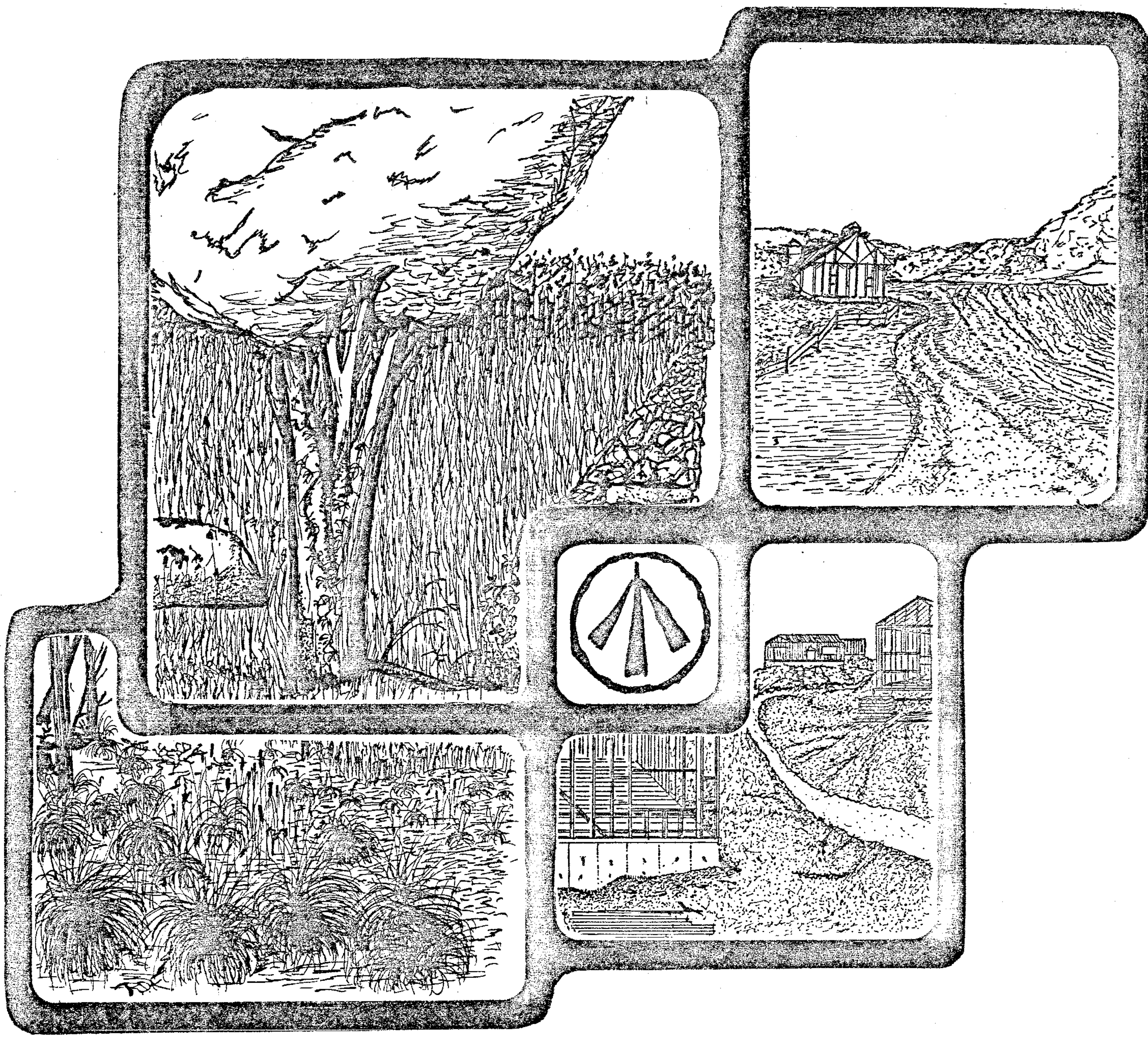
ENVIRONMENTAL REVIEW TEAM REPORT



SHELTON LAND FILL
SHELTON, CONNECTICUT

KING'S MARK
RESOURCE CONSERVATION & DEVELOPMENT AREA

KING'S MARK ENVIRONMENTAL REVIEW TEAM REPORT

SHELTON LAND FILL
SHELTON, CONNECTICUT

MARCH 1982

King's Mark Resource Conservation and Development Area
Environmental Review Team
Sackett Hill Road
Warren, Connecticut 06754

ACKNOWLEDGMENTS

The King's Mark Environmental Review Team operates through the cooperative effort of a number of agencies and organizations including:

Federal Agencies
- U.S.D.A. Soil Conservation Service

State Agencies
- Department of Environmental Protection
- Department of Health
- University of Connecticut Cooperative Extension Service

Local Groups and Agencies
- Litchfield County Soil and Water Conservation District
- New Haven County Soil and Water Conservation District
- Hartford County Soil and Water Conservation District
- Fairfield County Soil and Water Conservation District
- Northwestern Connecticut Regional Planning Agency
- Valley Regional Planning Agency
- Central Naugatuck Valley Regional Planning Agency
- Housatonic Valley Council of Elected Officials
- Southwestern Regional Planning Agency
- Greater Bridgeport Regional Planning Agency
- Regional Planning Agency of South Central Connecticut
- Central Connecticut Regional Planning Agency
- Capitol Regional Council of Governments
- American Indian Archaeological Institute

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FUNDING PROVIDED BY
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John McCormick, Derby

STAFF ADMINISTRATION PROVIDED BY

Northwestern Connecticut Regional Planning Agency

Lee Rand Burne, Chairman
Charles A. Boster, Director
Richard Lynn, ERT Coordinator
Rebecca Williams, ERT Cartographer
Irene Nadig, Secretary

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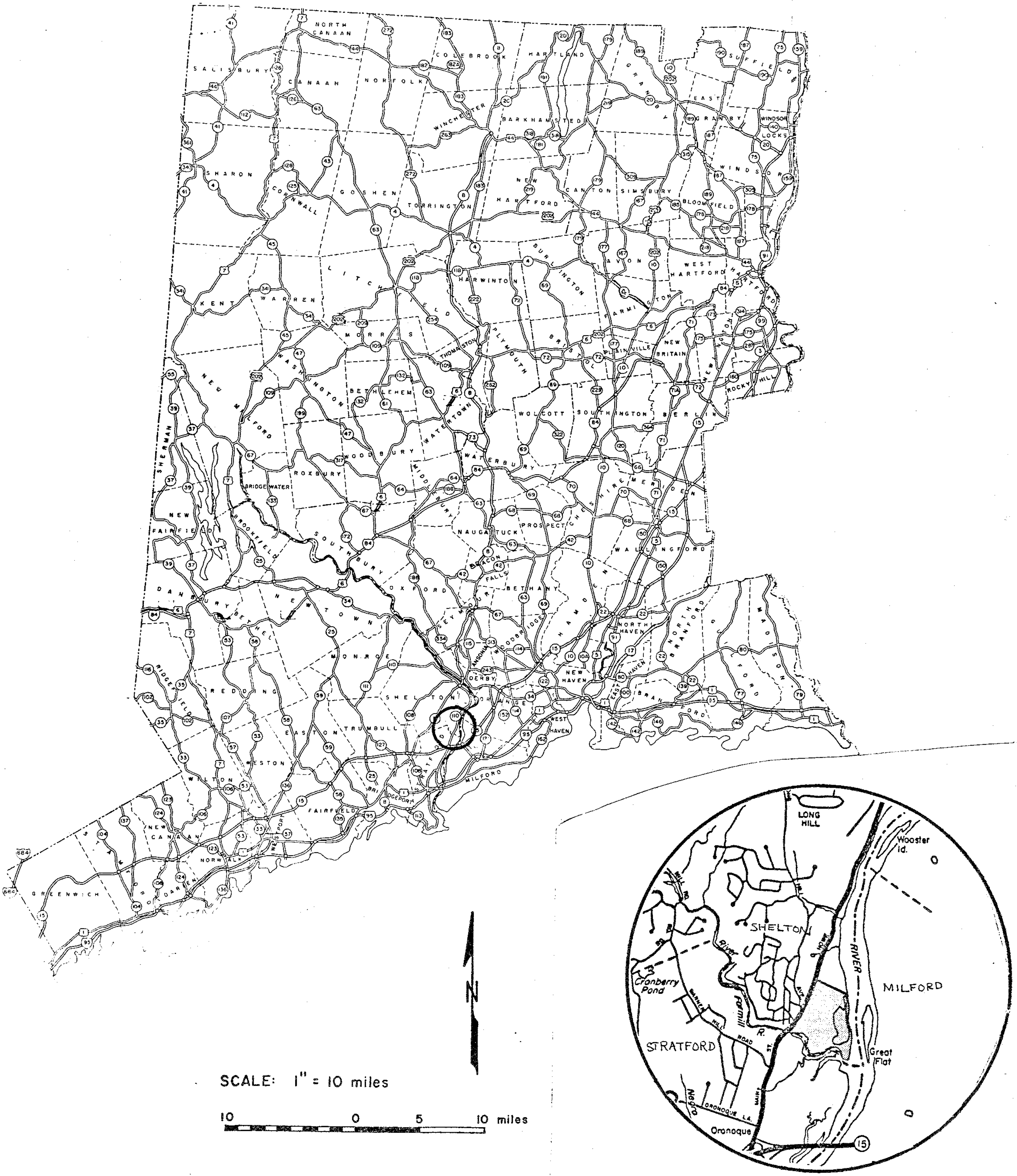
SHELTON LAND FILL
SHELTON, CONNECTICUT



ENVIRONMENTAL REVIEW TEAM REPORT
ON
SHELTON LANDFILL
SHELTON, CONNECTICUT

I. INTRODUCTION

The Town of Shelton is presently reviewing a proposed plan for regional use of the Shelton Landfill.

The Shelton Landfill is ± 106 acres in size, privately owned, and located in the southeastern corner of town adjacent to the Housatonic River. Route 110 (River Road) forms the western border of the property, and Farmill River the southern border. As shown in Figure 1, most of the site consists of disturbed land. The land has served as a landfill in the past and also as a source of sand and gravel. A relatively undisturbed wetland area does occur in the southern portion of the site.

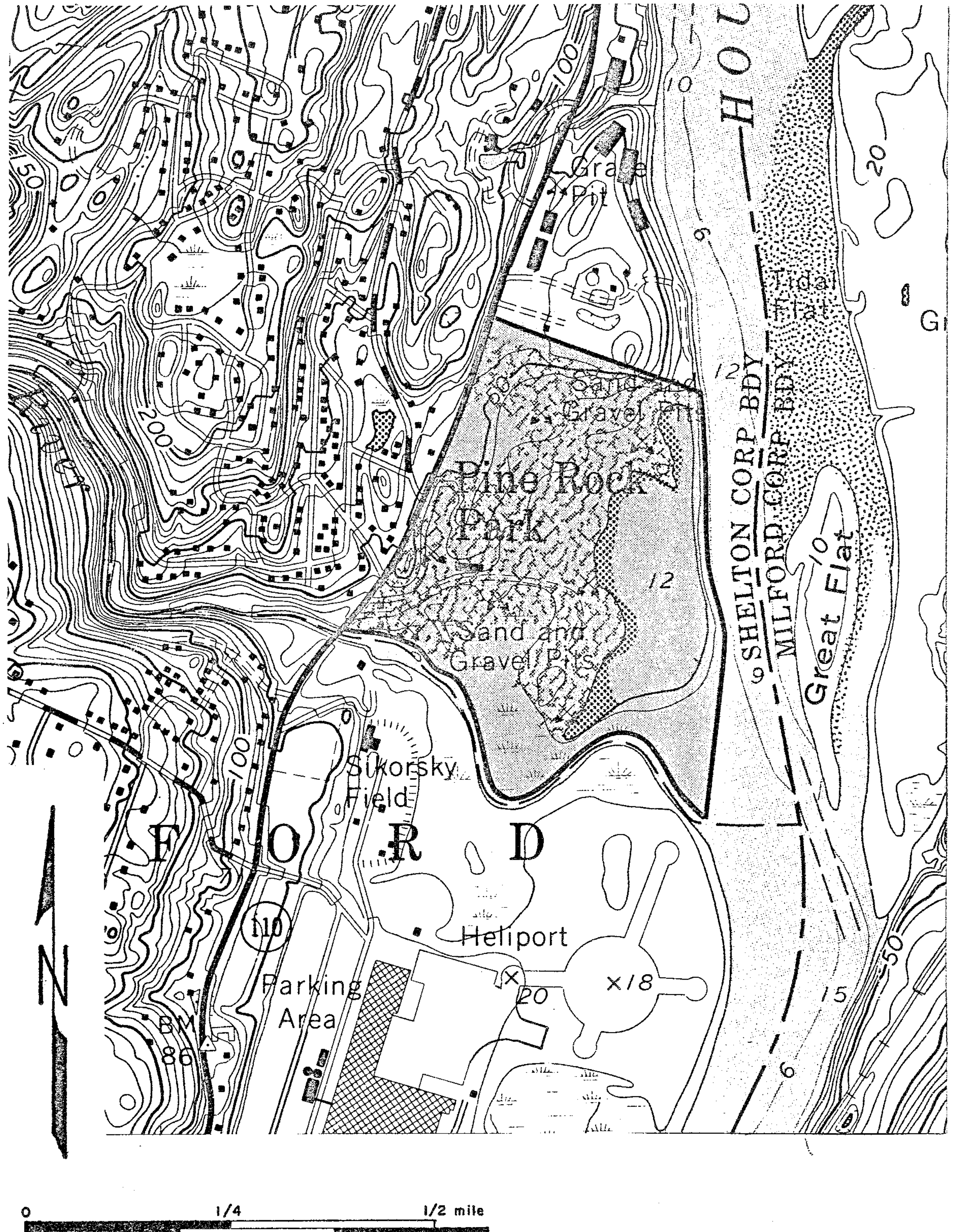
The northern third of the property is presently in landfill use. A ± 20 acre lagoon is located in the eastern third of the property. The site also contains a metal hydroxide dewatering and disposal facility and a disposal facility for asbestos wastes. The present landowner has an asphalt batching plant on the property, although this plant has not operated for several years. The Corps of Engineers has secured a permit to dispose of dredged material from the Housatonic River bottom in the southeastern portion of the property. The Corps will use a breach in the wall of the present lagoon for access to the site.

The Connecticut Resources Recovery Authority (CRRA) has secured an option to purchase the Shelton Landfill property from the present landowner. The CRRA is interested in utilizing the site for the disposal of municipal refuse from 6-10 other communities in Fairfield County. According to the CRRA, no industrial or hazardous wastes will be disposed of on this site. The CRRA anticipates that their landfill operation at this site would be completed in 6-7 years; the site would then be made available for other use (probably recreational).

The Shelton Conservation Commission requested the assistance of the King's Mark Environmental Review Team to help the town in analyzing the proposed project. Specifically, the Team was asked to identify the natural resource base of the site and to provide an objective evaluation of the potential impact resulting from the project.

The King's Mark Executive Committee considered the Town's request, and approved the project for review by the Team.

FIGURE I.
TOPOGRAPHIC MAP



SCALE: 1" = 1000'

The ERT met and field reviewed the site on January 27, 1982. Team members participating on this review consisted of the following:

Pam Goucher	Regional Planner	Valley Regional Planning Agency
Bob Orciari	Fishery Biologist	Ct. Department of Environmental Protection
Ron Rosza	Ecologist	Ct. Department of Environmental Protection
Dave Thompson	District Conservationist	USDA Soil Conservation Service
Richard Werner	Sanitarian	Valley Health District
Mike Zizka	Geohydrologist	Ct. Department of Environmental Protection

Prior to the review day, each team member was provided with a summary of the proposed project, a checklist of concerns to address, a detailed soil survey map, a soils limitation chart, and a topographic map of the site.

The review day consisted of a preliminary meeting to discuss the project and a tour of the site. The Team was accompanied by representatives of the Shelton Conservation Commission and the CRRA. Following the field review, individual reports were prepared by each team member and forwarded to the ERT Coordinator for compilation and editing into this final report.

This report presents the team's findings and recommendations. It is important to understand that the ERT is not in competition with private consultants, and hence does not perform design work or provide detailed solutions to development problems. Nor does the team recommend what ultimate action should be taken on a proposed project. The ERT concept provides for the presentation of natural resources information and preliminary development considerations--all conclusions and final decisions rest with the town and applicant. It is hoped the information contained in this report will assist the Town of Shelton and the CRRA in making environmentally sound decisions.

It should be noted that detailed project plans for excavation, filling and final grading were not available for the Team to inspect the day of the field review. As a result, the focus of this report is on "areas of concern" with regard to the proposed project. It should also be noted that a detailed analysis of water quality impact from this project will be performed by the Water Compliance Unit of DEP and the Solid Waste Management Unit of DEP under DEP permit procedures. Therefore, a detailed analysis of probable surface and ground water quality impact is not included herein.

If any additional information is required, please contact Richard Lynn, (868-7342), Environmental Review Team Coordinator, King's Mark RC&D Area, Sackett Hill Road, Warren, Connecticut 06754.

* * * * *

II. GEOLOGY

The Shelton landfill is located within a series of stratified drift deposits. "Stratified drift" consists of rock materials that were collected and transported by glacier ice during a period of forward expansion, and then washed from the ice by meltwaters during a period of glacial stagnation or retreat. The meltwaters sorted the rock debris, allowing particles of different sizes to become segregated by layers. As one digs down through the stratified drift, one may encounter a layer of coarse sand, followed by a layer of medium gravel, followed by a layer of silt, and so forth. Several test holes were drilled on the site, and the records of these test holes indicate the variations among the individual layers of the stratified drift. Fine to medium sand is the predominant constituent of the deposit, but there is also some coarse sand, some silt, and some fine to medium gravel. An eastwest geologic cross-section has been prepared by Fuss & O'Neill, Inc., using data from three well logs. The cross-section has been simplified and it conflicts somewhat with the well logs, particularly for Well C. However, it is a reasonable guide to the predominant grain sizes through the section.

Almost all of the stratified drift within the site has been disturbed (see Figure 2). The upper layers of the northern section have been buried by waste materials, including residential and commercial garbage and rubbish, and some metal hydroxide and asbestos wastes. The southern portion of the site has been largely stripped of its upper layers of stratified drift. A few exposures of crystalline metamorphic bedrock are present on the site.

Peaty deposits adjoin Farmill and Housatonic Rivers along the southern and southeastern boundaries of the property. These deposits consist of decayed organic material mixed with some sand, silt, and clay.

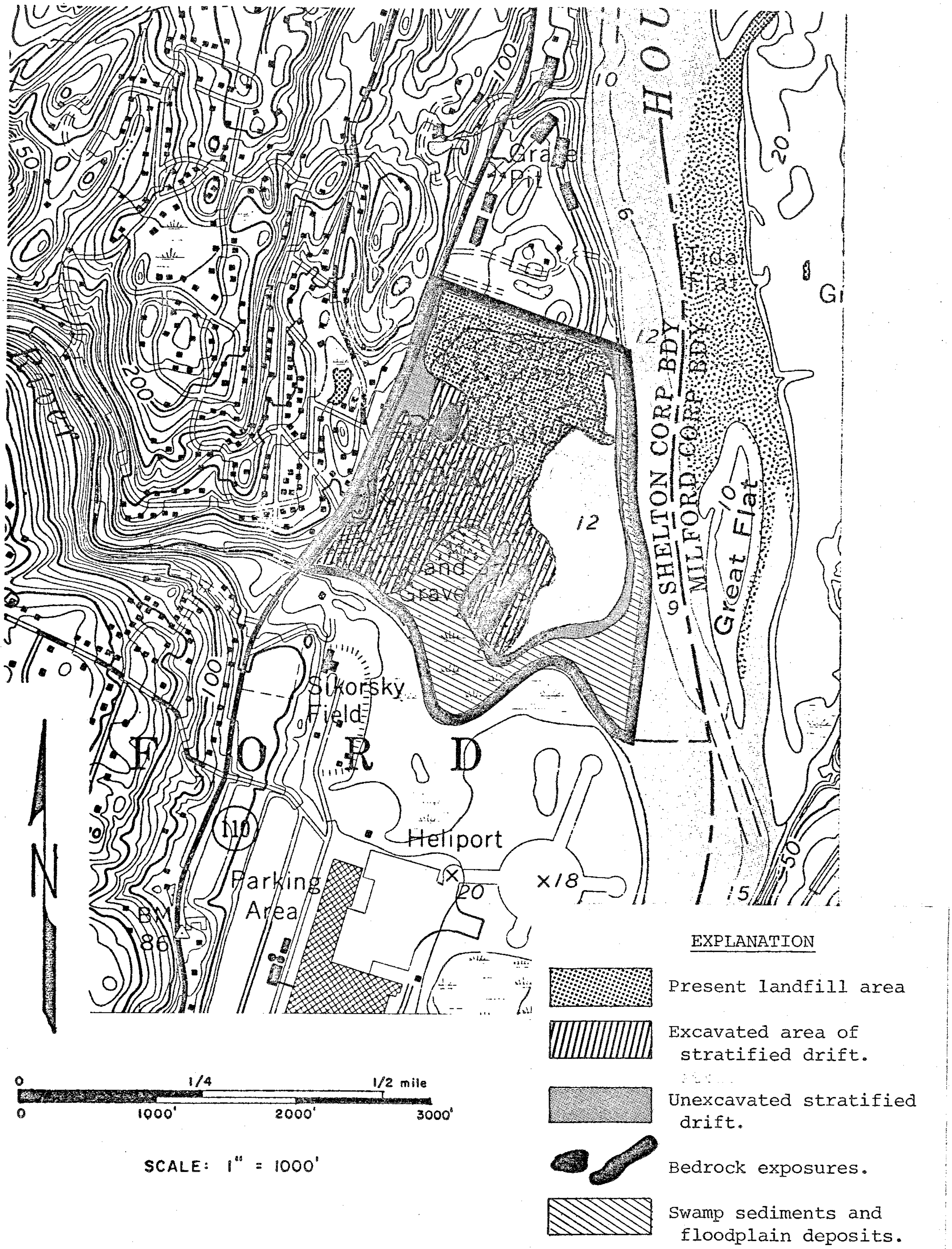
The landfilling operation is proposed to be expanded into the southern portion of the property. CRRA estimates that six or seven towns would utilize the landfill on an interim basis, for a period of up to several years. Refuse would probably consist mostly of residential garbage with some commercial wastes. No hazardous wastes are proposed to be brought into this new section of the landfill.

III. HYDROLOGY

A major reason for the interest in expanding the Shelton landfill is its relative hydrologic isolation. Although the site receives some drainage from the west and possibly from the north, it is almost a self-contained hydrologic unit. Groundwater flow through the site is probably entirely to the east or southeast, with Farmill and Housatonic Rivers serving as boundaries. The restricted groundwater flow regime maximizes the potential for monitoring the flow of leachate and for determining its effects on local water quality. In brief, most and very possibly all of the leachate generated in this landfill flows, if anywhere, directly eastward into the Housatonic River. If the landfill were far from a receiving stream, the groundwater flow paths would probably be very difficult to trace and, therefore, to control.

FIGURE 2.

SURFICIAL GEOLOGY MAP



The proximity of Housatonic River means that any leachate emerging from the landfill receives a substantial amount of dilution. The river has a drainage area of approximately 1,925 square miles at the point where it joins Farmill River. At some times, the flow of the river at Stevenson Dam in Monroe can be effectively "shut off". However, 384 square miles of drainage area, including the entire Naugatuck River watershed, lie between the Stevenson Dam and the Shelton landfill. A recording station on Naugatuck River at Beacon Falls showed a minimum one-day flow of 40 cubic feet per second. Records of this station were continuous from September 1928. The drainage area at this point is only 259 square miles. It seem likely then, that the minimum flow that could be expected in the vicinity of the Shelton landfill would be no less than 60 cfs.

Flood elevations of Housatonic River supplied by Fuss and O'Neill, the project engineers, indicate that the water surface elevation for a 100-year flood would be 13.8 feet above mean sea level in the project vicinity. A portion of the area intended for landfill expansion would therefore be inundated by a 100-year flooding event. DEP's Solid Waste Management regulations require that new landfills be protected from the 100-year flood. The applicant must therefore satisfy DEP with regard to this concern and show that the landfill would be adequately protected in the event of a 100-year flood.

The nature of the natural overburden (unconsolidated mineral material overlying bedrock) is relatively favorable for groundwater renovation. The principal size component of the overburden is fine-grained to medium-grained sand. There are some layers of silt or silty sand, and there are small percentages of silt mixed with some of the thicker sandy layers. The finer-grained particles in the deposit have the greatest potential for attenuation of contaminants. If the overburden were entirely composed of coarse-grained sand and gravel, it would be a very poor filter for polluted groundwater.

The types of pollutants that may come from a landfill vary with the nature of the fill. Obviously a hazardous-waste disposal site may generate a very different type of leachate than a bulky waste site or even a "standard" municipal landfill. Substantial variations may also occur in leachate derived from different municipal landfills. Among the most common pollutants are sodium, chloride, iron, magnesium, potassium, phosphates, sulfates, organic nitrogen compounds, and hydrocarbons, but this is hardly an exhaustive list.

The Solid Waste Unit of DEP has developed a substantial file on the Shelton landfill. Their data is necessarily more complete, and their ability to evaluate the expansion proposal is consequently much greater than that of the Environmental Review Team. The potential effects of any landfill proposal are so dependent upon the specific technical aspects of the proposal that it would be both unwise and unfair to the Town to attempt to catalogue in this report all of the considerations that must or should be weighed. The Team recommends that the Town work closely with the personnel of the Solid Waste Unit to resolve any questions that the Town may have. Personnel from the Solid Waste Unit are receptive to questions from townspeople on proposed landfill projects. The Team has included in Appendix B of this report a copy of the Solid Waste Unit's Guidelines for Engineering Evaluations of Solid Waste Disposal Areas. For another, more basic but fairly thorough discussion of landfills and their associated problems, the Team recommends the following article: Hagerty, D.J., Pavoni, J.L., and Heer, J.E., Jr., 1973, "Sanitary Landfill", Chapter 10 in Solid Waste Management, Van Nostrand Reinhold Co. A portion of that article is included with this report as Appendix C.

IV. SOILS AND FINAL GRADING

A Soils Map of the subject site is presented in Appendix A of this report together with a Soils Limitation Chart. As previously discussed, most of this site consists of disturbed land. Test holes drilled on the site show the surficial materials to consist predominantly of fine-grained to medium-grained sands. This material is relatively favorable for groundwater renovation as discussed in the Hydrology section of this report.

No final grading plan for this project was provided to the ERT. In preparing this plan, it would be desirable to terrace the surface of the landfill to accommodate future land uses. The ERT was informed that future land use would likely be recreational. Final grades should therefore be planned to accommodate anticipated field sports, picnic or viewing sites (particularly on the east face of the completed landfill), pedestrian access to the lagoon, and vehicular access to the sites. Some trade offs, in the form of refuse volume reduction, will likely be necessary to accommodate the future recreational use of this property. In the long run, however, limiting the landfill volume to accommodate future land use facilities will likely be in the best interests of the Town.

Daily cover is an important consideration in landfill planning. Based upon on-site investigation, it appears that at least some of the cover material would have to be transported to the site. In any event, careful consideration should be given to the characteristics of the soil cover as it will control water infiltration, movement of gases, litter, disease vectors, operability of machinery, and ultimately, the growth of vegetation and future use potential of the site.

V. FISHERIES

The Shelton landfill lies next to the Housatonic River approximately 6 miles upstream from Long Island Sound. At this location, the River is tidal and may have a small increase in salinity in its bottom waters. Both freshwater and anadromous* species of fish are present. Freshwater species would generally reside in the river throughout the year, while anadromous species would tend to pass through the area during certain times of the year. Species of fish that would very likely be present in the landfill area of the Housatonic River would include:

Freshwater		Anadronous/Catadromous
Chain pickerel	Common Sunfish	American eel
Carp	Largemouth bass	Alewive
Fallfish	Black crappie	Blueback herring
Golden shiner	Yellow perch	American shad
Spottail shiner	Rock bass	Sea lamprey
White catfish	Redbreasted sunfish	White perch
Brown bullhead	Bluegill sunfish	Striped bass
Banded Killifish		Sea-run brown trout

*Anadromous fish ascend rivers from the sea for breeding.
Catadromous fish live in fresh water and go to sea to spawn.

In addition, some saltwater species, such as menhaden, striped killifish, and mummichogs may occassionally visit the area.

The Farmill River runs along the southern border of the landfill, and is tidal up to a small dam just below Rt. 110. This river is stocked with brook, brown, and rainbow trout by the Connecticut Department of Environmental Protection. Other species of fish that would be present in the lowermost portion of the Farmill River are spottail shiner, American eel, sea-run brown trout, and fallfish.

Several important recreational fisheries exist near the landfill site on the Housatonic River. Upstream, a fishery for white perch, sea-run brown trout, and white catfish exists at the Derby Dam. Occassionally striped bass and shad are also caught. Downstream, a seasonal fishery for bluefish exists just upstream from Rt. I-95. On the Farmill River some fishing occurs for sea-run brown trout below the small dam and for stocked trout above and below the dam. Some fishing for largemouth bass also takes place in the lagoon adjacent to the land fill.

Because anadromous species migrate through the subject area, they would be exposed to potential landfill leachate for only short time periods. Freshwater species, particularly those with individuals residing in the lagoon, would tend to be affected more by leachate, since they would be exposed throughout the year. Also, with the Housatonic River being tidal in this area, leachate could affect fish upstream as well as downstream. Potential leachate from the landfill would generally cause chronic stress, increased susceptibility to disease, and tainting of flesh in fish.

According to engineering consultants hired by the applicant, tests indicate that no significant amount of leachate is presently entering the Housatonic or Farmill Rivers. Because the applicant proposes to continue the existing landfill operation without the disposal of hazardous wastes, the impacts to the fisheries of both rivers should not be significantly increased over that which may now be occurring.

VI. PLANNING CONSIDERATIONS

Traffic Impacts

The Connecticut Resources Recovery Authority has indicated that the Towns of Darien, Greenwich, Stratford, Westport, Trumbull, and perhaps New Haven and Fairfield will be associated with their proposed Shelton Landfill Acquisition Program. It is anticipated that approximately 43 twenty-ton capacity trucks, bringing refuse from these towns, will be entering and leaving the Shelton site each day. The trucks from Darien, Greenwich, Stratford, Westport and Fairfield would travel eastbound on I-95, exit at Route 110 in Stratford, and travel north to the Shelton site. Following this route, and assuming the trucks are covered, it appears that these trucks would have little impact on the local circulation system of Shelton.

It is unclear which routes the trucks from Trumbull and New Haven would be following. CRRA has indicated they will pursue the possibility of securing a special permit from ConnDOT so that the Trumbull trucks could use Route 15 (the Merritt Parkway) for a short distance. These trucks would then exit at Route

110 in Stratford and travel north to the site. However, if the permit is not granted, the Trumbull trucks might cross into Shelton on local streets. Some of the local streets are narrow and hilly, with no sidewalks. Truck traffic on these roads might decrease the safety of children walking to school. Depending on the location of the transfer facilities in New Haven, the trucks from that city will probably follow one or two routes: Route 34 to Derby, then Route 8 to Route 110 southbound to the site; or I-95 westbound to Route 110, northbound, to the site. The latter route would be preferable from a planning viewpoint.

Using ConnDOT figures, there are approximately 1260 vehicles, during peak hour, near the site on Route 110. A typical mix of trucks is about 10% of the total vehicles, or 126 trucks. Based on an eight-hour day, the estimate of 43 trucks per day represents less than six trucks per hour. The net increase of truck traffic, in the vicinity of the site, could therefore be expected to be less than 5%.

If other towns, besides the seven mentioned above, contract with CRRA to bring their refuse to the Shelton landfill, then the impact of truck traffic on local roads or Route 110 may increase. This would depend on the number of additional trucks and the location of the other towns.

The proximity of Sikorsky Aircraft, directly to the south of the Shelton Landfill, needs to be considered in scheduling the arrival and departure of trucks. The traffic in and out of Sikorsky's parking lots, between shifts and late in the afternoon, is very heavy. To avoid further congestion at this location, any trucks associated with the proposed CRRA operation should be instructed to avoid peak times.

The site lines in both directions of Route 110 appear adequate for trucks entering and leaving the site.

Visual Impact

Since CRRA has not yet revealed the specifics of their permit request from DEP, it is unclear just how much refuse will be disposed of at the Shelton site. It is also unclear how much vertical expansion CRRA is planning for the landfill. If the seven towns previously mentioned all contract with CRRA, then it is possible that 868 tons of refuse, or more, will be dumped at the site each day. To accommodate this much garbage each day for the next 4-6 years, it would appear that the present maximum elevation of the site may be increased by 50 feet or more. The visual impact of such heights would be disturbing and not in harmony with the current elevations of property to the north and south of the site.

Noise Impact

The noise associated with the machinery of the proposed landfill expansion will probably be muffled by the current traffic on Route 110. However, if the grade increases substantially, the noise may become more pronounced.

Sanitary Aspects

While the land use to the north and south of the site is primarily industrial, the land use west of the site (on the other side of Route 110) is primarily residential, with some small commercial establishments. The odor and vermin of the present landfill is of some concern to the area residents and will obviously be of greater concern if the landfill is expanded. If proper compaction and earth coverage principals are adhered to, the odor should be reduced to a minimum. However, often the rats that are found around a dump have been brought in with the garbage on the trucks. Long term and continuous control measures will therefore be needed to preclude infestation of neighboring dwellings.

According to the State Health Department, no public water supply wells are within a mile of the landfill and the public water line on River Road is sufficiently separated from the landfill so as not to cause a public health concern. As discussed previously, the flow of leachate is expected to travel toward Housatonic River and Farmill River rather than under River Road toward Pine Rock Park. For this reason, it is believed that wells in the Pine Rock Park area should not be affected by the regional landfill proposal. Consideration should nevertheless be given to establishing monitoring wells (if they have not already been established) in between the Pine Rock Park area and the landfill to see to what extent migration of leachate occurs.

Underground migration of methane is another concern which should be investigated. Increased amounts of garbage and trash will increase levels of methane gas. This gas is an explosion hazard, so current and projected levels of methane should be investigated in relation to dwelling units neighboring the landfill.

Consideration should also be given to the area where metal hydroxide sludge has been deposited on this site. These deposits could be problematic if landfilling is proposed atop these areas. It is the understanding of the ERT's planner that metal hydroxide sludges should not be covered with refuse as this may result in the leachate becoming too acidic. If future filling of the hydroxide sludge areas is proposed, the CRRA should work closely with the Solid Waste Management Unit of DEP to ensure that this is done in a safe manner.

The Valley Health District foresees no significant public health problem from the proposed project if the above mentioned items are adequately addressed and the proposal is implemented as planned. It should be noted that on the day of the ERT's field review, there was active dumping occurring but no one was inspecting the incoming waste either at the face of the landfill or at the public disposal site. Tighter control and surveillance of the incoming waste stream would be desirable in the future.

Future Refuse Disposal Plans for Shelton

The Twenty-Year Solid Waste Management Plan for the Valley Region was prepared in 1978 to investigate regional waste management alternatives. One of the options investigated at the time included the purchase or lease of the Gallucci property (the Shelton Landfill) by CRRA, who decided against it then. The City of Shelton then opted to lease a portion of the site and have it operated by the Archer Landfill Company until 1982 or 1987. The long-term solution to the problem of solid waste disposal for Shelton and all the Valley towns, as proposed in the plan, is resource recovery systems, either with CRRA or with a regional set-up. Efforts are currently underway in Naugatuck to construct such a facility, which would be capable of handling many town's refuse including Shelton's. Efforts are also underway to repair the resource recovery plant in Bridgeport and get it back on line. When it is fixed, it, too, would be a reasonable alternative for Shelton to join this system. A third alternative presently being investigated is the establishment of a small scale resource recovery facility in Ansonia, at the location of the Ansonia incinerator. It is hoped that this system may be on line within five years and will be designed to handle the Valley region's garbage, including Shelton's. In the interim, until any or all of the above plans are operational, landfills are a necessity. While landfills will still be necessary for the disposal of residue from the resource recovery plants, their lifespan will be increased tremendously because of the small amount of residue which will need to be buried there.

Future Planning Considerations for Shelton

Should CRRA decide to purchase the Shelton Landfill property and expand the landfill operation to include several other towns, the City of Shelton should, through its on-going planning process, have some long-term controls over the final elevation of the site. The City should know what the final elevations will be, and examine the alternatives of future uses of the property. If the final elevation is very high and the slopes very steep, the site may not be usable as riverside property. On the other hand, if the final elevations are not too high, the site may eventually be used as a riverside park or marina. The short-term economic benefits of CRRA expanding the landfill (and thus guaranteeing Shelton reasonably low disposal costs for the next few years) should be examined closely and compared with the long-term economic benefits. If the future use of this property is limited, the CRRA proposal may not be economically beneficial to Shelton.

VII. COASTAL RESOURCES

In accordance with Section 22a-98 of the Connecticut Coastal Management Act (CCMA) the developer's (CRRA) application for state permits (water compliance and solid waste certification) must demonstrate that (1); the proposed activity is consistent with all applicable Coastal Policies in Section 22a-92 (2); all potential adverse impacts are acceptable, and (3); any remaining adverse impacts have been mitigated. If the proposed project requires a municipal site plan or permit application as defined in Section 22a-105 (b) of the CCMA, a Coastal Site Plan Review (CSPR) Application must be prepared by CRRA and submitted to the town of Shelton. Currently, the extent of local jurisdiction is under question. However, the procedure and information required for the state permits and the municipal CSPR is of a similar nature and may be prepared concurrently, as outlined below.

A. Coastal Resource Identification

A map illustrating coastal resources on and adjacent to the site should be submitted as part of the state permit and/or municipal CSPR application. On-site coastal resources have been identified as Shorelands, Coastal Hazard Area, Estuarine Embayment (lagoon) and Tidal Wetlands. Adjacent coastal resources have been identified as Estuarine Embayment (Housatonic River) and Intertidal Flats (see Coastal Resources Map).

B. Coastal Policies

The State Permit and/or municipal CSPR application must include the identification of all applicable coastal resource and use policies and a determination of the consistency of the proposed development with the same policies. The following is a list of applicable policies as outlined in Planning Report #30[1]:

Coastal Hazard Areas IH(A)
Coastal Waters and Estuarine Embayments IM(A,C)
General Development II A(A)
General Resources IA (A,B,C,D)
Intertidal Flats IE (A,C,D)
Shorelands IK (A)
Solid Waste II M(B)
Tidal Wetlands IF (A,D)
Water Dependent Uses II B (A,B)

C. Adverse Impact Analysis

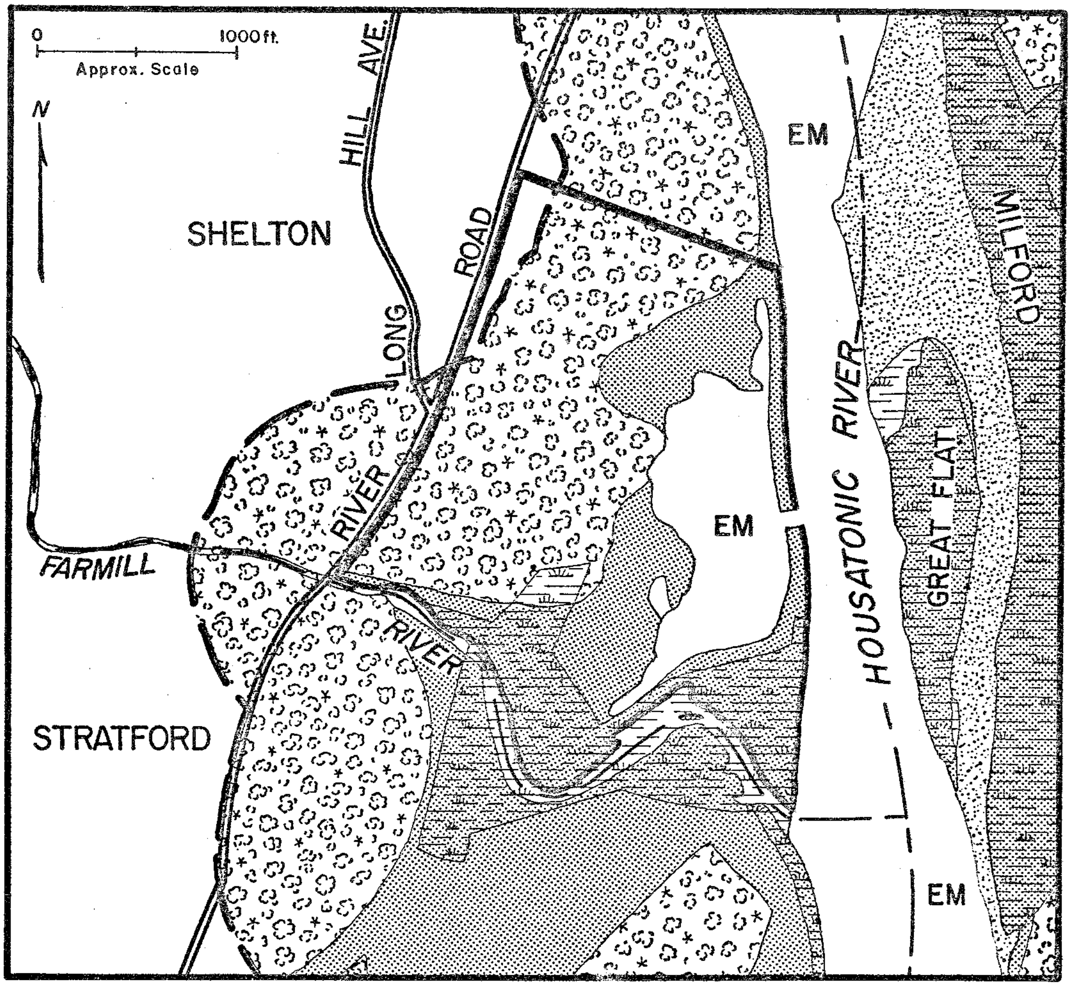
Potential adverse impacts as specified in the CCMA must be identified for the state permits and/or the municipal CSPR application. Potential adverse impacts which may result from this project include:

- Degrading water quality through the significant introduction of leachate into coastal waters from landfill activity at the site. The Connecticut Department of Environmental Protection currently classifies the water quality of the Housatonic River as "SC" adjacent to the site, with an established future goal of "SB". The proposed activity should be consistent with these standards and goals.

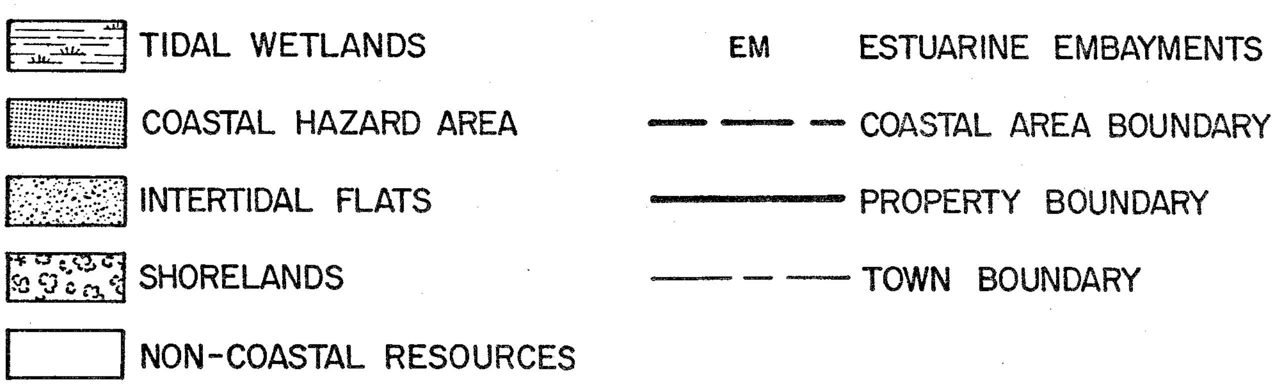
[1]Planning Report #30, Coastal Policies and Use Guidelines, Department of Environmental Protection. Coastal Management Program. Hartford, 1979.

FIGURE 3

COASTAL RESOURCES



LEGEND



- Degradation of tidal wetlands by direct encroachment at the southern portion of the site. Any landfill activity within the tidal wetland boundary would constitute an unacceptable adverse impact and render the proposed project inconsistent with the tidal wetlands policies within the CCMA. Further, to adequately protect the tidal wetlands, a substantial setback (100± ft.) should be established.

- Degradation of water quality during and after floods of 100 year significance. Portions of the proposed landfill expansion area fall within the 100 year FEMA flood boundary. It is recommended that the expansion area be sited as to minimize the portion of landfill activity within the flood hazard area, keeping to the shoreland areas wherever possible.

- Adverse impact on future water dependent development opportunities. The CCMA encourages, where appropriate, water dependent uses along the shorefront. The proposed regional landfill is not a water dependent use as defined in section 22a-93(16) of the Act. However, the existing use of the site as a landfill with associated activities significantly diminishes the site's suitability for a water dependent use. As long as the site is used as a solid waste landfill, whether under present or expanded conditions, the potential for a water dependent use is low. The possibility which should be explored is whether public access to the river could be incorporated into the proposal; public access is a water dependent use and is considered a desirable feature at most shorefront locations. The water dependent use potential of the site should be addressed within the plan for the closing and reuse of the landfill site.

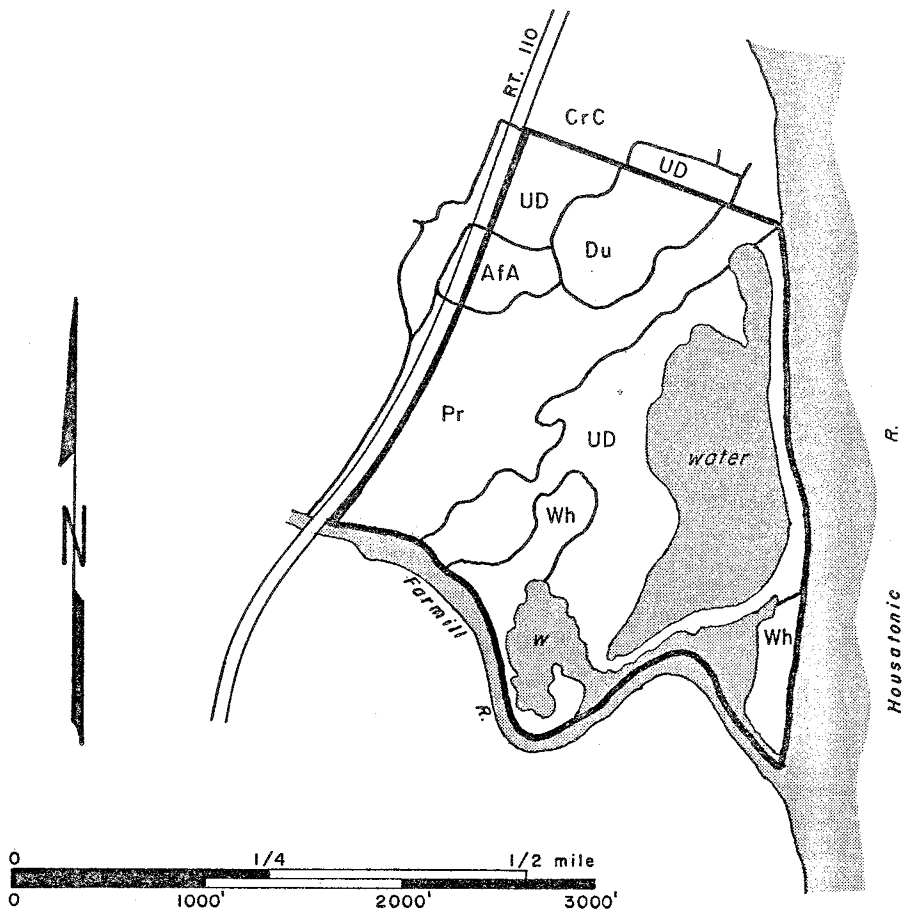
Approval of state permits and/or a municipal CSPR for the proposed project is dependent, in part, on findings of consistency with all applicable coastal policies and a determination that adverse impacts on coastal resources are acceptable.

* * * * *

APPENDIX

APPENDIX A.

SOILS MAP



* ADAPTED FROM FAIRFIELD COUNTY SOIL SURVEY, U.S.D.A. - S.C.S.

SCALE: 1" = 1000'

APPENDIX A. LIMITATION/POTENTIAL OF SOILS FOR SANITARY LANDFILL

MAP SYMBOL	SOIL NAME	AREA TYPE LANDFILL	TRENCH TYPE LANDFILL
CrC	Charlton-Hollis fine sandy loams, very rocky, 3-15% slopes	Severe limitation and low potential due to seepage.	Severe limitation and very low potential due to seepage and depth to rock.
UD	Udorthents, smoothed	Soils characteristics variable; on-site inspection required.	Soil characteristics variable; on-site inspection required.
DU	Dumps	Soil characteristics variable; on-site inspection required.	Soil characteristics variable; on-site inspection required.
AfA	Agawam fine sandy loam, 0-3% slopes	Severe limitations and low potential due to seepage.	Severe limitation and low potential due to seepage.
Pr	Pits, gravel	Soil characteristics variable; on-site inspection required.	Soil characteristics variable; on-site inspection required.
Wh	Westbrook mucky peat, low salt	Severe limitations and very low potential due to tide flooding and unstable muck.	Severe limitations and very low potential due to tide flooding and unstable muck.

Source: Hill, David E. "Soil Interpretation for Waste Disposal" Bulletin 776, The Connecticut Agricultural Experiment Station, New Haven, 1979.

APPENDIX B.

GUIDELINES FOR ENGINEERING EVALUATIONS

OF

SOLID WASTE DISPOSAL AREAS

Prepared by:

Solid Waste Unit
Department of Environmental Protection
February, 1978.

INTRODUCTION

Solid waste disposal operations in Connecticut, as regulated by the Solid Waste Management Unit of the DEP, are controlled under Section 19-524a through 19-524o of the Connecticut General Statutes, Public Act No. 75-403, and Sections 19-524-1 through 19-524-14 of the Administrative Regulations of the DEP.

These guidelines have been prepared to help direct engineering and operational submittals towards the requirements of those laws. They are also useful for providing guidance, when needed, on environmental impact assessments of past and present disposal operations. These guidelines will be used by the Solid Waste Unit to insure full, fair and complete application consideration and decision making. It is required that all laboratory analyses will be done in a laboratory certified by the State Department of Health.

Section 19-524-4(b)(3) mentions that solid waste disposal areas shall be classified and that permit applications follow guidelines for the proper class.

These classes are:

1. Existing sites where future disposal will take place only in areas where solid waste has previously been disposed of. In these cases, the application should cover Sections A1d, A3 and B of these guidelines. It should also present those items mentioned within Sections A1a and A1b which are important for a clear presentation of the proposed project. Selected information discussed in Section A2 may be required of the applicant, if deemed necessary, for evaluations on environmental acceptability.

2. Existing sites where future disposal will take place in areas where no solid waste had previously been disposed of. Applications for permits under this condition should include information outlined in Sections A and B of these guidelines. The Commissioner may, at his discretion, waive the requirements for submittal of some of the date under conditions of minor expansion and a projected minimal environmental impact.

3. New solid waste disposal areas. Applications for permits in this class must include at least the information discussed in Sections A and B of these guidelines.

Several additional points to consider in these proceedings include:

(1) approval of a site under the statutes and regulations administered by the Solid Waste Management Unit of the DEP does not constitute approval under other applicable State, Federal or local laws.

(2) the use of the proposed site as a solid waste disposal area should reasonably comply with the municipality or region's adopted 20-year solid waste management plan.

(3) the plans, reports and evaluations should be prepared by competent professionals including or under the direction of a Professional Engineer licensed and registered to practice in Connecticut. The seal of such an engineer must be affixed to all copies of supportive application materials submitted to the Commissioner.

(4) before solid waste can be deposited in a newly permitted area, the Commissioner must receive in writing, certification from a land surveyor licensed and registered in Connecticut that the site has been prepared according to the submitted plans and reports. He shall also certify that the base upon which solid waste will be placed meets to plus or minus six inches, the grades approved in those plans.

(5) the applicant may submit a portion of a full application, for preliminary review by the Commissioner. At new sites for example, the information discussed in Section A2 of these guidelines, supported by maps and plans as needed, can be forwarded for review prior to the initiation of work on other engineering and operational phases.

A. Engineering Analysis

A1. Maps and Site Plans

A1a. Detailed Area Map

At a scale of 1" = 500' (or at another scale appropriate to the setting), prepare a map showing the site in relation to surrounding natural and man-made features. This map should include an area at a minimum distance of one-half mile from the perimeter of the site. Examples of some items which must be noted and clearly labelled are:

watercourses (boundary line that delineates the 50-year flood; if available. If it is not available, best available information should be submitted).
wetlands (show boundaries of tidal and inland wetlands)
lakes and ponds
springs
water diversions
wells (differentiate between public water supply, domestic, industrial and irrigation).
water distribution lines
public water supply watershed areas(existing; proposed)
aquifers (existing or potential - delineate areas known or inferred to be underlain by stratified drift aquifers known to be capable of yielding quantities of ground water for public or industrial supply).
contour lines (minimum ten foot interval)
disposal area boundaries
buildings or structures
utilities (existing; proposed)
fuel pipelines
conservation areas
road
right-of-ways
power lines
sewer lines
unique natural areas
archieological and/or historical sites

Existing contour maps such as those prepared by the U.S. Geological Survey or provided from municipal government sources can be used in some cases. These maps should be updated, enlarged, and sufficiently detailed to present the required information in a clear, easily readable form.

A1b. Detailed Site Map

On as many map sheets as is necessary for a clear, understandable and comprehensive presentation, show in detail all significant features at the proposed solid waste disposal area and in the immediate or affected surroundings. A scale of 1" = 100' and a contour interval of two feet must be used, unless another scale or contour interval is deemed more appropriate to the site and such changes are approved in writing by the Commissioner. These maps shall show all items discussed under "Detailed Area Map" as well as all other information necessary for proper review. A minimum of the following items shall be noted:

(1) contour lines showing topography at the time of application.

(2) contour lines showing all modifications to site topography proposed in the course of site preparations.

(3) contour lines showing the topography of the proposed completed and final covered solid waste disposal area.

(4) all lines of cross section.

(5) boundaries of areas for excavation, soil backfill, solid waste fill or special waste fill proposed for disposal.

(6) property boundary lines.

(7) proposed buffer zones to adjacent properties, streams and surface water bodies.

(8) areas of exposed or near surface (less than ten feet) bedrock.

(9) location and exact elevations (at measuring point) of all test borings, test pits, observation wells, etc.

(10) proposed monitoring point locations.

(11) access roads, on-site roads; fencing and gates.

(12) proposed operations, maintenance or recycling facilities and buildings.

(13) miscellaneous on-site engineering.

(14) fire control facilities.

(15) cover material stockpiles.

The detailed site map must meet the most recent standards of accuracy for Class A-2 Transit Surveys as approved by the Connecticut State Board of Registration for Professional Engineers and Land Surveyors. The seal of a Land Surveyor registered in the State of Connecticut attesting to adherence to those accuracy standards shall be impressed on all copies submitted for application purposes.

The detailed site map shall be accompanied by at least two accurate, representative cross sections, one of which shall be parallel to the principal direction of ground water movement and the second shall be perpendicular to ground water movement. Sections should indicate minimum and maximum solid waste fill, backfill depths, ground water, bedrock, soils and other geologic data essential for adequate analysis.

A1c. Supplemental Maps

Those maps or plans not prepared as part of the study but available as reference materials should be submitted if they have been used for engineering and operational interpretations. Topics commonly covered include surficial and bedrock geology, flood line, encroachment lines and wetlands boundary maps.

A1d. Operational Plan Drawings

This item shall comprise a graphical presentation of the proposed operation and management plan. Representations of solid waste lift design, sequence of filling and excavation, solid waste cells, final contours, etc., must be provided. The primary user of these drawings will be the disposal area operator. The presentation should then follow in a clear, logical and easily understandable format. The plans should be suitable for posting at the operator's office so that disposal can proceed in the engineered, approved manner.

A2. Hydrologic and Geologic Information

A2a. Data Gathering - Items

The nature of subsurface conditions beneath the site as well as in related, potentially affected areas must be identified. A program of test borings, test pits, materials sampling, materials analysis, geophysical investigations, well installations, water level monitoring, etc., must be carried out, along with consultation of available references, to an extent sufficient for the setting of the site within the surrounding natural resources system. As a minimum, the following data must be submitted:

1. Geology

(a) the textural composition, thickness, layering and geometry of unconsolidated materials above the bedrock.

(b) notations on mottling, color variations, fragipans, clayey lenses (and their mineralogy, if pertinent), coarse-textured lenses and any other significant small scale features in the unconsolidated materials profile.

(c) data on permeability (see section (1), page 7), compressibility, degree of consolidation and other geotechnical properties of subsurface materials when such data have a significant influence over the success of the proposed site design.

(d) the structure and composition of bedrock (ledge, including the degree of fracturing and the degree of weathering); in particular, where these properties have an important influence on ground water flow within and above the rock.

2. Ground Water Hydrology

(a) a flow net of the ground water system in the unconsolidated materials consisting of equipotential lines and flowlines in both horizontal and vertical directions as determined from water table and piezometric measurements.

(b) trend and variation of the elevation of water tables or piezometric surfaces measured during the study period. Readings shall be taken at least monthly from on-site wells for a one year period to obtain an annual high water table measurement. Logical projections of the on-site maximum high water table can then be made by comparing the annual high water table with the corresponding long term water level trends published by the U.S. Geological Survey in Connecticut. The year of water level data may continue to be collected after applications for permits have been made, but it will be completed before the landfill operation commences.

On sites where drainage changes will be made to seasonally lower the water table, one year of water level measurements will be needed after the alterations have been made to demonstrate effectiveness of the system. Monitor wells should be located in the area of water table lowering as required by DEP personnel. Other permitted portions of the site may be landfilled while data is being collected in this area.

(c) delineation of the local and regional drainage divides of the surface and ground water flow systems. In those areas where the ground and surface water drainage divides are not coincident, available subsurface information and hydrologic interpretation may be used to estimate the position of the ground water drainage divides.

(d) the location of any stratified drift or bedrock aquifers within a radial distance of 2 miles from the site that are known or inferred to be capable of yielding large quantities of ground water for public or industrial supply. The significance of these aquifers in respect to present water use and future local, regional or State water resources planning shall be determined. Water resource plans of municipalities, local water companies, regional planning agencies or water authorities and the State of Connecticut are to be used as guides in determining the significance. Possible hydrologic relationships between the site and identified aquifers shall be outlined.

(e) the position of the proposed water quality monitoring points within the hydrogeologic system.

3. Surface Water Hydrology

(a) the location of any existing or proposed watershed lands to public water supply in the region. The hydrologic relationship between the potential site and that watershed must be established.

(b) the changes in surface water elevations, watercourse discharge volumes during the study period.

(c) information on the frequency and significance of surface water flooding.

4. Hydrologic Predictions

(a) possible directions of movement and discharge sites (stream channels, swamps, springs and seeps) of leachate-bearing ground water.

(b) predictions of changes in the configuration of the watertable due to land clearing, site preparation and solid waste disposal operations. An outline of the methods used should be included.

(c) collection of samples and analysis of baseline surface ground water quality data prior to initiation of solid waste disposal operations or modifications to those operations.

modifications to those operations.

A2b. Data Collection And Analyses

All hydrologic and geologic data collection and analysis methods shall follow established professional procedures and be completely outlined by the applicant.

1. Test Borings & Observation Wells

(a) all test borings and observation wells shall be constructed and installed by a reputable contractor and the work shall be supervised by the applicant's engineer.

(b) split-spoon or other types of drive-core samples of unconsolidated materials shall be collected during the drilling of all test holes and observation wells. These samples should be taken at minimum intervals of 5 feet, or at changes in strata.

(c) detailed logs of all test borings and observation wells shall be submitted by the applicant. Descriptions of the grain-size distribution of the unconsolidated materials shall be according to the Unified Soil Classification System. Samples of unconsolidated materials (and bedrock) shall be properly labelled for identification and stored by the applicant.

(d) as required, test borings shall penetrate the entire thickness of unconsolidated materials and a minimum of 5 feet of the underlying bedrock (unless otherwise approved by the Commissioner.)

(e) the construction details of all observation wells shall be provided. Information shall include location, altitude of land surface to the nearest tenth (0.1) of a foot, depth to the bottom of the well, screened interval (depth to top and bottom of well screen), type of casing, (i.e. galvanized steel, stainless steel, pvc plastic, etc.), diameter of casing, type of screen (brass, stainless steel, pcv plastic, etc.), width of screen openings, water level below land surface to the nearest hundredth (0.01) of a foot, and date of water level measurement.

(f) all observation wells shall be developed and tested to ascertain that the well is open (in hydraulic connection) to the water-bearing unit in which it is screened.

(g) observation wells installed to measure the position and fluctuations of the water table in unconsolidated materials shall be screened either (1) in the upper part of the saturated zone or (2) throughout the entire saturated thickness of unconsolidated material.

(h) observation wells installed as piezometers to measure head at a specific depth interval or point within the saturated zone shall be properly sealed above the top of the screen so as to provide accurate data on vertical head distribution.

(i) observation wells used for the collection of water samples shall be constructed of materials that will not affect the water quality. Sampling shall not occur until one (1) month after installation and development (unless otherwise approved by the Commissioner). A minimum of three (3) times the volume of water in the well casing shall be withdrawn from the well immediately prior to sample collection.

(j) observation wells shall be left in place so that additional water level measurements may be made during periods of high ground water levels.

(k) any abandoned bore holes or wells shall be adequately sealed to prevent surface water infiltration.

(l) In-situ and/or laboratory permeability measurements of representative undisturbed soil samples should be submitted for sites in till. For sites located on stratified drift (sand and gravel) deposits, permeability measurements as outlined above for representative samples of the major zone(s) of leachate movement, relatively impermeable layer(s) and potential aquifer deposit(s) should supplement engineering estimates of permeability based on sieve analyses.

There are several acceptable methods of in-situ permeability testing as well as for obtaining representative, relatively undisturbed samples for lab analysis. The most appropriate technique will depend in large measure upon the actual field conditions encountered. Consultation with the staff of the Solid Waste Unit prior to initiation of permeability testing will allow for selection of a mutually agreeable testing program. As a general practice, the Solid Waste Unit should be notified of any scheduled test borings or monitor well installations so that staff may be present to observe the drilling procedures.

A2c. Hydrogeologic Calculations

Calculations should be provided in the submittal which give reasonable approximations for the following aspects of the site hydrogeology:

1. Predicted rates and volumes of flow of leachate from the deposited solid wastes, (in particular, after field capacity of the wastes has been reached).

2. Ground water volumes flowing under the site and downgradient of the site available for dilution of leachate.

3. The position of the site within the local watershed and the ratio of the area of that watershed to that of the solid waste disposal site.

4. Prepare a dilution ratio of stream low flow at the surface watercourse which is eventually going to receive leachate discharges from the ground water vs the average daily leachate discharge of the proposed disposal area. Stream low flow should be the flow which is equalled or exceeded 99% of the time. It may be calculated or obtained from stream guaging records. The average daily leachate flow is obtained by estimating the annual infiltration over the area of the landfill and dividing by 365.

The methodology used and the logic in support of those methods must be fully presented.

A2d. Hydrogeologic Impact

Using data accumulated in the study, references from the literature, hydrogeologic calculations and other inputs, prepare a narrative discussing the possible detrimental impact of solid waste disposal at the suggested site on the quality, use or function (present, proposed or potential) of:

1. Surface water bodies and watercourses. Reference should be made to the Water Quality Standards administered by the Water Compliance Unit of the Department of Environmental Protection. Computations of the anticipated average output of dissolved solids from the landfill based on a reasonable dissolution rate of deposited refuse may be used in conjunction with computed ground and surface water dilution factors (and existing dissolved solids loads) to arrive at quantitative estimates of the relative impact of the landfill on existing water quality.

2. Ground water supplies. Include all types of supplies such as residential, commercial, industrial, agricultural and municipal wells and on-site or off-site aquifers.

Identify estimated maximum plume geometry in all areas which could be subject to contamination from leachate and estimate the rate of plume travel. Describe those regions where future development of on-site water supplies could be endangered.

This analysis is of extreme importance in the application. For disposal site consideration, the ability of the surrounding environment to favorably accept any disposal area derived leachate is a factor of the highest significance. Solid waste disposal areas must be designed to minimize such detrimental effects, though in some cases, the site will prove to be in an unacceptable location even if substantial engineering is proposed. A complete hydrogeologic assessment is the basis for fair and responsible decision making.

A2e. Permanent Monitoring Point Location & Sampling Program

A minimum of four points to monitor changes in water quality due to waste disposal operations shall be proposed in the application. One of these points (minimum) will be located so as to measure background quality of ground waters entering the disposal area. This point should be located sufficiently away from disposal operations to guard against receipt of leachate flow due to groundwater mounding. Three of these points (minimum) will monitor representative downgradient water quality. These points may be surface springs (of year-round flow), existing or proposed wells. Downgradient wells shall be placed so as to intercept major flow directions. It should be reiterated that the permit application should show proposed monitoring points. The DEP will consider those points for approval. New wells should not be installed by the applicant until such approval is obtained. Observation wells installed during site investigation stages can be approvable for use as monitor wells if assurance is provided that they meet the same standards as listed below. Full construction details on all wells should be provided including: the method of drilling, depth of drilling, diameter of hole, casing type, length and position of screen, slot size, etc. The strata into which the wells will be placed should be identified based upon previous subsurface work. The screened portion should be noted.

Monitor wells must be designed and installed under the following minimum standards:

1. Wells, screen and coupling shall have a uniform, minimum inside diameter of 2.0 inches unless otherwise approved by the Commissioner.

2. Downgradient wells should be provided with screens and shall be placed within portions of the saturated zone most likely to sustain leachate flow.

Long screens or multiple level wells will be needed in thick saturated zones to insure leachate detection in vertical and horizontal directions.

3. Well materials shall be of PVC or ABS plastics, stainless steel or other materials appropriate to the site setting and the water analysis program. The well shall be constructed to withstand installation and in-place stress.

4. Screen slot width shall be chosen so as to provide good transmission of ground water with minimal clogging. Clean, rounded, appropriately textured material may need to be placed around the well screen to aid in this function. Other methods proposed by the applicant for securing reliable results will be considered by the Commissioner.

5. Well screens shall be positioned so as to be capable of withdrawing adequate samples even during periods of low ground water levels.

6. Impermeable clay or grouting may be needed above screened sections to protect against undesirable exchange of groundwaters along the well casing.

7. Monitor wells in bedrock usually shall consist of open rock holes with well casing firmly seated and sealed into the rock.

8. All wells must pass a test for straightness. A ten-foot long pipe or rod with an outside diameter no greater than ½" smaller than the inside diameter of the well, must be proven to pass freely through the entire length of the well.

9. Impermeable materials shall be placed around the well near the ground surface to prevent rain and runoff infiltration.

10. All wells shall be developed after installation to clear fines from host materials, remove cutting wastes from the casing and thus secure high responsiveness of the water level in the well and maximum sample yields.

11. Wells shall be finished and protected from damage by installing a steel casing or pipe around (or as part of) upper sections of the well. A vented steel cap shall be secured onto the top of the steel casing.

12. The point from which all measurements are taken shall be clearly marked on the well.

13. All permanent monitor wells shall be assigned indentification numbers by the DEP. The applicant must make provisions for having that number clearly stamped or displayed onto the casing.

14. After approval of the proposed monitor well locations and designs are secured, the applicant will be given a time frame for well installation. Once the wells have been installed, a professional engineer engaged by the applicant shall certify that the wells have been placed in the approved manner and according to all current standards. Representatives of the DEP shall inspect the wells in the field with the applicant prior to a decision on final acceptance.

15. The DEP shall outline with the applicant a required schedule of water level readings, sample collection and sample analysis.

16. Water sampling methods are outlined under Section A2b of these guidelines.

A3. Supplementary Engineering Information

Miscellaneous data on engineering analyses used in site design as well as specifications for critical engineered structures should be provided in this section. Examples of topics which would be appropriately mentioned include:

1. Ground and surface water drainage modifications and diversions. For ground water control drains the following procedure should be followed:

a. the drainage performance should be predicted prior to construction and its influence verified by field observations.

b. the applicant should design the subsurface drainage system such that it will function as planned for the life of the site (the potential leachate producing period).

c. it should be clearly shown that there will be no chance for the drain to act as a leachate collection system.

2. Refuse decomposition gas controls at the disposal site and in areas potentially subject to gas accumulation.

3. sediment and erosion control facilities.

4. recycling facilities design.

5. office and maintenance building design.

6. litter control devices.

7. fencing and gates.

8. on-site access road design.

B. Operation and Management Plan

This section shall consist of a complete description of the proposed operation during its day-to-day and long term use. At least the following information should be presented:

1. the delineation of waste sources and general ranges in quantities from residential, commercial, industrial, agricultural and other sources.

2. a discussion on the sequence of filling and excavation. Describe lift thickness, slope and width on the working face, sequence of lifts, final layer sequences and sloping, etc. Note where trucks will empty in relation to the working face and cover material stockpile. Mention on-site surface water drainage directions and controls required as a result of the disposal operations. This section should comprise a written description of the operational plan drawings required in Section A1d.

3. The cell construction method of sanitary landfilling, as defined in the Solid Waste Regulations, shall be used as the basic operating procedure.

4. cover material use. Discuss cover material (daily, intermediate, final)

sources, amounts available and textures.

Acceptable daily, intermediate, and final cover shall consist of the following soil types as defined in the Unified Soil Classification :

GM - silty gravels, minimum of 10% fines, should compact well.
GC - clayey gravels, minimum of 10% fines, should compact well.
SM - silty sands, minimum of 10% fines, should compact well.
SC- clayey sands, minimum of 10% fines, should compact well.
ML - inorganic silts, fine sands, rock flour, and silty or clayey sands with slight placticity; should compact well, not erode easily, and conform to grain size curve limitations.

As an additional guide, proposed cover soils should have a grain size distribution falling within the shaded portion of the curve in Figure 1. These soils should be compactable, stable to erosion, and relatively impermeable when in place.

A sieve analysis of proposed final cover soils shall be provided to the department along with a small soil sample. If final cover soils cannot support vegetation, then a thin layer of organic topsoil may need to be applied over them. A variance may be granted for daily cover soil requirements when conformance to these suggested guidelines would result in severe hardship to the operator and when other soils are readily available which will produce a sanitary landfill.

5. a discussion of site preparations necessary prior to solid waste disposal.

6. general categories of materials which will be acceptable and those materials which will be excluded from the site.

7. procedures on managing recycling or other resource recovery facilities.

8. special wastes management. Mention all types, sources and quantities of liquid, industrial, difficult to handle or hazardous wastes and sludges which may be proposed for disposal at the site. Discuss what procedures will be followed for obtaining necessary State approvals for such practices.

9. provisions and facilities for difficult weather operations.

10. access to area. Discuss maintenance of on-site and access roads; note how entrance to the site will be provided and controlled.

11. operating hours. Note if the site will be open at other times for selected users and if there will be changes in operating hours during the year.

12. equipment type, size, condition and availability. Note those maintenance facilities that will be used. Discuss proposed contingency plans for temporarily replacing out-of-service equipment.

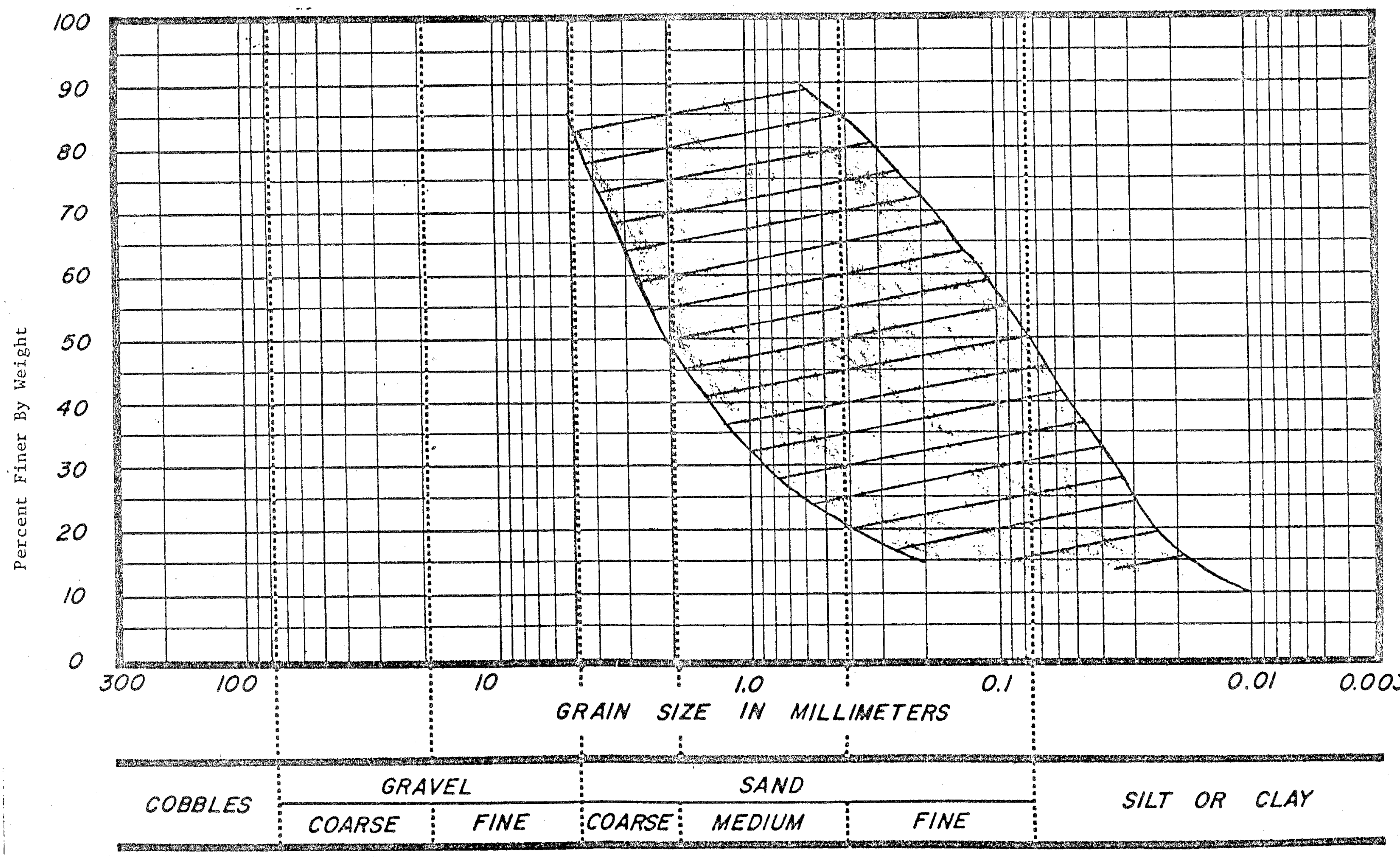
13. proposed weighing, measuring and record keeping procedures.

14. provisions for preventing and controlling blowing litter and dust.

15. proposed measures for fire prevention and control.

16. plans for vector control and extermination when needed.

FIGURE 1. SUGGESTED GRAIN SIZE RANGE FOR LANDFILL COVER SOILS



17. provisions for fulfilling Certified Operator requirements outlined in statutes and regulations.

18. those operator facilities (shelter, water, toilet, etc.) which will be made available.

19. first aid and other emergency provisions.

20. proposed telephone, radio or similar communications facilities.

21. reasonable estimates on available volume for waste disposal and probable site life.

22. proposed intermediate and final covering, grading and seeding methods. Discuss how proper soil fertilization and seed application weights will be determined. Note who will be responsible for such final closure.

23. probable future land use alternatives.

Where applicable, the prepared engineering plans should always reflect requirements outlined in the Solid Waste Regulations.

APPENDIX C.

SOLID WASTE MANAGEMENT

Chapter 10, Sanitary Landfill,

Hagerty, Pavoni, and Herr, 1973,

Van Nostrand Reinhold Company.

10-4. SITE SELECTION FOR SANITARY LANDFILLS

10-4.1 General

An initial factor in any site selection activity for a sanitary landfill is the determination of what land, and which sites, are available for use. In this connection, some attention should be paid to the zoning of various areas of a community. Land which has been zoned for commercial or industrial development is much

more likely to become available for sanitary landfill operations than that which has traditionally been zoned for residential use. Likewise, land which is still in the developmental stages and has not been surrounded by previous developments will be much more amenable to a landfill operation than land which is surrounded by developed areas, particularly residential ones. Near many large metropolitan areas there are suburban belts which contain sites suitable for landfilling operation. However, suburban residents generally are resentful and enthusiastically resist any attempts to bring urban refuse to the suburban area for disposal. Adequate planning, which should include a public relations program and competent leadership by elected officials, may overcome such suburban resistance, especially when an overall regional plan for waste disposal is drawn up so that both the metropolitan and suburban communities may dispose of wastes in the same landfill. With a comprehensive regional plan, the overall economies achieved with large-volume operations will make costs to both suburban and metropolitan consumers much lower, and the quality of collection and disposal service should improve. If the social and political considerations for location of a landfill have been given adequate attention and a number of sites are deemed acceptable, the technical characteristics of individual sites should be examined. The technical considerations for each site may be grouped as to environmental and economic factors. In this discussion of site selection, predominant emphasis is placed upon environmental considerations. The overall economics of a landfill operation, including the influence of site selection, were discussed previously.

10-4.2 Basic Considerations

The selection of a site for a sanitary landfill which will not be offensive and injurious to the surrounding environment will be based upon several different considerations. Before enumerating these, it is pertinent to ask a question concerning the basic philosophy of the sanitary landfill. Is the landfill a refuse cache, a place where materials are to be stored for possible later use, or is the landfill a particular form of waste treatment plant? Many persons, including some sanitary engineers who design fills, consider the sanitary landfill as primarily a storage area where reusable materials, because of the present unfavorable economics of separation, must be temporarily stored with degradable nonreusable materials. If the landfill is viewed from this standpoint, then the site for it should be selected so that little contact between the environment and the contained, temporarily stored materials occurs. For example, if the intention in burying wasted cans or other metals is that at a future date they will be returned to the manufacturing cycle, then the landfill will have to be designed so that the least amount of moisture infiltrates the cover soil and leads to oxidation of the metals within. If on the other hand, the sanitary landfill is considered to be a specialized form of waste treatment plant, then different criteria will apply for site selection and operation. For example, in such a case, considerable amounts of moisture will be necessary for complete and rapid degradation of the degradable wastes within the fill and the latter should be located in an area where rainfall will be sufficient. In addition the materials which are leached from the landfill by percolating waters will of necessity need to be collected and perhaps reinserted in the fill to accelerate the degradation process. In general, at the present time, the criteria for adequate sanitary landfilling are such that the contacts between the environment and the contained wastes are kept at a minimum. When such philosophy is adopted for the overall operation of the landfill, primary consideration must be given to avoiding the generation and dispersion of contaminants from the fill, and also avoiding the placement of a fill so that the surrounding environment is visibly marred.

10-4.3 Siting to Minimize Difficulties

A landfilling operation may be designed so that the aesthetic impairment is minimal. For example, surrounding the entire filling area with an embankment of earth which has been covered with grass and shrub plantings will effectively isolate the working face from its environs. Such measures may preclude any detrimental appearance of the landfilling operation. However, it should be recognized that certain facets of the operation may lead to poor appearance of the area or to nuisances for area residents. For example, the travel of collection and transfer trucks through the area where the landfill is located may create problems of litter, noise, or odor. Obviously, consideration must be given to minimizing such problems. The selection of routes for the trucks bringing refuse into the landfill site should be such that contact with residential areas is minimized. In addition, all trucks which are transferring refuse into the landfilling area should be adequately covered to prevent blowing paper and the generation of odors and flies. At present the problem of noise from transfer and collection trucks is not as amenable to solution: however, any general solution to the noise pollution problem will include a solution for landfill refuse trucks also. Of more direct concern to the landfill planner is the possibility that contaminants generated within the fill during decomposition of the contained refuse will enter the surrounding environment and prove hazardous or noisome to the residents of the area.

The introduction of contaminants from a landfill into the surrounding environment can occur only if those contaminants are transported in some way from within the landfill. One of the major sources of transport for contaminants is water which seeps or percolates through the fill and enters either the groundwater system or the surface system. Another source of transportation may arise from the contaminant itself; i.e., gases which are generated within a landfill as a result of degradation of the organic materials therein obviously may move in response to pressure and concentration gradients.

The most important single consideration with respect to contamination is the

introduction of water into the landfill and the emergence of that water carrying contaminant materials. The water content of the fill material will also have much to do with the progress of degradation in the landfill. Thus considerable attention should be given to the possibilities that water will be introduced into a fill and will migrate through it carrying out of the deposited refuse contaminants which may be in suspension in the water or may be dissolved therein. Additionally, the gases which are created during decomposition of the degradable refuse within a landfill may migrate laterally or vertically to enter the atmosphere or possibly to collect in dangerous concentrations near structures or in depressions. Thus, consideration must be given to the topography of a site, the climate of the area in which the landfill is proposed, the hydrology of the region both with respect to surface and groundwaters, and the overall geology of the site including the characteristics of both soils and rocks there.

10-4.4 Physical Factors in Siting

In general, any topographic land form may be used for the site of a landfill. However, the variations in topography from site to site will cause special difficulties and will necessitate special design considerations for the successful operation of a fill. For example, flat or gently rolling terrain may be most suitable for the landfilling operation itself, but may also receive high priority as the future location of recreational areas or industrial sites. Likewise, low-lying flatlands may be periodically flooded and may therefore not be suitable for landfilling operations. On the other hand, severely eroded topography, such as is found in many depressional areas where canyons and ravines are the dominant features, may be quite suitable for landfilling from the point of view that a considerable volume of refuse may be deposited in each acre of land because of the depression therein. However, the origin of these depressions must not be forgotten—erosion from flowing water has created them. Therefore, any landfilling operation contemplated for depressional areas such as ravines or canyons should take full account of the condition that any flowing water must be intercepted before it reaches the landfill. Adequate surface drainage features must also be designed so that erosional waters cannot interfere with the operation of the fill. On the other hand, many man-made depressions or other man-made features may function quite well as landfill sites. For example, abandoned strip mines may furnish an ideal location for a sanitary landfill, since the surrounding terrain is certainly not amenable to residential zoning. The problem of water seeping up into refuse location ordinarily will not be met in such strip mining areas. Very often, where coal seams have been exposed in a strip mining operation, the soil which underlies the coal beds may be an underclay or a shale formation, which in either case amounts to an almost impermeable layer quite suitable for excluding groundwaters and keeping the fill dry. In addition, if porous strata are encountered, an artificial barrier may be created between the fill and the porous bed by placing fine-grained soil blankets over the strata. If these expedients are employed, a suitable site may be attained and an area once blighted by man's activities may be reclaimed and put back into the category of a useful parcel of land. Other sites which may be amenable to such treatment include abandoned clay pits, sand and gravel quarries, and limestone quarries. Some special consideration should be given to the migration of groundwaters and generated gases whenever pervious formations such as gravel strata are encountered in a man-made excavation.

Special consideration must be given to any proposal for sanitary landfill operations in tidal areas or marshlands near the sea coast. Such operations should never be undertaken. Dumping of refuse in a saturated high-water environment such as marshland is totally undesirable from an engineering point of view. Moreover, the use of swamps or marshland as landfill sites totally ignores the very productive nature of these areas. The ecological considerations of the overall use of wetlands, whether marsh, swamp, or tidal, as landfill areas make obvious the fact that the gains in ability to dispose of refuse are almost always outweighed by the losses to man in the reduction of wildlife and scenic beauty occurring when such wet lands are altered.

The next factor to be considered in the selection of a landfill site is the overall climate of the area—the amount and time of occurrence of rainfall, the velocity and direction of the prevailing wind, and the overall temperature-time relationship for the site. Of special importance in many localities is the wind situation at any particular site. Quite often a windy site may be very dusty if rainfall is not sufficient to control the dust. Additionally a windy site may be covered with blowing paper. To prevent the occurrence of the latter, litter fences and other expedients may be used; of course, any extra expense associated with such measures must be taken into account. In general, excessively windy sites should be avoided if at all possible. When consideration is given to the amount and intensity of rainfall at a particular site, the relationships of the rainfall and the topography of the site should be considered. If the topography at a site is such that steep grades must be climbed by collection equipment or if the site is covered with a soil that is easily eroded, then the occurrence of high-intensity rainfalls will be very detrimental. If the soil is easily eroded, then the site must be flat or gently rolling in order for the intense rainfall not to have an adverse erosional effect on the project. A well-drained non-erodable soil will do much to reduce the problems associated with high-intensity rainfalls. On the other hand, in an area where rainfall is minimal, the problems of dust and blowing paper (where the site is windy) must be considered.

The primary consideration as to temperature in landfill design is the amount of time during the year when it is below freezing. If examination of records in a given area show that during the winter months the temperature remains below

freezing for a considerable time, then adequate cold weather operational measures must be employed. For example, cover material will be hard to obtain if frost has penetrated the upper few feet of the ground in an area where freezing temperatures are common during the winter months. In such a situation cover materials may be stockpiled during milder weather to be available for use during frozen ground operations.

Obviously, when consideration is given to the interrelationships between rainfall and topography, the hydrological aspects of a particular site are examined. Other important hydrologic aspects of landfill sites, in addition to surface runoff characteristics and rainfall intensities, are the location of the groundwater reservoir and the surface drainage pattern. Water passing over a fill can lead to infiltration, leaching of contaminants from the refuse, and pollution of surface and groundwater systems; obviously then the surface water drainage pattern at a particular site is of extreme importance. Surface water flow is important also from the point of view of daily operations of both collection and landfilling equipment. Finally, surface waters will be responsible for erosion of the land surface and may remove cover material *in situ* or may remove such material from completed refuse cells. Hydrologic investigations of the proposed landfill site should include determination of the frequency, duration, and intensity of storms during the period of recorded history of the area, and should also include records of the water losses to infiltration in the soil and evaporation and transpiration in the atmosphere. As a general principle, a sanitary landfill site should be designed so that surface waters do not invade the site from upland areas around the fill. In this way, the only source of problem water will be the rainfall which actually falls on the surface of the landfill itself. The amount of water which percolates down through the cover material in a landfill will depend upon the characteristics of the cover soil and also the hydraulic configurations of the area. For example, the hydraulic configuration of the area, including the grading of the surface, will determine the amount of time that surface water remains on the site; the longer the retention time of surface water on a site, the higher the amount of infiltration through the surface layer. A competent hydrologist supplied with information on the amount and intensity of rainfall, the infiltration and evapo-transpiration characteristics of the soil, cover, and the water storage characteristics of the soil cover can predict the quantities of water which will percolate into a landfill and reach the deposited refuse. The hydrologist must also, in order to adequately survey the proposed site, determine the location and characteristics of groundwater. If the proposed landfilling operation involves excavation below the permanent groundwater table, then flowing groundwaters may also, in addition to infiltrating surface waters, come into contact with deposited refuse and remove contaminatory materials from it. If contact between refuse and flowing water is anticipated on the basis of the hydrological analysis, then remedial measures must be employed to prevent the generation of a leachate rich in contaminants. For example, surface waters should be intercepted before they reach the landfill site, and rainwaters falling on the site itself should be rapidly and efficiently removed. Removal of falling rainwaters may be easily achieved by covering the site with impermeable materials such as clay soils and grading the surface areas to produce rapid runoff. If groundwater/refuse contact is anticipated, then revision of the design plans for the landfill must be made to include either elevation of the refuse above the groundwater table, or the placement of an impermeable barrier between groundwater and deposited wastes. On the other hand, if the placement of the landfill above the groundwater table makes the particular site economically unattractive, it may be possible to make provisions for collection and treatment of the leachate which is generated from the landfill. Such collection and treatment of the leachate will be an adequate solution to the water/wastes contact problem if no contaminatory materials are introduced as a result into either the surface water system or the groundwater system.

In summary, adequate hydrological investigations of a site will include gathering of data on surface drainage (rainfall characteristics, infiltration rates, evapotranspiration rates, storage capacity) and data on groundwater characteristics and quality (groundwater table location, direction and flow rate of groundwater, location of groundwater wells, water quality in aquifers). In some instances the problems of contamination of ground or surface waters from landfill leachate may be superfluous, since the quality of some aquifers and some surface bodies of water is already quite poor. However, the potential for purification of surface waters is high, and therefore no contamination of surface waters from landfill leachates should be tolerated. On the other hand, the quality of water in some groundwater systems is such that contaminants from a landfill do little to further impair its quality. Additionally, water flow in groundwater systems is generally much slower than in surface systems and the chances of purification of the former therefore is much lower than for the latter. On the basis of the foregoing reasoning some persons have drawn the conclusion that, if no immediate danger to residents of the surrounding area exists, some pollution of already polluted groundwaters may be tolerated. Extreme caution should be used in implementing such reasoning because growing demands for groundwater, and improved sanitation techniques (conversion of septic tank service to sewer service), may do much in future years to gradually purify presently polluted groundwater systems, while the possibility of purifying a landfill site which is polluting groundwater reservoirs is quite low. Therefore, it appears that only in extreme exceptions to general situations would it be permissible for a landfill to be designed on the assumption that any further pollution of groundwaters is acceptable.

Since the flow of water through a site is of extreme importance to the overall success of the landfilling operation, it appears important to consider the flow characteristics of water in various types of earth materials. Additionally, the

structural integrity of earthen materials is of importance in providing support for the proposed landfill construction. Therefore it is reasonable to give considerable attention to the geological aspects of any proposed landfill site, including the flow characteristics (permeability) of the soils and rocks present, and their structural characteristics. To be adequate, a geological investigation of a proposed site should include procurement of data concerning the depth and types of soil present at the site, the depth to and the characteristics of the types of rock which are present, as well as other significant properties of the underlying bedrock (general rock type, discontinuities within the strata–bedding planes, joints, faults–and microstructures in the rock). This data may be obtained from various sources, such as federal, state, or local agencies; for example, the U.S. Geological Survey, state geological surveys, the Soil Conservation Service, the U.S. Department of Agriculture, the U.S. Army Corps of Engineers, and local offices or university departments concerned with soil science, soil engineering, or geology. Some generalized statements may be made concerning the geology and soil characteristics of sites as they pertain to the successful operation of a landfill.

Engineers separate earth materials into two broad categories of "soil" and "rock" on the basis that rocks are those natural mineral aggregates which are not easily separated into their individual constituents by mild mechanical action; soils obviously are mineral aggregates which are easily separated by mild mechanical action, such as stirring in water, into their individual grains. For the different types of rocks, the geological classifications are, generally: sedimentary; metamorphic; and igneous. Igneous rocks can be considered primary in that they are formed during the cooling and solidification of molten magma. Erosional forces remove individual grains from these igneous rocks and transport them to other locations; and there they form sediments. If the sediments are acted upon by other natural forces, so that with time the individual sediment grains again become bonded together, the resultant rock is called a sedimentary rock. Metamorphic rocks are both igneous and sedimentary types which have been acted upon by natural forces and have been subjected to intense heat and/or intense pressure, so that the basic rock fabric has been changed. In general, the primary rocks, the igneous formations, have low permeability with respect to the fabric of the rock itself. However, bodies of igneous rock contain discontinuities such as joints and faults, and the overall mass permeability of the igneous formation may reach a significant value. Joints in igneous rock may result from contraction on cooling, expansion and contraction during subsequent movement, and tectonism. Most igneous rocks contain some joints and, therefore, at least preliminary consideration and investigation must be made of the permeability of an igneous formation; these rocks should not be considered impermeable unless proved so.

The statements made concerning igneous rocks may be repeated, in essence, for metamorphic rocks. Many of the latter have low fabric permeability but may have significant secondary permeability due to the presence of joints, faults, or other discontinuities. Again, as in the case of igneous types, the permeability of metamorphic rock should not be simply discounted but should be investigated. The permeability obviously will govern the potential for groundwater flow through the site and also the movement of leachate from a landfill. The third category of rocks, sedimentary, displays a wide range in permeabilities.

In discussing sedimentary rocks it is pertinent to first discuss sediments in general. Sediments are usually classified according to their average grain size—for example, as gravels, sands, silts, clays, etc. In general, gravels consist of sediments with grain sizes such that the grains are visible and generally greater than about 2 mm in diameter. Sands contain visible particles and are generally considered to consist of particles from a maximum diameter size of 2 mm down to the limit of visible particles, about 1/10 mm in diameter. Silts are those sediments which contain particles below the visible range in size but which are not in the colloidal size range. Generally this size range is considered to be from about 1/10 mm to about 0.005 mm. The soils which have particle sizes below 0.005 mm in equivalent diameter are generally classified as clays. Permeability, because of a number of factors, generally varies almost inversely with grain size in soils. Thus gravels are much more permeable than sands, while sands are much more permeable than silts and clays. Natural soils consist of various proportions of gravel, sand, silt, and clay particles. Thus a material which is predominantly gravel but which contains fine clay-size particles in its pores may be as impermeable as a material which contains essentially all clay-size particles. If a sediment, whether it be gravel, sand, silt, or clay is lithified and made into rock, then the character of the resultant sedimentary rock will reflect the properties of the original sediment. For example, a conglomerate created from gravel, or a sandstone created from a clean sand, will be much more permeable (fabric permeability) than will a shale created from clay-size particles. In general, then, the permeability of the rock fabric will vary with the particle size of the original constituent. Additionally secondary pores created by movement and distortion within a rock mass (joints, faults, etc.) also lend permeability to the mass and so should be considered. In general, the most pervious rocks and the formations which constitute the best aquifers are sedimentary formations of sandstones and limestones. Sandstones generally have a porous fabric and may also contain many joints. Limestones generally are jointed and also, in many cases, contain large solution cavities where percolating waters have enlarged existing joints. On the other hand, siltstones and shales have low fabric permeability and ordinarily do not contain closely spaced extensive joints or other fractures.

In considering the generation of leachate, the movement of groundwater through a fill, or the movement of leachate out of a fill into a groundwater system, it is necessary to investigate the permeability of any underlying rock formation. Obviously, the permeabilities of igneous, metamorphic, and fine-grained

sedimentary rocks many times will be negligible. However, the permeabilities of porous or highly fractured sediments are likely to be extremely high. In all cases, a thorough geologic investigation of the subsurface materials at and around a proposed landfill site should be conducted.

In addition to the rock strata which are present at a particular site, the engineer designing a landfill must also be concerned with the soil cover which is present. This soil will be used, in many cases, as the cover material during the construction of the landfill; or if the depth to bedrock is great, the landfill must be founded upon the existing soil at the site. For these reasons a comprehensive investigation of soil properties and characteristics is mandatory for any proposed landfill operation.

Cover material must function to control the infiltration of water into a landfill, but it must also function to prevent the exit and entrance of disease vectors such as flies, rats, and other vermin. Additionally, cover soils must act to control movements of gases produced during degradation of the contained refuse. Of course, the cover soil on a sanitary landfill acts to control blowing paper and other litter and finally serves the additional function that when the landfill is completed it provides a basis for the growth of vegetation. The cover soil, which acts as a barrier between various refuse cells in a sanitary landfill, will prevent the spread of any combustion which is initiated in an individual cell. If all of the uses of soil as a cover material are considered a conflict as to requirements becomes apparent. For example, many soils which are suitable for the control of disease vectors are not also suitable for the control of gas movement nor would they be suitable for the control of moisture movement. For example, gravel layers may effectively block the ingress of rodents into a fill, but would not prevent the movement of water or gases. (In addition gravel layers may not prevent the movement of small vectors such as fly larvae.) On the other hand, soils at the other end of the size range, such as silts or clays, are highly cohesive and have exceedingly small pores. In a saturated state, silts and clays have low permeabilities to both gas and water, and effectively prevent the movement of vectors. However, a clay soil is subject to shrinkage on drying, and a cover layer of clay may shrink and break open in cracks when it dries during summer months. Additionally, clay soils are very difficult to handle, place, and compact and do not furnish suitable traction for hauling and placement equipment. The establishment of a vegetative cover on a highly plastic clay soil would also be quite difficult. When all of the needs for cover soil are considered it appears that the best type of soil for cover purposes in a sanitary landfill is a well-graded type, a mixture of both fine and coarse constituents. The coarse constituents, such as sands and gravels, will lead to high strength and easier compaction in the finished product and the inclusion of the fines in the cover soil will produce a material which can be rendered impervious to the flow of water, the movement of gas, and the movement of vermin and disease vectors.

Investigations in connection with any proposed sanitary landfill should include a soil sampling program. Samples of the soil should be obtained from the existing surface and, if feasible, down to and including (by means of coring operations) underlying bedrock. An inventory of the particular soil types at the proposed site should then be made. In the inventory the characteristics of each of the particular soil layers which are present should be listed. Then, all possible uses of the available materials may be considered. For example, very plastic clay soil present at the site might be removed and stockpiled for use in a compacted barrier to prevent the movement of water or gas. Sandy and gravelly soils could be removed and stockpiled for use as subgrades in temporary road construction or, because they do not retain water and are therefore not subject to freezing problems, they could be stockpiled for use as cover material during winter operations. If the soils present at the site, taken individually, do not in themselves constitute good cover materials, it is possible that they might be blended in some way to produce a suitable cover material. It is often economical to transport cover material to a landfill site if the available materials are unsuitable. Since much of the operation of the landfill will consist of excavating, hauling, spreading, and compacting cover soil, ample consideration should be given to the workability and handling characteristics of the available soils. Generally, it is feasible to mix various types of coarse-grained soils such as sand and gravels, but practical mixing of fine-grained ones such as clays with coarser materials is not feasible because of the poor handling characteristics of the cohesive, sticky, fine-grained soils. Certain soils will have no use in a proposed landfill. For example, peats or highly organic materials have little value in a landfilling operation. The only possible use of a peat material would be as a very thin final cover layer to provide organic matter to enrich the upper layer of soil on which vegetation is to be established.

10-4.5 Summary on Site Selection

In summary, the factors to be considered in selecting a site for a proposed landfill include the location, economics, topography, climate, hydrology, geology, and the characteristics of the available soils which are present at the site. In essence, the site should be selected so that any contamination of the environment through waterborne pollutants or through the generation of effluent gases is eliminated.

ABOUT THE TEAM

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state, and regional agencies. Specialists on the team include geologists, biologists, foresters, climatologists, soil scientists, landscape architects, recreation specialists, engineers, and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC&D) Area - a 47 town area in western Connecticut.

As a public service activity, the team is available to serve towns and developers within the King's Mark Area --- free of charge.

PURPOSE OF THE TEAM

The Environmental Review Team is available to help towns and developers in the review of sites proposed for major land use activities. To date, the ERT has been involved in the review of a wide range of significant activities including subdivisions, sanitary landfills, commercial and industrical developments, and recreation/open space projects.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision-making. This is done through identifying the natural resource base of the project site and highlighting opportunities and limitations for the proposed land use.

REQUESTING A REVIEW

Environmental Reviews may be requested by the chief elected official of a municipality or the chairman of an administration agency such as planning and zoning, conservation, or inland wetlands. Requests for reviews should be directed to the Chairman of your local Soil and Water Conservation District. This request letter must include a summary of the proposed project, a location map of the project site, written permission from the landowner/developer allowing the team to enter the property for purposes of review, and a statement identifying the specific areas of concern the team should address. When this request is approved by the local Soil and Water Conservation District and the King's Mark RC&D Executive Committee, the team will undertake the review. At present, the ERT can undertake two reviews per month.

For additional information regarding the Environmental Review Team, please contact your local Soil Conservation District Office or Richard Lynn (868-7342), Environmental Review Team Coordinator, King's Mark RC&D Area, P.O. Box 30, Warren, Connecticut 06754.