Disposal Technologies for Hazardous and Toxic Waste

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CHAPTER 5

DISPOSAL TECHNOLOGIES

5-1. Definition. A disposal system is a properly engineered facility used for ultimate disposal of hazardous waste into or on land or water.

5-2. Applicability.

a. Disposal systems have general applicability to all types of waste streams. The different disposal techniques are collectively capable of handling wastes in solid, semisolid, and liquid forms. As many disposal systems have shown migration or dispersion of the contaminants to the surrounding environment, there is usually strong public resistance to siting a solid or hazardous waste disposal facility.

b. Disposal is often the method selected for final disposition of a waste material when available treatment or recovery options are not technically or economically feasible. For any disposal technique selected, care should be taken to ensure that the design, construction, and operation of a facility are based on sound engineering principles and are within regulatory guidelines.

5-3. Techniques. The specific disposal techniques addressed in this chapter include landfilling and deep well injection. Incineration, often considered as a disposal technique, is covered here as a treatment technology and has been discussed previously in Chapter 4. The following sections address the disposal of wastes in offsite and onsite landfills.

5-4. Regulatory Constraints.

a. Severe regulatory constraints are placed on the construction and operation of both landfills and deep well injection systems. Many of these regulatory requirements are subject to the interpretation of the Federal and state agencies having regulatory authority over the site or facility. Designers must coordinate with the appropriate agencies to ensure regulatory compliance at all steps of the process.

b. Of particular impact on the disposal of wastes are the “land ban” regulations promulgated under RCRA. These regulations effectively ban the landfilling of specific waste classifications without prior treatment in accordance with best demonstrated available technology (BDAT). With respect to the remediation of uncontrolled hazardous waste sites, the application of the land ban regulations is unclear, especially for soils and debris, and must be addressed on a site-specific basis with the appropriate regulatory authority.

Section I. Onsite Disposal

5-5. **General.** Onsite disposal incorporates the construction and subsequent operation of disposal facilities on or near the site being remediated. The primary advantage of onsite disposal is the reduction of the requirement for transporting the wastes, sometimes over long distances, to an offsite disposal facility. The primary disadvantages of onsite disposal are the commitment to the long-term operation and maintenance of such a facility and the potential loss of the land productive use.

5-6. **Landfills.**

a. Description of Technique.

(1) A landfill is defined as a disposal facility or part of a facility where hazardous waste in bulk or containerized form is placed in or on land, typically in excavated trenches or cells. Differentiating between landfills and surface impoundments may be difficult in certain cases; although surface impoundments are designed intentionally to hold liquid waste, landfills may also accept bulk liquids under certain conditions. Bulk or noncontainerized liquid waste or waste containing free liquids must not be placed in a landfill unless: (a) the landfill has a liner and a leachate collection and removal system that meet the requirements of 40 CFR 264.310(a), or (b) before disposal, the liquid waste is solidified.

(2) The primary restriction on landfilling of hazardous wastes is the elimination of liquid disposal. Bulk liquids or sludges with leachable liquids must not be landfilled at Department of the Army hazardous waste facilities; disposal of such wastes will be permitted only in surface impoundments. RCRA regulations permit disposal of liquids in small containers in an overpack drum (lab pack), provided that the latter contains sufficient absorbent material to absorb all of the liquid contents of the inside containers. The inside containers must be nonleaking and compatible with the contained waste. The overpack drum must be an open-head, DOT-specification metal shipping container of no more than 110-gallon capacity. Batteries, capacitors, or similar nonstorage containers which contain free liquids may be landfilled.

(3) Landfills should be sited in a hydrogeologic setting that provides maximum isolation of the waste from ground water. This is achieved by vertical separation of wastes from the uppermost ground water, and low permeability of the subsurface material providing the hydraulic separation. In addition, the landfill must be located above the 100-year flood level and not interfere with major surface drainage.

(a) Ideally, the soils in the area should be suitable for daily cover as well as final cover. In cold regions where frost penetration is significant (3 to 6 feet), the cover material should be stockpiled in as dry a condition as possible to facilitate wintertime operations.

(b) Location of landfills in karst terrain (or similar geologic formations) and in seismic zones 3 and 4 (as defined in Department of the Army, TM 4-809-10) should be avoided whenever possible. However, if landfills are sited in such areas, the following precautions should be taken:

- An extensive geological investigation must be performed to ensure that the facility is not located on or in the near vicinity of sink holes or caverns and that the soil and rock in the area are suitable for location of this type of facility.
- After the final site selection has been completed, HQUSACE will be notified of proposed location and geological conditions. This notification will be made a minimum of 30 days before design begins.

(4) Disposal by landfilling involves placement of wastes in a secure containment system that consists of double liners, a leak-detection system, a leachate-collection system, and a final cover. Wastes delivered to the landfill are unloaded by forklift or front-end loaders and placed in the active waste lift. Hazardous materials will be segregated in cells or subcells according to physical and chemical characteristics to prevent mixing of incompatible wastes. Following their placement, the hazardous wastes will be covered with sufficient soil to prevent wind dispersal. Successive lifts will be placed and the cover soil graded so that any direct precipitation is collected in a sump. All direct precipitation collected in the sump will be tested for contamination. As filling continues, wastes will be placed so as to direct any run-off toward a temporary sump at the lower segment of the base liner. For operations during extremely wet conditions, tarpaulins may be used to cover the active area to minimize infiltration of rainfall. In high rainfall regions, semipermanent roof/rainfall protection may be installed over the entire cell using either rigid or stress-tensioned structures. The structure should be designed to prevent all rainfall from entering the cell until final cover is completed; then it is dismantled and erected over the next cell. Another alternative to operations during extremely wet weather is to containerize or store wastes until the rainfall season is over. As areas of the secure landfill are filled to final grade, a final soil cover will be installed in accordance with the facility's operation plan. Figure 5-1 illustrates a cross section of a chemical waste landfill with a leachate collection system.

(5) The major design elements of hazardous wastes landfills are listed below:

(a) Double liners separated by a permeable layer such as sand.

(b) A leak detection system between the liners.

(c) A leachate collection and removal system above the top liner.

(d) Water run-on and run-off control systems.

(e) A final cover to minimize infiltration of precipitation into the closed landfill.

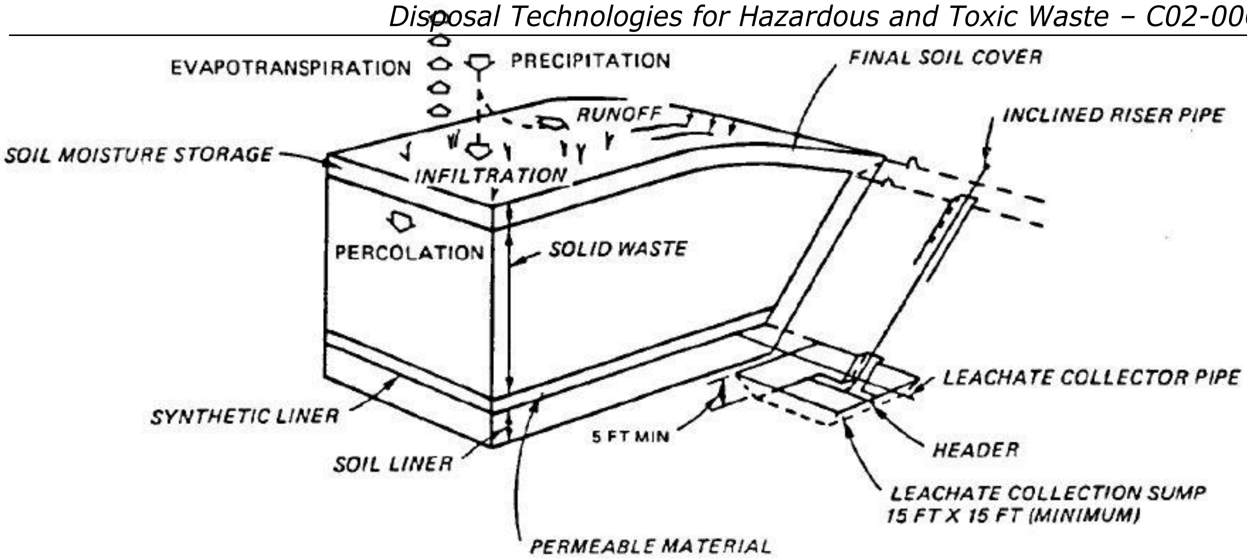

Figure 5-1. Cross Section of a Chemical Waste Landfill with Leachate Collection

(f) The base liner system is designed and constructed to prevent migration of wastes during the active life of the disposal unit into the liner, and out of the landfill into subsurface soil, ground water, or surface water. A leak detection system between the double liners enables the detection and removal of any seepage, and evaluation of liner performance. Located above the double liners is the leachate collection and removal system, which consists of slotted drainage pipes designed to collect leachate that flows under the influence of gravity to low points within the landfill. The leachate collection and removal system must be designed and operated to ensure that the depth of leachate over the liner does not exceed one foot.

(6) Closure of a landfill is achieved by installing a final cover which has a permeability less than or equal to that of the bottom liner. The cover should be capable of minimizing infiltration of liquids, functioning with minimum maintenance, promoting drainage and minimizing erosion of cover, and accommodating settling and subsidence.

(7) Secure landfills require equipment for handling wastes and cover material, performing support functions, spill and fire control, and decontamination. For waste handling, a forklift and a front-end loader are typically used to unload and place containers and solid materials in assigned active waste lifts. Dozers and self-loading scrapers are used to spread and compact cover material. For grading final surfaces, the crawler dozer is effective; it can economically doze earth over distances up to 300 feet. Scrapers can haul cover material economically over relatively long distances (more than 305 m (1,000 feet)). Since construction equipment is heavy when loaded, precautions must be taken in placing initial lifts of wastes over the base liner. Subsequent lifts of bulk wastes and soil cover should be consolidated by compactors to minimize settlement.

(a) Support equipment for a secure landfill may include a road grader, water truck, pickup trucks, and vacuum trucks. The road grader can be used to maintain dirt and gravel roads on the site, to grade the soil cover, and to maintain any unlined drainage channels surrounding the fill. Water trucks range from converted tank trucks to highly specialized, heavy vehicles that are generally used in road construction operations. They are used at the landfill for construction, to control dust, and if necessary, fight fires.

(b) In accordance with 40 CFR 264.32, all facilities must be equipped with communication or alarm systems, fire control equipment, spill control equipment, and decontamination equipment (unless an exemption is obtained from the EPA Regional Administrator).

(c) All equipment used to unload and place wastes must be decontaminated before being taken out of the disposal operation and staging area. Incoming vehicles not used in the unloading operation should be restricted to staging areas or clean soil areas within the landfill.

b. Applicability of Landfilling.

(1) Landfilling can be expected to undergo close public scrutiny. Landfilling is considered a suitable method for disposing of most wastes with some exception, including bulk liquids and ignitable or reactive wastes. If these wastes are solidified or made nonignitable or nonreactive in compliance with 40 CFR 264.312 through 264.316, then they may be placed in a hazardous waste landfill. Other wastes requiring special handling or pretreatment prior to landfilling include wastes with free liquids, incompatible wastes, infectious wastes, and contaminated wastes.

(2) Wastes containing PCBs are regulated under the Toxic Substances Control Act (TSCA) (PL 94-469). Wastes containing PCBs in concentrations between 50 and 500 parts per million can be incinerated or disposed of in a chemical waste landfill in accordance with 40 CFR 761, Subpart D. These wastes, if disposed of in a chemical waste landfill, must also meet all RCRA regulations regarding ignitability, reactivity, and free liquid. Wastes containing PCBs in excess of 500 parts per million must be incinerated.

(3) Radioactive wastes require special landfills and are not included in this discussion. Radioactive waste disposal is regulated separately by the NRC and is not regulated under RCRA and CERCLA.

c. Data Requirements.

The data requirements needed for planning and designing a hazardous waste landfill are detailed in 40 CFR Part 264, Subpart B, Sections 264.13 and 264.18, and Part 267, Subpart B, Section 267.10, Subpart C, Sections 267.21 and 267.23, and for TSCA landfills in 40 CFR Part 761 Subpart D. The reader is referred to the specific sections in the CFR for additional details and requirements. In general, data requirements for specific activities are as follows:

(1) General waste analysis to include a detailed chemical and physical analysis of a representative sample of the waste for disposal (Section 264.13).

(2) Location standards (Section 264.18).

(a) Seismic information including location and activity of any faults in the immediate area.

(b) Floodplain locations.

(3) Environmental performance standards (Section 267.10), general design requirements (Section 267.21), and closure and postclosure (Section 267.23).

(a) Proposed volume of waste for disposal.

(b) Physical and chemical characteristics of the waste.

(c) Hydrogeological characteristics.

(d) Quantity, quality, and direction of ground-water flow.

(e) Ground-water use and withdrawal rates.

(f) Topographic information.

(g) Climatological conditions.

(h) Hydrologic data including surface flow patterns.

(i) Amount and uses of nearby surface waters, along with associated water quality standards.

(j) Quality of nearby surface waters.

(k) Potential for waste volatilization and wind dispersal.

(l) Existing quality of the air.

(m) Land use and zoning patterns.

(n) Physical and chemical properties of the soil underlying the facility that supports an in-place liner.

(o) Permeability of the liner material.

(p) Potential pressure head of leachate on the liner.

(q) Potential for damage to the liner system during installation of an in-place liner.

(r) Potential volume of leachate or contaminated run-off that could be produced at the facility.

(s) Source and characteristics of potential cover material.

(t) Potential for health risks due to human exposure to waste constituents.

(u) Potential damage to wildlife, crops, vegetation, and physical structures due to exposure to waste constituents.

d. Design Criteria.

(1) The design criteria as given in the current regulations for both sanitary landfills and hazardous waste landfills are generally based on performance standards rather than specific design and construction requirements. That is, the owner/operator is responsible for ensuring or demonstrating to the appropriate regulatory agency that the landfill design being proposed will meet a number of performance standards (given in the regulations) when constructed and operated according to the design plan.

(2) The Part 241 regulations covering solid waste or sanitary landfills are structured in sections addressing individual aspects of landfill design and operation with each section divided into three subsections including: (a) requirement, (b) recommended design procedures, and (c) recommended operations procedures. The requirement subsections generally address the performance standards with the other two subsections addressing recommended procedures for design and operation. Therefore, landfills to be operated in the private sector are required to be designed to meet the performance standards but are not required to follow the guidelines in detail, In the case of landfills to be operated within the management control of a Federal agency, both the performance standards and the design and operating guidelines are mandatory pursuant to Section 211 of the Solid Waste Disposal Act, as amended (PL 89-272 and PL 91-512). In either case, many of the recommended design procedures are not specific and place the responsibility for developing specific design criteria on the potential owner/operator.

(3) Subpart N of Part 264 (264.301) contains the design and operating standards for landfills used to dispose of hazardous wastes. The basic requirements are:

(a) A liner to prevent migration of wastes out of the landfill and into subsurface soil or ground water or surface water during the landfill's active life.

(b) A leachate collection and removal system.

(c) Control of run-on and run-off.

(d) Capping the wastes at closure and conducting postclosure care.

(e) To provide flexibility, the design and operating characteristics required are expressed in terms of performance standards for system components as a whole.

(4) The regulations (Part 264 Subpart N) require the system to function through scheduled closure and to consist, at a minimum, of a leachate collection and removal system and at least one liner. The function of the leachate collection and removal system is to minimize the head (depth) of leachate on the liner. It must be capable of achieving a leachate head of one foot or less. The liner itself must be designed and constructed to prevent migration of liquids and allow no more than the minimum infiltration of liquids into the liner itself.

(5) The liner system must be designed and built to achieve containment of fluids during the life of the landfill unit, thus preventing the escape of hazardous constituents to surrounding soils and ultimately to the ground water. There must be at least one liner, and the material used must be resistant to the chemicals it will encounter in the wastes and in the leachate, and be of sufficient strength to withstand the forces it will encounter during installation and operation. A base is required to provide sufficient support to the liner to prevent failure. The liner system must cover all areas that are likely to be exposed to the waste and leachate.

(6) A cap or final cover must be designed to minimize infiltration of precipitation into the landfill after closure. It must be no more permeable than the liner system. It must operate with minimum maintenance and promote drainage from its surface and at the same time minimize erosion. The design must also accommodate settling and subsidence to minimize the potential for disrupting the continuity and function of the final cover as well as prevent water from ponding on the site.

(7) Two specific location standards concerning siting of a hazardous waste landfill are given in 40 CFR, Part 264, Subpart B, General Facility Standards. Section 264.18 pertains to seismic considerations and floodplains.

The reader is referred to this section in the CFR for additional information and requirements.

(8) 40 CFR, Part 761, Subpart D, Section 761.75 contains the design and operation standards for chemical waste landfills used for disposal of PCB wastes. The basic requirements are:

(a) A synthetic liner if the in-place or compacted soil liner does not have a permeability equal to or less than 1 x 10-7 cm/sec.

(b) A leachate collection monitoring system to be monitored monthly for quantity and quality.

(c) Ground-water monitoring system.

(d) Flood protection.

(9) Whenever a synthetic liner is used, special precautions will be taken to ensure that its integrity is maintained and that it is chemically compatible with the waste. Adequate measures should be provided to prevent excessive stresses on the liner due to inadequate subgrade preparation, equipment loads, or improper waste/cover placement methods. The liner must have a minimum thickness of .76 mm (30 mils); a 1.02 mm (40-mil) liner is usually recommended.

(10) If the landfill is located below the 100-year floodwater elevation, surface water diversion dikes around the perimeter of the landfill site with a minimum height equal to 0.6 m (2 feet) above the 100-year floodwater elevation will be provided. If the landfill is above the

100-year floodwater elevation, the operators will provide diversion structures capable of diverting all of the surface water run-off from a 24-hour, 25-year storm.

(11) PCB wastes will be placed in the landfill in a manner that will prevent damage to containers or articles. Other wastes placed in the landfill that are not chemically compatible with the PCB wastes including organic solvents will be segregated from the PCBs throughout the waste handling and disposal process.

e. Onsite or Offsite Landfill Considerations.

Several considerations must be made when determining whether to use an onsite or offsite landfill. The determination will have to be made on a site-specific basis. Onsite landfilling will require land and large capital expenses to prepare a landfill for burial of hazardous waste. The problem of public acceptance of onsite burial of waste that is to be "cleaned-up" is another consideration. Also, the long-term monitoring that a landfill will require can become a very expensive operation.

f. Advantages/Disadvantages.

(1) Landfilling is in many cases the most expedient, economical, and best understood method of disposing of wastes. Landfilling is generally the most economical method for disposing of large volumes of wastes, especially those with a low hazard to the environment and public health or where other options are not technically feasible.

(2) The disadvantages of landfilling are related to the concept of landfilling as a very long-term storage of waste material. The contaminants landfilled are not generally destroyed or rendered harmless. The requirements imposed by the RCRA and TSCA regulations have significantly increased the cost of landfilling due to requirements for more stringent site security; long-term monitoring, operation, and management; and the imposed long-term liability. The distribution of responsibility for contamination problems resulting from a landfilling operation even if it is properly permitted has not been totally defined and thus will probably result in numerous legal actions. Local public resistance to siting of landfills around high population areas , and even in some rural areas, has been significant and is expected to continue.

(3) Nevertheless, landfilling in a site that meets RCRA and state requirements will continue to be a viable and cost-effective disposal method for both sanitary and hazardous wastes.

5-7. Deep Well Injection.

a. Description.

In general, an underground well injection is simply the subsurface discharge of fluids through a bored, drilled, or driven well, or through a dug well, where the depth of a dug well is greater than the largest horizontal surface dimension. Injection wells must be designed to prevent fluid movement into underground aquifers used for drinking water. There must be no significant leak in the casing, tubing, or packer; and no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore. Testing for leaks can be achieved through monitoring of annulus pressure or pressure test with liquid or gas. The absence of significant fluid movement can be determined through the use of well records demonstrating the presence of adequate cement to prevent such migration (class II wells only) or the results of a temperature or noise log. The general requirements for underground injection wells are that they shall be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment. Underground injection is divided into five classes of wells (see 40 CFR 122.32 and 40 CFR 146.5) under regulations promulgated under the RCRA. Design and operating criteria for the five classes of wells are detailed in the RCRA regulations (40 CFR 146). An example of a deep injection well is presented in Figure 5-2.

b. Applicability.

(1) An investigation of all alternate disposal methods should be accomplished before deep well injection is considered. Deep well injection should be considered only when the hazardous liquid wastes cannot be treated or disposed of in other economical ways.

(2) Subpart C of 40 CFR Part 267 (interim) regulations pertains to new underground injection wells classified as class I wells (40 CFR 122.32) and are very general in nature. The reader is referred to 40 CFR 146 for more detailed information about design and operating requirements. In addition, the Subparts B, C, D, E, G, and H of Part 264 and Part 264.18 apply as well.

c. Data Requirements.

(1) In general, data requirements for determining and specifying casing and cementing requirements are as follows:

(a) Depth to the injection zone.

(b) Injection pressure, external pressure, internal pressure, and axial loading.

(c) Hole size.

(d) Size and grade of all casing strings.

(e) Corrosiveness of injected fluid, formation fluids, and temperatures.

(f) Lithology of injection and confining intervals.

(g) Type or grade of cement.

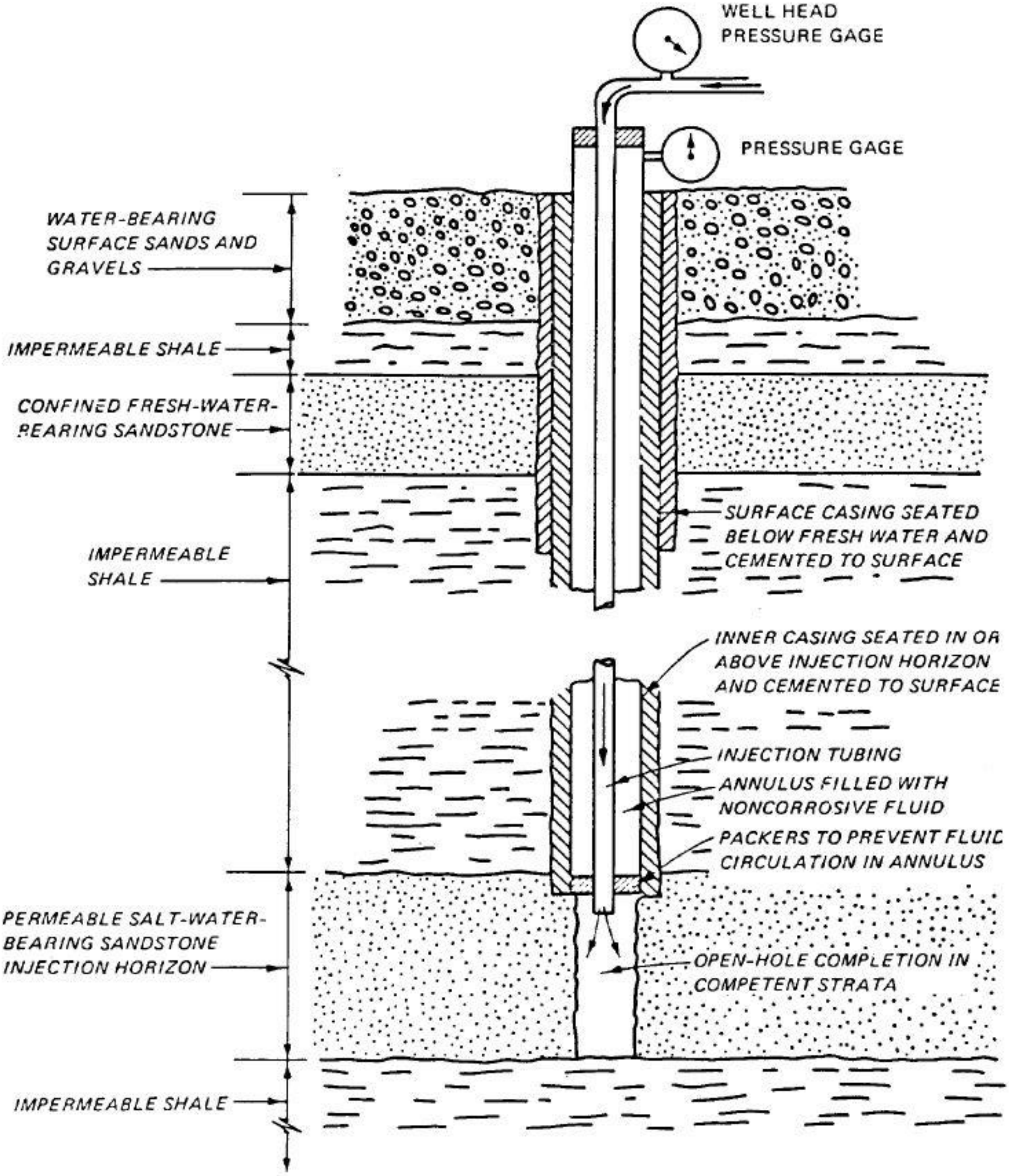

Figure 5-2. Deep Injection Well

(2) 40 CFR 146.12, lists the construction requirements in detail, and 40 CFR 146.13 lists the operating, monitoring, and reporting requirements that are in addition to the requirements of 40 CFR 264 and 267. In general, the data requirement are as follows:

(a) General waste analysis to include a detailed chemical and physical analysis of a representative sample of the waste to be disposed of (40 CFR 264.13).

(b) Data required to support the location standards (40 CFR 264.18) include:

- Seismic information including location and activity of any faults in the immediate area.
- Floodplain locations.

(3) Data required to support the environmental performance standards (40 CFR 267.10), general design requirements (40 CFR 267.21), and closure and postclosure (40 CFR 267.23) include:

(a) Proposed volume of waste for disposal.

(b) Physical and chemical characteristics of the waste.

(c) Hydrogeological characteristics.

(d) Quantity, quality, and direction of ground-water flow.

(e) Ground-water use and withdrawal rates.

(f) Potential for health risks due to human exposure to waste constituents.

(g) Potential damage to wildlife, crops, vegetation, and physical structures due to exposure to waste constituents.

(h) Hydrologic data including surface flow patterns.

(i) Topographic information.

(j) Climatological conditions.

(k) Amount and uses of nearby surface waters, along with associated water quality standards.

(l) Quality of nearby surface waters.

(m) Potential for waste volatilization and wind dispersal.

(n) Existing quality of the air.

(o) Land use and zoning patterns.

d. Design Criteria.

Underground Injection Control (UIC) Program regulations require all aspects of injection well systems to be reported and classified, including construction requirements that pertain to casing type and cement type, well dimensions, waste characteristics, corrosiveness, and leak prevention. The regulations also call for tests and logs, including electric logs on the injection zone formation and integrity of completed wells. In addition, midcourse evaluation of well performance is required for the first two years of operation. In general, all types of materials and procedures must be specifically described or referenced. As an example, steel and concrete corrosion resistance to the waste stream must be demonstrated.

Section II. Offsite Disposal

5-8. General.

a. Offsite disposal exploits the use of existing commercial disposal facilities. The primary advantage of offsite disposal is the minimization of the responsibility for long-term operation and maintenance of such a facility. A secondary advantage is the ability to maintain productive land uses. The primary disadvantage of offsite disposal is the requirement for transporting the wastes, usually over long distances, to an offsite disposal facility.

b. Requirements for offsite disposal must be coordinated with the operator of the offsite disposal facility. Each offsite disposal facility operates in accordance with facility-specific permit requirements. Operators strictly control waste-disposal operations. If offsite disposal is contemplated, coordination should be accomplished early in the design process.

c. Section 121 of CERCLA states that offsite disposal should be the least preferred remedial action alternative. This is not an outright prohibition; however, use of the offsite disposal option should be fully justified and documented during the planning and design process.

5-9. Landfills. The use of offsite landfills presents problems. Transportation of hazardous waste requires manifesting procedures and decontamination of equipment and trucks leaving the site. Haul routes have to be established, approved, and followed. When bids are being considered, the contractor’s proposed disposal facilities should be checked to be sure that they can legally receive and will receive the waste in question. Also, the transportation of certain wastes such as bulk explosive solids should be considered. At the Chem-Dyne remedial action site DOT regulations required that explosive solids be drummed before transporting. This resulted in very expensive handling and extra disposal costs. A similar problem was experienced with “solids” at the site. In most cases the “solids” had to be solidified to meet the landfill’s requirements for disposal. After solidification with bulking agents (fly ash, corn cobs, etc.) the volume and weight were greatly increased. Since disposal costs were determined on a “as disposed of” basis, the costs were much greater than originally estimated. If an offsite disposal facility is going to be used, a determination of who shall sign the manifest (contractor, Corps, or EPA) should be made before the project is initiated. Constriction Bulletin (CB) 93-6, Hazardous Waste Manifest Signature Policy and Procedures; CB 91-13, Preparation and Signature of Hazardous Waste Manifests and Land Ban Certificates on EPA Superfund Projects; CB 92-1, Asbestos Notification and Waste Shipment Record Requirements; and EP 200-1-2, Process and Procedures for RCRA Manifesting, provide current guidance on this topic. Also, a percentage of the payment to the contractor should be held back until manifests are received from the landfill indicating that the waste has been ultimately and properly disposed of. Offsite landfill disposal should be considered for disposal of dewatered contaminated dredged material and for treated residuals. These options include sanitary landfills, RCRA landfills, and TSCA landfills.

a. Sanitary landfills.

(1) Sanitary landfills are facilities designed primarily for the disposal of solid wastes on the land. Wastes are usually emptied into cells, spread, and compacted, and then covered daily with a 152-mm (6-inch) layer of soil or other suitable material. Solid wastes placed in sanitary landfills originate from residential and commercial sources. Wastes that may pose a substantial present or future hazard to human health or living organisms are excluded from a conventionally designed sanitary landfill. Therefore, as a disposal option for remediation of contaminated site, these facilities are applicable to relatively clean residuals from other treatment or pretreatment processes.

(2) Disposal of liquid material in a landfill would likely require elimination of free-draining water either by dewatering and drying or by solidification. Implementation and cost are affected by the distance and cost for transport to a landfill that would accept the material. Landfill fees are also significant. Because landfills are commonly used for municipal waste disposal, there may a local landfill relatively close to the project area. However, the demand for landfill capacity has resulted in restrictions on what many landfills will accept, particularly for large volumes of material.

(3) Sanitary landfills are regulated under the Solid Waste Disposal Act as amended by the Resource Act of 1970 and RCRA. Federal regulations providing guidelines for land disposal of solid wastes are presented in 40 CFR Part 241. These guidelines state that landfills should avoid effects on ground water and surface water, but design requirements are much less stringent than those presented in more recent regulations for RCRA hazardous waste facilities. Increased awareness of the potential hazards of landfills is being reflected in more stringent interpretation of design requirements for these facilities that will protect the environment.

b. RCRA Landfills.

(1) RCRA landfills are permitted for the disposal of certain hazardous wastes as defined under RCRA. RCRA landfills must meet requirements specified in 40 CFR Part 264.

These requirements include lining the bottom and sides of the site with two or more liners, a leachate collection system above the top liner, and a leachate detection system between the two liners. The top liner is a geosynthetic material referred to as a flexible membrane liner (FML), and the bottom liner is an FML or a 3-foot-thick compacted clay liner. The U.S. EPA currently favors a bottom liner that is a composite of an FML underlain by a clay liner. Closure of a RCRA landfill requires covering with a minimum of a three-layer cover consisting of a vegetative top cover, a drainage layer, and a composite (FML over compacted clay) liner. In addition to monitoring the leachate collection and removal system, a ground-water monitoring program is also required for a RCRA landfill.

(2) Permitted RCRA facilities are few in number, their availability for contaminated dredged material is limited, and the cost for transportation and disposal will be large. The

U.S. EPA regulations prohibit placement of liquids in RCRA landfills. Therefore, liquid wastes will have to be dried or solidified before the landfill will accept it.

c. Toxic Substance Control Act (TSCA) landfills.

(1) TSCA landfills are defined here as chemical waste landfills designed and constructed to comply with the provision of TSCA as defined in 40 CFR Part 761. This regulation establishes prohibitions of, and requirements for, the manufacture, processing, distribution in commerce, use, disposal, storage, and marking of PCBs and PCB items. In contrast to RCRA regulations for hazardous waste, which do not mention dredged material specifically, the TSCA regulation states that all dredged materials containing PCBs at concentrations greater than 50 mg/R (50 ppm) shall be disposed of in an incinerator (required if the concentration is greater than 500 mg/R (500 ppm)), in a TSCA landfill, or other method subject to the approval of the U.S. EPA Regional Administrator.

(2) Requirements for TSCA landfills include a requirement to locate in thick, relatively impermeable formations or to provide a 0.9 m(3-foot-thick) compacted clay liner with permeability less than 1 x 10-7 cm/sec. An FML with a minimum thickness of 0.76 mm (30 mils) and that has proven chemical compatibility with the waste may be substituted for the clay liner. The bottom of the site must be at least 15.2 m (50 feet) above the historical high water table. Ground-water monitoring and leachate collection systems are also required. As with RCRA landfills, materials containing free-draining liquids cannot be placed in the landfill for final disposal.

(3) Landfills designed specifically to meet TSCA requirements have limited availability. Disposal alternatives considered for dredged material contaminated with PBS at concentrations greater than 50 mg/R (50 ppm) have included confined disposal facilities designed to TSCA standards. These standards are in some ways less stringent than RCRA. However, the requirement to locate 15.2 in (50 feet) above the water table would prohibit implementation in many areas. Cost of this option is expected to be in the same range as for RCRA landfills.

5-10. Deep Well Injection. The use of deep well injection for offsite disposal presents many of the same problems as offsite landfills. The technical guidance presented in paragraph 5-7 is also applicable for offsite work.