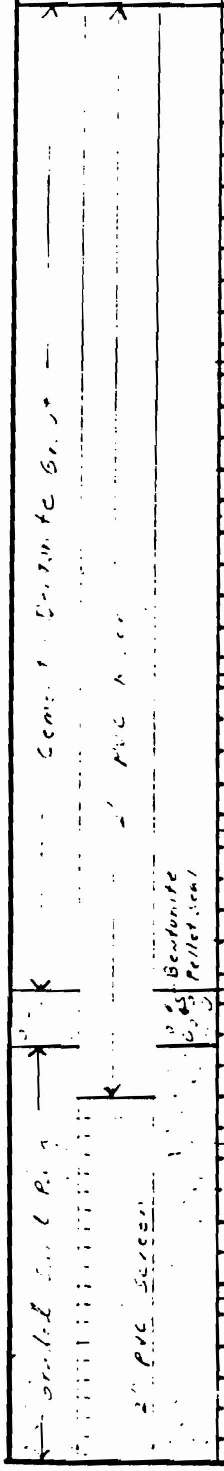
BORING NO. W-4
SHEET NO. 1 **OF** 2
JOB NO. 21273290
ELEVATION 1045.97
DATE STARTED 6/9/[illegible]
DATE FINISHED [illegible]
DRILLER JEFF T[illegible]
INSPECTOR T Roeper

PROJECT: COLESVILLE LANDF
CLIENT: Broome county
BORING CONTRACTOR: North Star Drilling Inc
GROUND WATER 37.4'

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		SS		
DIA.		2		
WT.		140 lbs		
FALL		30'		

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0	1	S.S	4 4 6	CLEAN FILL	
				3.0	
				Refuse, Fill	
5	2	SS	3 7 12	5.0	
				GLACIAL TILL SILT & CLAY, some(-) m-F Sand, little(-) F Gravel	
10	3	SS	23 22 12	SILT, some F-m Sand, little(+) F Gravel	
				13.0	
				OUTWASH	
15	4	SS	13 7 6	@ 15.5' grades To F-M SAND, Trace(+) silt	
20				20.0	
	5	SS	7 6 8	GLACIAL TILL	
				OUTWASH	
25	6	SS	4 6 5	Dark Brown m-F SAND, Trace silt	
30	7	SS	7 9 8		
35	8	SS	8 8 8	Grading To F SAND, little - silt	
					WL - 37.4
					Saturated
40	9	SS	7 12 12	F SAND, Some silt	
45					

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TEST BORING LOG
BORING NO. W-4
SHEET NO. 2 **OF** 2
JOB NO. 01173290

PROJECT : COLESVILLE LANDFILL
CLIENT : BROOME COUNTY

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	SAMPLE BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	45	10	S.S	9 10 11	@ 46' 2" [illegible] of SILT	
	50	11	S.S.	10 [illegible] 12	Fine SAND [illegible]	
					END OF BORING at 51.5'	[illegible] Fully develo[illegible] with air upon [illegible] pletion
	55					
	60					
	65					
	70					
	75					
	80					
	85					
	90					
	95					

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TEST BORING LOG
BORING NO. W-1

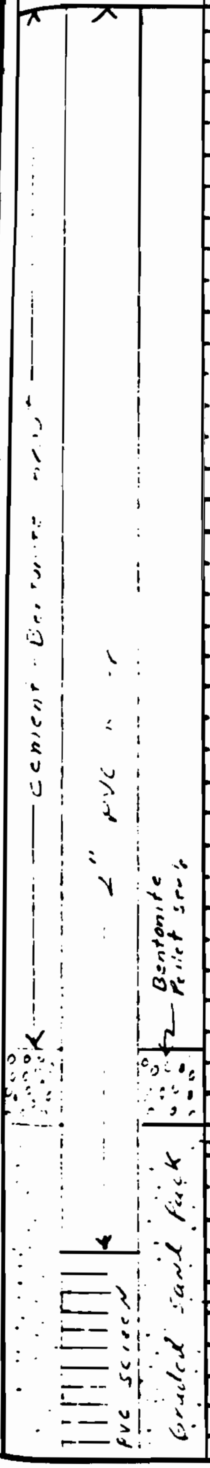
SHEET NO. 1 **OF** 2
JOB NO. 01273290
ELEVATION 1059.20
DATE STARTED 6/6/83
DATE FINISHED 6/6/83
DRILLER JEFF Thew
INSPECTOR T. Roeper

PROJECT : COLESVILLE LANDFILL
CLIENT : BROOME County
BORING CONTRACTOR : Northstar Drilling INC
GROUND WATER 45'

DATE	TIME	WATER EL.	SCREEN

	CAS.	SAMP.	CORE	TUBE
TYPE		S.S.		
DIA.		2"		
WT.		140 lbs		
FALL		30'		

WELL CONSTRUCTION



DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
0				CLEAN FILL	
7.0				REFUSE/FILL	
34.0				GLACIAL TILL	
35	1	S.S.	14 26 19	m-F GRAVEL, Some(+) F-C sand, little(+) silt & clay	
40	2	S.S.	10 19 19		
44.0				OUTWASH	

WEHRAN ENGINEERING
CONSULTING ENGINEERS

TEST BORING LOG

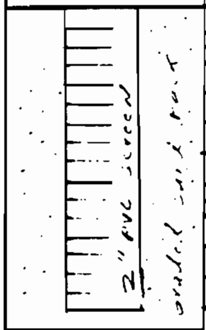
BORING NO. W-1

PROJECT : COLESVILLE LANDFILL

CLIENT : BROOME County

SHEET NO. 2 **OF** 2

JOB NO. 01273290

WELL CONSTRUCTION	DEPTH FEET	SAMPLE NO.	SAMPLE TYPE	SAMPLE BLOWS PER 6 INCHES	CLASSIFICATION	REMARKS
	45	3	S.S.	8 8 9	C-F SAND, little(+) F Gravel Trace Silt + Clay	Saturated
	50	4	S.S	6 4 5	@ 50'-51' silt + clay content increases to little	
collapsed soils	55	5	S.S	8 9 11	F-C SAND, little silt + clay Trace F Gravel	
	60	6	SS	2 5 8	m-c SAND little(-) SILT + clay, Trace F Gravel occasional 1/4" lense of silt + clay END OF BORING	61.5'
	65					Well Fully developed with air upon completion
	70					
	75					
	80					
	85					
	90					
	95					

APPENDIX C
STORMWATER DRAINAGE DESIGN

TR-55 DESIGN DATA

MANNING'S "n"

CHANNEL VELOCITY

STORM INTENSITY

STORM TYPE

MANNINGS "n" VALUE FOR RIP RAP

$n = .0395\ D_{50}^{1/6}$

REF. DESIGN OF STABLE CHANNELS AND
FLEXIBLE LININGS

H.E.C # 15 Hydraulic CIRCULAR

D_{50}	n
3"	.031
4"	.033
6"	.035
8"	.037
10"	.038
12"	.040

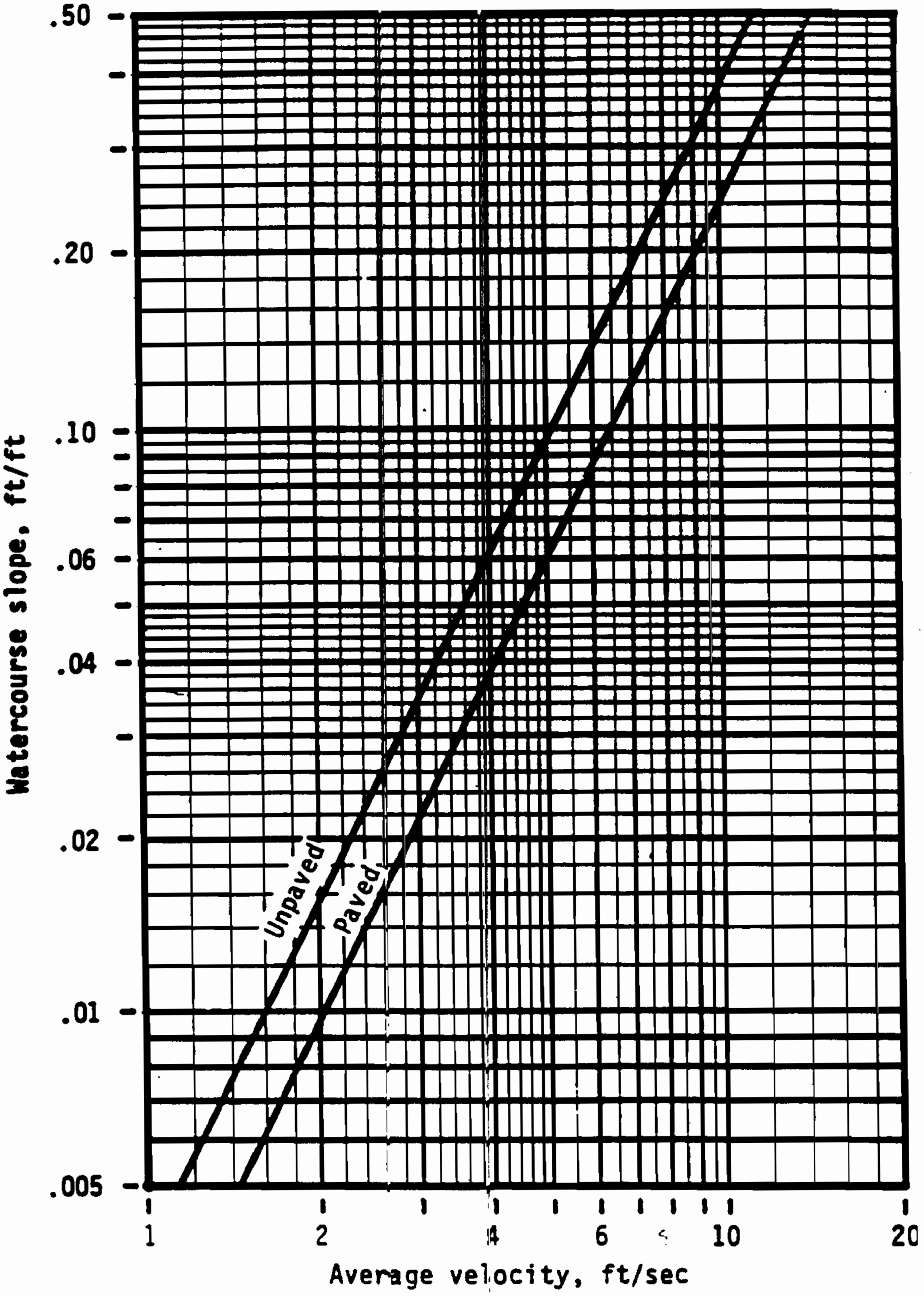
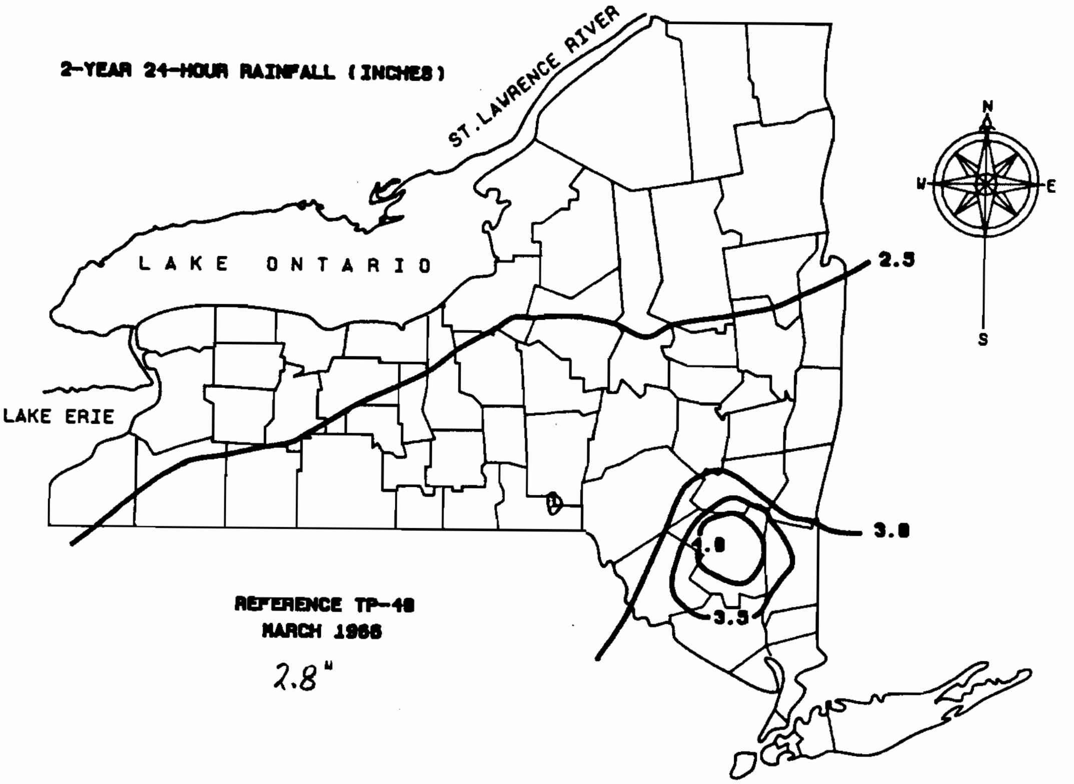


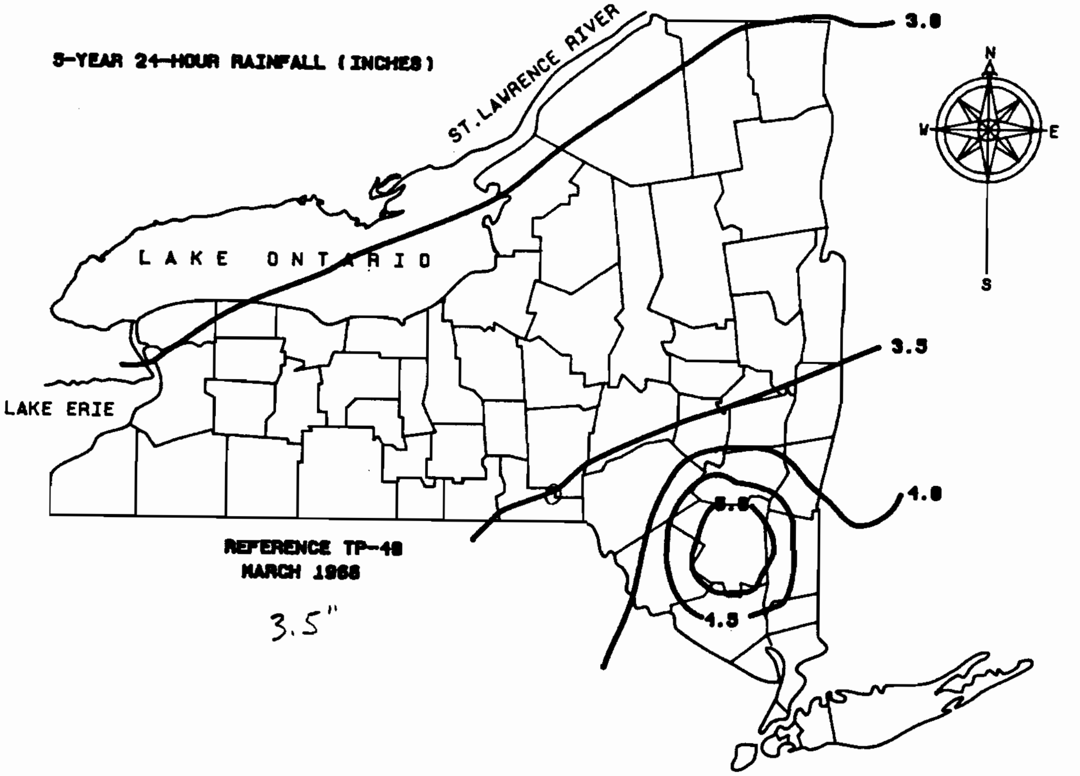
Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Exhibit 10.1

New York Rainfall Maps for Different Rainfall Frequencies



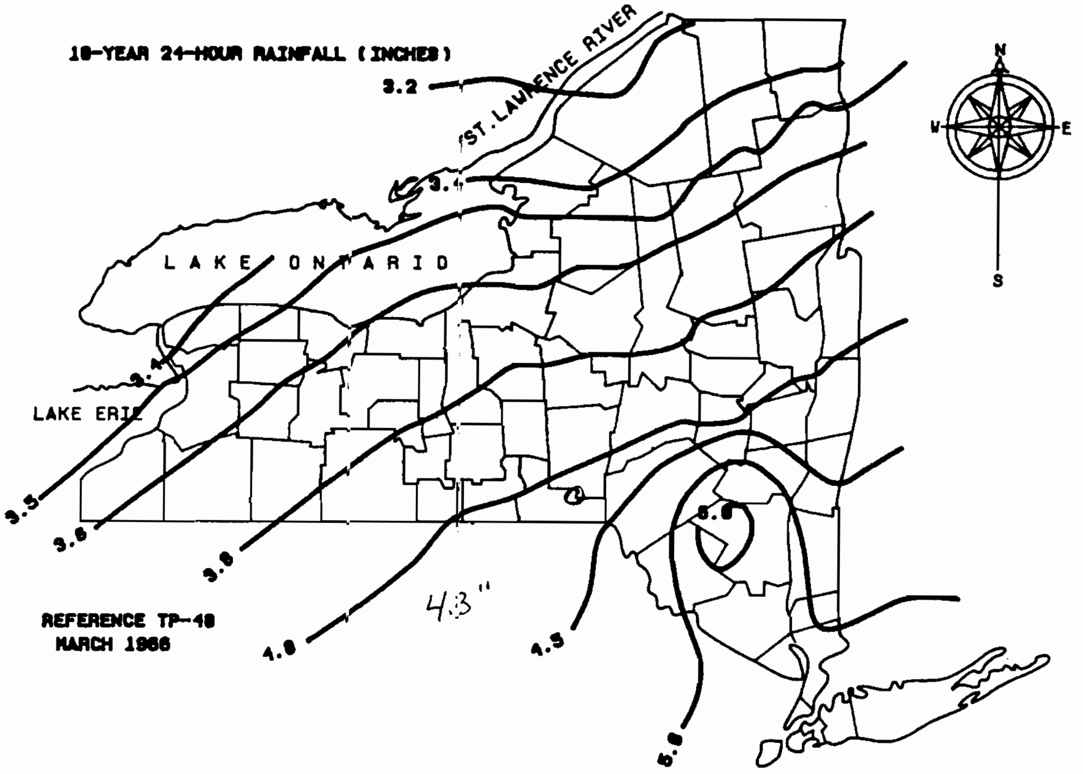
2.8"



3.5"

Exhibit 10.1 (cont'd)

New York Rainfall Maps for Different Rainfall Frequencies



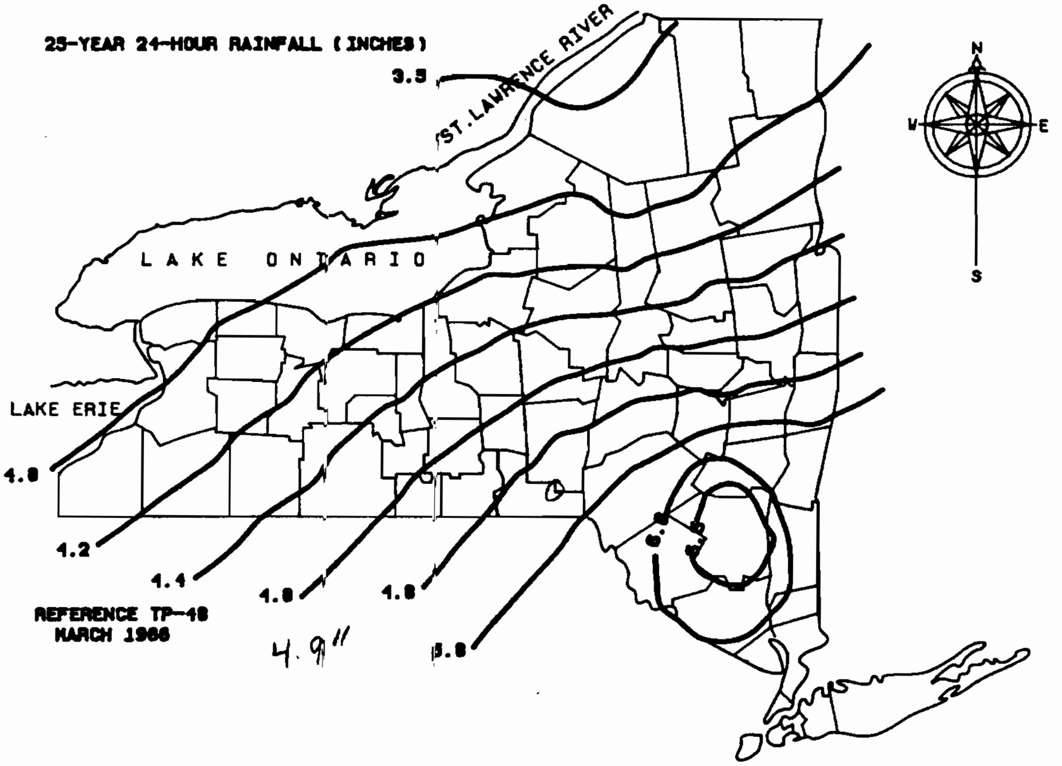
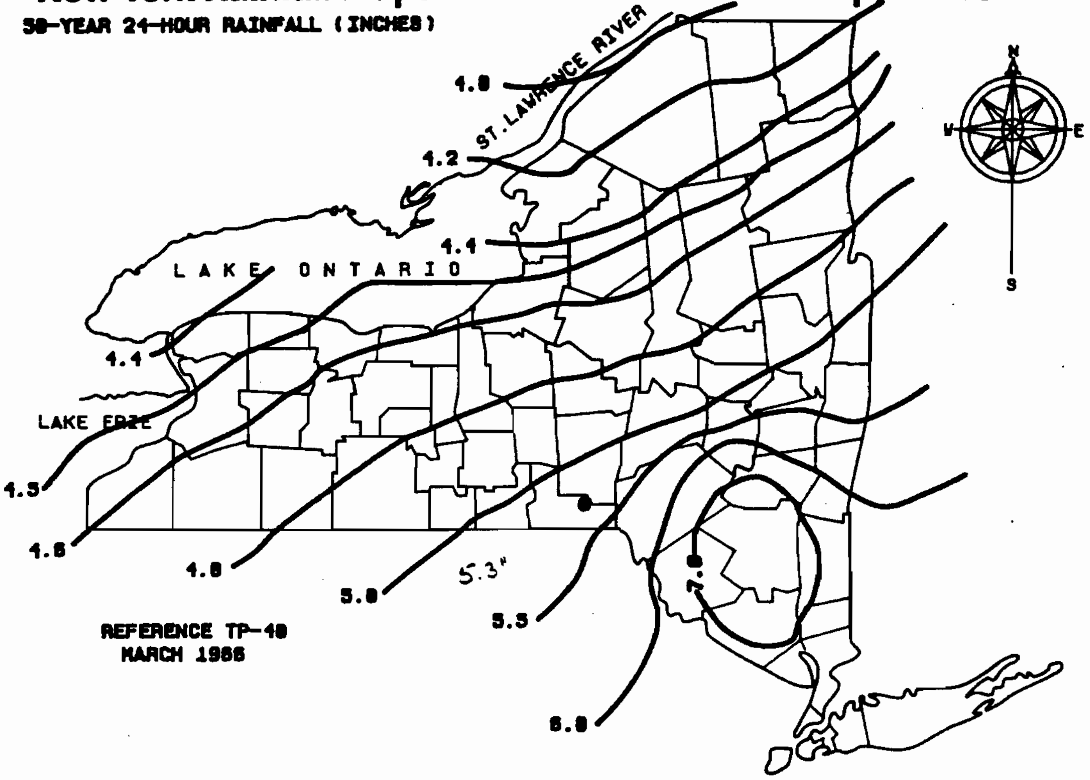
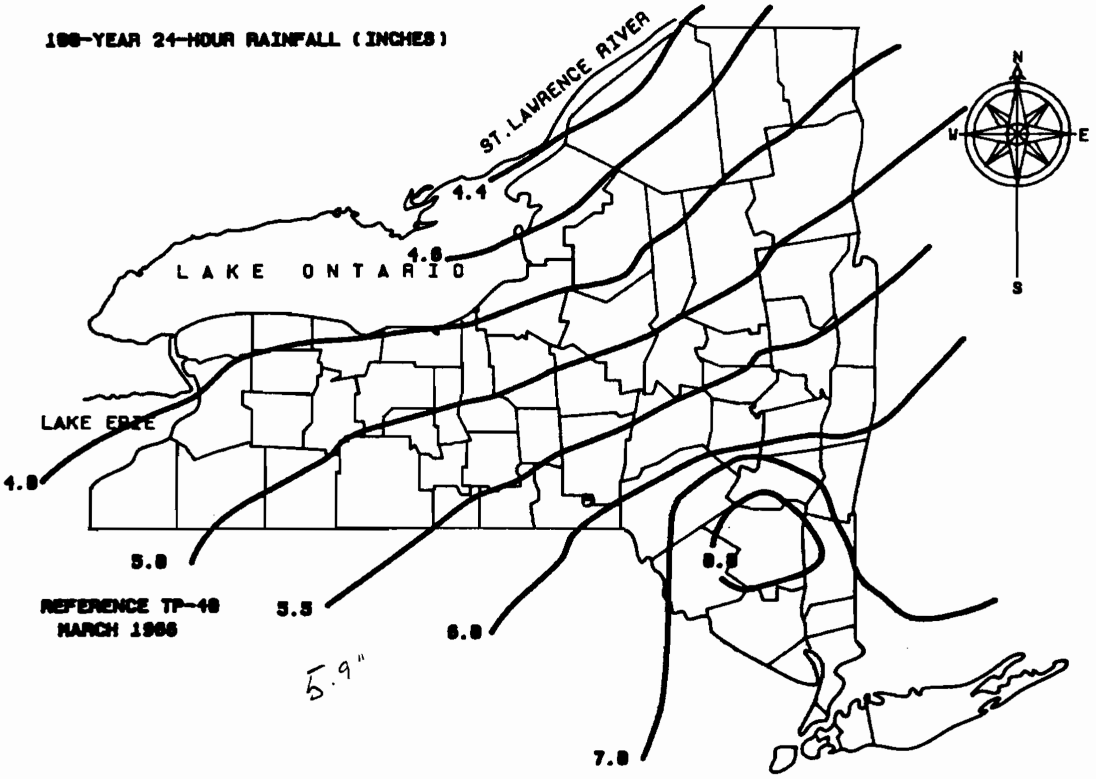


Exhibit 10.1 (cont'd)

New York Rainfall Maps for Different Rainfall Frequencies





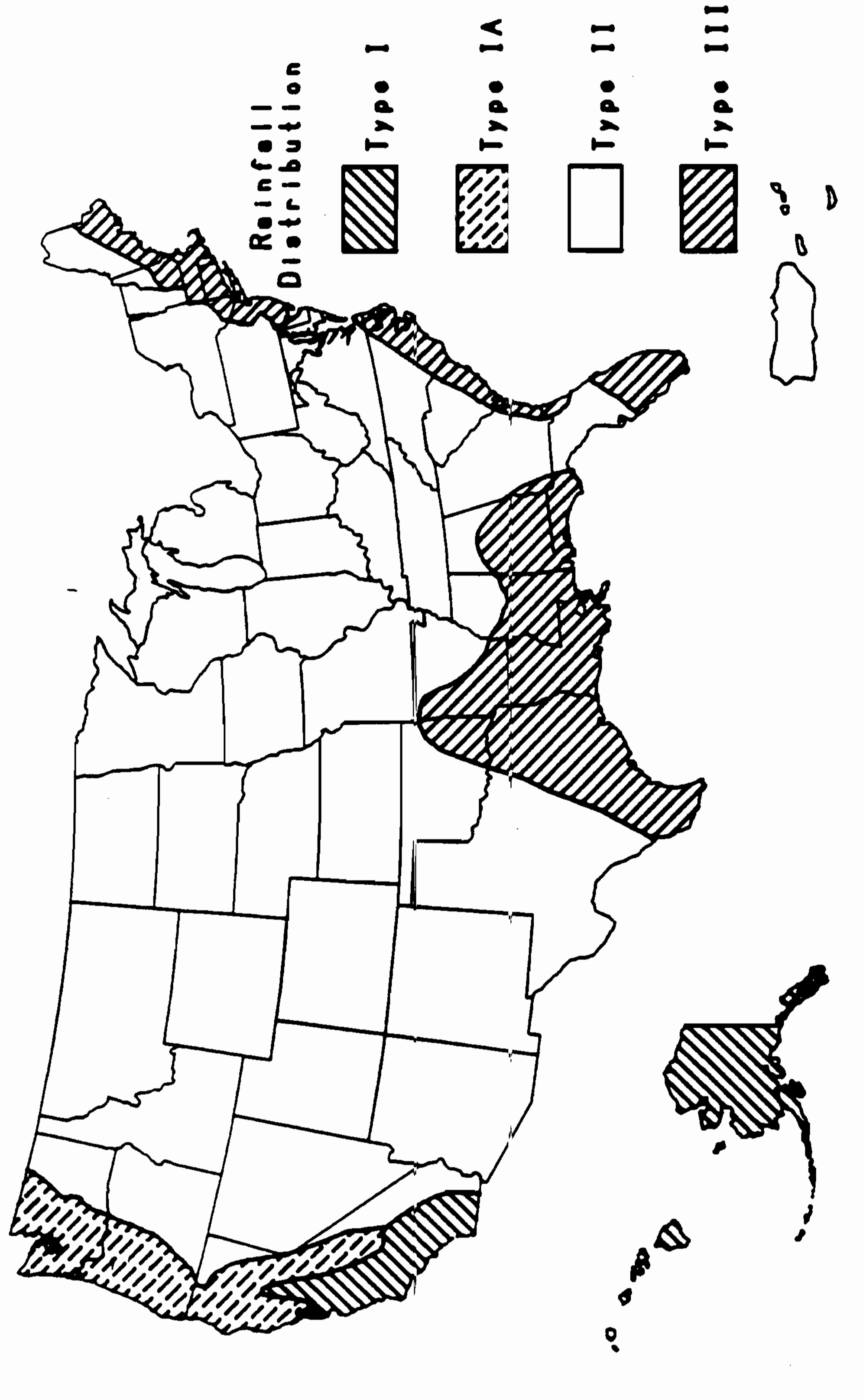


Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.

By ____________ Date ________ **WehranEnviroTech** Job No. ____________
Chkd. by ________ Date ________ Sheet No. ______ of ______
Subject ____________________________

TRIANGULAR AND TRAPEZOIDAL

CHANNEL DESIGN

By KPH Date 1-25-93
Chkd. by ______ Date ______
Subject COLESVILLE LANDFILL

WehranEnviroTech

Job No. 02260.C5
Sheet No. ______ of ______

CHANNEL	DRAINAGE AREA (AC)	CHANNEL SLOPE (%)	INLET ELEV.	OUTLET ELEV.	LENGTH (FT)	FLOW (CFS)	VELOCITY (FPS)	LINING TYPE	DEPTH (FT)	RIPRAP (D_{50})	GABION THICKNESS (in)	GABION Filling (D_{50})
DC-1-1	1.3	0.5	1062.5	1058.5	345.0	3.0	1.0	GRASS	2.0	—	—	—
DC-1-A	1.3	0.5	1058.5	1049.0	55	3.0	1.0	GRASS	2.0	—	—	—
DC-1-2	2.3	3.5	1049	1046.3	270.0	5.0	2.5	GRASS	1.5	—	—	—
DC-1-3	13.1	5.1	1049	1037.0	220.0	28.0	6.4	RIPRAP	1.7	6.0	—	—
DC-2	11.6	0.5	1062.5	1056.0	1300.0	26.0	2.5	GRASS	2.5	—	—	—
DC-2A	11.6	0.5	1056.0	1055.5	100.0	26.0	2.5	GRASS	2.5	—	—	—
DC-2-INLET	11.6	33.0	1055.5	1050.0	16.5	26.0	7.1	GABION	1.5	—	6"	3"
DC-3	0.8	0.5	1042.5	1041.4	230.0	3.0	1.0	GRASS	2.0	—	—	—
DC-4-1	4.9	3.0	1081.5	1056.3	830.0	14.0	3.0	GRASS	1.2	—	—	—
DC-4-2	10.9	0.5	1056.3	1051.0	1050.0	24.0	2.5	GRASS	2.5	—	—	—
DC-5-1	35.8	0.5	1150.0	1146.0	884.0	61.0	3.0	GRASS	2.5	—	—	—
DC-6	17.7	0.5	1060.2	1058.0	430.0	32.0	2.5	GRASS	3.0	—	—	—
DC-6-INLET	17.7	33.0	1058	1050.0	24.0	32.0	7.6	GABION	1.5	—	6"	3"
SEDIMENT BASIN OUTLET & SPILLWAY	39.7	(MAX) 33.0	1055	1048	60	107	16.9	GABION	1.5	-	18.0"	6"

By: Date: 1/22/93
Chk: KPH Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-1-1
Peak Flow, Q = 3 CFS
Ave. Slope, s = 0.5%

Select Basic Channel Geometry

[✓ Triangular, bottom width = 0 ft]
or
Trapazoidal, bottom width = ____

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3 FPS
Max. Velocity for Jute Lining = NA
Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 1.0 FPS
Therefore use: [✓ Grass], Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

- For Max. Velocity using Table D

Q = 4.8 at V = 1.0 and d = 1.3

- For Max. Capacity using Table C

Q = 3.6 at V = 0.5 and d = 1.5

Therefore set Total Depth = 2.0 inc. Freeboard and Settlement

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.8	9.6	0.95	2.0	18.0	1.05	2.2	29.4	1.18	2.5	46.4	1.35	2.8	72.9	1.50	3.2	****	1.65	3.5	145	1.82	3.8	199	2.05	4.3	280	2.50	5.3	500
1.0%	0.76	1.6	7.7	0.72	1.5	10.4	0.79	1.7	16.6	0.86	1.8	24.7	0.94	2.0	35.3	1.05	2.2	51.5	1.12	2.4	66.9	1.25	2.6	93.8	1.35	2.8	122	1.62	3.4	210
1.5%	0.53	1.1	3.7	0.59	1.2	7.0	0.65	1.4	11.3	0.71	1.5	16.8	0.77	1.6	23.7	0.84	1.8	32.9	0.91	1.9	44.2	0.98	2.1	57.6	1.05	2.2	73.5	1.22	2.6	****
2.0%	0.50	1.1	3.3	0.56	1.2	6.3	0.60	1.3	9.6	0.65	1.4	14.1	0.70	1.5	19.6	0.76	1.6	27.0	0.82	1.7	35.9	0.88	1.9	46.5	0.93	2.0	57.7	1.10	2.3	96.8
2.5%	0.46	1.0	2.8	0.50	1.1	5.0	0.54	1.1	7.8	0.58	1.2	11.2	0.62	1.3	15.4	0.67	1.4	20.9	0.72	1.5	27.6	0.77	1.6	35.6	1.05	2.2	73.5	0.93	2.0	69.2
3.0%	0.44	0.9	2.6	0.48	1.0	4.6	0.52	1.1	7.2	0.56	1.2	10.5	0.59	1.2	13.9	0.64	1.3	19.1	0.67	1.4	23.9	0.71	1.5	30.2	0.93	2.0	57.7	0.86	1.8	59.2
3.5%	0.40	0.8	2.1	0.44	0.9	3.9	0.47	1.0	5.9	0.50	1.1	8.3	0.53	1.1	11.2	0.58	1.2	15.7	0.61	1.3	19.8	0.65	1.4	25.3	1.05	2.2	73.5	0.77	1.6	47.4
4.0%	0.38	0.8	1.9	0.42	0.9	3.5	0.45	0.9	5.4	0.48	1.0	7.7	0.51	1.1	10.4	0.55	1.2	14.1	0.58	1.2	17.9	0.61	1.3	22.3	0.93	2.0	57.7	0.73	1.5	42.6
5.0%	0.37	0.8	1.8	0.39	0.8	3.0	0.42	0.9	4.7	0.45	0.9	6.7	0.48	1.0	9.2	0.51	1.1	12.1	0.53	1.1	15.0	0.57	1.2	19.5	1.05	2.2	73.5	0.66	1.4	34.8
7.0%	0.32	0.7	1.4	0.35	0.7	2.4	0.37	0.8	3.7	0.39	0.8	5.1	0.41	0.9	6.7	0.43	0.9	8.6	0.46	1.0	11.3	0.48	1.0	13.8	0.93	2.0	57.7	0.56	1.2	25.1
10.0%	0.28	0.6	1.0	0.31	0.7	1.9	0.32	0.7	2.7	0.35	0.7	4.1	0.36	0.8	5.2	0.38	0.8	6.7	0.40	0.8	8.5	0.42	0.9	10.6	1.05	2.2	73.5	0.48	1.0	18.4

NOTE: @ 0.5% and 0.5 FPS, R = 0.73, d = 1.5, and Q = 3.6 CFS

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

Table D
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	1.3	4.8	0.73	1.5	10.7	0.86	1.8	19.7	1.00	2.1	33.3	1.15	2.4	52.9	1.33	2.8	82.5	1.51	3.2	122	1.70	3.6	173	1.95	4.1	254	2.40	5.1	461
1.0%	0.44	0.9	2.6	0.53	1.1	5.6	0.62	1.3	10.3	0.70	1.5	16.3	0.79	1.7	25.0	0.90	1.9	37.8	1.00	2.1	53.3	1.10	2.3	72.6	1.23	2.6	100	1.50	3.2	180
1.5%	0.36	0.8	1.8	0.43	0.9	3.7	0.50	1.1	6.7	0.56	1.2	10.5	0.64	1.3	16.4	0.70	1.5	22.9	0.79	1.7	33.3	0.86	1.8	44.4	0.95	2.0	60.2	1.10	2.3	96.8
2.0%	0.33	0.7	1.5	0.39	0.8	3.0	0.45	0.9	5.4	0.51	1.1	8.7	0.57	1.2	13.0	0.62	1.3	17.9	0.69	1.5	25.4	0.76	1.6	34.7	0.84	1.8	47.0	1.00	2.1	80.0
2.5%	0.29	0.6	1.1	0.34	0.7	2.3	0.39	0.8	4.1	0.44	0.9	6.5	0.58	1.2	13.5	0.54	1.1	13.6	0.60	1.3	19.2	0.65	1.4	25.3	0.71	1.5	33.6	0.85	1.8	57.8
3.0%	0.28	0.6	1.0	0.33	0.7	2.1	0.37	0.8	3.7	0.42	0.9	5.9	0.46	1.0	8.5	0.51	1.1	12.1	0.56	1.2	16.7	0.60	1.3	21.6	0.67	1.4	29.9	0.78	1.6	48.7
3.5%	0.25	0.5	0.8	0.29	0.6	1.7	0.33	0.7	2.9	0.38	0.8	4.7	0.41	0.9	6.7	0.45	0.9	9.5	0.50	1.1	13.3	0.54	1.1	17.5	0.58	1.2	22.4	0.67	1.4	35.9
4.0%	0.24	0.5	0.8	0.28	0.6	1.6	0.32	0.7	2.6	0.35	0.7	4.1	0.39	0.8	6.1	0.43	0.9	8.6	0.47	1.0	11.8	0.51	1.1	15.6	0.55	1.2	20.2	0.63	1.3	31.8
5.0%	0.22	0.5	0.7	0.26	0.5	1.4	0.30	0.6	2.4	0.33	0.7	3.6	0.36	0.8	5.2	0.40	0.8	7.3	0.43	0.9	9.9	0.47	1.0	13.3	0.51	1.1	17.3	0.59	1.2	27.8
7.0%				0.23	0.5	1.1	0.26	0.5	1.8	0.28	0.6	2.6	0.31	0.7	3.8	0.34	0.7	5.4	0.37	0.8	7.3	0.39	0.8	9.1	0.42	0.9	11.8	0.48	1.0	18.4
10.0%							0.24	0.5	1.5	0.24	0.5	1.9	0.26	0.5	2.7	0.28	0.6	3.7	0.31	0.7	5.1	0.33	0.7	6.3	0.35	0.7	8.2	0.40	0.8	12.8

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

```
                     TR-55 GRAPHICAL DISCHARGE METHOD               VERSION 1.11
Project : COLESVILLE LANDFILL                         User: KPH     Date: 01-14-93
County  : BROOME                State: NY         Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-1-1

  Data: Drainage Area        :  1.3 * Acres
        Runoff Curve Number  :  80 *
        Time of Concentration:  0.46 * Hours
        Rainfall Type        :  II
        Pond and Swamp Area  :  NONE

=====================================================================
 | Storm Number           |   1   |   2   |   3   |   4   |   5   |   6   |
 |----------------------- | ------ | ------ | ------ | ------ | ------ | ------ |
 | Frequency  (yrs)       |   2   |   5   |  10   |  25   |  50   |  100  |
 |                        |       |       |       |       |       |       |
 | 24-Hr Rainfall (in)    |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
 |                        |       |       |       |       |       |       |
 | Ia/P Ratio             | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
 |                        |       |       |       |       |       |       |
 |           Used         | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
 |                        |       |       |       |       |       |       |
 | Runoff (in)            | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
 |                        |       |       |       |       |       |       |
 | Unit Peak Discharge    | 0.806 | 0.832 | 0.851 | 0.861 | 0.863 | 0.863 |
 |    (cfs/acre/in)       |       |       |       |       |       |       |
 |                        |       |       |       |       |       |       |
 | Pond and Swamp Factor  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
 |    0.0% Ponds Used     |       |       |       |       |       |       |
 |----------------------- | ------ | ------ | ------ | ------ | ------ | ------ |
 | Peak Discharge (cfs)   |     1 |     2 |     3 |     3 |     4 |     4 |
=====================================================================

* - Value(s) provided from TR-55 system routines
```

```
                 TR-55 Tc and Tt THRU SUBAREA COMPUTATION          VERSION 1.11
Project : COLESVILLE LANDFILL                     User: KPH        Date: 01-14-93
County  : BROOME                 State: NY    Checked:             Date: 1/22/93
Subtitle: CHANNEL DC-1-1

--------------------------------------------------------------------------------
Flow Type     2 year   Length   Slope  Surface   n    Area     Wp   Velocity  Time
               rain     (ft)   (ft/ft)  code         (sq/ft)  (ft)  (ft/sec)  (hr)
--------------------------------------------------------------------------------
Sheet          2.8      190     .01      E                                   0.364
Open Channel            400                                          1.2     0.093
                                                   Time of Concentration = 0.46*
                                                                           =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface             F Grass, Dense      --- Shallow Concentrated ---
    B Fallow (No Res.)           G Grass, Burmuda    ---      Surface Codes    ---
    C Cultivated < 20 % Res.     H Woods, Light               P Paved
    D Cultivated > 20 % Res.     I Woods, Dense               U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION            VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH     Date: 01-14-93
County  : BROOME              State: NY       Checked:         Date: 1/22/93
Subtitle: CHANNEL DC-1-1

-------------------------------------------------------------------------------
                                                    Hydrologic Soil Group
         COVER DESCRIPTION                      A        B        C        D
                                                        Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%             -        -        -    1.3(80)


Total Area (by Hydrologic Soil Group)                                  1.3
                                                                      ====

-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 1.3 Acres       WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By KAH Date 4/19/94

Chkd. by ______ Date ______

Subject Colesville Drainage Design

WehranEnviroTech

Job No. 02260 CS

Sheet No. ______ of ______

CHANNEL DC-1A

CHANNEL DC-1A WAS DESIGNED TO CONVEY WATER THROUGH THE CHANGE IN SLOPE CAUSED BY FINAL COVER CONSTRUCTION. CHANNEL DC-1A IS AN upgraded end SECTION FOR THE orginally DESIGNED channel DC-1-1. SINCE THE CHANNEL DC-1A HAS THE EXACT TRIBUTARY AREA OF CHANNEL DC-1-1 THE TR-55 INFORMATION (i.e. FLOW=3CFS) WAS UTILIZED FOR THE DESIGN.

By AJK DATE 4/18/94
CHK KPH DATE 4/19/94

```
DIVERSION CHANNEL DESIGN - RIP-RAP LINING                  JOB NO.    02260 CS

COLESVILLE LANDFILL
CHANNEL DC-1A


|------------------------- INPUT -   ---------------------------|
|                                                                |
| DESIGN PEAK DISCHARGE, Q (CFS) ....    ..........................   3.0 |
| CHANNEL SLOPE, S (FT/FT) ..  ....................................  0.136 |
| CHANNEL SIDESLOPE - LEFT SIDE (HORIZ/VERT) ...     ...............   3.0 |
| CHANNEL SIDESLOPE - RIGHT SIDE (HORIZ/VERT) ...    ...............   3.0 |
| CHANNEL BOTTOM WIDTH, B (FT)  ...................................   0.0 |
| MANNING'S ROUGHNESS COEFFICIENT, n ..  ..........................  0.040 |
| FREEBOARD (FT) .   ..............................................   0.5 |
|                                                                |
| BEGIN CALCULATIONS AT CHANNEL DEPTH (FT) .....     ...............   0.0 |
|                                                                |
|----------------------------------------------------------------|


 CHANNEL   X-SECT       TOP   HYDRAULIC                         FROUDE
   DEPTH      AREA    WIDTH    RADIUS  DISCHARGE  VELOCITY  NUMBER
    (FT)  (SQ FT)      (FT)      (FT)      (CFS)     (FPS)      Nf
=====================================================================

     0.0       0.0      0.0      0.00        0.0       0.0     0.00
     0.1       0.0      0.6      0.05        0.1       1.8     1.42
     0.2       0.1      1.2      0.09        0.3       2.9     1.59
     0.3       0.3      1.8      0.14        1.0       3.7     1.70
     0.4       0.5      2.4      0.19        2.2       4.5     1.79
     0.5       0.8      3.0      0.24        3.9       5.3     1.85
     0.6       1.1      3.6      0.28        6.4       5.9     1.91
     0.7       1.5      4.2      0.33        9.7       6.6     1.96
     0.8       1.9      4.8      0.38       13.8       7.2     2.01
     0.9       2.4      5.4      0.43       18.9       7.8     2.05
     1.0       3.0      6.0      0.47       25.1       8.4     2.08


        DESIGN DEPTH OF FLOW, D (FT) .      ............      0.5
        VELOCITY, V (FPS) .     ........................      5.3
        TOTAL DEPTH INCLUDING FREEBOARD (FT) ..               1.0
        RIP-RAP SIZE, d50 (IN) ....         ............      4.0
```

By: Date: 1/22/93

Chk: KDH Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-1-2

Peak Flow, Q = 5.0 cFS

Ave. Slope, s = 3.5 %

Select Basic Channel Geometry

Triangular, bottom width = 0 ft

or

[✓ Trapazoidal, bottom width = 3]

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3 FPS

Max. Velocity for Jute Lining = NA

Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 2.5 FPS

Therefore use: [✓ Grass], Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

- For Max. Velocity using Table D

Q = 5.9 at V = 2.5 and d = 0.5

- For Max. Capacity using Table C

Q = 6.9 at V = 2.0 and d = 0.7

Therefore set Total Depth = ~~1.0~~ inc. Freeboard and Settlement

1.5

Table D

GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 3

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	0.9	5.3	0.73	1.2	11.4	0.86	1.4	20.6	1.00	1.7	34.3	1.15	2.0	54.0	1.33	2.4	83.6	1.51	2.7	123	1.70	3.1	174	1.95	3.6	254	2.40	4.6	461
1.0%	0.44	0.6	3.1	0.53	0.8	6.4	0.62	1.0	11.2	0.70	1.1	17.5	0.79	1.3	26.3	0.90	1.5	39.3	1.00	1.7	54.9	1.10	1.9	74.3	1.23	2.2	102	1.50	2.7	182
1.5%	0.36	0.5	2.2	0.43	0.6	4.4	0.50	0.7	7.6	0.56	0.8	11.7	0.64	1.0	17.8	0.70	1.1	24.5	0.79	1.3	35.1	0.86	1.4	46.3	0.95	1.6	62.2	1.10	1.9	99.0
2.0%	0.33	0.4	1.9	0.39	0.5	3.8	0.45	0.6	6.4	0.51	0.8	9.9	0.57	0.9	14.5	0.62	1.0	19.6	0.69	1.1	27.3	0.76	1.2	36.7	0.84	1.4	49.2	1.00	1.7	82.4
2.5%	0.29	0.4	1.6	0.34	0.5	3.0	0.39	0.5	5.0	0.44	0.6	7.7	0.58	0.9	14.9	0.54	0.8	15.3	0.60	0.9	21.1	0.65	1.0	27.5	0.71	1.1	36.0	0.85	1.4	60.4
3.0%	0.28	0.4	1.5	0.33	0.4	2.8	0.37	0.5	4.6	0.42	0.6	7.1	0.46	0.7	9.9	0.51	0.8	13.9	0.56	0.8	18.7	0.60	0.9	23.8	0.67	1.1	32.3	0.78	1.3	51.4
3.5%	0.25	0.3	1.3	0.29	0.4	2.3	0.33	0.4	3.8	0.38	0.5	5.9	0.41	0.6	8.2	0.45	0.6	11.2	0.50	0.7	15.3	0.54	0.8	19.7	0.58	0.9	24.9	0.67	1.1	38.8
4.0%	0.24	0.3	1.2	0.28	0.4	2.2	0.32	0.4	3.6	0.35	0.5	5.3	0.39	0.5	7.5	0.43	0.6	10.3	0.47	0.7	13.7	0.51	0.8	17.8	0.55	0.8	22.6	0.63	1.0	34.6
5.0%	0.22	0.3	1.1	0.26	0.3	2.0	0.30	0.4	3.3	0.33	0.4	4.8	0.36	0.5	6.6	0.40	0.6	9.0	0.43	0.6	11.8	0.47	0.7	15.5	0.51	0.8	19.8	0.59	0.9	30.8
7.0%				0.23	0.3	1.7	0.26	0.3	2.7	0.28	0.4	3.7	0.31	0.4	5.2	0.34	0.5	7.0	0.37	0.5	9.2	0.39	0.5	11.3	0.42	0.6	14.2	0.48	0.7	21.4
10.0%							0.24	0.5	1.5	0.24	0.3	2.9	0.26	0.3	4.0	0.28	0.4	5.2	0.31	0.4	6.9	0.33	0.4	8.4	0.35	0.5	10.5	0.40	0.6	15.7

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

Table C

GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 3

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.4	10.1	0.95	1.6	18.7	1.05	1.8	30.2	1.18	2.1	47.3	1.35	2.4	73.8	1.50	2.7	****	1.65	3.0	146	1.82	3.4	199	2.05	3.9	281	2.50	4.8	500
1.0%	0.76	1.2	8.2	0.72	1.1	11.1	0.79	1.3	17.5	0.86	1.4	25.7	0.94	1.6	36.6	1.05	1.8	52.8	1.12	1.9	68.4	1.25	2.2	95.2	1.35	2.4	123	1.62	3.0	211
1.5%	0.53	0.8	4.2	0.59	0.9	7.7	0.65	1.0	12.2	0.71	1.1	18.0	0.77	1.2	25.1	0.84	1.4	34.5	0.91	1.5	45.9	0.98	1.7	59.5	1.05	1.8	75.4	1.22	2.1	****
2.0%	0.50	0.7	3.8	0.56	0.8	7.0	0.60	0.9	10.6	0.65	1.0	15.3	0.70	1.1	21.0	0.76	1.2	28.6	0.82	1.3	37.6	0.88	1.5	48.4	0.93	1.6	59.8	1.10	1.8	98.6
2.5%	0.46	0.7	3.3	0.50	0.7	5.7	0.54	0.8	8.8	0.58	0.9	12.4	0.62	1.0	16.8	0.67	1.1	22.6	0.72	1.1	29.5	0.77	1.2	37.6	1.05	1.8	75.4	0.93	1.6	71.7
3.0%	0.44	0.6	3.1	0.48	0.7	5.3	0.52	0.8	8.2	0.56	0.8	11.7	0.59	0.9	15.4	0.64	1.0	20.8	0.67	1.1	25.8	0.71	1.1	32.4	0.93	1.6	59.8	0.86	1.4	61.8
3.5%	0.40	0.6	2.6	0.44	0.6	4.6	0.47	0.7	6.9	0.50	0.7	9.6	0.53	0.8	12.7	0.58	0.9	17.4	0.61	0.9	21.8	0.65	1.0	27.5	1.05	1.8	75.4	0.77	1.2	50.2
4.0%	0.38	0.5	2.4	0.42	0.6	4.3	0.45	0.6	6.4	0.48	0.7	8.9	0.51	0.8	11.9	0.55	0.8	15.8	0.58	0.9	19.9	0.61	0.9	24.5	0.93	1.6	59.8	0.73	1.2	45.4
5.0%	0.37	0.5	2.3	0.39	0.5	3.8	0.42	0.6	5.7	0.45	0.6	8.0	0.48	0.7	10.7	0.51	0.8	13.9	0.53	0.8	16.9	0.57	0.9	21.7	1.05	1.8	75.4	0.66	1.0	37.7
7.0%	0.32	0.4	1.8	0.35	0.5	3.2	0.37	0.5	4.6	0.39	0.5	6.3	0.41	0.6	8.2	0.43	0.6	10.3	0.46	0.7	13.2	0.48	0.7	16.0	0.93	1.6	59.8	0.56	0.8	28.0
10.0%	0.28	0.4	1.5	0.31	0.4	2.6	0.32	0.7	2.7	0.35	0.5	5.3	0.36	0.5	6.6	0.38	0.5	8.4	0.40	0.6	10.5	0.42	0.6	12.8	1.05	1.8	75.4	0.48	0.7	21.4

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

```
                    TR-55 GRAPHICAL DISCHARGE METHOD                    VERSION 1.11
Project : COLESVILLE LANDFILL                         User: KPH        Date: 01-14-93
County  : BROOME                    State: NY      Checked:            Date: 1/22/93
Subtitle: CHANNEL DC-1-2

  Data: Drainage Area          :  2.3 * Acres
        Runoff Curve Number    :  80 *
        Time of Concentration:  0.48 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

=================================================================
| Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
------------------------------------------------------------------
| Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
|                       |       |       |       |       |       |       |
| 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.5  |  5.3  |  5.9  |
|                       |       |       |       |       |       |       |
| Ia/P Ratio            | 0.18  | 0.14  | 0.12  | 0.11  | 0.09  | 0.08  |
|                       |       |       |       |       |       |       |
|            Used       | 0.18  | 0.14  | 0.12  | 0.11  | 0.10  | 0.10  |
|                       |       |       |       |       |       |       |
| Runoff (in)           | 1.10  | 1.64  | 2.29  | 2.46  | 3.16  | 3.69  |
|                       |       |       |       |       |       |       |
| Unit Peak Discharge   | 0.788 | 0.814 | 0.833 | 0.836 | 0.844 | 0.844 |
|    (cfs/acre/in)      |       |       |       |       |       |       |
|                       |       |       |       |       |       |       |
| Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used    |       |       |       |       |       |       |
------------------------------------------------------------------
| Peak Discharge (cfs)  |     2 |     3 |     4 |     5 |     6 |     7 |
=================================================================

* - Value(s) provided from TR-55 system routines
```

```
                   TR-55 Tc and Tt THRU SUBAREA COMPUTATION          VERSION 1.11
Project : COLESVILLE LANDFILL                      User: KPH       Date: 01-14-93
County  : BROOME                  State: NY     Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-1-2

---------------------------------------------------------------------------------
Flow Type    2 year   Length   Slope  Surface   n    Area     Wp   Velocity  Time
              rain     (ft)   (ft/ft)   code        (sq/ft)  (ft)  (ft/sec)  (hr)
---------------------------------------------------------------------------------
Sheet         2.8      190     .01       E                                  0.364
Open Channel           270                                           3.0    0.025
Open Channel           400                                           1.2    0.093
                                                  Time of Concentration = 0.48*
                                                                           =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface            F Grass, Dense      --- Shallow Concentrated ---
    B Fallow (No Res.)          G Grass, Burmuda    ---     Surface Codes    ---
    C Cultivated < 20 % Res.    H Woods, Light              P Paved
    D Cultivated > 20 % Res.    I Woods, Dense              U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION              VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH        Date: 01-14-93
County  : BROOME             State: NY        Checked:            Date: 1/22/93
Subtitle: CHANNEL DC-1-2

-------------------------------------------------------------------------------
                                                     Hydrologic Soil Group
         COVER DESCRIPTION                        A         B         C         D
                                                          Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%               -         -         -    2.3(80)


Total Area (by Hydrologic Soil Group)                                      2.3
                                                                          ====

-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 2.3 Acres      WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By Date 1/22/93 Chkd. KPH Date 1-22-93

```
DIVERSION CHANNEL DESIGN - RIP-RAP LINING          JOB NO.   02260 CS

COLESVILLE LANDFILL
CHANNEL DC-1-3

|----------------------------- INPUT --------------------------------|
|                                                                    |
| DESIGN PEAK DISCHARGE, Q (CFS) . . . . . . . . . . . . .     28.0  |
| CHANNEL SLOPE, S (FT/FT)  . . . . . . . . . . . . . . .     0.051  |
| CHANNEL SIDESLOPE - LEFT SIDE (HORIZ/VERT)  . . . . . . .     3.0  |
| CHANNEL SIDESLOPE - RIGHT SIDE (HORIZ/VERT) . . . . . . .     3.0  |
| CHANNEL BOTTOM WIDTH, B (FT). . . . . . . . . . . . . . .     6.0  |
| MANNING'S ROUGHNESS COEFFICIENT, n  . . . . . . . . . . .   0.035  |
| FREEBOARD (FT)  . . . . . . . . . . . . . . . . . . . . .     0.5  |
|                                                                    |
| BEGIN CALCULATIONS AT CHANNEL DEPTH (FT)  . . . . . . . .     0.5  |
|                                                                    |
|--------------------------------------------------------------------|


  CHANNEL    X-SECT     TOP    HYDRAULIC                        FROUDE
   DEPTH      AREA     WIDTH     RADIUS   DISCHARGE  VELOCITY   NUMBER
    (FT)    (SQ FT)     (FT)      (FT)      (CFS)      (FPS)      Nf
======================================================================

     0.5       3.8       9.0      0.41       19.9       5.3      1.45
     0.6       4.7       9.6      0.48       27.5       5.9      1.48
     0.7       5.7      10.2      0.54       36.3       6.4      1.51
     0.8       6.7      10.8      0.61       46.3       6.9      1.54
     0.9       7.8      11.4      0.67       57.6       7.4      1.56
     1.0       9.0      12.0      0.73       70.2       7.8      1.59
     1.1      10.2      12.6      0.79       84.0       8.2      1.61
     1.2      11.5      13.2      0.85       99.2       8.6      1.62
     1.3      12.9      13.8      0.90      115.8       9.0      1.64
     1.4      14.3      14.4      0.96      133.7       9.4      1.66
     1.5      15.8      15.0      1.02      153.1       9.7      1.67


          DESIGN DEPTH OF FLOW, D (FT) . . . . . .         0.7
          VELOCITY, V (FPS)  . . . . . . . . . . .         6.4
          TOTAL DEPTH INCLUDING FREEBOARD (FT) . .         1.2
          RIP-RAP SIZE, d50 (IN) . . . . . . . . .         6.0
```

```
Project : COLESVILLE LANDFILL                       User: KPH      Date: 01-14-93
County  : BROOME                State: NY        Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-1-3

   Data: Drainage Area          :  13.1 * Acres
         Runoff Curve Number    :  80 *
         Time of Concentration:    0.58 * Hours
         Rainfall Type          :  II
         Pond and Swamp Area    :  NONE

====================================================================
| Storm Number           |   1   |   2   |   3   |   4   |   5   |   6   |
| ---------------------- | ------ | ------ | ------ | ------ | ------ | ------ |
| Frequency  (yrs)       |   2   |   5   |   10  |   25  |   50  |  100  |
|                        |       |       |       |       |       |       |
| 24-Hr Rainfall (in)    |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                        |       |       |       |       |       |       |
| Ia/P Ratio             |  0.18 |  0.14 |  0.12 |  0.10 |  0.09 |  0.08 |
|                        |       |       |       |       |       |       |
|           Used         |  0.18 |  0.14 |  0.12 |  0.10 |  0.10 |  0.10 |
|                        |       |       |       |       |       |       |
| Runoff (in)            |  1.10 |  1.64 |  2.29 |  2.81 |  3.16 |  3.69 |
|                        |       |       |       |       |       |       |
| Unit Peak Discharge    | 0.712 | 0.736 | 0.754 | 0.763 | 0.765 | 0.765 |
|    (cfs/acre/in)       |       |       |       |       |       |       |
|                        |       |       |       |       |       |       |
| Pond and Swamp Factor  |  1.00 |  1.00 |  1.00 |  1.00 |  1.00 |  1.00 |
|    0.0% Ponds Used     |       |       |       |       |       |       |
| ---------------------- | ------ | ------ | ------ | ------ | ------ | ------ |
| Peak Discharge (cfs)   |   10  |   16  |   23  |   28  |   32  |   37  |
====================================================================

* - Value(s) provided from TR-55 system routines
```

```
Project : COLESVILLE LANDFILL                        User: KPH       Date: 01-14-93
County  : BROOME                  State: NY       Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-1-3

--------------------------------------------------------------------------------
Flow Type     2 year   Length   Slope   Surface   n   Area    Wp   Velocity  Time
              rain      (ft)   (ft/ft)   code       (sq/ft)  (ft)  (ft/sec)  (hr)
--------------------------------------------------------------------------------
Sheet          2.8      300     .040      E                                0.302
Open Channel            1470                                        1.47   0.278
                                                   Time of Concentration = 0.58*
                                                                           =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface          F Grass, Dense      --- Shallow Concentrated ---
    B Fallow (No Res.)        G Grass, Burmuda    ---     Surface Codes    ---
    C Cultivated < 20 % Res.  H Woods, Light             P Paved
    D Cultivated > 20 % Res.  I Woods, Dense             U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

TRAVEL TIME WORKSHEET
OPEN CHANNEL FLOW SEGMENTS
FOR USE IN DETERMINATION OF TIME OF CONCENTRATION

COLESVILLE LANDFILL
CHANNEL TIME OF CONCENTRATION
DC-4 SEGMENTS

FLOW SEGMENT I.D.	FLOW SEGMENT DESCRIPTION	FLOW SEGMENT LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	TIME (HR)
1	DC-4-1	200	3.000	3.00	0.019
2	DC-4-2	1,050	0.050	1.20	0.243
3	DC-1-3	220	6.100	4.00	0.015
4					0.000
5					0.000
6					0.000
	TOTALS =	1,470			0.277

AVERAGE VELOCITY 1.47 FPS

This worksheet is used to determine the the average velocity of flow in a series of open channel flow segments. This is required when the time of concentration or travel time flow path contains more than two segments, which is the maximum accepted by the SCS TR-55 method. The average velocity is determined using a weighted average based upon the velocity in each flow segment and the travel time for each segment.

```
Project : COLESVILLE LANDFILL                  User: KPH      Date: 01-14-93
County  : BROOME                State: NY   Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-1-3

-------------------------------------------------------------------------------
                                                 Hydrologic Soil Group
         COVER DESCRIPTION                     A        B        C        D
                                                    Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%             -        -        -   13.1(80)


Total Area (by Hydrologic Soil Group)                                 13.1
                                                                      ====

-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 13.1 Acres     WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By: Date: 1/22/93

Chk: KPH Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-2

Peak Flow, Q = 26

Ave. Slope, s = 0.5%

Select Basic Channel Geometry

[✓ Triangular, bottom width = 0 ft]

or

Trapazoidal, bottom width = ____

Channel Side Slope (z:1), Z = 3

[UPHILL SLOPE WILL BE THE SLOPE OF FINAL COVER, APPROX. 14:1, THEREFORE THIS CALC WILL BE CONSERVATIVE FOR BOTH MAX. DEPTH & MAX VELOCITY]

Determine Required Lining

Max. Velocity for Grass Only = 3 fps

Max. Velocity for Jute Lining = NA

Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 2.5 fps

Therefore use: [✓ Grass], Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

– For Max. Velocity using Table D

Q = 33.3 at V = 2.5 and d = 2.1

– For Max. Capacity using Table C

Q = 29.4 at V = 2.0 and d = 2.2

Therefore set Total Depth = 2.5 inc. Freeboard and Settlement

Table C

GRASS LINED CHANNEL/DIVERSION WORKSHHET

PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.8	9.6	0.95	2.0	18.0	1.05	2.2	29.4	1.18	2.5	46.4	1.35	2.8	72.9	1.50	3.2	****	1.65	3.5	145	1.82	3.8	199	2.05	4.3	280	2.50	5.3	500
1.0%	0.76	1.6	7.7	0.72	1.5	10.4	0.79	1.7	16.6	0.86	1.8	24.7	0.94	2.0	35.3	1.05	2.2	51.5	1.12	2.4	66.9	1.25	2.6	93.8	1.35	2.8	122	1.62	3.4	210
1.5%	0.53	1.1	3.7	0.59	1.2	7.0	0.65	1.4	11.3	0.71	1.5	16.8	0.77	1.6	23.7	0.84	1.8	32.9	0.91	1.9	44.2	0.98	2.1	57.6	1.05	2.2	73.5	1.22	2.6	****
2.0%	0.50	1.1	3.3	0.56	1.2	6.3	0.60	1.3	9.6	0.65	1.4	14.1	0.70	1.5	19.6	0.76	1.6	27.0	0.82	1.7	35.9	0.88	1.9	46.5	0.93	2.0	57.7	1.10	2.3	96.8
2.5%	0.46	1.0	2.8	0.56	1.1	5.6	0.54	1.1	7.6	0.58	1.2	11.2	0.62	1.3	15.4	0.67	1.4	20.9	0.72	1.5	27.6	0.77	1.6	35.6	1.05	2.2	73.5	0.93	2.0	69.2
3.0%	0.44	0.9	2.6	0.48	1.0	4.6	0.52	1.1	7.2	0.56	1.2	10.5	0.59	1.2	13.9	0.64	1.3	19.1	0.67	1.4	23.9	0.71	1.5	30.2	0.93	2.0	57.7	0.86	1.8	59.2
3.5%	0.40	0.8	2.1	0.44	0.9	3.9	0.47	1.0	5.9	0.50	1.1	8.3	0.53	1.1	11.2	0.58	1.2	15.7	0.61	1.3	19.8	0.65	1.4	25.3	1.05	2.2	73.5	0.77	1.6	47.4
4.0%	0.38	0.8	1.9	0.42	0.9	3.5	0.45	0.9	5.4	0.48	1.0	7.7	0.51	1.1	10.4	0.55	1.2	14.1	0.58	1.2	17.9	0.61	1.3	22.3	0.93	2.0	57.7	0.73	1.5	42.6
5.0%	0.37	0.6	1.6	0.39	0.8	3.0	0.42	0.9	4.7	0.45	0.9	6.7	0.48	1.0	9.2	0.51	1.1	12.1	0.53	1.1	15.0	0.57	1.2	19.5	1.05	2.2	73.5	0.66	1.4	34.8
7.0%	0.32	0.7	1.4	0.35	0.7	2.4	0.37	0.8	3.7	0.39	0.8	5.1	0.41	0.9	6.7	0.43	0.9	8.6	0.46	1.0	11.3	0.48	1.0	13.8	0.93	2.0	57.7	0.56	1.2	25.1
10.0%	0.28	0.6	1.0	0.31	0.7	1.9	0.32	0.7	2.7	0.35	0.7	4.1	0.36	0.8	5.2	0.38	0.8	6.7	0.40	0.8	8.5	0.42	0.9	10.6	1.05	2.2	73.5	0.48	1.0	18.4

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

Table D
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	1.3	4.8	0.73	1.5	10.7	0.86	1.8	19.7	1.00	2.1	33.3	1.15	2.4	52.9	1.33	2.8	82.5	1.51	3.2	122	1.70	3.6	173	1.95	4.1	254	2.40	5.1	461
1.0%	0.44	0.9	2.6	0.53	1.1	5.6	0.62	1.3	10.3	0.70	1.5	16.3	0.79	1.7	25.0	0.90	1.9	37.8	1.00	2.1	53.3	1.10	2.3	72.6	1.23	2.6	100	1.50	3.2	180
1.5%	0.36	0.8	1.8	0.43	0.9	3.7	0.50	1.1	6.7	0.56	1.2	10.5	0.64	1.3	16.4	0.70	1.5	22.9	0.79	1.7	33.3	0.86	1.8	44.4	0.95	2.0	60.2	1.10	2.3	96.8
2.0%	0.33	0.7	1.5	0.39	0.8	3.0	0.45	0.9	5.4	0.51	1.1	8.7	0.57	1.2	13.0	0.62	1.3	17.9	0.69	1.5	25.4	0.76	1.6	34.7	0.84	1.8	47.0	1.00	2.1	80.0
2.5%	0.29	0.6	1.1	0.34	0.7	2.3	0.39	0.8	4.1	0.44	0.9	6.5	0.58	1.2	13.5	0.54	1.1	13.6	0.60	1.3	19.2	0.65	1.4	25.3	0.71	1.5	33.6	0.85	1.8	57.8
3.0%	0.28	0.6	1.0	0.33	0.7	2.1	0.37	0.8	3.7	0.42	0.9	5.9	0.46	1.0	8.5	0.51	1.1	12.1	0.56	1.2	16.7	0.60	1.3	21.6	0.67	1.4	29.9	0.78	1.6	48.7
3.5%	0.25	0.5	0.8	0.29	0.6	1.7	0.33	0.7	2.9	0.38	0.8	4.7	0.41	0.9	6.7	0.45	0.9	9.5	0.50	1.1	13.3	0.54	1.1	17.5	0.58	1.2	22.4	0.67	1.4	35.9
4.0%	0.24	0.5	0.8	0.28	0.6	1.6	0.32	0.7	2.6	0.35	0.7	4.1	0.39	0.8	6.1	0.43	0.9	8.6	0.47	1.0	11.8	0.51	1.1	15.6	0.55	1.2	20.2	0.63	1.3	31.8
5.0%	0.22	0.5	0.7	0.26	0.5	1.4	0.30	0.6	2.4	0.33	0.7	3.6	0.36	0.8	5.2	0.40	0.8	7.3	0.43	0.9	9.9	0.47	1.0	13.3	0.51	1.1	17.3	0.59	1.2	27.8
7.0%				0.23	0.5	1.1	0.26	0.5	1.8	0.28	0.6	2.6	0.31	0.7	3.8	0.34	0.7	5.4	0.37	0.8	7.3	0.39	0.8	9.1	0.42	0.9	11.8	0.48	1.0	18.4
10.0%							0.24	0.5	1.5	0.24	0.5	1.9	0.26	0.5	2.7	0.28	0.6	3.7	0.31	0.7	5.1	0.33	0.7	6.3	0.35	0.7	8.2	0.40	0.8	12.8

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

By: Date: 1/24/93

Chk: KPN Date: 1-26-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-2A

Peak Flow, Q = 26 CFS

Ave. Slope, s = 0.5 %

Select Basic Channel Geometry

Triangular, bottom width = 0 ft

or

[✓ Trapazoidal, bottom width = 3]

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3 fps

Max. Velocity for Jute Lining = NA

Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity = ≤ 2.5 fps

Therefore use: Grass, Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

- For Max. Velocity using Table D

Q = 34.3 at V = 2.5 and d = 1.7

- For Max. Capacity using Table C

Q = 30.2 at V = 2.0 and d = 1.8

Therefore set Total Depth = 2.5 inc. Freeboard and Settlement

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 3

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.4	10.1	0.95	1.6	18.7	1.05	1.8	30.2	1.18	2.1	47.3	1.35	2.4	73.8	1.50	2.7	****	1.65	3.0	146	1.82	3.4	199	2.05	3.9	281	2.50	4.8	500
1.0%	0.76	1.2	8.2	0.72	1.1	11.1	0.79	1.3	17.5	0.86	1.4	25.7	0.94	1.6	36.6	1.05	1.8	52.8	1.12	1.9	68.4	1.25	2.2	95.2	1.35	2.4	123	1.62	3.0	211
1.5%	0.53	0.8	4.2	0.59	0.9	7.7	0.65	1.0	12.2	0.71	1.1	18.0	0.77	1.2	25.1	0.84	1.4	34.5	0.91	1.5	45.9	0.98	1.7	59.5	1.05	1.8	75.4	1.22	2.1	****
2.0%	0.50	0.7	3.8	0.56	0.8	7.0	0.60	0.9	10.6	0.65	1.0	15.3	0.70	1.1	21.0	0.76	1.2	28.6	0.82	1.3	37.6	0.88	1.5	48.4	0.93	1.6	59.8	1.10	1.9	99.0
2.5%	0.46	0.7	3.3	0.50	0.7	5.7	0.54	0.8	8.8	0.58	0.9	12.4	0.62	1.0	16.8	0.67	1.1	22.6	0.72	1.1	29.5	0.77	1.2	37.6	1.05	1.8	75.4	0.93	1.6	71.7
3.0%	0.44	0.6	3.1	0.48	0.7	5.3	0.52	0.8	8.2	0.56	0.8	11.7	0.59	0.9	15.4	0.64	1.0	20.8	0.67	1.1	25.8	0.71	1.1	32.4	0.93	1.6	59.8	0.86	1.4	61.8
3.5%	0.40	0.6	2.6	0.44	0.6	4.6	0.47	0.7	6.9	0.50	0.7	9.6	0.53	0.8	12.7	0.58	0.9	17.4	0.61	0.9	21.8	0.65	1.0	27.5	1.05	1.8	75.4	0.77	1.2	50.2
4.0%	0.38	0.5	2.4	0.42	0.6	4.3	0.45	0.6	6.4	0.48	0.7	8.9	0.51	0.8	11.9	0.55	0.8	15.8	0.58	0.9	19.9	0.61	0.9	24.5	0.93	1.6	59.8	0.73	1.2	45.4
5.0%	0.37	0.5	2.3	0.39	0.5	3.8	0.42	0.6	5.7	0.45	0.6	8.0	0.48	0.7	10.7	0.51	0.8	13.9	0.53	0.8	16.9	0.57	0.9	21.7	1.05	1.8	75.4	0.66	1.0	37.7
7.0%	0.32	0.4	1.8	0.35	0.5	3.2	0.37	0.5	4.6	0.39	0.5	6.3	0.41	0.6	8.2	0.43	0.6	10.3	0.46	0.7	13.2	0.48	0.7	16.0	0.93	1.6	59.8	0.56	0.8	28.0
10.0%	0.28	0.4	1.5	0.31	0.4	2.6	0.32	0.7	2.7	0.35	0.5	5.3	0.36	0.5	6.6	0.38	0.5	8.4	0.40	0.6	10.5	0.42	0.6	12.8	1.05	1.8	75.4	0.48	0.7	21.4

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

Table D
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 3

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	0.9	5.3	0.73	1.2	11.4	0.86	1.4	20.6	1.00	1.7	34.3	1.15	2.0	54.0	1.33	2.4	83.6	1.51	2.7	123	1.70	3.1	174	1.95	3.6	254	2.40	4.6	461
1.0%	0.44	0.6	3.1	0.53	0.8	6.4	0.62	1.0	11.2	0.70	1.1	17.5	0.79	1.3	26.3	0.90	1.5	39.3	1.00	1.7	54.9	1.10	1.9	74.3	1.23	2.2	102	1.50	2.7	182
1.5%	0.36	0.5	2.2	0.43	0.6	4.4	0.50	0.7	7.6	0.56	0.8	11.7	0.64	1.0	17.8	0.70	1.1	24.5	0.79	1.3	35.1	0.86	1.4	46.3	0.95	1.6	62.2	1.10	1.9	99.0
2.0%	0.33	0.4	1.9	0.39	0.5	3.8	0.45	0.6	6.4	0.51	0.8	9.9	0.57	0.9	14.5	0.62	1.0	19.6	0.69	1.1	27.3	0.76	1.2	36.7	0.84	1.4	49.2	1.00	1.7	82.4
2.5%	0.29	0.4	1.6	0.34	0.5	3.0	0.39	0.5	5.0	0.44	0.6	7.7	0.58	0.9	14.9	0.54	0.8	15.3	0.60	0.9	21.1	0.65	1.0	27.5	0.71	1.1	36.0	0.85	1.4	60.4
3.0%	0.28	0.4	1.5	0.33	0.4	2.8	0.37	0.5	4.6	0.42	0.6	7.1	0.46	0.7	9.9	0.51	0.8	13.9	0.56	0.8	18.7	0.60	0.9	23.8	0.67	1.1	32.3	0.78	1.3	51.4
3.5%	0.25	0.3	1.3	0.29	0.4	2.3	0.33	0.4	3.8	0.38	0.5	5.9	0.41	0.6	8.2	0.45	0.6	11.2	0.50	0.7	15.3	0.54	0.8	19.7	0.58	0.9	24.9	0.67	1.1	38.8
4.0%	0.24	0.3	1.2	0.28	0.4	2.2	0.32	0.4	3.6	0.35	0.5	5.3	0.39	0.5	7.5	0.43	0.6	10.3	0.47	0.7	13.7	0.51	0.8	17.8	0.55	0.8	22.6	0.63	1.0	34.6
5.0%	0.22	0.3	1.1	0.26	0.3	2.0	0.30	0.4	3.3	0.33	0.4	4.8	0.36	0.5	6.6	0.40	0.6	9.0	0.43	0.6	11.8	0.47	0.7	15.5	0.51	0.8	19.8	0.59	0.9	30.8
7.0%				0.23	0.3	1.7	0.26	0.3	2.7	0.28	0.4	3.7	0.31	0.4	5.2	0.34	0.5	7.0	0.37	0.5	9.2	0.39	0.5	11.3	0.42	0.6	14.2	0.48	0.7	21.4
10.0%							0.24	0.5	1.5	0.24	0.3	2.9	0.26	0.3	4.0	0.28	0.4	5.2	0.31	0.4	6.9	0.33	0.4	8.4	0.35	0.5	10.5	0.40	0.6	15.7

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

By KOH Date 1-21-93 Chkd. Date 1/22/93

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DIVERSION CHANNEL DESIGN - GABION LINING          JOB NO.   00000 XX

COLESVILLE LANDFILL
CHANNEL DC-2 INLET CHANNEL

 |---------------------------- INPUT ---------------------------------|
 |                                                                    |
 |  DESIGN PEAK DISCHARGE, Q (CFS) . . . . . . . . . . . . . .    26.0 |
 |  CHANNEL SLOPE, S (FT/FT)  . . . . . . . . . . . . . . . . .  0.033 |
 |  CHANNEL SIDESLOPE - LEFT SIDE (HORIZ/VERT)  . . . . . . . .    3.0 |
 |  CHANNEL SIDESLOPE - RIGHT SIDE (HORIZ/VERT) . . . . . . . .    3.0 |
 |  CHANNEL BOTTOM WIDTH, B (FT). . . . . . . . . . . . . . . .    3.0 |
 |  MANNING'S ROUGHNESS COEFFICIENT, n  . . . . . . . . . . . .  0.025 |
 |  GABION MATTRESS THICKNESS, t (IN) (USE 6, 9, 12 OR 18)   .    6.0 |
 |  FREEBOARD (FT)  . . . . . . . . . . . . . . . . . . . . . .    0.5 |
 |                                                                    |
 |  BEGIN CALCULATIONS AT CHANNEL DEPTH (FT)  . . . . . . . . .    0.5 |
 |                                                                    |
 |--------------------------------------------------------------------|


   CHANNEL    X-SECT    TOP    HYDRAULIC                          FROUDE
    DEPTH      AREA    WIDTH     RADIUS   DISCHARGE   VELOCITY    NUMBER
    (FT)     (SQ FT)   (FT)      (FT)      (CFS)       (FPS)        Nf
=====================================================================

     0.5       2.3      6.0      0.37       12.4        5.5        1.59
     0.6       2.9      6.6      0.42       17.6        6.1        1.63
     0.7       3.6      7.2      0.48       23.7        6.6        1.66
     0.8       4.3      7.8      0.54       30.9        7.1        1.69
     0.9       5.1      8.4      0.59       39.1        7.6        1.72
     1.0       6.0      9.0      0.64       48.4        8.1        1.74
     1.1       6.9      9.6      0.70       58.9        8.5        1.76
     1.2       7.9     10.2      0.75       70.6        8.9        1.78
     1.3       9.0     10.8      0.80       83.6        9.3        1.80
     1.4      10.1     11.4      0.85       97.9        9.7        1.82
     1.5      11.3     12.0      0.90      113.6       10.1        1.84


          DESIGN DEPTH OF FLOW, D (FT) . . . . . . .       0.8
          VELOCITY, V (FPS)  . . . . . . . . . . . .       7.1
          TOTAL DEPTH INCLUDING FREEBOARD (FT) . .         1.3
          GABION THICKNESS, t (IN) . . . . . . . .         6.0
          FILLING STONE SIZE, d50 (IN) . . . . . .         3.0
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                       TR-55 GRAPHICAL DISCHARGE METHOD             VERSION 1.11
Project : COLESVILLE LANDFILL                     User: KPH         Date: 01-14-93
County  : BROOME                 State: NY     Checked:             Date: 1/22/93
Subtitle: CHANNEL DC-2

  Data: Drainage Area          :  11.6 * Acres
        Runoff Curve Number    :  80 *
        Time of Concentration:    0.55 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

=================================================================
| Storm Number                |   1   |   2   |   3   |   4   |   5   |   6   |
 ---------------------------- ------- ------- ------- ------- ------- -------
| Frequency  (yrs)            |   2   |   5   |  10   |  25   |  50   |  100  |
|                             |       |       |       |       |       |       |
| 24-Hr Rainfall (in)         |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                             |       |       |       |       |       |       |
| Ia/P Ratio                  | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
|                             |       |       |       |       |       |       |
|            Used             | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
|                             |       |       |       |       |       |       |
| Runoff (in)                 | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
|                             |       |       |       |       |       |       |
| Unit Peak Discharge         | 0.733 | 0.757 | 0.775 | 0.785 | 0.787 | 0.787 |
|    (cfs/acre/in)            |       |       |       |       |       |       |
|                             |       |       |       |       |       |       |
| Pond and Swamp Factor       | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used          |       |       |       |       |       |       |
 ---------------------------- ------- ------- ------- ------- ------- -------
| Peak Discharge (cfs)        |    9  |   14  |   21  |   26  |   29  |   34  |
=================================================================

* - Value(s) provided from TR-55 system routines
```

```
                 TR-55 Tc and Tt THRU SUBAREA COMPUTATION         VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH      Date: 01-14-93
County  : BROOME               State: NY      Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-2

-------------------------------------------------------------------------------
Flow Type   2 year   Length   Slope  Surface   n   Area     Wp   Velocity  Time
             rain     (ft)   (ft/ft)   code       (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet        2.8      120      .01      E                                 0.252
Open Channel          1300                                         1.2    0.301
                                                 Time of Concentration = 0.55*
                                                                         =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface           F Grass, Dense     --- Shallow Concentrated ---
    B Fallow (No Res.)         G Grass, Burmuda   ---     Surface Codes    ---
    C Cultivated < 20 % Res.   H Woods, Light             P Paved
    D Cultivated > 20 % Res.   I Woods, Dense             U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                    TR-55 CURVE NUMBER COMPUTATION                  VERSION 1.11
Project : COLESVILLE LANDFILL                       User: KPH      Date: 01-14-93
County  : BROOME                 State: NY      Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-2

------------------------------------------------------------------------------
                                                       Hydrologic Soil Group
         COVER DESCRIPTION                          A        B        C        D
                                                            Acres (CN)
------------------------------------------------------------------------------

FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%                 -        -        -   11.6(80)


Total Area (by Hydrologic Soil Group)                                     11.6
                                                                          ====

------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 11.6 Acres      WEIGHTED CURVE NUMBER:80*
------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By: Date: 1/23/93
Chk: KPH Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-3
Peak Flow, Q = 3 CFS
Ave. Slope, s = 0.5%

Select Basic Channel Geometry

[✓ Triangular, bottom width = 0 ft]
or
Trapazoidal, bottom width = ____

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3.0 FPS
Max. Velocity for Jute Lining = NA
Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 1.0 FPS
Therefore use: [✓ Grass], Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

- For Max. Velocity using Table D

Q = 4.8 at V = 1.0 and d = 1.3

- For Max. Capacity using Table C

Q = 3.6 at V = 0.5 and d = 1.5

Therefore set Total Depth = 2.0 inc. Freeboard and Settlement

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.8	9.6	0.95	2.0	18.0	1.05	2.2	29.4	1.18	2.5	46.4	1.35	2.8	72.9	1.50	3.2	****	1.65	3.5	145	1.82	3.8	199	2.05	4.3	280	2.50	5.3	500
1.0%	0.76	1.6	7.7	0.72	1.5	10.4	0.79	1.7	16.6	0.86	1.8	24.7	0.94	2.0	35.3	1.05	2.2	51.5	1.12	2.4	66.9	1.25	2.6	93.8	1.35	2.8	122	1.62	3.4	210
1.5%	0.53	1.1	3.7	0.59	1.2	7.0	0.65	1.4	11.3	0.71	1.5	16.8	0.77	1.6	23.7	0.84	1.8	32.9	0.91	1.9	44.2	0.98	2.1	57.6	1.05	2.2	73.5	1.22	2.6	****
2.0%	0.50	1.1	3.3	0.56	1.2	6.3	0.60	1.3	9.6	0.65	1.4	14.1	0.70	1.5	19.6	0.76	1.6	27.0	0.82	1.7	35.9	0.88	1.9	46.5	0.93	2.0	57.7	1.10	2.3	96.8
2.5%	0.46	1.0	2.8	0.53	1.1	5.8	0.54	1.1	7.5	0.56	1.2	11.2	0.62	1.3	15.4	0.67	1.4	20.9	0.72	1.5	27.6	0.77	1.6	35.6	1.05	2.2	73.5	0.93	2.0	69.2
3.0%	0.44	0.9	2.6	0.48	1.0	4.6	0.52	1.1	7.2	0.56	1.2	10.5	0.59	1.2	13.9	0.64	1.3	19.1	0.67	1.4	23.9	0.71	1.5	30.2	0.93	2.0	57.7	0.86	1.8	59.2
3.5%	0.40	0.8	2.1	0.44	0.9	3.9	0.47	1.0	5.9	0.50	1.1	8.3	0.53	1.1	11.2	0.58	1.2	15.7	0.61	1.3	19.8	0.65	1.4	25.3	1.05	2.2	73.5	0.77	1.6	47.4
4.0%	0.38	0.8	1.9	0.42	0.9	3.5	0.45	0.9	5.4	0.48	1.0	7.7	0.51	1.1	10.4	0.55	1.2	14.1	0.58	1.2	17.9	0.61	1.3	22.3	0.93	2.0	57.7	0.73	1.5	42.6
5.0%	0.37	0.8	1.8	0.39	0.8	3.0	0.42	0.9	4.7	0.45	0.9	6.7	0.48	1.0	9.2	0.51	1.1	12.1	0.53	1.1	15.0	0.57	1.2	19.5	1.05	2.2	73.5	0.66	1.4	34.8
7.0%	0.32	0.7	1.4	0.35	0.7	2.4	0.37	0.8	3.7	0.39	0.8	5.1	0.41	0.9	6.7	0.43	0.9	8.6	0.46	1.0	11.3	0.48	1.0	13.8	0.93	2.0	57.7	0.56	1.2	25.1
10.0%	0.28	0.6	1.0	0.31	0.7	1.9	0.32	0.7	2.7	0.35	0.7	4.1	0.36	0.8	5.2	0.38	0.8	6.7	0.40	0.8	8.5	0.42	0.9	10.6	1.05	2.2	73.5	0.48	1.0	18.4

NOTE: @ 0.5% and 0.5 fps, R = .73, d = 1.5, and Q = 3.6 CFS

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

Table D

GRASS LINED CHANNEL/DIVERSION WORKSHHET

PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	1.3	4.8	0.73	1.5	10.7	0.86	1.8	19.7	1.00	2.1	33.3	1.15	2.4	52.9	1.33	2.8	82.5	1.51	3.2	122	1.70	3.6	173	1.95	4.1	254	2.40	5.1	461
1.0%	0.44	0.9	2.6	0.53	1.1	5.6	0.62	1.3	10.3	0.70	1.5	16.3	0.79	1.7	25.0	0.90	1.9	37.8	1.00	2.1	53.3	1.10	2.3	72.6	1.23	2.6	100	1.50	3.2	180
1.5%	0.36	0.8	1.8	0.43	0.9	3.7	0.50	1.1	6.7	0.56	1.2	10.5	0.64	1.3	16.4	0.70	1.5	22.9	0.79	1.7	33.3	0.86	1.8	44.4	0.95	2.0	60.2	1.10	2.3	96.8
2.0%	0.33	0.7	1.5	0.39	0.8	3.0	0.45	0.9	5.4	0.51	1.1	8.7	0.57	1.2	13.0	0.62	1.3	17.9	0.69	1.5	25.4	0.76	1.6	34.7	0.84	1.8	47.0	1.00	2.1	80.0
2.5%	0.29	0.6	1.1	0.34	0.7	2.3	0.39	0.8	4.1	0.44	0.9	6.5	0.58	1.2	13.5	0.54	1.1	13.6	0.60	1.3	19.2	0.65	1.4	25.3	0.71	1.5	33.6	0.85	1.8	57.8
3.0%	0.28	0.6	1.0	0.33	0.7	2.1	0.37	0.8	3.7	0.42	0.9	5.9	0.46	1.0	8.5	0.51	1.1	12.1	0.56	1.2	16.7	0.60	1.3	21.6	0.67	1.4	29.9	0.78	1.6	48.7
3.5%	0.25	0.5	0.8	0.29	0.6	1.7	0.33	0.7	2.9	0.38	0.8	4.7	0.41	0.9	6.7	0.45	0.9	9.5	0.50	1.1	13.3	0.54	1.1	17.5	0.58	1.2	22.4	0.67	1.4	35.9
4.0%	0.24	0.5	0.8	0.28	0.6	1.6	0.32	0.7	2.6	0.35	0.7	4.1	0.39	0.8	6.1	0.43	0.9	8.6	0.47	1.0	11.8	0.51	1.1	15.6	0.55	1.2	20.2	0.63	1.3	31.8
5.0%	0.22	0.5	0.7	0.26	0.5	1.4	0.30	0.6	2.4	0.33	0.7	3.6	0.36	0.8	5.2	0.40	0.8	7.3	0.43	0.9	9.9	0.47	1.0	13.3	0.51	1.1	17.3	0.59	1.2	27.8
7.0%				0.23	0.5	1.1	0.26	0.5	1.8	0.28	0.6	2.6	0.31	0.7	3.8	0.34	0.7	5.4	0.37	0.8	7.3	0.39	0.8	9.1	0.42	0.9	11.8	0.48	1.0	18.4
10.0%							0.24	0.5	1.5	0.24	0.5	1.9	0.26	0.5	2.7	0.28	0.6	3.7	0.31	0.7	5.1	0.33	0.7	6.3	0.35	0.7	8.2	0.40	0.8	12.8

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

```
                    TR-55 GRAPHICAL DISCHARGE METHOD                    VERSION 1.11
Project : COLESVILLE LANDFILL                        User: KPH        Date: 01-14-93
County  : BROOME                  State: NY       Checked:            Date: 1/23/93
Subtitle: CHANNEL DC-3

  Data: Drainage Area          :  .8 * Acres
        Runoff Curve Number    :  80 *
        Time of Concentration:    0.14 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

==================================================================
 | Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
  ---------------------- ------- ------- ------- ------- ------- -------
 | Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
 |                       |       |       |       |       |       |       |
 | 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
 |                       |       |       |       |       |       |       |
 | Ia/P Ratio            | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
 |                       |       |       |       |       |       |       |
 |            Used       | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
 |                       |       |       |       |       |       |       |
 | Runoff (in)           | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
 |                       |       |       |       |       |       |       |
 | Unit Peak Discharge   |1.364  |1.390  |1.409  |1.420  |1.421  |1.421  |
 |    (cfs/acre/in)      |       |       |       |       |       |       |
 |                       |       |       |       |       |       |       |
 | Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
 |   0.0% Ponds Used     |       |       |       |       |       |       |
  ---------------------- ------- ------- ------- ------- ------- -------
 | Peak Discharge (cfs)  |     1 |     2 |     3 |     3 |     4 |     4 |
==================================================================

* - Value(s) provided from TR-55 system routines
```

```
                TR-55 Tc and Tt THRU SUBAREA COMPUTATION          VERSION 1.11
Project : COLESVILLE LANDFILL                     User: KPH      Date: 01-14-93
County  : BROOME                   State: NY      Checked:       Date: 1/23/93
Subtitle: CHANNEL DC-3

-------------------------------------------------------------------------------
Flow Type    2 year   Length   Slope   Surface   n    Area     Wp   Velocity  Time
              rain     (ft)   (ft/ft)   code         (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet         2.8      100      .11       E                                  0.084
Open Channel           230                                             1.2   0.053
                                                     Time of Concentration = 0.14*
                                                                             =====

       --- Sheet Flow Surface Codes ---
   A Smooth Surface             F Grass, Dense       --- Shallow Concentrated ---
   B Fallow (No Res.)           G Grass, Burmuda     ---     Surface Codes    ---
   C Cultivated < 20 % Res.     H Woods, Light              P Paved
   D Cultivated > 20 % Res.     I Woods, Dense              U Unpaved
   E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION                VERSION 1.11
Project : COLESVILLE LANDFILL                      User: KPH        Date: 01-14-93
County  : BROOME                  State: NY     Checked:            Date: 1/23/93
Subtitle: CHANNEL DC-3

-------------------------------------------------------------------------------
                                                     Hydrologic Soil Group
        COVER DESCRIPTION                          A        B        C        D
                                                            Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%                -        -        -     .8(80)


Total Area (by Hydrologic Soil Group)                                      .8
                                                                          ====

-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: .8 Acres        WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By: Date: 1/22/93
Chk: KPN Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC - 4 - 1
Peak Flow, Q = 14 CFS
Ave. Slope, s = 3.0 %

Select Basic Channel Geometry

Triangular, bottom width = 0 ft
or
[✓ Trapazoidal, bottom width = 7']

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3 FPS
Max. Velocity for Jute Lining = NA
Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 3.0
Therefore use: Grass, Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

– For Max. Velocity using Table D

Q = 14.5 at V = 3.0 and d = 0.6

– For Max. Capacity using Table C

Q = 16.0 at V = 2.5 and d = 0.7

Therefore set Total Depth = 1.2 inc. Freeboard and Settlement

Table D

GRASS LINED CHANNEL/DIVERSION WORKSHHET

PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'	
SIDE SLOPE (z:1)	3
BOTTOM WIDTH (B) =	7

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	0.8	7.1	0.73	1.0	14.4	0.86	1.2	24.9	1.00	1.4	39.9	1.15	1.7	60.9	1.33	2.0	91.8	1.51	2.3	132	1.70	2.7	185	1.95	3.2	266	2.40	4.1	474
1.0%	0.44	0.5	4.6	0.53	0.7	8.9	0.62	0.8	14.9	0.70	0.9	22.4	0.79	1.1	32.5	0.90	1.2	46.9	1.00	1.4	63.9	1.10	1.6	84.6	1.23	1.8	113	1.50	2.3	196
1.5%	0.36	0.4	3.5	0.43	0.5	6.6	0.50	0.6	10.9	0.56	0.7	16.0	0.64	0.8	23.5	0.70	0.9	31.4	0.79	1.1	43.4	0.86	1.2	56.0	0.95	1.3	73.3	1.10	1.6	113
2.0%	0.33	0.4	3.1	0.39	0.5	5.8	0.45	0.5	9.4	0.51	0.6	14.0	0.57	0.7	19.7	0.62	0.8	26.1	0.69	0.9	35.1	0.76	1.0	45.9	0.84	1.1	59.9	1.00	1.4	95.9
2.5%	0.29	0.3	2.6	0.34	0.4	4.8	0.39	0.5	7.7	0.44	0.5	11.4	0.58	0.7	20.3	0.54	0.7	21.3	0.60	0.8	28.4	0.65	0.8	36.0	0.71	0.9	45.8	0.85	1.2	73.2
3.0%	0.28	0.3	2.5	0.33	0.4	4.6	0.37	0.4	7.2	0.42	0.5	10.7	0.46	0.6	14.5	0.51	0.6	19.6	0.56	0.7	25.7	0.60	0.8	31.9	0.67	0.9	41.9	0.78	1.0	63.8
3.5%	0.25	0.3	2.2	0.29	0.3	4.0	0.33	0.4	6.2	0.38	0.4	9.2	0.41	0.5	12.4	0.45	0.5	16.4	0.50	0.6	21.8	0.54	0.7	27.4	0.58	0.7	33.8	0.67	0.9	50.3
4.0%	0.24	0.3	2.1	0.28	0.3	3.8	0.32	0.4	5.9	0.35	0.4	8.4	0.39	0.5	11.6	0.43	0.5	15.4	0.47	0.6	20.0	0.51	0.6	25.2	0.55	0.7	31.2	0.63	0.8	45.8
5.0%	0.22	0.2	1.9	0.26	0.3	3.5	0.30	0.3	5.5	0.33	0.4	7.8	0.36	0.4	10.4	0.40	0.5	13.8	0.43	0.5	17.7	0.47	0.6	22.5	0.51	0.6	28.0	0.59	0.7	41.5
7.0%				0.23	0.3	3.0	0.26	0.3	4.6	0.28	0.3	6.3	0.31	0.4	8.6	0.34	0.4	11.3	0.37	0.4	14.4	0.39	0.5	17.4	0.42	0.5	21.4	0.48	0.6	30.9
10.0%							0.24	0.5	1.5	0.24	0.3	5.2	0.26	0.3	6.9	0.28	0.3	8.8	0.31	0.4	11.5	0.33	0.4	13.7	0.35	0.4	16.8	0.40	0.5	24.0

VELOCITY IN FPS

R = HYDRAULIC RADIUS FROM FIGURE A6–3

d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)

Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 7

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.2	12.2	0.95	1.3	22.0	1.05	1.5	34.7	1.18	1.7	53.1	1.35	2.0	80.8	1.50	2.3	114	1.65	2.6	155	1.82	2.9	210	2.05	3.4	292	2.50	4.3	512
1.0%	0.76	1.0	10.2	0.72	1.0	14.1	0.79	1.1	21.7	0.86	1.2	31.1	0.94	1.3	43.2	1.05	1.5	60.7	1.12	1.6	77.6	1.25	1.9	106	1.35	2.0	135	1.62	2.6	225
1.5%	0.53	0.7	5.9	0.59	0.7	10.4	0.65	0.8	16.0	0.71	0.9	22.9	0.77	1.0	31.2	0.84	1.1	41.9	0.91	1.3	54.6	0.98	1.4	69.5	1.05	1.5	86.8	1.22	1.8	135
2.0%	0.50	0.6	5.4	0.56	0.7	9.6	0.60	0.8	14.2	0.65	0.8	20.0	0.70	0.9	26.9	0.76	1.0	35.7	0.82	1.1	46.1	0.88	1.2	58.1	0.93	1.3	70.7	1.10	1.6	113
2.5%	0.46	0.6	4.8	0.50	0.6	8.2	0.54	0.7	12.2	0.58	0.7	16.9	0.62	0.8	22.4	0.67	0.9	29.3	0.72	1.0	37.5	0.77	1.0	46.9	1.05	1.5	86.8	0.93	1.3	84.9
3.0%	0.44	0.5	4.6	0.48	0.6	7.7	0.52	0.6	11.5	0.56	0.7	16.0	0.59	0.7	20.8	0.64	0.8	27.4	0.67	0.9	33.5	0.71	0.9	41.3	0.93	1.3	70.7	0.86	1.2	74.6
3.5%	0.40	0.5	4.0	0.44	0.5	6.8	0.47	0.6	10.0	0.50	0.6	13.6	0.53	0.7	17.8	0.58	0.7	23.6	0.61	0.8	29.1	0.65	0.8	36.0	1.05	1.5	86.8	0.77	1.0	62.5
4.0%	0.38	0.4	3.7	0.42	0.5	6.4	0.45	0.5	9.4	0.48	0.6	12.9	0.51	0.6	16.8	0.55	0.7	21.9	0.58	0.7	27.0	0.61	0.8	32.7	0.93	1.3	70.7	0.73	1.0	57.4
5.0%	0.37	0.4	3.6	0.39	0.5	5.8	0.42	0.5	8.5	0.45	0.5	11.7	0.48	0.6	15.4	0.51	0.6	19.6	0.53	0.7	23.7	0.57	0.7	29.6	1.05	1.5	86.8	0.66	0.9	49.2
7.0%	0.32	0.4	3.0	0.35	0.4	5.0	0.37	0.4	7.2	0.39	0.5	9.7	0.41	0.5	12.4	0.43	0.5	15.4	0.46	0.6	19.4	0.48	0.6	23.1	0.93	1.3	70.7	0.56	0.7	38.5
10.0%	0.28	0.3	2.5	0.31	0.4	4.3	0.32	0.7	2.7	0.35	0.4	8.4	0.36	0.4	10.4	0.38	0.4	13.1	0.40	0.5	16.0	0.42	0.5	19.2	1.05	1.5	86.8	0.48	0.6	30.9

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

```
Project : COLESVILLE LANDFILL                      User: KPH       Date: 01-14-93
County  : BROOME                 State: NY      Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-4-1

  Data: Drainage Area           :  4.9 * Acres
        Runoff Curve Number     :  80 *
        Time of Concentration:  0.32 * Hours
        Rainfall Type           :  II
        Pond and Swamp Area     :  NONE

==================================================================
| Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
 ---------------------- ------- ------- ------- ------- ------- -------
| Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
|                       |       |       |       |       |       |       |
| 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                       |       |       |       |       |       |       |
| Ia/P Ratio            | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
|                       |       |       |       |       |       |       |
|            Used       | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
|                       |       |       |       |       |       |       |
| Runoff (in)           | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
|                       |       |       |       |       |       |       |
| Unit Peak Discharge   |0.964  |0.992  |1.013  |1.025  |1.026  |1.026  |
|    (cfs/acre/in)      |       |       |       |       |       |       |
|                       |       |       |       |       |       |       |
| Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used    |       |       |       |       |       |       |
 ---------------------- ------- ------- ------- ------- ------- -------
| Peak Discharge (cfs)  |    5  |    8  |   11  |   14  |   16  |   19  |
==================================================================

* - Value(s) provided from TR-55 system routines
```

```
Project : COLESVILLE LANDFILL                       User: KPH      Date: 01-14-93
County  : BROOME                 State: NY       Checked:          Date: 1/14/93
Subtitle: CHANNEL DC-4-1

-------------------------------------------------------------------------------
Flow Type    2 year   Length   Slope   Surface  n   Area    Wp   Velocity  Time
              rain     (ft)   (ft/ft)   code       (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet         2.8      300     .040      E                                 0.302
Open Channel           200                                          3.0    0.019
                                                    Time of Concentration = 0.32*
                                                                            =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface             F Grass, Dense     --- Shallow Concentrated ---
    B Fallow (No Res.)           G Grass, Burmuda   ---     Surface Codes     ---
    C Cultivated < 20 % Res.     H Woods, Light              P Paved
    D Cultivated > 20 % Res.     I Woods, Dense              U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
Project : COLESVILLE LANDFILL                   User: KPH       Date: 01-14-93
County  : BROOME                 State: NY   Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-4-1

------------------------------------------------------------------------------
                                                      Hydrologic Soil Group
        COVER DESCRIPTION                          A        B        C        D
                                                           Acres (CN)
------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%                -        -        -    4.9(80)


Total Area (by Hydrologic Soil Group)                                       4.9
                                                                           ====

------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 4.9 Acres      WEIGHTED CURVE NUMBER:80*
------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By: Date: 1/23/93
Chk: KDN Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC-4-2
Peak Flow, Q = 24 CFS
Ave. Slope, s = 0.5%

Select Basic Channel Geometry

[✓ Triangular, bottom width = 0 ft]
or
Trapazoidal, bottom width = ____

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3.0
Max. Velocity for Jute Lining = NA
Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 2.5 Fps
Therefore use: [✓ Grass], Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

– For Max. Velocity using Table D

Q = 33.3 at V = 2.5 and d = 2.1

– For Max. Capacity using Table C

Q = 29.4 at V = 2.0 and d = 2.2

Therefore set Total Depth = 2.5 inc. Freeboard and Settlement

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.8	9.6	0.95	2.0	18.0	1.05	2.2	29.4	1.18	2.5	46.4	1.35	2.8	72.9	1.50	3.2	****	1.65	3.5	145	1.82	3.8	199	2.05	4.3	280	2.50	5.3	500
1.0%	0.76	1.6	7.7	0.72	1.5	10.4	0.79	1.7	16.6	0.86	1.8	24.7	0.94	2.0	35.3	1.05	2.2	51.5	1.12	2.4	66.9	1.25	2.6	93.8	1.35	2.8	122	1.62	3.4	210
1.5%	0.53	1.1	3.7	0.59	1.2	7.0	0.65	1.4	11.3	0.71	1.5	16.8	0.77	1.6	23.7	0.84	1.8	32.9	0.91	1.9	44.2	0.98	2.1	57.6	1.05	2.2	73.5	1.22	2.6	****
2.0%	0.50	1.1	3.3	0.56	1.2	6.3	0.60	1.3	9.6	0.65	1.4	14.1	0.70	1.5	19.6	0.76	1.6	27.0	0.82	1.7	35.9	0.88	1.9	46.5	0.93	2.0	57.7	1.10	2.3	96.8
2.5%	0.46	1.0	2.8	0.50	1.1	5.0	0.54	1.1	7.8	0.58	1.2	11.2	0.62	1.3	15.4	0.67	1.4	20.9	0.72	1.5	27.6	0.77	1.6	35.6	1.05	2.2	73.5	0.93	2.0	69.2
3.0%	0.44	0.9	2.6	0.48	1.0	4.6	0.52	1.1	7.2	0.56	1.2	10.5	0.59	1.2	13.9	0.64	1.3	19.1	0.67	1.4	23.9	0.71	1.5	30.2	0.93	2.0	57.7	0.86	1.8	59.2
3.5%	0.40	0.8	2.1	0.44	0.9	3.9	0.47	1.0	5.9	0.50	1.1	8.3	0.53	1.1	11.2	0.58	1.2	15.7	0.61	1.3	19.8	0.65	1.4	25.3	1.05	2.2	73.5	0.77	1.6	47.4
4.0%	0.38	0.8	1.9	0.42	0.9	3.5	0.45	0.9	5.4	0.48	1.0	7.7	0.51	1.1	10.4	0.55	1.2	14.1	0.58	1.2	17.9	0.61	1.3	22.3	0.93	2.0	57.7	0.73	1.5	42.6
5.0%	0.37	0.8	1.8	0.39	0.8	3.0	0.42	0.9	4.7	0.45	0.9	6.7	0.48	1.0	9.2	0.51	1.1	12.1	0.53	1.1	15.0	0.57	1.2	19.5	1.05	2.2	73.5	0.66	1.4	34.8
7.0%	0.32	0.7	1.4	0.35	0.7	2.4	0.37	0.8	3.7	0.39	0.8	5.1	0.41	0.9	6.7	0.43	0.9	8.6	0.46	1.0	11.3	0.48	1.0	13.8	0.93	2.0	57.7	0.56	1.2	25.1
10.0%	0.28	0.6	1.0	0.31	0.7	1.9	0.32	0.7	2.7	0.35	0.7	4.1	0.36	0.8	5.2	0.38	0.8	6.7	0.40	0.8	8.5	0.42	0.9	10.6	1.05	2.2	73.5	0.48	1.0	18.4

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

Table D

GRASS LINED CHANNEL/DIVERSION WORKSHHET

PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	1.3	4.8	0.73	1.5	10.7	0.86	1.8	19.7	1.00	2.1	33.3	1.15	2.4	52.9	1.33	2.8	82.5	1.51	3.2	122	1.70	3.6	173	1.95	4.1	254	2.40	5.1	461
1.0%	0.44	0.9	2.6	0.53	1.1	5.6	0.62	1.3	10.3	0.70	1.5	16.3	0.79	1.7	25.0	0.90	1.9	37.8	1.00	2.1	53.3	1.10	2.3	72.6	1.23	2.6	100	1.50	3.2	180
1.5%	0.36	0.8	1.8	0.43	0.9	3.7	0.50	1.1	6.7	0.56	1.2	10.5	0.64	1.3	16.4	0.70	1.5	22.9	0.79	1.7	33.3	0.86	1.8	44.4	0.95	2.0	60.2	1.10	2.3	96.8
2.0%	0.33	0.7	1.5	0.39	0.8	3.0	0.45	0.9	5.4	0.51	1.1	8.7	0.57	1.2	13.0	0.62	1.3	17.9	0.69	1.5	25.4	0.76	1.6	34.7	0.84	1.8	47.0	1.00	2.1	80.0
2.5%	0.29	0.6	1.1	0.34	0.7	2.3	0.39	0.8	4.1	0.44	0.9	6.5	0.58	1.2	13.5	0.54	1.1	13.6	0.60	1.3	19.2	0.65	1.4	25.3	0.71	1.5	33.6	0.85	1.8	57.8
3.0%	0.28	0.6	1.0	0.33	0.7	2.1	0.37	0.8	3.7	0.42	0.9	5.9	0.46	1.0	8.5	0.51	1.1	12.1	0.56	1.2	16.7	0.60	1.3	21.6	0.67	1.4	29.9	0.78	1.6	48.7
3.5%	0.25	0.5	0.8	0.29	0.6	1.7	0.33	0.7	2.9	0.38	0.8	4.7	0.41	0.9	6.7	0.45	0.9	9.5	0.50	1.1	13.3	0.54	1.1	17.5	0.58	1.2	22.4	0.67	1.4	35.9
4.0%	0.24	0.5	0.8	0.28	0.6	1.6	0.32	0.7	2.6	0.35	0.7	4.1	0.39	0.8	6.1	0.43	0.9	8.6	0.47	1.0	11.8	0.51	1.1	15.6	0.55	1.2	20.2	0.63	1.3	31.8
5.0%	0.22	0.5	0.7	0.26	0.5	1.4	0.30	0.6	2.4	0.33	0.7	3.6	0.36	0.8	5.2	0.40	0.8	7.3	0.43	0.9	9.9	0.47	1.0	13.3	0.51	1.1	17.3	0.59	1.2	27.8
7.0%				0.23	0.5	1.1	0.26	0.5	1.8	0.28	0.6	2.6	0.31	0.7	3.8	0.34	0.7	5.4	0.37	0.8	7.3	0.39	0.8	9.1	0.42	0.9	11.8	0.48	1.0	18.4
10.0%							0.24	0.5	1.5	0.24	0.5	1.9	0.26	0.5	2.7	0.28	0.6	3.7	0.31	0.7	5.1	0.33	0.7	6.3	0.35	0.7	8.2	0.40	0.8	12.8

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

```
Project : COLESVILLE LANDFILL                        User: KPH        Date: 01-14-93
County  : BROOME                   State: NY      Checked:            Date: 1/22/93
Subtitle: CHANNEL DC-4-2

  Data: Drainage Area           :  10.9 * Acres
        Runoff Curve Number     :  80 *
        Time of Concentration:     0.56 * Hours
        Rainfall Type           :  II
        Pond and Swamp Area     :  NONE

================================================================
| Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
 ---------------------- ------- ------- ------- ------- ------- -------
| Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
|                       |       |       |       |       |       |       |
| 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                       |       |       |       |       |       |       |
| Ia/P Ratio            | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
|                       |       |       |       |       |       |       |
|           Used        | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
|                       |       |       |       |       |       |       |
| Runoff (in)           | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
|                       |       |       |       |       |       |       |
| Unit Peak Discharge   |0.726  |0.750  |0.768  |0.778  |0.779  |0.779  |
|    (cfs/acre/in)      |       |       |       |       |       |       |
|                       |       |       |       |       |       |       |
| Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used    |       |       |       |       |       |       |
 ---------------------- ------- ------- ------- ------- ------- -------
| Peak Discharge (cfs)  |    9  |   13  |   19  |   24  |   27  |   31  |
================================================================

* - Value(s) provided from TR-55 system routines
```

```
Project : COLESVILLE LANDFILL                           User: KPH          Date: 01-14-93
County  : BROOME                   State: NY         Checked:              Date: 1/22/93
Subtitle: CHANNEL DC-4-2

-----------------------------------------------------------------------------------------
Flow Type     2 year    Length    Slope   Surface    n    Area      Wp   Velocity    Time
               rain      (ft)    (ft/ft)    code         (sq/ft)   (ft)  (ft/sec)    (hr)
-----------------------------------------------------------------------------------------
Sheet          2.8       300       .04       E                                      0.302
Open Channel             200                                                3.0     0.019
Open Channel             1050                                               1.2     0.243
                                                    Time of Concentration = 0.56*
                                                                            =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface              F Grass, Dense       --- Shallow Concentrated ---
    B Fallow (No Res.)            G Grass, Burmuda     ---     Surface Codes     ---
    C Cultivated < 20 % Res.      H Woods, Light               P Paved
    D Cultivated > 20 % Res.      I Woods, Dense               U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
Project : COLESVILLE LANDFILL                    User: KPH        Date: 01-14-93
County  : BROOME               State: NY      Checked:            Date: 1/22/93
Subtitle: CHANNEL DC-4-2

-------------------------------------------------------------------------------
                                                    Hydrologic Soil Group
         COVER DESCRIPTION                        A        B        C        D
                                                        Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%               -        -        -   10.9(80)


Total Area (by Hydrologic Soil Group)                                   10.9
                                                                        ====

-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 10.9 Acres      WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By: Date: 1/22/93
Chk: KPN Date: 1-25-93

GRASS LINED CHANNEL/DIVERSION DESIGN

Channel ID: DC - 6
Peak Flow, Q = 32 CFS
Ave. Slope, s = 0.5%

Select Basic Channel Geometry

[✓ Triangular, bottom width = 0 ft]
or
Trapazoidal, bottom width = ____

Channel Side Slope (z:1), Z = 3

Determine Required Lining

Max. Velocity for Grass Only = 3.0 FPS
Max. Velocity for Jute Lining = NA
Max. Velocity for Erosion Control Mat = NA

From Table D at the given slope and flow, Velocity ≤ 2.5 fps
Therefore use: Grass, Jute, or Erosion Control Mat (circle one)

Determine Channel Depth:

- For Max. Velocity using Table D

Q = 33.3 at V = 2.5 and d = 2.1

- For Max. Capacity using Table C

Q = 46.4 at V = 2.5 and d = 2.5

Therefore set Total Depth = 3.0 inc. Freeboard and Settlement

Table D
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'D'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.6	1.3	4.8	0.73	1.5	10.7	0.86	1.8	19.7	1.00	2.1	33.3	1.15	2.4	52.9	1.33	2.8	82.5	1.51	3.2	122	1.70	3.6	173	1.95	4.1	254	2.40	5.1	461
1.0%	0.44	0.9	2.6	0.53	1.1	5.6	0.62	1.3	10.3	0.70	1.5	16.3	0.79	1.7	25.0	0.90	1.9	37.8	1.00	2.1	53.3	1.10	2.3	72.6	1.23	2.6	100	1.50	3.2	180
1.5%	0.36	0.8	1.8	0.43	0.9	3.7	0.50	1.1	6.7	0.56	1.2	10.5	0.64	1.3	16.4	0.70	1.5	22.9	0.79	1.7	33.3	0.86	1.8	44.4	0.95	2.0	60.2	1.10	2.3	96.8
2.0%	0.33	0.7	1.5	0.39	0.8	3.0	0.45	0.9	5.4	0.51	1.1	8.7	0.57	1.2	13.0	0.62	1.3	17.9	0.69	1.5	25.4	0.76	1.6	34.7	0.84	1.8	47.0	1.00	2.1	80.0
2.5%	0.29	0.6	1.1	0.34	0.7	2.3	0.39	0.8	4.1	0.44	0.9	6.5	0.58	1.2	13.5	0.54	1.1	13.6	0.60	1.3	19.2	0.65	1.4	25.3	0.71	1.5	33.6	0.85	1.8	57.8
3.0%	0.28	0.6	1.0	0.33	0.7	2.1	0.37	0.8	3.7	0.42	0.9	5.9	0.46	1.0	8.5	0.51	1.1	12.1	0.56	1.2	16.7	0.60	1.3	21.6	0.67	1.4	29.9	0.78	1.6	48.7
3.5%	0.25	0.5	0.8	0.29	0.6	1.7	0.33	0.7	2.9	0.38	0.8	4.7	0.41	0.9	6.7	0.45	0.9	9.5	0.50	1.1	13.3	0.54	1.1	17.5	0.58	1.2	22.4	0.67	1.4	35.9
4.0%	0.24	0.5	0.8	0.28	0.6	1.6	0.32	0.7	2.6	0.35	0.7	4.1	0.39	0.8	6.1	0.43	0.9	8.6	0.47	1.0	11.8	0.51	1.1	15.6	0.55	1.2	20.2	0.63	1.3	31.8
5.0%	0.22	0.5	0.7	0.26	0.5	1.4	0.30	0.6	2.4	0.33	0.7	3.6	0.36	0.8	5.2	0.40	0.8	7.3	0.43	0.9	9.9	0.47	1.0	13.3	0.51	1.1	17.3	0.59	1.2	27.8
7.0%				0.23	0.5	1.1	0.26	0.5	1.8	0.28	0.6	2.6	0.31	0.7	3.8	0.34	0.7	5.4	0.37	0.8	7.3	0.39	0.8	9.1	0.42	0.9	11.8	0.48	1.0	18.4
10.0%							0.24	0.5	1.5	0.24	0.5	1.9	0.26	0.5	2.7	0.28	0.6	3.7	0.31	0.7	5.1	0.33	0.7	6.3	0.35	0.7	8.2	0.40	0.8	12.8

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-3
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'D; 01/22/93 (file: jhf disc: tools:retard'd.wk1)

Table C
GRASS LINED CHANNEL/DIVERSION WORKSHHET
PREPARED IN ACCORDANCE WITH THE SCS ENGINEERING FIELD MANUAL FOR CONSERVATION PRACTICES AND
THE STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

RETARDANCE 'C'
SIDE SLOPE (z:1) 3
BOTTOM WIDTH (B) = 0

$$\frac{33 - 29.4}{x - 2.2} \sim \frac{46.4 - 33}{2.5 - 2.2}) \; x \sim$$

VELOCITY	1.0			1.5			2.0			2.5			3.0			3.5			4.0			4.5			5.0			6.0		
SLOPE	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q	R	d	Q
0.5%	0.85	1.8	9.6	0.95	2.0	18.0	1.05	2.2	29.4	1.18	2.5	46.4	1.35	2.8	72.9	1.50	3.2	****	1.65	3.5	145	1.82	3.8	199	2.05	4.3	280	2.50	5.3	500
1.0%	0.76	1.6	7.7	0.72	1.5	10.4	0.79	1.7	16.6	0.86	1.8	24.7	0.94	2.0	35.3	1.05	2.2	51.5	1.12	2.4	66.9	1.25	2.6	93.8	1.35	2.8	122	1.62	3.4	210
1.5%	0.53	1.1	3.7	0.59	1.2	7.0	0.65	1.4	11.3	0.71	1.5	16.8	0.77	1.6	23.7	0.84	1.8	32.9	0.91	1.9	44.2	0.98	2.1	57.6	1.05	2.2	73.5	1.22	2.6	****
2.0%	0.50	1.1	3.3	0.56	1.2	6.3	0.60	1.3	9.6	0.65	1.4	14.1	0.70	1.5	19.6	0.76	1.6	27.0	0.82	1.7	35.9	0.88	1.9	46.5	0.93	2.0	57.7	1.10	2.3	96.8
2.5%	0.46	1.0	2.8	0.50	1.1	5.0	0.54	1.1	7.8	0.58	1.2	11.2	0.62	1.3	15.4	0.67	1.4	20.9	0.72	1.5	27.6	0.77	1.6	35.6	1.05	2.2	73.5	0.93	2.0	69.2
3.0%	0.44	0.9	2.6	0.48	1.0	4.6	0.52	1.1	7.2	0.56	1.2	10.5	0.59	1.2	13.9	0.64	1.3	19.1	0.67	1.4	23.9	0.71	1.5	30.2	0.93	2.0	57.7	0.86	1.8	59.2
3.5%	0.40	0.8	2.1	0.44	0.9	3.9	0.47	1.0	5.9	0.50	1.1	8.3	0.53	1.1	11.2	0.58	1.2	15.7	0.61	1.3	19.8	0.65	1.4	25.3	1.05	2.2	73.5	0.77	1.6	47.4
4.0%	0.38	0.8	1.9	0.42	0.9	3.5	0.45	0.9	5.4	0.48	1.0	7.7	0.51	1.1	10.4	0.55	1.2	14.1	0.58	1.2	17.9	0.61	1.3	22.3	0.93	2.0	57.7	0.73	1.5	42.6
5.0%	0.37	0.8	1.8	0.39	0.8	3.0	0.42	0.9	4.7	0.45	0.9	6.7	0.48	1.0	9.2	0.51	1.1	12.1	0.53	1.1	15.0	0.57	1.2	19.5	1.05	2.2	73.5	0.66	1.4	34.8
7.0%	0.32	0.7	1.4	0.35	0.7	2.4	0.37	0.8	3.7	0.39	0.8	5.1	0.41	0.9	6.7	0.43	0.9	8.6	0.46	1.0	11.3	0.48	1.0	13.8	0.93	2.0	57.7	0.56	1.2	25.1
10.0%	0.28	0.6	1.0	0.31	0.7	1.9	0.32	0.7	2.7	0.35	0.7	4.1	0.36	0.8	5.2	0.38	0.8	6.7	0.40	0.8	8.5	0.42	0.9	10.6	1.05	2.2	73.5	0.48	1.0	18.4

VELOCITY IN FPS
R = HYDRAULIC RADIUS FROM FIGURE A6-2
d = DEPTH OF CHANNEL IN FEET (NOT INCLUDING ALLOWANCES FOR FREEBOARD, LINING INSTALLATION, OR SETTLEMENT)
Q = FLOW IN CFS

RETARDANCE 'C; 01/22/93 (file: jhf disc: tools:retard'c.wk1)

By KPN Date 1-21-93 Chkd. Date 1/22/93

```
DIVERSION CHANNEL DESIGN - GABION LINING                JOB NO.    00000 XX

COLESVILLE LANDFILL
CHANNEL DC-6 INLET CHANNEL

|-----------------------------  INPUT  -------------------------------|

 DESIGN PEAK DISCHARGE, Q (CFS)  . . . . . . . . . . . . . . .      32.0
 CHANNEL SLOPE, S (FT/FT)  . . . . . . . . . . . . . . . . . .     0.033
 CHANNEL SIDESLOPE - LEFT SIDE (HORIZ/VERT)  . . . . . . . . .       3.0
 CHANNEL SIDESLOPE - RIGHT SIDE (HORIZ/VERT) . . . . . . . . .       3.0
 CHANNEL BOTTOM WIDTH, B (FT). . . . . . . . . . . . . . . . .       3.0
 MANNING'S ROUGHNESS COEFFICIENT, n  . . . . . . . . . . . . .     0.025
 GABION MATTRESS THICKNESS, t (IN)  (USE 6, 9, 12 OR 18)  .          6.0
 FREEBOARD (FT)  . . . . . . . . . . . . . . . . . . . . . . .       0.5

 BEGIN CALCULATIONS AT CHANNEL DEPTH (FT)  . . . . . . . . .         0.5

|---------------------------------------------------------------------|


  CHANNEL     X-SECT     TOP     HYDRAULIC                            FROUDE
   DEPTH       AREA     WIDTH      RADIUS   DISCHARGE   VELOCITY     NUMBER
   (FT)      (SQ FT)    (FT)       (FT)      (CFS)       (FPS)        Nf
=====================================================================

    0.5        2.3       6.0       0.37       12.4        5.5        1.59
    0.6        2.9       6.6       0.42       17.6        6.1        1.63
    0.7        3.6       7.2       0.48       23.7        6.6        1.66
    0.8        4.3       7.8       0.54       30.9        7.1        1.69
    0.9        5.1       8.4       0.59       39.1        7.6        1.72
    1.0        6.0       9.0       0.64       48.4        8.1        1.74
    1.1        6.9       9.6       0.70       58.9        8.5        1.76
    1.2        7.9      10.2       0.75       70.6        8.9        1.78
    1.3        9.0      10.8       0.80       83.6        9.3        1.80
    1.4       10.1      11.4       0.85       97.9        9.7        1.82
    1.5       11.3      12.0       0.90      113.6       10.1        1.84


         DESIGN DEPTH OF FLOW, D (FT) . . . . . .         0.9
         VELOCITY, V (FPS)  . . . . . . . . . . .         7.6
         TOTAL DEPTH INCLUDING FREEBOARD (FT) . .         1.4
         GABION THICKNESS, t (IN) . . . . . . . .         6.0
         FILLING STONE SIZE, d50 (IN) . . . . . .         3.0
```

```
                     TR-55 GRAPHICAL DISCHARGE METHOD              VERSION 1.11
Project : COLESVILLE LANDFILL                         User: KPH    Date: 01-14-93
County  : BROOME                State: NY          Checked:        Date: 1/23/93
Subtitle: CHANNEL DC-6

  Data: Drainage Area          :  17.7 * Acres
        Runoff Curve Number    :  79 *
        Time of Concentration:    0.73 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

==================================================================
| Storm Number           |   1   |   2   |   3   |   4   |   5   |   6   |
 ----------------------- ------- ------- ------- ------- ------- -------
| Frequency  (yrs)       |   2   |   5   |  10   |  25   |  50   |  100  |
|                        |       |       |       |       |       |       |
| 24-Hr Rainfall (in)    |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                        |       |       |       |       |       |       |
| Ia/P Ratio             | 0.19  | 0.15  | 0.12  | 0.11  | 0.10  | 0.09  |
|                        |       |       |       |       |       |       |
|            Used        | 0.19  | 0.15  | 0.12  | 0.11  | 0.10  | 0.10  |
|                        |       |       |       |       |       |       |
| Runoff (in)            | 1.04  | 1.57  | 2.21  | 2.72  | 3.06  | 3.59  |
|                        |       |       |       |       |       |       |
| Unit Peak Discharge    | 0.619 | 0.642 | 0.659 | 0.668 | 0.673 | 0.673 |
|    (cfs/acre/in)       |       |       |       |       |       |       |
|                        |       |       |       |       |       |       |
| Pond and Swamp Factor  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|   0.0% Ponds Used      |       |       |       |       |       |       |
| ---------------------- | ----- | ----- | ----- | ----- | ----- | ----- |
| Peak Discharge (cfs)   |   11  |   18  |   26  |   32  |   36  |   43  |
==================================================================

* - Value(s) provided from TR-55 system routines
```

```
                    TR-55 Tc and Tt THRU SUBAREA COMPUTATION          VERSION 1.11
Project : COLESVILLE LANDFILL                         User: KPH     Date: 01-14-93
County  : BROOME                  State: NY       Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-6

--------------------------------------------------------------------------------
Flow Type    2 year    Length   Slope   Surface   n    Area     Wp   Velocity  Time
              rain      (ft)   (ft/ft)   code         (sq/ft)  (ft)  (ft/sec)  (hr)
--------------------------------------------------------------------------------
Sheet          2.8       300     .25       I                                  0.584
Shallow Concent'd       1210     .25       U                                  0.042
Open Channel             430                                          1.2     0.100
                                                    Time of Concentration = 0.73*
                                                                            =====

           --- Sheet Flow Surface Codes ---
    A Smooth Surface            F Grass, Dense       --- Shallow Concentrated ---
    B Fallow (No Res.)          G Grass, Burmuda     ---     Surface Codes     ---
    C Cultivated < 20 % Res.    H Woods, Light                 P Paved
    D Cultivated > 20 % Res.    I Woods, Dense                 U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                    TR-55 CURVE NUMBER COMPUTATION                  VERSION 1.11
Project : COLESVILLE LANDFILL                       User: KPH       Date: 01-14-93
County  : BROOME                  State: NY      Checked:           Date: 1/22/93
Subtitle: CHANNEL DC-6

--------------------------------------------------------------------------------
                                                      Hydrologic Soil Group
         COVER DESCRIPTION                       A         B         C         D
                                                            Acres (CN)
--------------------------------------------------------------------------------
OTHER AGRICULTURAL LANDS
Woods                             fair           -         -         -   17.7(79)


Total Area (by Hydrologic Soil Group)                                    17.7
                                                                         ====


--------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 17.7 Acres      WEIGHTED CURVE NUMBER:79*
--------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

TUMBLING FLOW DOWNCHUTE DESIGN

NORTH CREEK DOWNCHUTE

By KPN Date 7-25-93
Chkd. by ________ Date ________
Subject ________

WehranEnviroTech

Job No. 02260-C3
Sheet No. ________ of ________

TUMBLING FLOW DOWNCHUTE DESIGN SUMMARY

LOCATION	DRAINAGE AREA (AC)	CHANNEL SLOPE (%)	INLET ELEV.	OUTLET. ELEV.	LENGTH (FT)	FLOW (CFS)	ELEMENT HEIGHT (FT)	CHANNEL LINED DEPTH	LENGTH BETWEEN ELEMENTS	OUTLET VELOCITY (FPS)	
~~DG-5-2~~	~~40.0~~	~~8.33~~	~~1146~~	~~1136~~	~~120~~	~~67.0~~	~~0.70~~	~~2.7~~	~~6.0~~	~~6.7~~	NOT IN CONTRACT
~~IMPROVED STREAM~~	~~58.1~~	~~9.0~~	~~1146.0~~	~~1056.0~~	~~900~~	~~85.0~~	~~0.70~~	~~3.0~~	~~6.5~~	~~6.5~~	NOT IN CONTRACT
NORTH CREEK DOWNCHUTE	13.9	25.0	1037.0	990	180	27.0	0.70	2.5'	6.0	5.9	

NORTH CREEK STEP DOWNCHUTE

THE DESIGN OF THIS CHANNEL IS BASED ON THE TUMBLING FLOW METHOD AS PRESENTED IN INNOVATIONS IN STORMWATER MANAGEMENT FOR LANDFILL CLOSURE BY STEVEN M. GAMELSKY, VICE PRESIDENT, SCS ENGINEERS.

THE DESIGN CONSISTS OF A TRAPEZOIDAL CHANNEL WITH CONCRETE BLOCKS INSTALLED WITHIN THE CHANNEL BOTTOM TO ACT AS INDIVIDUAL ENERGY DISSIPATOR ELEMENTS, SPACED EVENLY THROUGHOUT THE CHANNEL. THE DESIGN PROVIDES A LOW VELOCITY CONTROLLED DISCHARGE INTO THE EXISTING CHANNEL.

EQUATIONS THAT GOVERN THE DESIGN

$$q = (16.5 - 0.206\,S)\,K^{3/2}$$

$$y_1 = 0.35\,q^{2/3}$$

$$V_c = (g\,q)^{1/3}$$

$$L/K = 8.5 \text{ TO } 10.0$$

VARIABLES

q = UNIT DISCHARGE (CFS/FT OF BASE WIDTH (b))

S = CHANNEL SLOPE (%)

K = HEIGHT OF ELEMENT (FT)

g = 32.2 FT/SEC^2

y_1 = CONTROL DEPTH ON MAXIMUM RISE OF WATER OVER ELEMENT (FT)

V_c = CRITICAL VELOCITY - (ALSO OUTLET VELOCITY (FPS))

L - LENGTH BETWEEN ELEMENTS

By KPH Date 1-20-93 **WehranEnviroTech** Job No. 02260.CS
Chkd. by Date 1/22/93 Sheet No. of
Subject Colesville Landfill

NORTH CREEK STEP DOWNCHUTE

Q_{25} 29 CFS + 0.22 CFS (TREATMENT PLANT) = 29.0

$b = 4.5'$

$S = 25\%$

DESIGN;

$q = Q_{25}/b = 29.0/4.5 = 6.44$

$q = (16.5 - .206S)(K^{3/2})$ SOLVE FOR K

$$K = \left[\frac{q}{(16.5 - .206S)}\right]^{2/3} = \left(\frac{6.44}{16.5 - .206(25)}\right)^{2/3}$$

$K = .69$

DETERMINE DEPTH OF WATER ABOVE BLOCK

$y_1 = .35q^{2/3} = .35(6.44)^{2/3}$

$y_1 = 1.21$

DETERMINE SPACING BETWEEN ELEMENTS

$L/K = 8.5$ TO 10 $L = 8.5(K) = 8.5(.69) = 5.87$
$L = 10.0(K)$ $10(.69) = 6.9$

USE 6' SPACING

DETERMINE CRITICAL VELOCITY (V_c) – ALSO OUTLET VELOCITY

$V_c = (gq)^{1/3}$

$= (32.2\ 6.44)^{1/3}$

$V_c = 5.92$ FPS

By KPH Date 1-20-93
Chkd. by JJH Date 1/22/93
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WehranEnviroTech
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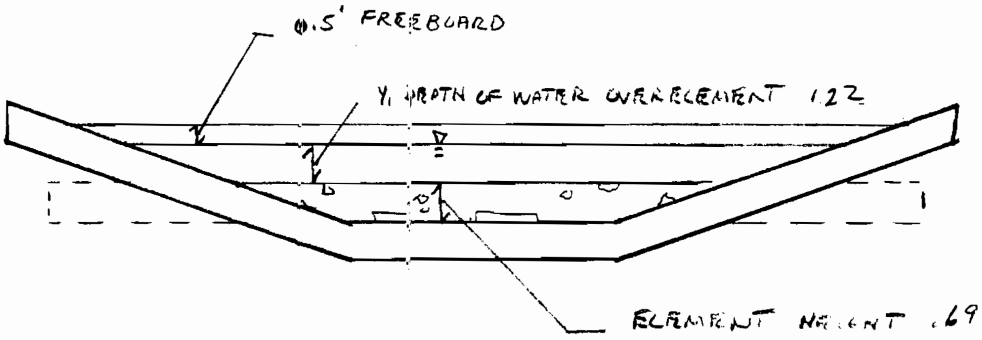
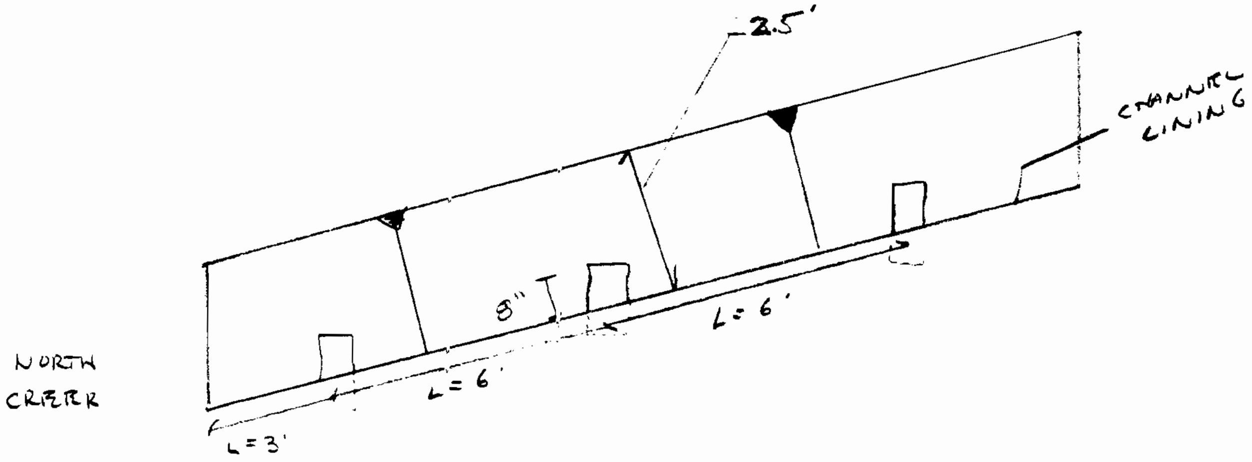
NORTH CREEK STEP DOWNCHUTE



CHANNEL DEPTH 2.41 => 2.5'

CHANNEL LINING: EITHER - 6" GABION MATTRESS w/ D_{50} = 3" FILLING

- D_{50} = 8" RIP RAP



deformation to the Reno mattress due to fill movement. The values in table 2 are derived from model tests conducted in 1982/83 (Hydraulics Laboratory Engineering Research Center, Colorado State University - Fort Collins - U.S.A.) which are described later. This research has also quantified the advantages that derive from containment of the fill material by mesh when compared with loose rip rap protection.

It has been shown that Reno mattress linings have double the stability of rip rap of the same stone grading against bed tractions. Furthermore, it was verified that, for a given velocity of flow, the Reno mattress needs only be 1/3 to 1/4 as thick as a rip rap lining.

ment du revêtement des berges.

La vitesse critique, élément de cette table, est égale à la vitesse que le revêtement peut supporter en toute sécurité sans mouvement de la pierre à l'intérieur du matelas Reno; la vitesse limite correspond à la vitesse acceptable mais entraînant de légères déformations du matelas Reno dues au tassement de la pierre.

Les données de la table 2 découlent des essais sur maquette datant de 1982-1983 et exécutés par Hydraulics Laboratory Engineering Research Center Colorado State University - Fort Collins - U.S.A.

Ces essais seront décrits par la suite. L'étude que nous venons de citer a entre autre permis de quantifier les avantages de l'action de rétention du matériau de remplissage exercée par le grillage, par rapport aux revêtements en enrochements. Il a été démontré que le revêtement en matelas Reno est stable en présence de charriage de fond dont les tensions sont

en la tabla 2 válida para los revestimie de fondo pero con buena aproxima también para aquellos de las orillas.

En esta tabla por «velocidad crítica» entiende la que puede soportar revestimiento con seguridad sin movim tos de piedras en el interior del colc Reno; por «velocidad límite» se entienc que puede ser aceptada admitie modestas deformaciones del colchón R causadas por el movimiento de la pie Los valores de la tabla 2 derivan de prue efectuadas sobre modelo en 1982/1 (Hydraulics Laboratory Engineering search Center Colorado State Univers Fort Collins - USA) que serán descri más adelante.

Esta búsqueda ha cuantificado además ventajas que derivan de la acción contención ejercitada por la red metá sobre el material de relleno con respec los revestimientos en material suelto (rap). Se ha demostrado que el revestimie en colchones Reno es estable para fuer

Tab. 2 - Indicative Reno Mattress and gabion thicknesses in relation to water velocities

Tab. 2 - Epaisseurs approximatives des revêtements en matelas Reno et en gabions en fonction de la vitesse du courant

Tab. 2 - Espesores indicativos de los revestimientos en colchones Reno y gaviones en función de la velocidad d la corriente

Type Type Tipo	Thickness Epaisseur Espesor		Filling stones Pierraille de remplissage Pedrisco de relleno			Critical velocity Vitesse critique Velocidad crítica		Limit velocity Vitesse limite Velocidad límite	
			Stone size Granulométrie Dimensiones	dd_{90}					
	m	in	mm		in	m/s	FPS	m/s	FP
Reno mattress Matelas Reno Colchones Reno	0.15 - 0.17	6	70 - 100	0.085	3	3.5	11	4.2	1
			70 - 150	0.110	4	4.2	14	4.5	1
	0.23 - 0.25	9	70 - 100	0.085	3	3.6	12	5.5	1
			70 - 150	0.120	5	4.5	15	6.1	2
	0.30	12	70 - 120	0.100	4	4.2	14	5.5	1
			100 - 150	0.125	5	5.0	16	6.4	2
Gabions Gabions Gaviones	0.50	18	100 - 200	0.150	6	5.8	19	7.6	2
			120 - 250	0.190	7.5	6.4	21	8.0	2

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Fig. 15 - U.S.A. - New York - Bank protection near Buffa

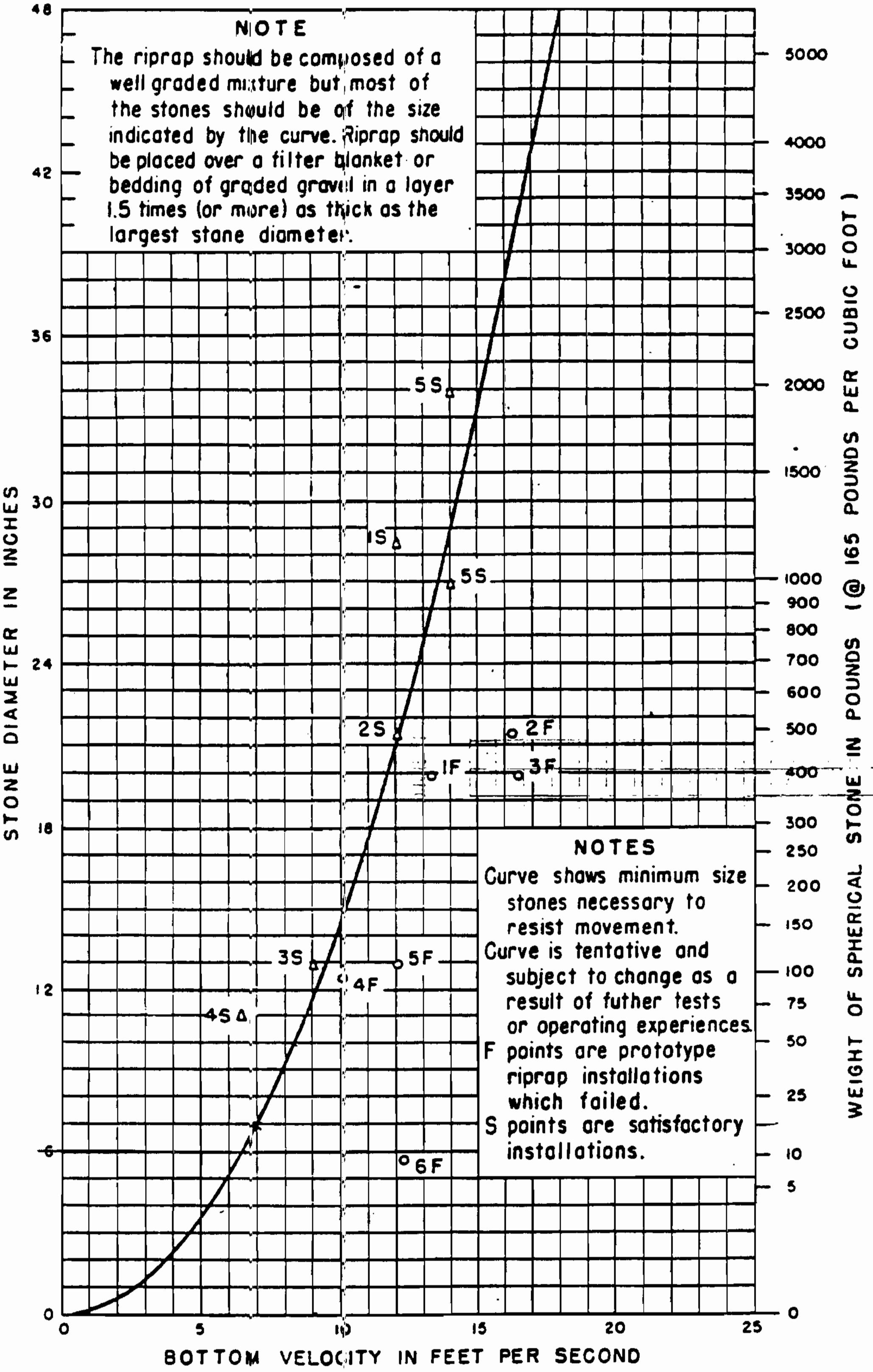
Fig. 15 - U.S.A. - New York - Revêtement de berg réalisé en proximité de la ville de Buffalo.

Fig. 15 - U.S.A. - New York - Defensa de un dique en cercanías de Buffalo.

Job No.____________________

Sheet No. _______of_________

SIZE OF RIPRAP TO BE USED DOWNSTREAM FROM STILLING BASINS



NOTE

The riprap should be composed of a well graded mixture but most of the stones should be of the size indicated by the curve. Riprap should be placed over a filter blanket or bedding of graded gravel in a layer 1.5 times (or more) as thick as the largest stone diameter.

NOTES

Curve shows minimum size stones necessary to resist movement.

Curve is tentative and subject to change as a result of futher tests or operating experiences.

F points are prototype riprap installations which failed.

S points are satisfactory installations.

Figure 165.—*Curve to determine maximum stone size in riprap mixture.*

Source: Hydraulic Design of Stilling Basins and Energy Dissipators

```
Project : COLESVILLE LANDFILL                        User: KPH        Date: 01-14-93
County  : BROOME                  State: NY      Checked:             Date: 1/22/93
Subtitle: NORTH CREEK DOWNCHUTE

  Data: Drainage Area          :  13.9 * Acres
        Runoff Curve Number    :  80 *
        Time of Concentration:    0.59 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

==================================================================
| Storm Number               |   1   |   2   |   3   |   4   |   5   |   6   |
 ----------------------   ------ ------ ------ ------ ------ ------
| Frequency  (yrs)           |   2   |   5   |  10   |  25   |  50   |  100  |
|                            |       |       |       |       |       |       |
| 24-Hr Rainfall (in)        |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
|                            |       |       |       |       |       |       |
| Ia/P Ratio                 | 0.18  | 0.14  | 0.12  | 0.10  | 0.09  | 0.08  |
|                            |       |       |       |       |       |       |
|            Used            | 0.18  | 0.14  | 0.12  | 0.10  | 0.10  | 0.10  |
|                            |       |       |       |       |       |       |
| Runoff (in)                | 1.10  | 1.64  | 2.29  | 2.81  | 3.16  | 3.69  |
|                            |       |       |       |       |       |       |
| Unit Peak Discharge        | 0.705 | 0.729 | 0.747 | 0.756 | 0.758 | 0.758 |
|    (cfs/acre/in)           |       |       |       |       |       |       |
|                            |       |       |       |       |       |       |
| Pond and Swamp Factor      | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used         |       |       |       |       |       |       |
 ----------------------   ------ ------ ------ ------ ------ ------
| Peak Discharge (cfs)       |  11   |  17   |  24   |  29   |  33   |  39   |
==================================================================

* - Value(s) provided from TR-55 system routines
```

```
Project : COLESVILLE LANDFILL                          User: KPH       Date: 01-14-93
County  : BROOME                    State: NY       Checked:           Date: 1/22/93
Subtitle: NORTH CREEK DOWNCHUTE

--------------------------------------------------------------------------------
                                                       Hydrologic Soil Group
         COVER DESCRIPTION                           A         B         C        D
                                                            Acres (CN)
--------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%                  -         -         -   13.9(80)


Total Area (by Hydrologic Soil Group)                                        13.9
                                                                             ====

--------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 13.9 Acres      WEIGHTED CURVE NUMBER:80*
--------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

```
Project : COLESVILLE LANDFILL                        User: KPH       Date: 01-14-93
County  : BROOME               State: NY          Checked:           Date: 1/22/93
Subtitle: NORTH CREEK DOWNCHUTE

-----------------------------------------------------------------------------------
Flow Type     2 year   Length   Slope   Surface  n    Area    Wp   Velocity  Time
               rain     (ft)   (ft/ft)   code       (sq/ft)  (ft) (ft/sec)  (hr)
-----------------------------------------------------------------------------------
Sheet          2.8      300      .04       E                                 0.302
Open Channel            180                                          8.0     0.006
Open Channel            1470                                         1.47    0.278
                                                  Time of Concentration = 0.59*
                                                                          =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface            F Grass, Dense      --- Shallow Concentrated ---
    B Fallow (No Res.)          G Grass, Burmuda    ---     Surface Codes    ---
    C Cultivated < 20 % Res.    H Woods, Light               P Paved
    D Cultivated > 20 % Res.    I Woods, Dense               U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

CULVERT DESIGN

BY-PASS CULVERT

TREATMENT PLANT ACCESS ROAD CULVERT

By KDH Date 1-25-93
Chkd. by ________ Date ________
Subject ________

WehranEnviroTech

Job No. 02260. CS
Sheet No. ________ of ________

CULVERT DESIGN SUMMARY

TYPE	CULVERT	Q25	SLOPE (%)	LENGTH (FT)	INLET ELEV.	OUTLET ELEV.	HEADWATER (FT)	TOP OF HEADWALL ELEV.
2-36" RCP	BY-PASS	95.0	6.7	150	1061.0	1050.80	3.75	1065.0
1-18" RCP	T.P ACCESS ROAD	5.0	2.9	67	1050.9	1049.0	1.3	1054.2

By KPH **Date** 1-19-93
Chkd. by TJL **Date** 1/22/93
Subject Colesville Landfill

WehranEnviroTech

Job No. 02260CS
Sheet No. ______ **of** ______

BY-PASS CULVERT

CULVERT DESIGNED TO PASS THE 25yr 24Hr STORM. CULVERT CONVEYS FLOW FROM IMPROVED STREAM CHANNEL AROUND THE PROPOSED SEDIMENT POND AND DISCHARGE INTO THE EXISTING STREAM CHANNEL. OUTLET PROTECTION WILL BE PROVIDED TO PROVIDE A SMOOTH TRANSITION INTO THE STREAM CHANNEL.

$Q_{25} = 95$ CFS

SLOPE = CONSERVATIVELY ASSUME 6.7%

LENGTH = 150'

INLET CONTROL TRY TWIN 36" CPC (47.5 CFS/CULVERT)

$\frac{Hw}{D} = 1.25$ $Hw = 1.2\ (3) = 3.75'$ (CHART 1)

OUTLET CONTROL

$H = 1.8$ (CHART 5)
$d_c = 2.3$ (CHART 4
$h_o = \frac{d_c + D}{2}$ $\frac{2.3+3}{2} = 2\ 65$

$Hw = H - L(S_{\ })+ h_o$
$\cdot 1.8 - 150(.067) + 2\ 65$
$= -\ 5.6$

INLET CONTROLS $Hw = 3.75'$

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

$$= \frac{1.49}{n} \frac{\pi D^2}{4} \left(\frac{D}{4}\right)^{2/3} (S)^{1/2} = \frac{1.49}{.02} \frac{\pi (3)^2}{4} \left(\frac{3}{4}\right)^{2/3} (.067)^{1/2}$$

$Q_{CAPACITY} = 187.6 > 47.5$

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

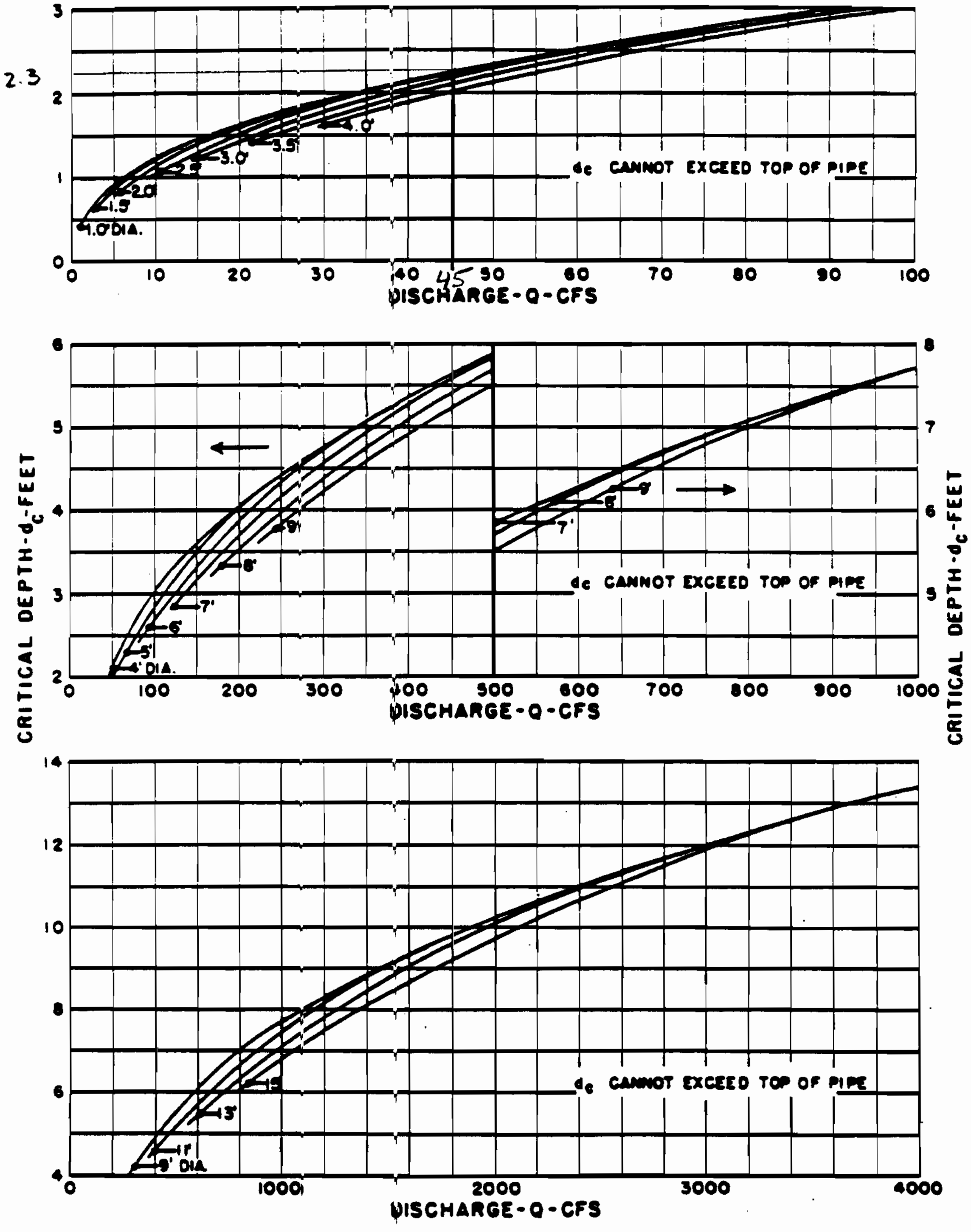
Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g}\right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

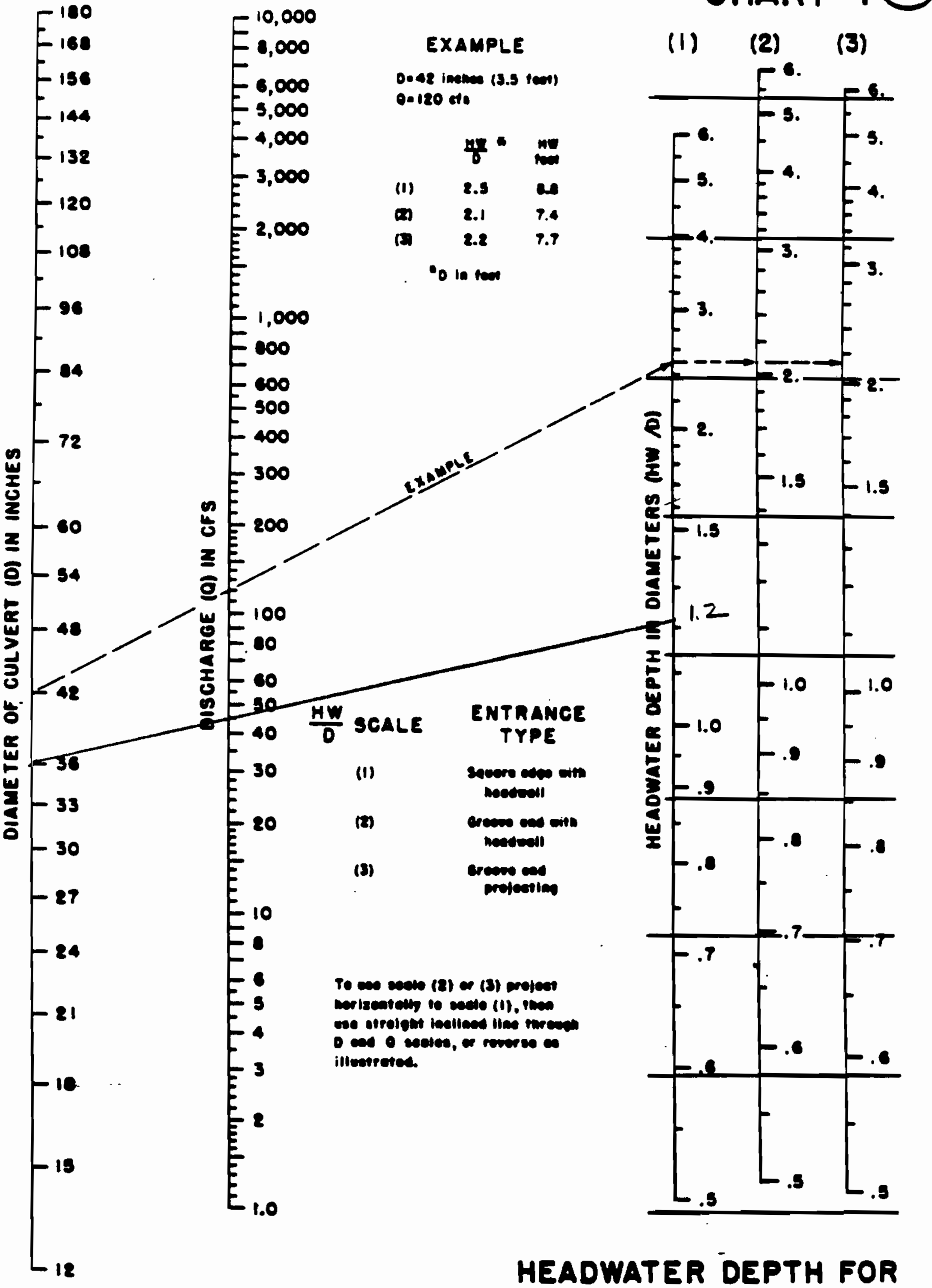
CHART 4



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

CHART 1



EXAMPLE

D=42 inches (3.5 feet)
Q=120 cfs

	$\frac{HW}{D}$*	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Square edge with headwall
(2)	Groove end with headwall
(3)	Groove end projecting

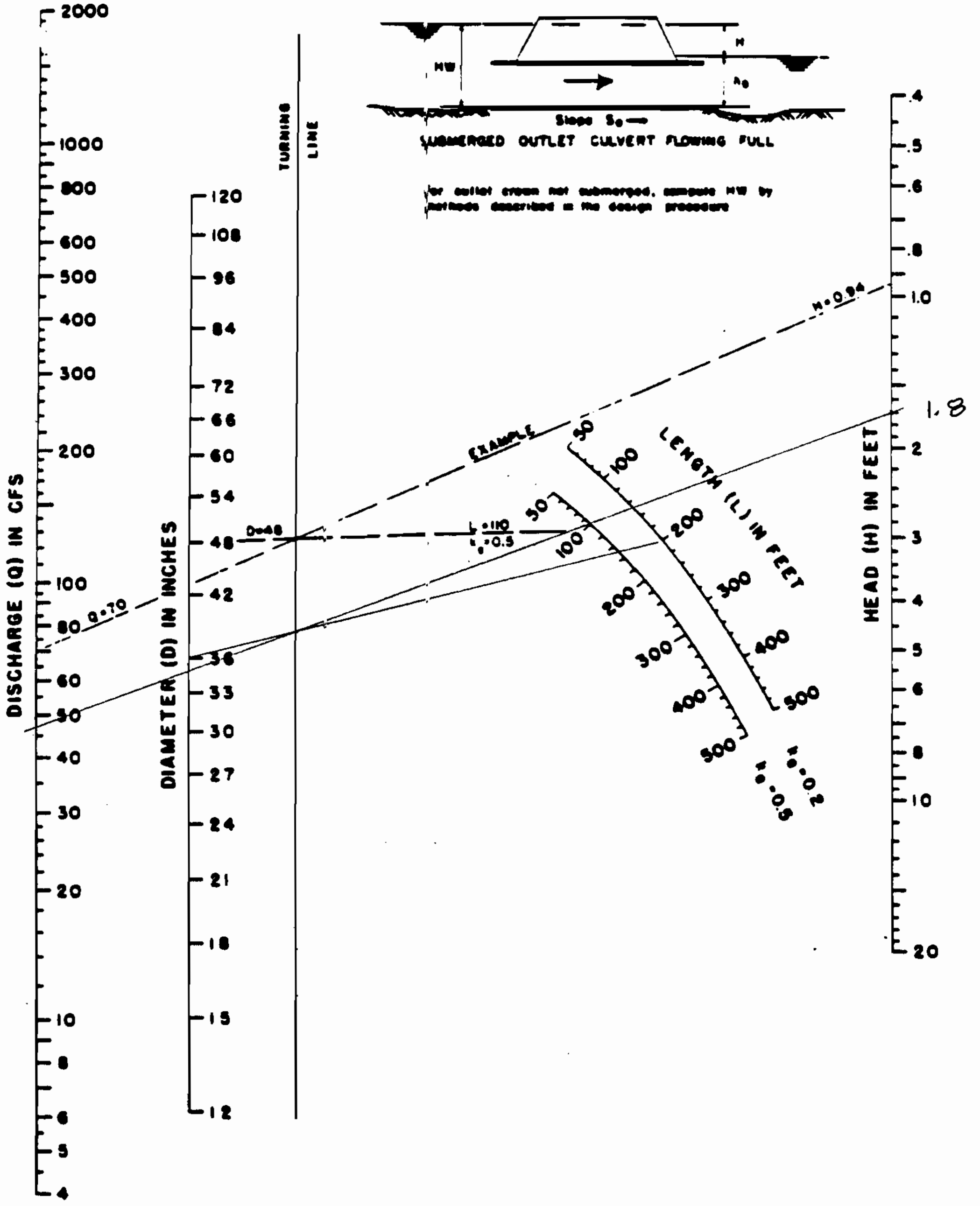
To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 5



BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL
n = 0.012

```
                    TR-55 GRAPHICAL DISCHARGE METHOD              VERSION 1.11
Project : COLESVILLE LANDFILL                   User: KPH         Date: 01-14-93
County  : BROOME             State: NY       Checked:             Date: 1/22/93
Subtitle: BY-PASS CULVERT

  Data: Drainage Area          :  58.1 * Acres
        Runoff Curve Number    :  79 *
        Time of Concentration:    0.87 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

==================================================================
 | Storm Number           |   1   |   2   |   3   |   4   |   5   |   6   |
 |----------------------- |-------|-------|-------|-------|-------|-------|
 | Frequency   (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
 |                        |       |       |       |       |       |       |
 | 24-Hr Rainfall (in)    |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
 |                        |       |       |       |       |       |       |
 | Ia/P Ratio             | 0.19  | 0.15  | 0.12  | 0.11  | 0.10  | 0.09  |
 |                        |       |       |       |       |       |       |
 |            Used        | 0.19  | 0.15  | 0.12  | 0.11  | 0.10  | 0.10  |
 |                        |       |       |       |       |       |       |
 | Runoff  (in)           | 1.04  | 1.57  | 2.21  | 2.72  | 3.06  | 3.59  |
 |                        |       |       |       |       |       |       |
 | Unit Peak Discharge    | 0.558 | 0.579 | 0.595 | 0.603 | 0.607 | 0.608 |
 |    (cfs/acre/in)       |       |       |       |       |       |       |
 |                        |       |       |       |       |       |       |
 | Pond and Swamp Factor  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
 |    0.0% Ponds Used     |       |       |       |       |       |       |
 |----------------------- |-------|-------|-------|-------|-------|-------|
 | Peak Discharge (cfs)   |   34  |   53  |   76  |   95  |  108  |  127  |
==================================================================

* - Value(s) provided from TR-55 system routines
```

```
                 TR-55 Tc and Tt THRU SUBAREA COMPUTATION         VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH      Date: 01-14-93
County  : BROOME               State: NY      Checked:          Date: 1/22/93
Subtitle: BY-PASS CULVERT

-------------------------------------------------------------------------------
Flow Type   2 year   Length   Slope  Surface   n   Area     Wp   Velocity  Time
             rain     (ft)   (ft/ft)   code       (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet        2.8      300      .25      I                                 0.584
Shallow Concent'd     884      .25      U                                 0.030
Open Channel          884                                          1.2    0.205
Open Channel          940                                          5.0    0.052
                                                 Time of Concentration = 0.87*
                                                                         =====


        --- Sheet Flow Surface Codes ---
    A Smooth Surface           F Grass, Dense     --- Shallow Concentrated ---
    B Fallow (No Res.)         G Grass, Burmuda   ---     Surface Codes    ---
    C Cultivated < 20 % Res.   H Woods, Light               P Paved
    D Cultivated > 20 % Res.   I Woods, Dense               U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION                  VERSION 1.11
Project : COLESVILLE LANDFILL                           User: KPH     Date: 01-14-93
County  : BROOME                State: NY            Checked:         Date: 1/22/93
Subtitle: BY-PASS CULVERT

---------------------------------------------------------------------------------
                                                      Hydrologic Soil Group
        COVER DESCRIPTION                        A        B        C        D
                                                          Acres (CN)
---------------------------------------------------------------------------------
OTHER AGRICULTURAL LANDS
Woods                             fair           -        -        -   58.1(79)


Total Area (by Hydrologic Soil Group)                                  58.1
                                                                       ====

---------------------------------------------------------------------------------
               TOTAL DRAINAGE AREA: 58.1 Acres     WEIGHTED CURVE NUMBER:79*
---------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

By KPH Date 1-21-93
Chkd. by Date 1/22/93
Subject

WehranEnviroTech
COLESVILLE LANDFILL

Job No. 02260 CS
Sheet No. ________ of ________

TREATMENT PLANT ACCESS ROAD CULVERT

- CULVERT LOCATED IN CHANNEL DC-1-2 TO ALLOW VEHICLE TRAFFIC TO TREATMENT PLANT

Q_{25} = 5.0 CFS (FROM DC-1-2 CHANNEL SIZING)

S = 2.9 %

L = 67 FT

TRY 1 - 18" RCP CULVERT

INLET CONDITION

CHART 1 $\frac{H_W}{D} = .85$ $H_W = .85(1.5') = 1.3'$

OUTLET CONDITION

CHART 5 $H = 0.2'$
CHART 4 $d_c = 0.8'$

$h = \frac{d_c + D}{2}$ OR T_W

$\frac{0.8 + 1.5}{2} = 1.15 > 0.7$ (FROM DC-1-2 FLOW DEPTH)

$H_W = H - L(S_o) - h_o$
$0.2 - 67(.029) + 1.15$
$H_W = 0$

INLET CONDITION GOVERNS $H_W = 1.3'$

CHECK PIPE CAPACITY

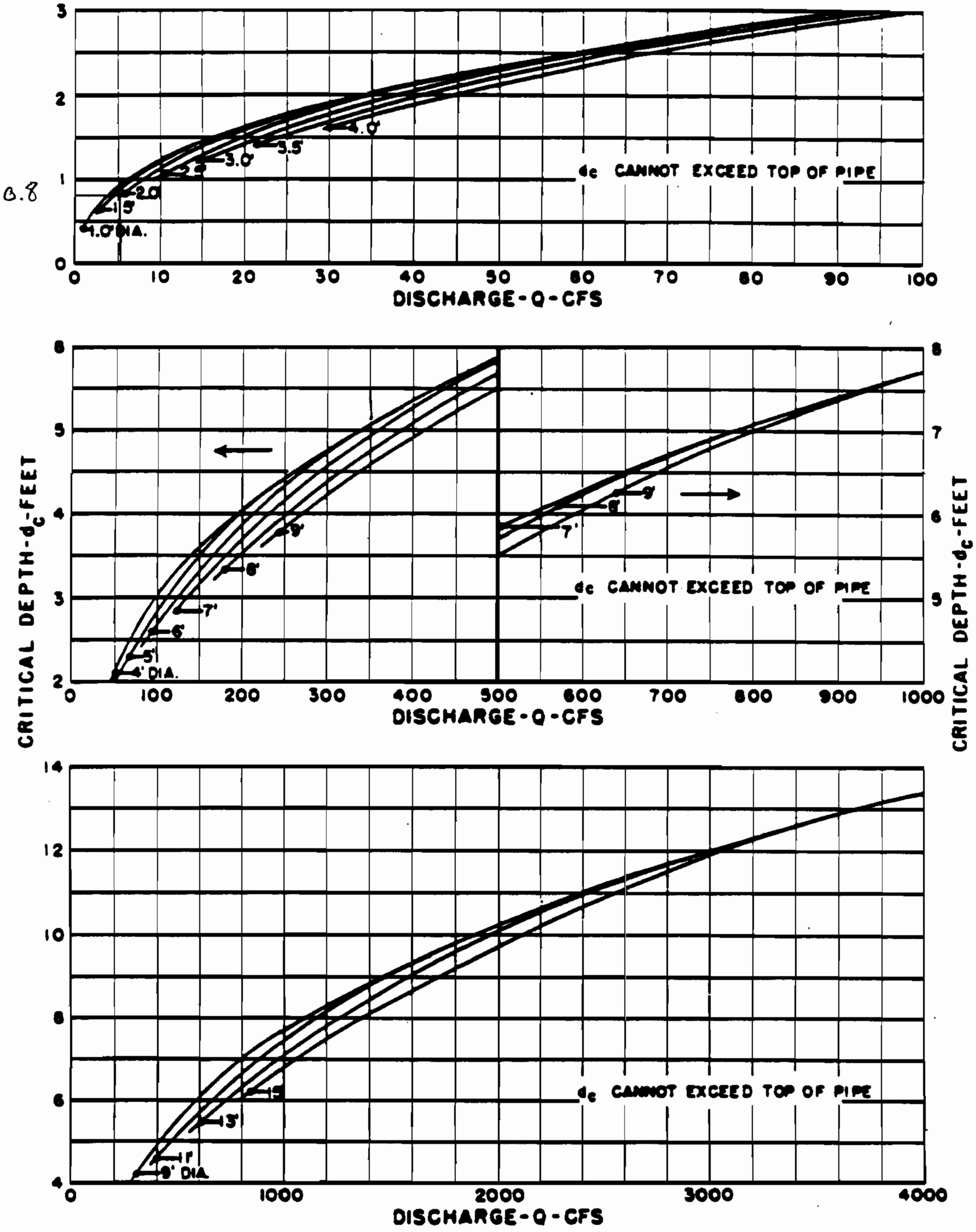
$$Q_{CAP} = \frac{1.49}{n} A (R)^{2/3} (S)^{1/2}$$

$$Q_{CAP} = \frac{1.49}{0.12} \left(\frac{\pi 1.5^2}{4}\right) \left(\frac{1.5}{4}\right)^{2/3} (.0290)^{1/2}$$

Q_{CAP} 19.4 > 5.0 OK

CHART 4

0.8

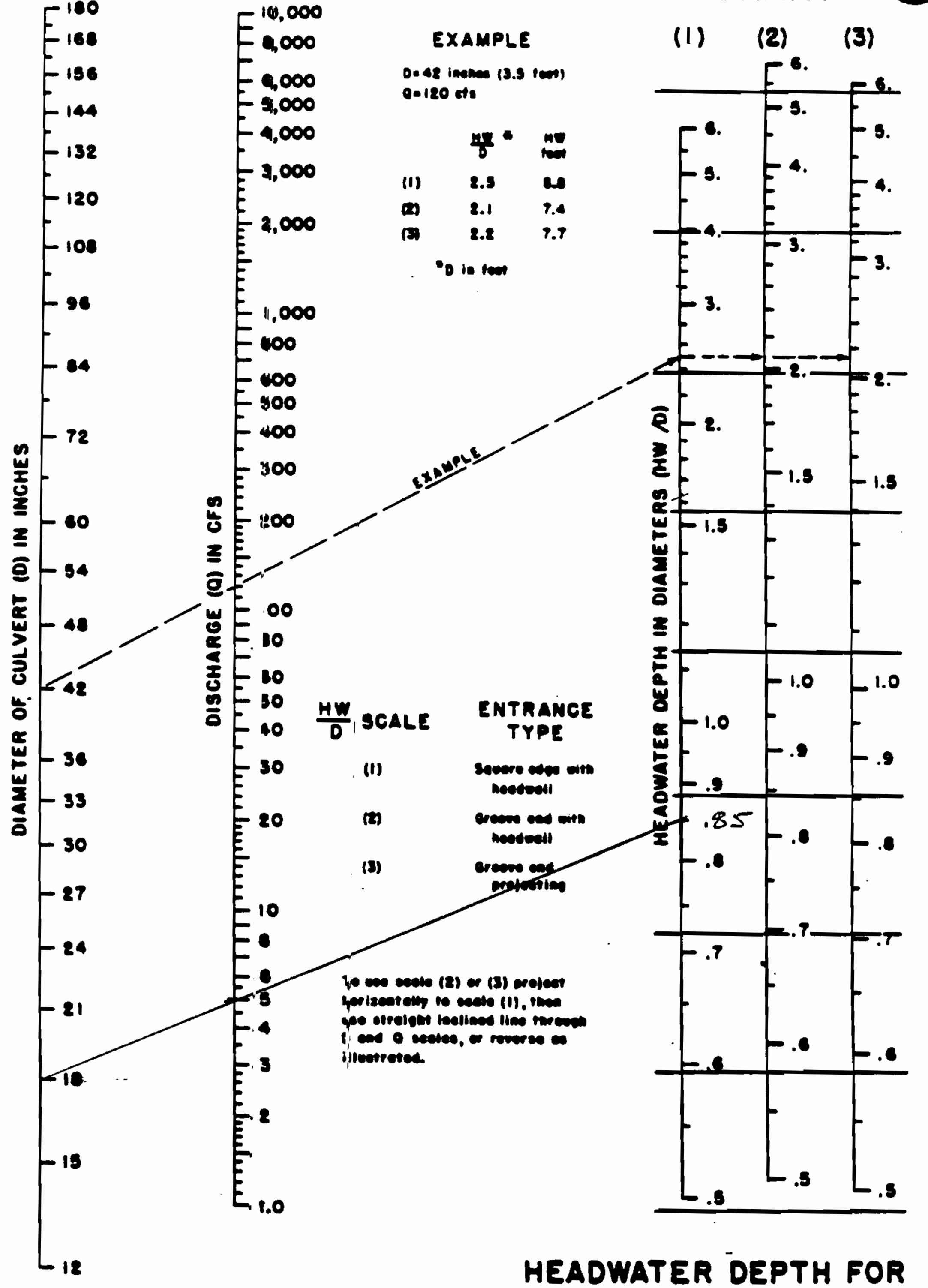


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

CHART 1



EXAMPLE

D=42 inches (3.5 feet)
Q=120 cfs

	$\frac{HW}{D}$ *	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Square edge with headwall
(2)	Groove end with headwall
(3)	Groove end projecting

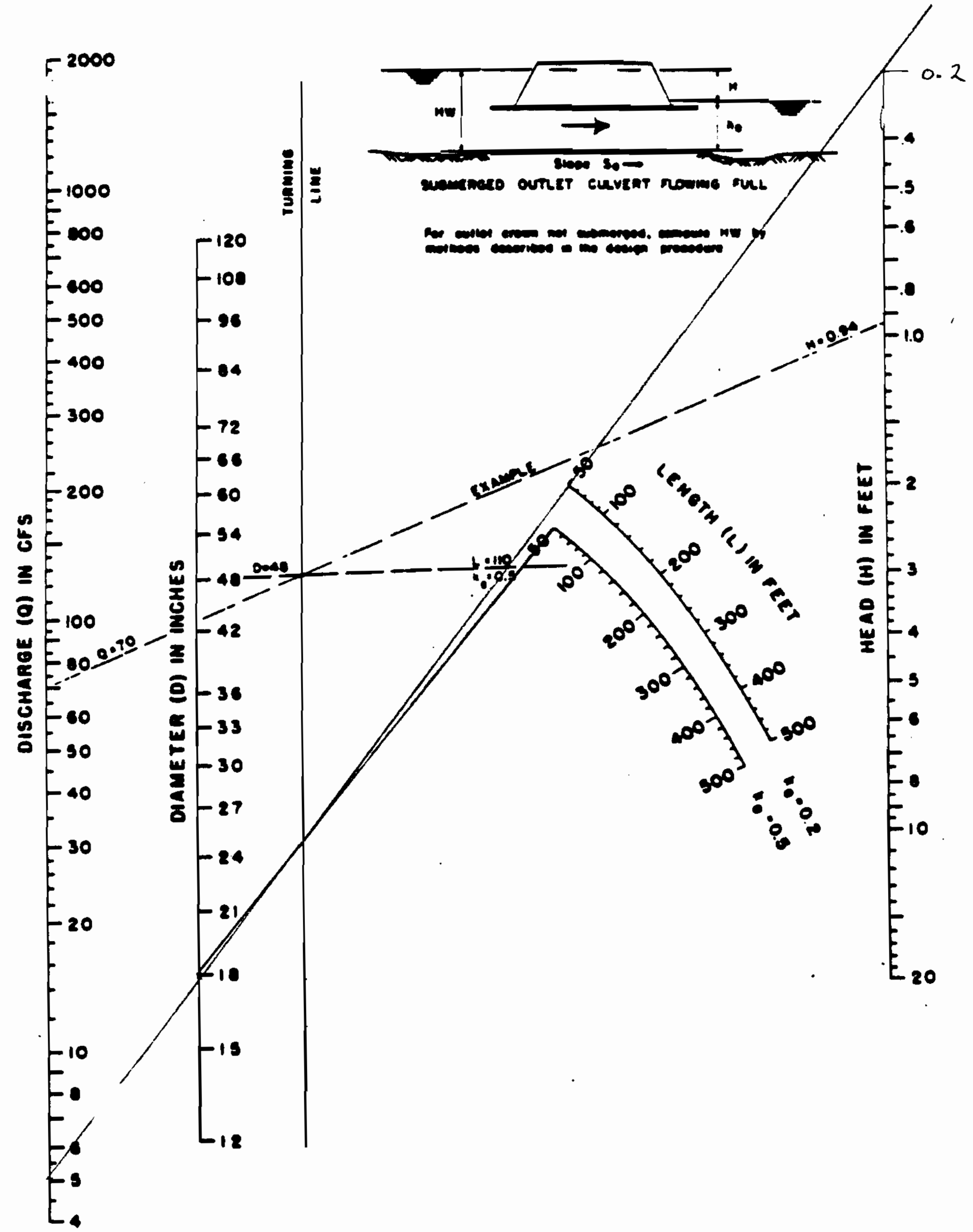
To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 5



BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full Entrance head loss

$$H_e = k_e \left(\frac{V^2}{2g} \right)$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be

```
                    TR-55 GRAPHICAL DISCHARGE METHOD                VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH        Date: 01-14-93
County  : BROOME                 State: NY    Checked:            Date: 1/22/93
Subtitle: CHANNEL DC-1-2

  Data: Drainage Area          :  2.3 * Acres
        Runoff Curve Number    :  80 *
        Time of Concentration:  0.48 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

=================================================================
| Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
 ---------------------- ------- ------- ------- ------- ------- -------
| Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
|                       |       |       |       |       |       |       |
| 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.5  |  5.3  |  5.9  |
|                       |       |       |       |       |       |       |
| Ia/P Ratio            | 0.18  | 0.14  | 0.12  | 0.11  | 0.09  | 0.08  |
|                       |       |       |       |       |       |       |
|            Used       | 0.18  | 0.14  | 0.12  | 0.11  | 0.10  | 0.10  |
|                       |       |       |       |       |       |       |
| Runoff (in)           | 1.10  | 1.64  | 2.29  | 2.46  | 3.16  | 3.69  |
|                       |       |       |       |       |       |       |
| Unit Peak Discharge   |0.788  |0.814  |0.833  |0.836  |0.844  |0.844  |
|    (cfs/acre/in)      |       |       |       |       |       |       |
|                       |       |       |       |       |       |       |
| Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|    0.0% Ponds Used    |       |       |       |       |       |       |
 ---------------------- ------- ------- ------- ------- ------- -------
| Peak Discharge (cfs)  |     2 |     3 |     4 |     5 |     6 |     7 |
=================================================================

* - Value(s) provided from TR-55 system routines
```

```
                 TR-55 Tc and Tt THRU SUBAREA COMPUTATION          VERSION 1.11
Project : COLESVILLE LANDFILL                          User: KPH    Date: 01-14-93
County  : BROOME               State: NY            Checked:        Date: 1/22/93
Subtitle: CHANNEL DC-1-2

-------------------------------------------------------------------------------
Flow Type     2 year   Length   Slope  Surface   n    Area    Wp   Velocity  Time
               rain     (ft)  (ft/ft)   code        (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet          2.8      190     .01      E                                  0.364
Open Channel            270                                          3.0    0.025
Open Channel            400                                          1.2    0.093
                                                  Time of Concentration = 0.48*
                                                                          =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface           F Grass, Dense     --- Shallow Concentrated ---
    B Fallow (No Res.)         G Grass, Burmuda   ---     Surface Codes     ---
    C Cultivated < 20 % Res.   H Woods, Light              P Paved
    D Cultivated > 20 % Res.   I Woods, Dense              U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION                 VERSION 1.11
Project : COLESVILLE LANDFILL                         User: KPH      Date: 01-14-93
County  : BROOME                 State: NY         Checked:          Date: 1/22/93
Subtitle: CHANNEL DC-1-2

-------------------------------------------------------------------------------
                                                       Hydrologic Soil Group
         COVER DESCRIPTION                         A        B        C        D
                                                          Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Good condition; grass cover > 75%                -        -        -    2.3(80)


Total Area (by Hydrologic Soil Group)                                     2.3
                                                                         ====


-------------------------------------------------------------------------------
                 TOTAL DRAINAGE AREA: 2.3 Acres      WEIGHTED CURVE NUMBER:80*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

CULVERT OUTLET PROTECTION

By KPH Date 1-21-93 **WehranEnviroTech** Job No. 02260.CS
Chkd. by Date 1/22/93 Sheet No. ____ of ____
Subject COLESVILLE LANDFILL

CULVERT OUTLET PROTECTION

OUTLET PROTECTION WAS DESIGNED TO INSURE CHANNEL PROTECTION BEYOND THE DISCHARGE POINT OF THE CULVERTS UNTIL FLOW VELOCITIES ARE REDUCED TO A LEVEL CONSISTENT WITH A STABLE DOWN STREAM CONDITION.

THE DESIGN PROCEDURE IS FROM THE NEW YORK STATE GUIDLINES FOR URBAN EROSION AND SEDIMENT CONTROL (NYSGUESC)

CULVERT	DIAM	TAILWATER ①	DESIGN CONDITION
BY-PASS	36" RCP	0.8	TW < 0.50D.
T.P ACCESS	18 RCP	0.5'-0.7'	TW < 0.50 D

1. TAILWATER ASSUMED TO BE APPROX. DEPTH OF UPSTREAM FLOW. FOR BY BY PASS CULVERT. ACTUAL DOWNSTREAM CHANNEL DEPTH (DC-1-2) USED FOR T.P ACCESS CULVERT

By KPH Date 1-21-93
Chkd. by Date
Subject COLESVILLE LANDFILL

WehranEnviroTech

Job No. 02260.CS
Sheet No. of

OUTLET PROTECTION

THE DESIGN CHARTS PROVIDED IN THE NYSGUESC REQUIRE FULL PIPE FLOW. SINCE THIS CONDITION DOES NOT EXIST THE DEPTH OF FLOW AND VELOCITY AT THE OUTLET MUST BE USED.

DESIGN STEPS

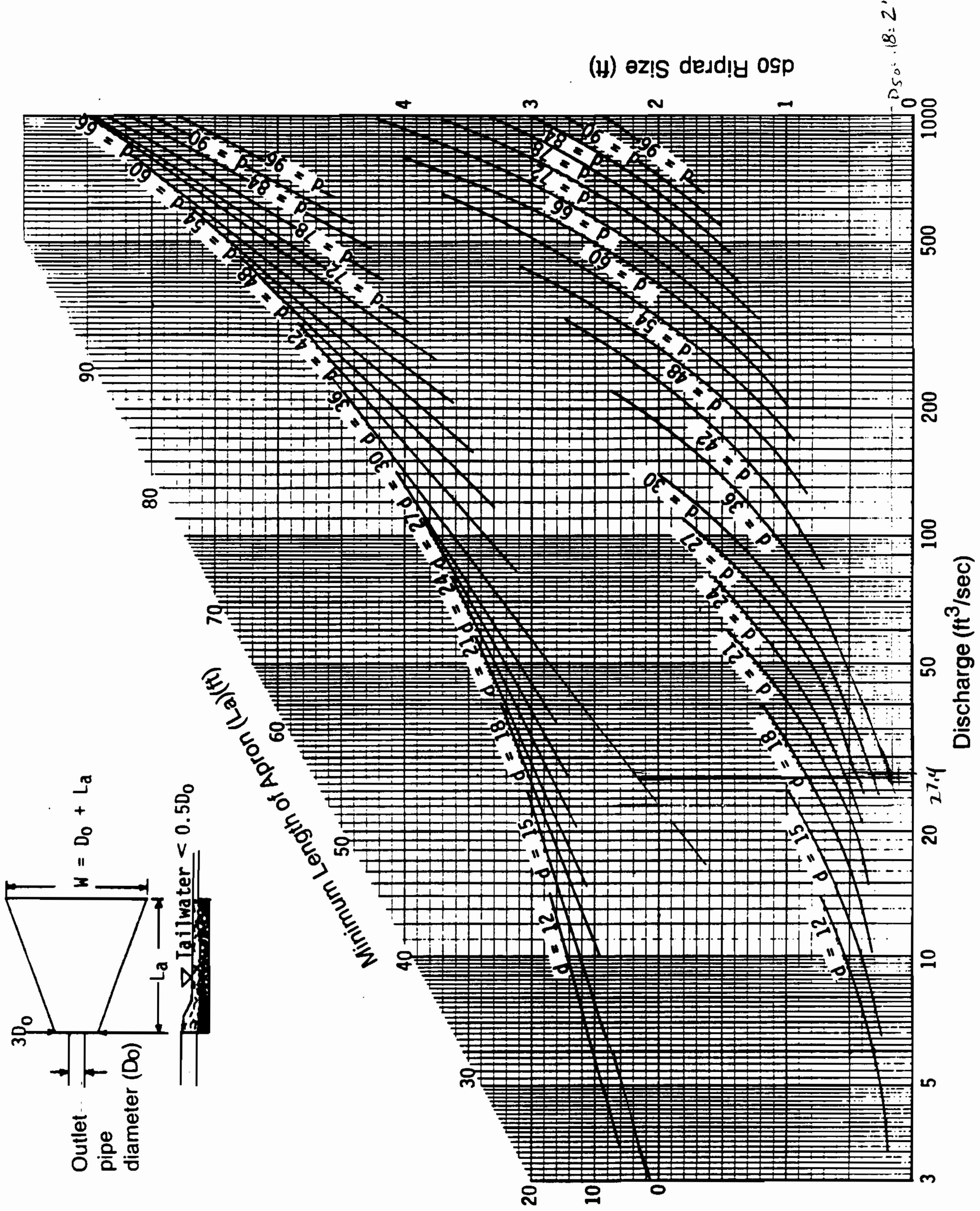
1. CALCULATE q FOR A FULL FLOWING PIPE USING MANNING'S EQN

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

2. DETERMINE d/D RATION FROM ATTACHED REFERENCE
3. DETERMINE V/VFULL USING REFERENCE
4. CALCULATE VFULL FROM QFULL/TOTAL AREA
5. FIND VACT FROM VACT/VFULL
6. CALCULATE $Q_{nomograph} = V_{ACTUAL} \times A_{ACTUAL}$

   USING depth OF FLOW AS DIAMETER
7. DETERMINE OUTLET PROTECTION FROM GRAPH

Figure 5B.12
Outlet Protection Design - Minimum Tailwater Condition
(Design of Outlet Protection from a Round Pipe Flowing Full, Minimum Tailwater Condition: $T_W < 0.5D_O$)



CULVERT OUTLET PROTECTION DESIGN SUMMARY

CULVERT	Q NOM.	D_{50} REQUIRED	LENGTH OF APRON
BY-PASS	20.0	$D_{50}=2'$	0
T.P. ACCESS	2.2	$D_{50}=0$	N/A

ACCORDING TO DESIGN PROCEDURE NO OUTLET PROTECTION IS REQUIRED.

DUE TO EXPECTED VELOCITIES THROUGH CULVERT OUTLET PROTECTION will be PROVIDED CONSISTING OF 20' LONG LEVEL APRON WITH THE 1ST 9LF will be 18" GABION, THE REMAINDER $d_{50} = 6"$

REFER TO CULVERT OUTLET PROTECTION DETAIL IN PLAN SET

By KDH Date 1-21-93
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OUTLET PROTECTION DESIGN

CULVERT	QFULL①	SLOPE	DIA.	QACT	d/D②	d	V/VFULL	VFULL③	VACTUAL	QNOMOGRAPH④
BY PASS	188 CFS	6.7%	36"	47.5	0.39	1.17	0.69	26.6 FPS	18.4 FPS	20 CFS
T.P. ACCESS	21.0 CFS	3.4%	18"	5 CFS	0.39	0.59	0.69	11.88 FPS	8.2 FPS	2.2 CFS

1. SEE CULVERT DESIGN FOR CAPACITY CALCULATION

2. SEE REF "APPENDIX 19.C"

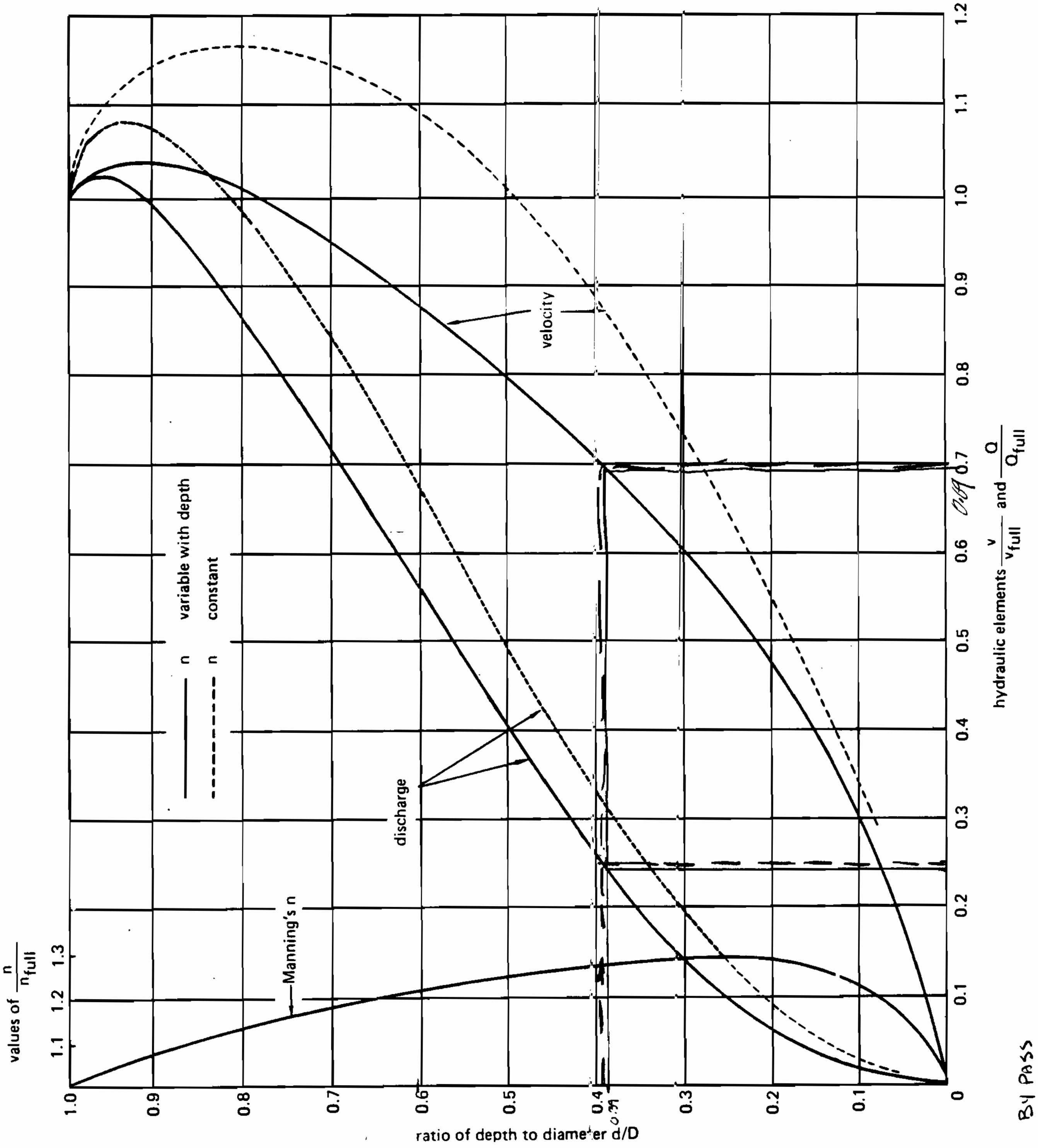
3 $V_{FULL} = \frac{Q_{FULL}}{\frac{\pi D^2}{4}}$

4 Q_{nom} : V_{ACT} ACT
$V_{ACT}\ \frac{\pi d^2}{4}$ – depth of flow

APPENDIX 19.C

Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.



- - - - BY PASS

—— T. P ACCESS

*

SEDIMENT BASIN

DESIGN STORM

SEDIMENT STORAGE

SPILLWAY SIZING

By KPH Date 1-20-93 **WehranEnviroTech** Job No. 02260 CS
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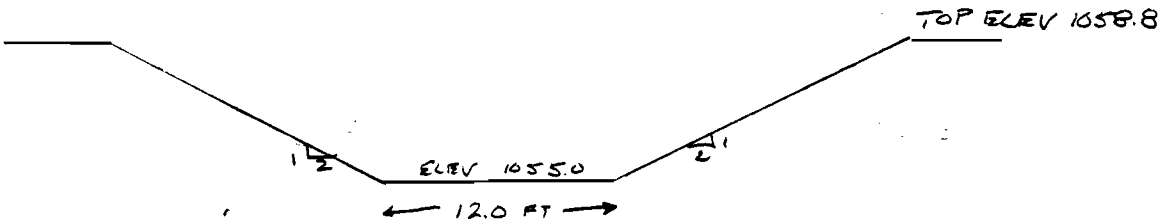
SEDIMENT BASIN

DESIGN STORM 10 yr 24hr STORM

Q_{25} = 68 CFS (FROM TR-55)

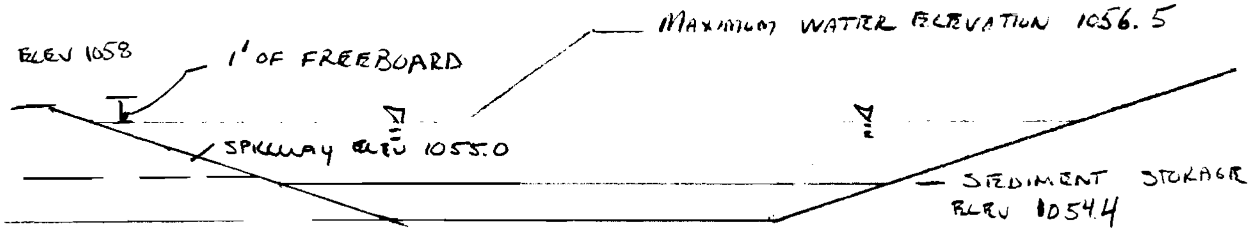
SIZE GABION SPILLWAY TO PASS ONE HUNDRED YEAR STORM ALONE AND ALLOW CONSTRUCTION OF THE SEDIMENT BASIN WITH ONE OUTLET



SEDIMENT STORAGE 39.7 ACRES ~1800 CF/ACRE

71,460 CF = STORAGE

STORAGE ELEVATION ± 1054.4 (SEE VOLUME CALC)



1055.5
1055-outlet

BY:____ DATE:____ CHK:____ DATE:__

DIVERSION CHANNEL DESIGN – GABION LINING

JOB NO. 02260 CS

COLESVILLE LANDFILL CLOSURE
.SEDIMENT BASIN SPILLWAY

INPUT	
DESIGN PEAK DISCHARGE, Q (CFS)	107.0
CHANNEL SLOPE, S (FT/FT)	0.330
CHANNEL SIDESLOPE – LEFT SIDE (HORIZ/VERT)	2.0
CHANNEL SIDESLOPE – RIGHT SIDE (HORIZ/VERT)	2.0
CHANNEL BOTTOM WIDTH, B (FT)	12.0
MANNING'S ROUGHNESS COEFFICIENT, n	0.030
GABION MATTRESS THICKNESS, t (IN) (USE 6, 9, 12 OR 18)	18.0
FREEBOARD (FT)	1.0
BEGIN CALCULATIONS AT CHANNEL DEPTH (FT)	0.0

CHANNEL DEPTH (FT)	X–SECT AREA (SQ FT)	TOP WIDTH (FT)	HYDRAULIC RADIUS (FT)	DISCHARGE (CFS)	VELOCITY (FPS)	FROUDE NUMBER Nf
0.0	0.0	12.0	0.00	0.0	0.0	0.00
0.1	1.2	12.4	0.10	7.4	6.1	3.40
0.2	2.5	12.8	0.19	23.6	9.5	3.80
0.3	3.8	13.2	0.28	46.5	12.3	4.05
0.4	5.1	13.6	0.37	75.4	14.7	4.23
0.5	6.5	14.0	0.46	109.9	16.9	4.37
0.6	7.9	14.4	0.54	149.7	18.9	4.49
0.7	9.4	14.8	0.62	194.5	20.7	4.59
0.8	10.9	15.2	0.70	244.3	22.5	4.68
0.9	12.4	15.6	0.78	299.0	24.1	4.75
1.0	14.0	16.0	0.85	358.4	25.6	4.82

DESIGN DEPTH OF FLOW, D (FT)	0.5
VELOCITY, V (FPS)	16.9
TOTAL DEPTH INCLUDING FREEBOARD (FT)	1.5
GABION THICKNESS, t (IN)	18.0
FILLING STONE SIZE, d50 (IN)	6.0

```
                         COLESVILLE LANDFILL
                         SEDIMENT POND VOLUME


              CALCULATED    01-22-1993    16:25:46
                    DISK FILE : B:COLEVILL.VOL

              Planimeter scale: 1 inch = 50 ft.
                                                      *
Elevation    Planimeter       Area   A1+A2+sqr(A1*A2)  Volume    Volume Sum
   (ft)      (sq.in.)       (acres)      (acres)     (acre-ft)   (acre-ft)
-----------------------------------------------------------------------------
1,050.00         5.26         0.30         0.00         0.00           0.00
1,052.00          *I*         0.37         1.01         0.67           0.67
1,054.00          *I*         0.45         1.12         1.50           1.50
1,054.40          *I*         0.47         1.15         1.68 (73,180 SF) 1.68
1,058.00        11.00         0.63         1.37         3.65           3.65


   *I* ---> Interpolated area from closest two planimeter readings.

                                                                          2
   IA = (sq.rt(Area1) + ((Ei-E1)/(E2-E1))*(sq.rt(Area2)-sq.rt(Area1)))

   where: E1, E2       = Closest two elevations with planimeter data
          Ei           = Elevation at which to interpolate area
          Area1,Area2  = Areas computed for E1, E2, respectively
          IA           = Interpolated area for Ei


*  Incremental volume computed by the Conic Method for Reservoir Volumes.

   Volume = (1/3) * (EL2-EL1) * (Area1 + Area2 + sq.rt.(Area1*Area2))

   where: EL1, EL2      = Lower and upper elevations of the increment
          Area1,Area2   = Areas computed for EL1, EL2, respectively
          Volume        = Incremental volume between EL1 and EL2
```

```
                    TR-55 GRAPHICAL DISCHARGE METHOD              VERSION 1.11
Project : COLESVILLE LANDFILL                     User: KPH       Date: 01-14-93
County  : BROOME                State: NY      Checked:           Date: 1/22/93
Subtitle: SEDIMENT BASIN

  Data: Drainage Area          :  39.7 * Acres
        Runoff Curve Number    :  83 *
        Time of Concentration:    0.73 * Hours
        Rainfall Type          :  II
        Pond and Swamp Area    :  NONE

======================================================================
 | Storm Number          |   1   |   2   |   3   |   4   |   5   |   6   |
 ------------------------ ------- ------- ------- ------- ------- -------
 | Frequency  (yrs)      |   2   |   5   |  10   |  25   |  50   |  100  |
 |                       |       |       |       |       |       |       |
 | 24-Hr Rainfall (in)   |  2.8  |  3.5  |  4.3  |  4.9  |  5.3  |  5.9  |
 |                       |       |       |       |       |       |       |
 | Ia/P Ratio            | 0.15  | 0.12  | 0.10  | 0.08  | 0.08  | 0.07  |
 |                       |       |       |       |       |       |       |
 |            Used       | 0.15  | 0.12  | 0.10  | 0.10  | 0.10  | 0.10  |
 |                       |       |       |       |       |       |       |
 | Runoff (in)           | 1.29  | 1.86  | 2.55  | 3.08  | 3.45  | 4.00  |
 |                       |       |       |       |       |       |       |
 | Unit Peak Discharge   | 0.645 | 0.663 | 0.673 | 0.673 | 0.673 | 0.673 |
 |    (cfs/acre/in)      |       |       |       |       |       |       |
 |                       |       |       |       |       |       |       |
 | Pond and Swamp Factor | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
 |    0.0% Ponds Used    |       |       |       |       |       |       |
 | --------------------- | ------ | ------ | ------ | ------ | ------ | ------ |
 | Peak Discharge (cfs)  |   33  |   49  |   68  |   82  |   92  |  107  |
======================================================================

* - Value(s) provided from TR-55 system routines
```

```
                 TR-55 Tc and Tt THRU SUBAREA COMPUTATION         VERSION 1.11
Project : COLESVILLE LANDFILL                    User: KPH       Date: 01-14-93
County  : BROOME               State: NY      Checked:           Date: 1/22/93
Subtitle: SEDIMENT BASIN

-------------------------------------------------------------------------------
Flow Type    2 year   Length   Slope  Surface   n   Area     Wp   Velocity  Time
              rain     (ft)   (ft/ft)   code       (sq/ft)  (ft)  (ft/sec)  (hr)
-------------------------------------------------------------------------------
Sheet         2.8      300     .25      I                                  0.584
Shallow Concent'd      1210    .25      U                                  0.042
Open Channel           430                                         1.2     0.100
                                                 Time of Concentration = 0.73*
                                                                         =====

        --- Sheet Flow Surface Codes ---
    A Smooth Surface           F Grass, Dense     --- Shallow Concentrated ---
    B Fallow (No Res.)         G Grass, Burmuda   ---       Surface Codes     ---
    C Cultivated < 20 % Res.   H Woods, Light               P Paved
    D Cultivated > 20 % Res.   I Woods, Dense               U Unpaved
    E Grass-Range, Short
* - Generated for use by GRAPHIC method
```

```
                      TR-55 CURVE NUMBER COMPUTATION                VERSION 1.11
Project : COLESVILLE LANDFILL                       User: KPH       Date: 01-14-93
County  : BROOME                   State: NY     Checked:           Date: 1/22/93
Subtitle: SEDIMENT BASIN

-------------------------------------------------------------------------------
                                                       Hydrologic Soil Group
        COVER DESCRIPTION                         A         B        C        D
                                                            Acres (CN)
-------------------------------------------------------------------------------
FULLY DEVELOPED URBAN AREAS (Veg Estab.)
Open space (Lawns,parks etc.)
  Poor condition; grass cover < 50%               -         -        -  16.6(89)
  Good condition; grass cover > 75%               -         -        -  11.6(80)


OTHER AGRICULTURAL LANDS
Woods                             fair            -         -        -  11.5(79)



Total Area (by Hydrologic Soil Group)                                   39.7
                                                                        ====


-------------------------------------------------------------------------------
                TOTAL DRAINAGE AREA: 39.7 Acres      WEIGHTED CURVE NUMBER:83*
-------------------------------------------------------------------------------
* - Generated for use by GRAPHIC method
```

ENERGY DISSAPATOR PAD

By KPH Date 1-21-93 **WehranEnviroTech** Job No. 02260.CS
Chkd. by Date 1/22/93 Sheet No. ______ of ______
Subject Colesville Landfill

ENERGY DISSAPATOR PAD

ENERGY DISSAPATOR PADS ARE DESIGNED ON FLOW FROM CHANNEL DC-6 (SEE ATTACHED). BOTH INLET CHANNELS (DC-2-INLET & DC-6-INLET) will have PADS AT THE INTERSECTION OF THE CHANNEL AND BASIN FLOOR.

PADS ARE PROVIDED AT POINTS WHERE CHANNELIZED FLOW will UNDERGO HYDRAULIC JUMP AND THE POTENTIAL FOR SCOURING OF THE SUBGRADE IS PROBABLE.

THE DESIGN METHOD IS IN ACCORDANCE WITH PROCEDURES OUTLINED IN "HYDRAULIC DESIGN OF STILLING BASINS AND ENERGY DISSAPATORS" PUBLISHED by THE BUREAU OF RECLAMATION. HYDRAULIC JUMP CALCULATIONS BASED UPON PROCEDURES DISCUSSED IN "HANDBOOK OF HYDRAULICS" by BRATER AND KING

By KPN Date 1-21-93 **WehranEnviroTech** Job No. 02260 CS
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ENERGY DISSAPATOR PAD DESIGN

$Q = 32.0$ CFS
$V_1 = 7.6$ FPS
$b = 3.0$ FT
$D_1 = 0.9$ FT

} GENERATED FROM TR-55 AND CHANNEL SIZING SHEET REFER TO CHANNEL DC-6-INLET

DESIGN

1. DETERMINE FROUDE #

$$F = \frac{V_1}{\sqrt{g D_1}} = \frac{7.6}{\sqrt{32.2(0.9)}}$$

* FOR FORMULA REFER TO ATTACHED SHT FIG. 7

$F = 1.41$

2. DETERMINE CONJUGATE DEPTH AFTER HYDRAULIC JUMP (D_2)

$$\frac{D_2}{D_1} = \frac{1}{2}\left[\sqrt{1+8F_1^2} - 1\right.$$

$$D_2 = \frac{0.9}{2}\left[\sqrt{1+8(1.41)^2} - 1\right]$$

$D_2 = 1.41$

3. DETERMINE LENGTH OF JUMP FROM FIG. 7

FOR $F_1 = 1.41$ $\frac{L}{D_2} = 3.6$ $3.6(1.41)$

$L = 5.0'$

USE LENGTH 6.0'
WIDTH 12.0'

GABION PROTECTION 12" THICK
$D_{50} = 6''$ FILLING

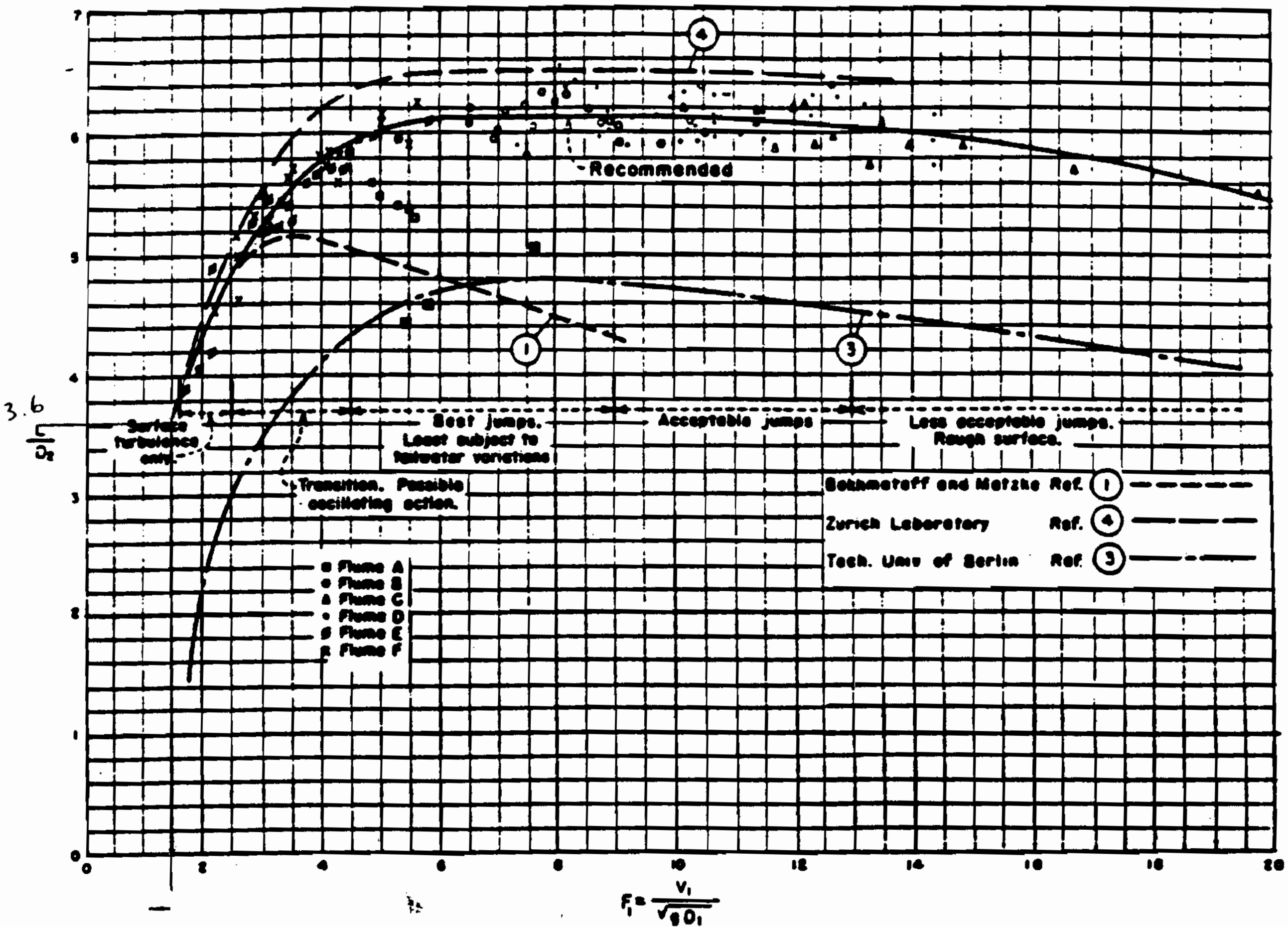

FIGURE 7.—*Length of jump in terms of D_2 (Basin I).*

the Federal Institute of Technology, Zurich, Switzerland, on a flume 0.6 of a meter wide and 7 meters long. The curve numbers are the same as the reference numbers in the "Bibliography" which refer to the work.

As can be observed from Figure 7, the test results from Flumes B, C, D, E, and F plot sufficiently well to establish a single curve. The five points from Flume A, denoted by squares, appear somewhat erratic and plot to the right of the general curve. Henceforth, reference to Figure 7 will concern only the recommended curve, which is considered applicable for general use.

Energy Absorption in Jump

With the experimental information available, the energy absorbed in the jump may be computed. Columns 14 through 18, Table 1, list the computations, and the symbols may be defined by consulting the specific energy diagram in Figure 4. Column 14 lists the total energy, E_1, entering the jump at Section 1 for each test. This is simply the depth of flow, D_1, plus the velocity head computed at the point of measurement. The energy leaving the jump, which is the depth of flow plus the velocity head at Section 2, is tabulated in Column 15. The differences in the values of Columns 14 and 15 constitute the loss of energy, in feet of water, attributed to the conversion, Column 16. Column 18 lists the percentage of energy lost in the jump, E_L, to the total energy entering the jump, E_1. This percentage is plotted with respect to the Froude number and is shown as the curve to the left on Figure 8. For a Froude number of 2.0, which would correspond to a relatively thick jet entering the jump at low velocity, the curve shows the

UNIVERSAL SOIL LOSS CALCULATIONS

UNIVERSAL SOIL LOSS EQUATION (USLE)

- CALCULATIONS -

USLE WAS PERFORMED ON TWO DISTINCT AREAS, THE FIRST AREA CONSISTS OF THE PORTION OF THE SITE TRIBUTARY TO THE SEDIMENT POND THE SECOND AREA CONSISTS OF THE AREA TO BE CAPPED THAT IS NOT TRIBUTARY TO THE SEDIMENT POND.

FOR EACH AREA THE SOIL LOSS AND SEDIMENT YIELD WAS CALCULATED ASSUMED CONDITIONS, TOTAL SCARIFICATION AND TOTAL VEGETATION.

FOR THE AREA TRIBUTARY TO THE SEDIMENT POND THE ASSUMPTION OF ENTIRE SCARIFICATION WAS USED TO CHECK THE SEDIMENT STORAGE CAPACITY OF THE POND ON A WORST CASE SITUATION. AS SHOWN ON THE SUMMARY TABLE THE AVAILABLE SEDIMENT STORAGE EXCEEDS THE PREDICTED YIELD FROM THE WORST CASE SCENARIO. THE USLE WAS PERFORMED FOR THE SECOND AREA, NOT TRIBUTARY TO THE SEDIMENT POND, ASSUMING TOTAL SCARIFICATION. THOUGH THE TOTAL SEDIMENT YIELD EXCEEDS THE RECOMMENDED VALUE IT MUST BE RECOGNIZED THAT BASED UPON THE EXISTING SITE TOPOGRAPHY, TYPICAL FINAL COVER CONSTRUCTION PROCEDURE AND PROPOSED STORMWATER CONTROL MEASURES IT IS EXTREMELY UNLIKELY THAT THIS CAN OR WILL OCCUR DURING THE CONSTRUCTION SEQUENCE.

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UNIVERSAL SOIL LOSS EQUATION

THE UNIVERSAL SOIL LOSS EQUATION (USLE) IS UTILIZED TO ESTIMATE SOIL EROSION DUE TO STORMWATER RUNOFF FROM SPECIFIC FIELD AREAS. THE USLE PREDICTS SOIL LOSS AS A PRODUCT OF SIX VARIABLES NUMERICALLY REPRESENTED. THE USLE IS SUBSTANTIALLY LESS ACURATE IN PREDICTING SHORT TERM VARIATION IN SOIL LOSS AND IS BEST USED AS A MEANS FOR PREDICTING LONG TERM AVERAGES. THE USLE CALCULATES SOIL LOSS DUE TO THE EROSIVE FORCE OF RAINFALL (GROSS EROSION), THE EQUATION DOES NOT TAKE INTO CONSIDERATION SEDIMENT DEPOSITION WITHIN THE WATERSHED. A SEDIMENT YIELD FACTOR HAS BEEN USED TO ADJUST THE GROSS EROSION OCCURING TO WHAT ACTUALLY MIGRATES OFF SITE. THE YIELD FACTOR TAKES INTO ACCOUNT RELIEF OF WATERSHED, CHANNELIZATION OF STORMWATER, WATERSHED SIZE AND SOIL CHARACTERISTICS. DUE TO THE LARGE DEGREE OF UNCERTAINTY WITH THE PARAMETERS AN ESTIMATE WAS MADE BASED ON RECOMENDATIONS IN THE NEW YORK STATE GUIDLINES FOR URBAN EROSION AND SEDIMENT CONTROL.

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THE USLE WAS ALSO PERFORMED FOR BOTH WATERSHEDS ASSUMING POST CONSTRUCTION CONDITION OR TOTAL VEGETATION. AS SHOWN ON THE SUMMARY TABLE THE SEDIMENT YIELD FOR BOTH AREAS IS WITHIN ACCEPTABLE LIMITS (less than 2.0 tons/acre yr).

SINCE THE REMOVAL OF THE SEDIMENT POND IS CONTINGENT UPON THE ESTABLISHMENT OF VEGETATION IN THE BORROW AREA, THE HIGH SEDIMENT YIELDS FROM THIS AREA will be HANDLED BY THE SEDIMENT POND. FOR THE AREA NOT TRIBUTARY TO THE SEDIMENT POND; SEDIMENT YIELD CAN BE EXPECTED TO BE LESS THEN THE 2.0 TON/ACRES YR Recomended SINCE THE AREA SCARIFIED will be only A limited PORTION OF THE TOTAL AREA WITH THE REST OF THE AREA BEING UNDISTURBED OR Mulched FOR FINAL COVER

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Chkd. by [illegible] Date 3/23/93
Subject

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UNIVERSAL SOIL LOSS EQUATION

SUMMARY TABLE

DRAINAGE AREA DESCRIPTION	COVER DESCRIPTION	GROSS EROSION/YR		SEDIMENT YIELD/YR		POND SEDIMENT STORAGE (TONS)	
		PER AC (TONS/AC)	TOTAL (TONS)	PER AC	TOTAL	(TOTAL)	CLEANOUT LEVEL)
ENTERING INTO SEDIMENT BASIN (AREA = 39.7 AC)	ENTIRELY SCARIFIED	95.2	3779	38.1	1511.6	1897	949
	ENTIRELY VEGETATED	4.76	189.0	1.90	75.4	N/A	N/A
NOT ENTERING INTO SEDIMENT BASIN (AREA = 13.9 AC)	ENTIRELY SCARIFIED	16.8	233	5.0	69.9	N/A	N/A
	ENTIRELY VEGETATED	.84	11.7	.25	3.5	N/A	N/A

By KPH Date 3/19/93
Chkd. by Date 3/23/93
Subject COLESVILLE LF

WehranEnviroTech

Job No. 02260 CS
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UNIVERSAL SOIL LOSS EQUATION

AREA ENTERING INTO RECLAIMED SEDIMENT BASIN.

EQUATION

$A = RKLSC$

COMPUTE SOIL LOSS ASSUMING REESTABLISHMENT OF VEGETATION IN ALL AREAS.

$R = 100$
$K = 0.28$
* $LS = 3.4$
$C = 0.05$

CALCULATE A = TONS/ACRE YEAR

$A = 100(0.28)(3.4)(0.05) = 4.76$ TONS/ACRE YEAR

A REPRESENTS SOIL LOSS. ACTUAL SEDIMENT YIELD RANGES FROM 10 TO 70% OF LOSSES.

CONSERVATIVELY ASSUME 40% OF SOIL MOVES OFF SITE.

ASSUMPTION BASED UPON RELATIVELY MILD SLOPES AT PERIMETER OF DRAINAGE AREA AND CORRESPONDING SOIL DEPOSITION.

4.76 TONS/ACRE YEAR × 0.40 = 1.90 TONS/ACRE YEAR

1.9 T/Ac yr - ACTUAL OFFSITE SOIL LOAD.

By KDH Date 3/19/93
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UNIVERSAL SOIL LOSS EQUATION

AREA NOT ENTERING INTO THE SEDIMENT POND.

COMPUTE SOIL LOSS ASSUMING REESTABLISHMENT OF VEGETATION.

$$\left.\begin{array}{l} R = 100 \\ K = 0.28 \\ LS = 0.6 \\ C = 0.05 \end{array}\right\} \text{VARIABLES}$$

$$A = 100\,(0.28)(0.6)(0.05)$$
$= 0.84$ TONS/ACRE YR = TOTAL SOIL LOSS

CALCULATE SOIL YIELD FROM SITE. YIELD VALUES RANGE FROM 10% TO 70% OF SOIL LOSS. C VALUE ASSUMED AT 30% BASED ON:

- AVERAGE SLOPE EXTREMELY SHALLOW
- PROPOSED DRAINAGE CHANNELS REDUCE OFF SITE SEDIMENT DISCHARGE
- CONSTRUCTION SEQUENCE WILL LIMIT DEVELOPMENT OF AREAS PRONE TO EROSION

0.84 TONS/AC YEAR × 0.30 = .25 TONS/ACRE YR

By KPH Date 1-22-93
Chkd. by Date 1/26/93
Subject

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WESVILLE LANDFILL

UNIVERSAL SOIL LOSS EQUATION

EQ $A = R \times KLS$

A = COMPUTED SOIL LOSS PER ACRE IN TONS

R = RAINFALL INTENSITY FACTOR

L = SLOPE LENGTH FACTOR

S = SLOPE GRADIENT FACTOR

COMPUTE SOIL LOSS FOR 1 YEAR

R = 100

DISTURBED AREA ENTERING INTO SEDIMENT BASIN = 39.7 ACRES -

AVERAGE GRADIENT = 10%

AVERAGE SLOPE LENGTH = 600'

K VALUE - GLACIAL TILL - COARSE SILTY w/ PAN (SEE pg. B5.8

K = 0.28

LS VALUE (SEE TABLE B.4) 3.4

$A = 100 (0.28)(3.4)(39.7) = 3,779$ TONS

ASSUME GLACIAL TILL DENSITY 135 lb/CF -

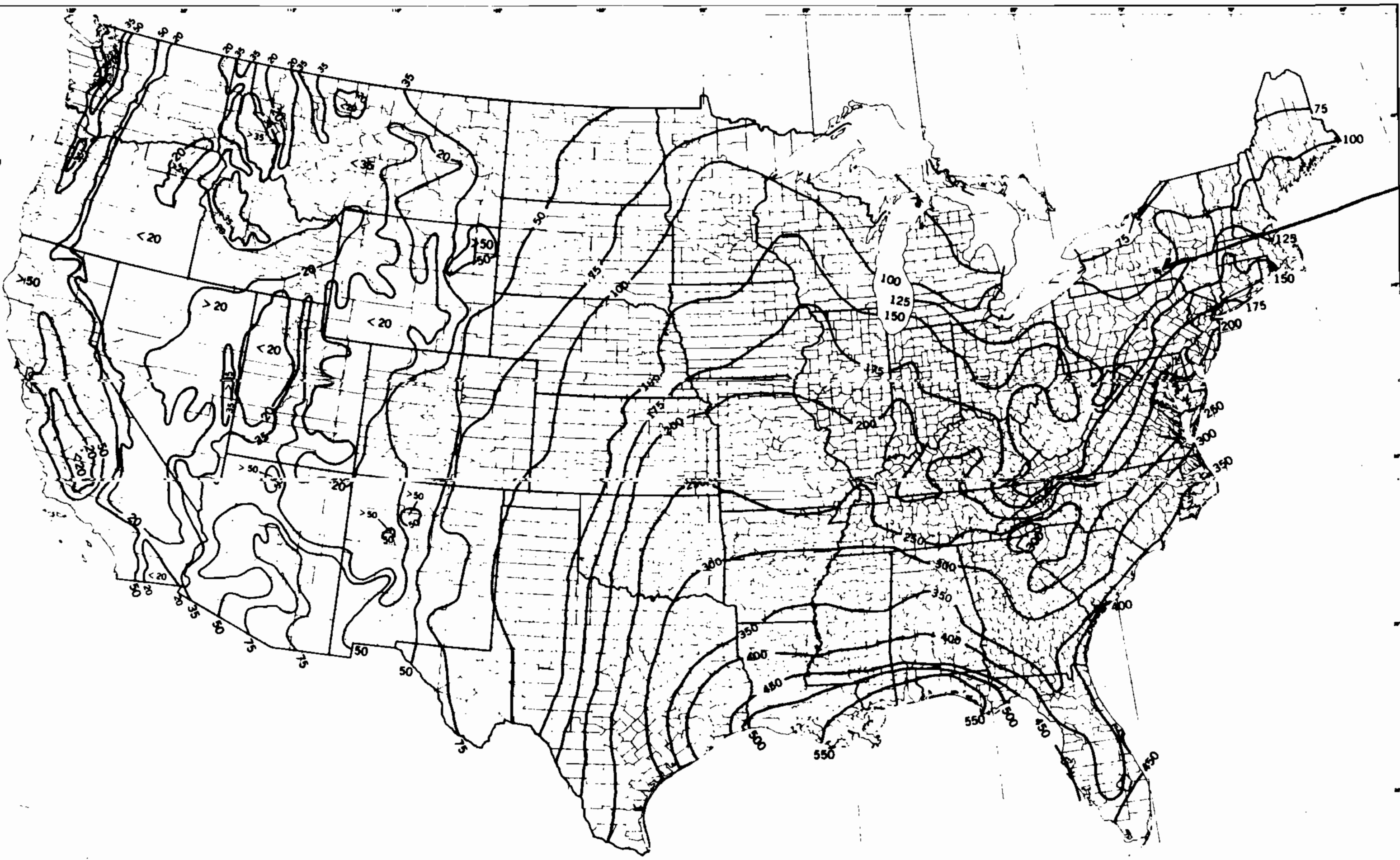
3779 TONS × 2000 lbs/TON × $\frac{1}{135 \frac{lb}{CF}}$ = 2074 CY/YR

* FOR AREA NOT ENTERING INTO THE SEDIMENT POND

AREA = 13.9 AC R = 100, L = 200', K = 0.28 SLOPE = 4% LS = 0.6

$A = 100 (0.28)(0.6)(13.9) = 233$ TONS/YR

233 TONS/ACRE × $\frac{2000 \text{ lbs}}{TN}$ × $\frac{1 CF}{135 \text{ lb}}$ × $\frac{1 CY}{27 CF}$ = 128 CY/YR



$R \approx 100$

Figure 1.—Average annual values of the rainfall index.[1]

---

[1] Measured in EI units—(100 foot tons/acre) (inches/hour). Wischmeier and Smith *(7)*.

Appendix 5A

Table 5.A.1 Typical C Factor Values Reported in the Literature.*

	Condition	C factor
1.	Bare soil conditions	
	freshly disked to 6-8 inches	1.00
	after one rain	0.89
	loose to 12 inches smooth	0.90
	loose to 12 inches rough	0.80
	compacted root raked	1.20
	compacted bulldozer scraped across slope	1.20
	same except root raked across	0.90
	rough irregular tracked all directions	0.90
	seed and fertilize, fresh, unprepared seedbed	0.64
	same after six months	0.54
	seed, fertilize and 12 months chemical	0.38
	not tilled algae crusted	0.01
	tilled algae crusted	0.02
	undisturbed except scraped	0.66 - 1.30
	scarified only	0.76 - 1.31
	sawdust 2 inches deep, disked in	0.61
2.	Asphalt emulsion	
	1210 gallons/acre	0.01 - 0.019
	605 gallons/acre	0.14 - 0.57
	302 gallons/acre	0.28 - 0.60
3.	Dust binder	
	605 gallons/acre	1.05
	1210 gallons/acre	0.29 - 0.78
4.	Other chemicals	
	1000 lb fiber glass roving with 60-150 gallons/acre	0.01 - 0.05
	Aquatain	0.68
	Aerospray 70, 10 percent cover	0.94
	Curasol AE	0.30 - 0.48
	PVA	0.71 - 0.90
	Terra-Tack	0.66
	wood fiber slurry, 1400 lb/acre fresh	0.01 - 0.02
	wood fiber slurry, 3500 lb/acre fresh	0.10
5.	Seedings[1]	
	temporary, 0 to 60 days[2]	0.40
	temporary, after 60 days	0.05
	permanent, 2 to 12 months	0.05
6.	Brush	0.35

1. If plantings are used with mulches, use the minimum C values.
2. If dry weather occurs at planting and emergence is a problem, extend the 0-60 days to a period when rainfall normally occurs.

* National Cooperative Highway Research Program, 1976.

Table 5.A.2. C Factors for Mechanically Prepared Woodland Sites.[4].

Percent of soil covered with residue in contact with soil surface	Soil Condition and Weed Cover							
	Excellent		Good		Fair		Poor	
	NC	WC	NC	WC	NC	WC	NC	WC
None								
A. Disked, raked or bedded[1,2].	.52	.20	.72	.27	.85	.32	.94	.36
B. Burned[3].	.25	.10	.26	.10	.31	.12	.45	.17
C. Drum chopped[3].	.16	.07	.17	.07	.20	.08	.29	.11
10% Cover								
A. Disked, raked or bedded[1,2].	.33	.15	.46	.20	.54	.24	.60	.26
B. Burned[3].	.23	.10	.24	.10	.26	.11	.36	.16
C. Drum chopped[3].	.15	.07	.16	.07	.17	.08	.23	.10
20% Cover								
A. Disked, raked or bedded[1,2].	.24	.12	.34	.17	.40	.20	.44	.22
B. Burned[3].	.19	.10	.19	.10	.21	.11	.27	.14
C. Drum chopped[3].	.12	.06	.12	.06	.14	.07	.18	.09
40% Cover								
A. Disked, raked or bedded[1,2].	.17	.11	.23	.14	.27	.17	.30	.19
B. Burned[3].	.14	.09	.14	.09	.15	.09	.17	.11
C. Drum chopped[3].	.09	.06	.09	.06	.10	.06	.11	.07
60% Cover								
A. Disked, raked or bedded[1,2].	.11	.08	.15	.11	.18	.14	.20	.15
B. Burned[3].	.08	.06	.09	.07	.10	.08	.11	.08
C. Drum chopped[3].	.06	.05	.06	.05	.07	.05	.07	.05
80% Cover								
A. Disked, raked or bedded[1,2].	.05	.04	.07	.06	.09	.08	.10	.09
B. Burned[3].	.04	.04	.05	.04	.05	.04	.06	.05
C. Drum chopped[3].	.03	.03	.03	.03	.03	.03	.04	.04

1. Multiply A values by following values to account for surface roughness:

Very rough, major effect on runoff and sediment storage, depressions greater than 6 inches	.40
Moderate	.65
Smooth, minor surface sediment storage, depressions less than 2 inches	.90

2. The C values for A are for the first year following treatment. For A type sites 1 to 4 years old multiply C value by .7 to account for aging. For sites 4 to 8 years old use Table 5.6. For sites more than 8 years old use Table 5.7.

3. The C values for B and C areas are for the first 3 years following treatment. For sites treated 3 to 8 years ago use Table 5.6. For sites treated more than 8 years ago use Table 5.7.
4. Soil Conservation Service (1977).

Table B.3 (cont'd)
Approximated K Values for Some Representative Soils on Construction Sites in New York

Depositional Unit, Family Textural Class and Representative Series	Horizon[1]	Texture[2]	Erodibility Class & K Values		
				K Values[3,4]	
			Class	Range	Norm
I. Glacial Till (cond't)					
Cazenovia	A	sil	High	0.37-0.49	0.43
	Bt	sicl	High	0.37-0.49	0.43
	C	gsil	Medium	0.24-0.32	0.28
Nunda	Ap	ch sil	High	0.37-0.49	0.43
	B2	ch sil	High	0.37-0.49	0.49
	IIB2t	gcl	Medium	0.24-0.32	0.28
	IIC	gl	Medium	0.24-0.32	0.28
FINE					
Hornell	A	sil	Medium	0.24-0.32	0.28
	B	sic	High	0.37-0.49	0.43
	C	sh sic	Medium	0.24-0.32	0.28
	R		Shale bedrock 20 to 40" below surface.		
Remsen	A	sicl	High	0.37-0.49	0.43
	Bt	c	Medium	0.24-0.32	0.28
	C	c	High	0.37-0.49	0.43
Churchville	A	sil	High	0.37-0.49	0.43
	Bt	sic	Medium	0.24-0.32	0.28
	IIC	gl	Medium	0.24-0.32	0.28
COARSE LOAMY, NO PAN					
Charlton	A	fsl	Low	0.10-0.20	0.17
	B	fsl	High	0.37-0.49	0.43
	C	gfsl	Medium	0.24-0.32	0.28
Nellis	A	l	Medium	0.24-0.32	0.28
	B	l	High	0.37-0.49	0.43
	C	gl	Medium	0.24-0.32	0.28
Pittsfield	A	l	Medium	0.24-0.32	0.28
	B	gfsl	Low	0.10-0.20	0.17
	C	gfsl	High	0.37-0.49	0.43
COARSE LOAMY/SANDY or SANDY SKELETAL					
Canton	A	fsl	Medium	0.24-0.32	0.28
	B	fsl	Very High	0.55-0.78	0.64
	IIC	vgls	Low	0.10-0.20	0.17
COARSE SILTY w/PAN					
Canaseraga	A	sil	High	0.37-0.49	0.43
	B	sil	Very High	0.55-0.78	0.46
	IIBx & C	ch	High	037-0.49	0.43

Table B.4
Slope-Effect Table

Slope Length in Feet (L)	LS Value % Slope(s)															
	2	4	6	8	10	12	14	16	18	20	25	30	35	40	50	100
10	.1	.1	.2	.3	.4	.6	.7	.9	1.1	1.3	2.0	2.7	3.6	4.6	6.9	25.7
15	.1	.2	.3	.4	.5	.7	.9	1.1	1.4	1.6	2.4	3.3	4.4	5.6	8.4	31.5
20	.1	.2	.3	.4	.6	.8	1.5	1.3	1.6	1.9	2.8	3.8	5.0	6.4	9.7	36.4
25	.1	.2	.3	.5	.7	.9	1.2	1.4	1.7	2.1	3.1	4.3	5.6	7.2	10.9	40.7
30	.1	.2	.4	.5	.8	1.0	1.3	1.6	1.9	2.3	3.4	4.7	6.1	7.9	11.9	44.6
35	.1	.2	.4	.6	.8	1.1	1.4	1.7	2.1	2.5	3.7	5.1	6.7	8.5	12.9	
40	.2	.3	.4	.6	.9	1.2	1.5	1.8	2.2	2.7	3.9	5.4	7.1	9.1	13.8	
50	.2	.3	.5	.7	1.0	1.3	1.7	2.0	2.4	3.0	4.4	6.0	8.0	10.2	15.4	
60	.2	.3	.5	.8	1.1	1.4	1.8	2.2	2.7	3.3	4.8	6.6	8.7	11.2	16.9	
100	.2	.4	.7	1.0	1.4	1.8	2.3	2.8	3.5	4.2	6.2	8.5	11.3	14.4	21.8	
200	.3	.6	1.0	1.4	2.0	2.6	3.3	4.0	5.0	5.9	8.7	12.1	15.9	20.4		
300	.4	.7	1.2	1.7	2.4	3.2	4.0	5.0	5.9	7.3	10.7	14.8	19.5	24.9		
400	.4	.8	1.4	2.0	2.8	3.6	4.7	5.0	6.0	8.4	12.4	17.1	22.6			
500	.5	.9	1.5	2.2	3.1	4.1	5.2	6.4	7.6	9.4	13.8	19.1	25.2			
600	.5	1.0	1.7	2.4	3.4	4.5	5.7	7.0	8.3	10.3	15.1	20.9				
800	.6	1.2	1.9	2.8	3.9	5.1	6.7	8.1	9.6	11.9	17.5	24.1				
1000	.7	1.3	2.1	3.14	4.4	5.8	7.4	9.1	10.8	13.3	19.5					

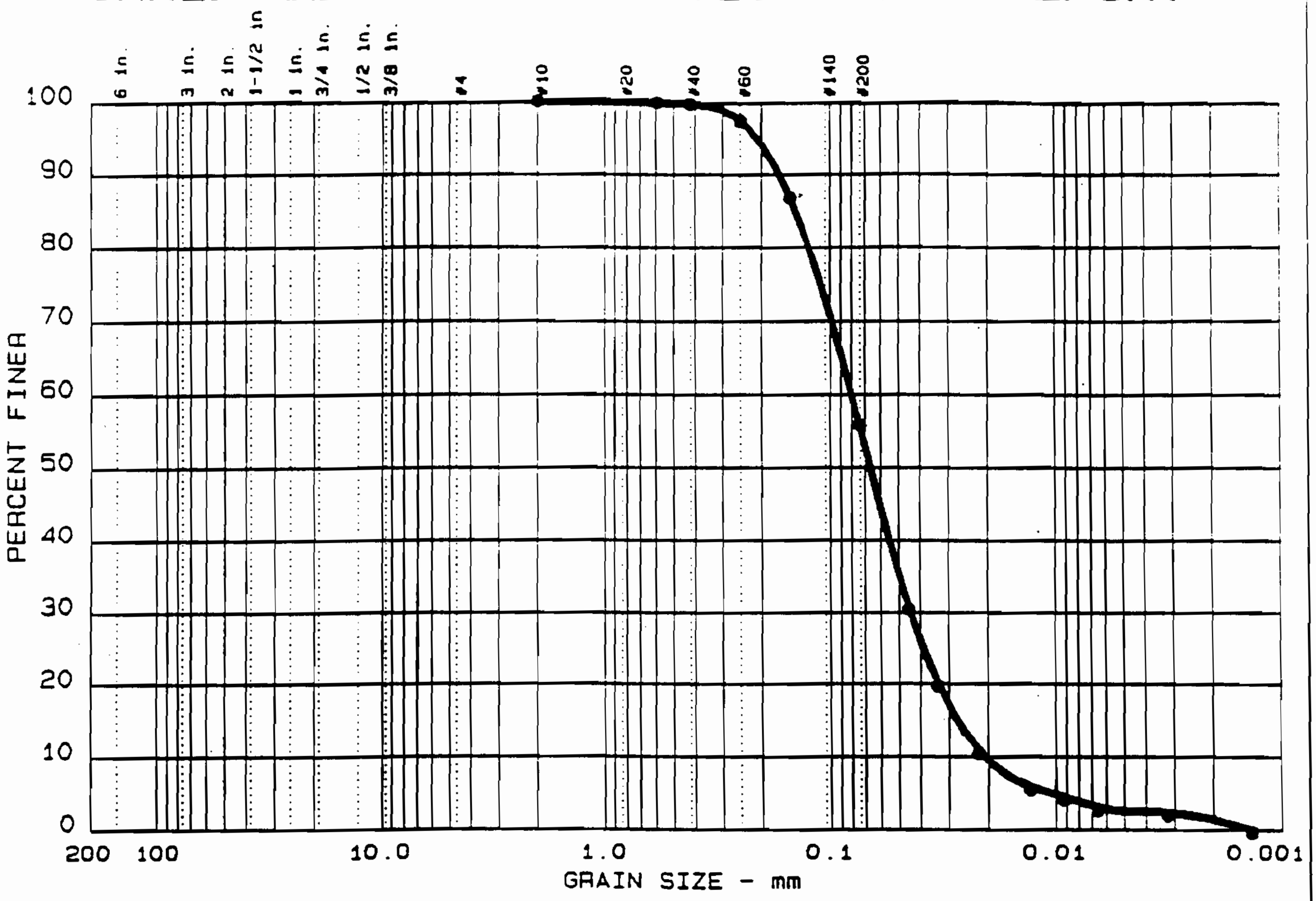
$(LS) = \underline{V\ L}\ X\ (.76 + .53s = .076s^2)$

Table B.3 (cont'd)
Approximated K Values for Some Representative Soils on Construction Sites in New York

Depositional Unit, Family Textural Class and Representative Series	Horizon[1]	Texture[2]	Erodibility Class & K Values		
				K Values[3,4]	
			Class	Range	Norm
I. Glacial Till (cond't)					
LOAMY SKELETAL					
Manlius	A	sh	Medium	0.24-0.32	0.28
	B	vsh sil	Low	0.10-0.20	0.17
	C	fract'd shales w/ silty fines	Low	0.10-0.20	0.17
	R		Shale bedrock 20 to 40" below surface.		
FINE LOAMY w/PAN					
Volusia	A	ch sil	Low	0.10-0.20	0.17
	Bx	ch sil	High	0.37-0.49	0.43
	C	vch l	Medium	0.24-0.32	0.28
FINE LOAMY, NO PAN					
Kendaia	A	sil	Medium	0.24-0.32	0.28
	B	gsil	Medium	0.24-0.32	0.28
	C	gl	Medium	0.24-0.32	0.28
II. Glacial Outwash and Water Worked Morainic Deposits					
SANDY SKELETAL					
Hinckley	A	ls	Low	0.10-0.20	0.17
	B	gls	Low	0.10-0.20	0.17
	C	vgs	Low	0.10-0.20	0.17
SANDY					
Colonie	A	lfs	Medium	0.24-0.32	0.28
	B	fs	Low	0.10-0.20	0.17
	C	fs	Low	0.10-0.20	0.17
LOAMY SKELETAL					
Chenango	A	gl	Low	0.10-0.20	0.17
	B	vgl	Low	0.10-0.20	0.17
	C	gls	Low	0.10-0.20	0.17
FINE LOAMY/SANDY or SANDY SKELETAL					
Palmyra	A	gl	Low	0.10-0.20	0.17
	B	gl	Medium	0.24-0.32	0.28
	IIC	g & s	Low	0.10-0.20	0.17
LOAMY SKELETAL/CLAYEY					
Varysburg	A	gl	Low	0.10-0.20	0.17
	B2t	vgl	Low	0.10-0.20	0.17
	IIB2t	sic	Medum	0.24-0.32	0.28
	IIC	layered sic,sil sicl	High	0.37-0.49	0.43

APPENDIX D
SOIL ANALYSIS

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	44.2	53.2	2.6

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.14	0.08	0.07	0.044	0.0272	0.0207	1.18	3.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Sandy silt	ML		A-4 (0)

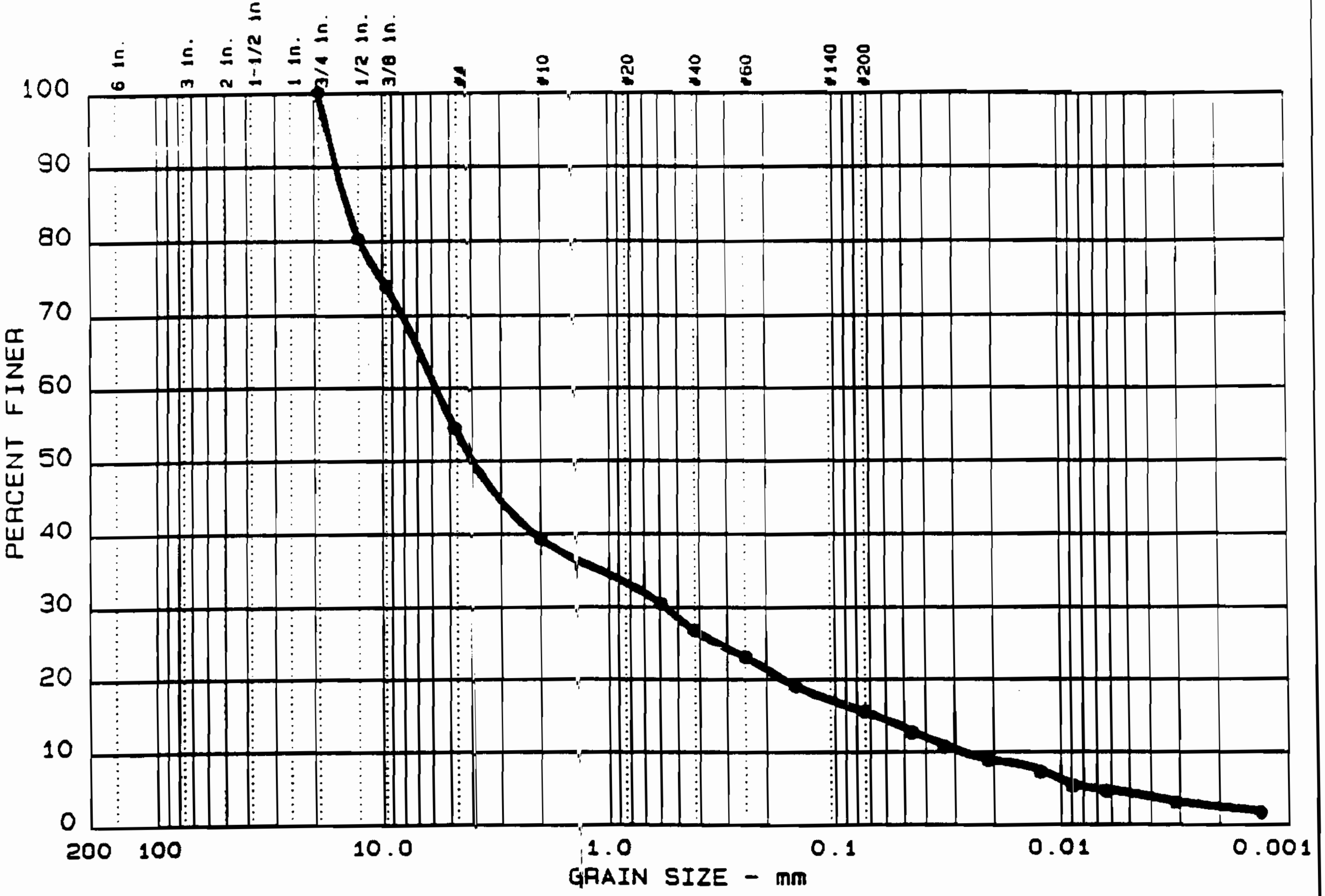
Project No.: 02260.HG　Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-1 S-4 6-8'　Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 22.0%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	45.6	38.9	11.2	4.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			14.29	5.75	3.98	0.569	0.0653	0.0275	2.04	208.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty gravel with sand	GM		A-1-b

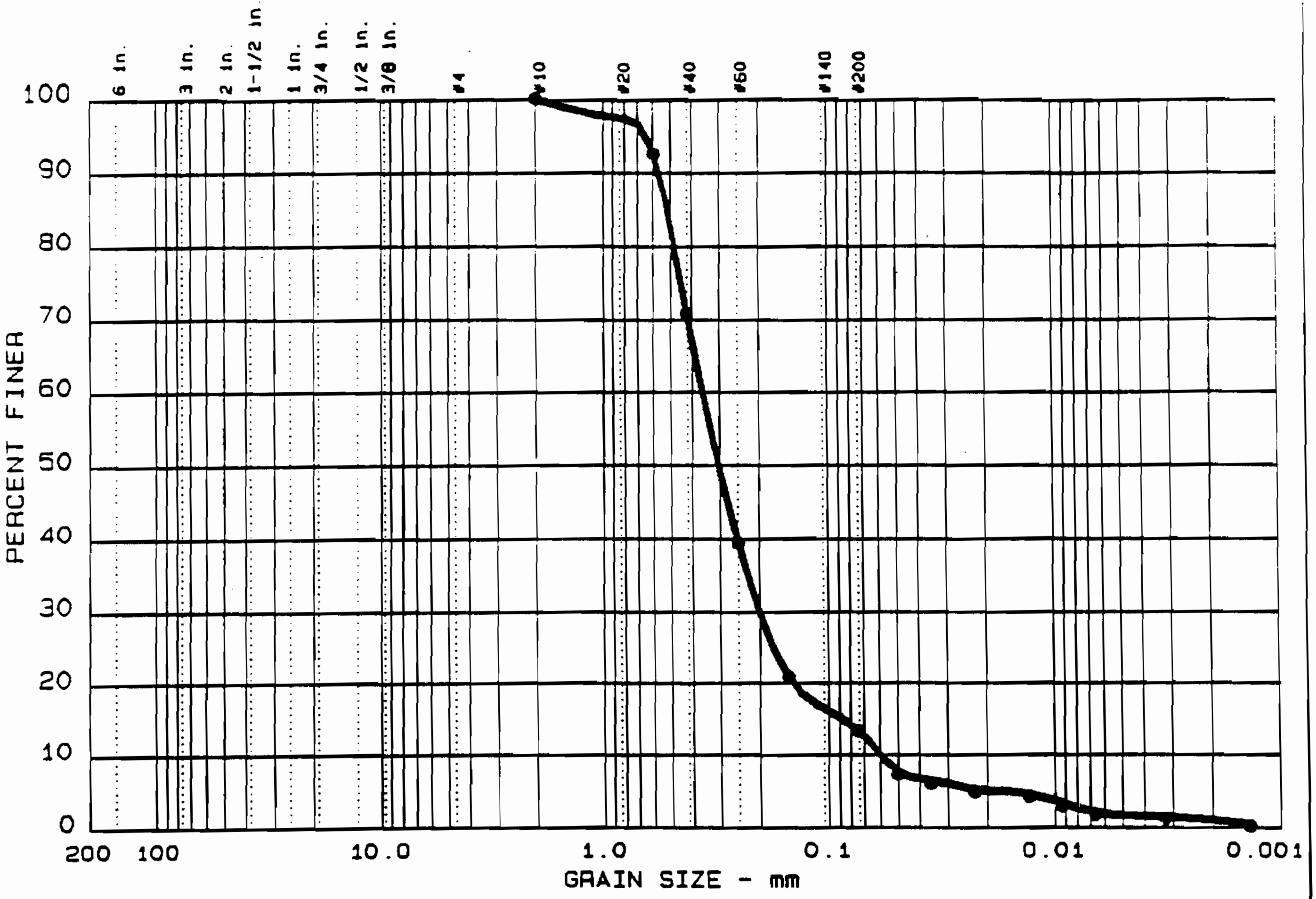
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-1 S-10 18-20' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT=7.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	86.7	11.7	1.6

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.51	0.36	0.30	0.201	0.0868	0.0587	1.93	6.1

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● DARK BROWN Silty sand	SM		A-2-4(0)

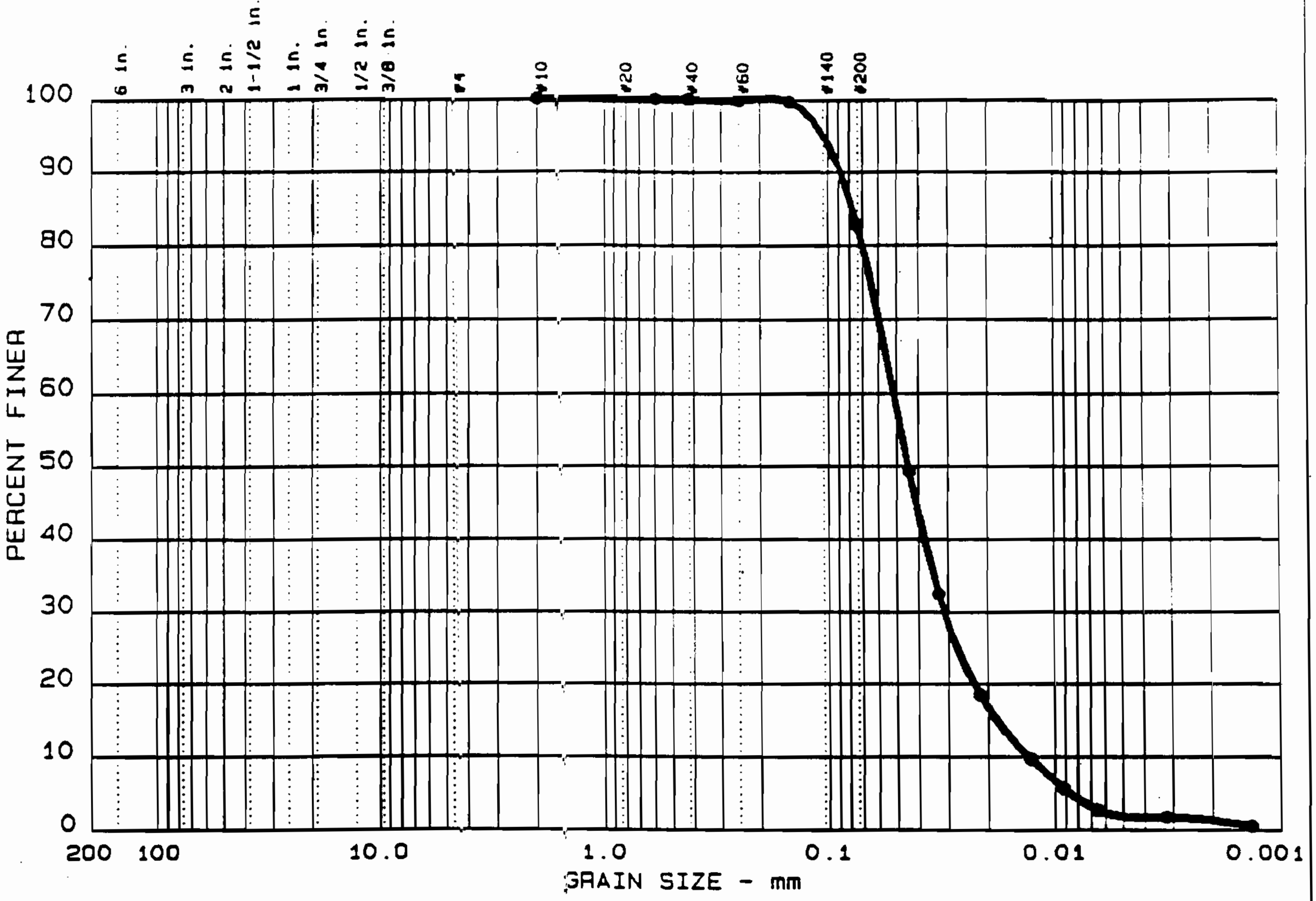
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-2 S-3 7-9' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 20.3%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	17.3	81.0	1.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.08		0.04	0.031	0.0180	0.0131	1.43	3.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt with sand	ML		A-4 (0)

Project No.: 02260.HG Date: 3-27-92

Project: COLESVILLE LF

Client: BROOME COUNTY

● Sample: PW-2 S-10 18-20' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.

Entered by: J.R.

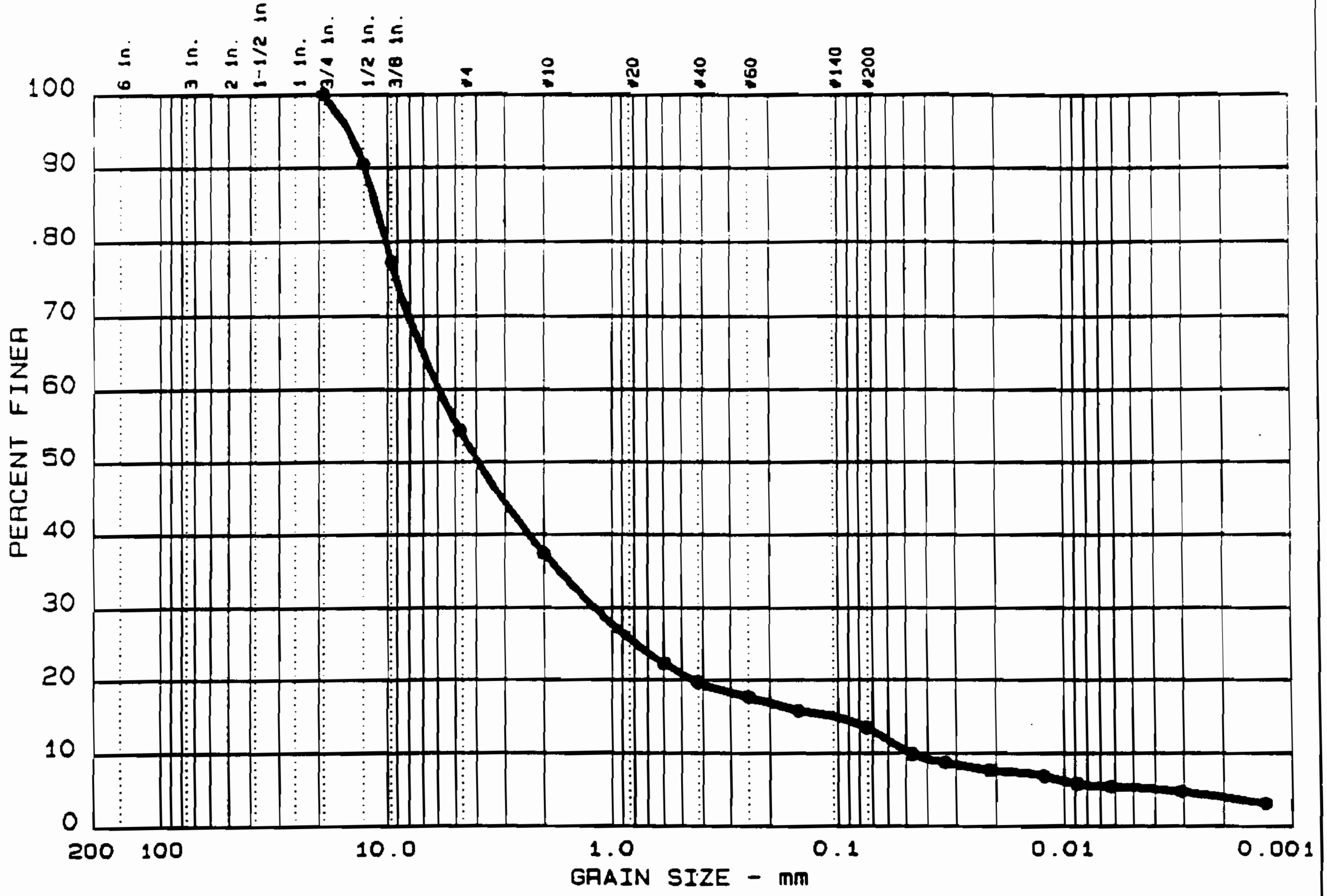
Checked by: R.S.A.

Remarks:

MOISTURE CONTENT = 21.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	45.7	40.8	8.2	5.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			11.18	5.93	3.95	1.194	0.1052	0.0481	5.00	123.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty gravel with sand	GM		A-1-a

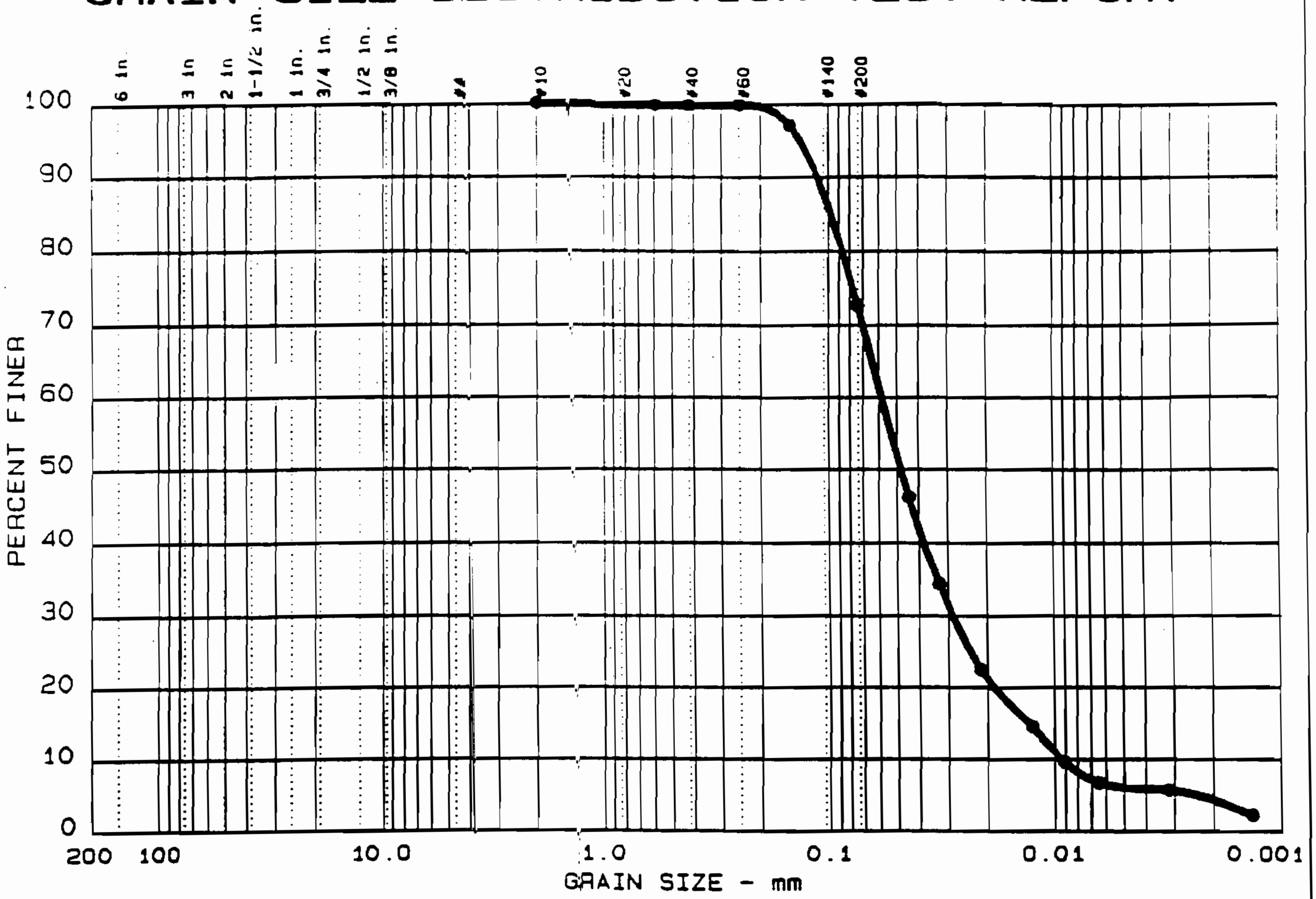
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-3 S-3 4-6' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 5.2%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	27.3	66.8	5.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.10		0.05	0.028	0.0130	0.0092	1.52	6.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt with sand	ML		A-4 (0)

Project No.: 02260.HG Date: 3-27-92

Project: COLESVILLE LF

Client: BROOME COUNTY

● Sample: PW-3 S-9 16-18' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.

Entered by: J.R.

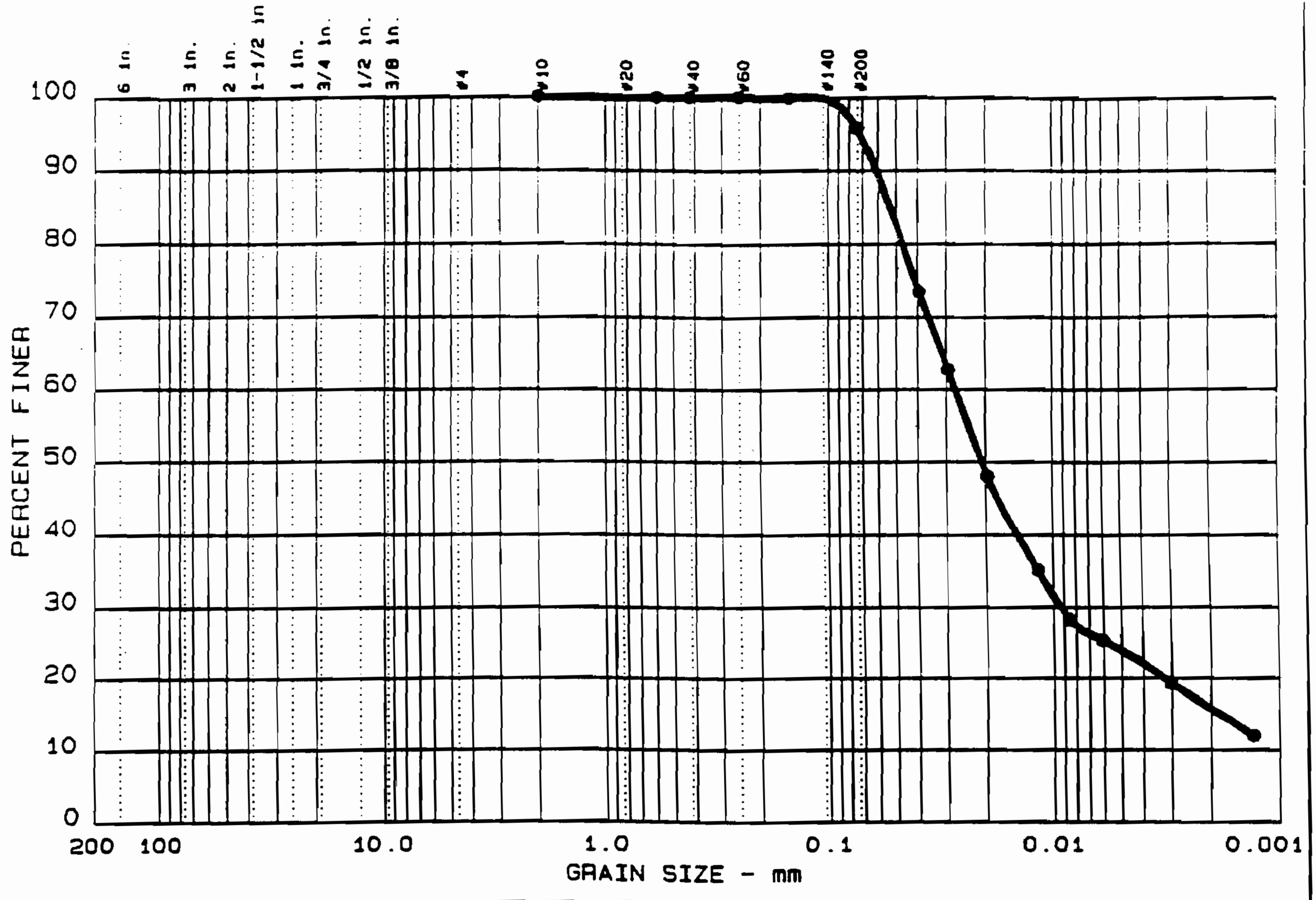
Checked by: R.S.A.

Remarks:

MOISTURE CONTENT = 21.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	4.2	71.9	23.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●					0.02	0.009	0.0018			

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt	ML		A-4 (0)

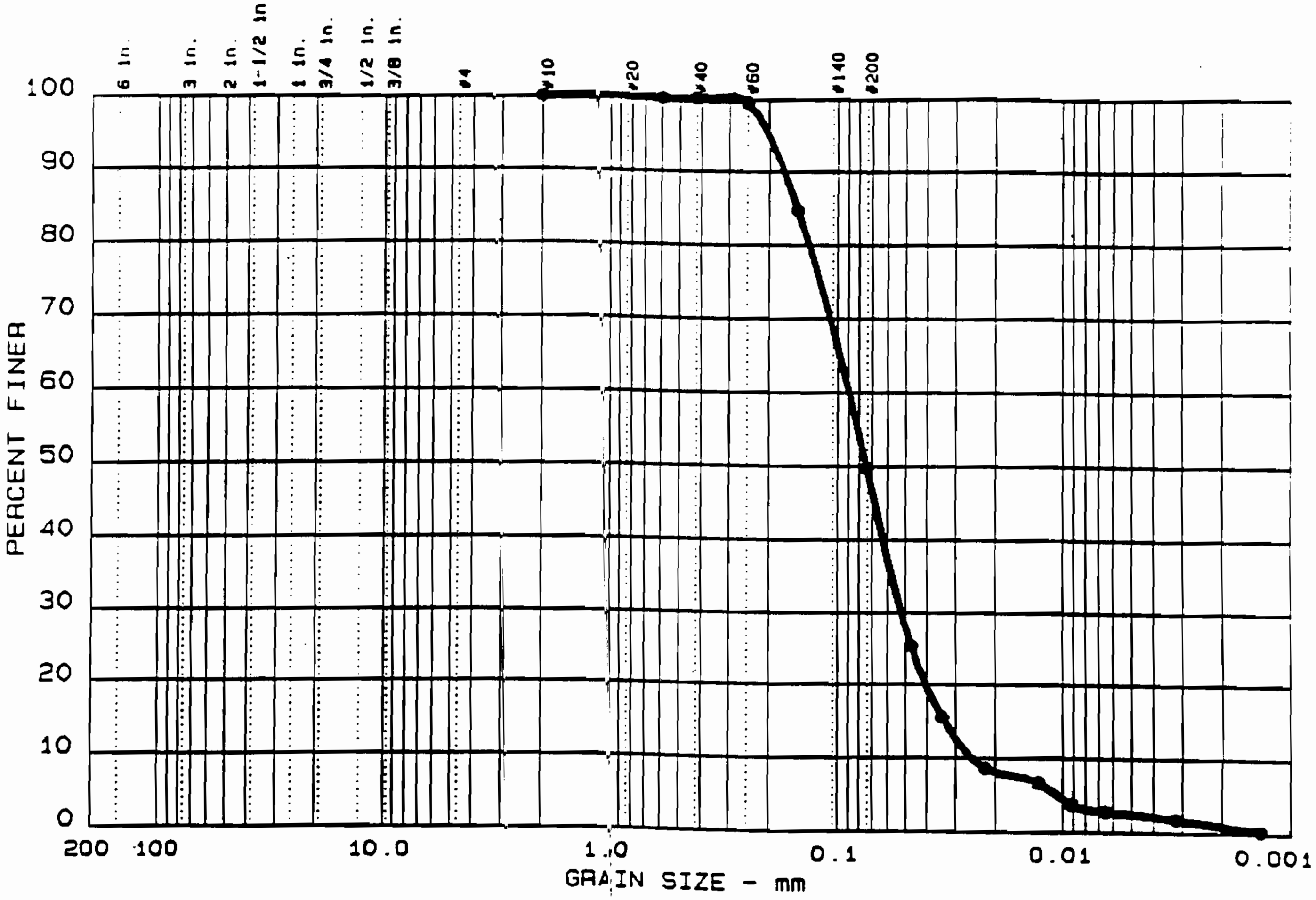
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-3 S-17B 32-34' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 22.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	50.4	47.3	2.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.15	0.09	0.07	0.052	0.0335	0.0251	1.21	3.5

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-4 (0)

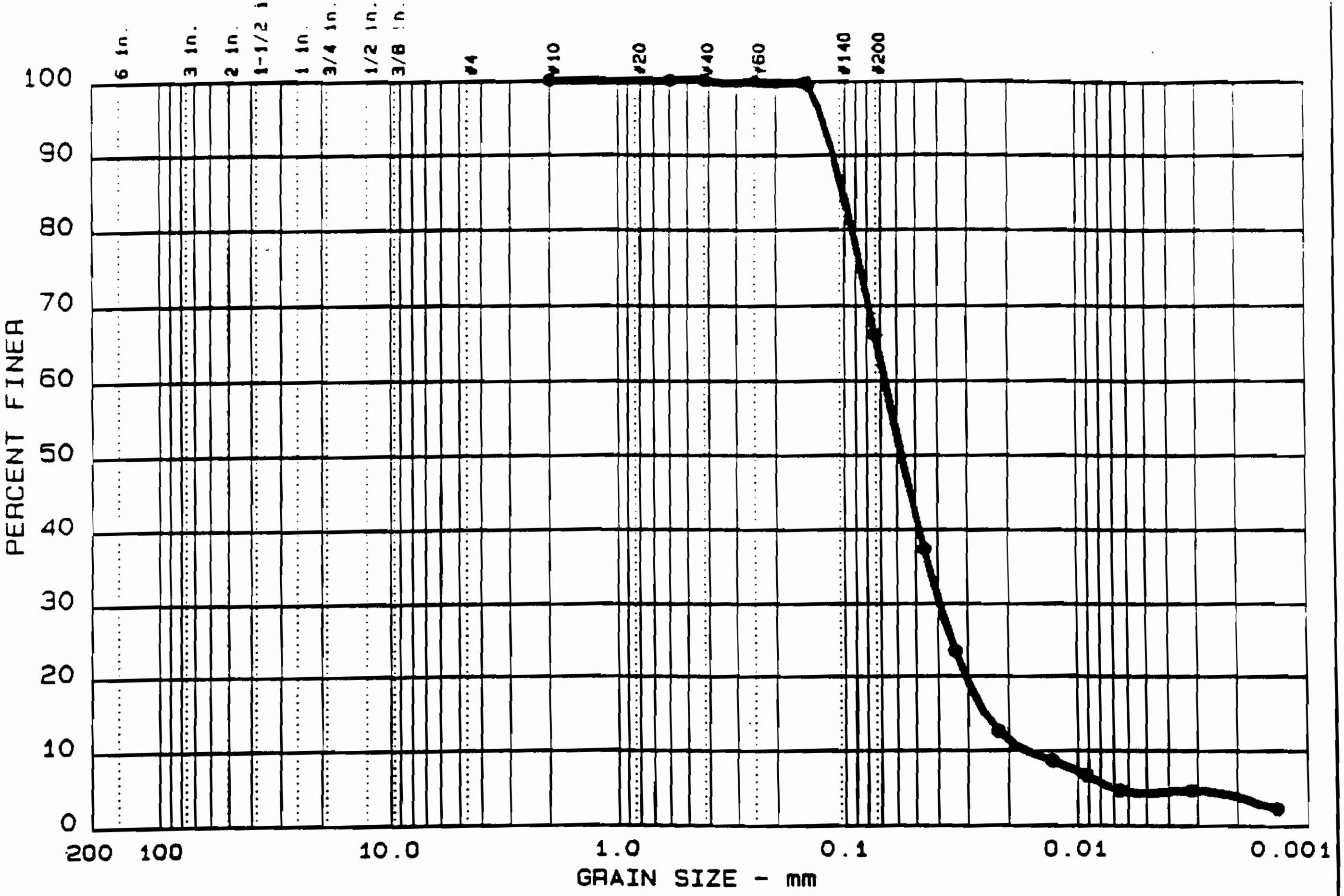
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-4 S-3 10-12' Sample No.:

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 13.7%

WEHRAN ENGINEERING

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	33.9	61.8	4.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.10		0.06	0.039	0.0251	0.0170	1.36	3.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Sandy silt	ML		A-4 (0)

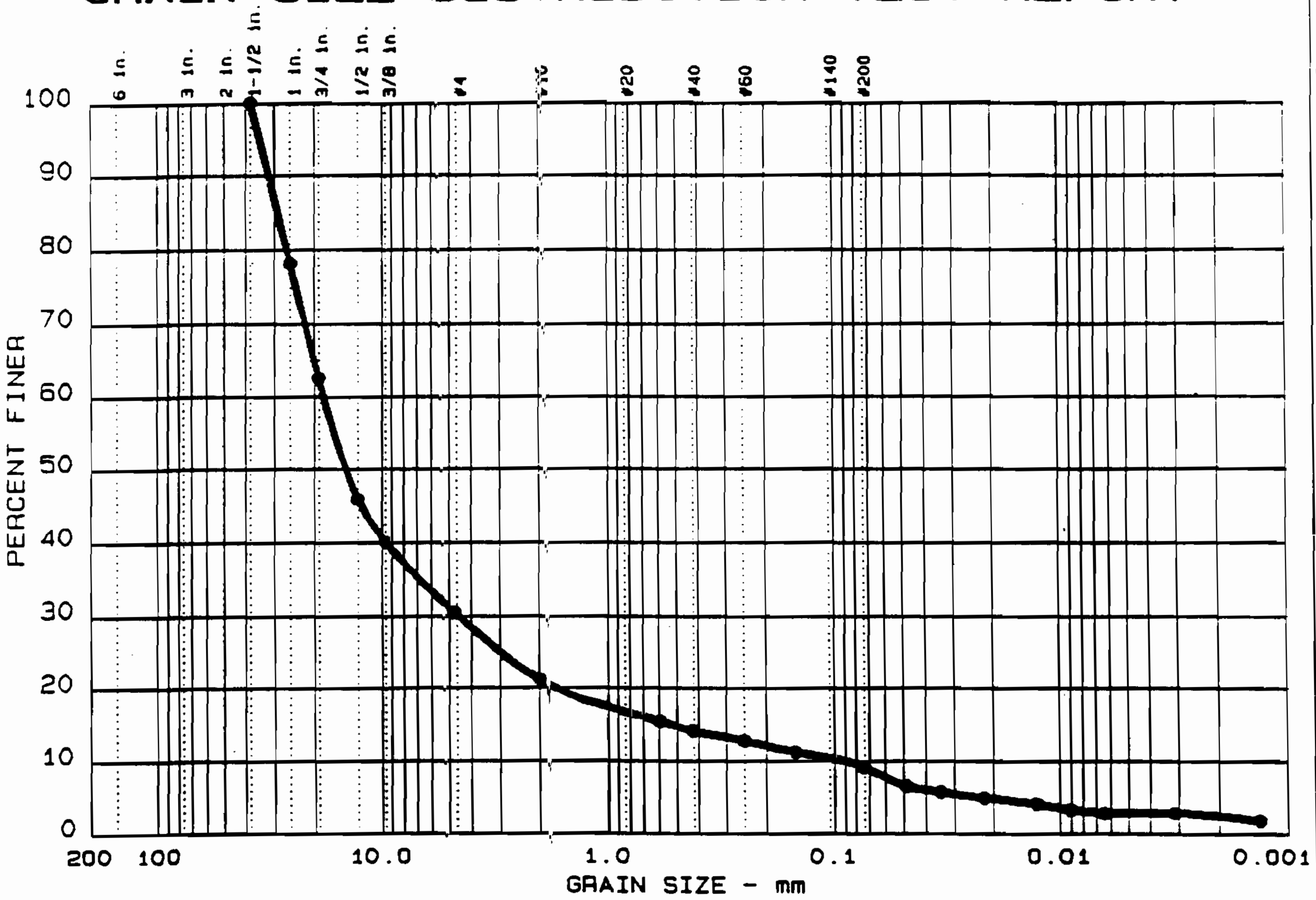
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-4 S-9 22-24' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 20.3%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	69.6	21.2	6.4	2.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			28.77	18.07	14.35	4.592	0.5212	0.0895	13.03	201.8

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN WITH DARK GRAY GRAVEL Poorly graded gravel with silt and sand	GP-GM		A-1-a

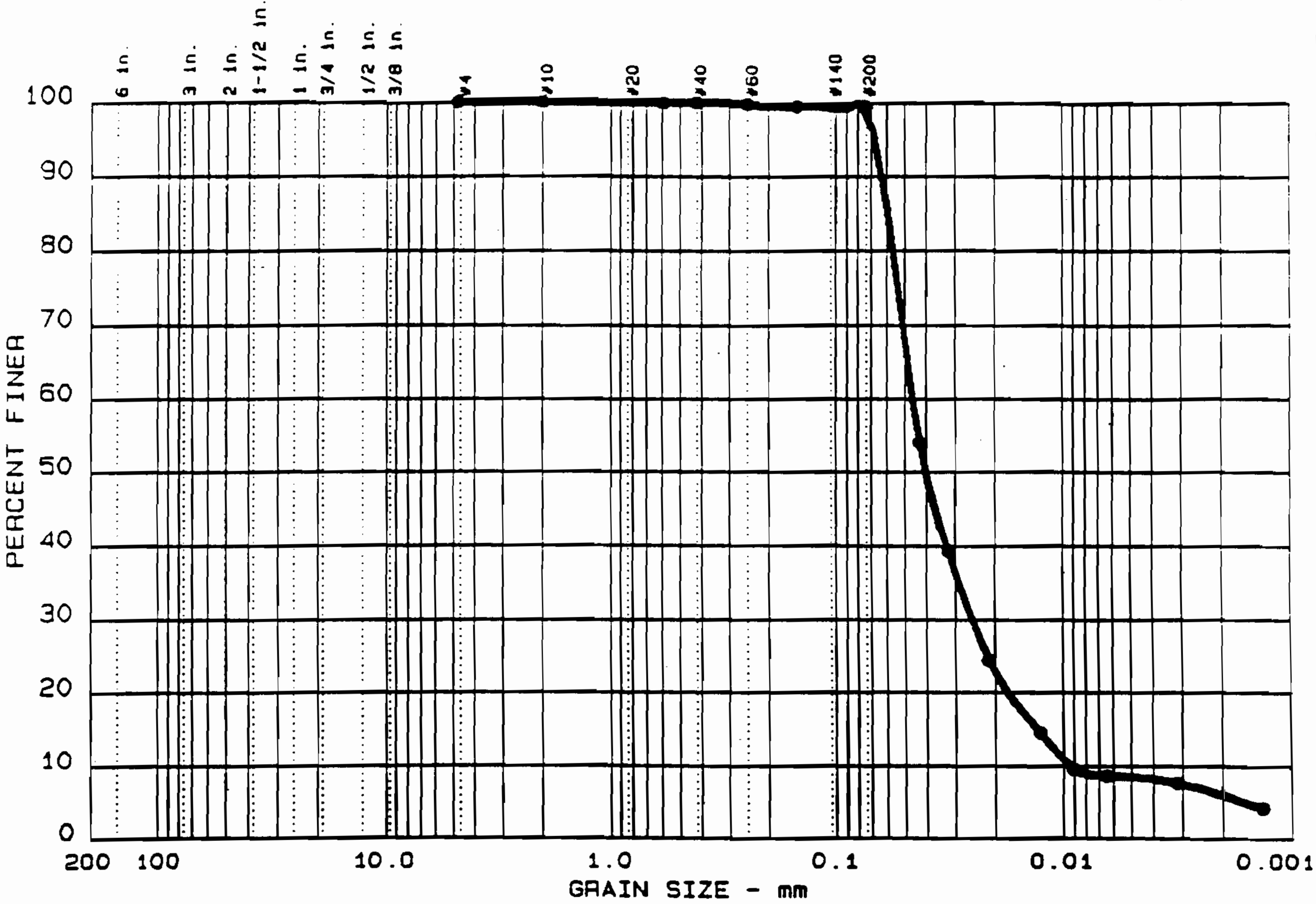
Project No.: 02260.HG
Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-5 S-2 5-7'
Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: J.R.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 8.8%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	0.7	90.8	8.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●					0.04	0.025	0.0129	0.0093	1.47	4.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● GRAYISH BROWN Silt	ML		A-4 (0)

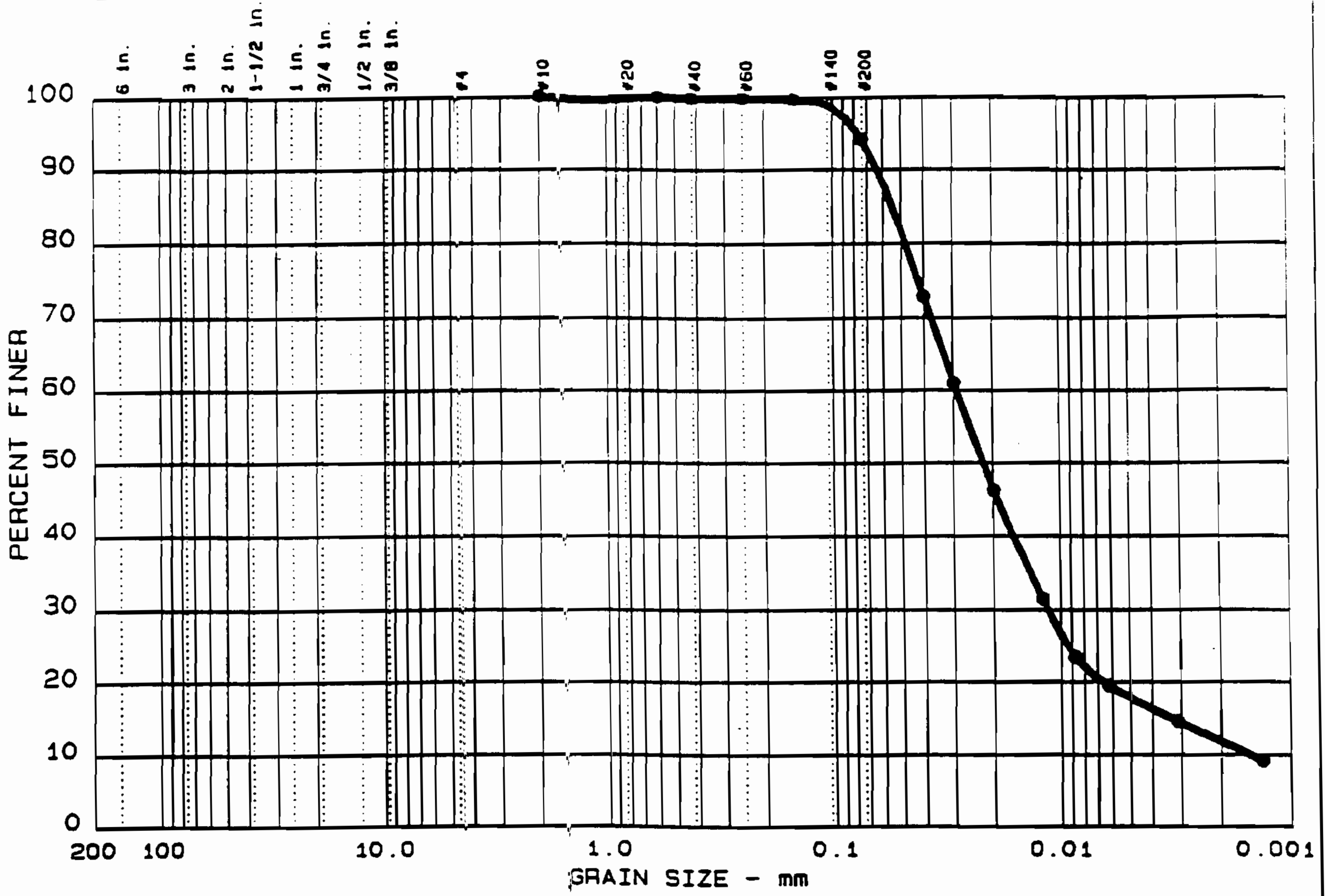
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-5 S-11 23-25' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 22.1%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	5.8	76.4	17.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●					0.02	0.011	0.0033	0.0015	3.01	19.1

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt	ML		A-4 (0)

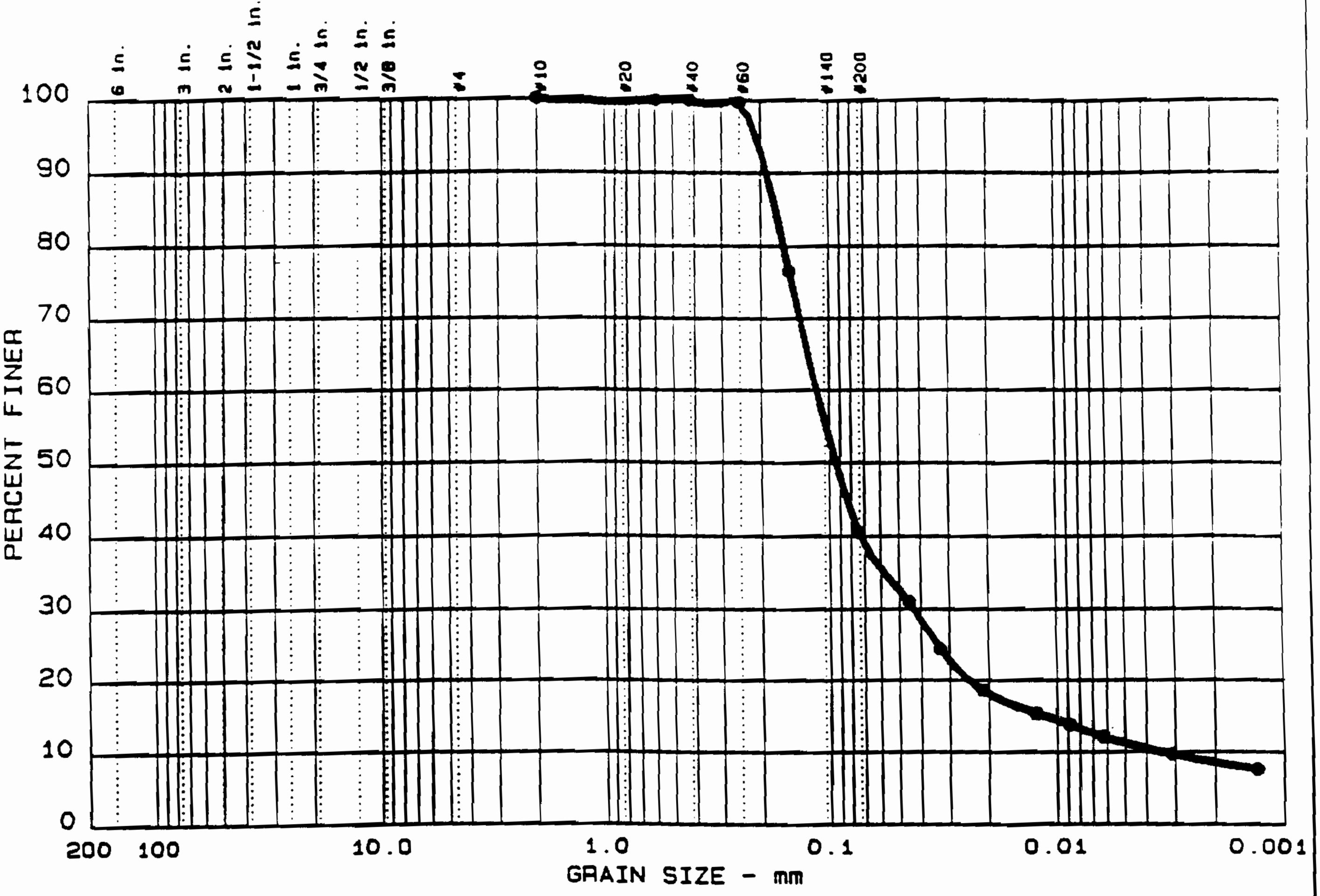
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-5 S-15 31-33' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 23.3%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	59.6	29.3	11.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.17	0.11	0.09	0.043	0.0114	0.0035	4.66	32.5

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-4 (0)

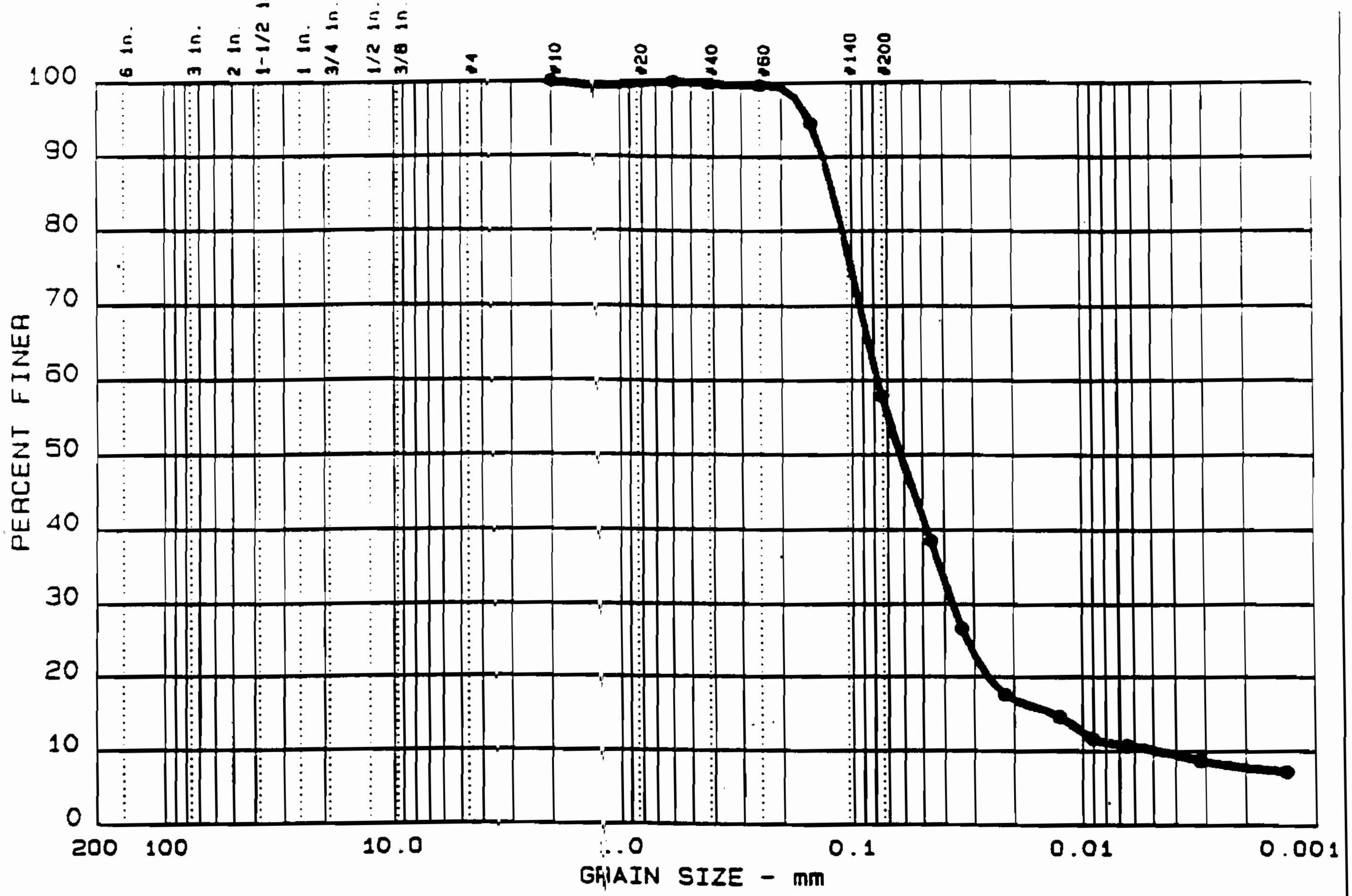
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-6 S-12 34-36' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 10.2%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	42.2	47.8	10.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.12	0.06	0.06	0.037	0.0134	0.0049	3.62	15.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Gravelly silt	ML		A-4 (0)

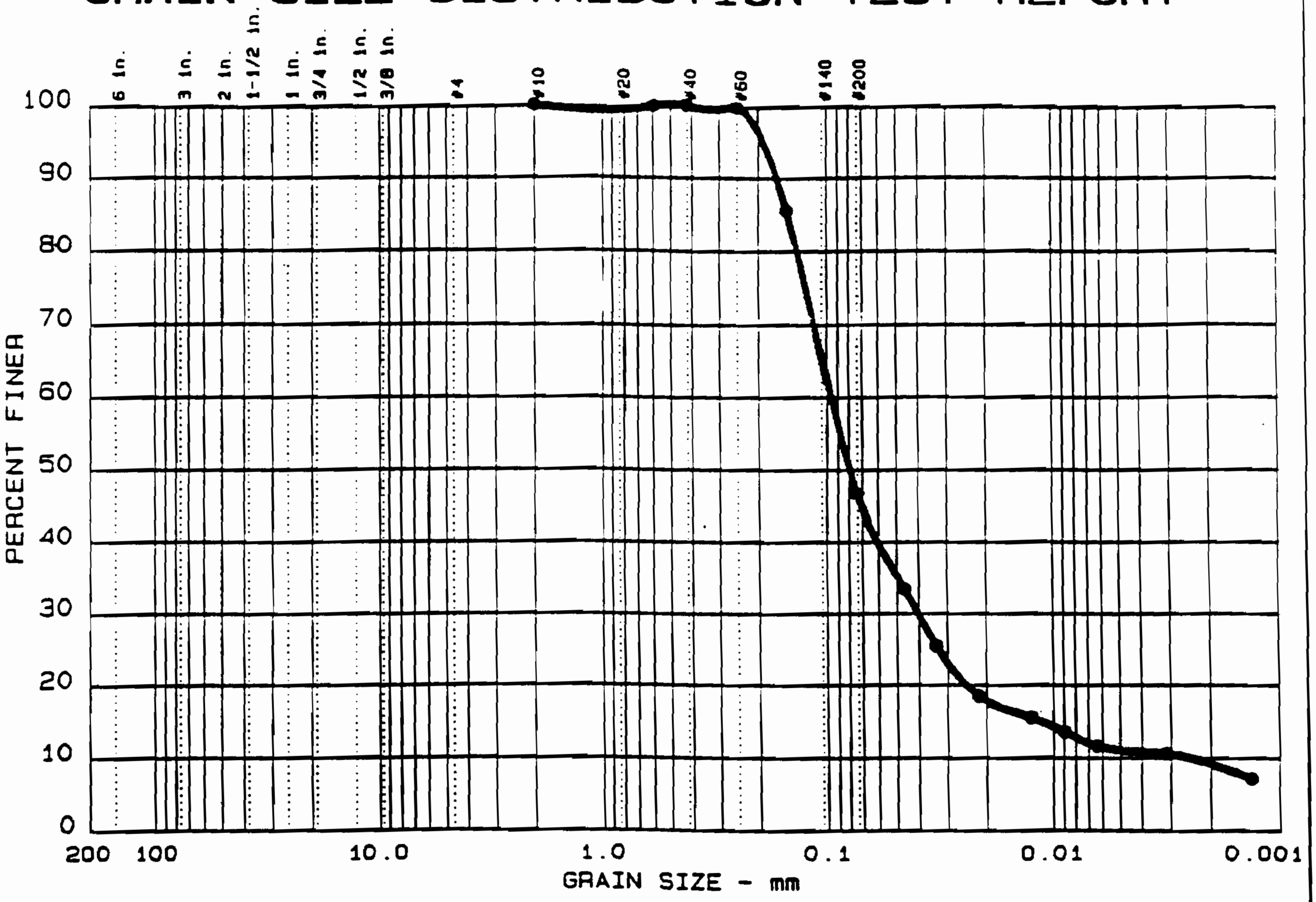
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-6 S-29 68-70' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 16.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	53.3	35.7	11.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.15	0.10	0.08	0.040	0.0111	0.0025	6.92	38.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-4 (0)

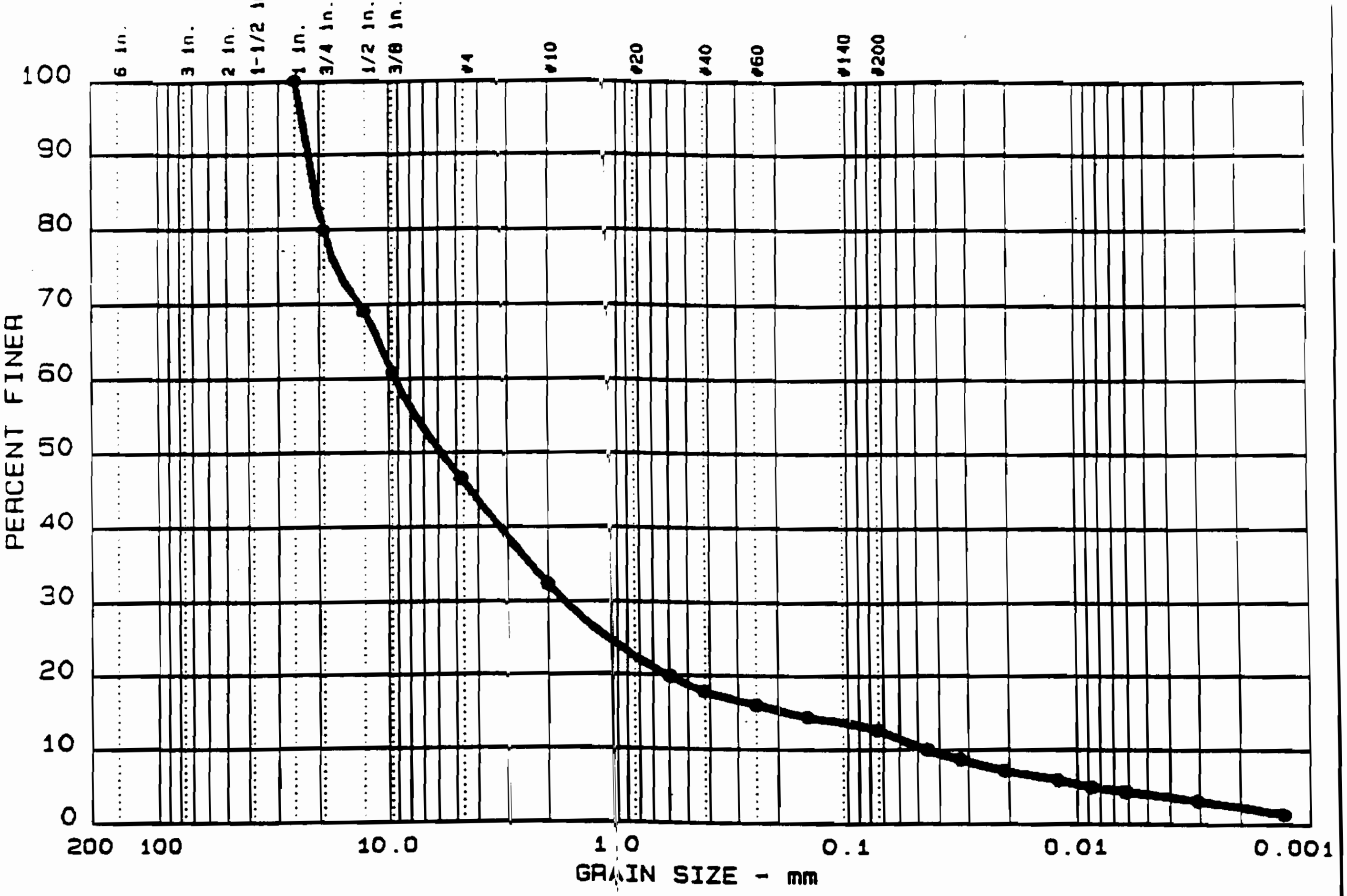
Project No.: 02260.HG　　Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-6 S-33 76-78'　　Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 17.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	53.5	33.9	8.6	4.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			20.80	9.26	5.84	1.704	0.1764	0.0459	6.84	201.8

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● LIGHT BROWN Silty gravel with sand	GM		A-1-a

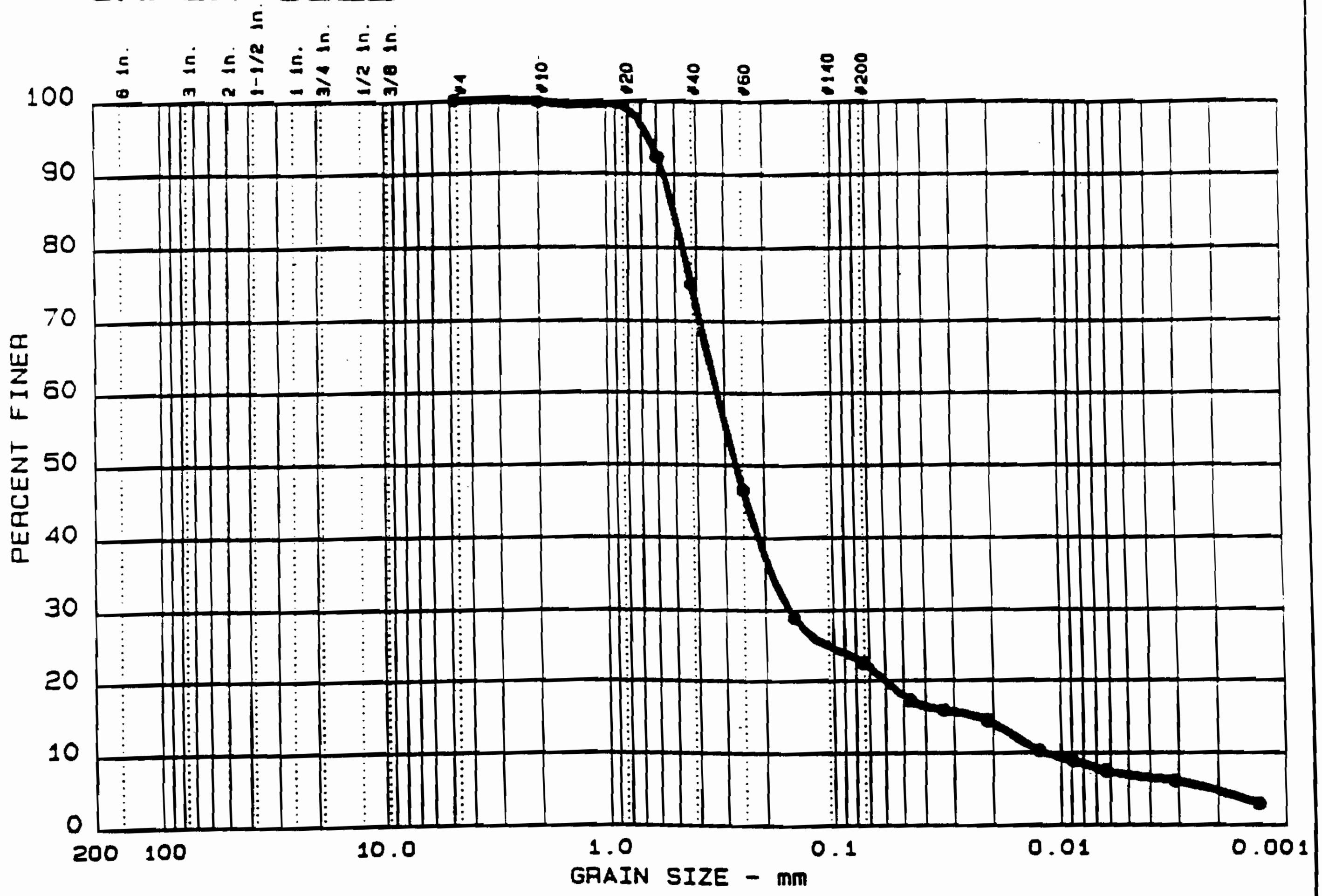
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-7 S-3 10-12' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 1.6%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	77.5	15.6	6.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.50	0.32	0.27	0.156	0.0234	0.0119	6.37	27.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-2-4(0)

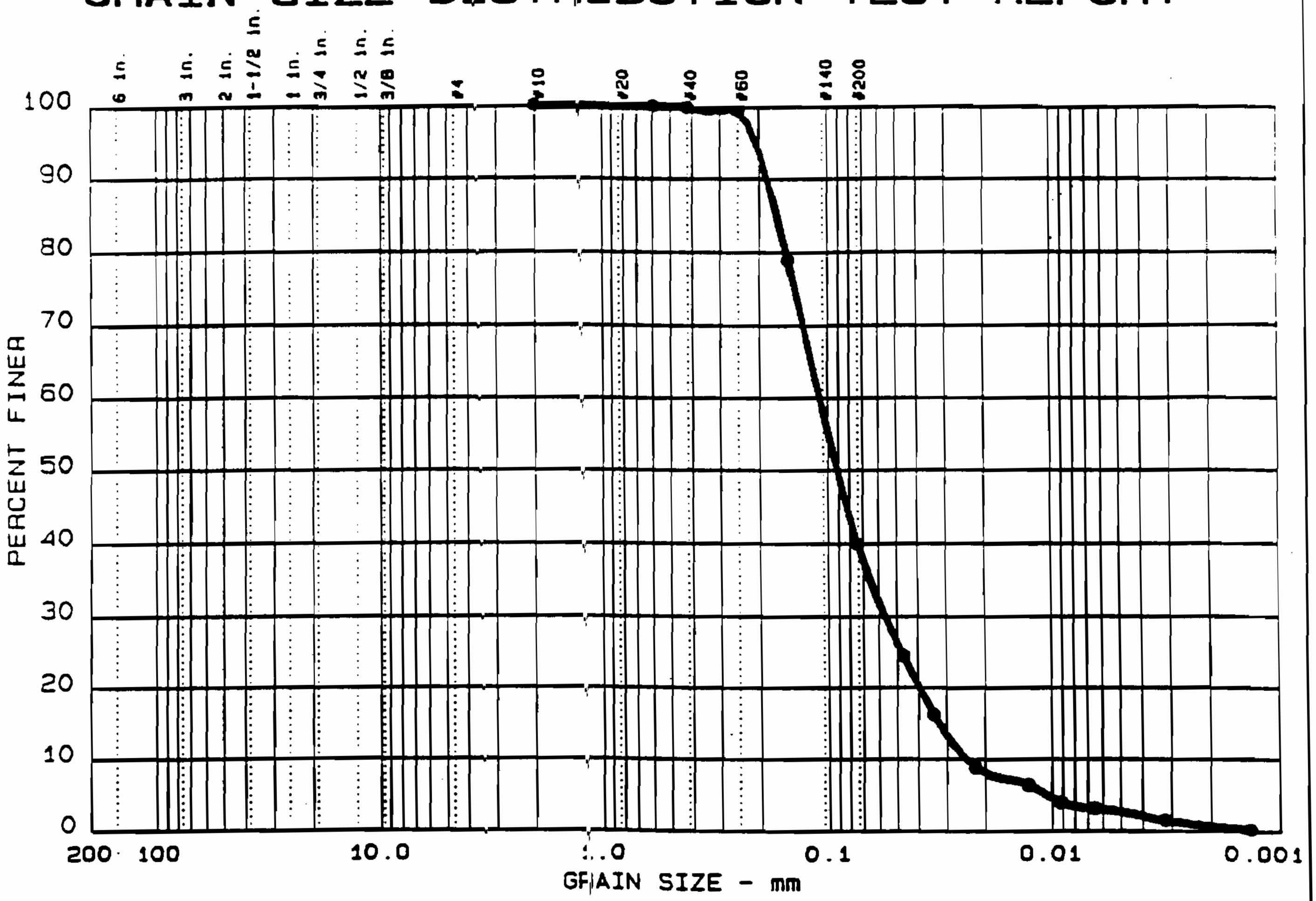
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-7 S-7B 23-24' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 7.3%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	60.2	37.3	2.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.17	0.11	0.09	0.056	0.0321	0.0244	1.21	4.4

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-4(0)

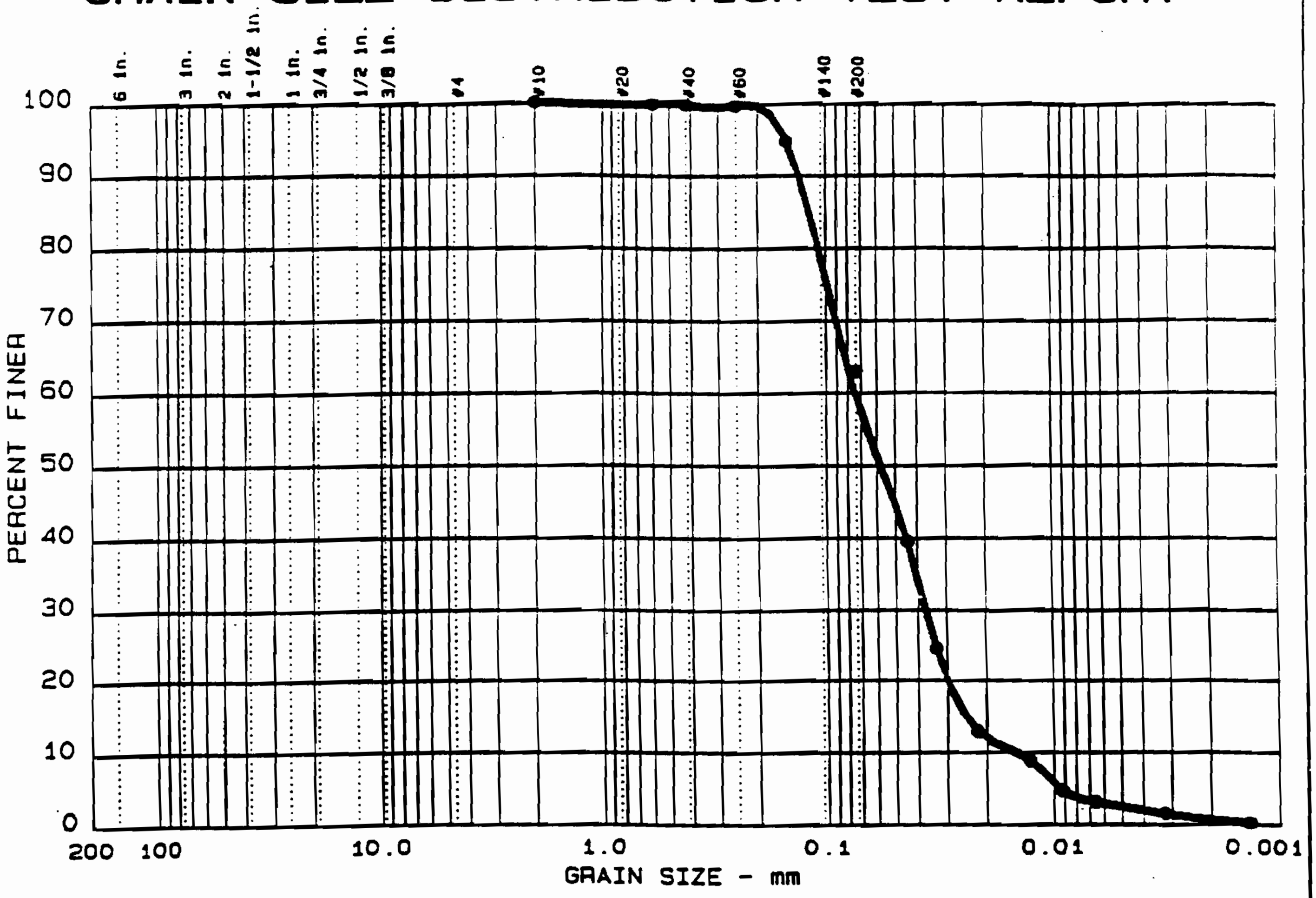
Project No.: 02260.HG Date: 3-27-92
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-7 S-20 48-50' Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 20.8%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	40.3	57.3	2.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.12		0.06	0.037	0.0246	0.0147	1.25	5.0

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Sandy silt	ML		A-4 (0)

Project No.: 02260.HG
Project: COLESVILLE LF
Client: BROOME COUNTY
● Sample: PW-7 S-28 64-66'

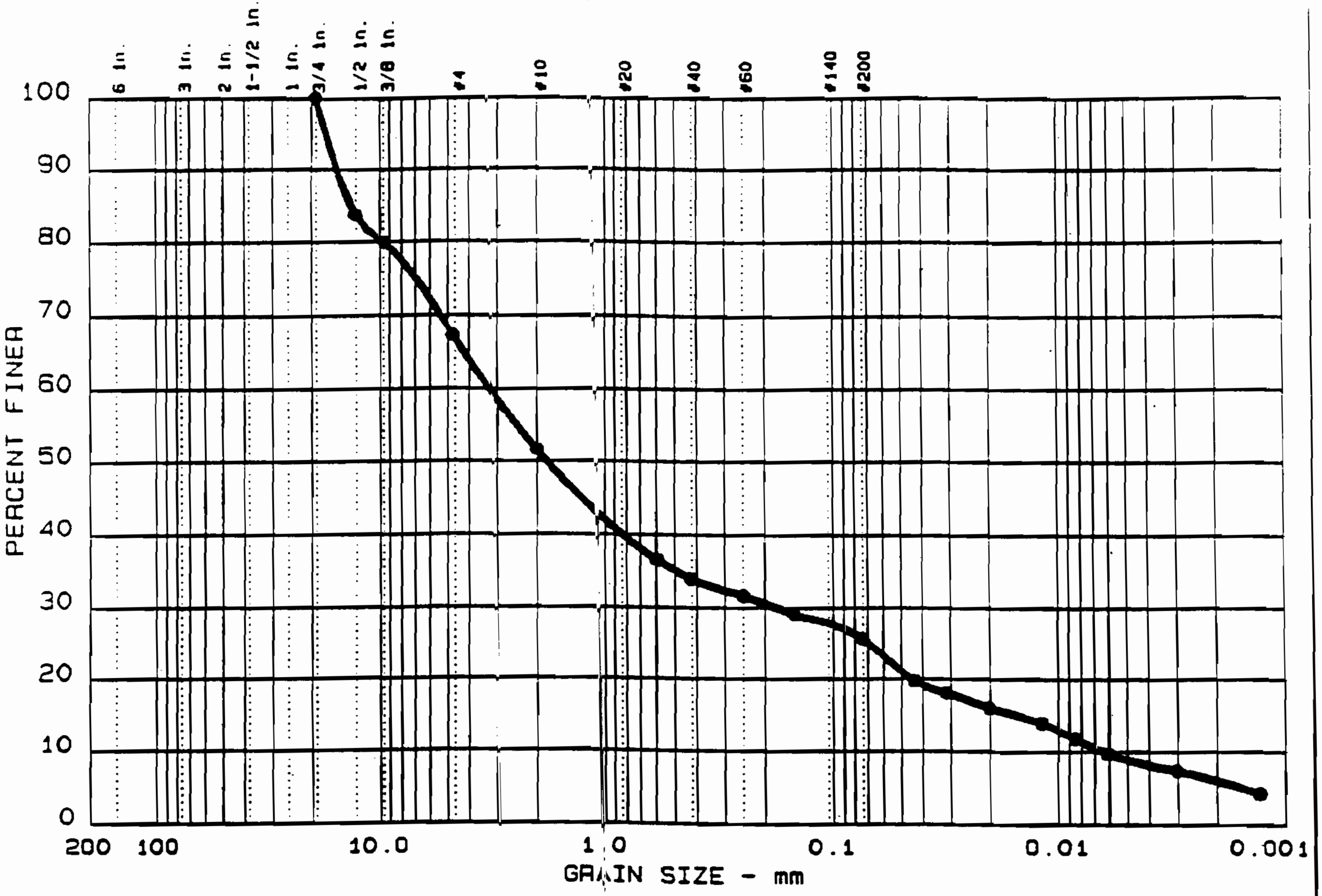
Date: 3-27-92
Sample No.:

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 21.7%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-4	0.0	32.7	41.8	16.7	8.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			13.34	3.27	1.80	0.184	0.0153	0.0064	1.62	512.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Light Gray Silty sand with gravel	SM		A-2-4 (0)

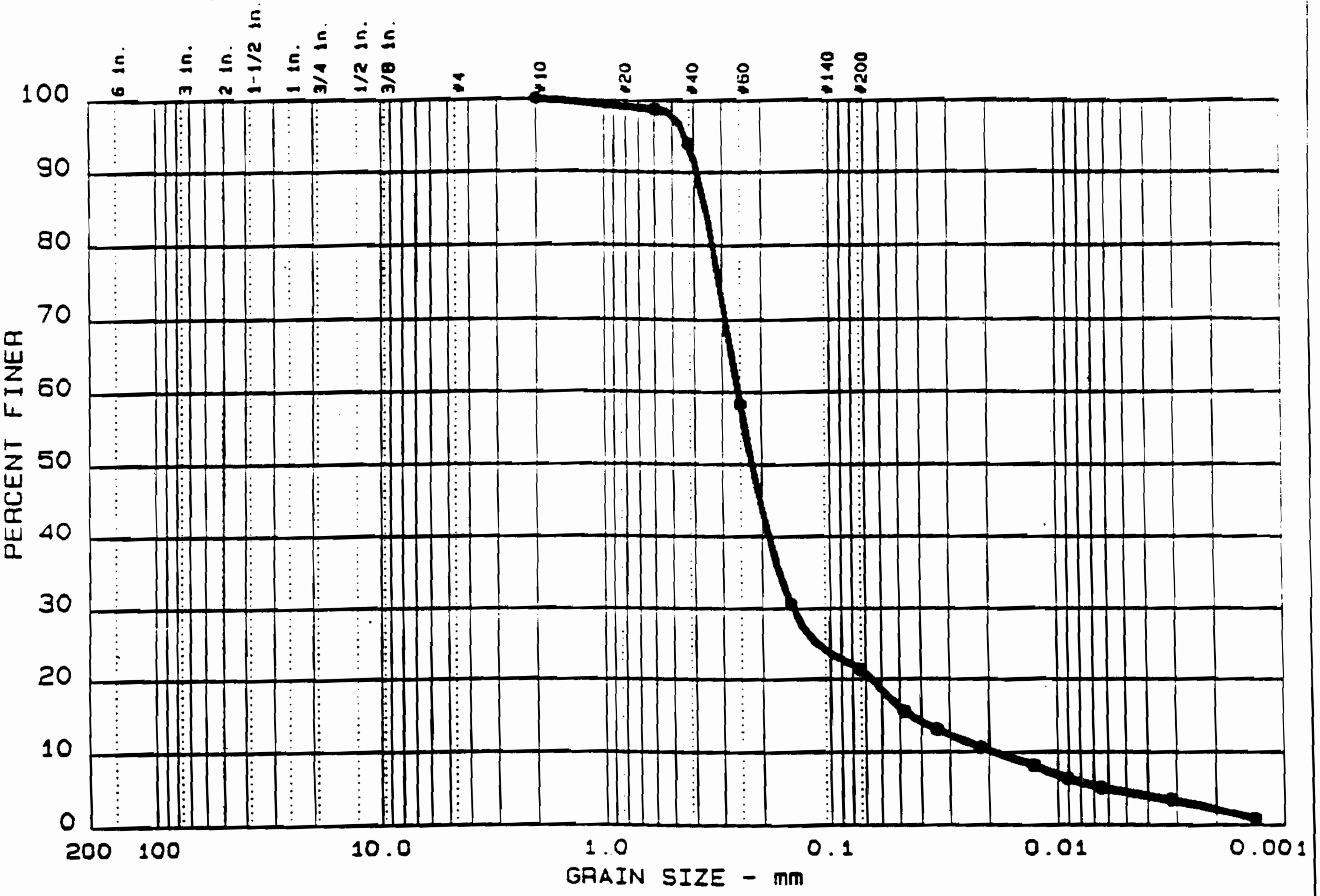
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-8 S-4 15-17' Sample No.: S-4

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 3.1%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-11	0.0	0.0	78.7	16.9	4.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.35	0.26	0.22	0.147	0.0448	0.0191	4.40	13.4

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Dark Brown Silty sand	SM		A-2-4(0)

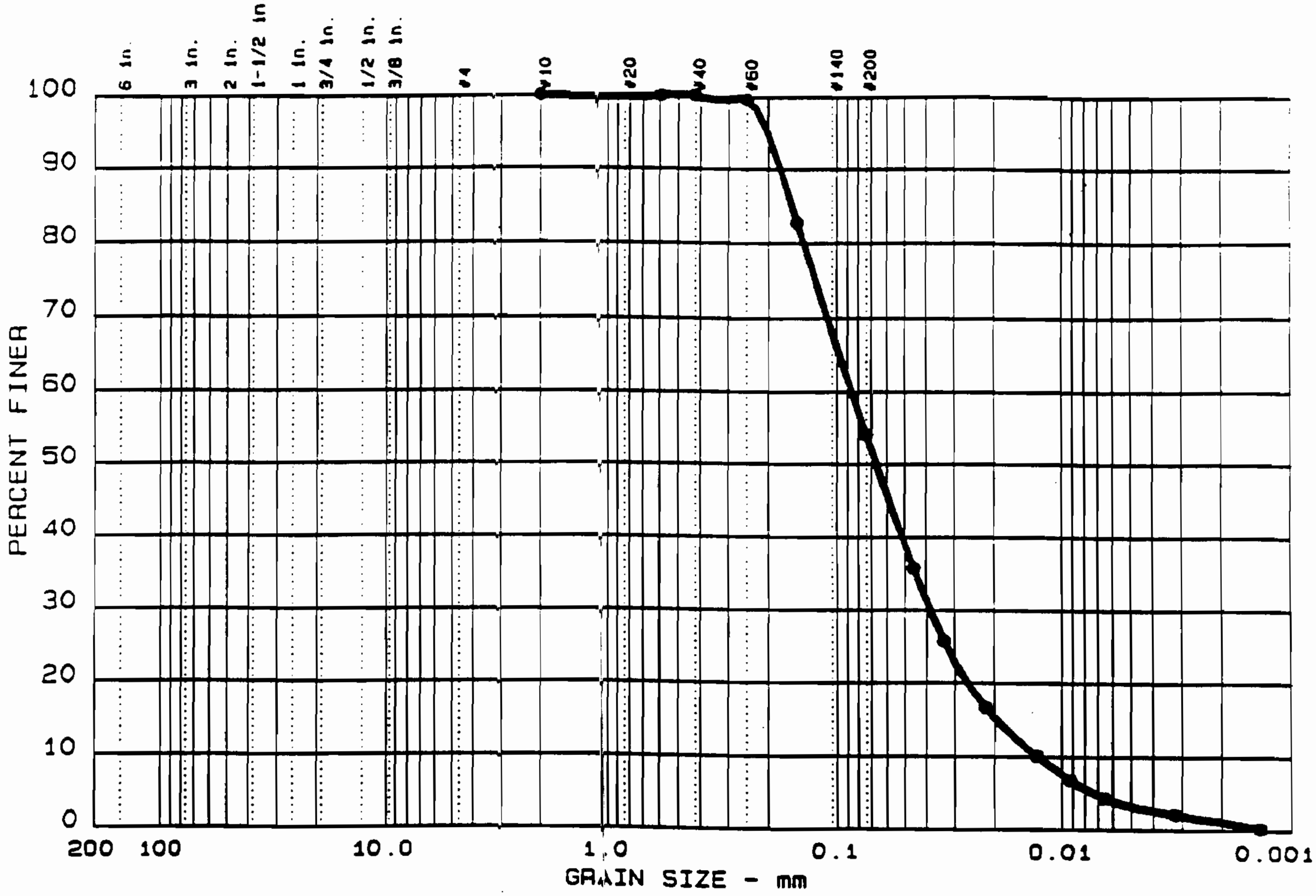
Project No.: 02260 HG   Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-8 S-11 32-34'   Sample No.: S-11

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 10.0%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL		% SAND	% SILT	% CLAY
●	S-28	0.0	0.0		45.9	51.0	3.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.16	0.09	0.07	0.038	0.0194	0.0127	1.35	6.8

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Sandy silt	ML		A-4 (0)

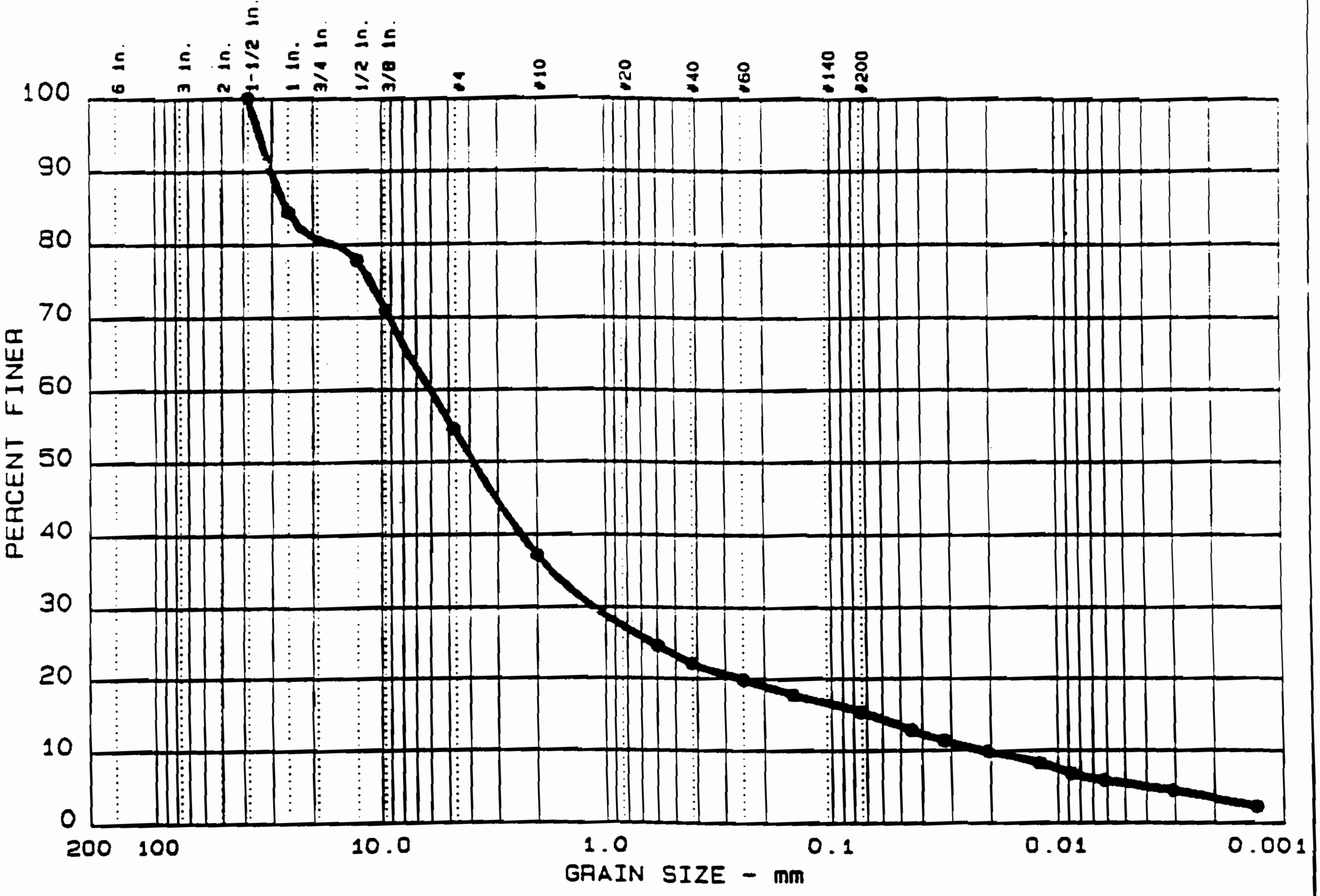
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-8 S-28 66-68' Sample No.: S-28

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 20.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-4	0.0	45.5	39.2	9.9	5.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			25.94	6.07	3.88	1.118	0.0689	0.0223	9.23	272.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Light Gray Silty gravel with sand	GM		A-1-a

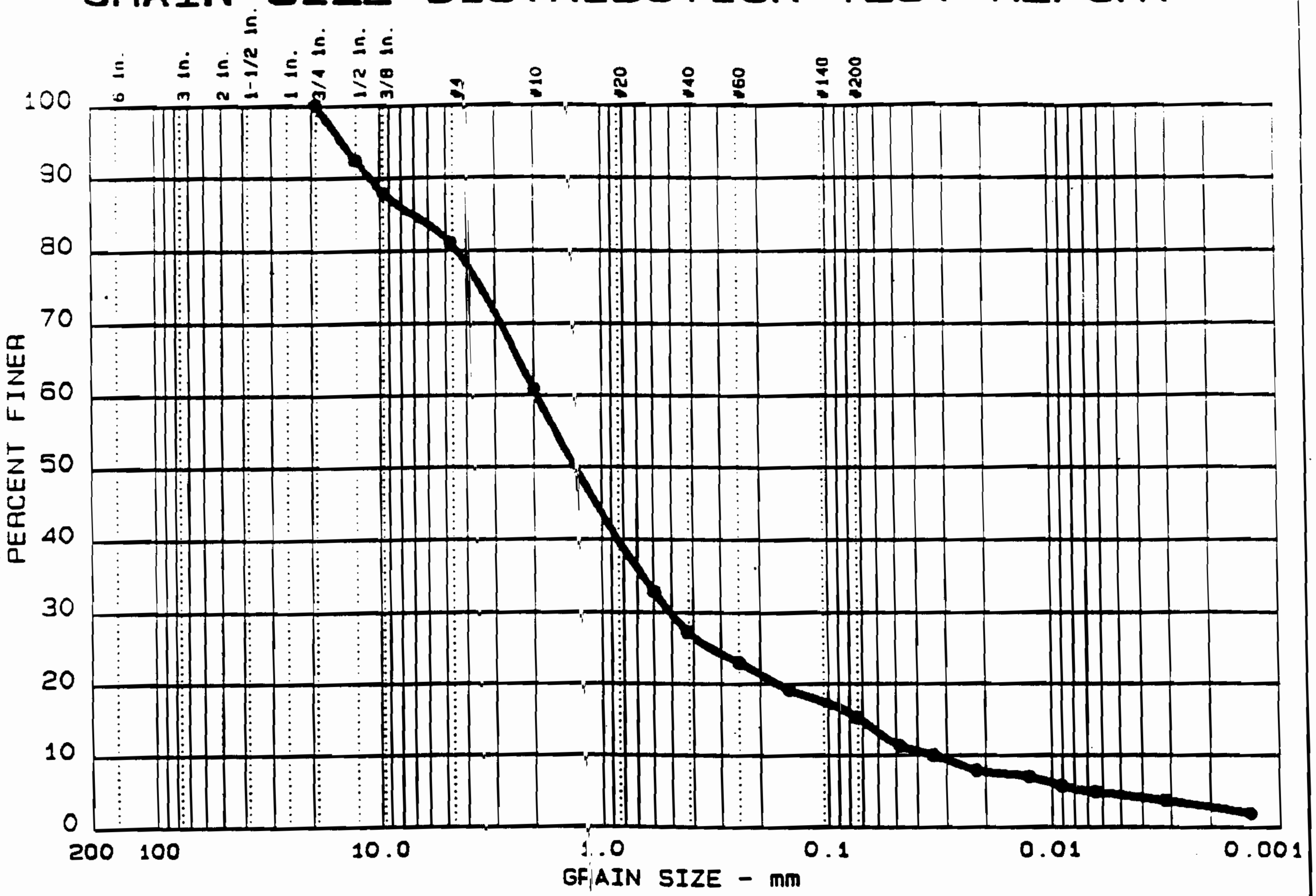
Project No.: 02260 HG
Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-9 S-4 15-17'
Sample No.: S-4

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 3.7%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-7	0.0	18.9	65.8	10.9	4.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			7.00	1.93	1.30	0.507	0.0716	0.0339	3.94	56.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Silty sand with gravel	SM		A-1-b

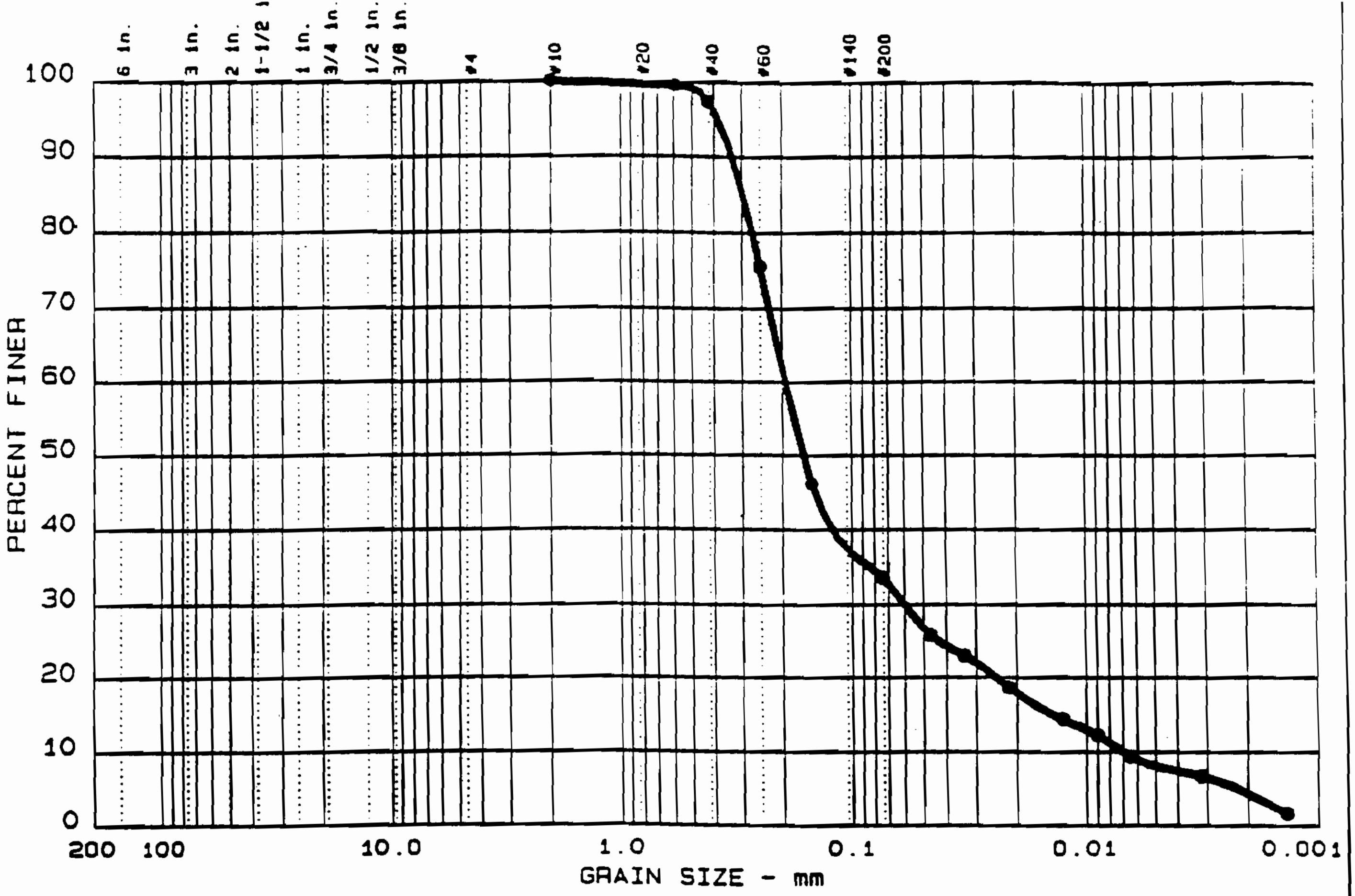
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-9 S-7 24-26' Sample No.: S-7

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 6.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
● S-17	0.0	0.0	66.6	25.4	8.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.30	0.19	0.16	0.060	0.0138	0.0069	2.65	28.0

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Silty sand	SM		A-2-4 (0)

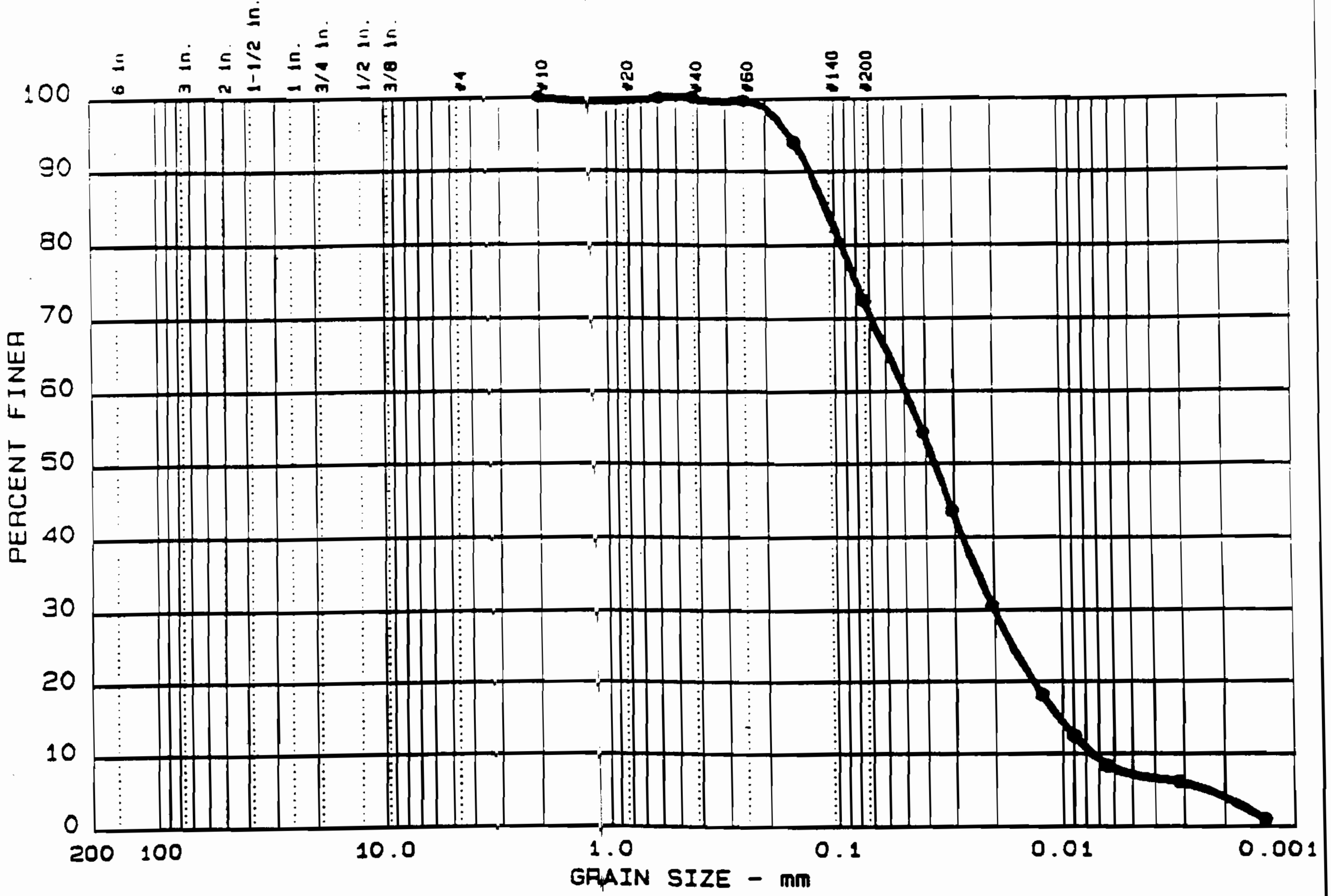
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-9 S-17 44-46' Sample No.: S-17

MEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 14.0%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-32	0.0	0.0	27.6	65.4	7.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.11		0.04	0.020	0.0104	0.0074	1.10	6.6

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Silt with sand	ML		A-4 (0)

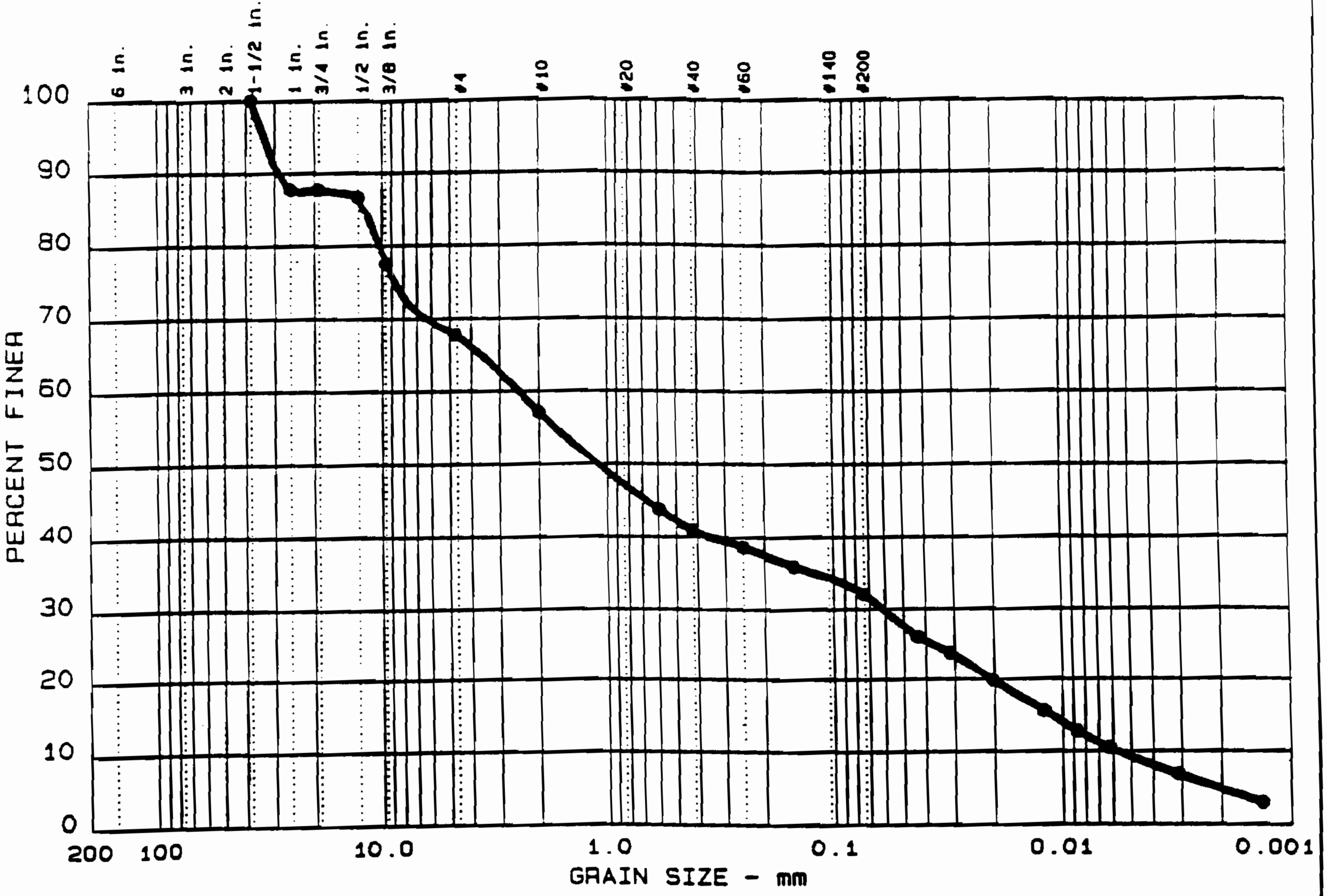
Project No.: 02260 HG
Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-9 S-32 74-76'
Sample No.: S-32

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 19.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-5	0.0	32.3	35.8	22.8	9.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			11.75	2.48	1.11	0.062	0.0111	0.0058	0.27	431.5

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Yellowisn Brown Silty sand with gravel	SM		A-2-4 (0)

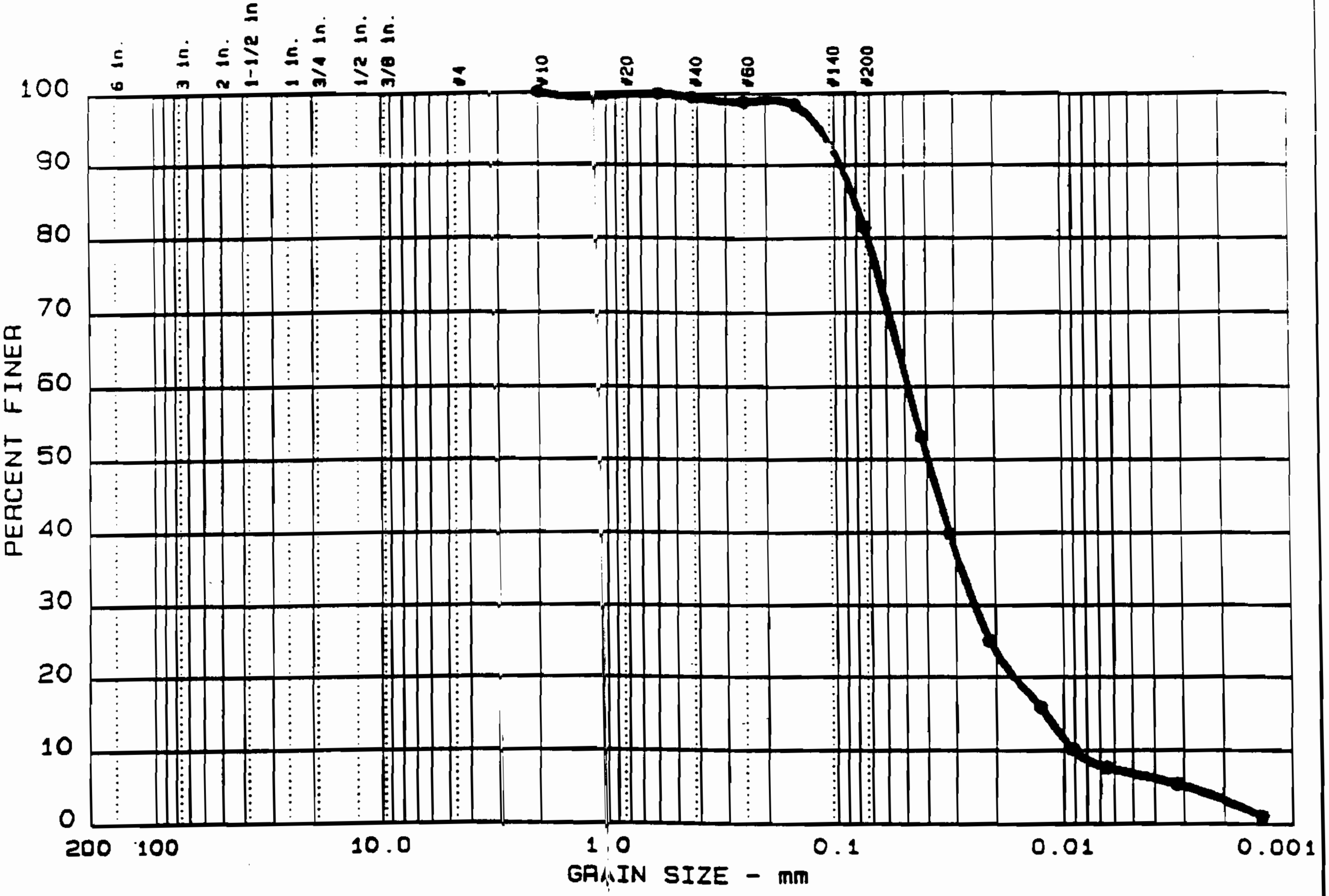
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-10 S-5 20-22' Sample No.: S-5

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 6.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S11B	0.0	0.0	18.5	74.7	6.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.08		0.04	0.025	0.0120	0.0090	1.42	5.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Silt with sand	ML		A-4 (0)

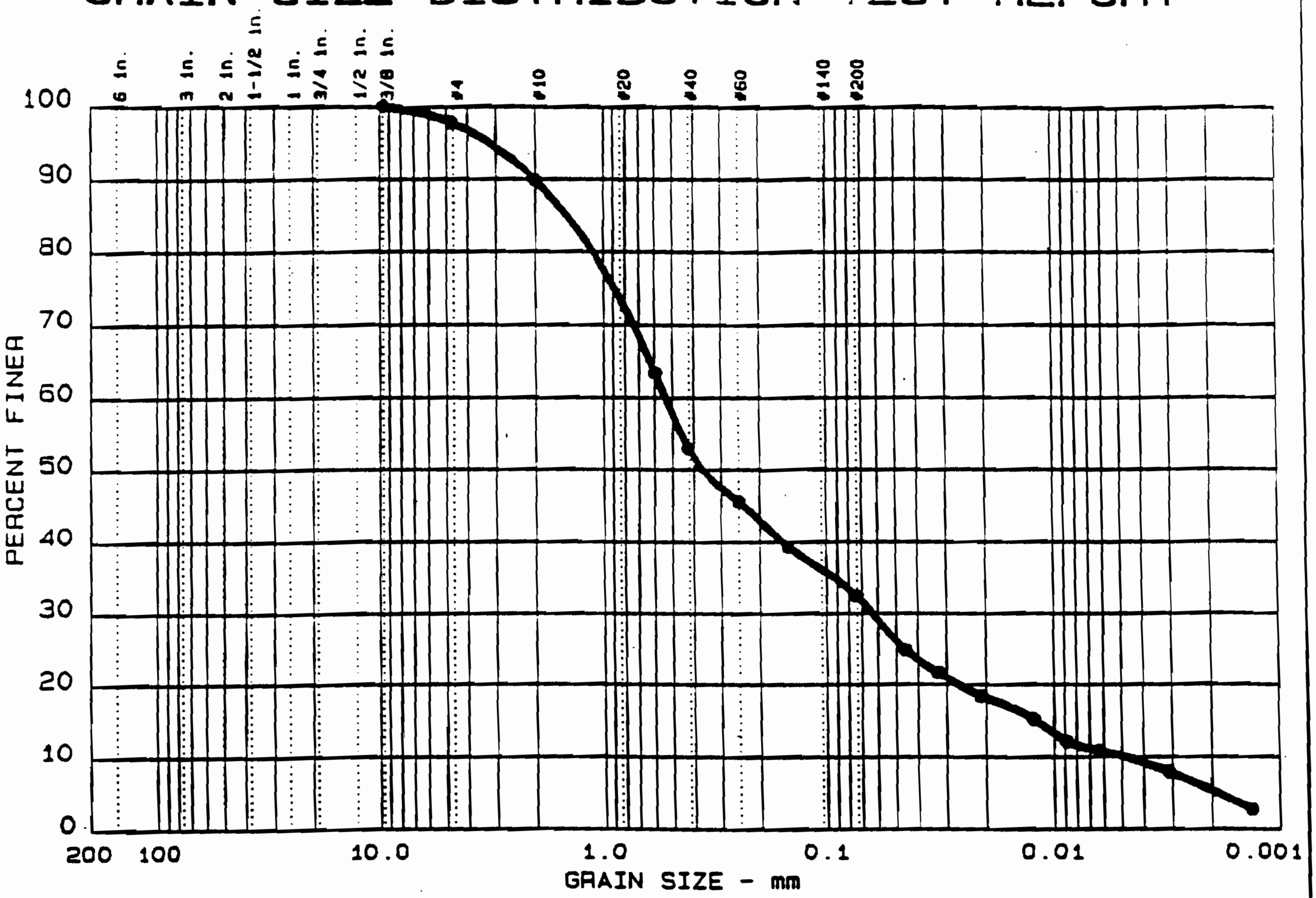
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-10 S-11B 42-43' Sample No.: S11B

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 17.7%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	S-24	0.0	2.2	65.4	22.2	10.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.45	0.53	0.36	0.063	0.0119	0.0048	1.57	110.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● Brown Silty sand	SM		A-2-4(0)

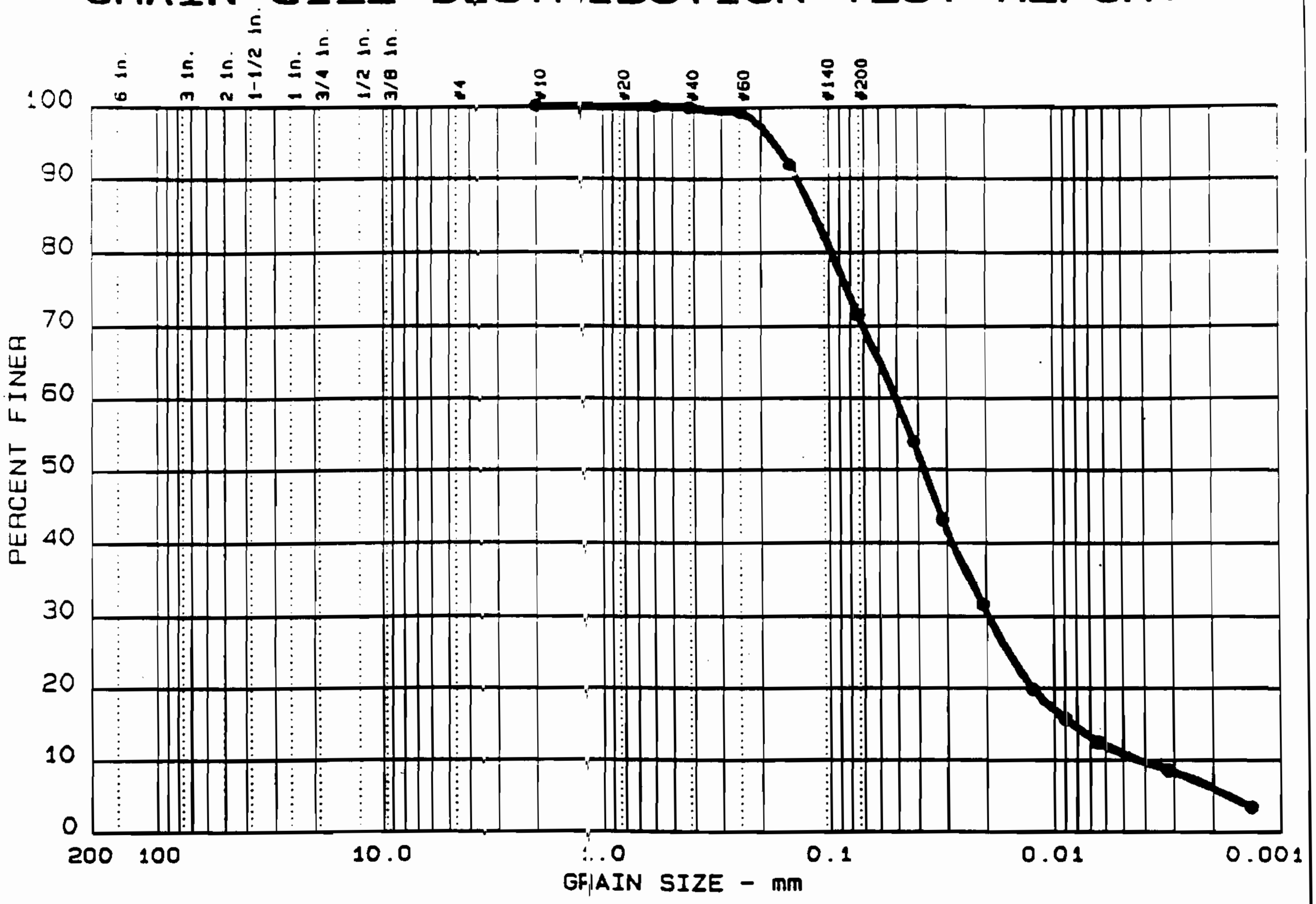
Project No.: 02260 HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-10 S-24 67-69' Sample No.: S-24

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: K.H.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT = 7.0%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	28.5	60.8	10.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.11		0.04	0.019	0.0083	0.0043	1.75	11.7

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt with sand	ML		A-4 (0)

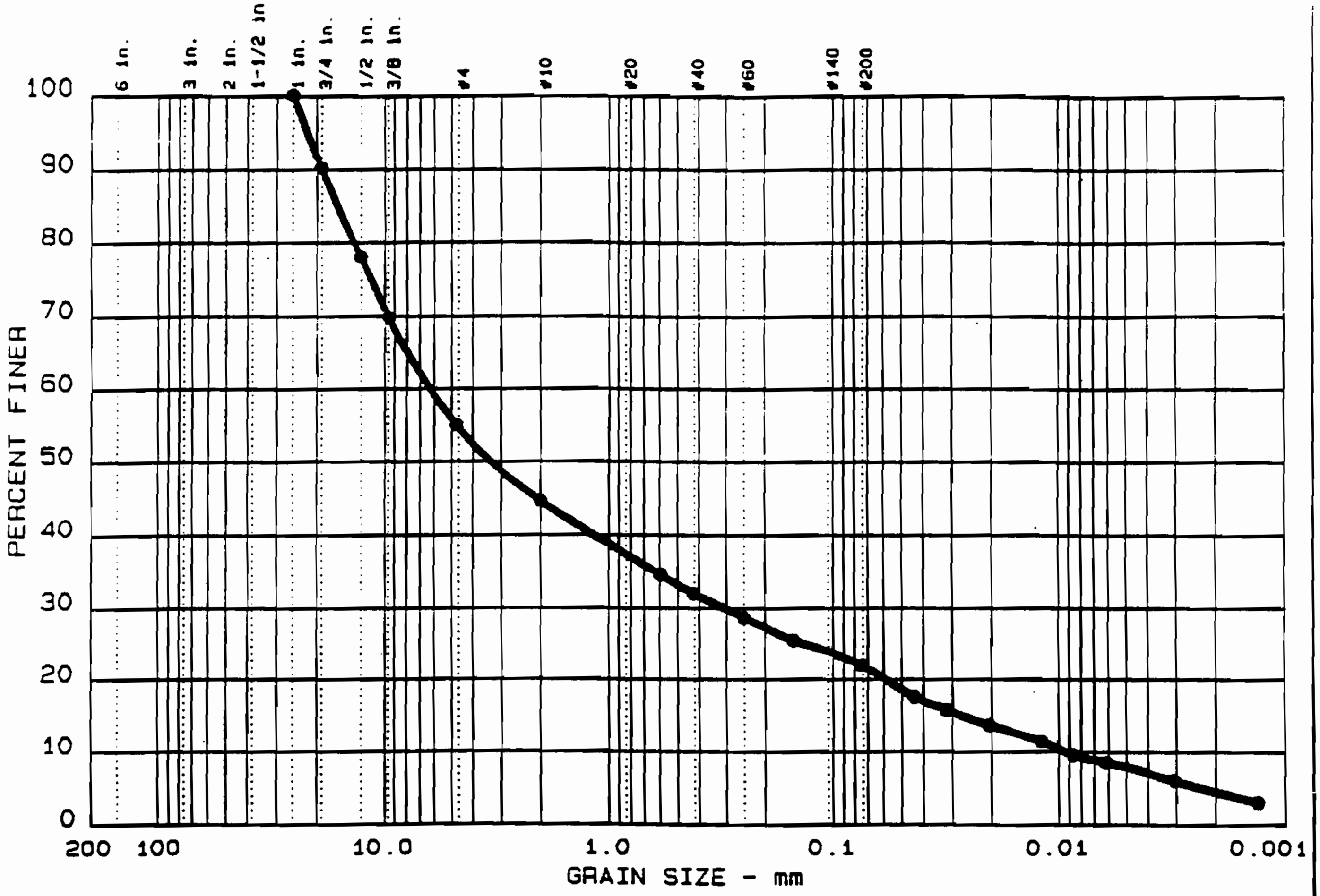
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-10 S-31 81-83' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 17.6%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	45.1	33.0	14.1	7.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			16.03	6.24	3.35	0.313	0.0272	0.0093	1.68	668.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty gravel with sand	GM		A-1-b

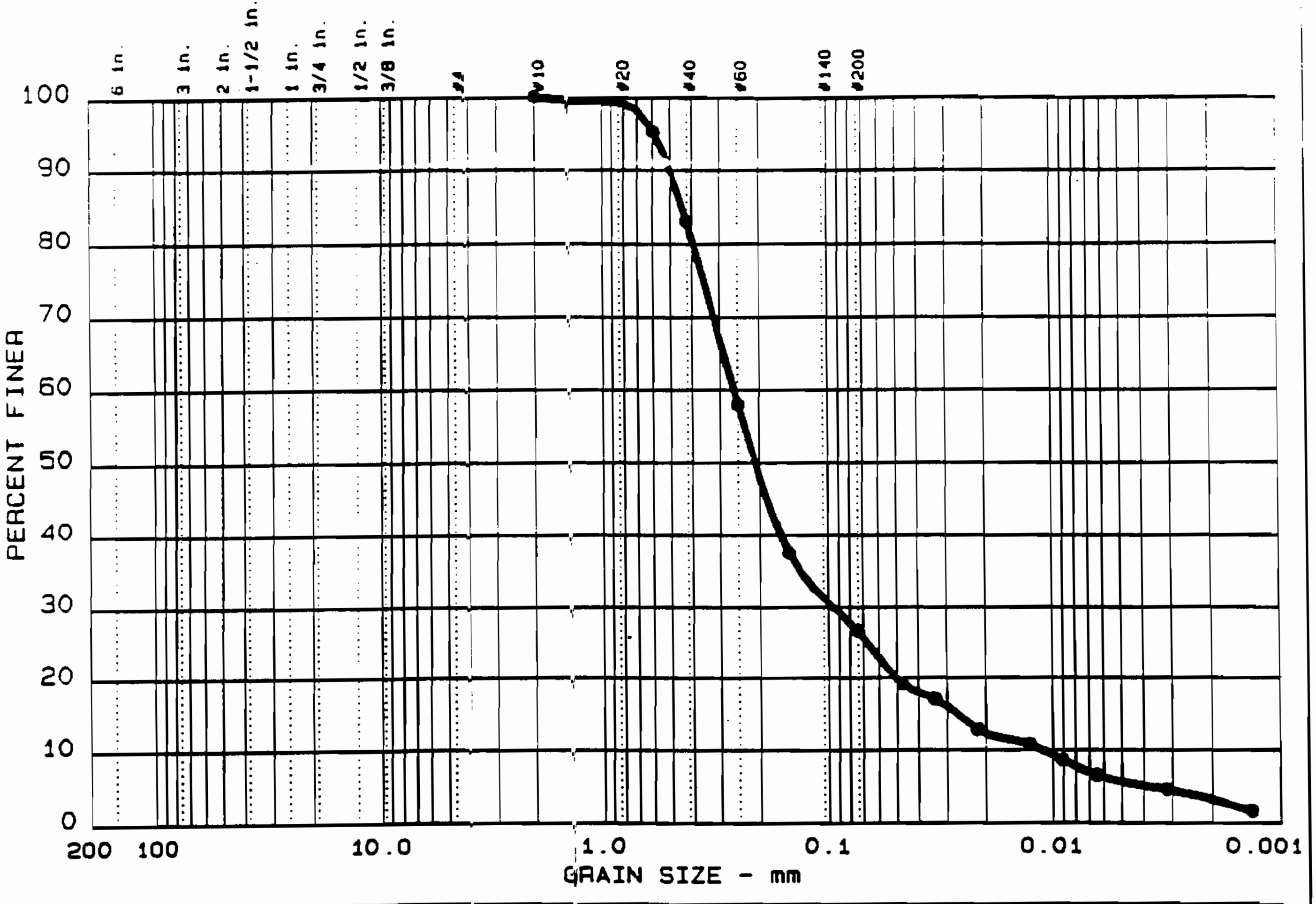
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-11 S-5 20-22' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 5.3%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	73.4	21.0	5.6

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.44	0.26	0.21	0.096	0.0268	0.0110	3.21	23.6

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-2-4 (0)

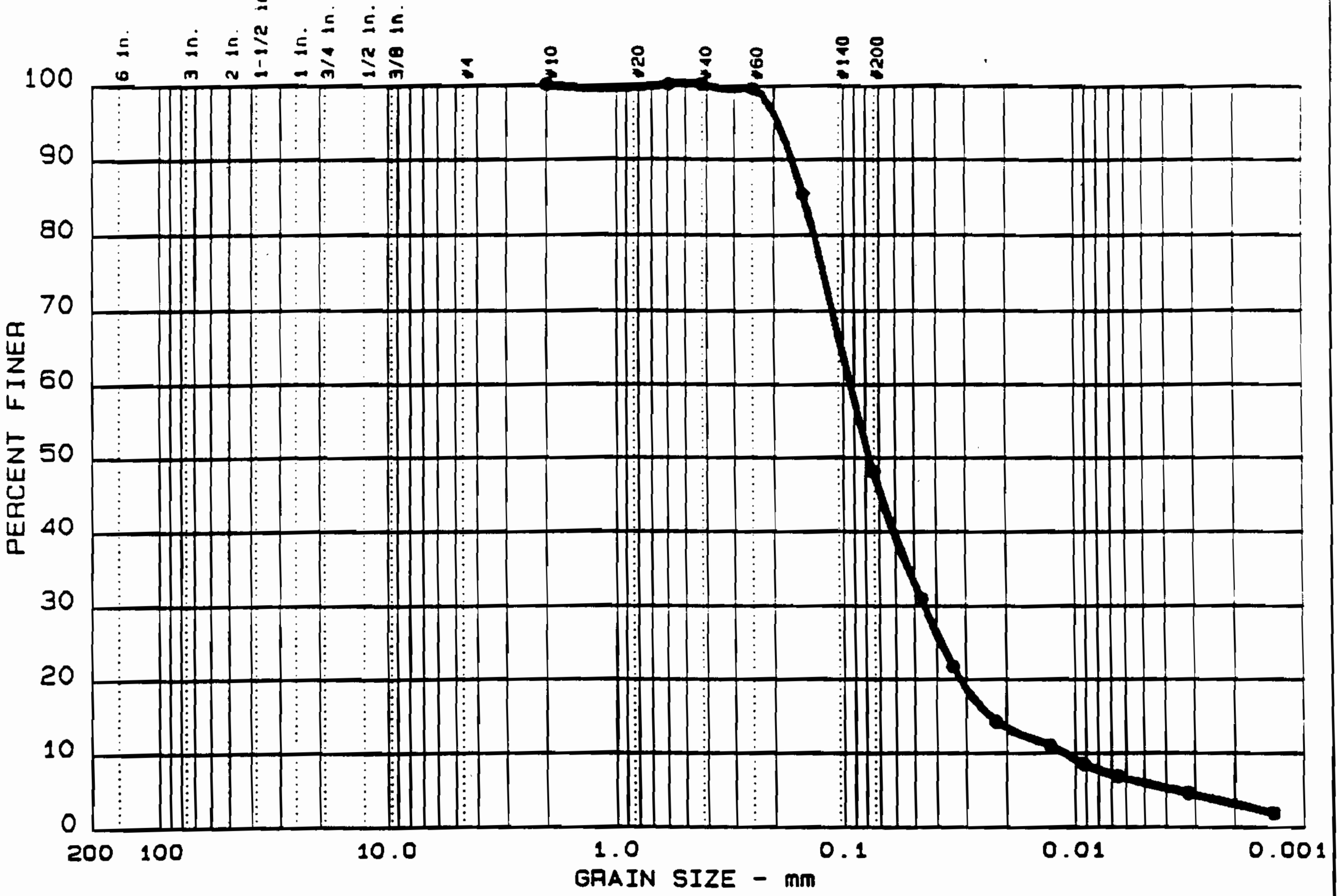
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-11 S-17 48-50' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 13.1%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	52.0	42.1	5.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.15	0.09	0.08	0.045	0.0234	0.0112	1.96	8.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-4 (0)

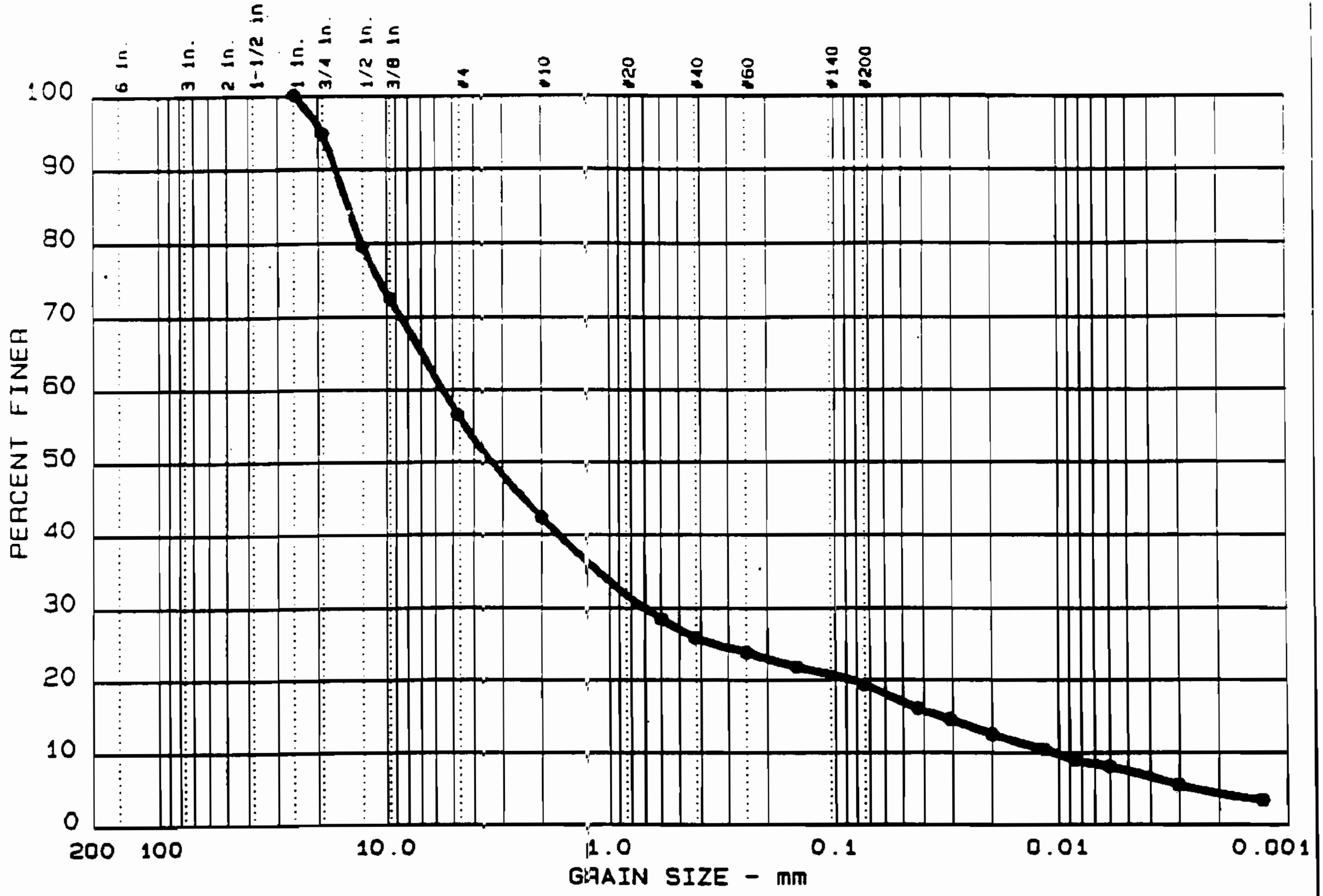
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-11 S-28 69-71' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 18.6%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	43.5	37.2	11.9	7.4

	LL	PI	D85	D60	D50	D30	D15	D10	Cc	Cu
●			14.62	5.55	3.35	0.708	0.0335	0.0105	8.61	530.9

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty gravel with sand	GM		A-1-b

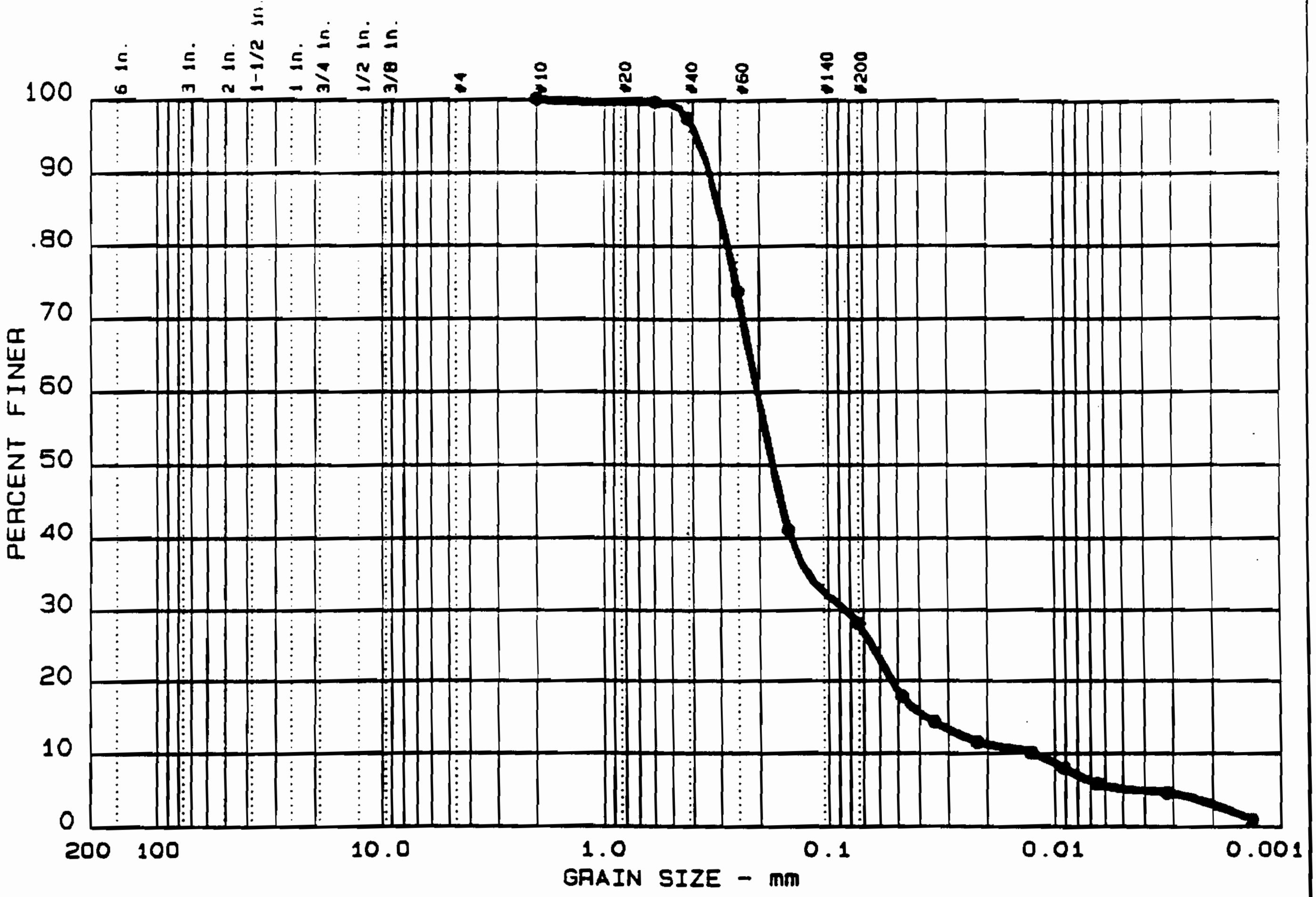
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-12 S-6 20-22' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 8.2%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	72.0	22.9	5.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.30	0.20	0.18	0.084	0.0376	0.0126	2.75	16.2

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-2-4 (0)

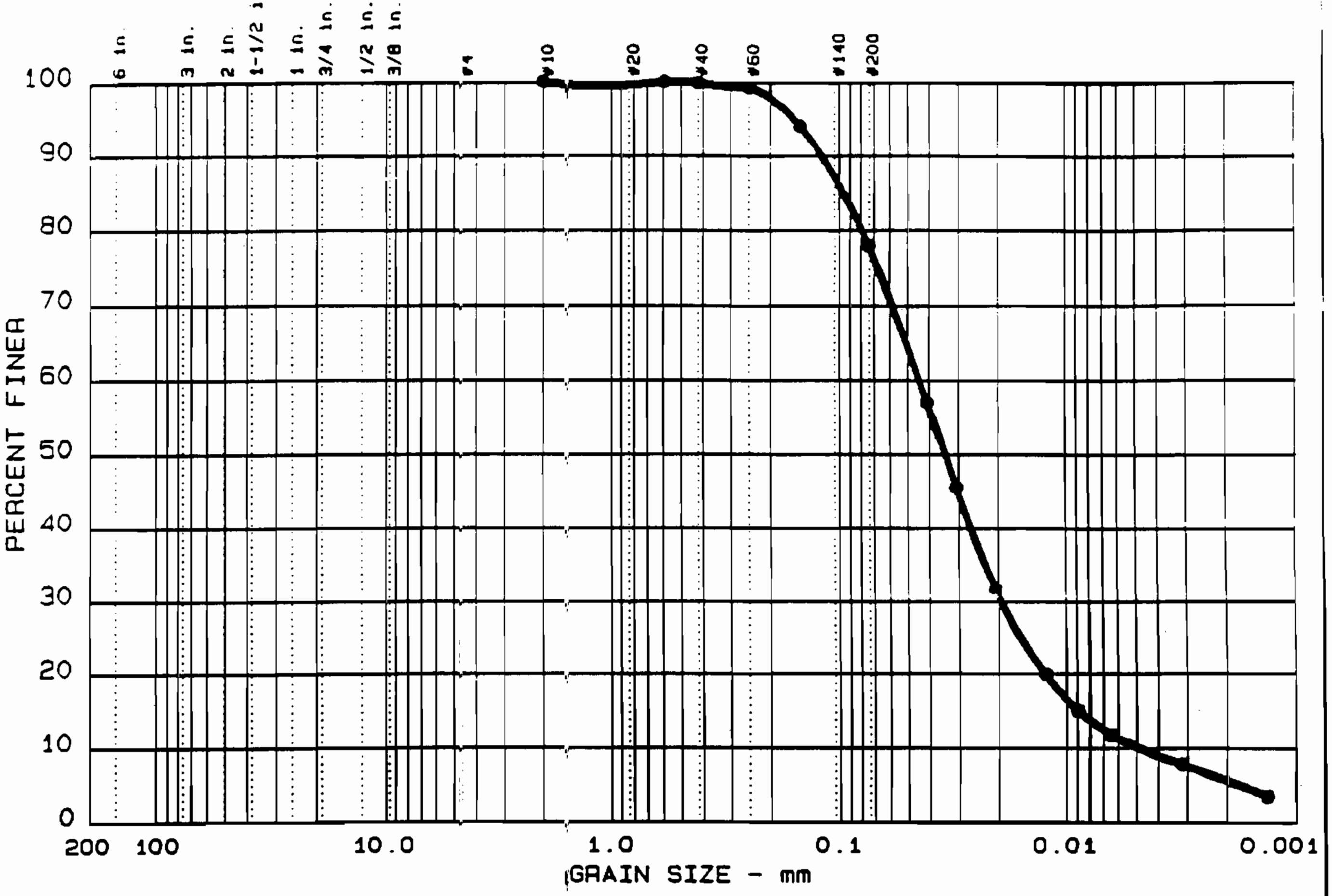
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-12 S-19 55-57' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 19.9%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	22.1	67.9	10.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.10		0.03	0.019	0.0089	0.0049	1.76	9.0

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt with sand	ML		A-4 (0)

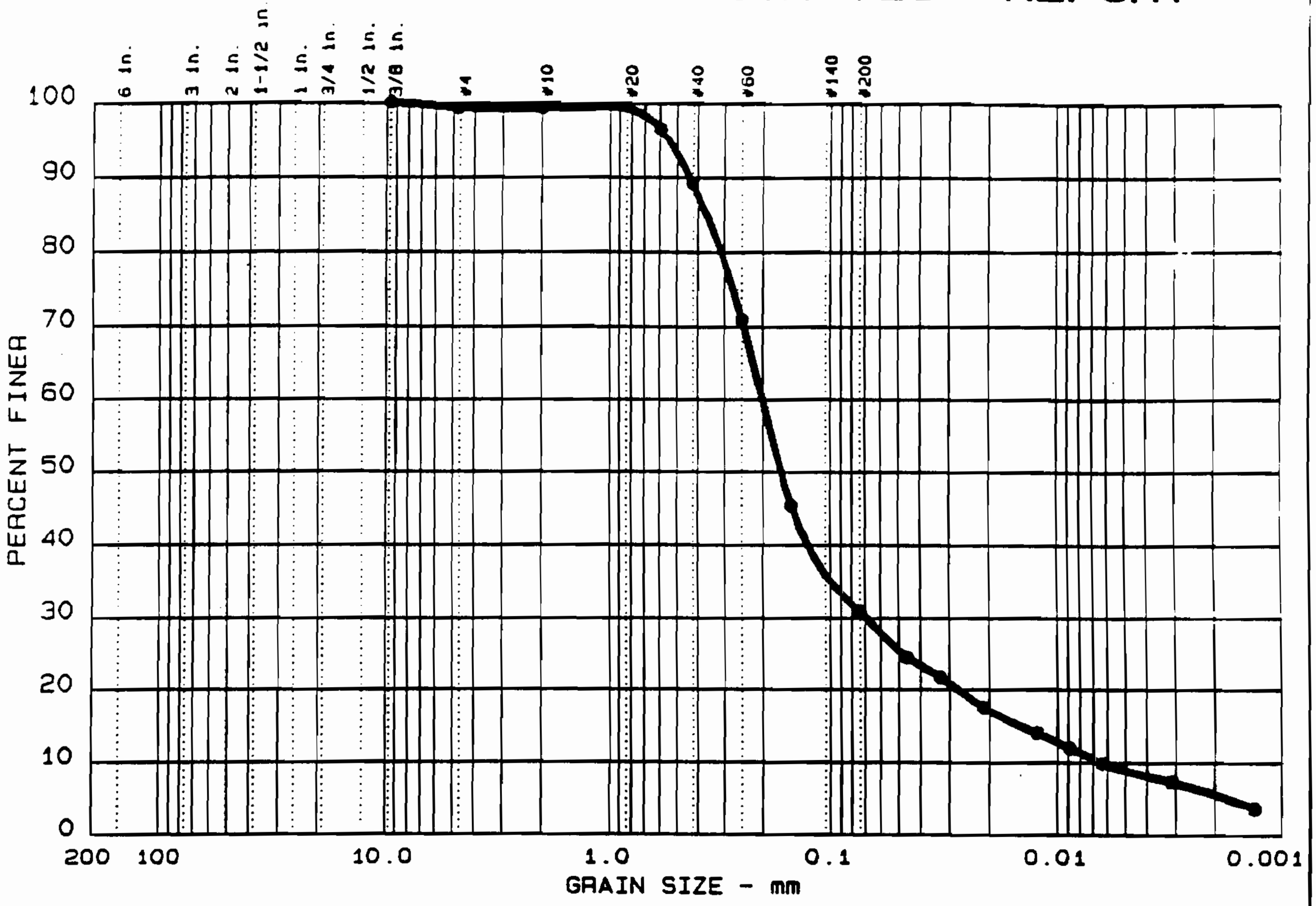
Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-12 S-29 75-77' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 22.4%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.8	68.4	22.0	8.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.36	0.20	0.17	0.069	0.0146	0.0064	3.67	31.3

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silty sand	SM		A-2-4 (0)

Project No.: 02260-HG Date: 3-30-92

Project: COLESVILLE LANDFILL

Client: BROOME COUNTY

● Sample: PW-13 S-20 50-52' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.

Entered by: D.L.

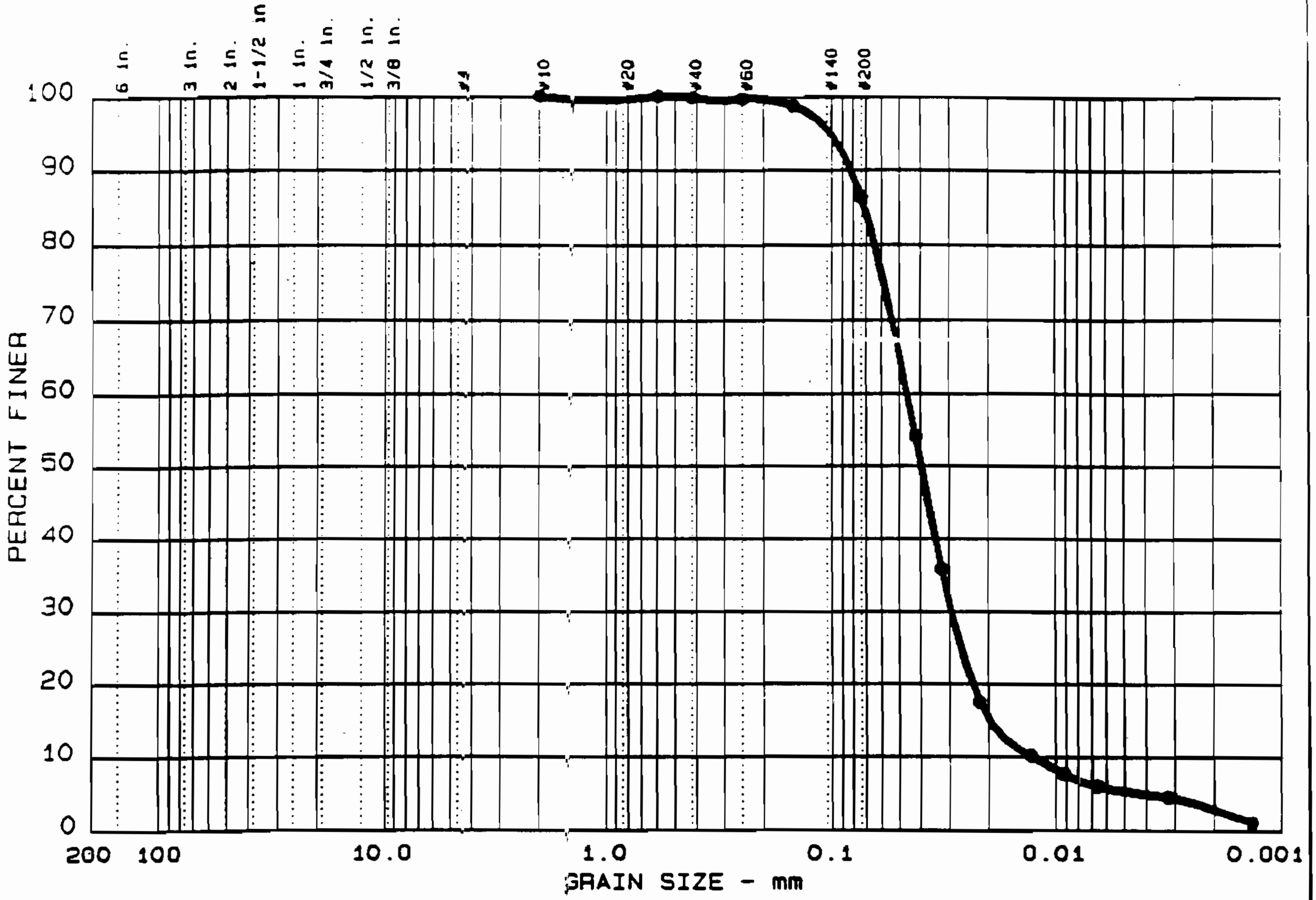
Checked by: R.S.A.

Remarks:

MOISTURE CONTENT= 17.5%

Figure No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	S. #	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●		0.0	0.0	13.5	81.2	5.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●					0.04	0.029	0.0197	0.0127	1.46	3.6

MATERIAL DESCRIPTION	ASTM	BURMISTER	AASHTO
● BROWN Silt	ML		A-4 (0)

Project No.: 02260-HG Date: 3-30-92
Project: COLESVILLE LANDFILL
Client: BROOME COUNTY
● Sample: PW-13 S-33 76-78' Sample No.:

WEHRAN ENGINEERING

Performed by: D.L.
Entered by: D.L.
Checked by: R.S.A.
Remarks:
MOISTURE CONTENT= 24.1%

Figure No.

APPENDIX E
PERMIT APPLICATION AND VARIANCE APPLICATION

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

APPLICATION FOR VARIANCE FROM 6 NYCRR 360

SEE APPLICATION INSTRUCTIONS ON REVERSE SIDE

PROJECT NO.	DATE RECEIVED
DEPARTMENT ACTION ☐ Approved ☐ Disapproved	DATE

1. OWNER'S NAME Broome County	2. ADDRESS (Street, City, State, Zip Code) P.O. Box 1766, Binghamton, NY 13902	3. Telephone No. (607)-778-2482
4. OPERATOR'S NAME Broome County	5. ADDRESS (Street, City, State, Zip Code) P.O. Box 1766, Binghamton, NY 13902	6. Telephone No. (607)-778-2482
7. ENGINEER'S NAME Wehran-New York, Inc.	8. ADDRESS (Street, City, State, Zip Code) 666 East Main Street, Middletown, NY 10940	9. Telephone No. (914)-343-0660

10. PROJECT/FACILITY NAME
Colesville Landfill

11. PROJECT STATUS ☒ Public ☐ Private ☐ Proposed ☐ Existing	12. COUNTY IN WHICH FACILITY IS LOCATED Broome County	13. ENVIRONMENTAL CONSERVATION REGION

14. DESCRIBE SPECIFIC LOCATION OF FACILITY

The Colesville Landfill is located on a 117-acre parcel of land owned by the County of Broome on East Windsor Road, 150 feet east of the intersection of Dyer Flat Road.

15. TYPE OF PROJECT FACILITIES: ☐ Composting ☐ Transfer ☐ Shredding ☐ Baling ☒ Sanitary Landfill ☐ Incineration ☐ Pyrolysis ☐ Resource Recovery-Energy ☐ Resource Recovery-Materials ☐ Other

16. BRIEFLY DESCRIBE THE PROJECT INCLUDING THE BASIC PROCESS AND MAJOR COMPONENTS

The proposed construction includes the installation of landfill final cover over the entire 31-acre site in accordance with 6NYCRR Part 360 Regulations. Additionally, a 17-acre borrow area will be developed to provide final cover soils within the 117-acre parcel.

17. SPECIFIC PROVISION OF 6 NYCRR 360 FROM WHICH A VARIANCE IS REQUESTED:	Section 360-2.13	Paragraph (P)(2)(i)	Variance Request No. 1

18. BRIEFLY DESCRIBE PROPOSED VARIANCE

The proposed gas venting layer will consist of either 6 inches of sand with 2×10^{-3} cm/sec permeability or a geocomposite drain, with 12-inch collection trenches in each alternative instead of the required 12-inch layer. The proposed alternatives have equivalent or better venting capabilities while providing sufficient protection to the overlying flexible membrane liner.

Refer to the Final Engineering Design Report Appendix G for Gas Venting Layer Equivalency Calculations.

19. IMPACTS OF VARIANCE APPROVAL OR DISAPPROVAL:

a. Environmental Impact:

No environmental impact is associated with the variance. Each alternative has been shown to be equivalent with the required gas venting layer.

b. Economic Impact:

The economic impact of the variance is significant. Use of either alternative significantly reduces the cost of the gas venting layer.

20. CERTIFICATION:

I hereby affirm under penalty of perjury that information provided on this form and attached statements and exhibits is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

June 1, 1994
Date

PE
Signature and Title

7-19-5 (6/77)

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

APPLICATION FOR VARIANCE FROM 6 NYCRR 360

SEE APPLICATION INSTRUCTIONS ON REVERSE SIDE

PROJECT NO.	DATE RECEIVED
DEPARTMENT ACTION ☐ Approved ☐ Disapproved	DATE

1. OWNER'S NAME Broome County	2. ADDRESS (Street, City, State, Zip Code) P.O. Box 1766, Binghamton, NY 13902	3. Telephone No. (607)-778-2482
4. OPERATOR'S NAME Broome County	5. ADDRESS (Street, City, State, Zip Code) P.O. Box 1766, Binghamton, NY 13902	6. Telephone No. (607)-778-2482
7. ENGINEER'S NAME Wehran-New York, Inc.	8. ADDRESS (Street, City, State, Zip Code) 666 East Main Street, Middletown, NY 10940	9. Telephone No. (914)-343-0660

10. PROJECT/FACILITY NAME
Colesville Landfill

11. PROJECT STATUS ☒ Public ☐ Private ☐ Proposed ☐ Existing	12. COUNTY IN WHICH FACILITY IS LOCATED Broome County	13. ENVIRONMENTAL CONSERVATION REGION

14. DESCRIBE SPECIFIC LOCATION OF FACILITY

The Colesville Landfill is located on a 117-acre parcel of land owned by the County of Broome on East Windsor Road, 150 feet east of the intersection of Dyer Flat Road.

15. TYPE OF PROJECT FACILITIES: ☐ Composting ☐ Transfer ☐ Shredding ☐ Baling ☒ Sanitary Landfill ☐ Incineration ☐ Pyrolysis ☐ Resource Recovery-Energy ☐ Resource Recovery-Materials ☐ Other

16. BRIEFLY DESCRIBE THE PROJECT INCLUDING THE BASIC PROCESS AND MAJOR COMPONENTS

The proposed construction includes the installation of landfill final cover over the entire 31-acre site in accordance with 6NYCRR Part 360 Regulations. Additionally, a 17-acre borrow area will be developed t provide final cover soils within the 117-acre parcel.

17. SPECIFIC PROVISION OF 6 NYCRR 360 FROM WHICH A VARIANCE IS REQUESTED: Section 360-2.13	Paragraph (r)(2)(ii)	Variance Request No. 2

18. BRIEFLY DESCRIBE PROPOSED VARIANCE

The minimum final cover slope will be two percent instead of the required four percent. The proposed shallower slopes are utilized in order to prevent excavation of the in-place waste and minimize development of an off-site borrow area to fill over the existing slopes to achieve four percent slopes. Additionally, since the site has not received waste since 1984; only minor settlement is expected in localized areas at the site.

Refer to the Final Engineering Design Report Appendix B for landfill Settlement Evaluation.

19. IMPACTS OF VARIANCE APPROVAL OR DISAPPROVAL:

a. Environmental Impact:

Limited environmental impact is expected with the variance. Analysis of the site predicts only minimal amounts of settlements will occur after final closure of the site. To minimize the potential for adverse impact, regular inspections of the site will be performed to effect early indication of settlement and its potential impact to the site. Additionally, a maintenance program will be implemented to address any deficiencies identified during inspections of the final cover and rapidly restore landfill grade and drainage. Disapproval of the variance will result in significant environmental impacts due to either relocation of the in-place waste or the need to further develop the on-site borrow area and import soil from off site.

b. Economic Impact:

The economic impact fo the variance is significant to excavation of the in-place waste or overfilling the existing grades will require significant increase in construction effort and environmental monitoring.

20. CERTIFICATION:

I hereby affirm under penalty of perjury that information provided on this form and attached statements and exhibits is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

June 1, 1994
Date

Joseph J. [illegible] PE
Signature and Title

47-19-5 (6/77)

47-19-2 (11/89)—10e

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF SOLID WASTE

DEPARTMENT USE ONLY
DEC APPLICATION NUMBER
FACILITY CODE

APPLICATION FOR A SOLID WASTE MANAGEMENT FACILITY PERMIT

Please read all instructions before completing this application

Please **TYPE** or **PRINT** clearly

1. TYPE OF APPLICATION (Check All Applicable Boxes):
☒ Permit to Construct ☐ Initial (New) ☐ Renewal
☐ Permit to Operate ☐ Subsequent Stage (New) ☐ Modification

2. **APPLICANT** IS THE:
☒ Facility Owner
☒ Facility Operator

3. FACILITY OWNER'S NAME	4. FACILITY OPERATOR'S NAME	5. ENGINEER'S NAME AND P.E. LICENSE NO.
Broome County	Broome County	Barry J. Cheney P.E. #54349
Address P.O. Box 1766	Address P.O. Box 1766	Firm Name Wehran-New York, Inc.
City Binghamton	City Binghamton	Address 666 East Main Street
State/Zip Code New York 13902	State/Zip Code New York 13902	City/State/Zip Code Middletown, NY 10940
Telephone Number (607) 778-2482	Telephone Number (607)778-2482	Telephone Number (914) 343-0660

6 FACILITY NAME AND LOCATION (Attach USGS Topo Map showing exact location)
Name Colesville Landfill
Street East Windsor Road
City, State, Zip Code
Town Colesville County Broome
Coordinates
NYTM—E 770000 NYTM—N 789000

7. SITE OWNER'S NAME Broome County
Address P.O. Box 1766
City Binghamton
State/Zip Code New York 13902
Telephone (607) 778-2482

8. TYPE OF FACILITY (Check all applicable boxes)
☒ Landfill (Specify category) Superfund
☐ Research, Development and Demonstration
☐ Land Application
☐ Solid Waste Incineration
☐ Refuse Derived Fuel Processing
☐ Composting
☐ Recyclables Handling and Recovery
☐ Other (Describe)
☐ Transfer Station
☐ Medical Waste
☐ Waste Tire Storage
☐ Landfill Gas Recovery
☐ Waste Oil

9. IS APPLICATION BEING FILED BY OR ON BEHALF OF A MUNICIPALITY?
☒ Yes ☐ No If yes, name.
Broome County

10. FEE AMOUNT ENCLOSED
$

11. NAME(S) OF ALL MUNICIPALITIES SERVED
Site closed

12. SOLID WASTE HANDLED
a. List wastes to be accepted N/A
b. Quantity (Specify Units)
Existing "approved design capacity" N/A
Proposed "approved design capacity" N/A

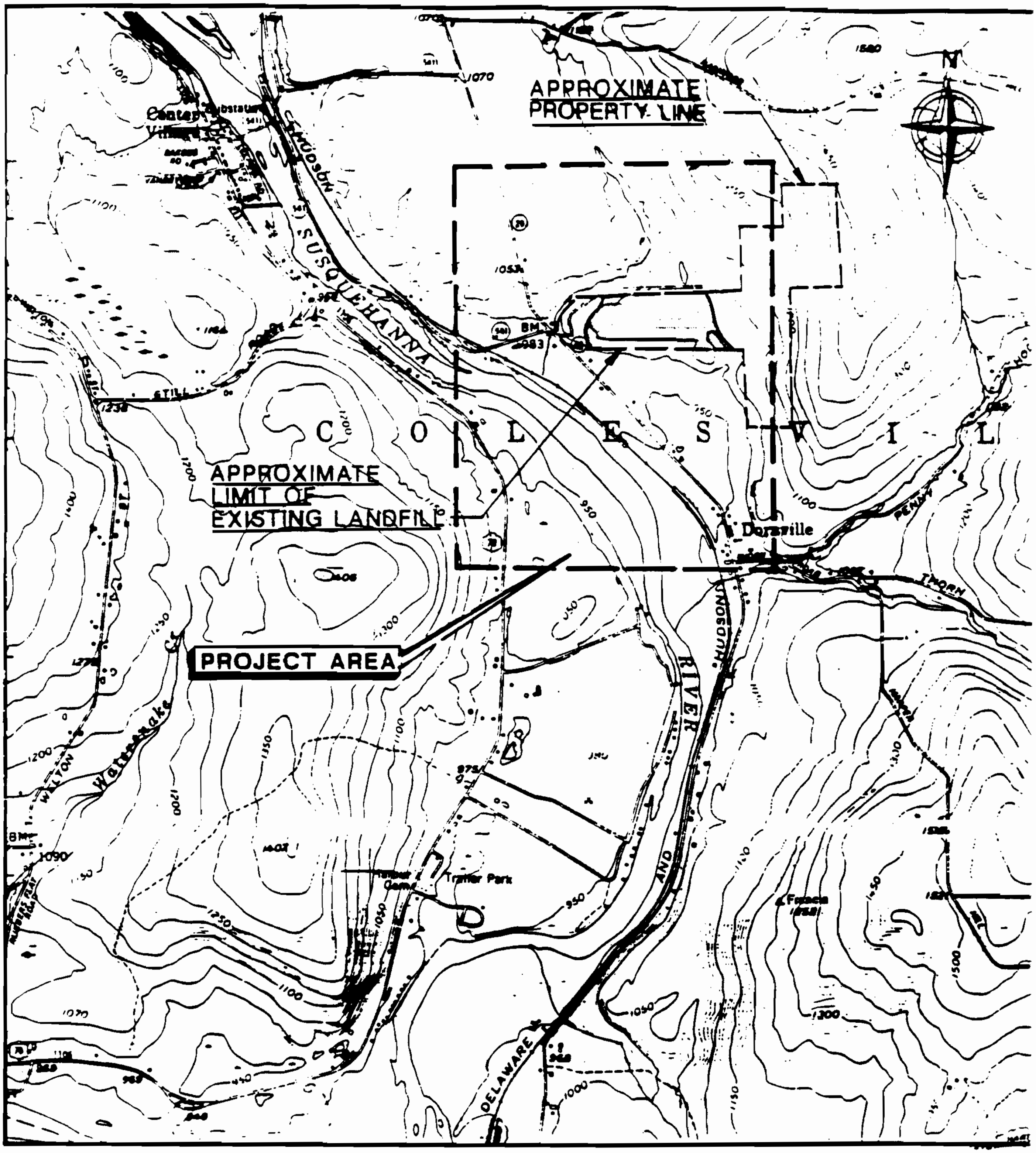
13. PROVIDE THE FOLLOWING INFORMATION WHERE APPLICABLE
a. Facility area proposed in the application 31.0 acres
b. Facility area ultimately planned 31.0 acres
c. Ultimate facility height above existing ground level N/A feet
d. Total site area 117.0 acres
e. Existing landfill area on this site and adjacent properties 31.0 acres

14. IS A VARIANCE REQUESTED FROM ANY PROVISION OF 6 NYCRR PART 360?
☒ Yes ☐ No If yes, cite the specific provision(s)
1. 360-2.13(P)(2)(i)
2. 360-2.13(r)(2)(ii)

15. CERTIFICATION:
I hereby affirm under penalty of perjury that information provided on this form and attached statements and exhibits was prepared by me or under my supervision and direction and is true to the best of my knowledge and belief, and that I have the authority or am authorized as ______ (title) of ______ (Entity) to sign this application pursuant to 6 NYCRR Part 360. I am aware that any false statement made herein is punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

Date Signature Print Name

REGIONAL DRA COPY



SOURCE:

TOPOGRAPHY TAKEN FROM

1957 AFTON, N.Y.

U.S.G.S. QUADRANGLE

7.5 MINUTE SERIES

SCALE: 1" = 2000'

FIGURE 2-1

SITE LOCATION MAP

WEHRAN ENGINEERING
CONSULTING ENGINEERS

APPENDIX F
EMERGENCY CONTACT LISTING

EMERGENCY RESPONSE AGENCIES AND CONTACTS

Regulatory Agencies - (Mandatory Within 2 Hours After Spill)

New York State Department of Environmental Conservation	(800) 457-7362

Oil and Hazardous Material Clean-up Contractors (if required)

IT Corporation, Stratford, CT	(203) 386-0100
Hitchcock, Bridgeport, CT	(203) 334-2161
Clean Harbors, Albany, NY	(518) 434-0149

Local Agencies (if required)

Broome County Sheriff, Binghamton, NY	(607) 778-1911
New York State Police, Binghamton, NY	(607) 775-1241
Local Police, Harpursville, NY	(607) 772-1010
Fire Department, Harpursville, NY	(607) 772-1010
Lourdes Hospital, Binghamton, NY	(607) 798-5231
Ambulance/Rescue Squad, Harpursville, NY	(607) 772-1010

Broome County (within 24 hours) Deputy for Engineering Services (Mike McElhare, Director)	(607) 778-2482

APPENDIX G
GAS VENTING LAYER EQUIVALENCY

By KPH **Date** 12/15/92
Chkd. by ______ **Date** ______
Subject COLESVILLE LANDFILL

WehranEnviroTech

Job No. 02260.CS
Sheet No. 1 **of** 3

GAS COLLECTION ALTERNATIVE DESIGNS

CHECK PROPOSED ALTERNATIVES FOR EQUIVALENCY WITH REQUIRED COLLECTION LAYER.

I. - REQUIRED ALTERNATIVE, 12" SAND LAYER

II GEOCOMPOSITE LAYER WITH COLLECTION PIPES IN TRENCHES

III 6" SAND LAYER WITH COLLECTION PIPES IN TRENCHES

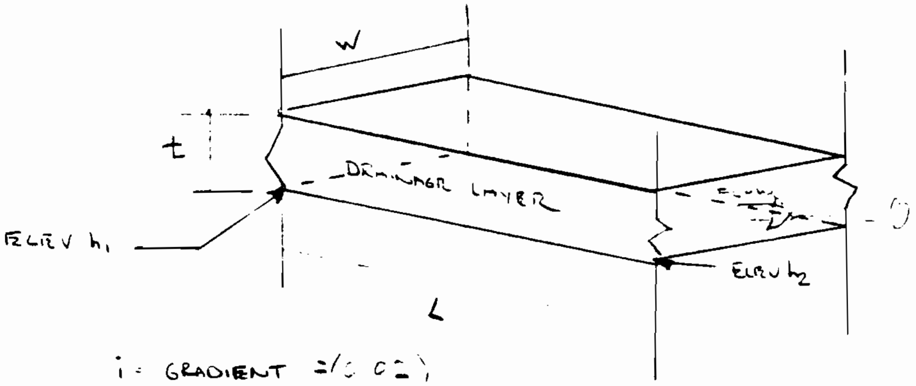
THE FOLLOWING EQUIVALENCY CALCULATIONS ARE BASED UPON THE HYDRAULIC TRANSMISSIVITY OF THE LAYER WHICH HAS BEEN SHOWN TO CORRELATE WITH GAS TRANSMISSIVITY AND COMPARISON CAN BE MADE REGARDLESS OF GRADIENT.

I 12" SAND LAYER

PERMEABILITY = 1×10^{-3} cm/sec

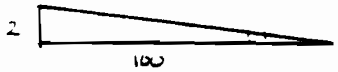
1 PASSIVE VENT/ACRE

OPERATE WITHOUT CLOGGING



T = 12" = 30.48 cm

i = GRADIENT = (0.02)



K = PERMEABILITY = 1×10^{-3} cm/sec

TRANSMISSIVITY . $Q = KT$

$= 1 \times 10^{-3}$ cm/sec (30.48 cm)

$= .0305$ cm²/sec

By KFH Date 12-13-9? **WehranEnviroTech** Job No. 02264.05
Chkd. by ______ Date ______ Sheet No. 2 of 3
Subject ______

DETERMINE FLOW RATES FOR ALTERNATIVES

II & III FOR COMPARISON TO PART 360 REQUIREMENT

II GEOCOMPOSITE LAYER WITH TRENCHED COLLECTION PIPES

(REFER TO SKETCH ON PRECEDING PAGE FOR UNIT AREA)

$i = 0.02$ (SEE PRECEDING PAGE)

$T =$ TRANSMISSIVITY $= 2.0 \times 10^{-3}\ m^2/s = 20\ cm^2/sec$ PER UNIT WIDTH
(SEE ATTACHED GRAPH)

* GRADIENT OF $i = .02$ USED AS A CONSERVATIVE DESIGN APPROACH. AS shown on THE ATTACHED GRAPH LOWER GRADIENTS YIELDS LOWER TRANSMISSIVITY

$$\frac{Q_{GEOCOMPOSITE}}{Q_{SAND-12''}} = \frac{20\ cm^2/sec}{.0305\ cm^2/sec} = 655.74$$

III 6" SAND LAYER WITH TRENCHED COLLECTION PIPES

(REFER TO SKETCH ON PRECEDING PAGE FOR UNIT AREA)

$t = 6'' = 15.24$

$K = 2 \times 10^{-3}\ cm/sec$

$Q = KT = 2 \times 10^{-3}\ cm/sec \times 15.24\ cm$

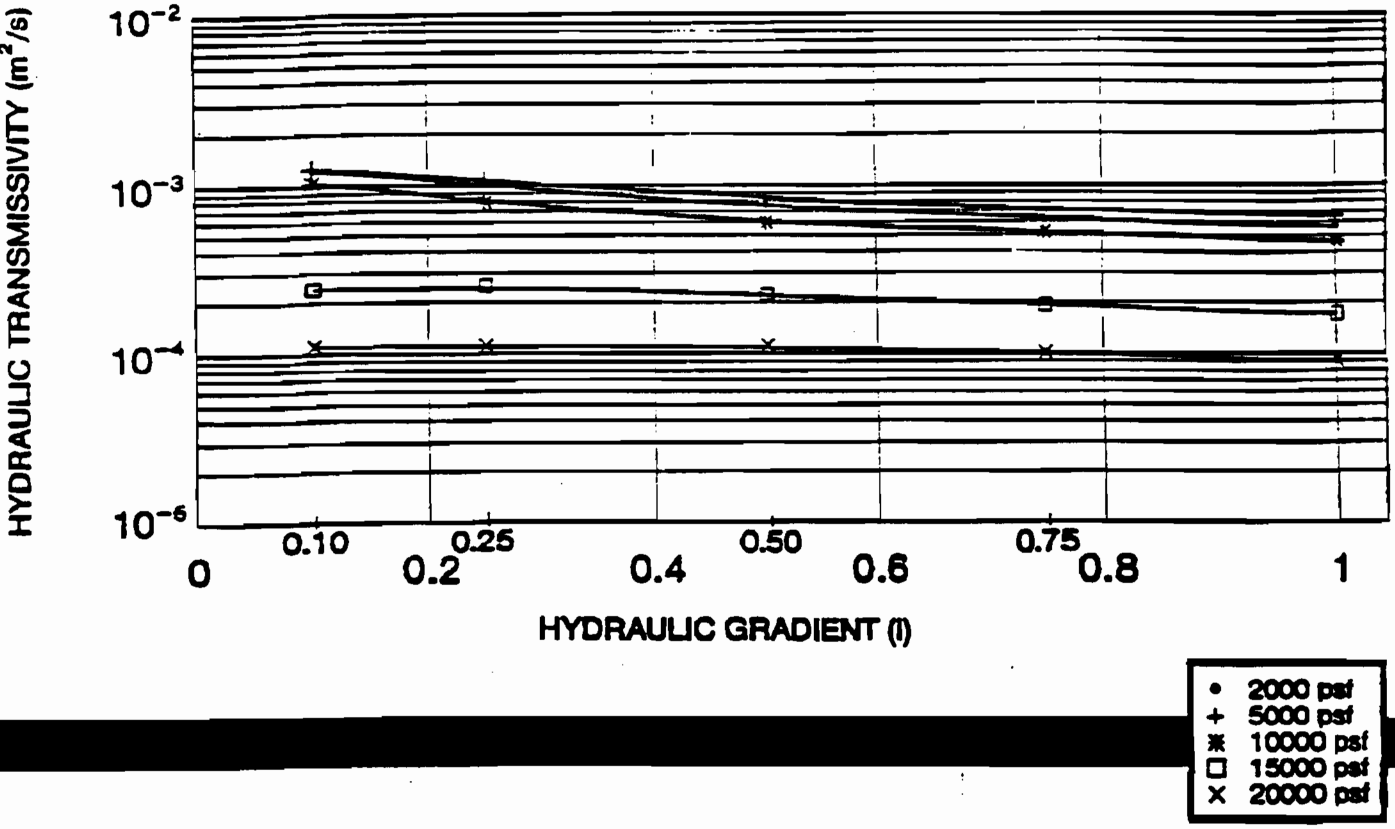
$Q = .0305\ cm^2/sec$

$$\frac{Q_{SAND\ 6''}}{Q_{SAND\ 12''}} \quad \frac{.0305\ cm^2/sec}{.0305\ cm^2/sec} = 1$$

3 of 3

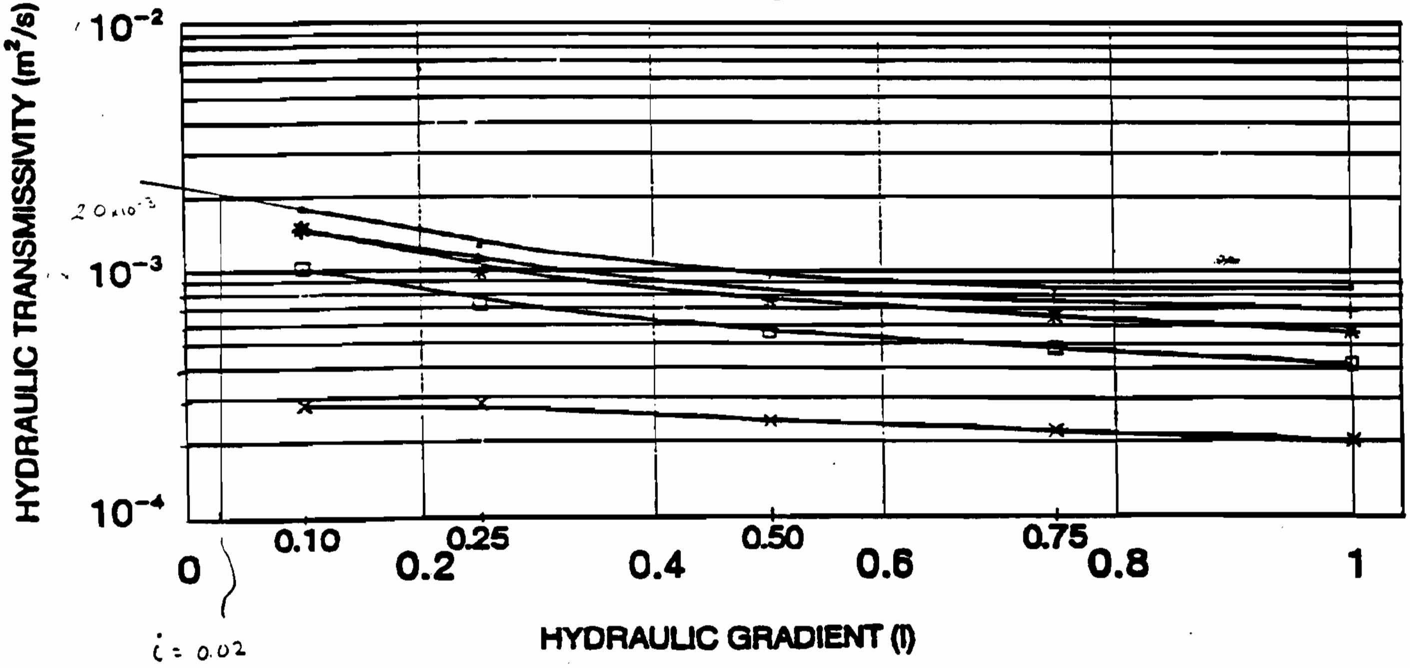
POLY-NET PN2000

HDPE/PN2000/geotextile/soil



POLY-NET PN3000

HDPE/PN3000/geotextile/soil



2.0×10^{-3}

$i = 0.02$

MLr

APPENDIX H
VLDPE CHEMICAL RESISTANCE

MDPE/VLDPE MATERIALS DEVELOPMENT

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ABSTRACT

Medium density polyethylenes (MDPE) and very low density polyolefins (VLDPE) are becoming the materials of choice in a wide range of geomembrane applications. Excellent inherent properties in chemical resistance and mechanical strength make MDPE the preferred material for demanding chemical environments. VLDPE's unique combination of toughness and flexibility enables the design of systems that can provide outstanding durability even under extreme climatic conditions. This paper describes key material properties of MDPEs and VLDPEs and discusses their influence on field performance.

INTRODUCTION

Over the last ten years, the use of geomembranes has experienced rapid growth in waste containment applications. Synthetic, flexible membrane lining systems are increasingly proving to be one of the most cost effective and environmentally sound options for efficient waste management and for the conservation of natural resources. In 1990, approximately 500MM ft^2 of geomembranes are projected to be installed, a 66% increase over 1987 [1, 2].

In parallel with this growth, the industry has aggressively pursued the development of products and services to meet current and emerging performance requirements. With the emphasis on durability and with the leadership of the EPA, industry members are individually and collectively working to advance the state of techno and ensure system integrity throughout the designed life an installation. An integral part of this effort is the development of analytical and testing tools that will enable the industry to more quantitatively predict field performance. This technology will play a key role in continually improving our products and services as well a addressing public concerns for long-term environmental protection.

The wide acceptance of MDPE, and more recently of VLDPE, in geomembrane applications is largely the result their outstanding inherent properties. Understanding th properties and their effects on field performance enables designers and installers to select and utilize materials that best fulfill the requirements of the application. Th paper discusses MDPEs and VLDPEs relative to key material properties and their influence on field performance.

MEDIUM DENSITY POLYETHYLENES (MDPE)

The initial MDPE product technology for geomembranes was derived from the pipe industry where these materials have been successfully utilized for over 30 years. More recently, the technology and field experience accumulated in pipe is providing the geomembrane industry with the foundation to better quantify the durability of geomembra installations. At the same time, the unique requirements of geomembrane applications are becoming increasingly evident and are resulting in the development of advanced resins a compounds specifically tailored for geomembranes.

MDPE geomembranes, which are erroneously being called HDPE geomembranes, are based on medium density polyethylene with densities up to 0.940 g/cc. Most commercial grades range from 0.936 to 0.939 g/cc. These resins are manufactured by a number of different processes utilizing various catalysts, comonomers and operating conditions.

Although all MDPEs have similar, linear molecular structures, their properties can vary significantly depending on the specific combination of the above manufacturing variables. Overall, MDPEs offer high mechanical strength with excellent environmental resistance. Formulated with the appropriate type, concentration and dispersion of carbon black, MDPEs also provide superior resistance to ultraviolet (UV) light.

However, MDPE's key inherent advantage is its outstanding resistance to a broad range of chemicals. The absence of polar functional groups, in conjunction with about 60% crystallinity, results in very low permeability to water and to aqueous solutions of acids, bases and salts, as well as most organic chemicals. Although some chemical compounds, such as aromatics and halocarbons, can swell the polymer structure and increase permeability, the MDPE polymer chains themselves are not degraded [3].

The stress crack resistance of MDPE and its potential influence on the durability of an installation is one of the technology areas receiving increased attention. Several accelerated tests designed to project field performance (e.g. pipe hydrostatic burst test, compressed ring test, etc.) have been developed and are widely used in the pipe industry. In geomembranes, the Constant Tensile Load (CTL) test appears to be the leading candidate. Programs are underway at GRI, ASTM (D35), UCC&P and other industry members to define test procedures and conditions. This is a much needed tool for assessing long-term product performance as well as setting improved standards for new product development.

The stress crack resistance of polyethylenes is a strong function of density. It is also dependent on a number of other variables controlled by the manufacturing process. These include molecular weight, molecular weight distribution, branching distribution and comonomer type and concentration. Collectively, these variables can substantially affect stress crack resistance even at constant density. Figure 1 presents the relative performance of different MDPEs under CTL conditions.

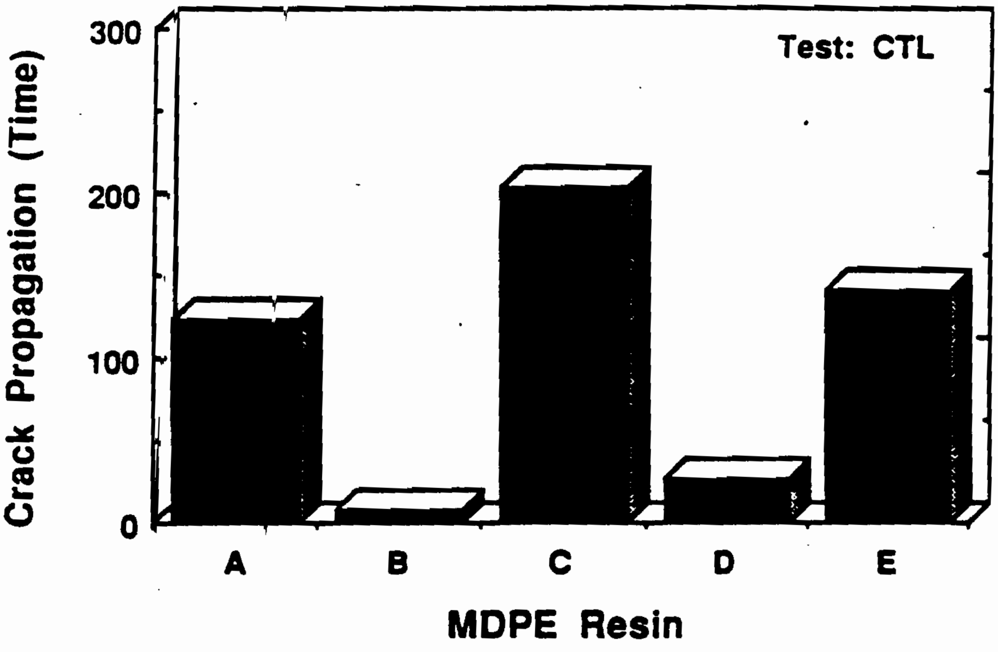

Figure 1. Relative Crack Propagation for Different MDPEs

The test measures the crack propagation time required for a notched specimen to fail in a brittle mode at elevated temperatures (usually 50°C) and sub-yield stresses (30 to 80%). The test results show that for seemingly similar resins (equivalent densities), the crack propagation resistance can vary significantly by an order of magnitude or higher. Similar results have been previously reported with both MDPE and HDPE [4]. Therefore, selecting a resin by convenient index properties (e.g. density, MI, etc.) alone, will likely be insufficient for assessing stress crack performance under sustained, low stress levels. CTL is one of the preferred, available tools for evaluating the effect of these low field stresses. Inclusion of such data in the material selection process will further enhance the industry's excellent field experience with MDPE.

VERY LOW DENSITY POLYOLEFINS (VLDPE)

VLDPE is the most recent olefinic entry into the geomembranes market where it is experiencing wide acceptance in a variety of applications including canals, leach pads, tunnel linings and landfill caps. It represents a new class of ethylene copolymers that have bridged the gap between the tough polyethylenes and the flexible rubbers (Figure 2).

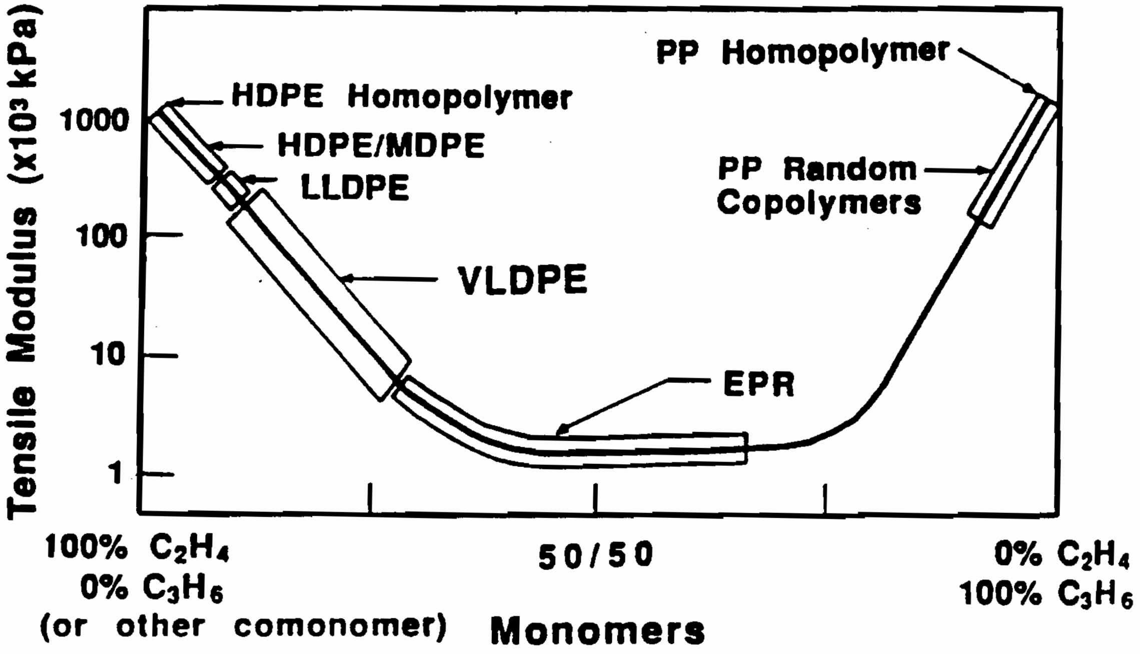

Figure 2. Olefin Polymers

VLDPE is manufactured in a process similar to that used for MDPE and, as with MDPE, has a linear molecular structure and short chain branching. Through comonomer incorporation, the branching frequency is increased while density and crystallinity are substantially decreased. VLDPE densities range from 0.880 to 0.915 g/cc and crystallinities from about 10 to 30 %.

It is the combined effect of the non-polar, linear molecule, the low crystallinity and the higher alpha olefin comonomer(s) that results in VLDPE's unique balance of properties in toughness, chemical resistance, low temperature flexibility, elongational behavior, stress crack resistance and mechanical strength. Figure 3 illustrates the strength-density envelope for FLEXOMER™ gas phase VLDPEs. The high tensile strengths attained are equivalent to or higher than those of existing materials, such as CPE, CSPE and PVC, and competitive with MDPE. This enables the designer to utilize the performance advantages of VLDPEs without compromising mechanical strength.

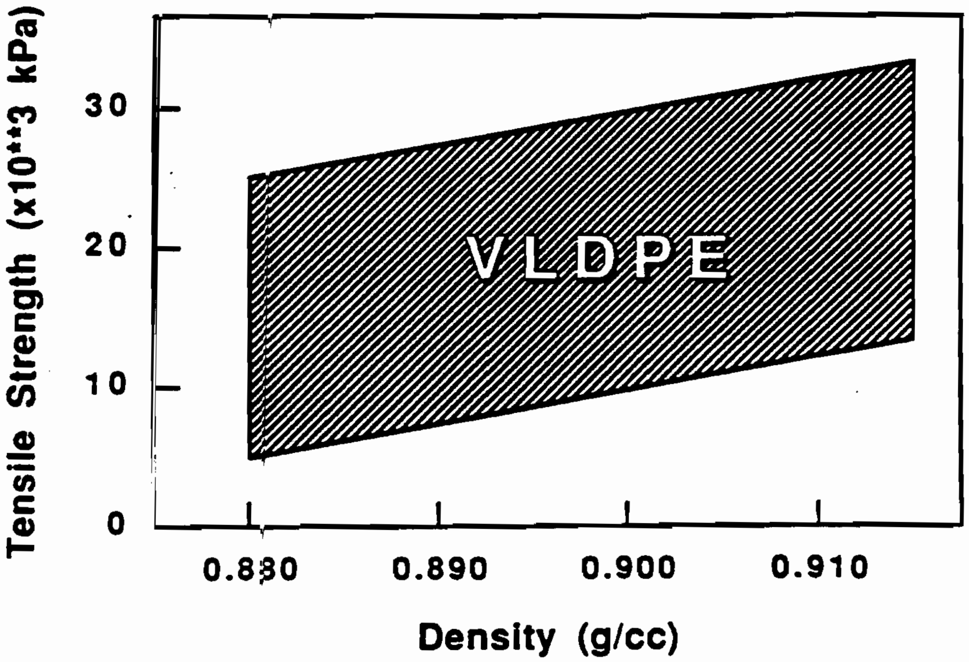

Figure 3. Strength-Density Envelope for FLEXOMER™ VLDPEs

During and after installation, many geomembrane systems are exposed to extreme environmental conditions that could limit the utility and performance of a material. Figure 4 presents the dynamic elastic modulus of three commercial grade polymers, VLDPE, PVC and MDPE, as a function of temperature.

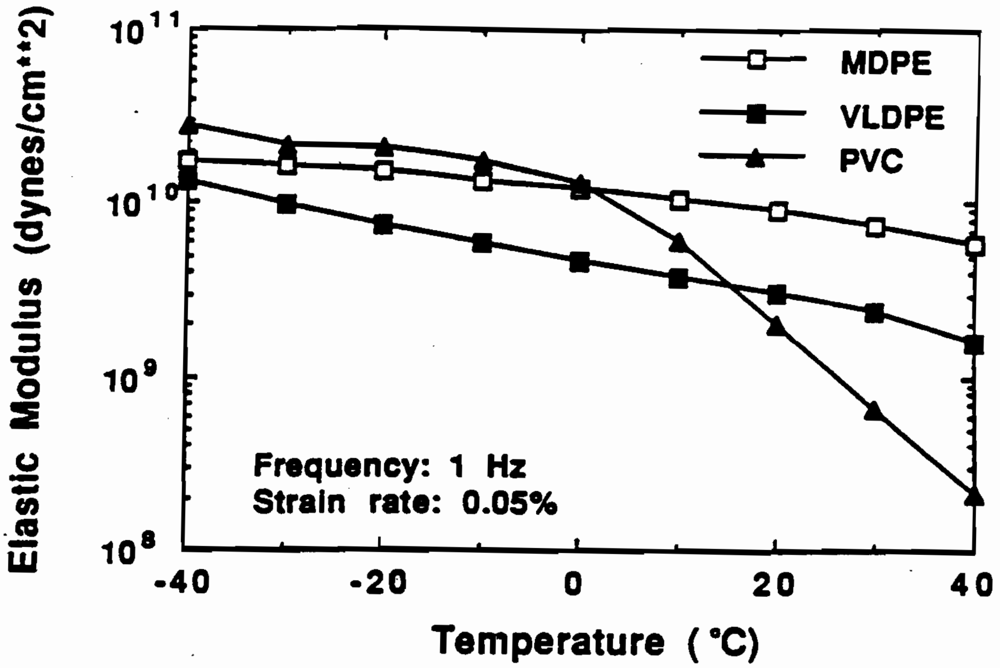

Figure 4. VLDPE/MDPE/PVC Dynamic Elastic Modulus (DMA)

With PVC, the data show that stiffness will change dramatically as ambient temperatures change from cold to hot. As temperature approaches 0°C (32°F), PVC rapidly becomes stiffer and more brittle due to its high glass transition temperature. At high temperatures, conversely, the high plasticizer content substantially reduces PVC's modulus and results in low dimensional rigidity. With VLDPE, however, modulus changes are small and gradual. VLDPE's low glass transition temperature, low crystallinity and absence of plasticizer result in a product that is more flexible at low temperatures and has higher dimensional rigidity at high temperatures. Relative to MDPE, VLDPE at -20°C is still more flexible than MDPE at 25°C. Consequently, VLDPE geomembranes can be readily installed throughout the year under extreme climatic conditions and without the risk of failures due to brittleness.

For applications where subsidence of underlying material(s) is possible (e.g. landfill caps) the deformation characteristics of the polymer are essential. Figure 5 presents the uniaxial elongation of commercial VLDPE, PVC and HDPE as a function of temperature.

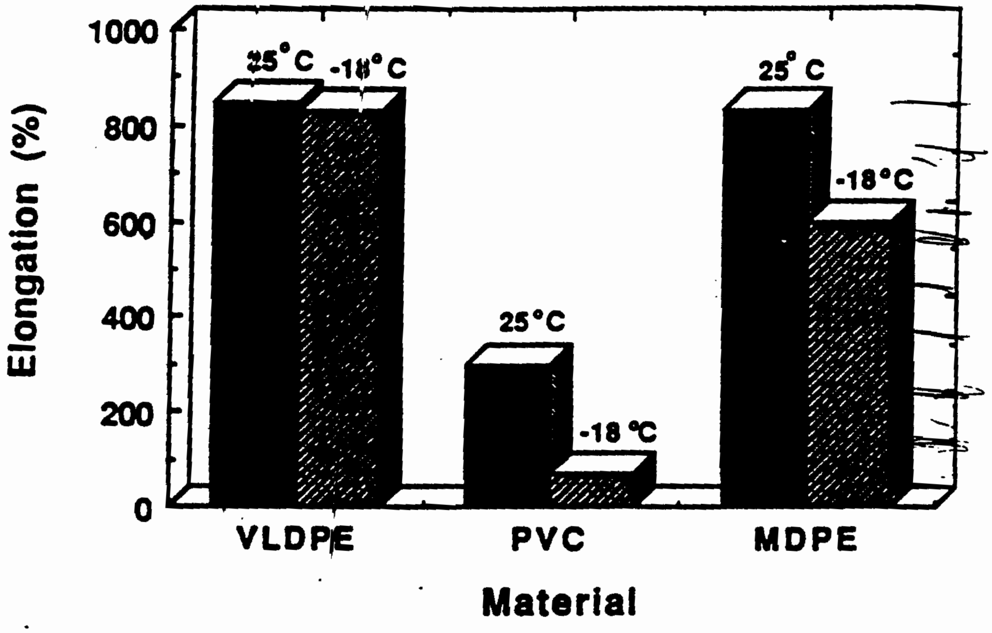

Figure 5. VLDPE/MDPE/PVC Elongation vs Temperature

At ambient conditions all three materials have sufficient elongation to sustain substantial subsidence. At -18°C (0°F), however, the elongation of VLDPE remains essentially the same while that of PVC is reduced by more than 75%. Although the field deformation process will likely be three-dimensional, the data illustrate VLDPE's outstanding elongational performance at temperatures frequently encountered in geomembrane installations.

The stress crack resistance of VLDPE has also been evaluated with excellent results. In the constant strain, bent strip ESCR test (ASTM D 1693), no stress cracking of VLDPE has occurred. Likewise, in ongoing CTL tests, the crack propagation resistance of VLDPE is already several times higher than of the best commercial MDPEs. It appears that, largely due to the low crystallinity and high branching frequency, the stress crack resistance of VLDPEs is outstanding. Work in this area is continuing. Nonetheless, our data strongly suggest that VLDPEs will enable the designer to engineer systems that have superior long-term resistance to cracking.

As with all polyolefins, VLDPE can be formulated to provide UV resistance. Partly due to the higher branching frequency, however, VLDPE has different stabilization requirements than MDPE. Stabilization systems to further enhance VLDPE's UV performance have been identified and long-term verification testing is in progress. In the interim, VLDPEs are recommended for geomembranes that have limited exposure to sunlight.

Finally, VLDPE shares the same alkane chemistry (inert, non-polar) and structure (linear) that gives MDPE its outstanding chemical resistance. It is nearly impermeable to water and to aqueous solutions of inorganics, though, due to its lower crystallinity, VLDPE shows higher swell and permeability to organics. Relative to PVC, VLDPE offers improved overall resistance to a wide range of chemicals (Table 1). Material selection for a given application, however, should be based on direct evaluations with the involved chemical solution, as recommended by the EPA.

Table 1
Chemical Exposure Data

	PERMEABILITY (ASTM E 96)	
	VLDPE	PVC
Methane (cc-mil/m^2-24hrs-atm)	23	59
H_2O (MVT) (g-mil/m^2-24hrs-atm)	16	50

	% Weight Change (ASTM D 543)	
	VLDPE	PVC
Methyl Ethyl Ketone	+3.2	dissolved
Motor Oil	+4.3	-8.2
10% NaOH (aq.)	-0.2	-0.3
Gasoline	+41.4	-27.1
95% H_2SO_4 (aq.)	-0.1	+2.5

CONCLUSIONS

The broad chemical resistance of MDPE, coupled with its high mechanical strength and weathering resistance, makes it a material that provides excellent field performance.

The stress crack resistance of seemingly "equivalent" MDPEs can vary significantly. Thus, material selection should not rely on index properties alone.

Accelerated tests, such as the CTL, should be developed and implemented to more quantitatively predict the long-term performance of geomembranes and help direct new product development.

VLDPE represents a new class of high performance materials that are both tough and flexible. VLDPE's outstanding low temperature properties, stress crack resistance and elongational characteristics facilitate geomembrane installation and substantially improve system durability.

ACKNOWLEDGMENTS

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THE DURABILITY OF POLYETHYLENE, IN PARTICULAR VERY LOW DENSITY POLYETHYLENE (VLDPE)

Polyethylene has become the material of choice for applications requiring durability. This is because of its appropriate blend of chemical resistance, ultraviolet light resistance, biological resistance, and stress crack resistance. As such it has become the material of choice for undersea telephone cables, gas transmission pipelines, agriculture and household chemical sales, modern automotive gasoline tanks, low level radioactive waste disposal drums, and hazardous waste containment.

Chemical Resistance

Polyethylene is naturally inert to a wide range of different chemicals, including acids, bases, heavy metals, hydrocarbons, inorganic salts, detergents, natural fats and oils, chlorinated hydrocarbons, and others. Its chemical resistance is proven by a large amount of testing in many different industries. Therefore, its use in many different chemical containment applications is unmatched.

Biological Resistance

Many liners contain plasticizers and other soluble constituents which impart flexibility and processability to the material. Oils or plasticizers are extractable materials which tend to leach out, causing stiffening and brittleness of the membrane. This extraction process occurs in the presence of common household solvents and even in normal soil. The embrittled material can then result in cracking of the liner.

Plasticized liners are known to be eaten or gnawed through by rodents in addition to being able to support fungus and microorganism growth. Microorganisms can also cause embrittling of the liner as they feed on the plasticizers. Polyethylene is inherently flexible and, therefore, contains no plasticizer additives. It consequently will not lose its flexibility due to extraction of the additives over time. The fact that it has no plasticizers and is made of polyethylene means that VLDPE tends to be resistant to rodents and does not support microorganisms. Rodents have been shown to avoid polyethylene membranes positioned so as to directly obstruct their burrowing.

Stress Crack Resistance

Modern polyethylene resins have excellent resistance to stress cracking. VLDPE is extremely ductile and is therefore not susceptible to brittle failures such as environmental stress cracking.

CHEMICAL RESISTANCE OF VLDPE

REAGENT	VLDPE
Acetaldehyde	S
Acetic acid, 1-80%	S
Acetic acid, 80-100%	U
Acetic acid, glacial	U
Acetic anhydride	D
Acetone	D
Acetphenetidine	S
Acetophenone	U
Acrylic emulsions	S
Allyl alcohol	U
Allyl chloride	U
Aluminum bromide, sat. sol.	S
Aluminum chloride, dil. sol.	S
Aluminum chloride, conc. sol.	S
Aluminum fluoride, conc. sol.	S
Aluminum hydroxide	S
Aluminum sulfate, concl. sol.	S
Alums (all types) conc. sol.	S
Ammonia, 100% dry gas	S
Ammonium carbonate	S
Ammonium chloride, sat. sol.	S
Ammonium fluoride, 20%	S
Ammonium hydroxide	S
Ammonium metaphosphate, sat. sol.	S
Ammonium nitrate, sat. sol.	S
Ammonium oxalate	S
Ammonium parsulfate, sat. sol.	S
Ammonium phosphate, 75%	S
Ammonium sulfate, sat. sol.	S
Ammonium sulfide, sat. sol.	S
Ammonium thiocyanate, sat. sol.	S
Amyl acetate, 100%	U
Amyl alcohol, 100%	U
Amyl chloride, 100%	U
Aniline, 100%	D
Antimony chloride	S
Apple juice	S
Aqua regia	U
Argyrol	S
Arsenic acid, 100%	S
Aspirin	S
Atabrine	S
Automotive oil	U
Barium carbonate, sat. sol.	S
Barium chloride, sat. sol.	S
Barium hydroxide	S
Barium sulfate, sat. sol.	S
Barium sulfide, sat. sol.	S

REAGENT	VLDPE
Beer	S
Benzaldehyde	U
Benzene	U
Benzene sulfonic acid	S
Benzoic acid	S
Benzyl alcohol	U
Bismuth carbonate, sat. sol.	S
Bleach lye	S
Black liquor	S
Borax, cold, sat. sol.	S
Boric acid, sol.	S
Brake fluid	U
Brandy	S
Bromic acid, 10%	S
Bromine, liq.	U
Bromine water	U
Bromobenzene	U
Butanedoil, 1-100%	S
Butter	S
Butyl acetate	U
Butyl alcohol, 100%	S
n-Butylamine	U
Butyraldehyde	U
Bulyfic acid	U
Calcium bisulfide	S
Calcium carbonate, sat. sol.	S
Calcium chlorate, sat. sol.	S
Calcium chloride, sat. sol.	S
Calcium hydroxide	S
Calcium hypochlorite, bleach sol.	S
Calcium nitrate, 50%	S
Calcium sulfate	S
Camphor oil	U
Carbon dioxide, 100% dry	S
Carbon dioxide, 100% wet	S
Carbon dioxide, cold, sat. sol.	S
Carbon disulfide	U
Carbon monoxide	S
Carbon tetrachloride	U
Carbonic acid	S
Castor oil, conc.	S
Cetane	U
Cheese	S
Chloracetic acid	U
Chlorine, 100% dry gas	U
Chlorine, moist gas	U
Chlorine, liq.	U
Chlorobenzene	U
Chloroform	U
Chlorosulfonic acid, 100%	U
Chocolate syrup	S
Chrome alum. sat.	S

REAGENT	VLDPE
Chromic acid, 1-50%	S
Chromic acid + sulfuric acid (cleaning solution)	D
Cider	S
Citric acid, sat. sol.	S
Clove oil	S
Coconut oil alcohols	S
Cola concentrates	S
Copper chloride, sat. sol.	S
Copper cyanide, sat. sol.	S
Copper fluoride, 2%	S
Copper nitrate, sat. sol.	S
Copper sulfate, dil. sol.	S
Corn seed oil	S
Cottonseed oil	S
Cresol	U
Cresylic acids, 50%	U
Cuprous chloride, sat. sol.	S
Cyclohexane	U
Cyclohexanol	D
Cyclohexanone	U
Cyclohexylamine	U
Decahydronaphthalene	U
n-Decane	U
Decyl alcohol	U
Detergents, synthetic	S
Developers, photographic	S
Dextrin, sat. sol.	S
Dextrose, sat. sol.	S
Diazo salts	S
Di-n-butylamine	U
Di-n-butylether	U
Dibutyl phthalate	D
Dichloroethylene	U
Diethylene glycol	S
Diethyl uther	U
Dighycolic acid	S
Dihydronaphthalene	U
Disobutylene	U
Disopropyl ketone	U
Dimethylamine	U
Dipermine	U
Disinfectant (pine)	U
Disinfectant eucalyptus	U
Disodium phosphate	S

REAGENT	VLDPE
Eggs	S
Ethyl acetate	U
Ethyl alcohol, 35%	S
Ethyl alcohol, 100%	S
Ethyl aniline	U
Ethyl butyrate	U
Ethyl chloride	U
Ethylether	U
Ethylene	-
Ethylene chlorohydrin	U
Ethylene dichloride	U
Ethylene glycol	S
Fabric conditioner	S
Ferric chloride, sat. sol.	S
Ferric nitrate, sat. sol.	S
Ferric sulfate	S
Ferrous chloride, sat. sol.	S
Ferrus sulfate	S
Fish solubles	S
Fluoboric acid	S
Fluorine	U
Fluosilicic acid, 32%	S
Fluosilicic acid, conc.	S
Formaldehyde, 40$	S
Formamide	S
Formic acid, 0-20%	S
Formic acid, 20-50%	S
Formic acid, 100%	S
Frutcose, sat. sol.	S
Fruit pulp	S
Fuel oil	U
Furfural	U
Furfuryl alcohol	U
Gallic acid, sat. sol.	S
Gasoline	U
Gin	U
Glucose	S
Glycerine	S
Glycol	S
Glycolic acid, 30%	S
Grape juice	S
Grape syrup	S
Hair shampoo	S
Hand creams	S
Heptane	U
Hexachlorophene	S
tart-Hexanol	S

REAGENT	VLDPE
Honey	S
Hydrazine hydrate	S
Hydrobromic acid, 50%	S
Hydrochloric acid, 10%	S
Hydrochloric acid, 35%	S
Hydrochloric acid, conc.	S
Hydrochloric acid, sat. sol.	S
Hydrofluoric acid, 40%	S
Hydrofluoric acid, 60%	S
Hydrofluoric acid, 75%	S
Hydrogen, 100%	S
Hydrogen chloride, gas, dry	S
Hydrogen peroxide, 30%	S
Hydrogen peroxide, 90%	D
Hydrogen phosphide, 100%	S
Hydroquinone	S
Hydrogen sulfide, dry gas	S
Hypochlorous acid, conc.	S
Inks	S
Iodine, potassium iodide sol. conc.	U
Iodine tincture	U
Jams and jellies	S
Kerosene	D
Lactic acid, 10-90%	S
Latex	S
Lard	D
Lauryl alcohol	U
Lauryl sulfate	U
Lead acetate, sat. sol.	S
Lemon syrup	S
Linseed oil	U
Liqueur	S
Lube oil	U
Lysol	U
Magnesium carbonate, sat. sol.	S
Magnesium chloride, sat. sol.	S
Magnesium hydroxide, sat. sol.	S
Magnesium nitrate, sat. sol.	S
Magnesium sulfate, sat. sol.	S
Margarine	U
Malsic acid	S
Mercuric chloride, sat. sol.	S
Mercuric cyanide, sat. sol.	S
Mercurous nitrate, sat. sol.	S

REAGENT	VLDPE
Mercury	S
Methallyl chloride	U
Methane	U
Methyl alcohol, 100%	S
Methylated spirits	U
Methyl bromide	U
Methyl chloride	U
Methylene chloride	U
Methyl ethyl ketone	U
Methyl formate	U
Methyl Isobutyl ketone	U
Methyl salicylate	U
Methylsulfuric acid	S
Milk	S
Mineral oils	U
Molasses	S
Naphtha	U
Naphthalene	U
Nickel chloride, sat. sol.	S
Nickel nitrate, conc. sol.	S
Nickel sulfate, sat. sol.	S
Nicotine, dil. sol.	S
Nicotinic acid	S
Nitric acid, 0-30%	S
Nitric acid, 30-50%	S
Nitric acid, 70%	S
Nitric acid, 95-98%	U
Nitric acid, fuming	U
Nitrobenzene	U
Nitroethane	S
Nitromethane	S
Octyl alcohol	U
Octyl cresol	U
Oleic acid	U
Oleum	U
Olive oil	-
Orange extract	S
Orange syrup	S
Oxalic acid, sat. sol.	S
Ozone, 100%	U
Paper mill liquors	S
Peanut oil	-
n-Pentane	U
Perchloric acid, 10%	S
Petrol	U
Petroleum ether	U
Phosphoric acid, 30%	S
Phosphoric acid, 90%	S

REAGENT	VLDPE
Phosphorus, yellow, 100%	S
Phosphorus oxychloride	U
Phosphorus pentoxide	S
Phosphorus trichloride	S
Photographic solutions	S
Pickling baths (H2SO4, HCl)	S
Picric acid	S
Pineapple juice	S
Pine oil	U
Plating solutions (brass, cadmium, copper, gold, indium, lead, nickel, silver tin, zinc)	S
Plating solutions (chromium)	U
Plumbing cleaner	S
Potato chips	S
Potassium bicarbonate, sat. sol.	S
Potassium borate, 1%	S
Potassium bromate, 10%	S
Potassium bromide, sat. sol.	S
Potassium carbonate	S
Potassium chlorate, sat. sol.	S
Potassium chloride, sat. sol.	S
Potassium chromate, 40%	S
Potassium cyanide, sat. sol.	S
Potassium dichromate, 40%	S
Potassium fluoride	S
Potassium hydroxide, dil. sol.	S
Potassium hydroxide, conc. sol.	S
Potassium nitrate, sat. sol.	S
Potassium perborate, sat. sol.	S
Potassium perchlorate, 10%	S
Potassium permanganate, 20%	S
Potassium persulfide, sat. sol.	S
Potassium sulfate, conc. sol.	S
Potassium sulfide, conc. sol.	S
Potassium sulfite, conc. sol.	S
Propargyl alcohol	S
Propyl alcohol	S
Propylene dichloride	U
Propylene glycol	S
Rayon coagulating bath	S
Rum	S
Sea water	S
Selenic acid	S
Shortening	S
Silicic acid	S
Silicone oil	U
Silver nitrate sol.	S
Soap sol., all conc.	S
Sodium acetate, sat. sol.	S

REAGENT	VLDPE
Sodium benzoate, 35%	S
Sodium bicarbonate, sat. sol.	S
Soidum bisulfate, sat. sol.	S
Sodium bisulfite, sat. sol.	S
Sodium borate	S
Sodium bromide, dil. sol.	S
Sodium carbonate, conc. sol.	S
Sodium carbonate	S
Sodium chlorate, sat. sol.	S
Sodium chloride, sat. sol.	S
Sodium cyanide	S
Sodium dichromate, sat. sol.	S
Sodium ferricyanide, sat. sol.	S
Sodium ferrocyanide, sat. sol.	S
Sodium fluoride, sat. sol.	S
Sodium hydroxide, dil. sol.	S
Sodium hydroxide, conc. sol.	S
Sodium Hyperchlorite	S
Sodium hypochlorite, 20%	S
Sodium nitrate	S
Sodium nitrite	S
Sodium sulfate	S
Sodium sulfide, 25%	S
Sodium sulfite, sat. sol.	S
Soy bean oil	-
Stannic chloride, sat. sol.	S
Stannous chloride, sat. sol.	S
Starch solution, sat. sol.	S
Stearic acid, 100%	S
Sugar sol., 50%	S
Sulfur	S
Sulfuric acid, 0-50%	S
Sulfuric acid, 80%	S
Sulfuric acid, 98%	U
Sulfuric acid, fuming	U
Sulfurous acid	S
Sulfur dioxide	S
Sulfur trioxide	S
Sulfuryl chloride	U
Tallow	S
Tannic acid, 10%	S
Tanning extracts, comm.	S
Tartaric acid	S
Tea	S
Tetrachloroethane	U
Tetrachlorethylene	U
Tetrahydrofurane	U
Tetrahydronaphthalene	U
Toluene	U
Tomato sauce	S
Transformer oil	U
Trichlorobenzene	U

REAGENT	VLDPE
Trichloroethylene	U
Triethanolamine	U
Trisodium phosphate, sat. sol.	S
Turpentine	U
Urea, D-30%	S
Urine	S
Vegetable oil	U
Vinegar, comm.	S
Vanilla extract	S
Water	S
Wax	S
Whiskey	D
Wines	S
Wine vinegar	U
Worchestershire sauce	U
Xylene	U
Yeast	S
Zinc chloride, sat. sol.	S
Zinc fluoride	S
Zinc sulfate, sat. sol.	S

KEY TO RATING:

S - Satisfactory
D - Limited recommendation (many applications possible depending on mil thickness, temperature and package design.
U - Unsatisfactory

VLDPE plugs a gap in PE's density spectrum

■ *Very low-density polyethylene is coming in as a cost-effective nonpolar replacement for polar resins such as PVC, EVA, and thermoplastic polyurethanes in such applications as film, sheet, and tubing. Going for VLDPE is a combination of flexibility, toughness, high use temperatures, and relative processing ease.*

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Union Carbide Corporation
Bound Brook, New Jersey

By combining flexibility and strength in a linear, nonpolar polymer, very low-density polyethylene (VLDPE) fills the long-existing gap between low-modulus, low-density ethylene propylene rubber (EPR) and high-modulus, low-density polyethylene (LDPE) (*Table 1*). VLDPE's linear structure and molecular weight—the key to the resin's low density and physical properties—are achieved through a polymerization process similar to that of linear low-density polyethylene (LLDPE) (see the *Box*, page 59). Through the choice of catalysts, suppliers can alter molecular weight distribution to produce changes in physical properties. VLDPE's nonpolar nature—the result of an exclusively hydrocarbon composition—means resistance to polar solvents (like water) and good tensile property values. Two VLDPE grades are now on the market (more are forthcoming); both have met with excellent results. Already, they are being used in applications ranging from gaskets to soft films, displacing ethylene vinyl acetate copolymers (EVA), PVC, and thermoplastic polyurethanes—polar polymers that have long benefited from the density/modulus void now plugged by VLDPE.

Structure and properties

For VLDPE—as with all polymers—the arrangement of molecules into various structures and configurations determines the resin's properties, which in turn affect its processing characteristics and ultimately its end uses.

Table 1. **Properties of representative nonpolar polyethylene resins.**

Resin	Density, grams per cubic centimeter	Secant modulus; 10^3psi[a]
HDPE	0.94 to 0.97	80 to 175
LLDPE	0.915 to 0.93	30 to 50
LDPE	0.915 to 0.93	20 to 30
VLDPE	0.900 to 0.906	11 to 17
EPR[b]	0.875	0.5 to 1.0

[a] One-percent elongation
[b] Ethylene propylene rubbers

Polymerization and molecular weight

The linear structure and lack of long-chain branching in both LLDPE and VLDPE arise from their similar polymerization mechanisms. In the low-pressure polymerization of LLDPE, the random incorporation of alpha olefin comonomers produces sufficient short-chain branching to yield densities in the range of 0.915 to 0.930 gram-per cubic centimeter. The even lower densities of VLDPE resins are achieved by adding more comonomer (which produces more short-chain branching than occurs in LLDPE, and thus a lower level of crystallinity) and using proprietary catalysts and reactor technology. No external plasticizers are used in the production of VLDPE. Catalysts are available to produce VLDPE of both narrow molecular weight distribution (MWD = 4) as well as broader molecular weight distribution (MWD = 8). Molecular weight values and trade designations for the resins used in this analysis are given in the *Table* below. ■

Molecular weight and distribution for VLDPE grades and related resins.

Resins[*]		Molecular weight values		
Notation	Trade designation	10^{-5} number average	10^{-5} weight average	Distribution
LDPE	DYNH-9	0.235	2.12	9.0
LLDPE	GRSN-7047	0.275	1.14	4.1
VLDPE-1	DFDA-1137	0.311	1.37	4.4
VLDPE-2	DFDA-1138	0.187	1.55	8.3

[*] All resins made by Union Carbide Corp.

Structure. VLDPE can be characterized as a linear polymer (virtually no long-chain branching) with a narrow molecular weight distribution. The amount of short-chain branching, because it exceeds that of LLDPE, yields a lower level of crystallinity, giving rise to densities below 0.915 gram per cubic centimeter—less than that of LLDPE and even LDPE (*Table 1*). The molecular weight distribution of VLDPE (and of LLDPE)—narrower than that of LDPE (*Fig. 1*)—combined with its linear structure gives rise to different crystalline structures and different degrees of entanglements than are found in LDPE. The presence of numerous short-chain branches in VLDPE diminishes the formation of crystalline regions in the backbone of the polymer. Where crystalline regions are formed, they are distorted (made imperfect) by the presence of the branching. The longer chains of LDPE create even greater crystal distortion. At the same level of crystallinity, the crystalline structures of VLDPE and LDPE are sufficiently different so as to yield distinctly different physical properties in the fin-

Table 2. **Typical molding and extrusion properties of VLDPE grades and other ethylene-based resins.**

Property	Test method	Resins VLDPE-1[a]	VLDPE-2[a]	LDPE[a]	LLDPE[a]	EVA[b]
Density, grams per cubic centimeter	D1505	0.906	0.900	0.920	0.920	0.930
Melt index, grams per 10 minutes	D1238	0.8	0.4	2.0	0.8	2.0
Tensile strength, 10^3 psi	D638	2.8	2.4	2.0	2.3	2.5
Ultimate elongation, percent	D638	900	800	600	800	800
Secant modulus, 10^3 psi[c]	D638	17	13	21	30	13
Environmental stress crack resistance after 500 hours, percent failure	D1693	0	0	100[d]	0	75
Flexural failure, 10^6 cycles[e]	Note[f]	1.2	4.0	0.01	0.5	0.7
Tensile impact resistance, 10^3 foot-pounds per cubic inch[g]	Note[f]	9	10	4	9	—
Brittleness at −100°C, percent failure	D746	0	0	50[h]	0	50[i]
Melting point, °C[j]	Note[f]	118	116	108	120	96

[a] All resins made by Union Carbide; trade designations and molecular-weight values appear in the *Box*, page 59

[b] Ethylene vinyl acetate copolymers of LDPE, with vinyl acetate comonomer content of 10 percent

[c] One percent elongation.

[d] 20 hour test time.

[e] 0.5- by 0.05-inch specimens, flexed 180 degrees, tested at 300 cycles per minute at room temperature.

[f] Union Carbide test method.

[g] At room temperature.

[h] At −90°C.

[i] At −95°C.

[j] Determined by differential scanning calorimetry.

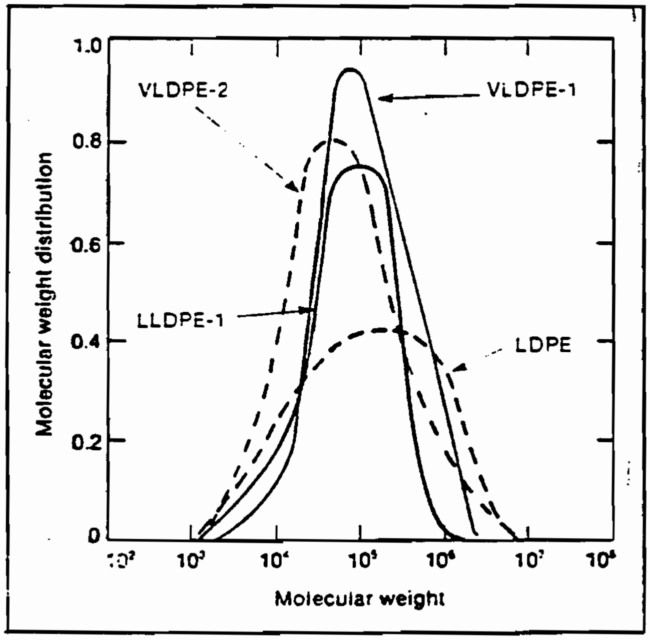

Figure 1. *The molecular weight distribution of both VLDPE grades is narrower than that of LDPE. Differences in the distribution of the VLDPE resins are largely due to the choice of catalyst used during polymerization. VLDPE's narrow molecular weight, combined with its linear structure, give rise to different crystalline structures and different degrees of entanglements than are found with LDPE*

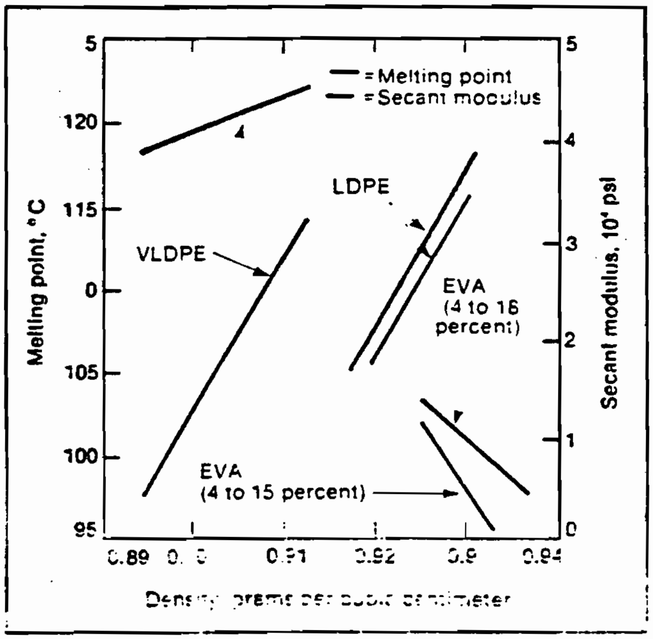

Figure 2. *The fewer imperfections in VLDPE's crystalline structure account for its high melting point and higher use temperature range than are found with EVA copolymers, whose side groups disrupt the resin's crystalline structure and thus lower its melting point. VLDPE's modulus is in a range not otherwise available to nonpolar polyethylenes*

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Tensile strength, 10³ psi	D638	2.8	2.4	2.0	2.3	2.5
Ultimate elongation percent	D638	900	800	600	800	800
Secant modulus, 10³ psi[c]	D638	17	13	21	30	13
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Flexural failure, 10⁶ cycles[e]	Note[f]	1.2	4.0	0.01	0.5	0.7
Tensile impact resistance, 10³ foot-pounds per cubic inch[g]	Note[f]	9	10	4	9	—
Brittleness at −100°C, percent failure	D746	0	0	50[h]	0	50[i]
Melting point, °C[j]	Note[f]	118	116	108	120	96

[a] All resins made by Union Carbide; trade designations and molecular-weight values appear in the *Box*, page 59.

[b] Ethylene vinyl acetate copolymers of LDPE, with vinyl acetate comonomer content of 10 percent.

[c] One-percent elongation.

[d] 20-hour test time.

[e] 0.5- by 0.05-inch specimens, flexed 180 degrees, tested at 300 cycles per minute at room temperature.

[f] Union Carbide test method.

[g] At room temperature.

[h] At −90°C.

[i] At −95°C.

[j] Determined by differential scanning calorimetry.

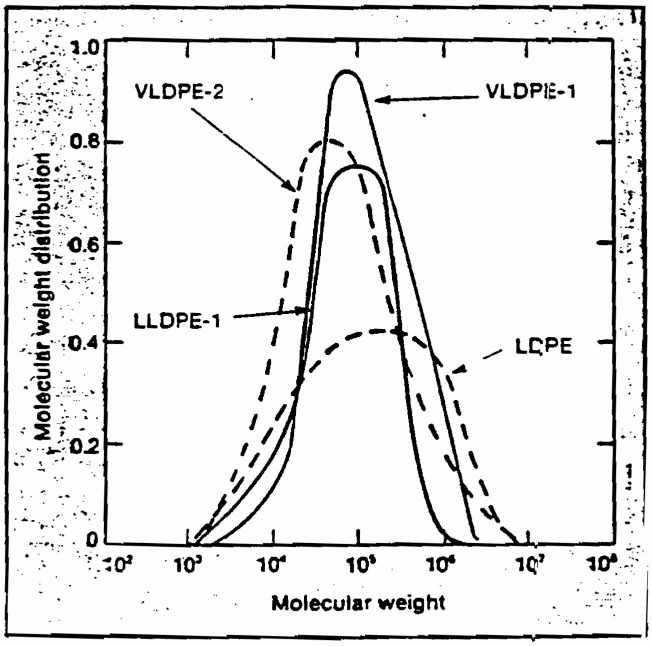

Figure 1. *The molecular weight distribution of both VLDPE grades is narrower than that of LDPE. Differences in the distribution of the VLDPE resins are largely due to the choice of catalyst used during polymerization. VLDE's narrow molecular weight, combined with its linear structure, give rise to different crystalline structures and different degrees of entanglements than are found with LDPE.*

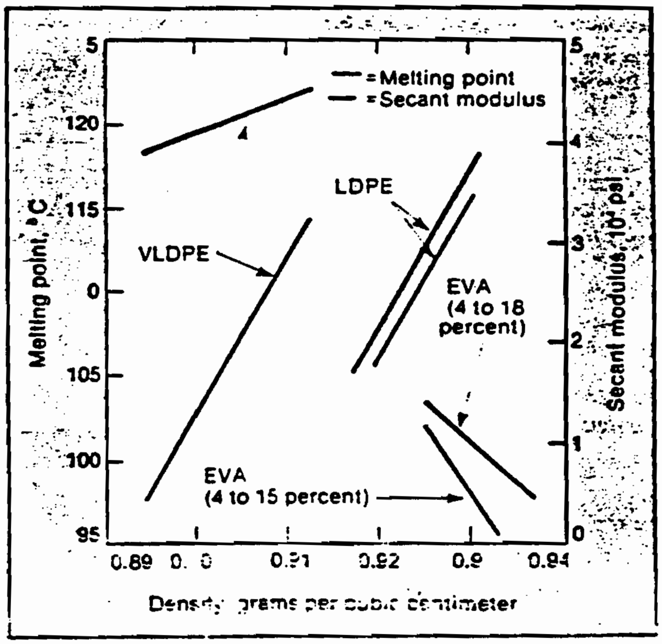

Figure 2. *The fewer imperfections in VLDPE's crystalline structure account for its high melting point and higher use temperature range than are found with EVA copolymers, whose side groups distort the resin's crystalline structure and thus lower its melting point. VLDPE's modulus is in a range not otherwise available to nonpolar polyethylenes.*

ished products (as seen in the processing and film properties listed in *Tables 2* and *3*).

Differences in the degree of crystallinity, in crystal size, and the number and kinds of imperfections affect the melting point of the polymer. The fewer significant imperfections in the crystalline structure of the short-chain branched VLDPE compared to that of the long-chain branched LDPE, for instance, result in the former's higher melting point[a] (*Fig. 2*). The considerably higher melting point of VLDPE compared to that of EVA copolymers (whose side groups also distort the crystalline structure) translates into higher use temperatures for products made from VLDPE resins.

Modulus. Structure (and density) also affect modulus, as shown in *Fig. 2*, where secant modulus as a function of density is plotted for a resin with short-chain branches (VLDPE), a resin with long-chain branches (LDPE), and EVA (copolymers of LDPE with a vinyl acetate comonomer content of 4 to 18 percent). The modulus versus density curve for VLDPE is in a range not previously available with a nonpolar polyethylene material.

Rheology. As with other narrow molecular weight distribution polymers, VLDPE tends to resist shear and exhibit a higher viscosity than the broad molecular weight distribution, long-chain branched resins it seeks to replace, but the melt is free of their strong strain-hardening behavior (resistance to stretching). The melt shear characteristics of 1 melt index, narrow molecular weight distribution VLDPE-1 and 0.4 melt index, broader molecular weight distribution VLDPE-2, for instance, fall between those of 1 and 2 melt index LLDPE resins (*Fig. 3*) in the shear rate range normally encountered in film extrusion. *Figure 3* also indicates that, since VLDPE's rheological profile falls within LLDPE's range, VLDPE can be accommodated in LLDPE extrusion equipment. At moderate rates, VLDPE resins can even be processed on extrusion equipment not designed for LLDPE resins.

VLDPE resins exhibit higher extensional viscosity than LLDPE resins (*Fig. 4*), which roughly translates into higher melt tension and better blown-film fabrication stability. Still, since VLDPE melt does not strain-harden in the melt, blown-film processing technology appropriate for LLDPE works well with VLDPE.

Other properties. Being nonpolar, VLDPE polymers are tougher and more

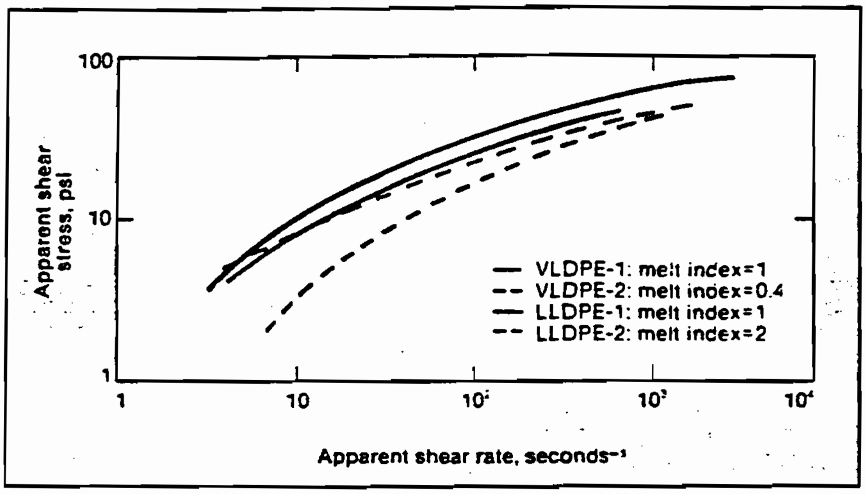

Figure 3. *The melt shear characteristics of both VLDPE grades fall between those of 1 and 2 melt index LLDPE resins, in the range normally encountered in film extrusion. VLDPE can thus be processed on extrusion equipment designed for LLDPE with only minor modifications of processing parameters. At moderate rates, VLDPE can even be processed on equipment not designed for LLDPE.*

Table 3. **Typical film properties of VLDPE versus those for competitive materials.**

Property	**Test method**	**Resin** **VLDPE-1**[a]	**VLDPE-2**[a]	**LDPE**[a]	**LLDPE**[a]	**EVA**[b]
Material properties						
Density, grams per cubic centimeter	D1505	0.906	0.900	0.918	0.918	0.930
Melt index, grams per 10 minutes	D1238	0.8	0.4	2.0	1.0	2.5
Film Properties[c]						
Average gage, mils	—	1.2	1.3	1.2	1.3	1.4
Tensile strength, 10^3 psi	D882					
Machine direction		4.3	4.6	2.9	4.5	3.3
Transverse direction		4.0	3.5	2.7	4.0	3.5
Elongation, percent	D882					
Machine direction		560	590	300	600	470
Transverse direction		840	700	500	600	550
Tensile impact resistance, 10^3 foot-pounds per cubic inch	Note[d]					
Machine direction		11	15	4	9	—
Transverse direction		8	13	6.5	7	—
Dart drop impact resistance, grams	D1709	350	370	90	100	—
Elmendorf tear strength, grams per mil	D1922					
Machine direction		130	60	260	90	80
Transverse direction		320	340	160	340	105
Secant modulus, 10^3 psi[e]	D882					
Machine direction		15	11	19	24	11
Transverse direction		14	13	24.1	29	11
Puncture resistance, inch-pounds per mil	Note[d]	16	16	8	10	—

[a] All resins made by Union Carbide; trade designations and molecular weight values appear in the *Box*, page 59
[b] Ethylene vinyl acetate copolymers of LDPE, with vinyl acetate comonomer content of 10 percent
[c] Blowup ratio: 2 to 1
[d] Union Carbide test method
[e] One-percent elongation

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[a] As determined by differential scanning calorimetry

chemically resistant than their polar competitors like PVC, EVA, and ethylene ethyl acrylate. As for optical properties, gloss increases and haze decreases with narrowing molecular weight distribution; contact clarity—good regardless of molecular weight distribution—improves further with decreasing density. VLDPE either equals or exceeds LLDPE, LDPE, and EVA in low-temperature performance, environmental stress crack resistance, flexural life, and tensile strength. (Molding and extrusion properties for VLDPE and related materials are given in *Table 2*; *Table 3* compares film properties of VLDPE to those of various competitive resins.)

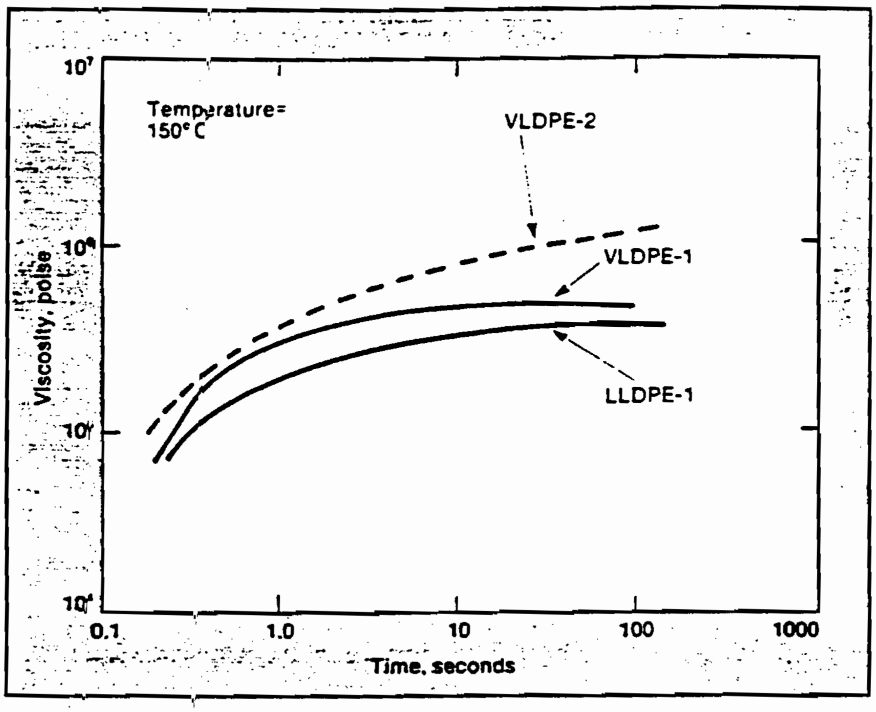

Figure 4. *The higher extensional viscosity of VLDPE resins compared to that of LLDPE translates into higher melt tension and better blown-film fabrication stability. Since VLDPE does not strain-harden in the melt, blown-film processing technology appropriate for LLDPE works well with VLDPE.*

Processing parameters

With marked rheological similarity to LLDPE, it's no surprise that VLDPE can be processed in most machines being used for other polyethylenes (extruders, small-part injection-molding machines, and blowmolding machines). Film extrusion characteristics for VLDPE are similar to those for 2 melt index LLDPE or 0.5 melt index LDPE. Melt temperatures of 205 to 235°C have been found to yield the most optimal properties.

VLDPE's pumping efficiency is very good. Output per screw revolution is in fact greater than for LDPE, although screw torque is higher (but still generally within the operating range of most commercial equipment). For an LLDPE-compatible screw, the barrel temperature profile when extruding VLDPE should begin with a 175°C feed zone, increasing to 210°C at the screw tip. The transfer line and die should be roughly 215°C.

For blown-film processing, low-pressure-drop dies with die gaps of 0.035 to 0.040 inch are preferred. Blowup ratios of 2 to 1 or greater yield optimal properties. Dual-lip air rings yield up to 0.54 kilogram per hour-centimeter more output, the result of better bubble stability. The use of stabilizer bars and cages also contributes to higher blown-film processing rates.

For large-part extrusion-blowmolding and for tubing extrusion, a melt temperature of 235 to 250°C is preferred; for injection molding and injection-blowmolding, a minimum stock temperature of 275°C is suggested. Owing to its low crystallinity, VLDPE mold shrinkage is about one-half that of 0.92-density LLDPE or LDPE. Changes in mold design and size may thus be necessary. Longer molding cycles are also needed to obtain sufficient shrinkage for ejection of the VLDPE part from the mold.

Applications and pricing

In many cases, significant cost saving can be obtained by using VLDPE. At 62 cents per pound (hopper car price), VLDPE is a strong candidate to replace or is competitive with thermoplastic polyurethanes (roughly $1 per pound), EVA (anywhere from 45 to 75 cents per pound), and other resins in such applications as squeeze tubes and bottles, liners for drums, boxes, and cartons, caps, cap liners, and closures, and sheet and profile. VLDPE is also replacing medical-grade PVC (roughly 80 cents per pound) in flexible tubing and other applications in which PVC tends to embrittle with time. VLDPE also yields more volume per pound than the much denser PVC, an additional bonus. VLDPE is replacing other polyethylenes (as well as PVC) in a wide range of shrink and stretch wraps and in wire and cable applications. Other uses include monofilaments, toys, gaskets, and pond liners; other applications are under study.

VLDPE-1 and VLDPE-2 are the two fully commercialized grades of the resins. In the sample stage are two more VLDPEs: one with an even lower density (0.890 gram per cubic centimeter) is expected to carry a premium price; the other is of even higher melt index than VLDPE-1 and has a density of 0.900 gram per cubic centimeter. Also forthcoming are coextruded film and blend combinations that will synergistically produce properties better than either of the component resins exhibit alone. Blends of VLDPE with either polypropylene, HDPE, or LLDPE hold the greatest promise. ■

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TABLE 4.5 GENERAL CHEMICAL RESISTANCE GUIDELINES OF COMMONLY USED GEOMEMBRANES[a]

	Geomembrane type																	
	Butyl rubber		Chlorinated polyethylene (CPE)		Chloro-sulfonated polyethylene (CSPE)		Elasticized polyolefin		Epichlorohydrin rubber		Ethylene propylene diene monomer (EPDM)		Polychloroprene (neoprene)		polyethylene		Polyvinyl chloride (PVC)	
Chemical	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F	100°F	158°F
General:																		
Allphatic hydrocarbons			×	×			×		×	×			×	×	×	×		
Aromatic hydrocarbons							×		×	×			×	×	×	×		
Chlorinated solvents	×	×					×		×	×	×		×		×	×		
Oxygenated solvents	×	×					×		×		×	×	×	×	×	×		
Crude petroleum solvents			×	×			×		×	×			×	×	×	×		
Alcohols	×	×	×	×			×		×	×	×	×	×	×	×	×	×	×
Acids:																		
Organic	×	×	×	×	×		×		×		×	×	×	×	×	×	×	×
Inorganic	×	×	×	×	×		×		×		×	×	×	×	×	×	×	×
Bases:																		
Organic	×	×	×	×	×		×		×	×	×	×	×	×	×	×	×	×
Inorganic	×	×	×	×	×		×		×	×	×	×	×	×	×	×	×	×
Heavy metals	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×
Salts	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×

[a] ×, generally good resistance.

Source: After Vandervoort [5].

SOURCE: DESIGNING WITH GEOSYNTHETICS

Chemical compatibility testing of geomembranes and piping materials exposed to landfill leachate

Bruce E. Dudzik, Daniel E. Oman, and Keith A. Bowden

Will leachate from a landfill chemically degrade geomembranes and piping?

In the pulp and paper industry, landfills have been used to dispose of mill wastes for many years. In the past, the disposal areas may not have been engineered facilities. Current regulations not only require that landfills be engineered, but usually they specify the use of composite liners of clay and geomembrane (plastic).

The New York State Department of Environmental Control has regulatory authority for the design, construction, and operation of industrial solid-waste facilities as detailed in Title 6 of Part 360 of the New York Compilation of Rules and Regulations (*1*). Among other items, Part 360 now requires the following:

- Municipal solid-waste facilities must have a double-composite liner, with each liner having a minimum of a 60-mil geomembrane in combination with a primary liner of 45.7 cm (18 in.) or a secondary liner of 61.0 cm (24 in.) of compacted, low-permeability soils.
- All industrial landfills must have at least one composite liner and a leachate collection system to transport leachate out of the landfill cell and minimize the quantity of liquid allowed to collect on the landfill liner.
- Documentation must be submitted to demonstrate that the geomembrane and leachate collection pipe are chemically compatible with the leachate expected to be generated in the landfill.

The following three tests are commonly performed on geomembranes and piping used in landfill liner applications:

- Conformance testing demonstrates that the geomembrane liner meets the specifications of the solid waste facility.
- Chemical compatibility testing determines whether the geomembrane is compatible with the leachate expected to be generated.
- Quality assurance/quality control testing (QA/QC) assures that the installation of the liner meets all specifications and regulatory requirements.

I. Major constituents in Deferiet Landfill leachate

Parameter	*Concentration*
Alkalinity, mg/L as $CaCO_3$	2500
COD, mg/L	3900
Chloride, mg/L	46
Conductivity, μmhos/cm at 25°C	4700
Total hardness, mg/L as $CaCO_3$	2300
Oil and grease, mg/L	45
Solids, mg/L	
Total dissolved	3500
Total suspended	830
Sulfate, mg/L	<50
TOC, mg/L	1200
BOD_5, mg/L	660
pH	7.3
Calcium, mg/L	610
Iron, mg/L	110
Magnesium, mg/L	73
Manganese, mg/L	20
Potassium, mg/L	190
Sodium, mg/L	47
Acetone, μg/L	1300
2-butanone, μg/L	2600
Toluene, μg/L	1200
Phenol, μg/L	180
2-methylphenol, μg/L	560
4-methylphenol, μg/L	690

Only major constituents are reported for inorganic parameters. Only organic parameters with detectable quantities are listed.

Dudzik is senior project engineer and Oman is vice-president/program manager, RMT, Inc., 744 Heartland Trail, P.O. Box 8923, Madison, Wis. 53708-8923. Bowden is manager, safety and environmental, Champion International Corp., Anderson Ave., Deferiet, N.Y. 13628.

II. Tests performed on HDPE geomembranes

Test	*Test method*	*Comments*
Carbon black content	ASTM D1603	. . .
Carbon black dispersion	ASTM D3015	Appendix A1
Crystallinity (DSC)	ASTM E793	20°C/min scan rate
Dimensional changes	Method 9090	Section 7.6
Extractables	ASTM D4321	. . .
Gauge thickness	ASTM D374	Method C
Hardness	ASTM D2240	Shore Durometer Type D
Infrared spectroscopy	KBr pellet sampling method	Thin-layer microtome of sample, 12-min scan rate
Mass (water absorption)	Method 9090	Section 7.6
Melt index	ASTM D1238	Condition E
Modulus of elasticity	ASTM D638	Type IV specimen and 2 in./min extension rate
Mullen burst	ASTM D3787	. . .
Oxidative induction temperature (OIT)		Using a Perkin-Elmer DSC-4, 20°C/min scan rate, 30-psi air atmosphere
Puncture resistance	FTMS 101C	Method 2065
Seam peel strength	ASTM D413	. . .
Seam shear strength	ASTM D882	. . .
Specific gravity	ASTM D792	. . .
Tear resistance	ASTM D1004	. . .
Tensile properties	ASTM D638	Type IV specimen and 2 in./min extension rate
Thermal gravimetric analysis (TGA)	Method in Earnest (*6*)	40°C/min scan rate and a 30-psi nitrogen atmosphere

ASTM = American Society for Testing and Materials.
FMTS = Federal Test Method Standard.

III. Tests for PVC piping samples

Test	*Test method*	*Comments*
Dimensions and mass	Method 9090	Section 7.6
Infrared spectroscopy	KBr pellet sampling method	Thin-layer microtome of sample, 12-min scan rate
Oxidative induction temperature (OIT)		Using a Perkin-Elmer DSC-4, 20°C/min scan rate, 30-psi air atmosphere
Pipe joint strength	NSF No. 54	Appendix A, modified version of ASTM D4437. Transverse dogbone specimens of joint are tested using ASTM D638 with a crosshead speed of 2 in./min
Stiffness	ASTM D2412	. . .
Thermal gravimetric anlaysis (TGA)	Method in Earnest (*6*)	40°C/min scan rate and a 30-psi nitrogen atmosphere
Thickness	ASTM D374C	. . .

Material selection

The three geomembranes tested in this program were manufactured from polyethylene, a semicrystalline polymer that has been used in geomembranes for approximately 30 years because of its excellent chemical resistance.

Originally, we considered only high-density polyethylene (HDPE) as the material for the piping in a leachate collection system. Because HDPE geomembranes are similar in material composition to HDPE piping, no compatibility testing of HDPE piping was performed.

A cost evaluation indicated, however, that the use of polyvinyl chloride (PVC) pipe could substantially reduce the installation cost of the leachate collection system. Since pure PVC is a rigid, amorphous (no crystalline structure) plastic with chemical resistance properties that are better than average, it was considered suitable for use as a piping material and was added to the compatibility testing program. Because the quantity of leachate was limited, only one manufacturer's product could be tested.

The compatibility testing of the geomembranes and piping was conducted using leachate obtained from the existing solid-waste disposal facility at Deferiet Mill. This facility is approximately 12 miles from the new facility constructed in the Town of LeRay, New York.

Approximately 375 L of leachate was collected and shipped to the testing laboratory. The program of detailed inorganic and organic testing conducted on the leachate encompassed the entire priority pollutant list.

Detailed leachate characterization data are presented in **Table I**. These characterization data compared well with previous leachate testing at the Deferiet Mill (*2*) and with studies of the New York paper industry (*3*).

Compatibility testing procedures

The objective of chemical compatibility testing is to simulate in the laboratory the exposure to leachate that geomembranes would reasonably be expected to experience during the operation of a landfill and after it is closed. Therefore, compatibility testing requires a reproducible method for exposing geomembrane specimens to leachate and a way to assess the long-term effects of that exposure.

Both of these requirements have been met in an EPA test method commonly referred to as Method 9090 (*4*), published in 1986. Method 9090 first defines a procedure for conducting the immersion of geomembrane samples in representative leachate. Second, to assess the long-term use of the geomembranes, Method 9090 specifies that the testing be conducted at normal ambient temperature (23°C) and at 50°C. The testing temperature of 50°C was chosen to simulate 20 years of leachate exposure under average conditions. Third, Method 9090 defines the tests to assess geomembrane performance and the time intervals for conducting the tests. Performance is assessed by observing trends in test results conducted over time including the results obtained on unexposed samples.

Method 9090 involves immersing geomembrane samples in leachate at temperatures of 23°C and 50°C for periods of 30, 60, 90, and 120 days. After each exposure period, samples are removed and tested. The method specifies the type of immersion vessel, its size, and the degree of mixing required to ensure that the leachate completely immerses each sample throughout the testing periods. In addition, Method 9090 also recommends that the leachate in each immersion cell be drained and replaced after each 30-day exposure to ensure against the loss of volatile organics.

The EPA method also specifies sample preparation and the physical and mechanical tests to be performed. The following tests were run on the geomembranes in the Deferiet program. The first two are specified in Method 9090, and the third was recommended by the project consultant:

- Physical tests: "nondestructive" tests that measure physical properties of the sample, such as thickness and dimensional stability
- Mechanical tests: "destructive" tests that measure the strength properties of the sample, such as tear resistance
- Chemical tests: tests that measure chemical properties of the sample by techniques such as infrared spectroscopy, differential scanning calorimetry (DSC), and thermal gravimetric analysis (TGA).

It is beyond our scope here to describe the test procedures or how their results are interpreted. The Deferiet Materials Conformance and Compatibility Test Report contains a more detailed description of the tests (*5*).

Table II lists the tests performed on the three HDPE geomembranes. **Table III** lists the tests performed on the PVC leachate collection piping.

Geomembrane test results

Variations in test results on exposed and unexposed samples can be due to either material degradation or material variability. However, in evaluating the results of Method 9090 testing, the Environmental Protection Agency has recognized only degradation as the cause of variation in results. The EPA methods for interpreting results of Method 9090 testing need to take into account the variability of the material. Careful interpretation, analysis, and comparison of results of nondestructive, destructive, and chemical tests can be used to differentiate between changes caused by material variation and those caused by degradation.

In interpreting the results of Method 9090 testing, the general practice in industry and regulatory agencies is to conclude that changes of less than 50% in the results of physical and mechanical testing indicate that no degradation of the material occurred as a result of leachate exposure. When changes in physical and mechanical properties exceed 50%, then problems with the material could be experienced as the result of material variability or degradation, or a combination of the two. For chemical testing results (expressed in °C), values within ±20°C are generally considered to be within normal ranges.

Only five of the 22 tests in Table II are discussed here, because they are the most useful ones in making the distinction between material variability and degradation.

Differential scanning calorimetry

Tests performed by DSC are used to assess a material's molecular structure and resistance to oxidation. Table

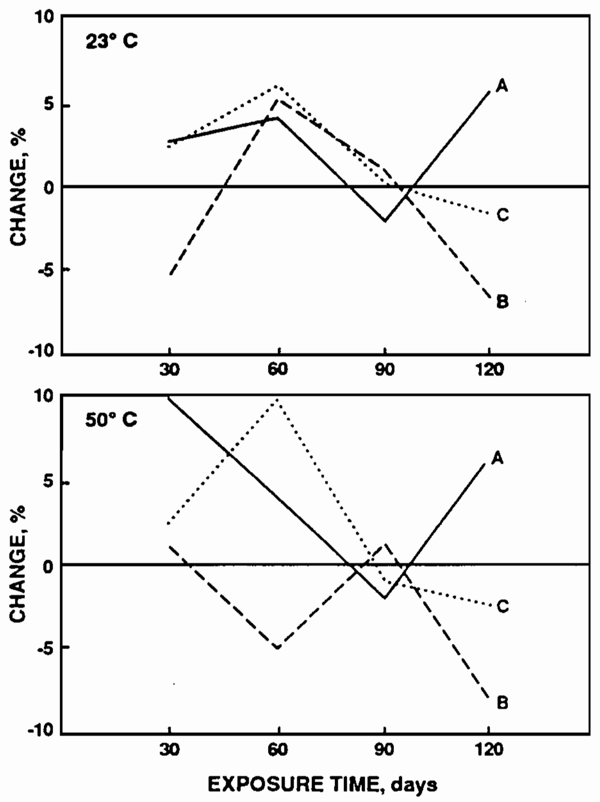
IV. DSC results for geomembranes from Manufacturers A, B, and C

Property	*Initial*	*After 120 days*	
		23°C	*50°C*
Manufacturer A			
Crystallinity, %	48.3	42.6	44.4
Max. energy absorption, °C	125.2	124.4	124.7
Oxidative induction temp. (OIT), °C	264.7	263.8	260.4
Onset of endotherm, °C	117.6	117.0	118.2
Manufacturer B			
Crystallinity, %	47.9	44.4	44.0
Max. energy absorption, °C	124.6	125.3	125.2
Oxidative induction temp. (OIT), °C	263.3	267.1	268.2
Onset of endotherm, °C	117.4	118.0	117.5
Manufacturer C			
Crystallinity, %	45.6	45.5	45.8
Max. energy absorption, °C	126.8	126.2	126.7
Oxidative induction temp. (OIT), °C	262.1	262.0	262.3
Onset of endotherm, °C	118.3	118.9	119.3

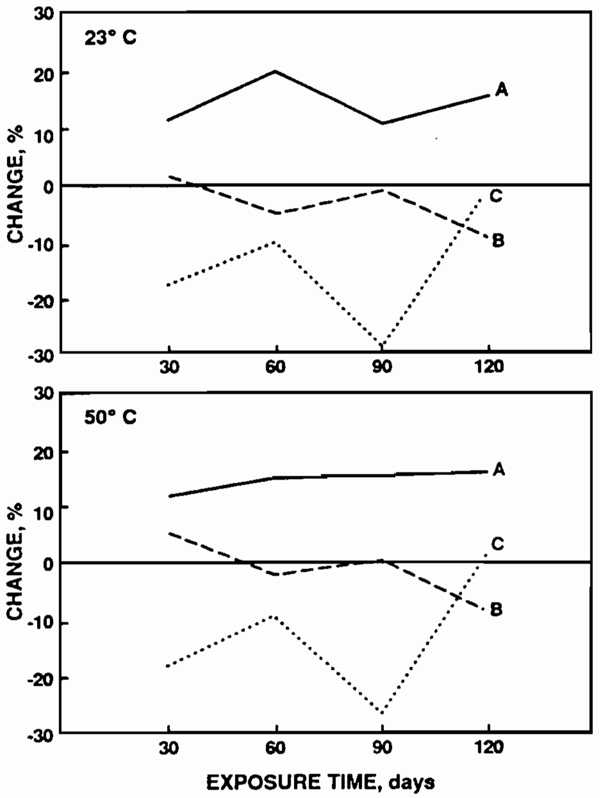
V. Results of tensile properties tests on unexposed geomembranes

Test	*Manufacturer*		
	A	*B*	*C*
Machine direction			
Yield strength, MPa	17.4	17.1	17.4
Yield elongation, %	14.8	17.5	16.5
Break strength, MPa	28.1	25.2	27.2
Break elongation, %	1126	1130	1194
Cross direction			
Yield strength, MPa	18.4	18.4	18.1
Yield elongation, %	15.1	15.3	16.2
Break strength, MPa	31.8	26.0	30.5
Break elongation, %	1286	1224	1280

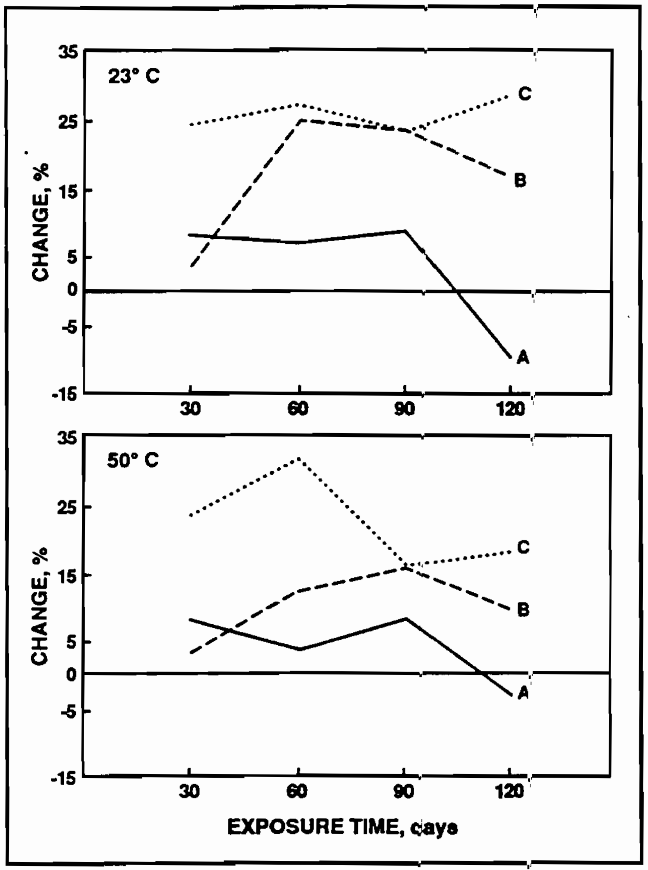
1. MD yield strengths for geomembranes from Manufacturers A, B, and C at 23°C and 50°C



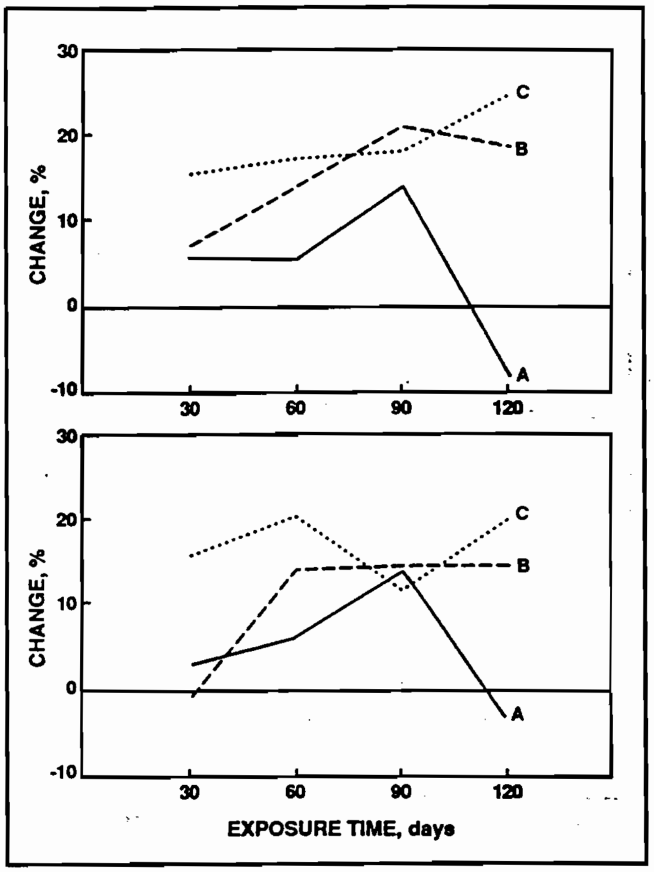
2. MD yield elongation for geomembranes from Manufacturers A, B, and C at 23°C and 50°C



3. MD break strength for geomembranes from Manufacturers A, B, and C at 23°C and 50°C



4. MD break elongation for geomembranes from Manufacturers A, B, and C at 23°C and 50°C



IV summarizes all of the testing performed by DSC. For each of the three HDPE geomembranes, data were collected on crystallinity, temperature at maximum energy absorption, oxidative induction temperature (OIT), and the temperature of the onset of endotherm. Table IV includes the data for both the 23°C and 50°C immersion temperatures.

The results of tests performed on exposed samples at 120 days and on unexposed samples are very consistent, with the exception of the crystallinity values between the geomembrane samples for Manufacturers A and B. For these two geomembranes, the reductions in crystallinity values compared with those of the initial, unexposed samples are an indication of manufacturing variability, not of material degradation from leachate exposure. (Note that the crystallinity for Manufacturer C does not change.)

Infrared spectroscopy

Infrared spectroscopy is used to assess the structure of the polymer, including the presence of additives. The method is used to identify specific degradation processes, which would be identifiable by the presence of new spectral bands in the samples exposed for 120 days. A principal degradation process would be oxidation of the polymer, which would be indicated by the presence of an O-H bond peak in the IR scan in the wavelength range of 1600-1800 cm^{-1}. On the IR scans after 120 days, no new bands were present, including even no new O-H bands.

The comparison of the results for the three 120-day samples with the results of the unexposed samples is important. The comparison shows, in combination with the OIT results, that no degradation of the geomembranes has taken place in the Method 9090 tests. In addition, the IR results indicate that leachate organic constituents have not been absorbed into the geomembrane polymer matrices.

VI. Moduli of elasticity of unexposed membranes

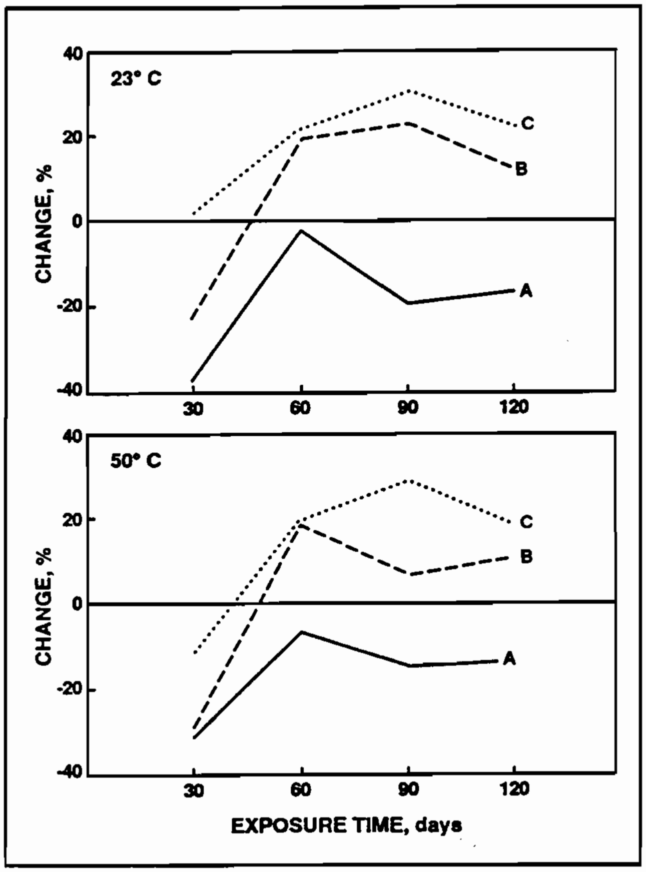
Manufacturer	*Modulus of elasticity, MPa*		
	Average	*Minimum*	*<550**
	Machine direction		
A	560	464	3
B	391	328	5
C	403	354	5
	Cross-machine direction		
A	544	459	2
B	444	415	5
C	428	358	5

*Number of specimens below 550 MPa.

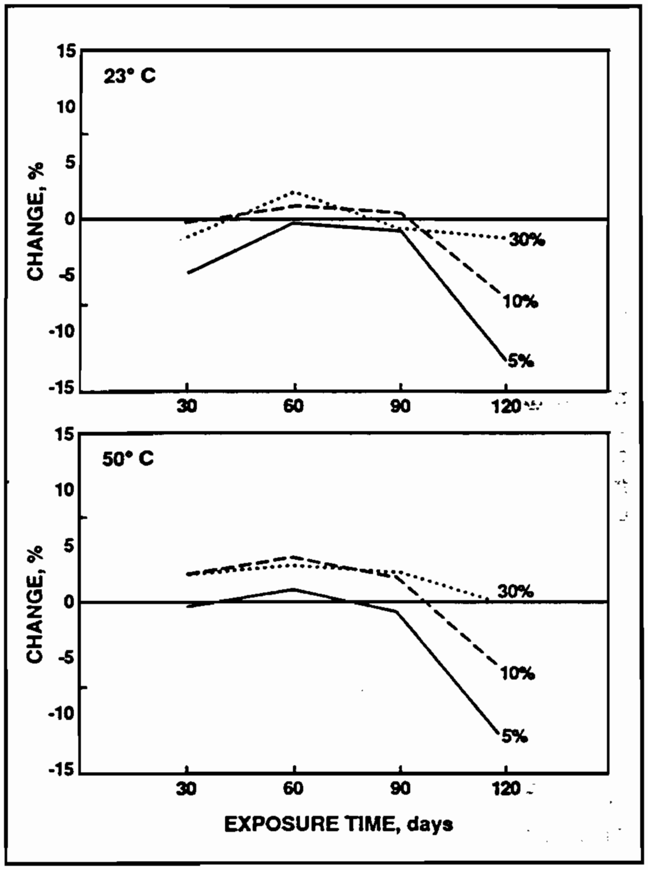
Tensile properties

Tensile properties define the mechanical strength of finished products. As defined by ASTM D638, tensile prop-

5. MD modulus of elasticity for geomembranes from Manufacturers A, B, and C at 23°C and 50°C



6. Piping stiffness at 23°C and 50°C for deflection values of 5%, 10%, and 30%



erties of geomembranes are defined by the following tests:

- Yield stress, MPa
- Yield elongation, %
- Break stress, MPa
- Break elongation, %
- Modulus of elasticity, psi.

Stress and elongation at yield and at break. Yield stress is specifically defined as the stress corresponding to the first point on the stress-strain curve at which there is a large increase in strain for no increase in stress (*7*). The elongation at yield is the stretched length of the specimen at the yield point and is measured as a percentage of original specimen length. Break stress is the force required to break or rupture the specimen, and the break elongation is the length at the break point as a percentage of original length.

Table V summarizes the results of the tests for tensile properties of unexposed samples. The values tabulated are mean values based on the results of ten tests—five replications at each of the two immersion temperatures. Samples were tested in both the machine direction and the cross-machine direction.

National Sanitation Foundation, Standard No. 54 (*8*) requires that 60-mil HDPE geomembranes have a yield strength of at least 13.8 MPa, a yield elongation of at least 10%, a minimum break stress of 20.7 MPa, and a minimum break elongation of 500%.

The results for the three HDPE geomembranes are summarized below, based on the average values calculated for each test (from Table V):

- All of these test values for tensile strength at yield are above the minimum of 13.8 MPa.
- All of the test values for elongation at yield are above the minimum 10% value. The unexposed values for Manufacturer A are low, whereas test results throughout the 120-day exposure testing are more typical of the product. The low values for unexposed samples combined with normal values during the immersion testing account for all of the large percent changes in Fig. 4.
- All of the test values for tensile strength at break are above the minimum of 20.7 MPa.
- All of the test values for elongation at break are above the minimum 500% value.
- The three geomembranes are functionally equivalent in terms of their relative merits, based on the tensile properties tests.
- No trends with respect to either time or temperature were noted in the compatibility test results.

Figures 1–4 present the test results in terms of percent change over the 120-day leachate exposure period for yield strength, yield elongation, break strength, and break elongation in the machine direction (MD).

Modulus of elasticity. The modulus of elasticity is the ratio of stress change to the corresponding strain change.

It is defined as the slope of the initial linear portion of the uniaxial stress–strain curve. It is a constant for a given material and is a measure of the material's stiffness. The modulus of elasticity was determined by using the tangent method of ASTM D638, which requires five replicate samples per direction per geomembrane.

Table VI summarizes the modulus-of-elasticity data for both the machine and cross-machine directions for unexposed samples of the three geomembranes. NSF No. 54 specifies a value of 550 MPa as the minimum acceptable value for modulus of elasticity. The geomembrane from Manufacturer A is the only product tested that had an average modulus of elasticity above this value in the machine direction.

Normally, the modulus test (and any other test for measuring strength) will have lower results for the cross direction than for the machine direction. While this is true for Manufacturer A's geomembrane, both of the other geomembranes exhibited the opposite results. The moduli of elasticity for Manufacturers B and C indicate, along with melt flow index and specific gravity, that they are manufactured from a resin of lower density than that used by Manufacturer A.

Figure 5 graphs the machine-direction results for the 120-day compatibility testing. The graphs show no clear time-dependent trends for any of the three geomembranes, further substantiating that no degradation of the materials is taking place from leachate exposure.

Thermogravimetric analysis

Thermogravimetric analysis (TGA) defines the composition on a percent-by-weight basis, and it is useful in assessing the thermal properties of finished products. None of the TGA compositional data show the presence of two or more polymer fractions for the geomembranes. The presence of two or more polymer fractions can be indicative of the manufacturer's use of regrind (grinding off-spec product and adding it back into the extruder to make new product). This practice often leads to higher-than-average molecular weight distributions in the manufactured product.

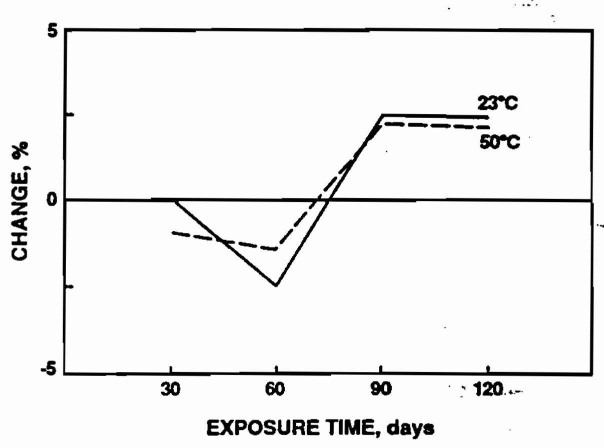
In addition to percent composition, results are presented for the onset-of-decomposition temperature and the temperature at the maximum rate of weight loss. Significant changes in these two parameters are helpful in assessing structural changes of the geomembrane.

Overall, the results of the TGA analysis, including the data for percent composition and the onset-of-decomposition temperature, were that all three geomembranes showed little change in composition after 120 days of immersion in leachate. These results are also consistent with those obtained from the DSC analyses. Geomembranes A and C showed little change in both composition and decomposition temperatures. However, the geomembrane from Manufacturer B did exhibit some reduction in the onset-of-decomposition temperature and the temperature of the rate of maximum decomposition. Such changes are more likely associated with material variability than with material degradation.

VII. PVC piping DSC and TGA results

Test	*Unexposed sample*	*120-day exposure* 23°C	*120-day exposure* 50°C
	DSC		
Oxidative induction temperature, °C	286.39	286.35	286.00
	TGA		
Composition, %			
Volatiles	0.52	0.55	0.54
Polymer 1	57.70	57.18	57.65
Polymer 2	23.03	16.94	17.72
Residue	18.74	25.32	24.08
Onset-of-decomposition temp., °C	271.35	266.89	268.07
Temp. at max. rate of weight loss, °C	285.00	289.00	276.28

7. Results of the wall thickness tests at immersion cell temperatures of 23°C and 50°C



Piping test results

Compressive strength (stiffness)

ASTM D2412 is the test method used to determine the compressive strength (stiffness) of the pipe and is thus analogous to the tensile properties test performed on the geomembrane. This method is based on determining the pipe stiffness in megapascals at 5%, 10%, and 30% deflection. The stiffness is used to assess the ability of the pipe to withstand the load imposed by the weight of the wastes stored in the landfill cell.

Compressive strengths are expressed in megapascals, which are the units obtained by dividing the load (kilograms) by the cross-sectional area normal to the load. The cross-sectional area is the specimen length times deflection. The ratio of loads required to go from one deflection to a greater deflection (in percent) is almost always less than the ratios of the respective deflections. Therefore, the resulting strengths in MPa at 10% deflection, for example, will be less than those at 5% deflection. The same analysis applies to values obtained at 30% deflection.

Figure 6 shows the consistency of the stiffness results throughout the 120-day period for both the 23°C and 50°C tests. The results show larger percent decreases occurring at the 120-day interval for all three deflection values at both temperatures. However, the magnitude of the changes is well below the values usually considered to indicate actual changes in piping material properties.

Differential scanning calorimetry

Oxidative induction temperature data are presented in Table VII for both the 23°C and 50°C immersion samples. The results are consistent throughout the immersion periods and show no indication of polymer degradation.

Infrared spectroscopy

A comparison of results for unexposed and 120-day samples shows, in conjunction with the OIT results, that the pipe has not been degraded from leachate exposure. In addition, the IR results indicate that organic constituents of the leachate have not been absorbed into the piping polymer matrix.

Thermogravimetric analysis

The TGA data in Table VII show excellent consistency in all three tests conducted (composition, onset-of-decomposition temperature, and temperature at the maximum rate of weight loss). The presence of two polymer fractions in the PVC piping is normal. The onset-of-decomposition temperatures are consistent with those obtained for oxidative induction temperature, showing insignificant decomposition or interaction with leachate.

Wall thickness

Wall thickness is a nondestructive test to determine if swelling or shrinkage of the material is occurring from exposure to leachate. This test is the counterpart of the dimensional change test on the geomembranes.

Results of the test are shown in Fig. 7. The changes are less than ±5%, which places them within the range of precision and bias of the tests. Therefore, the changes in this figure are statistically insignificant, and the data show no apparent trends for the two immersion cell temperatures in the Method 9090 testing. In addition, the changes in Fig. 7 are not as extreme in range as those shown for the destructive piping stiffness test in Fig. 6.

Conclusions

The results of the conformance and compatibility testing indicate that the geomembranes and the PVC piping tested would be suitable for use in the Deferiet solid-waste management facility. In addition, the geomembranes all met the minimum requirements as specified in NSF Standard No. 54.

These conclusions are supported by the evidence that exposure to leachate did not cause material degradation. Changes in test results were found to be caused by material variability, not degradation, for the following reasons:

- The results of the IR spectroscopy and OIT tests show that after immersion in the leachate for 120 days, oxidation or absorption of leachate constituents into the samples did not occur.
- The results of the crystallinity test, in combination with those for specific gravity, hardness, and tensile strength, showed that plasticization or crosslinking of the polyethylene geomembranes did not occur.
- None of the physical, mechanical, or chemical test results showed any trends over the 120 days of leachate exposure.
- The results for piping stiffness (where material differences and degradation are variables) were compared with the results for wall thickness (where material degradation is the only variable). This comparison emphasized that changes in the Method 9090 test results for both the geomembrane and piping materials were attributable to material variations. These variations arise from differences in the raw resins used to manufacture the material or from the manufacturing processes themselves.

The results of the compatibility testing of the HDPE geomembranes also showed their suitability for use in the landfill leachate collection pipe. The testing of both HDPE and PVC leachate collection pipe allowed Champion to choose between the two, solely on the basis of cost.

It is recommended that chemical testing (IR, DSC, and TGA) be incorporated into any compatibility testing program to provide direct evaluation of degradation mechanisms that affect materials. The use of chemical testing will help evaluate Method 9090 test results to identify changes caused by material variability and those caused by degradation from leachate exposure.

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