

STATE OF WEST VIRGINIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS

Design and Construction Standards for Centralized Pits

The following design standards for centralized pits utilized by natural gas production operations to store wastewaters (e.g. drilling or hydraulic fracturing fluids) shall be accomplished in such a manner as to protect the health and safety of the people, the natural resources, and environment of the State. Centralized pits shall be designed, constructed and maintained to be structurally sound and reasonably protected from unauthorized acts of third parties and comply with West Virginia Code §22-6A-9 and West Virginia Code of State Rules §§ 35-1 and 4. The operator may use alternate construction standards, based on standard engineering practices, if they meet or exceed those listed below, if the construction plans are developed and sealed by a professional engineer registered in West Virginia and if the construction plans based upon the alternate standards are approved in writing by the Department prior to construction.

I. Areas Where Centralized Pits Are Prohibited

- a. In the 100-year floodplain of waters of this State as determined by NFIP floodplain mapping.
- b. In or within 100 feet of a wetland.
- c. In areas underlain by limestone or carbonate formations where the formations are greater than 5 feet thick and present at the topmost geologic unit. These areas include areas mapped by the West Virginia Geological Survey as underlain by the formations, unless competent geologic studies demonstrate the absence of limestone and carbonate formations.
- d. Within 500 feet measured horizontally from an occupied dwelling, unless the owner thereof has provided a written waiver consenting to the pit being closer than 500 feet.
- e. Within 500 feet of a perennial stream.
- f. Within 500 feet of a private water source.
- g. Within 1,000 feet of a public water source.

II. Construction Standards

- a. Site Preparation shall include the following:
 - i. The foundation for a centralized pit embankment must be stripped and grubbed to a depth of two feet prior to any placement & compaction of earthfill.
 - ii. Any encountered springs in the foundation area must be drained to the outside/downstream toe of the embankment with a drain section two foot by two foot in dimension consisting of WV DOT Type A sand, compacted by hand tamper. No geotextiles to be used around sand. The last three feet of this drain at the outside/downstream slope must be AASHTO #8 material.
- b. Soils Standards for centralized pit shall include the following:
 - i. Soils to be used for embankment construction shall be classified in accordance with ASTM D-2487 (Unified Soils Classification). A minimum of three samples must be classified.
 - ii. Soils acceptable for dam embankment construction are limited to GC, GM, SC, SM, CL or ML. Soils must contain a minimum of 20% of Plus (larger than) No. 200 sieve and be "well graded" material with no cobbles or boulder size material mixed with the clay.
- c. Soil Compaction shall be performed as followed:
 - i. Compaction for embankments done with a sheepsfoot or pad roller;
 - ii. Lifts must be in horizontal layers and loose lift thickness shall be 9" or less;
 - iii. Maximum particle size must be no greater than 6";
 - iv. 5 pass minimum of the compaction equipment over the entire surface of each lift;
 - v. Compaction to visible non-movement of the embankment material, compactive effort shall not exceed optimum moisture limits.
- d. Embankment Design shall include the following:
 - i. Minimum embankment top width of 12' is required
 - ii. Minimum inside & outside sideslopes of 3H:1V are required
 1. A slope variance to a maximum of 2:1 may be approved by the Secretary where the operator provides engineering calculations and documentation to demonstrate a factor of safety of 1.5 or greater.
 - iii. Exposed embankment slopes, not covered by compacted rockfill or riprap, must be limed, fertilized seeded and mulched. Permanent vegetative ground covering compliant with the erosion and sediment control plan must be established upon completion of pit construction.
- e. The bottom of the pit shall be 20 inches above the seasonal high groundwater table at a minimum.

- f. In order to preserve the integrity of the liner system the pit shall be equipped with a manifold system for delivering and withdrawing fluids from the pit.
- g. Pipelines transporting any fracing fluids to or from the pit must have pressure monitored at both ends of the pipeline to ensure that no leakage is occurring. In the event of a leak the operator must cease operation of the pipeline until leaks are found and corrected.

III. Liner System Requirements

- a. The liner system for centralized pits shall include the following elements:
 - i. Sub-base
 - ii. Secondary Liner
 - iii. Leak Detection Zone
 - iv. Primary Liner
- b. Sub-base Requirements
 - i. The sub-base shall bear the weight of the liner system, water and equipment operating on the pit without causing or allowing a failure of the liner system.
 - ii. Accommodate potential settlement without damage to the liner system.
 - iii. Be a barrier to the transmission of liquids.
 - iv. Cover the bottom and sidewalls of the pit.
 - v. Consist of an upper 6 inches that is:
 - 1. Compacted to a standard proctor density of at least 95%.
 - 2. No more permeable than 1.0×10^{-6} cm/sec., based on laboratory and field testing. Soil compaction and permeability testing shall be conducted on the bottom and sides at a minimum rate of once per five acres to ensure permeability of no more than 1.0×10^{-6} cm/sec.
 - 3. Hard, uniform, smooth and free of debris, rock fragments, plant materials and other foreign material.
 - 4. Free of coarse rock fragments greater than 0.75" in diameter.
 - vi. The sub-base shall be covered with non-woven geotextile fabric to cushion the secondary liner and allow for adequate venting between the secondary liner and sub-base to prevent entrapment of gases beneath the liner system.
- c. Secondary Liner Requirements
 - i. The secondary liner shall prevent the migration of water or wastewater through the liner to the greatest degree that is technologically possible.
 - ii. The effectiveness of the secondary liner in preventing the migration of water or wastewater may not be adversely affected by the physical or chemical characteristics of water or wastewater from the pit.
 - iii. The liner shall be designed, constructed and maintained so that the physical and chemical characteristics of the liner are not adversely affected by the waste and the liner is resistant to physical, chemical and other failure during transportation, handling, installation and use. Liner compatibility shall satisfy EWW Method 9090, *Compatibility Test for Wastes and Membrane Liners*, or other documented data approved by the Department.
 - iv. The secondary liner shall cover the bottom and sidewalls of the pit.
 - v. The secondary liner shall:
 - 1. Be composed of a synthetic material with a coefficient of permeability not greater than 1.0×10^{-7} cm/sec., based on laboratory testing.
 - 2. Have a minimum thickness of 60mil unless a greater thickness is required by manufacturer recommendations.
 - 3. Be installed according to manufacturer's specifications under the supervision of an authorized representative of the manufacturer. An approved quality assurance and quality control plan shall be implemented in the field during the installation of the liner.
 - 4. Be inspected for uniformity, damage and imperfections during construction and installation.
 - 5. Use of a composite secondary liner does not relieve the operator of responsibility for a separate primary liner.
- d. Leak Detection Zone
 - i. The leak detection zone shall:
 - 1. Rapidly detect and collect liquid entering the leak detection zone, and rapidly transmit the liquid to the leak detection sump.
 - 2. Withstand chemical attack from the water or wastewater being impounded.
 - 3. Withstand anticipated loads, stresses and disturbances from impounded liquid.

4. Function without clogging.
 5. Prevent the liner from puncturing, cracking, tearing, stretching or otherwise losing its physical integrity.
 6. Cover the bottom and sidewalls of the pit.
 7. Create a flow zone between the secondary liner and the primary liner equal to, or more permeable than 1.0×10^{-2} cm/sec., based on a laboratory testing and, when required by the Department, field testing.
 8. Contain a perforated piping system capable of detecting and intercepting liquid within the leak detection zone and conveying the liquid to a collection sump.
 - a. The collection sump shall be equipped with a sump pump with a switch to automatically activate the pump when a leak occurs.
 - b. Discharge from the sump pump shall be directed back into the pit or other suitable containment. The sump shall have no outlet other than the sump pump discharge.
 - c. The pump and sump shall be of sufficient size and capacity to convey any leak that may occur back into the pit without a discharge.
 9. The piping system shall also meet the following requirements:
 - a. The slope, size and spacing of the piping system shall assure that liquids drain from the leak detection zone.
 - b. The pipes shall be installed primarily perpendicular to the flow and shall have a minimum post-settlement grade of at least 2%.
 - c. The minimum diameter of the perforated pipe shall be 4 inches with a wall thickness of Schedule-80 or greater, as specified by ASTM, or equivalent.
 - d. The pipes shall be cleaned and maintained as necessary.
 10. The leak detection zone shall have a minimum bottom slope of 2%.
 11. The leak detection zone and sump shall be designed to allow the operator to monitor and record leakage rates.
 12. Contain non-carbonate stones or aggregate with no sharp edges.
 13. The operator shall monitor the leak detection zone weekly to determine whether liquid is flowing from the zone.
- e. Primary Liner Requirements
- i. The primary liner shall prevent the migration of water and wastewater through the liner to the greatest degree that is technologically possible.
 - ii. The effectiveness of the primary liner in preventing the migration of water and wastewater may not be adversely affected by the physical or chemical characteristics of water or wastewater from the pit.
 - iii. The liner shall be designed, constructed and maintained so that the physical and chemical characteristics of the liner are not adversely affected by the waste and the liner is resistant to physical, chemical and other failure during transportation, handling, installation and use. Liner compatibility shall satisfy EWV Method 9090, *Compatibility Test for Wastes and Membrane Liners*, or other documented data approved by the Department. The primary liner shall cover the bottom and sidewalls of the pit.
 - iv. The primary liner shall:
 1. Be composed of a synthetic material with a coefficient of permeability not greater than 1.0×10^{-7} cm/sec., based on laboratory testing.
 2. Have a minimum thickness of 60mil unless a greater thickness is required by manufacturer recommendations.
 3. Be installed according to manufacturer's specifications under the supervision of an authorized representative of the manufacturer. An approved quality assurance and quality control plan shall be implemented in the field during the installation of the liner.
 4. Be inspected for uniformity, damage and imperfections during construction and installation.
 - v. Use of a composite primary liner does not relieve the operator of responsibility for a separate secondary liner.
- f. Allowable Leakage Rates within the Leak Detection Zone
- i. Allowable leakage rates within the Leak Detection Zone shall be determined based upon the maximum depth of the impounded fluid as specified in the table below. The area shall be calculated as the area of the liner in contact with the impounded fluid.

Fluid Height (ft)	ALR (gallons/acre/day)
$h \leq 10$	340
$10 < h \leq 15$	420
$15 < h \leq 20$	490
$20 < h \leq 25$	550
$25 < h \leq 30$	610
$h > 30$	case by case

- ii. In the event that the flow rate of leakage through the primary liner, as collected in the leak detection sump, exceeds the value above for a given fluid depth, the addition of fluid shall be ceased and the pit shall be drained to the extent necessary and the leak or leaks shall be located and repaired.

IV. Water Quality Monitoring

- a. A person or company that operates a centralized pit shall install, operate and maintain a monitoring system that can detect the entry of contaminants into the ground or surface water.
- b. A person or a company may not construct, install or use a monitoring system for a centralized pit until that system has first been approved by the Department in writing.
- c. The water quality monitoring system shall accurately characterize groundwater flow, groundwater chemistry and flow systems on the site and adjacent area. The system shall consist, at a minimum, of the following:
 - i. For the purpose of establishing baseline groundwater data at least one monitoring well hydraulically downgradient from the proposed pit area in the direction of decreasing static head that is capable of providing representative data of groundwater prior to the construction of the pit
- d. The downgradient monitoring well/wells shall be:
 - i. Sufficient in number, location and depth to be representative of water quality.
 - ii. Located so that they do not interfere with routine well operations.
 - iii. Located within 200 feet of the permitted centralized pit.
 - iv. Wells drilled under this section shall be drilled by drillers licensed under the West Virginia Monitoring Well Rules, West Virginia Code of State Rules § 47-59.
 - v. The well materials shall be decontaminated prior to installation.
- e. Standards for monitoring wells and casing of monitoring wells shall be as follows:
 - i. The casing shall maintain the integrity of the monitoring well borehole and shall be constructed of material that will not react with the groundwater being monitored.
 - ii. The minimum casing diameter shall be 4 inches unless otherwise approved by the Department in writing.
 - iii. The well shall be constructed with a screen that meets the following requirements:
 - 1. The screen shall be factory-made.
 - 2. The screen may not react with the groundwater being monitored.
 - 3. The screen shall maximize open area to minimize entrance velocities and allow rapid sample recovery.
 - 4. The well shall be filter-packed with chemically inert clean quartz sand, silica or glass beads. The material shall be well rounded and dimensionally stable.
 - 5. The casing shall be clearly visible and protrude at least 1 foot above the ground, unless the Department has approved flush mount wells.
 - 6. The annular space above the sampling depth shall be sealed to prevent contamination of samples and the groundwater.
 - 7. The casing shall be designed and constructed in a manner that prevents cross contamination between surface water and groundwater.
 - 8. Alternative casing designs for wells in stable formations may be approved by the Department.
- f. Monitoring well casings shall be enclosed in a protective casing that shall:
 - i. Be of sufficient strength to protect the well from damage by heavy equipment and vandalism.
 - ii. Be installed for at least the upper 10 feet of the monitoring well, as measured from the well cap, with a maximum stick up of 3 feet, unless otherwise approved by the Department in writing.
 - iii. Be grouted and placed with a concrete collar at least 3 feet deep to hold it firmly in position.
 - iv. Be numbered for identification with a label capable of withstanding field conditions and painted in a highly visible color.

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- v. Protrude above the monitoring well casing.
- vi. Have a locked cap.
- vii. Be made of steel or another material of equivalent strength.
- g. Analyses of data collected shall be submitted to the Department within 60 days of sampling or 15 days after completion of analyses, whichever is sooner, unless the Department approves another time period.
- h. Water samples must be collected from monitoring wells on a minimum frequency of once per calendar quarter and analyzed by a laboratory in compliance with DEP's laboratory certification program requirements for the following parameters at a minimum:
 - i. Total dissolved solids
 - ii. Chloride
 - iii. Sulfates
 - iv. PH
 - v. Specific conductance

V. Engineer Certification

- a. Design plans for centralized pits must be developed signed and sealed by a registered professional engineer in West Virginia.
- b. A qualified engineer shall provide oversight for all aspects of construction to ensure that construction is completed in substantial conformance with the design and quality assurance and quality control plan.
- c. Upon completion, a facility completion and final certification report must be submitted to the Department. The report must be completed signed and sealed by the licensed professional engineer who provided oversight for construction and must contain the following items at a minimum:
 - i. A statement that the engineer provided oversight for all aspects of construction and that the pit was constructed as designed and in substantial conformance with these requirements and the quality assurance and quality control plan.
 - ii. Soils classification testing results for the embankments in accordance with Section II requirements.
 - iii. Soil compaction testing results for the sub-base in accordance with Section II requirements.
 - iv. As-built drawings noting any deviation from the original plans submitted to the Department, any deviations from original plans must be approved prior to construction.
 - v. Quarry tickets for drain material.
 - vi. Quality assurance and quality control test results in accordance with Section II requirements.
 - vii. Color photographs of the following at a minimum:
 - 1. The cleared and grubbed foundation.
 - 2. Leak detection system installation.
 - 3. Placement and compaction of fill.
 - 4. The completed embankments.
 - 5. The completed sub-base.
 - 6. The completed secondary liner.
- d. The pit shall not be filled until the facility completion and final certification report is received and approved by the Department.