

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

**POND SEALING OR LINING**

**SOIL-CEMENT**

(No.)

CODE 740 CA INTERIM

**DEFINITION**

A liner for a pond consisting of a highly compacted mixture of soil and measured amount of cement and water

**PURPOSES**

To reduce seepage losses from ponds for water conservation and environmental protection.

**CONDITIONS WHERE PRACTICE APPLIES**

This practice applies where:

- Ponds where water loss from excess seepage prevent the pond from fulfilling its planned purpose and where excess seepage will waste water, cause damage to land and crops, or cause environmental problems.
- Soils are suitable for treatment with cement.
- Soils to be treated are Unified Soils Groups GW, GP, GM, GC, SW, SP, SM, or SC.

This practice does not apply to ponds storing agricultural wastewater.

**CRITERIA**

Structures to be lined shall have been constructed to meet all applicable NRCS standards. All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

**Soil Properties**

Sealing with soil-cement is applicable on coarse-grained soils. The ideal soil material should contain no more than 35 percent passing the No. 200 sieve size, and less than 0.5 percent of organic matter. The soil

should not contain gravel larger than 2 inches nor more than 45 percent gravel larger than 1/4 inch.

Clay balls (nodules of clay and silt intermixed with granular soil) have a tendency to form when the Plasticity Index (PI) of the soil is greater than 8, and tend to wash out and weaken the soil-cement structure. The PI of the soil shall be no greater than 8. Clay balls greater than 1 inch shall be removed. Clay balls less than 1 inch shall be limited to 10 percent.

If soils at project site are found to be not suitable, soils from a borrow area within an economical haul distance should be investigated.

**Rate of Application**

The rate of application shall be 10 percent cement by volume.

On large projects where the minimum amount of cement needed is determined to keep project costs low, the rate of application shall be based on laboratory tests.

Short-cut procedures have been developed for sandy soils containing less than 50 percent material smaller than 0.05 mm (silt and clay) and less than 20 percent material smaller than 0.005 mm (clay). These procedures are outlined in the Portland Cement Association Soil Cement Laboratory Handbook. Method A can be used for soils not containing material retained on the No. 4 sieve and Method B is used for soils retained on the No. 4 sieve. These short-cut procedures do not always indicate the minimum cement factor, but they do provide a safe cement factor that is generally close to that indicated by standard ASTM wet-dry and freeze-thaw tests.

For all other soils, the design cement factor shall be determined from wet-dry and freeze-thaw tests. The allowable weight loss for test specimens are as given under "Laboratory Data".

**Thickness of Treated Blanket**

The minimum thickness of the finished treated blanket shall be 4 inches for water depths up to 8 feet. Additional thickness shall be provided for greater water depths.

**Subgrade**

To reduce damage to the lining by vegetation, the subgrade shall be treated with a soil sterilant prior to the placement of soil-cement.

**Area to be Treated**

The total wetted area shall be treated and treatment shall be provided to an elevation that will protect the sides against wave action.

**Laboratory Data and Report**

A 200 pound sample of the on-site material shall be collected and submitted to a soil mechanics laboratory for testing. The following tests are to be performed, and a design mix determined that will yield the following results with the minimum cement content:

Test	Result
Compressive Strength (28 days)	greater than 750 psi
Wet-Dry Test (ASTM D559) (loss of weight)	less than 10 percent
Freeze-Thaw Test (ASTM D560) (percent loss of weight)	less than 10 percent

The laboratory shall prepare a report that contains the original worksheets and results of all tests performed.

The laboratory report shall also contain the test data for:

Moisture-Density Relationship of soil material with the percentage of cement that is determined to be the design-mix. (ASTM D558)

**ASTMs**

- D558 Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
- D559 Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
- D560 Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures

**CONSIDERATIONS****PLANS AND SPECIFICATIONS**

Plans and specifications for sealing ponds with soil-cement shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

**OPERATION AND MAINTENANCE**

An operation and maintenance plan must be prepared by the Designer for use by the owner or other responsible for operating this practice. The plan should provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damaged components.

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE SPECIFICATION

**POND SEALING OR LINING  
SOIL-CEMENT**

CODE 740 – CA INTERIM

**I. SCOPE**

The work shall consist of constructing a soil-cement lining in a pond. The surface of the compacted soil-cement shall conform to the elevations and cross sections shown on the drawings or as staked in the field.

**II. SUBGRADE PREPARATION**

The subgrade area for the soil-cement shall be cleared of all trees, brush, weeds, sod, loose rocks, or other material not suitable for the subgrade.

Clearing and disposal methods shall be in accordance with applicable state and county laws with due regard to the safety of persons and property.

In the area to be lined, the soil material used with the cement shall be at least 5 inches thick.

The inside embankment slopes shall not be steeper than 5:1 horizontal to vertical. Slopes steeper than 5:1 will be permitted if the Contractor demonstrates that the soil-cement can be mixed or deposited on grade and compacted as specified to the satisfaction of the Engineer. The maximum slope shall be no more than 3:1 horizontal to vertical where a lift (layer) type lining is used.

The subgrade shall be firm and able to support without yielding or subsequent settlement the construction equipment and the compaction of the soil-cement. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

**III. MATERIALS**

**Cement**

Shall be Type II low alkali or Type V Portland cement; and shall be free of lumps and partially set masses. The rate of application shall be as specified on the "Practice Requirement" sheet.

**Water**

Shall be relatively free from acid, alkali, oil, or organic matter.

**Soil Material**

Shall not contain aggregates larger than 1/2 the lining thickness, and no more than 40 percent by dry weight shall be retained on a No. 4 sieve, and shall not have more than 35 percent nor less than 5 percent material passing the No. 200 sieve. Soil material with less than 5 percent passing the No. 200 sieve can be used, but the cement factor shall be increased 1 percentage point for each 1 percent that the portion of the soil passing the No. 200 sieve is less than 5 percent.

Clay balls (nodules of clay and silt intermixed with granular soil) greater than 1 inch shall be removed. Clay balls less than 1 inch shall be limited to 10 percent.

**IV. MIXING AND PLACING**

The soil aggregate shall be so pulverized that, at the completion of moist mixing, 100% by dry weight passes a 1-in. (25.4 mm) sieve, and a minimum of 80% passes a No. 4 (4.75 mm) sieve, exclusive of gravel or stone retained on those sieves.

Soil-cement shall not be mixed or placed when the soil aggregate or subgrade is frozen, or when the air temperature is below 45° F (8° C). However, when the air temperature is at least 40°F (5° C) and rising, soil-cement construction may proceed.

Moisture in the soil at the time of cement application shall not exceed the quantity that will permit a uniform and intimate mixture of the soil and cement during mixing operations, and shall be no more than the optimum moisture content for the soil-cement mixture.

The operations of cement application, mixing, spreading, compacting, and finishing shall be continuous and completed within 4 hours in daylight or under satisfactory lighting.

#### **IV. ADDITIONAL CRITERIA FOR IN-PLACE MIXING**

##### **General**

No soil-cement mixture shall remain undisturbed more than 30 minutes during mixing or compaction.

**Preparation.** The surface of the soil to be processed into soil-cement shall be at an elevation so that, when mixed with cement and water and recompacted to the required density, the final elevation will be as shown in the plans or as directed by the engineer. The material in place and surface conditions shall be approved by the engineer before the next phase of construction is begun.

**Pulverizing.** Before cement is applied, the soil to be processed may be scarified to the full depth of mixing. The soil should be damp at the time of scarifying to reduce the amount of dust and to aid in pulverization. The product of pulverization shall be such that at the completion of moist mixing, 100% by dry weight passes a 1-inch sieve, and not less than 80% passes a No. 4 sieve, exclusive of gravel or stone retained on those sieves.

##### **Application of cement**

Prior to distribution of cement, the soil shall be moistened to at least a 2-foot depth. The moisture content and depth will be determined by inspection prior to application of cement. No cement shall be applied when moisture content in the soil exceeds the optimum moisture content for the soil-cement mixture.

The cement shall be uniformly distributed over the soil at the specified rate. No cement shall be spread more than 60 minutes ahead of the start of mixing.

##### **Mixing**

The cement shall be uniformly mixed with the soil material to a depth of 4 inches below the finished grade. Mixing in-place shall be completed within 1½ hours.

##### **Application of water**

Sufficient water in light applications shall be added during mixing to maintain the moisture content of the soil-cement mixture near optimum as determined by the engineer, and soil-cement mixture shall be mixed until the result is a uniform mixture of soil, cement, and water is obtained for the full design depth and width.

#### **V. ADDITIONAL CRITERIA FOR OFF-SITE MIXING**

##### **General**

Soil and cement can be central-plant-mixed in an approved mixer of either the continuous flow or batch type. The plant shall be equipped with metering and feeding devices that will add the soil, cement, and water into the mixer in the specified quantities. The mixing time shall be that which is required to secure a uniform mixture of soil, cement, and water.

##### **Handling and placing**

The soil-cement mixture shall be transported in trucks having beds that are smooth, clean, and tight.

The total elapsed time between the addition of water to the mixture and the start of compaction shall not exceed 45 minutes, and the mixture is not to be left undisturbed for longer than 30 minutes during this period.

Necessary precaution shall be taken to avoid damage to the in-place mixture by the equipment.

Deposition of raw earth or foreign materials between layers or strips of soil-cement shall be avoided.

Earth ramps crossing completed soil-cement must have at least 2 feet of compacted thickness.

The mixture shall be placed on moistened embankments or previously completed soil-cement, with spreading equipment that will produce strips or layers of such widths and thickness as are necessary for compaction to the required dimensions.

All soil-cement surfaces which must be bonded to succeeding layers or strips of soil-cement shall be kept moist.

## VI. COMPACTION

Compaction of the soil-cement mixture shall commence immediately following the completion of mixing or deposition on grade and shall be completed within 1 hour.

The soil-cement mixture shall be uniformly compacted in such a manner that the completed soil-cement in-place forms a dense, uniform mass with a relatively smooth surface.

Compaction shall meet the requirements of one of the following as specified:

1. Compaction shall be accomplished with pneumatic-tired equipment. Initial compaction may be done with a sprocket packer or similar equipment to provide a firm support for the pneumatic-tired equipment.
2. Compaction shall result in densities equal to or greater than 96 percent of the maximum obtained by laboratory compaction at optimum moisture of like soils in accordance with ASTM D558.

At the time of compaction the moisture content shall not be less than 1 percentage point below optimum; shall be less than that which will cause the soil-cement to become unstable during compaction and finishing operations; and shall not be more than 2 percentage points above optimum.

Areas within 2 feet of any structure need not be compacted with the pneumatic-tired equipment but will be "sealed off" in accordance with Paragraph "Structures".

Compliance with compaction requirements will be determined by the procedure given in ASTM D1556 or D2167 for Methods 2 and by observation of performance for Method 1.

Compacted areas not meeting the specified requirements shall be repaired in accordance with Paragraph IX.

## VII. CURING

Immediately upon completion of compaction, the surface shall be moistened with a light spray of water and shall be kept wet until no more moisture is absorbed.

Soil-cement surfaces cured with water shall be kept wet for a minimum period of 7 days immediately following compaction.

When a curing compound is used, it shall be applied as soon as the surface film of moisture disappears but while the surface still has a damp appearance.

The curing compound shall meet the requirements of ASTM Designation C309. Coverage shall not exceed 200 square feet per gallon.

## VIII. CONSTRUCTION JOINTS

At the end of each day's work, or whenever construction operations are interrupted for more than 3 hours, a transverse construction joint shall be made. Such joints shall be full-depth vertical joints.

## IX. SPECIAL REQUIREMENTS

### Structures

The structures within the area being lined with soil-cement shall be "sealed off" with a concrete or plastic soil-cement slab with a minimum thickness of 4 inches. The projection of the slab from the structure will depend upon the distance required to cut a true vertical surface, free of loose or shattered material, in the compacted soil-cement, usually 2 feet or more. The slab shall be adequately cured prior to filling the reservoir with water.

### Materials for slab

Concrete--The recommended proportions of the various ingredients of concrete shall be such as to obtain adequate strengths for the intended purpose. In no case, however, shall there be more than 6.3 cubic feet of bulk aggregate per sack of cement, nor shall there be more than 7½ gallons of water per sack of cement introduced into the mix. All material shall be proportioned by weight and/or volume.

### Plastic Soil-Cement

Plastic soil-cement is a mixture of soil and Portland cement combined with sufficient water to produce, at time of placing, a consistency similar to that of plastering mortar. The cement content shall be at least 4 percent, by weight, more than for the soil-cement mixture.

## **X. REPAIRS**

Unsatisfactory areas of soil-cement shall be replaced by excavating 4 inches deep and outward the distance required to cut a true vertical surface, free of loose or shattered material, in the compacted soil-cement. The repair area shall be dampened with water and immediately refilled with a mixture of soil-cement. The soil-cement mixture shall be compacted and cured. No skin patches will be permitted.

## **XI. VEGETATIVE COVER**

Unless otherwise specified, a protective cover of vegetation shall be established on the disturbed area outside of the area treated. The planting of vegetative materials shall conform to the requirements of Practice Specification 342, Critical Area Planting.

## **XII. SPECIAL MEASURES**

Measures and construction methods shall be incorporated as needed and practical that enhance fish and wildlife values. Special attention shall be given to protecting visual resources and maintaining key shade, food and den trees.

## **XIII. CONSTRUCTION OPERATIONS**

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, Contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

## **XIV. OPERATION AND MAINTENANCE ITEMS**

A properly operated and maintained pond is an asset to your farm. This pond sealing was designed and installed to limit the seepage loss from the pond. The estimated life span of this system is at least 10 years. The life of this system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation and maintenance to maintain satisfactory performance. Here are some recommendations to help

you develop a good operation and maintenance program.

Maintain the soil covering on artificial liners at the construction depth.

Limit the use or travel of any equipment in the area that was sealed.

Prevent all livestock from using any area of the pond that was sealed by artificial liners.

If fences are installed, they shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.

Settlement or cracks in the soil weaken earthen sections and may accelerate the development of flow paths that may result in structure failure. This should be investigated to determine the cause and immediately repaired.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Immediately remove any debris that may harm or reduce the effectiveness of sealants.

Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, or outlets or other apparatuses.

Other items specific to your project are listed on the "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE  
NATURAL RESOURCES CONSERVATION SERVICE  
CALIFORNIA

**PRACTICE REQUIREMENTS  
FOR  
740 - POND SEALING OR LINING  
SOIL-CEMENT**

For: Business Name \_\_\_\_\_  
Job Location \_\_\_\_\_  
County \_\_\_\_\_ RCD \_\_\_\_\_ Farm/Tract No. \_\_\_\_\_  
Referral No. \_\_\_\_\_ Prepared By \_\_\_\_\_ Date \_\_\_\_\_

**IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.**

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. \_\_\_\_\_
2. Practice Specifications \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_
3. Soil cement density, Method: \_\_\_\_\_ of Compaction \_\_\_\_\_
4. Application rate \_\_\_\_\_ lbs/sq.yds \_\_\_\_\_
5. Special Requirements: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
6. Special Maintenance Requirements: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**PRACTICE APPROVAL:**

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class \_\_\_\_\_

Limiting elements:	Units
<u>Head on lining</u> _____	_____ ft
_____	_____
_____	_____
_____	_____

Design Approved by: \_\_\_\_\_ Date: \_\_\_\_\_

**LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:**

The landowner/operator acknowledges that:

- a. He/she has received a copy of the construction drawings and specification, and that he/she has an understanding of the contents, and the requirements.
- b. He/she has obtained all the necessary permits.
- c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.
- d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by: \_\_\_\_\_ Date: \_\_\_\_\_

**PRACTICE COMPLETION:**

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/ \_\_\_\_\_ Date \_\_\_\_\_



UNITED STATES DEPARTMENT OF AGRICULTURE  
NATURAL RESOURCES CONSERVATION SERVICE

**740 – POND SEALING OR LINING**

**SOIL-CEMENT**

**OPERATION AND MAINTENANCE**

Sponsor/Land user: \_\_\_\_\_ Date: \_\_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_

Location GPS Coordinates Map Datum: \_\_\_\_\_ E \_\_\_\_\_ N \_\_\_\_\_

Quad Sheet Name \_\_\_\_\_ SEC \_\_\_\_\_ T \_\_\_\_\_ R \_\_\_\_\_

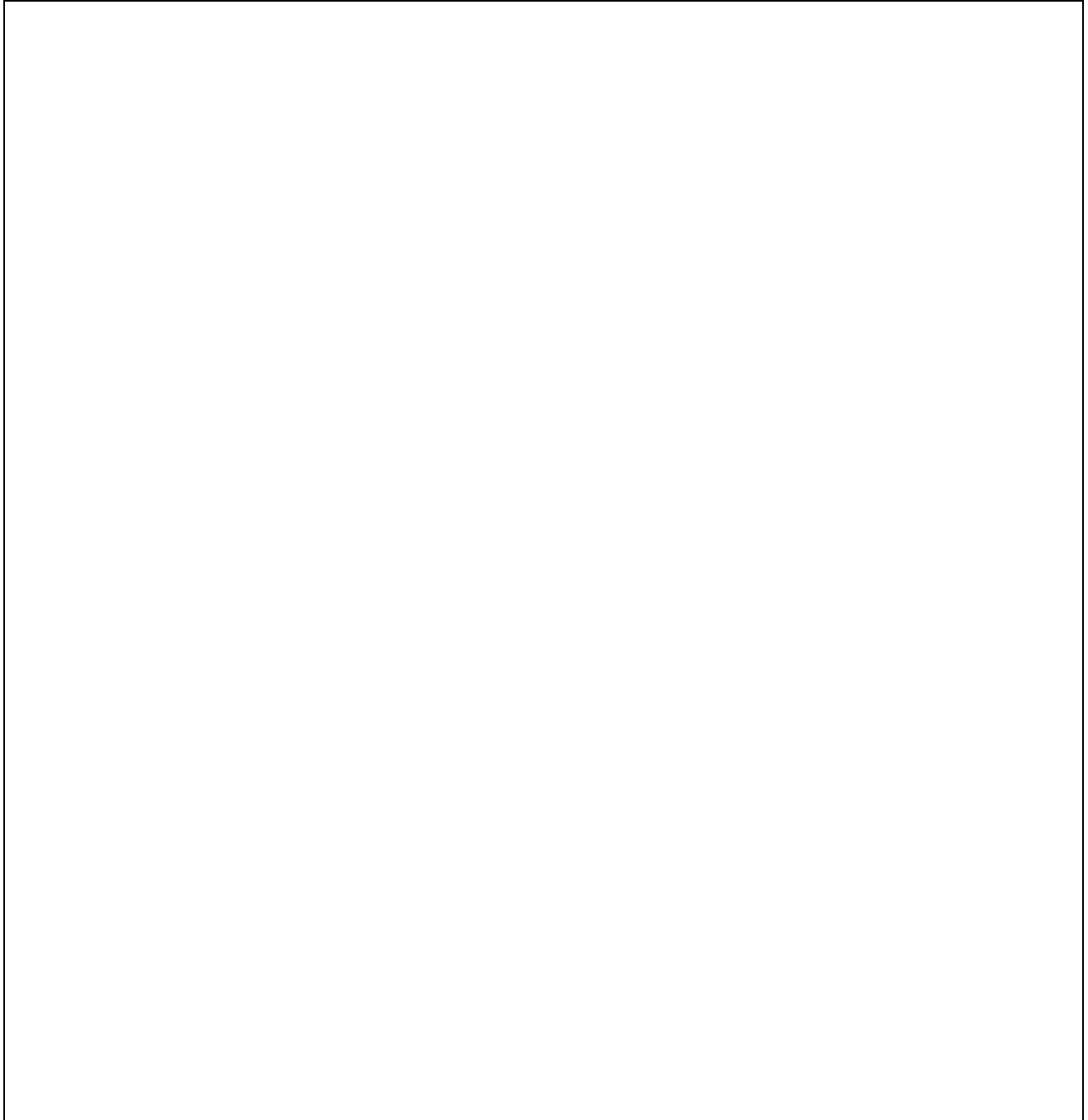
A properly operated and maintained pond lining or sealing is an asset to the farm. This system was designed and installed to reduce seepage in a pond. The estimated life span of this installation is at least 10 years. The life of this installation can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic operation to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program:

**GENERAL RECOMMENDATIONS**

- Maintain the soil covering on liners at the construction depth.
- Limit the use or travel of any equipment in the area that was sealed. Avoid excessive speeds and sharp turns.
- Prevent all livestock from using any area of the pond which was sealed by artificial liners.
- Fences shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.
- Settlement or cracks in the soil weaken earthen sections and may accelerate the development of flow paths that may result in structure failure. This should be investigated to determine the cause and immediately repaired.
- Inspect for damage from rodents or burrowing animals. Repair any damage. Take appropriate corrective actions to alleviate further damage.
- Immediately remove any debris that may harm or reduce the effectiveness of sealants.
- Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, or outlets or other apparatuses.

**SPECIFIC RECOMMENDATIONS FOR YOUR POND LINING OR SEALING PROJECT**



**CONTACT YOUR LOCAL NATURAL RESOURCES CONSERVATION SERVICE OFFICE FOR ANY ADDITIONAL TECHNICAL ASSISTANCE YOU MIGHT NEED FOR IMPLEMENTATION OF THIS OPERATION AND MAINTENANCE FOR YOUR POND LINING OR SEALING PROJECT.**

**STATEMENT OF WORK**  
**Pond Sealing or Lining**  
**Soil-Cement (740)**

**These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.**

## **DESIGN**

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### **Deliverables:**

1. Design documents that demonstrate criteria in practice standard have been met and are compatible with planned and applied practices
  - a. Practice purpose(s) as identified in the conservation plan.
  - b. List of required permits to be obtained by the client
  - c. Compliance with NRCS national and state utility safety policy (NEM part 503-Safety, Section 503.00 through 503.22)
  - d. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
    - i. Hydrogeology
    - ii. Application Rate and/or Liner Thickness
    - iii. Liner Protection
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Subpart B Documentation, 511.11 and Part 512, Subpart D Quality Assurance Activities, 512.30 through 512.32).
4. Operation and maintenance plan
5. Certification that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03(b)(2))
6. Design modifications during installation as required

## **INSTALLATION**

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### **Deliverables**

1. Pre-installation conference with client and contractor
2. Verification that client has obtained required permits
3. Staking and layout according to plans and specifications including applicable layout notes
4. Installation inspection
  - a. Actual materials used
  - b. Inspection records
5. Facilitate and implement required design modifications with client and original designer
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation
7. Certification that the installation process and materials meets design and permit requirements

## **CHECK OUT**

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### **Deliverables**

1. As-built documentation
  - a. Extent of practice units applied
  - b. Drawings
  - c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits (NEM Subpart A, 505.03(c)(1))
3. Progress reporting

**STATEMENT OF WORK**  
**Pond Sealing or Lining**  
**Soil-Cement (740)**

**REFERENCES**

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- Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard, Pond Sealing or Lining, Soil Cement - 740.
- National Engineering Manual
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook