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CANBERRA, A.C.T.

THE INFLUENCE OF GEOLOGY AND HYDROGEOLOGY ON LANDFILL DISPOSAL OF SOLID WASTE, AND ITS APPLICATION IN CANBERRA, A.C.T.

by

E. G. WILSON

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SUBMISSION TO THE PARLIAMENTARY JOINT COMMITTEE ON THE AUSTRALIAN CAPITAL TERRITORY

CONCERNING

THE INQUIRY INTO LONG-TERM COLLECTION AND DISPOSAL TECHNIQUES FOR CANBERRA CITY WASTE

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SUMMARY

In Canberra, solid waste is disposed of in open dumps and sanitary landfill sites. A major environmental problem resulting from such practice is the pollution of groundwater by leachate, and the monitoring of groundwater pollution is an essential part of landfill management that must be continued long after a site is closed. The selection of landfill sites depends on the physical constraints of geology and hydrogeology, but planners do not always sufficiently consider the physical constraints in the selection of landfill sites. The success of a landfill site depends mainly on site selection, and must be supported by good site management techniques and groundwater-pollution monitoring procedures. In many communities, public authorities maintain good land-fill practice by setting high standards for landfill operators, and by controlling the site through regulations and the supervision of monitoring procedures.

INTRODUCTION

This submission is concerned with those aspects of geology and hydrogeology that control the successful disposal of solid waste. The disposal of solid wastes can create health, aesthetic, and environmental problems, and only careful site selection, proper landfill operations, and regular groundwater-pollution monitoring procedures will ensure that the environmental demands are met.

The submission touches on the content of solid waste and the methods of disposal that are currently in use; the most serious environmental aspect of solid-waste disposal, which is groundwater pollution, will be discussed, and the requirements for site selection, management, and groundwater monitoring will be outlined. Reference to the controls through ordinances that are imposed on the operators of solid-waste disposal sites elsewhere will be cited.

TYPES OF SOLID WASTE

Urban society generates many types of solid waste. Table 1 lists the various categories and sources of refuse material. Wastes that pose special handling problems or are usually not a part of normal municipal solid-waste disposal programs are not included in Table 1; such wastes would include wastes from processing plants and industry; hazardous, pathological, and radioactive wastes from institutions and industry; solids and sludge from sewerage treatment works; and other special types of solid waste.

METHODS OF SOLID-WASTE DISPOSAL

The disposal of solid wastes is generally accomplished by one or more of six methods. All are currently in use in various parts of Australia, but the method adopted in any particular area usually depends on local conditions, and to some extent on public acceptance. The six methods are:

1. Open dumps
2. Sanitary landfill
3. Incineration
4. On-site disposal
5. Feeding of garbage to swine
6. Composting

TABLE 1 - Classification of refuse

(Adapted from American Public Works Association, 1966)

Kind of refuse	Composition	Source
Garbage	Wastes from preparation, cooking, and serving food; market wastes; wastes from handling, storage, and sale of produce	Households, restaurants, institutions, stores, and markets
Rubbish	Combustible: paper, cartons, boxes, barrels, wood, excelsior, tree branches, yard trimmings, wood furniture, bedding, and dunnage Noncombustible: metals, tin cans, metal furniture, dirt, glass, crockery, and minerals	
Ashes	Residue from fires used for cooking and heating and from on-site incineration	
Trash from streets	Sweepings, dirt, leaves, catch-basin dirt, and contents of litter receptacles	Streets, sidewalks, alleys, vacant lots
Dead animals	Cats, dogs, horses, and cows	
Abandoned vehicles	Unwanted cars and trucks left on public property	
Demolition	Lumber, pipes, brick, masonry, and other construction materials from razed buildings and other structures	Demolition sites to be used for new buildings, renewal projects, and expressways
Construction wastes	Scrap lumber, pipe, and other construction materials	New construction and remodelling

METHODS OF SOLID-WASTE DISPOSAL

Each of the methods has a special relation to the water resources of the area, but only the first two methods will be examined as they depend on geology and hydrogeology for their successful operation, and are the main methods in use in Canberra.

Open dumps

By far the oldest and most prevalent means of solid-waste disposal is in open dumps, which in Canberra were located wherever land could be obtained for this purpose. Practices at open dumps differ: in some dumps the refuse is periodically levelled and compacted, but in others the refuse is piled as high as equipment will permit, and at some sites the solid wastes are ignited and allowed to burn to reduce volume. In general, little effort is expended to prevent the nuisance and health hazards that frequently accompany open dumps. Open dumps have been used for solid-waste disposal in Canberra since its inception; however, they are being progressively replaced by sanitary landfill sites.

Sanitary landfill

Although the practice of burying garbage to provide landfill has been used for many years, the technique of sanitary landfill as we know it today did not come into common practice until the 1960s. Sanitary landfill consists of alternate layers of compacted refuse and soil. Each day the refuse is deposited, compacted, and covered with a layer of soil. Two types of sanitary landfill are common: area landfill, on essentially flat land sites; and depression landfill, in natural or man-made ravines, gullies, or pits. Depth of the landfill depends largely on local conditions, types of equipment, availability of land, and other factors, but it may range from about 2 m to as much as 30 m, as in the worked-out coal strip-mining areas of Pennsylvania, USA.

HYDROLOGIC IMPLICATIONS

Type of pollution

The type of pollution that may arise is directly related to the type of refuse and the manner of disposal. Leachates from open dumps and sanitary landfill usually contain both biological and chemical constituents. Organic matter, decomposing under aerobic conditions, produces carbon dioxide, which combines with the leaching water to form carbonic acid. This in turn, acts upon metals in the refuse and upon calcareous materials in the soil and rocks, resulting in increasing hardness of the water. Under anaerobic conditions, bacterial action decomposes organic refuse releasing ammonia,

which is ultimately oxidized to form nitrate. In both landfills and open dumps, where decomposition is accomplished by bacterial action, the leachate has a high biochemical oxygen demand (BOD).

Table 2 indicates the magnitude of the constituents leached from solid wastes under various conditions. These data were compiled by Hughes (1967) from several sources, and presented by Schneider (1970).

Hydrologic factors

Precipitation on the refuse-disposal site will either infiltrate the refuse or run off as overland flow. In open dumps, there is little likelihood of runoff unless the refuse is highly compacted; in sanitary landfills, the rate of infiltration is governed by the permeability and infiltration capacity of soil used as cover for the refuse. A part of the water entering the refuse percolates downward to the soil below and eventually to the water-table; during the percolation process the water leaches both organic and inorganic constituents from the refuse. Upon reaching the water-table, the leachate moves as a part of the groundwater; it may move laterally to a point of discharge at the land surface, or remain as a polluted plume of water slowly moving within the aquifer.

Well documented cases of pollution caused by leachates from solid-waste disposal sites are to be found in the literature (California Water Pollution Control Board, 1961). The long-term character of the pollution is well proved by the numerous plumes of contaminated water currently being monitored; in some cases the plumes originated from refuse dumps and landfill sites that had been closed for over 15 years.

Groundwater in the Canberra area is held mainly in fractured rock aquifers or in overlying weathered rock or soil; some is held in transported sediments, e.g., river alluvium. Most groundwater eventually discharges as springs and seepages into streams that feed the Murrumbidgee River; although groundwater does not constitute a major source of water, it is a supplementary resource that should not be needlessly polluted. The pollution of groundwater by the disposal of solid waste as landfill could present a problem to health in groundwater discharge areas such as surface seepages and springs. As the leakage of groundwater from underlying aquifers is common in Canberra, both the isolation of solid waste from groundwater and the retention of leachate are of major importance at sanitary landfill sites in Canberra.

The time to control pollution from a landfill site is at the time of site selection, and the following practices should be accepted in order to minimize groundwater pollution, and to assess its long-term effects:

TABLE 2 - Percentages of materials leached from refuse and ash, based on weight of refuse as received (Adapted from Hughes, 1967)

Material leached		Percentage leached under given conditions*					
		1	2	3	4	5	6
Permanganate value	30 min	0.039					
Do.	4 hr	0.060	0.037				
Chloride		0.105	0.127		0.11	0.037	
Ammonia nitrogen		0.055	0.037		0.036		
Biochemical oxygen demand		0.515	0.249		1.27		
Organic carbon		0.285	0.163				
Sulphate		0.130	0.084		0.011	0.22	0.30
Sulphide		0.011					
Albuminous nitrogen		0.005					
Alkalinity (as $CaCO_3$)					0.39	0.042	
Calcium					0.08	0.021	2.57
Magnesium					0.015	0.014	0.24
Sodium				0.260	0.075	0.078	0.29
Potassium				0.135	0.09	0.049	0.38
Total Iron					0.01		
Inorganic phosphate					0.0007		
Nitrate						0.0025	
Organic nitrogen		0.0075	0.0072		0.016		

* Conditions of leaching:

1. Analyses of leachate from domestic refuse deposited in standing water.
2. Analyses of leachate from domestic refuse deposited in unsaturated environment and leached only by natural precipitation.
3. Material leached in laboratory before and after ignition.
4. Domestic refuse leached by water in a test bin.
5. Leaching of incinerator ash in a test bin by water.
6. Leaching of incinerator ash in a test bin by acid.

(a) Surface drainage should be provided to ensure that maximum runoff is diverted away from the area of fill, and to prevent surface erosion of the material overlying the refuse.

(b) The permeability of the material overlying the fill should be minimal.

(c) The proximity of the water-table to the base of the fill, and the hydrologic properties of the material beneath the fill, should be determined to assess the susceptibility of the groundwater to pollution.

(d) A study of the groundwater aquifers, including their points and distances of discharges, is required to assess the pollution effect of leachate from the refuse should it penetrate the aquifer.

SELECTION OF A SANITARY LANDFILL SITE

The selection of a sanitary landfill site is concerned with the physical constraints of a site that are imposed by geology and hydrogeology. It is also concerned with the constraints imposed by the value judgement of the planning team concerned with the economics of urban development. Sometimes the constraints originating from the planning team are accepted before the physical constraints are considered; for example, a request for the selection of landfill sites may be accompanied by a map showing all the areas pre-empted for other purposes; sometimes the areas left are completely unsuited for landfill sites. The physical constraints on the selection of landfill sites can be quite restrictive in Canberra; it is essential that they are considered at the same time as the planning team engages in its development studies, and that the selection of landfill sites does not become an afterthought to urban planning.

Good accepted practice is to consider a disposal site favourably if the refuse will remain dry or unsaturated, thus reducing the rate of production of contaminants and preventing their mobilization. Two types of site fall into this class: sites where disposal is below the ground surface but above the zone of saturation; and sites where refuse is placed on the ground surface and covered and graded to prevent the entry of water.

Physical constraints

The physical constraints at a site concern the geology relative to the permeability and ease of excavation of the earth and rock, and the hydrogeology, geomorphology, and general geology of the surrounding area.

A site should comprise earth and rock materials that can be excavated by mechanical means to depths of 10 m or more, and that have a permeability suitable for use as soil cover for solid waste in the daily operation of the site. To fulfil the basic conditions set out above (see under 'Hydrologic factors') for the minimization of groundwater pollution, refuse disposal sites should be located on flat deeply weathered upland areas and interfluves; on ridges at the heads of draws, gullies, or ravines; and in dry open-pit mines or quarries. These sites are likely to have minimum damage from surface runoff, and to be well above the water-table. Undesirable sites consist of depressions where water accumulates; low or middle reaches of gullies, draws, or small valleys; stream floodplains and the upper portions of alluvial fans where some permeable sediments are to be expected. Table 3 sets out in tabular form the suitability of geological materials in Canberra for landfill purposes.

Operation of the site

The management of a site should be subjected to good engineering practice, and will require:

(a) a constant check on the suitability of earth for use as cover in the daily operation of placing and compaction of landfill

(b) a regular check on the need for a basal seal before placing any refuse in a new part of the site;

(c) the maintenance of surfaces to prevent erosion and water infiltration

and

(d) the drilling of boreholes for use as groundwater sampling and water-level measuring points.

(e) The regular monitoring and periodic sampling of water in observation boreholes; chemical and biological analyses of samples, and interpretation of results.

MONITORING OF POLLUTION DERIVED FROM LANDFILL SITES

No landfill site, past or present, should be accepted as environmentally satisfactory and free from groundwater pollution without the support of data derived from a groundwater monitoring program. The monitoring should commence by drilling bores that can be used for making water-level measurements, and taking groundwater samples; this should be carried out well before any solid waste is deposited at the site. Monitoring

TABLE 3

SUITABILITY OF GEOLOGICAL MATERIALS IN CANBERRA FOR LANDFILL

Geological materials & approx.thickness	Ease of excavation	Permeability of in situ material	Suitability of material for refuse cover	Position of highest water-table (above or below base of excavation)	Permeability of material at base of excavation. Is a seal required?	Type of underlying aquifer
Outwash fan deposits, up to 15 m (includes thick yellow podzolic soils)	Readily excavated by mechanical means	Variable,but mainly low; some sandy beds quite permeable.	Permeability varies, but low permeability dominant; suitable	Generally above base but close to base of excavation	Variable permeability; may require a seal	Fractured rock; all types found in the area; aquifer may be confined and under pressure; minor water supply
Deeply weathered volcanics to 20 m	Readily excavated by mechanical means	Generally low	Permeability varies, but low permeability dominant; suitable	Generally below base of excavation,about 3 m	Generally low permeability; seal not usually required	Fractured volcanic rock; may be minor water supply
Deeply weathered sediments to 15 m	Readily excavated by mechanical means	Generally low	Permeability low in fine-grained sediments such as shales and mudstone; suitable	High annual fluctuation in low-permeability sediments; position of water-table variable	Generally low permeability; seal not required	Fractured sedimentary rock of low permeability; minor supply in sandstone
Alluvium generally less than 6 m	Readily excavated by mechanical means	Variable from high to low	Permeability variable from low to very high: silty fraction may be suitable	Generally at or near base of alluvium	Permeability at base of excavation probably high; seal generally essential	Alluvial and or fractured rock; may be minor supply
Wind-blown sands, rarely thicker than 3 m	Readily excavated by mechanical means	Very permeable to low	Permeability variable from low to medium clayey 'B' horizon; suitable	Well below base of excavation, but some perched sections	Medium permeability; seal at base is preferred	Fractured rock; all types

of water-levels and of the quality of the groundwater should be continued throughout the working life of the landfill site, and for many years after it has ceased to operate; the results should be expertly evaluated. These procedures will ensure that the extent and nature of any groundwater pollution is well documented and the implications understood.

CONTROL OF LANDFILL OPERATIONS

Landfill operations should be subjected to regular inspection and reviewed during their development and working life. In many parts of the world, sanitary landfill sites must conform to rigid specifications of site selection, landfill management, and groundwater monitoring; control is usually exercised by a public authority which requires that the site application includes all the data pertaining to the site, the method and detail of landfill operation, and the pollution monitoring procedure for groundwater (Pennsylvania Department of Health, 1970). The site application forms required for 'Solid Waste Disposal and/or Processing' by the Department of Environmental Resources, Commonwealth of Pennsylvania, are attached to this paper as Appendix 1, and provide an example of good practice appropriate to an inland area.

CONCLUSIONS

The selection of solid-waste disposal sites, and their management and pollution-monitoring procedures, are primarily concerned with the geology and hydrogeology of the site and its surroundings.

The pollution of groundwater by leachate is one of the main environmental problems of the disposal of solid waste in a landfill.

Disused landfill sites retain a potential for groundwater pollution that must be monitored so that the long-term environmental impact can be assessed.

The authorization and control of landfill sites by a public authority has been adopted in many parts of the world as a means of ensuring sound sanitary landfill practice.

REFERENCES

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SCHNEIDER, W.J., 1970 - Hydrologic implications of solid-waste disposal, Water in the urban environment. US GEOL. Surv. Circ. 601-F.

A P P E N D I X I

Commonwealth of Pennsylvania
Department of Environmental Resources

SOLID WASTE DISPOSAL AND/OR PROCESSING SITE APPLICATION MODULE

H712.122 REV. 1-71

DATE PREPARED

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
COMMUNITY ENVIRONMENTAL SERVICES

SOLID WASTE DISPOSAL AND/OR PROCESSING
SITE APPLICATION MODULE
PHASE I

For Department of Health Use Only

PREPARED BY (Name & Address)

PART I – LAND DISPOSAL FACILITY

A. SITE IDENTIFICATION

1. NAME OF SITE _____

2. ADDRESS OF SITE _____

3. SITE ACQUISITION (Check Appropriate Block)

☐ PRESENTLY OWNED ☐ WILL LEASE FOR _____ YEARS
☐ WILL PURCHASE ☐ WILL RENT

4. OWNER OF RECORD (Name & Address) _____

B. FACILITY INFORMATION

1. IS THIS AN EXISTING FACILITY? ☐ Yes ☐ No

2. IS THIS A PROPOSED FACILITY? ☐ Yes ☐ No

PART II – GOVERNMENTAL APPROVAL

A. SITE APPROVAL FROM COUNTY AND MUNICIPALITY

1. IF THE SITE WILL BE IN A MINE, HAS THE PROPOSED SITE BEEN APPROVED BY THE COUNTY IN WHICH THE SITE IS LOCATED? ☐ Yes ☐ No

2. HAS THE PROPOSED SITE BEEN APPROVED BY THE MUNICIPALITY IN WHICH IT WILL BE LOCATED? ☐ Yes ☐ No

B. REQUIREMENTS

1. ARE THERE ANY CERTIFICATES, PERMITS, OPERATION REQUIREMENTS, OR LICENSES REQUIRED BY ANY OF THE FOLLOWING:

A. MUNICIPALITY? (If Yes, Describe) _____ ☐ Yes ☐ No

B. PLANNING COMMISSION? (If Yes, Describe) _____ ☐ Yes ☐ No

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B. REQUIREMENTS – CONTINUED

C. COUNTY? (If Yes, Describe) _____ ☐ Yes ☐ No

D. STATE DEPARTMENT OF MINES AND MINERALS? (If Yes, Describe) _____ ☐ Yes ☐ No

E. OTHER? (If Yes, Describe) _____ ☐ Yes ☐ No

C. ZONING

1. CLASSIFICATION OF SITE _____

2. ENFORCEMENT AGENCY _____

3. WILL ZONING OF SITE PERMIT SANITARY LANDFILL? ☐ Yes ☐ No

4. RESTRICTIONS (If Any) _____

5. ADJACENT PROPERTIES WITHIN A QUARTER-MILE (Check Appropriate Blocks Which Indicate The Use Of Adjacent Properties Surrounding The Site)

	North	East	South	West
A. RESIDENTIAL	☐	☐	☐	☐
B. COMMERCIAL	☐	☐	☐	☐
C. LIGHT INDUSTRIAL	☐	☐	☐	☐
D. HEAVY INDUSTRIAL	☐	☐	☐	☐
E. AGRICULTURAL	☐	☐	☐	☐
F. MIXED	☐	☐	☐	☐
G. NONE	☐	☐	☐	☐

PART III – SOIL AND GEOLOGICAL CHARACTERISTICS

A. LOCATION – A COPY OF THE USGS TOPOGRAPHIC MAP MUST BE ATTACHED TO EACH COPY OF THE APPLICATION; USE 7.5 MINUTE QUADRANGLE MAP, IF PUBLISHED.

1. SITE LOCATION (Include The Name Of The USGS Topographic Map, Indication Of 7.5 Or 15.0 Minute Quadrangles, Year of Publication, Inches North And West Of Southeast Corner, And Latitude And Longitude).

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A. LOCATION – CONTINUED

A. _____ INCHES NORTH, _____ INCHES WEST OF SOUTHEAST CORNER OF ☐ 7.5' ☐ 15.0'

QUADRANGLE MAP, (Date) _____

B. _____ DEG, _____ MIN, _____ SEC N LATITUDE

C. _____ DEG, _____ MIN, _____ SEC W LONGITUDE

2. TOPOGRAPHIC SETTING (Hillside, Flood Plain, Strip Mine, Quarry, Field, Etc.) _____

3. PLOT ON TOPOGRAPHIC MAP THE FOLLOWING:

A. LOCATION AND EXTENT OF PROPOSED LANDFILL _____

B. LOCATION OF: (Place the following information on the Topographic Map if it is within the site or within a quarter-mile of the outer perimeter of the site. Check each item placed on map with an (•) or appropriate symbol below.)

(1) WELLS _____

(2) SPRINGS _____

(3) SWAMPS _____

(4) STREAMS _____

(5) PUBLIC WATER SUPPLIES _____

(6) OTHER BODIES OF WATER _____

(7) UNDERGROUND AND SURFACE MINES _____

(8) MINING SPOIL PILES _____

(9) MINE POOL DISCHARGE POINTS (Even if a discharge point is farther than a quarter-mile from the site) _____

(10) ELEVATION OF MINE POOLS _____

(11) GAS AND OIL WELLS _____

(12) AREAL EXTENT OF MINE POOLS _____

B. SOILS

1. LIST ALL SOIL SERIES AND PHASES WITHIN THE SITE:

A. _____

B. _____

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B. SOILS – CONTINUED

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

K. _____

2. LIST ALL SOIL SERIES AND PHASES TO BE USED AS COVER MATERIAL:

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

H. _____

I. _____

J. _____

K. _____

3. A COPY OF SOIL MAP OR REFERENCES TO SITE LOCATION ON PUBLISHED SOIL SURVEY MUST BE INCLUDED.

C. GROUND WATER GEOLOGY

1. GLACIAL GEOLOGY

A. TYPE OF DEPOSIT(S) _____

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C. GROUND WATER GEOLOGY – CONTINUED

B. TEXTURE OF DEPOSIT(S) _____

C. THICKNESS OF DEPOSIT(S) _____

2. BEDROCK

A. TYPE(S) _____

B. DEPTH TO _____

C. EXTENT OF WEATHERING _____

D. NAME AND AGE OF FORMATION(S) _____

3. STRUCTURE

A. BASIC DESCRIPTION OF STRUCTURE _____

_____

_____

B. STRIKE AND DIP OF BEDS _____

C. DIRECTION OF PLUNGE _____

D. FRACTURES (Strike and Dip, Type, Spacing)

	Strike And Dip	Type	Spacing (State Inches or Feet)	Indicate If Open or Closed
(1) JOINTS				
(2) CLEAVAGE				
(3) FAULTS				

E. FOLDS (MINOR FOLDING)

(1) TYPE: ANTICLINE _____ SYNCLINE _____

(2) STRIKE AND PLUNGE OF FOLD AXIS _____

4. GROUND WATER

A. DEPTH TO GROUND WATER _____

(1) HOW DETERMINED _____

(2) SEASONAL VARIATION _____

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C. GROUND WATER GEOLOGY – CONTINUED

(3) IF DEPTH TO GROUND WATER CANNOT BE DETERMINED, IT IS RECOMMENDED THAT ONE BORING OR WELL NEAR THE HIGHEST ELEVATION OF THE PROPOSED SITE BE DRILLED TO A DEPTH OF 10 FEET INTO THE GROUND WATER OR 10 FEET INTO BEDROCK, WHICHEVER IS DEEPEST (Maximum Depth – 150 Feet).

(A) LOCATE THE WELL OR BORING ON ACCOMPANYING TOPOGRAPHIC MAP. _____

(B) PROVIDE A COMPLETE LOG (Description of Well) _____

_____

(C) INDICATE THE METHOD OF DRILLING _____

B. DIRECTION(S) OF GROUND WATER MOVEMENT _____
(If more than one direction of ground water flow, indicate those directions also.)

C. DISCHARGE OF GROUND WATER (Must be indicated on USGS Topographic Map). _____

(1) DISTANCE AND DIRECTION TO DISCHARGE POINT(S) _____

(2) NAME(S) OF DISCHARGE POINT(S) _____
(Springs, Streams, Etc.)

(3) AREA TRIBUTARY TO DISCHARGE POINT(S) _____

D. HOW WAS INFORMATION DETERMINED? _____

_____

_____

_____

_____

5. SURFACE WATER

A. FLOODING HAZARD FREQUENCY IS _____ TIMES IN _____ YEARS.

B. WILL THERE BE A DISCHARGE OF LEACHATE TO SURFACE WATERS? ☐ Yes ☐ No

C. WILL LEACHATE COLLECTION AND TREATMENT FACILITIES BE CONSTRUCTED? ☐ Yes ☐ No

(1) IF YES, HAVE YOU APPLIED FOR A SANITARY WATER BOARD PERMIT FOR COLLECTION, TREATMENT, AND DISCHARGE OF THE LEACHATE? ☐ Yes ☐ No

6. SUBSURFACE INFORMATION (Detailed information is needed on subsurface conditions for a proper analysis of the site. This information on soils, geology and ground water may be determined from deep cuts, borings, and wells; backhoe pits and natural outcrops; or artificial cuts.)

A. ARE THERE NATURAL OUTCROPS OR ARTIFICIAL CUTS IN THE VICINITY OF THE SITE? ☐ Yes ☐ No
(Road cuts, railroad cuts, strip mines, quarries, etc.)

(1) DEPTH OF CUT OR THICKNESS OF OUTCROP _____

(2) LOCATION OF CUT OR OUTCROP (Show on Topographic Map) _____

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
COMMUNITY ENVIRONMENTAL SERVICES

SOLID WASTE DISPOSAL AND/OR PROCESSING
SITE APPLICATION MODULE
PHASE I

For Department of Health Use Only

C. GROUND WATER GEOLOGY – CONTINUED

(3) REASON FOR OPENING CUT _____

(4) DETAILED DESCRIPTION OF CUT OR OUTCROP _____

B. COMPLETE WHERE INSUFFICIENT INFORMATION IS AVAILABLE TO COMPLETE 6A ABOVE.

HAVE BORINGS OR CUTS BEEN MADE FOR SITE EVALUATION? ☐ Yes ☐ No
(An adequate number of borings or cuts should be made to a depth of 5 feet into the ground water or to bedrock or to 20 feet below the proposed or existing base of the landfill.)

(1) LOCATE THE CUT(S) OR BORING(S) ON THE ACCOMPANYING TOPOGRAPHIC MAP. _____

(2) PROVIDE THE COMPLETE LOG(S) (DESCRIPTION) OF THE CUT(S) OR BORING(S). _____

(3) INDICATE THE METHOD OF DRILLING OR MAKING CUTS _____

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SOLID WASTE DISPOSAL AND/OR PROCESSING SITE APPLICATION MODULE PHASE II

For Department of Health Use Only

PART I – SOLID WASTE CHARACTERISTICS

SOURCE, TYPE, AND VOLUME OF WASTES (CHECK THE SOURCE AREA, GIVE A BRIEF DESCRIPTION OF THE TYPE OF PRESENT WASTE AND 10-YEAR PROJECTED VOLUME – IF THE PROPOSED LIFE OF THE LANDFILL IS LESS THAN 10 YEARS, WHAT IS THE PROJECTED VOLUME OF WASTE IN THE FINAL YEAR OF LANDFILL OPERATION? SUBMIT CHEMICAL ANALYSES OF HAZARDOUS WASTES WHICH ARE PROPOSED TO BE ACCEPTED OR ARE BEING ACCEPTED BY THE LANDFILL.)

A. SOURCE	TYPE (Description)	PRESENT VOL. – TONS	PROJECTED VOL. (10 YRS) – TONS
1. RESIDENTIAL			
2. COMMERCIAL			
3. INDUSTRIAL			
4. AGRICULTURAL			
5. OTHER (EXPLAIN)			

ADDITIONAL COMMENTS ON SOURCE, TYPE, AND VOLUME OF WASTE _____

B. DAILY WASTE QUANTITIES (INDICATE AMOUNT OF WASTE THE LANDFILL WILL ACCEPT EACH DAY, STATED IN VOLUME OR WEIGHT.)

	VOLUME	WEIGHT
1. ESTIMATED PER CAPITA DAILY WASTE QUANTITIES		
2. MAXIMUM DAILY VOLUME OR WEIGHT		
3. MINIMUM DAILY VOLUME OR WEIGHT		
4. AVERAGE DAILY VOLUME OR WEIGHT		
5. RATIO (MAX. OVER MIN.)		

PART II – LANDFILL DESIGN AND OPERATION

A. DETAILED PLANS AND MAPS OF LANDFILL

SUBMIT ONE COPY OF EACH SET OF PLANS AND MAPS WITH EACH MODULE. THE FRONT COVER OR FLYLEAF OF EACH SET OF DRAWINGS AND SPECIFICATIONS MUST BEAR THE SIGNATURE AND SEAL OF THE REGISTERED PROFESSIONAL ENGINEER. EACH DRAWING MUST BEAR AN IMPRINT OR REASONABLE FACSIMILE OF SUCH SEAL.

1. PROPERTY LINE MAP

A. ONE MAP SHOULD INDICATE PROPERTY LINES OF SITE, USE OF ADJACENT PROPERTIES, AND SHOULD SHOW ALL RIGHT-OF-WAYS (FUEL AND POWER LINES, ROADS, ETC.)

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A. DETAILED PLANS AND MAPS OF LANDFILL – CONTINUED

(1) IF RIGHT-OF-WAYS EXIST, NAME OF OWNER/COMPANY _____

(2) DOES OWNER OR OPERATOR OWN MINERAL RIGHTS? ☐ Yes ☐ No

(3) IF NOT, NAME AND ADDRESS OF OWNER OF MINERAL RIGHTS _____

_____

_____

2. DETAILED TOPOGRAPHIC MAP(S) OF SITE SHOULD INCLUDE THE FOLLOWING:
(MORE THAN ONE MAP MAY BE USED TO SHOW THE REQUIRED INFORMATION LISTED BELOW)

A. SCALE (1:200' OR LARGER, MEANING RATIO LARGER THAN .005) _____

B. 5' CONTOUR INTERVAL _____

C. LOCATION OF ACCESS ROADS AND ROADS ON LANDFILL _____

D. LOCATION OF FENCING _____

E. LOCATION OF WEIGHING FACILITIES _____

F. LOCATION OF EXISTING AND PROPOSED UTILITIES
(IF EXISTING FACILITIES ARE LOCATED FARTHER THAN A QUARTER-MILE FROM THE SITE, THEY MAY BE SHOWN ON PROPERTY LINE MAP.) _____

G. LOCATION OF HIGH-TENSION POWER LINE RIGHT-OF-WAYS _____

H. LOCATION OF DISCHARGE POINT OF GROUND WATER _____

I. LOCATION OF AND IDENTITY OF MONITORING WELLS, SPRINGS, AND WELLS DRILLED AT HIGHEST ELEVATION _____

J. DIRECTION OF GROUND WATER FLOW (IF MORE THAN ONE DIRECTION OF GROUND WATER FLOW, INDICATE OTHER DIRECTIONS ALSO.) _____

K. LOCATION OF: (PLACE THE FOLLOWING INFORMATION ON THE DETAILED TOPOGRAPHIC MAP IF IT IS WITHIN THE SITE OR WITHIN A QUARTER-MILE OF THE OUTER PERIMETER OF THE SITE: CHECK EACH ITEM BELOW AS IT IS PLACED ON THE MAP.)

☐ WELLS	☐ SOIL STOCKPILE	☐ POWER LINE RIGHT-OF-WAYS
☐ SPRINGS	☐ FIRE HYDRANTS	☐ FUEL LINE RIGHT-OF-WAYS
☐ SWAMPS	☐ OTHER BODIES OF WATER	☐ LIFTS
☐ STREAMS	☐ UNDERGROUND & SURFACE MINES	☐ WATER TOWERS
☐ PUBLIC WATER SUPPLIES	☐ MINING SPOIL PILES	☐ DIVERSION DITCHES
☐ FIRE PONDS	☐ GAS & OIL WELLS	

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A. DETAILED PLANS AND MAPS OF LANDFILL - CONTINUED

3. LIFT DESIGN (CHECK EACH ITEM AS IT IS INCLUDED ON THE DETAILED PLANS.)

   A. TOTAL THICKNESS OF EACH LIFT _____

   B. WORKING GRADE OF EACH LIFT _____

   C. SLOPE AND WIDTH OF WORKING FACE _____

   D. APPROXIMATE TIME INTERVAL BETWEEN LIFTS _____

   E. SEQUENCE OF LIFTS AND COVER MATERIAL USAGE IN FILL AREA _____

   F. FINAL SLOPE SEQUENCE _____

   G. COVER SUPPLY SOURCES _____

   H. DRAINAGE DEVICES _____

4. PLANS FOR FINISHED SITE (CHECK EACH ITEM INCLUDED)

   A. SHOW IN GENERAL: SLOPE AND CONTOURS _____
   OTHER (EXPLAIN ON LIST) _____

5. ONE BORING OR WELL IS REQUIRED NEAR THE HIGHEST ELEVATION OF THE PROPOSED SITE. IT MUST BE TO A DEPTH OF 10 FEET INTO THE GROUND WATER OR 20 FEET INTO THE BEDROCK, WHICHEVER IS DEEPER. (MAXIMUM DEPTH – 100 FEET). IF GROUND WATER IS ENCOUNTERED, SUBMIT CHEMICAL ANALYSES OF GROUND WATER. (CHECK EACH ITEM AS COMPLETED.)

   A. PROVIDE A COMPLETE LOG (DESCRIPTION) OF WELL _____

   B. INDICATE METHOD OF DRILLING _____

6. LEACHATE COLLECTION AND TREATMENT PROPOSAL

   A. LOCATION OF TREATMENT FACILITIES _____

   B. CROSS-SECTIONS OF TREATMENT LAGOONS AND PROPOSED COLLECTION FACILITIES _____

   C. LOCATION OF DISCHARGE POINTS OF TREATED LEACHATE _____

7. LOCATION OF PROPOSED GROUND WATER MONITORING POINTS MUST BE SHOWN ON DETAILED TOPOGRAPHIC MAP.

   A. HAVE PROPOSED GROUND WATER MONITORING POINTS BEEN SUBMITTED? ☐ Yes ☐ No

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MONITORING WELL(S) OR SPRING(S) SITES ARE: ☐ APPROVED ☐ DISAPPROVED

COMMENTS _____

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B. GENERAL PLAN OF OPERATION (DESCRIBE; CHECK AS COMPLETED)

1. PROPOSED LANDFILL METHOD	_____	10. EROSION CONTROL	_____
2. SCHEDULE OF FILLING	_____	11. TRAFFIC CONTROL	_____
3. SITE PREPARATION	_____	12. FINAL COVER	_____
4. DESIGNATION OF UNLOADING AREA	_____	13. FINAL SLOPES	_____
5. SIZE OF WORKING FACE	_____	14. PROPOSED REVEGETATION PROCEDURE	_____
6. CELL CONSTRUCTION	_____	15. COMPLETED SITE MAINTENANCE PROVISIONS	_____
7. COMPACTION & COVERING PRACTICE	_____	16. OTHER (SPECIFY)_____	_____
8. PROVISIONS FOR BLOWING LITTER CONTROL	_____	_____	_____
9. MANAGEMENT OF SURFACE WATER	_____	_____	_____

PART III – LANDFILL OPERATIONAL SUPPORT

A. EQUIPMENT

1. LIST TYPE, MODEL NUMBER; GIVE A BRIEF DESCRIPTION OF EQUIPMENT USED IN LANDFILL OPERATION.

_____
_____
_____
_____
_____
_____
_____
_____

B. ACCESS ROADS, BRIDGES, OR TUNNELS – ROADS (ALL-WEATHER ACCESS ROADS NEGOTIABLE BY LOADED COLLECTION VEHICLES SHALL BE PROVIDED TO THE ENTRANCE OF THE SITE OR FACILITY WHERE A PUBLIC ROAD DOES NOT EXIST. THE MINIMUM CARTWAY WIDTH FOR THE TWO-WAY TRAFFIC SHALL BE TWENTY-TWO (22) FEET, OR FOR ONE-WAY TRAFFIC (SEPARATE ROADS) A MINIMUM CARTWAY WIDTH OF TWELVE (12) FEET.)

1. PROVIDE THE FOLLOWING INFORMATION FOR PUBLIC ROADS LEADING TO THE DISPOSAL SITE:

ROUTE NUMBER	LOAD LIMIT (TONS)	TYPE (INSERT NUMBER) *
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

* ROAD TYPES

(1) CONCRETE
(2) ASPHALT
(3) GRAVEL
(4) OTHER (Specify)

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B. ACCESS ROADS, BRIDGES, OR TUNNELS – CONTINUED

2. PROVIDE THE FOLLOWING INFORMATION FOR ROADS ON THE LANDFILL:

WIDTH	LENGTH	TYPE (INSERT NUMBER) *

*ROAD TYPES

(1) CONCRETE
(2) ASPHALT
(3) GRAVEL
(4) DIRT
(5) OTHER (Specify)

3. BRIDGES (LIST LOCATION, HEIGHT & WEIGHT RESTRICTIONS – INCLUDE ONLY BRIDGES IN THE AREA LEADING TO THE LANDFILL.)

LOCATION	HEIGHT RESTRICTIONS	WEIGHT RESTRICTIONS

4. TUNNELS (LOCATION, HEIGHT RESTRICTIONS)

TUNNEL	LOCATION	HEIGHT RESTRICTIONS

C. FIRE PROTECTION

1. FIRE DEPARTMENT

A. NAME _____

B. ADDRESS _____

C. DISTANCE FROM SITE _____

2. POND

A. LOCATION _____

B. VOLUME OF WATER _____

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C. FIRE PROTECTION – CONTINUED

3. SOIL STOCKPILE

A. LOCATION _____

B. VOLUME OF SOIL _____

4. WATER UNDER PRESSURE

A. LOCATION _____

B. VOLUME OF WATER _____

C. WATER PRESSURE _____

D. CONTROL PROGRAM (BRIEFLY DESCRIBE PROGRAM; BE SPECIFIC IF CHEMICALS OR PESTICIDES ARE TO BE USED.)

1. RODENT CONTROL _____

2. FLY CONTROL _____

3. BIRD CONTROL _____

4. DUST CONTROL _____

5. ODOR CONTROL _____

6. OTHER (EXPLAIN) _____

E. PUBLIC UTILITIES

	YES OR NO ON SITE	YES OR NO OFF SITE	DISTANCE FROM SITE TO UTILITY	DATE FACILITY WILL BE AVAILABLE ON THE SITE
1. WATER				
2. COMMUNICATIONS (DESCRIBE TYPE)				

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F. EMPLOYEE FACILITIES

	YES OR NO ON SITE	YES OR NO OFF SITE	DISTANCE TO	DATE AVAILABLE
1. SHELTER				
2. DRINKING WATER				
(DESCRIBE)				
3. TOILET FACILITIES				
4. LAVATORIES				
5. SHOWERS				

6. DESCRIBE SEWAGE SYSTEM (IF OTHER THAN PUBLIC SEWER) _____

G. WEIGHING AND MEASURING FACILITIES

1. SCALES

   A. DESCRIPTION _____

   B. LOCATION _____

2. OTHER (SPECIFY)

   A. TYPE _____

   B. DESCRIPTION _____

   C. LOCATION _____

H. ENGINEER

1. NAME _____
2. ADDRESS _____
3. REGISTRATION NUMBER _____
4. SIGNATURE _____
5. SEAL OF REGISTERED PROFESSIONAL ENGINEER

SEAL

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DEPARTMENT OF HEALTH
COMMUNITY AND ENVIRONMENTAL SERVICES

SOLID WASTE DISPOSAL AND/OR PROCESSING SITE APPLICATION MODULE

PHASE III

For Department of Health Use Only

PREPARED BY	SITE IDENTIFICATION

PART I – TO BE SUBMITTED ON COMPLETION OF GROUNDWATER MONITORING SYSTEM
(Monitoring well(s) or Spring(s))

A. FOR WELL(S) OR SPRING(S) APPROVED AS MONITORING SITES, Complete the following:

1. WELL(S)

Well Number	Type Of Well	Depth	Casing Diameter	Casing Depth	Depth To And Size Of Casing Perforations	Type Of Grouting	Elevation	Depth To Groundwater

2. SPRING(S)

Spring Number	Elevation	Rate Of Flow (GPM)

3. OTHER(S)

Location Number	Describe Or Explain	List Pertinent Information (Flow, Depth To Groundwater, Elevations, Etc.)

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B. MONITORING POINT LOCATIONS

Monitoring Point Number	Name Of Topographic Map	MEASURED FROM SOUTHEAST CORNER		Latitude	Longitude
		Inches North	Inches West		

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C. WATER QUALITY – WELL(S), SPRING(S), AND OTHER(S)

1. CHEMICAL ANALYSES

								Monitoring Point Number
								Well Number
								Spring Number
								Other Number
								Temperature (Degrees F.)
								pH
								Alkalinity (MG/L)
								Total Iron (MG/L)
								Manganese (MG/L)
								Aluminum (MG/L)
								Sulfates (MG/L)
								Chlorides (MG/L)
								Fluorides (MG/L)
								Phosphates (MG/L)
								Albuminoid Nitrogen (MG/L)
								Ammonia Nitrogen (MG/L)
								Nitrite–Nitrogen (MG/L)
								Nitrate-Nitrogen (MG/L)
								Total Dissolved Solids (MG/L)
								Suspended Solids (MG/L)
								Solid Solids (MG/L)
								ABS (MG/L)
								BOD (MG/L)
								COD (MG/L)
								Specific Conductance (Micromhos)

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C. WATER QUALITY – CONTINUED

2. NAME AND ADDRESS OF LAB PERFORMING CHEMICAL ANALYSES _____

D. WELL DATA

					Well Number
					Use of Water (Fire, Domestic, Sanitary Facilities, Etc.)
					Pump
					Type
					Rated Capacity
					Depth To Pump (Ft.)
					Depth To Bottom Of Suction Pipe (Ft.)
					Pump Test Data (12-Hour Pump Test At A Uniform Rate Is Required To Clean Well)
					Bailed or Pumped At (GPM-Uniform Rate)
					Static Water Level (Prior To Start Of Pumping) (Ft.)
					Pumping Water Level (Prior To Start Of Pumping) (Ft.)
					Drawdown ____ Feet After 12 Hours Of Pumping
					Specific Capacity (GPM/FT) Pumping Rate / Drawdown

SUBMIT DRILLER'S LOG OF WELLS.