Ponds: planning, design, and construction

Ponds for many purposes:

Fish Production

Water Supply

Esthetics

Recreation

Wildlife Habitat

Natural ponds:

- Formed in natural depressions in the landscape
- Not man-made—don't have constructed dams or embankments
- May be permanent or seasonal
- Not easily controlled/managed

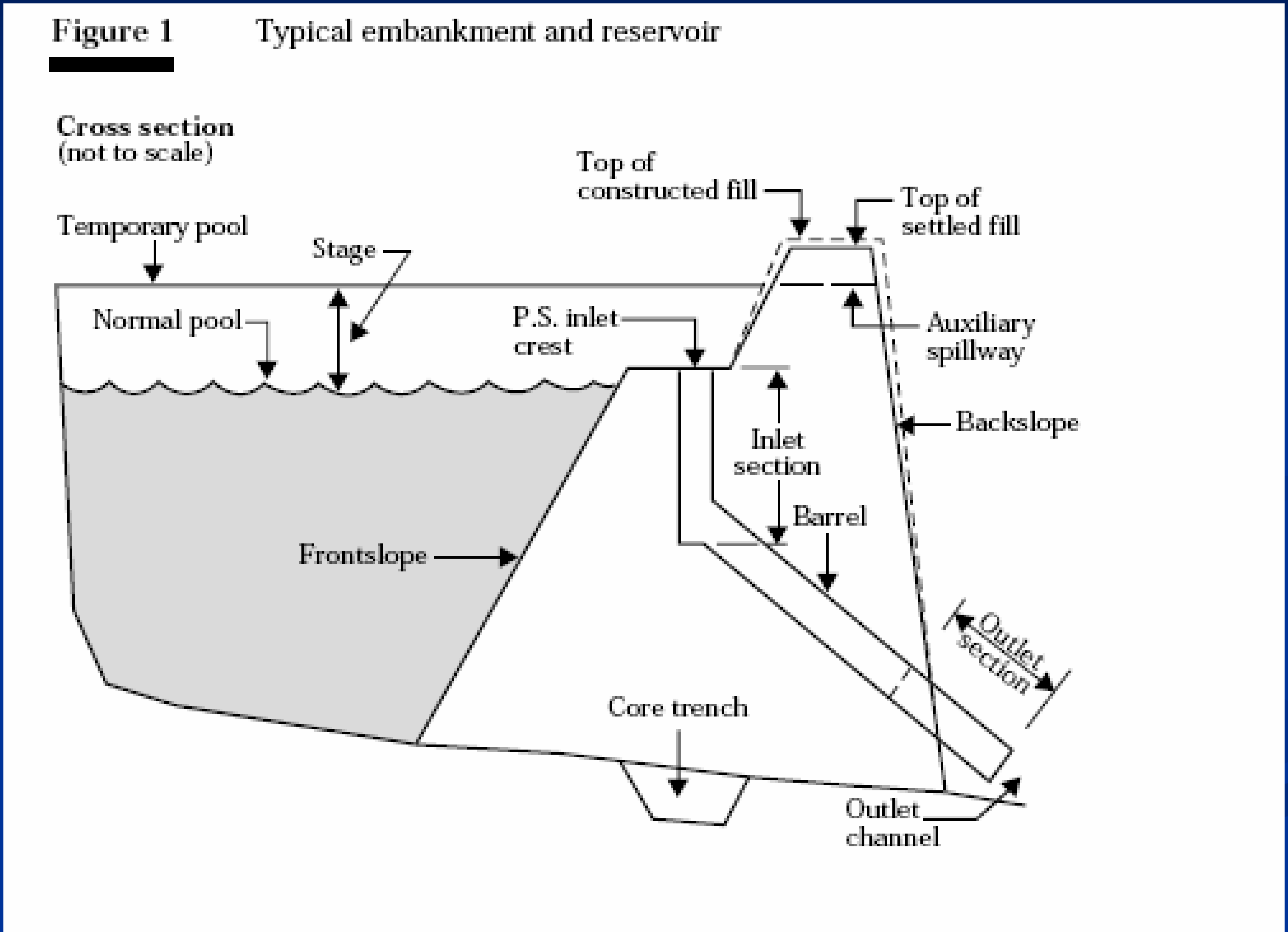
Excavated ponds:

- Designed for specific purposes
- Uniform shapes and sizes
- Flat, sloped bottoms
- Free of stumps, rocks, etc.
- Usually drainable
- Have reliable sources of good quality water
- More easily managed than natural ponds

Watershed ponds:

- Fit into the topography of the watershed
- Use watershed runoff as water source
- Partially excavated; usually have a dam
- Less easily managed than excavated ponds
- Water supply/management depends on weather

Basic terminology:



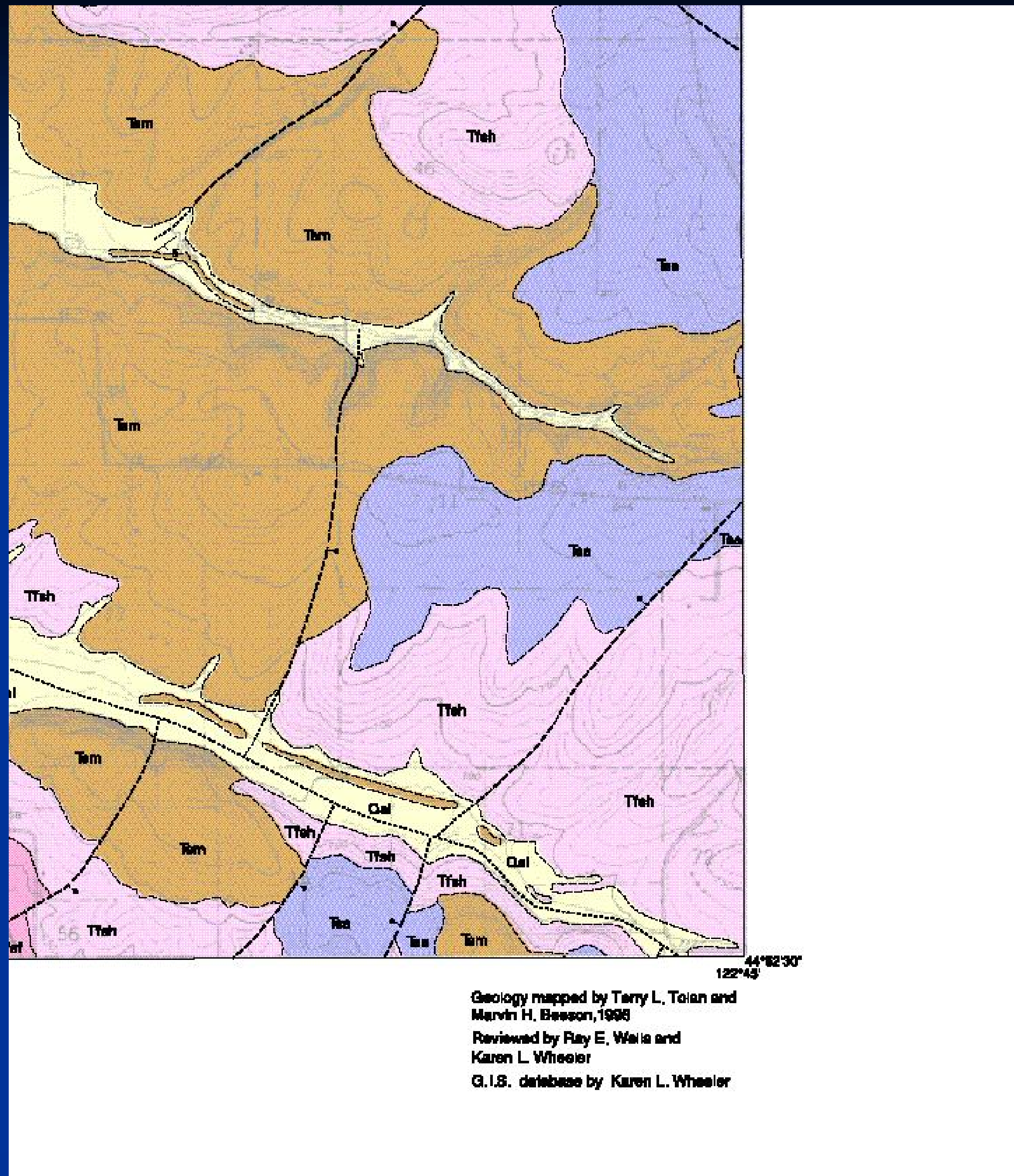
Site selection

- Choose site to fit landscape
- Consider more than one location and select the one that is most ecologically appropriate, esthetic, and practical site.
- Weighing both onsite and offsite effects of constructing a pond is essential in site selection.
- Choose site to maximize storage for smallest amount of embankment.
- Consider potential for pollution from contributing watershed area.

Geology

- Knowledge of local geology is important especially for large dams.
- Well logs are another source of subsurface geologic information.
- View the interactive geologic map of Oregon http://nwdata.geol.pdx.edu/OR-Geology/

Geologic maps may be available that include your property

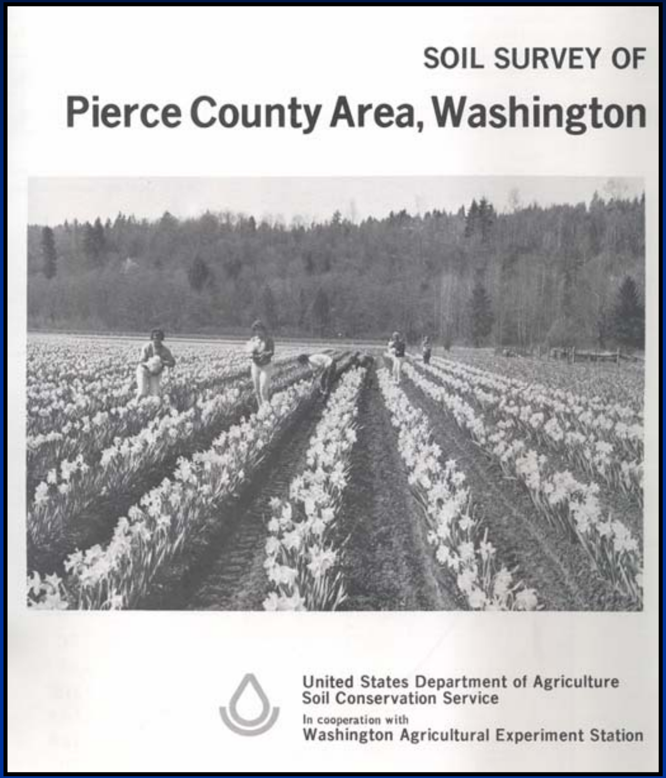


Soils

- Most counties in Oregon have published soil surveys
- Check out soil survey report for your county
- Soils information can be accessed via the Internet, too, via the Soil Data Mart.

Soil Survey reports:

Soil Survey is a Scientifically-Based Inventory

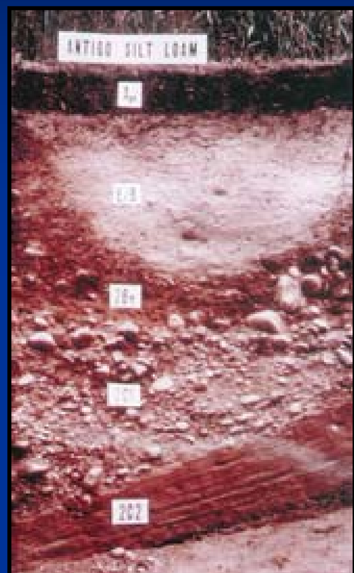


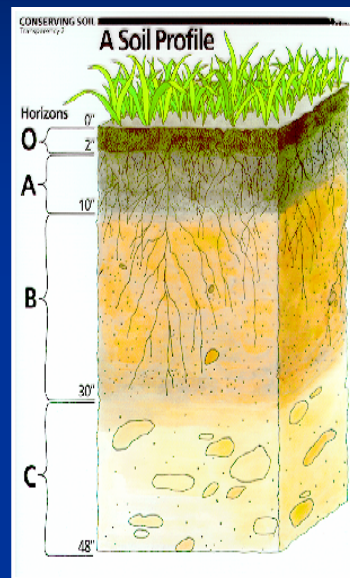
A soil survey includes maps, descriptions, properties, climate, and interpretations. These are excellent sources of information.

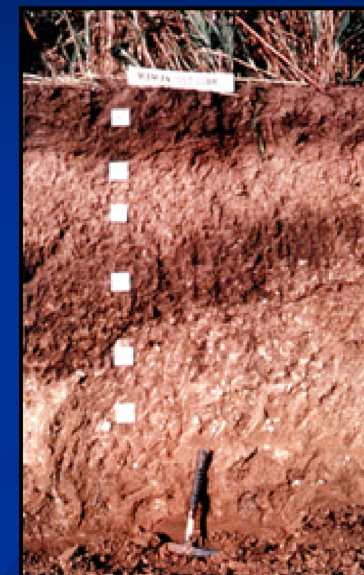
About 3000 counties in the United States have a soil survey.

Soils Have Unique Physical, Chemical, and Biological Properties Important to Their Use

color
texture
structure
consistence
roots
pores
other features







Soil is a natural body of solids, liquid, and gases, with either horizons or layers, and the ability to support rooted plants.

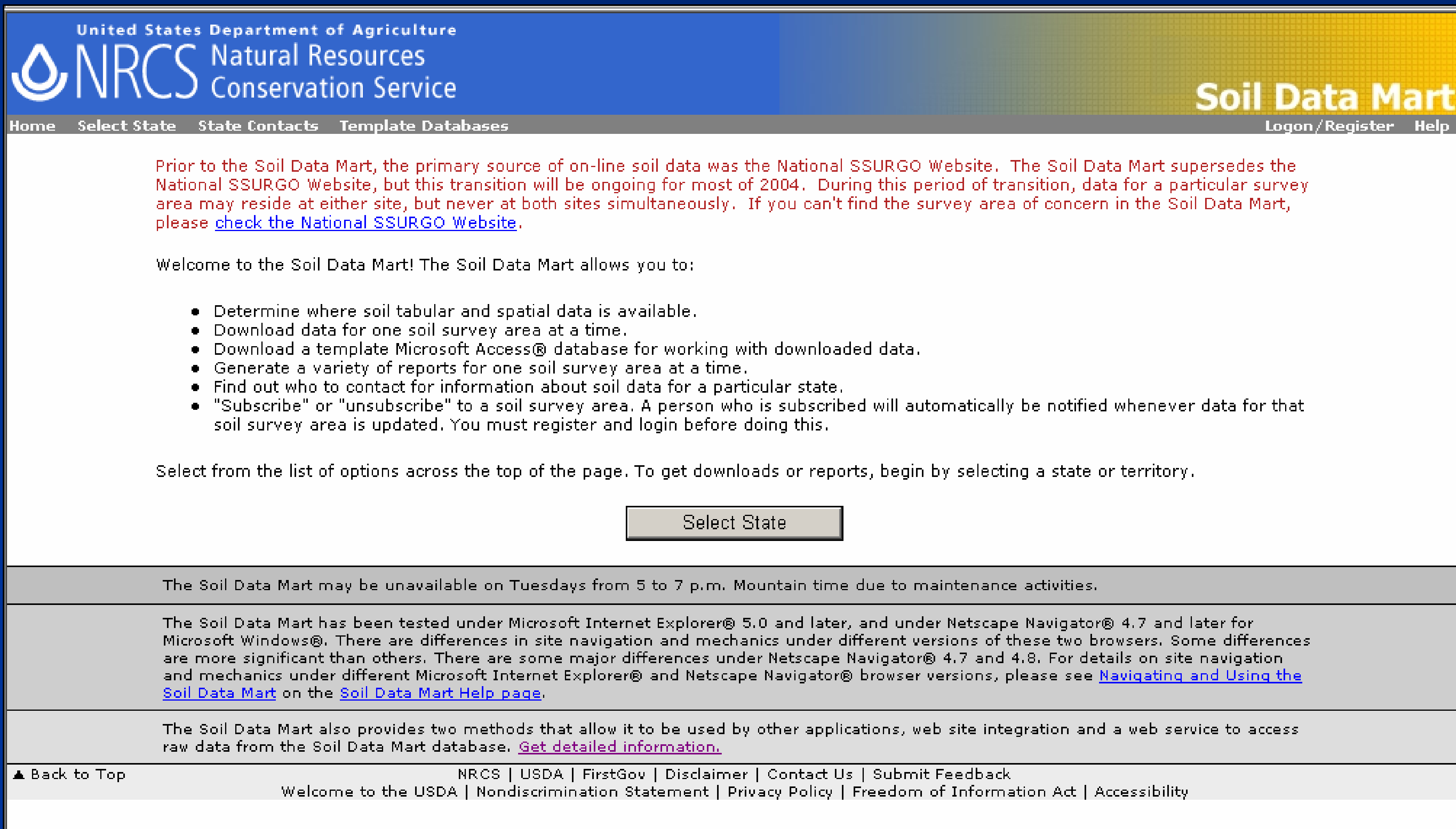
So how do you getting started using the Soil Data Mart ??

Go to the web site:

soildatamart.nrcs.usda.gov

Soil Data Mart Home Page

soildatamart.nrcs.usda.gov



Please select a state or territory with at least one survey area:

State or Territory Code	State or Territory Name	Available Survey Areas
NV	Nevada	1
NH	New Hampshire	0
NJ	New Jersey	0
NM	New Mexico	0
NY	New York	3
NC	North Carolina	67
ND	North Dakota	1
OH	Ohio	6
OK	Oklahoma	11
OR	Oregon	1
PA	Pennsylvania	18
RI	Rhode Island	0
SC	South Carolina	0
SD	South Dakota	0
TN	Tennessee	52
TX	Texas	1
UT	Utah	5
VT	Vermont	4

Select County

Select Survey Area

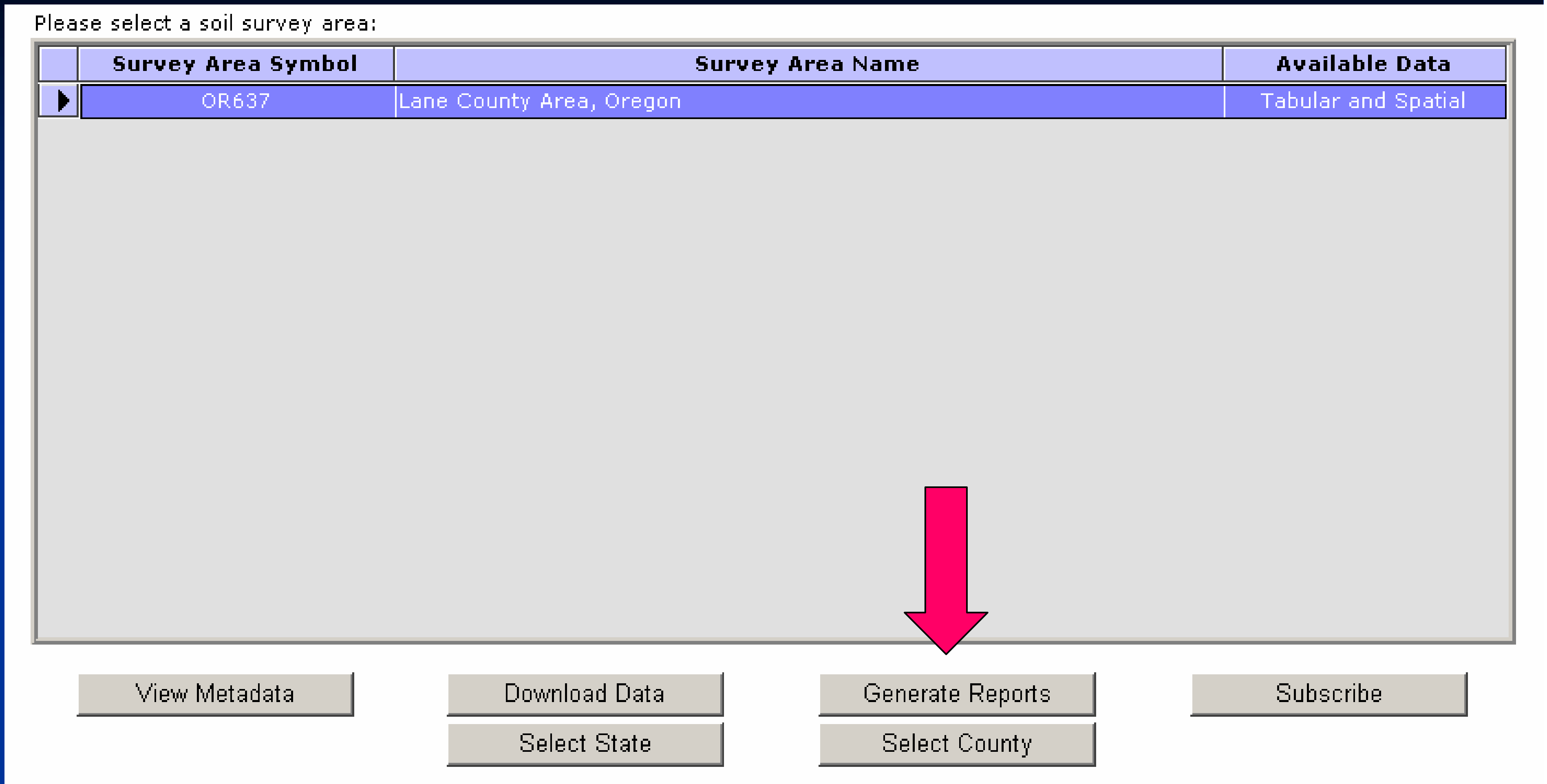
Select either a county or survey area. Some counties are covered by multiple soil survey areas, and some soil survey areas cover multiple counties.

Please select a county or parish with at least one survey area:

County Code	County Name	Available Survey Areas
OR025	HARNEY	0
OR027	HOOD RIVER	0
OR029	JACKSON	0
OR031	JEFFERSON	0
OR033	JOSEPHINE	0
OR035	KLAMATH	0
OR037	LAKE	0
OR039	LANE	1
OR041	LINCOLN	0
OR043	LINN	0
OR045	MALHEUR	0
OR047	MARION	0
OR049	MORROW	0
OR051	MULTNOMAH	0
OR053	POLK	0
OR055	SHERMAN	0
OR057	TILLAMOOK	0

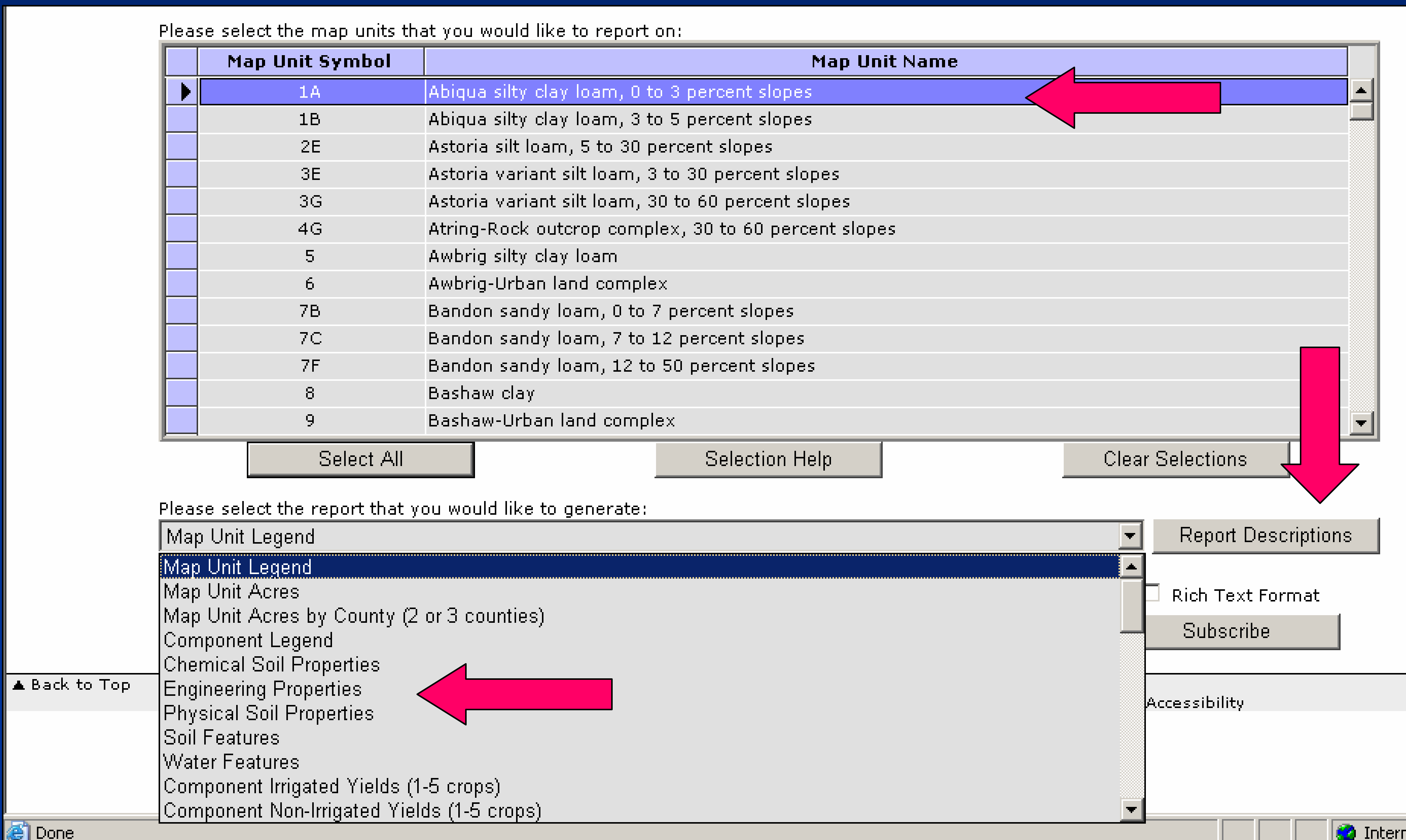
Select Survey Area

Then select a survey area. In the case of Lane County, there is one survey area available.



You can generate a variety of soils reports online.

Select the map units you want in the report and the type of report. There is also an option to include a report description.



Engineering Properties (H)

Lane County Area, Oregon

[Absence of an entry indicates that the data were not estimated]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				Pct	Pct					Pct	
1A:												
Abiqua	0-21	Silty clay loam	ML	A-6	0	0-5	100	95-100	95-100	85-95	35-40	10-15
	21-38	Clay, Silty clay, Silty clay loam	CH, CL	A-7	0	0-10	100	90-100	90-100	85-100	40-55	15-30
	38-60	Clay, Gravelly clay loam, Silty clay loam	ML	A-6, A-7	0	0-10	65-100	60-100	55-100	50-95	35-50	10-20
6:												
Bashaw	0-41	Clay	CH	A-7	0	0	100	95-100	95-100	85-95	70-90	40-60
	41-63	Clay, Sandy clay, Silty clay	CH	A-7	0	0	100	90-100	90-100	55-95	60-90	35-60
11C:												
Bellpine	0-13	Silty clay loam	CL	A-6, A-7	0	0-10	100	100	95-100	85-95	35-45	15-20
	13-34	Clay, Silty clay	MH	A-7	0	0-15	100	90-100	80-100	70-95	50-60	20-25
	34-44	Weathered bedrock	---	---	---	---	---	---	---	---	---	---
24:												
Chapman	0-8	Loam	ML	A-4	0	0	95-100	95-100	80-95	60-75	30-40	5-10
	8-42	Clay loam, Loam	ML	A-4, A-6	0	0	90-100	85-100	75-100	55-80	30-40	5-15
	42-50	Gravelly loam, Gravelly sandy loam	SM	A-1, A-2, A-4	0	0	70-80	60-70	35-55	20-40	20-25	NP-5
	50-60	Very gravelly sandy loam	GM	A-1	0	0	40-60	35-50	20-35	10-20	0-14	NP
29:												
Cloquato	0-14	Silt loam	ML	A-4	0	0	100	100	95-100	80-95	20-30	NP-5
	14-50	Silt loam	ML	A-4	0	0	100	100	95-100	75-90	20-30	NP-5
	50-60	Stratified sand to silt loam	SM	A-2	0	0	100	95-100	50-70	15-30	0-14	NP

NRCS Oregon Soil Survey Web Site:

www.or.nrcs.usda.gov/pnw_soil/or_data.html

United States Department of Agriculture
NRCS Natural Resources Conservation Service
Oregon

Oregon Home | About Us | News | Features | Programs | Technical Resources | Partnerships | PNW Soils | Contact Us | A A A

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Pacific Northwest Soils Region

- About
- Status of Soil Surveys
- Soil Survey Reports
- Spatial Data
- Databases
- Technical Information
- SSURGO2 Templates
- Map Finishing
- Contacts
- Links
- News

States in the Pacific Northwest Soils Region

- Idaho Soils
- Oregon Soils
- Washington Soils

Oregon Soil Survey Reports and Data

Soil Survey Reports

Oregon reports consist of maps, text, and tables. Maps can be viewed using an internet browser. The text and tables and be viewed using an internet browser or downloaded.

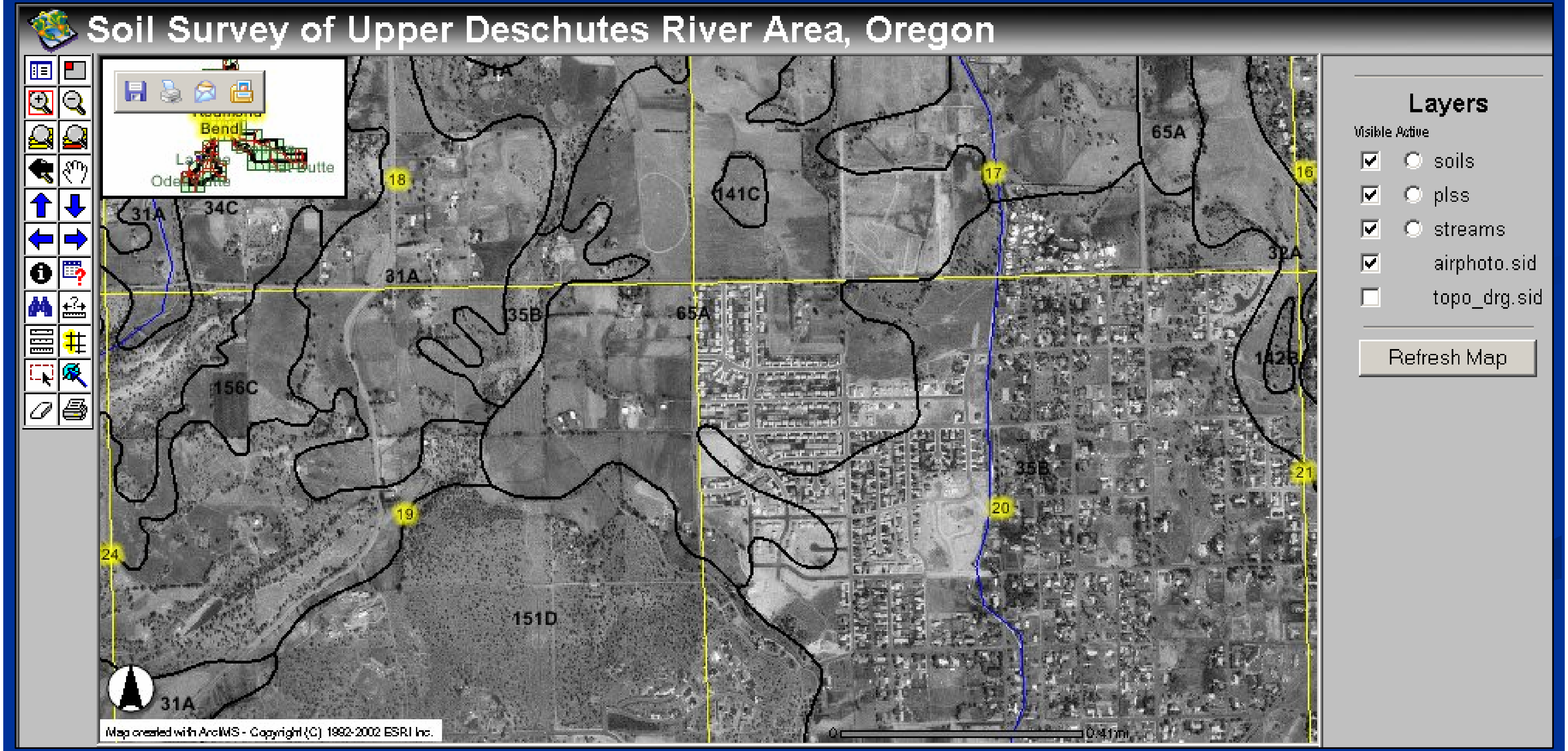
Soil Survey Data

Oregon data is available as shape files in two projections. Databases are formatted for use in Microsoft Access. Soil Data Viewer is an ArcView3.x extension that allows you to easily create soil-based thematic maps. Download the Soil Data Viewer extension and instructions.

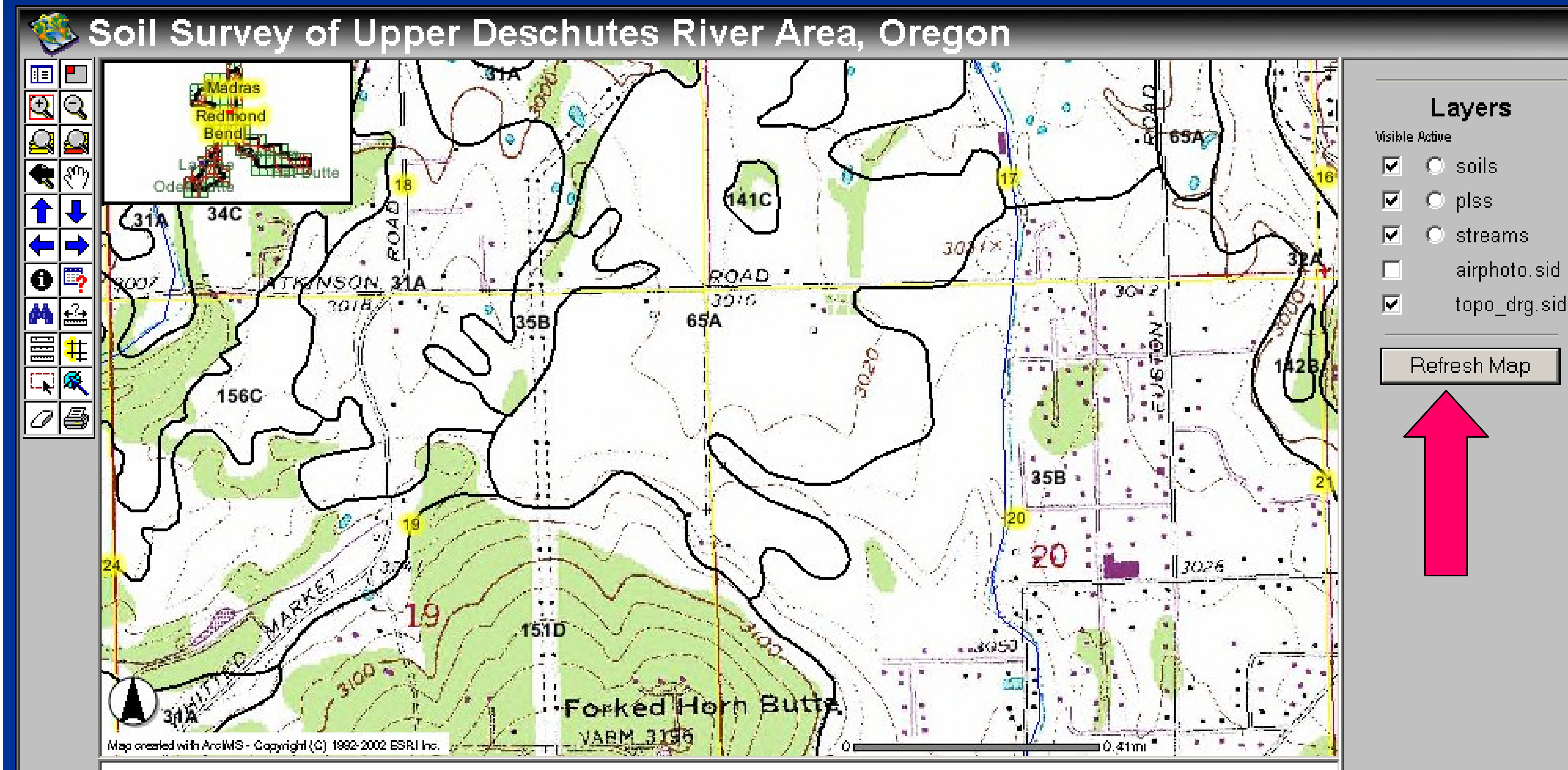
County	Survey
Baker	OR604 Baker County Area
Benton,Lincoln	OR601 Alsea Area
Benton	OR606 Benton County Area
Clackamas	OR610 Clackamas County
Clatsop	OR007 Clatsop County
Columbia	OR009 Columbia County
Coos	OR011 Coos County
Curry	OR015 Curry County

Click on the soil survey area of interest.

The soil map is displayed with a digital orthophoto background. Section lines are in yellow. Section numbers are highlighted in yellow.



You can also display soil maps with a topographic map background. Click on the “topo_drg.sid” layer then “Refresh Map”

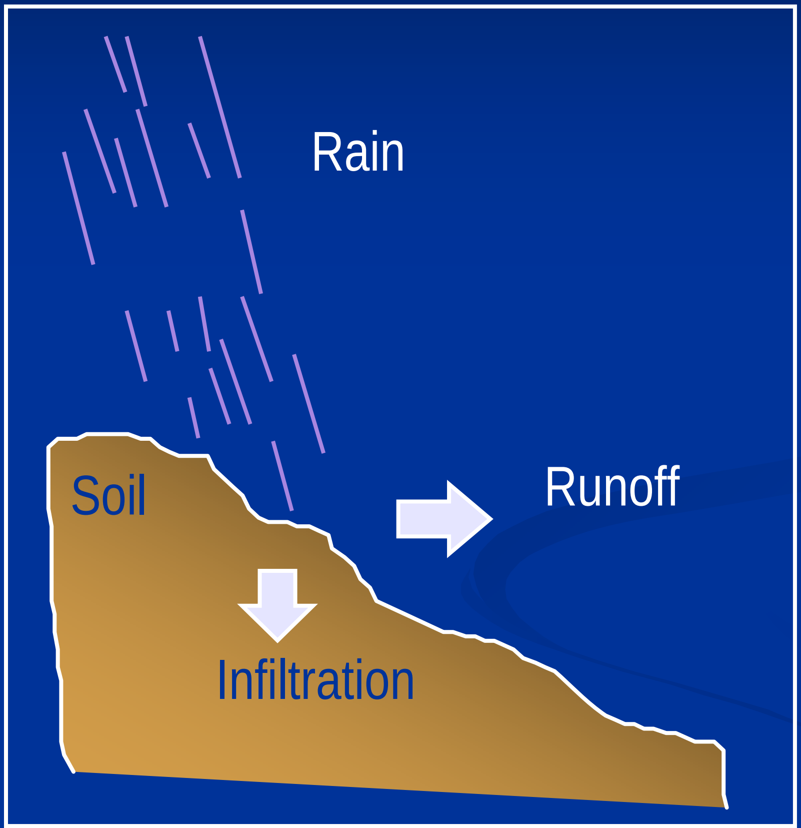


Let's say you've selected a purpose for the pond

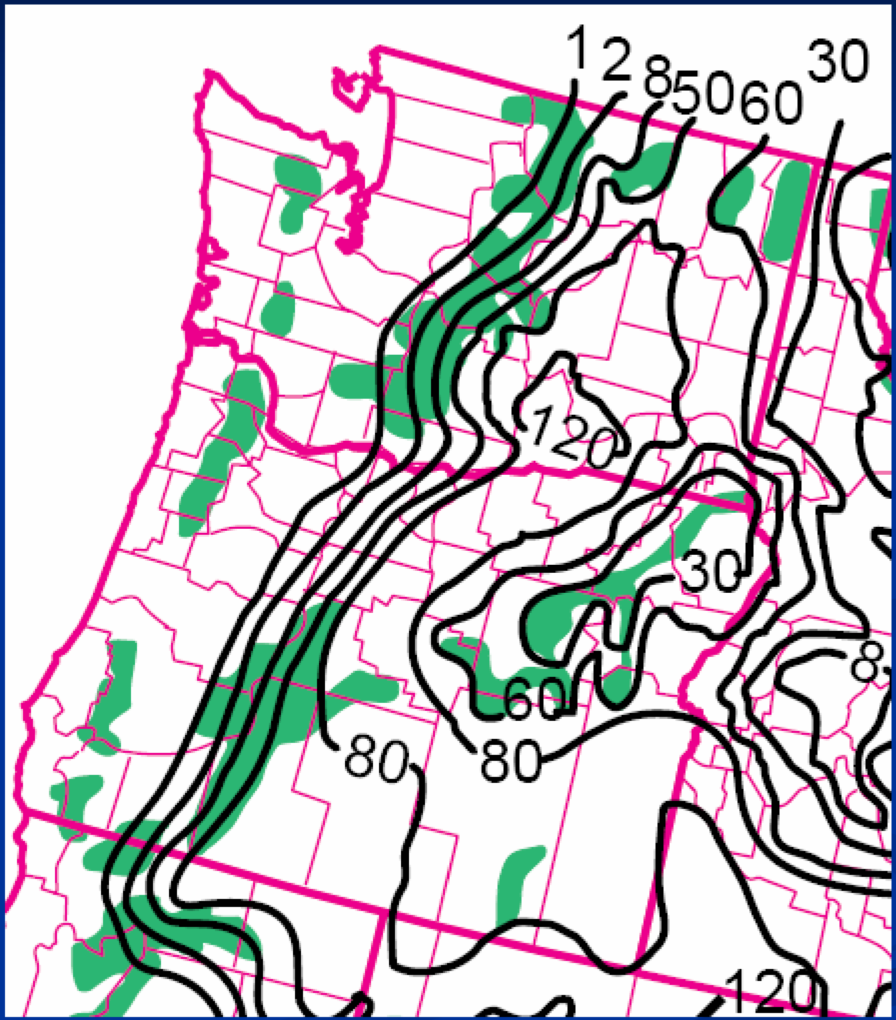
- Irrigation
- Fish and wildlife/recreation
- Waste storage
- Livestock water supply
- Fire protection

Watershed hydrology is next

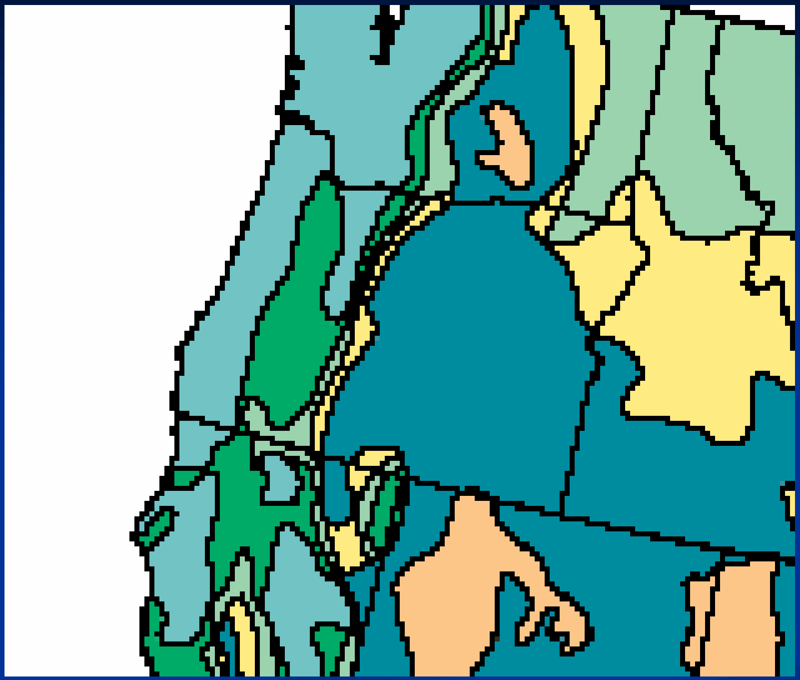
- Determine watershed area that will contribute water to the pond.
- Determine the amount of runoff to the pond site.

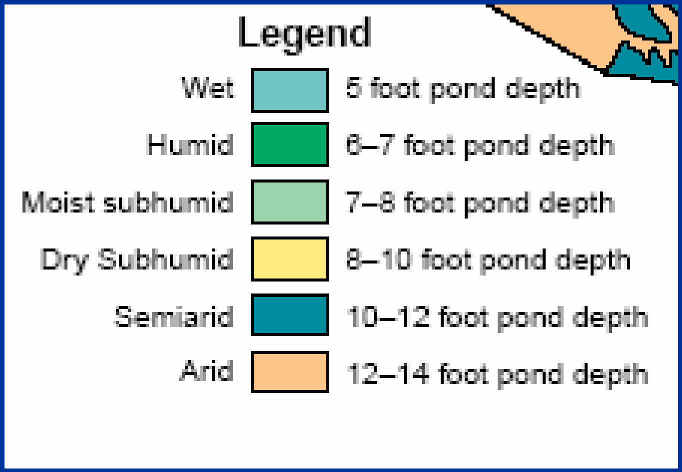

Rain
Runoff
Soil
Infiltration

Estimated drainage area in acres required for each acre-foot of storage in a pond.



Recommended minimum depth of water for ponds.





Determine pond capacity

- Rule of thumb method for determining capacity of pond:
  - Determine max. depth at dam.
  - Determine surface area (acres).
  - Multiply by 0.4
  - Result is in acre-feet of storage.
  - 1 acre-foot = 325,651 gallons

Estimating storm runoff from catchment area

- NRCS procedure
- Requires assessment of land use, cover, and soils in the catchment area or watershed.
- Uses NOAA Atlas for precipitation data
- Tool that can be used is Win-TR55 by NRCS. Find it at: http://www3.wcc.nrcs.usda.gov/hydro/hydro-tools-models-wintr55.html

Hydrologic Soil Groups

- **Group A** is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Hydrologic Soil Groups

- **Group B** is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Hydrologic Soil Groups

- **Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Hydrologic Soil Groups

- **Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface and shallow soils over nearly impervious material.

Runoff curve numbers

- Curve numbers are related to hydrologic soil groups and land use/land cover.
- The higher the curve number value, the higher the runoff, e.g. concrete and other impervious surfaces have a curve number of 98.
- Refer to reference tables for typical values.
- Develop a weighted curve number for the watershed.

Web resources

- There are many places on the web that have aids to help with runoff calculations.
  - Here's one at Purdue Univ.: http://www.ecn.purdue.edu/runoff/

Volume of storm runoff

- Storm runoff volume is important to know for a given frequency event:
  - This volume is needed to compute storage, as well as the peak discharge rate for the storm.
  - See page 18 in Ag. Handbook 590

Runoff depth

Table 5 Runoff depth, in inches

Rainfall (inches)	Curve number 60	65	70	75	80	85	90
1.0	0	0	0	0.03	0.08	0.17	0.32
1.2	0	0	0.03	0.07	0.15	0.28	0.46
1.4	0	0.02	0.06	0.13	0.24	0.39	0.61
1.6	0.01	0.05	0.11	0.20	0.34	0.52	0.76
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88
6.0	1.92	2.35	2.87	3.28	3.78	4.31	4.85
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78
11.0	5.72	6.44	7.13	7.82	8.48	9.14	9.77
12.0	6.56	7.32	8.05	8.76	9.45	10.12	10.76

Given: 3-inch rainfall on 100 acres; wt. CN = 75; runoff depth = 0.96; volume = (0.96x100)/12 = 8 acre-feet.

Hydrology

- This runoff volume for a 3-inch rainfall may be related to a given frequency storm event.
- The peak discharge from the drainage area to the pond will be important for designing the principal and auxiliary spillways.
- These structures are sized to allow excess runoff to be safely routed through the pond and on downstream without endangering the dam.

Site surveys

- Conduct a site survey to layout the dam centerline, spillways and other features.
- A profile of the dam centerline is used to set the top of the dam, determine pond capacity, and locate the spillways.
- It is also used to compute the volume of earthfill required to build the dam.

Surveys

- Establish a similar centerline for the auxiliary spillway, beginning on the upstream end well below the pond's normal water surface and continuing downstream where water can be safely discharged without endangering the dam.
- Establish a benchmark that will not be disturbed during construction and tie all survey points to this.

Embankment ponds

- A detailed soils investigation is required to determine the characteristics of the soils on site.
  - Will they hold water in the reservoir?
  - What materials can be used for embankment construction? Can borrow be taken from the floor of the reservoir area or does it need to come from upland sources?

Foundation conditions

- Foundation must be able to support the weight of the dam to ensure stability and provide resistance to seepage.
- Soil borings or test pits can be used to investigate the foundation conditions.
- Holes should be at least 1.5 times the height of the dam.
- Ensure there are no steep dropoffs that might cause cracking of the dam.

Foundation conditions

- If the foundation is on rock or excavated to bedrock, the rock should be examined for thickness and for fissures and seams that will pass water.
- Sand and gravel deposits in the foundation should be removed to decrease seepage potential.
- A cutoff core trench of impervious compacted material can be installed under the dam, or an upstream blanket of similar material can be placed on the dam and pond area.

Foundation conditions

- Fine-grained materials, such as silts and clays, are relatively impervious, but may have a low degree of stability (soft and compressible).
- Flattening the side slopes of the dam may be required to decrease the unit load on a soft foundation.
- Peat, muck or any soil with high organic-matter content should be removed from the foundation.

Foundation conditions

- Good foundation materials are those that provide both stability and imperviousness.
  - These include mixtures of coarse- and fine-textured soils, such as gravel-sand-clay mixtures, gravel-sand-silt mixture, and sand-clay or sand-silt mixtures.
  - Less desirable but ok foundation materials include gravelly clays, sandy clays, silty clays, silty and clayey fine sands, and clayey silts that have slight plasticity.
  - Undisturbed sampling may be needed to test strength of foundation materials (large dams only).

Fill material

- Availability of suitable fill is a determining factor in site selection.
- Locate enough soil volume to meet 1.5 times the volume required for the dam.
  - This will allow for shrinkage and volume loss due to compaction of the soil when building the dam.
  - If site conditions allow, borrow can be taken from within the pond area.

Fill material

- Need to know the engineering properties of the soils available at the site.
- Some soil mechanics tests are required to determine these properties.
- Index tests: will give USCS classification and plasticity index
- Soil/moisture/density tests: will give information needed to determine construction properties of the soil materials.
- Special tests needed to determine shrink-swell potential (clays) and whether soils are dispersive.

EMBANKMENTS									
COMPACTION CHARACTERISTICS	STANDARD PROCTER UNIT DENSITY LBS. PER CU. FT.	TYPE OF ROLLER DESIRABLE	RELATIVE CHARACTERISTICS		RESISTANCE TO PIPING	ABILITY TO TAKE PLASTIC DEFORMATION UNDER LOAD WITHOUT SHEARING	GENERAL DESCRIPTION & USE	UNIFIED SOIL CLASSES
			PERMEABILITY	COMPRESSIBILITY				
Good	125-135	crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Very stable, pervious shells of dikes and dams.	GW
Good	115-125	crawler tractor or steel wheeled & vibratory	High	Very Slight	Good	None	Reasonably stable, pervious shells of dikes and dams.	GP
Good with close control	120-135	rubber-tired or sheepsfoot	Medium	Slight	Poor	Poor	Reasonably stable, not well suited to shells but may be used for impervious cores or blankets.	GM
Good	115-130	sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, may be used for impervious core.	GC
Good	110-130	crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair	None	Very stable, pervious sections, slope protection required.	SW
Good	100-120	crawler tractor & vibratory or steel wheeled	High	Very Slight	Fair to Poor	None	Reasonably stable, may be used in dike with flat slopes.	SP
Good with close control	110-125	rubber-tired or sheepsfoot	Medium	Slight	Poor to Very Poor	Poor	Fairly stable, not well suited to shells, but may be used for impervious cores or dikes.	SM
Good	105-125	sheepsfoot or rubber-tired	Low	Slight	Good	Fair	Fairly stable, use for impervious core for flood control structures.	SC
Good to Poor Close control essential	95-120	sheepsfoot	Medium	Medium	Poor to Very Poor	*Very Poor	Poor stability, may be used for embankments with proper control. *Varies with water content.	ML
Fair to Good	95-120	sheepsfoot	Low	Medium	Good to Fair	Good to Poor	Stable, impervious cores and blankets.	CL
Fair to Poor	80-100	sheepsfoot	Medium to Low	Medium to High	Good to Poor	Fair	Not suitable for embankments.	OL
Poor to Very Poor	70-95	sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Poor stability, core of hydraulic fill dam, not desirable in rolled fill construction.	MH
Fair to Poor	75-105	sheepsfoot	Low	High	Excellent	Excellent	Fair stability with flat slopes, thin cores, blanket & dike sections.	CH
Poor to Very Poor	65-100	sheepsfoot	Medium to Low	Very High	Good to Poor	Good	Not suitable for embankments.	OH
DO NOT USE FOR EMBANKMENT CONSTRUCTION								Pt

CHANNELS: LONG DURATION TO CONSTANT FLOWS. RELATIVE DESIRABILITY: EROSION RESISTANCE	CHANNELS: RELATIVE DESIRABILITY: COMPACTED EARTH LINING	FOUNDATION: BEARING VALUE	FOUNDATION: RELATIVE DESIRABILITY: SEEPAGE IMPORTANT	FOUNDATION: RELATIVE DESIRABILITY: SEEPAGE NOT IMPORTANT	FOUNDATION: REQUIREMENTS FOR SEEPAGE CONTROL: PERMANENT RESERVOIR	FOUNDATION: REQUIREMENTS FOR SEEPAGE CONTROL: FLOODWATER RETARDING	UNIFIED SOIL CLASSES
1	-	Good	-	1	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.	GW
2	-	Good	-	3	Positive cutoff or blanket	Control only within volume acceptable plus pressure relief if required.	GP
4	4	Good	2	4	Core trench to none	None	GM
3	1	Good	1	6	None	None	GC
6	-	Good	-	2	Positive cutoff or upstream blanket & toe drains or wells.	Control only within volume acceptable plus pressure relief if required.	SW
7 if gravelly	-	Good to Poor depending upon density	-	5	Positive cutoff or upstream blanket & toe drains or wells.	Control only within volume acceptable plus pressure relief if required	SP
8 if gravelly	5 erosion critical	Good to Poor depending upon density	4	7	Upstream blanket & toe drains or wells	Sufficient control to prevent dangerous seepage piping.	SM
5	2	Good to Poor	3	8	None	None	SC
-	6 erosion critical	Very Poor, susceptible to liquefication	6, if saturated or pre-wetted	9	Positive cutoff or upstream blanket & toe drains or wells.	Sufficient control to prevent dangerous seepage piping.	ML
9	3	Good to Poor	5	10	None	None	CL
-	7 erosion critical	Fair to Poor, may have excessive settlement	7	11	None	None	OL
-	-	Poor	8	12	None	None	MH
10	8 volume change critical	Fair to Poor	9	13	None	None	CH
-	-	Very Poor	10	14	None	None	OH
-	-	REMOVE FROM FOUNDATION					Pt

FOUNDATION SOILS, BEING UNDISTURBED, ARE INFLUENCED TO A GREAT DEGREE BY THEIR GEOLOGIC ORIGIN. JUDGEMENT AND TESTING MUST BE USED IN ADDITION TO THESE GENERALIZATIONS.

TYPICAL NAMES	IMPORTANT PROPERTIES						UNIFIED SOIL CLASSES
	SHEAR STRENGTH	COMPRESS-IBILITY	WORKABILITY AS CONSTRUCTION MATERIAL	PERMEABILITY WHEN COMPACTED	PERMEABILITY K CM. PER SEC.	PERMEABILITY K FT. PER DAY	
Well graded gravels, gravel-sand mixtures, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-2}$	$K > 30$	**GW**
Poorly graded gravels, gravel-sand mixtures, little or no fines.	Good	Negligible	Good	Very Pervious	$K > 10^{-2}$	$K > 30$	**GP**
Silty gravels, gravel-sand-silt mixtures.	Good to Fair	Negligible	Good	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	**GM**
Clayey gravels, gravel-sand-clay mixtures.	Good	Very Low	Good	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	**GC**
Well graded sands, gravelly sands, little or no fines.	Excellent	Negligible	Excellent	Pervious	$K > 10^{-3}$	$K > 3$	**SW**
Poorly graded sands, gravelly sands, little or no fines.	Good	Very Low	Fair	Pervious	$K > 10^{-3}$	$K > 3$	**SP**
Silty sands, sand-silt mixtures.	Good to Fair	Low	Fair	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	**SM**
Clayey sands, sand-clay mixtures.	Good to Fair	Low	Good	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	**SC**
Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Fair	Medium to High	Fair	Semi-Pervious to Impervious	$K = 10^{-3}$ to 10^{-6}	$K = 3$ to 3×10^{-3}	**ML**
Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Fair	Medium	Good to Fair	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	**CL**
Organic silts and organic silty clays of low plasticity.	Poor	Medium	Fair	Semi-Pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-1}$ to 3×10^{-3}	**OL**
Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Fair to Poor	High	Poor	Semi-Pervious to Impervious	$K = 10^{-4}$ to 10^{-6}	$K = 3 \times 10^{-1}$ to 3×10^{-3}	**MH**
Inorganic clays of high plasticity, fat clays.	Poor	High to Very High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	**CH**
Organic clays of medium to high plasticity, organic silts.	Poor	High	Poor	Impervious	$K = 10^{-6}$ to 10^{-8}	$K = 3 \times 10^{-3}$ to 3×10^{-5}	**OH**
Peat and other highly organic soils.	NOT SUITABLE FOR CONSTRUCTION						**Pt**

Principal Spillways

- Principal spillways allow for passage of excess water during small storm events and reduce the frequency of operation of the auxiliary spillway.
  - Usually sized to control runoff up to a 10-year frequency storm.
  - Design should be performed by someone with training and experience in engineering and sizing hydraulic structures.

Auxiliary spillways

- These operate during infrequent storms and protect the embankment from being overtopped by water from the pond.
  - Having adequate capacity in the auxiliary spillway is critical.
  - Again design is best left to experienced engineer.

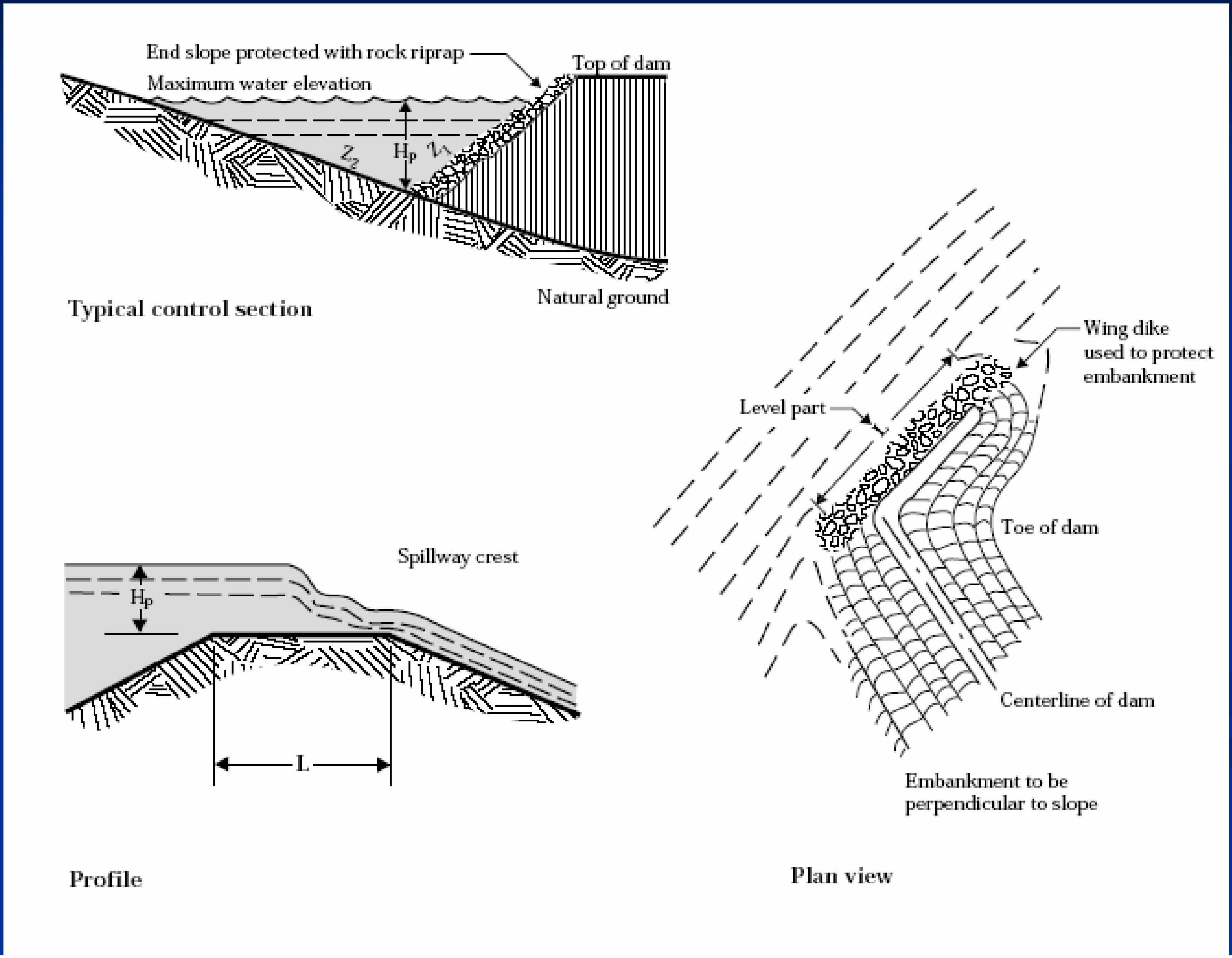
Spillway design guide

Table 7 Minimum spillway design storm

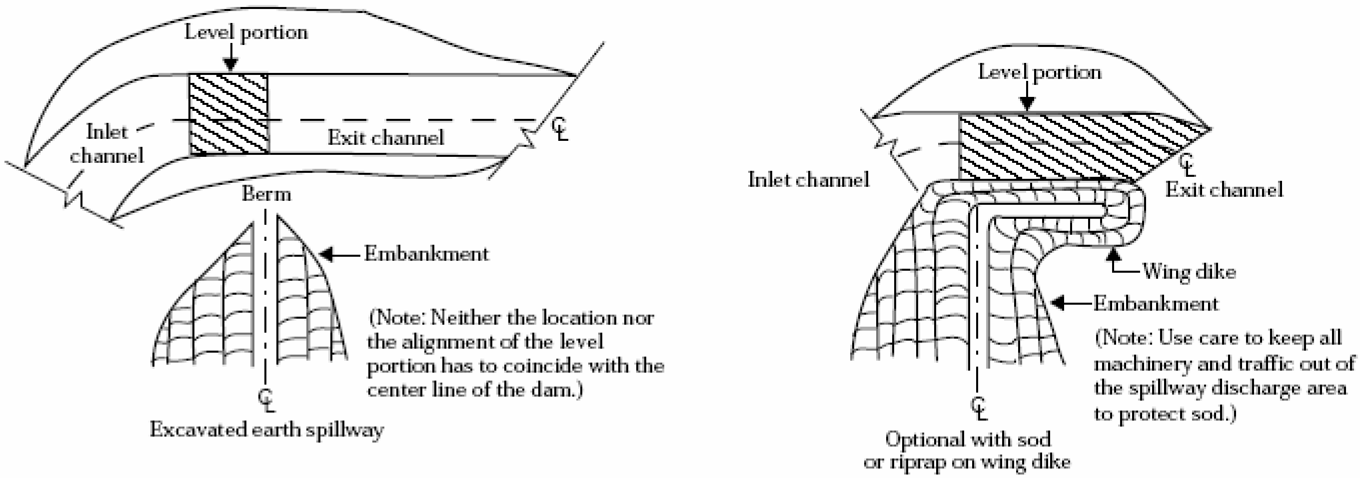
Drainage area (acre)	Effective height of dam 1/ (ft)	Storage (acre-ft)	Minimum design storm: Frequency (yr)	Minimum design storm: Minimum duration (hr)
20 or less	20 or less	Less than 50	10	24
20 or less	More than 20	Less than 50	25	24
More than 20	20 or less	Less than 50	25	24
All others			50	24

1/ The effective height of the dam is the difference in elevation between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam.

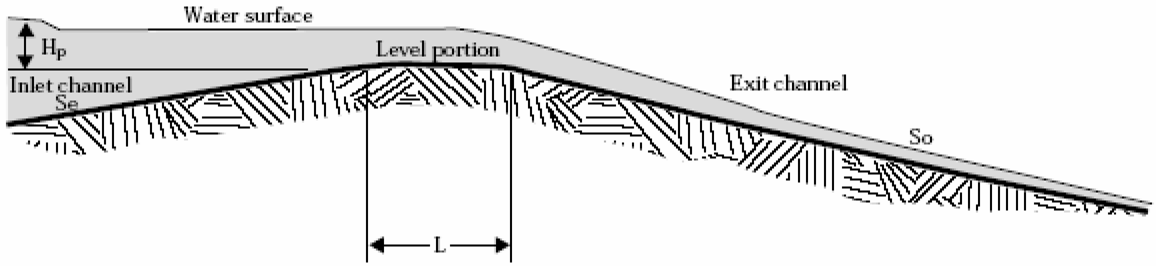
Plan, profile, and cross section of excavated spillway



Excavated earth spillway



Plan view of earth spillways

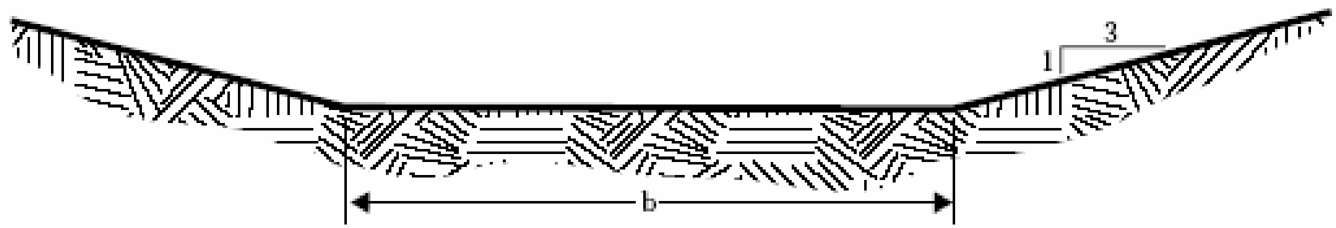


Profile along centerline

Definition of terms:

H_p = depth of water in reservoir above crest
L = length of level portion min. 25 ft
b = bottom width of spillway
So = slope for exit channel
Se = slope of inlet channel

Excavated earth spillway



Cross section of level portion

Conduits through dams (principal spillways)

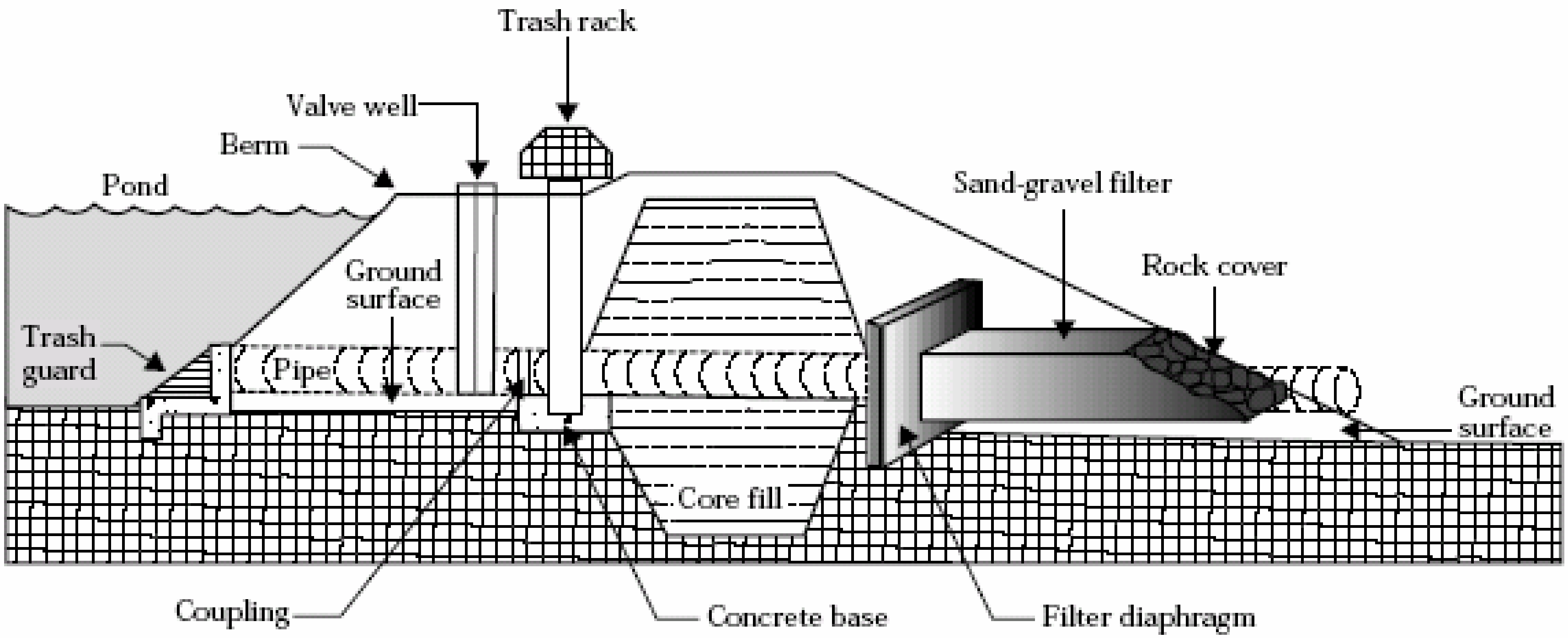
Require careful installation to protect from piping and internal scour along the conduit.

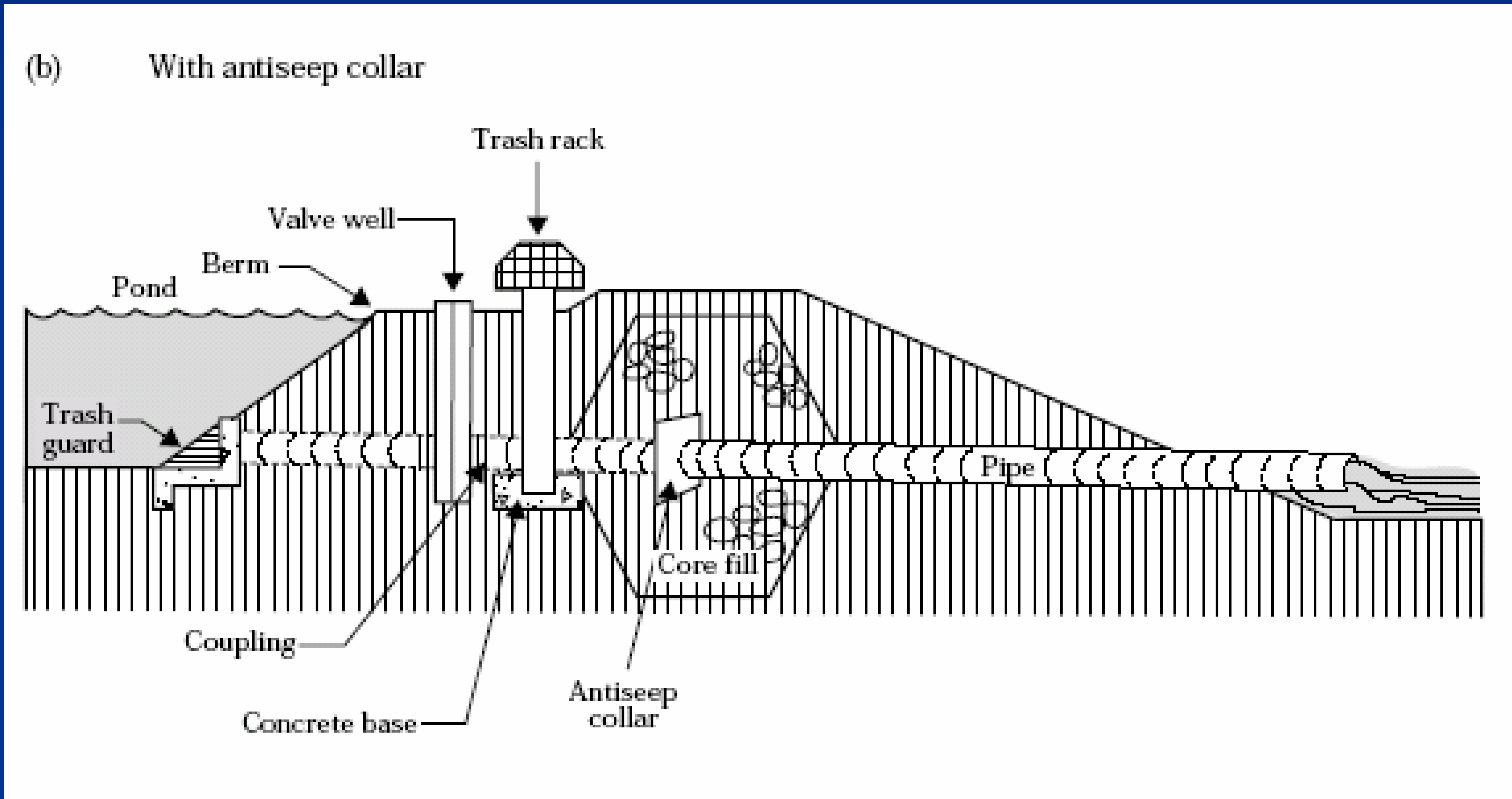
- Use of Anti-seep collars
- Use of Filter diaphragms

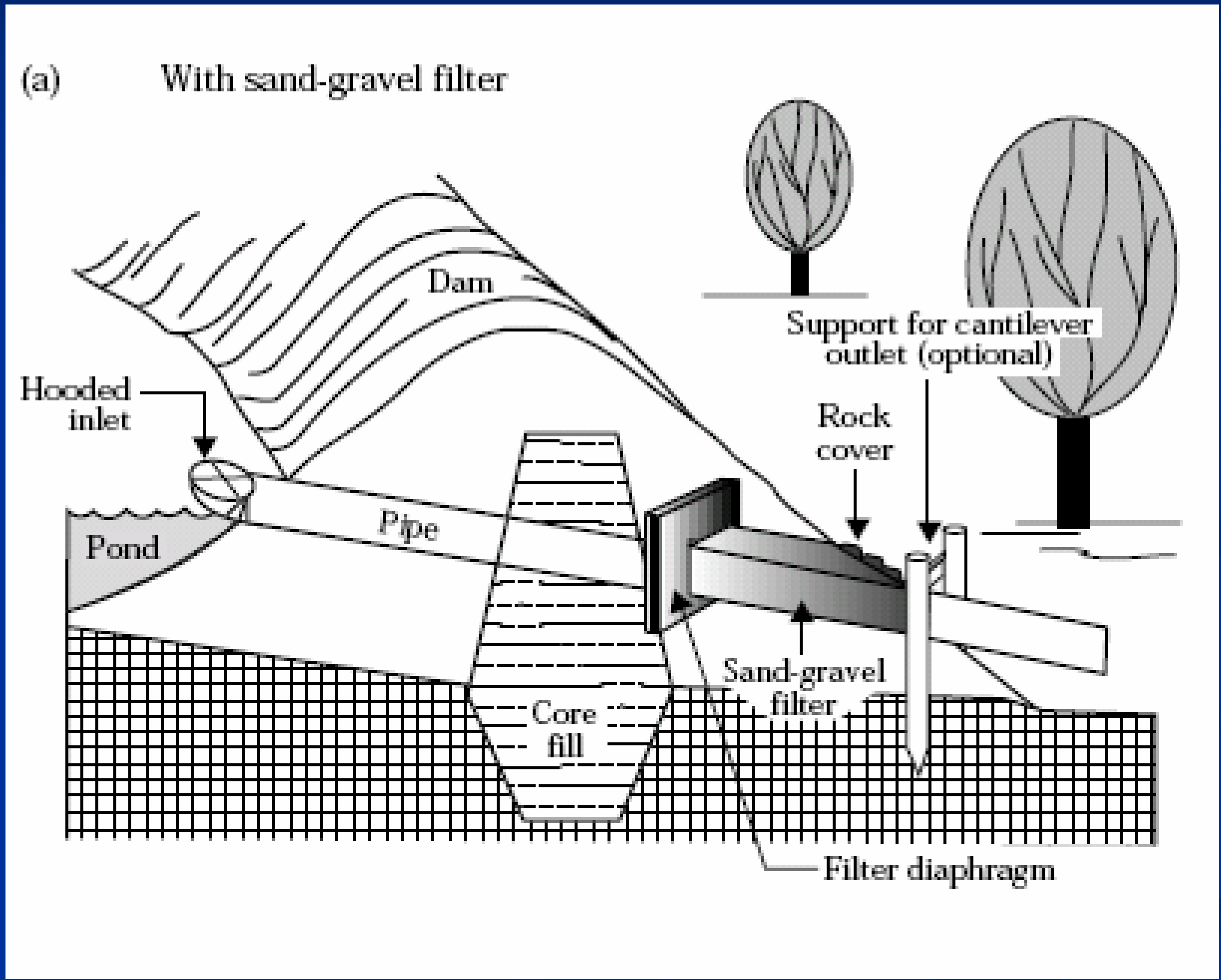
Figure 22 Drop-inlet pipe spillway with antiseep collar

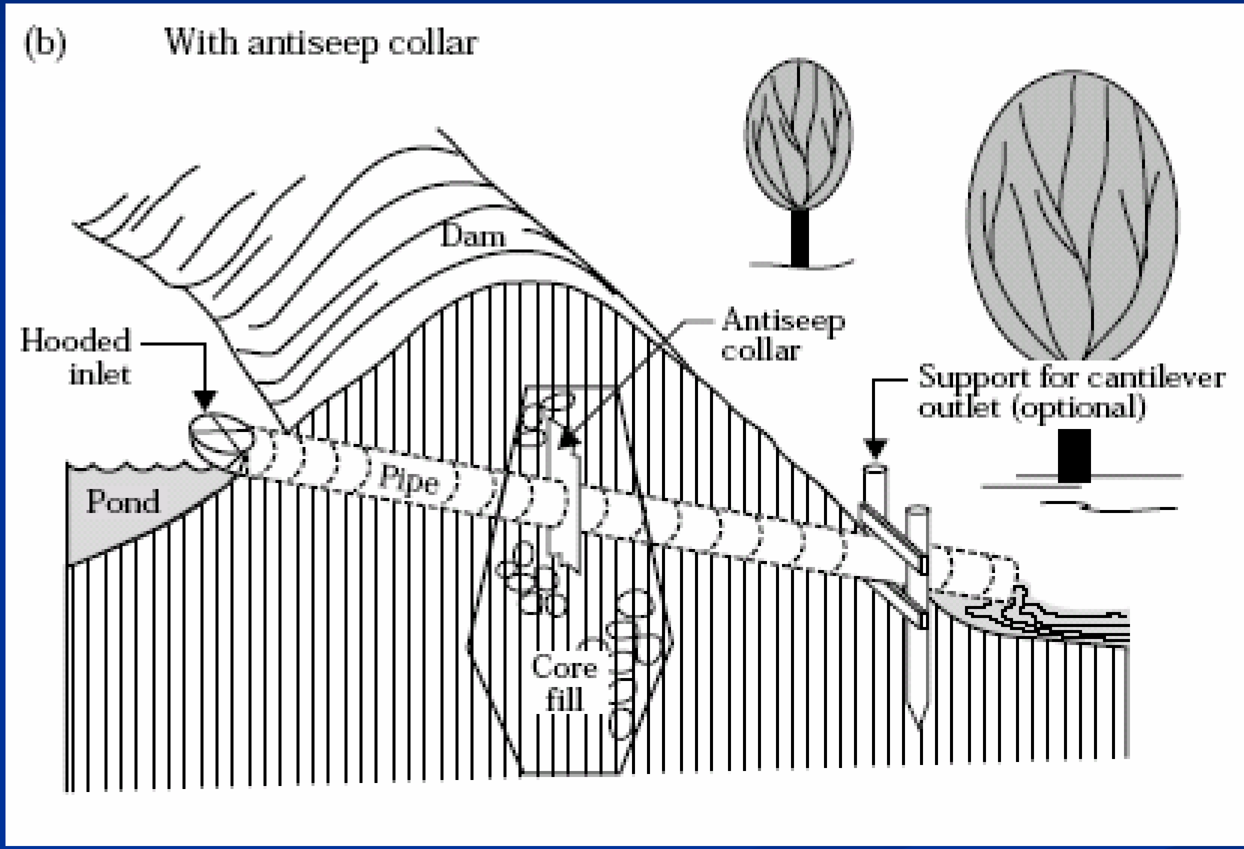
Figure 23 Drop-inlet pipe spillways

(a) With sand-gravel filter




(b) With antiseep collar
Trash rack
Valve well
Berm
Pond
Trash guard
Pipe
Core fill
Coupling
Concrete base
Antiseep collar


(a) With sand-gravel filter
Dam
Support for cantilever outlet (optional)
Hooded inlet
Rock cover
Pond
Pipe
Sand-gravel filter
Core fill
Filter diaphragm


(b) With antiseep collar
Dam
Hooded inlet
Antiseep collar
Support for cantilever outlet (optional)
Pond
Pipe
Core fill

Pond construction

- Construction stake-out and site preparation
- Core trench excavation
- Placement of earthfill in the embankment
- Principal spillway
- Auxiliary spillway
- Toe drain
- Replace topsoil and seed the site to appropriate vegetation

Soil compaction

- Equipment types:

  Sheepsfoot roller

  Vibratory roller

  Rubber-tired loaded scraper

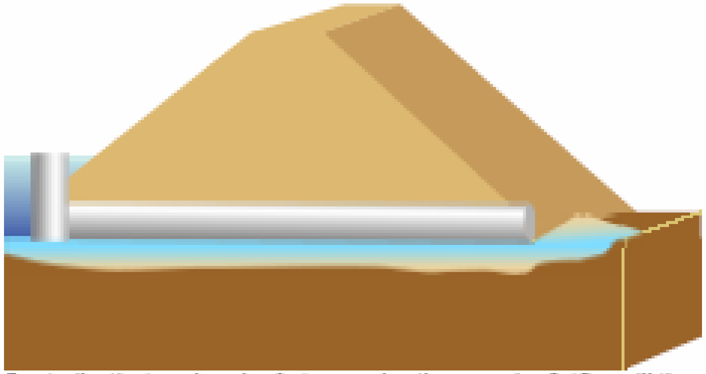
Soil lifts for compaction should not be more than 9 inches thick.

Problems sites

Figure 5.—Embankment dam failure caused by internal erosion of earthfill near the conduit. Flow was not directly along the contact between earthfill and conduit, but in the earthfill away from conduit. Hydraulic fracture in highly dispersive clay embankment soils caused the failure. The embankment design included antiseep collars, but not a filter diaphragm.

Figure 17.—Failure of an embankment dam following first filling. The failure was attributed to internal erosion because the time required for seepage to develop through the compacted embankment and cause failure was very short. Also, the soils are not the type ordinarily considered susceptible to backward erosion piping. Antiseep collars were not effective in preventing the failure.

Figure 18.—Antiseep collars were not adequate to prevent the internal erosion failure of this embankment dam. The internal erosion that occurred on first filling of the reservoir occurred in dispersive clay soils that are not susceptible to backward erosion piping.



Eventually, the tunnel erosion feature reaches the reservoir. Outflow will then increase substantially, leading to direct erosion of the embankment dam and complete breach or draining of the reservoir through the tunnel that develops.

The resulting failure often completely destroys the embankment dam, leaving few traces of the original piping tunnel. The failure of this embankment dam was attributed to piping of foundation sands. Photo courtesy of National Oceanic and Atmospheric Administration.

Figure 10 (cont'd).—The backward erosion piping process associated with intergranular seepage and the subsequent backward erosion of soil particles.


DEERE

Construction traffic considerations


FIATALLIS


SAMSUNG
Rhine
SE 210

Investigate sites by excavating test pits to observe soil stratigraphy


CATERPILLAR

Problems with existing ponds

- Excessive seepage.
  - Poor geologic conditions
  - Poorly designed
  - Improper construction
    - Leaky dam
    - Leaky foundation or abutments
- Does not fill to capacity.
  - Poor hydrology/watershed runoff
  - Oversized design for the site

My pond is leaking—
what can I do to seal it up?

Leaking ponds:

- This is usually the result of improper construction or construction on poor soils
- Preventive actions that can be taken:
  - Construct only on good soils
  - Use correct construction procedures
- Corrective actions that can be taken:
  - Add a layer of clay to the pond bottom
  - Add a modified core trench in weak area
  - Install a plastic liner

Proper soils for construction:

- Soils must be impermeable to water
- Soils must therefore have a minimum clay content:
  - 20% clay for general purposes
  - 30% clay for dam cores
- Some sand, silt, and even gravel in the mix is good—but the amount of each of these should be limited

Proper pond construction procedures:

- **Remove topsoil from the dam area**
- **Build a core trench into the base of the dam**
- **Extend core trench well into a clay layer below the original ground surface**
- **Back-fill core trench with high-clay soil ($\geq$ 30% clay)**
- **Compact backfill soil in layers $\leq$ 6" thick**

Core trench construction:



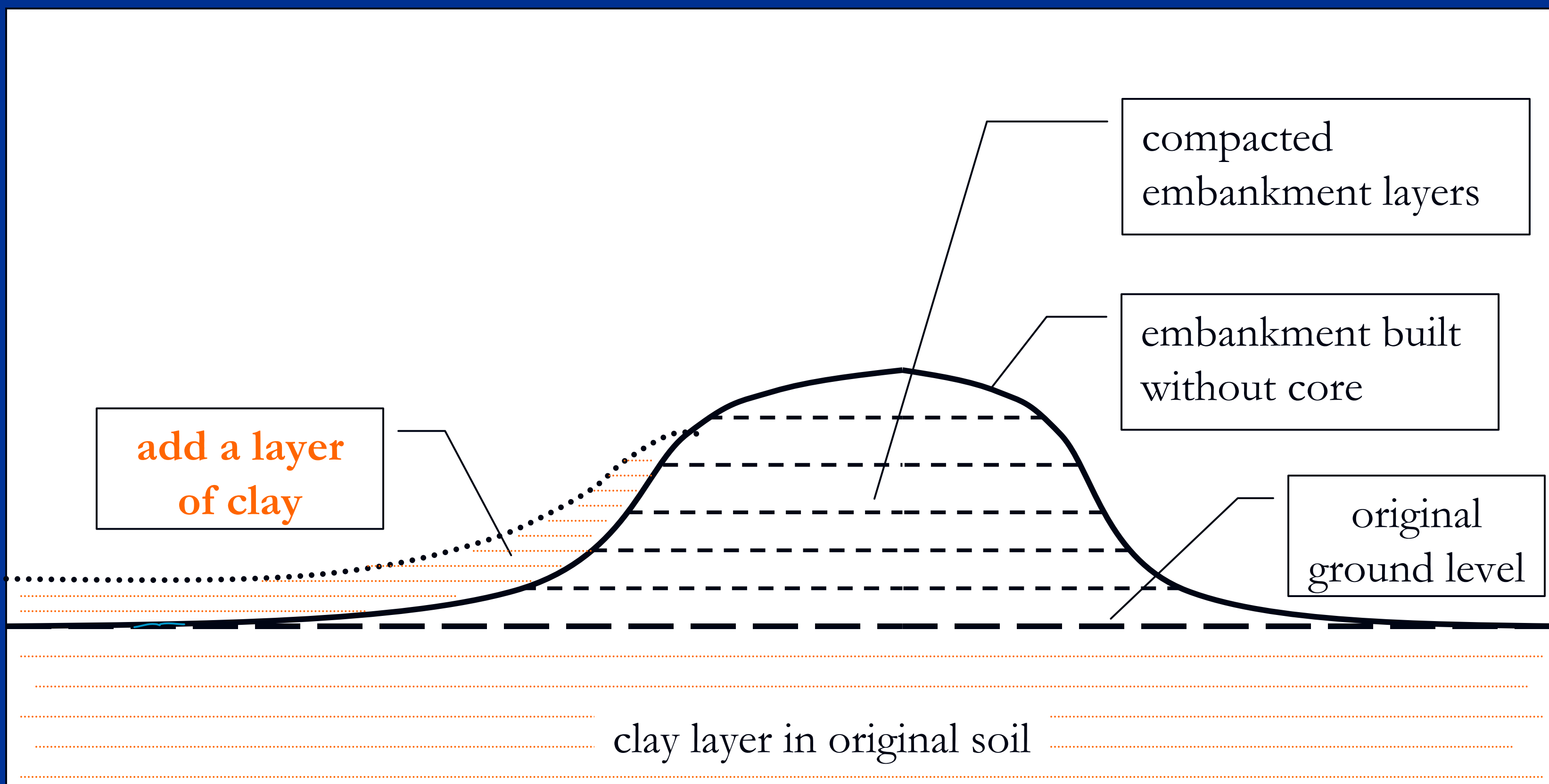

Core trench construction:

Core trenches can also be excavated by hand

Sealing pond with compacted clay liners:

- **Work during the dry season**
- **Drain the pond and allow it to dry**
- **Bring in soil with ≥ 30% clay**
- **Spread a ≤ 6” thick layer evenly over pond bottom and up embankments**
- **Compact with a sheepsfoot roller**

Adding a clay blanket to an existing pond:

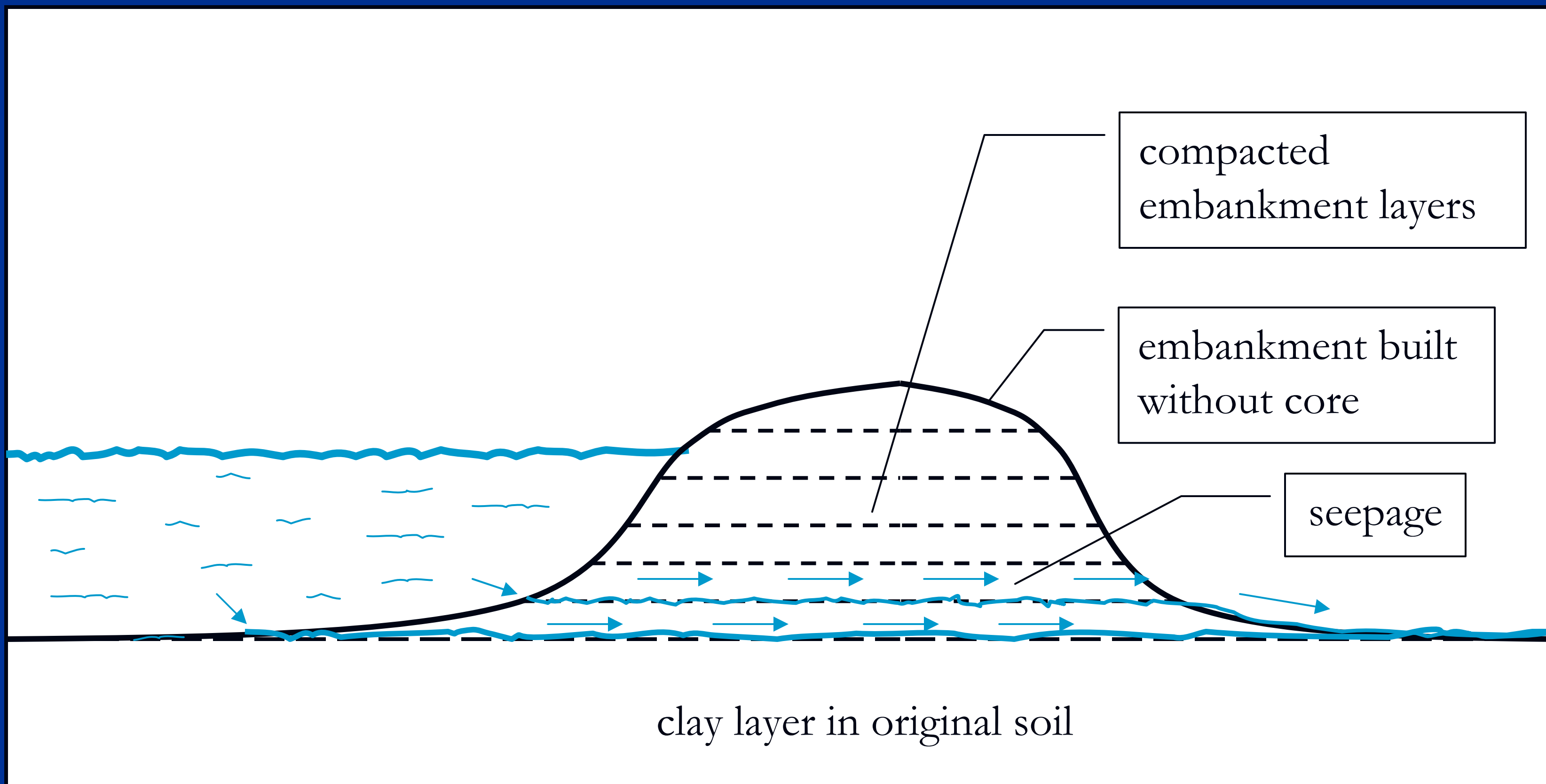


Sealing a pond bottom by adding a clay blanket:

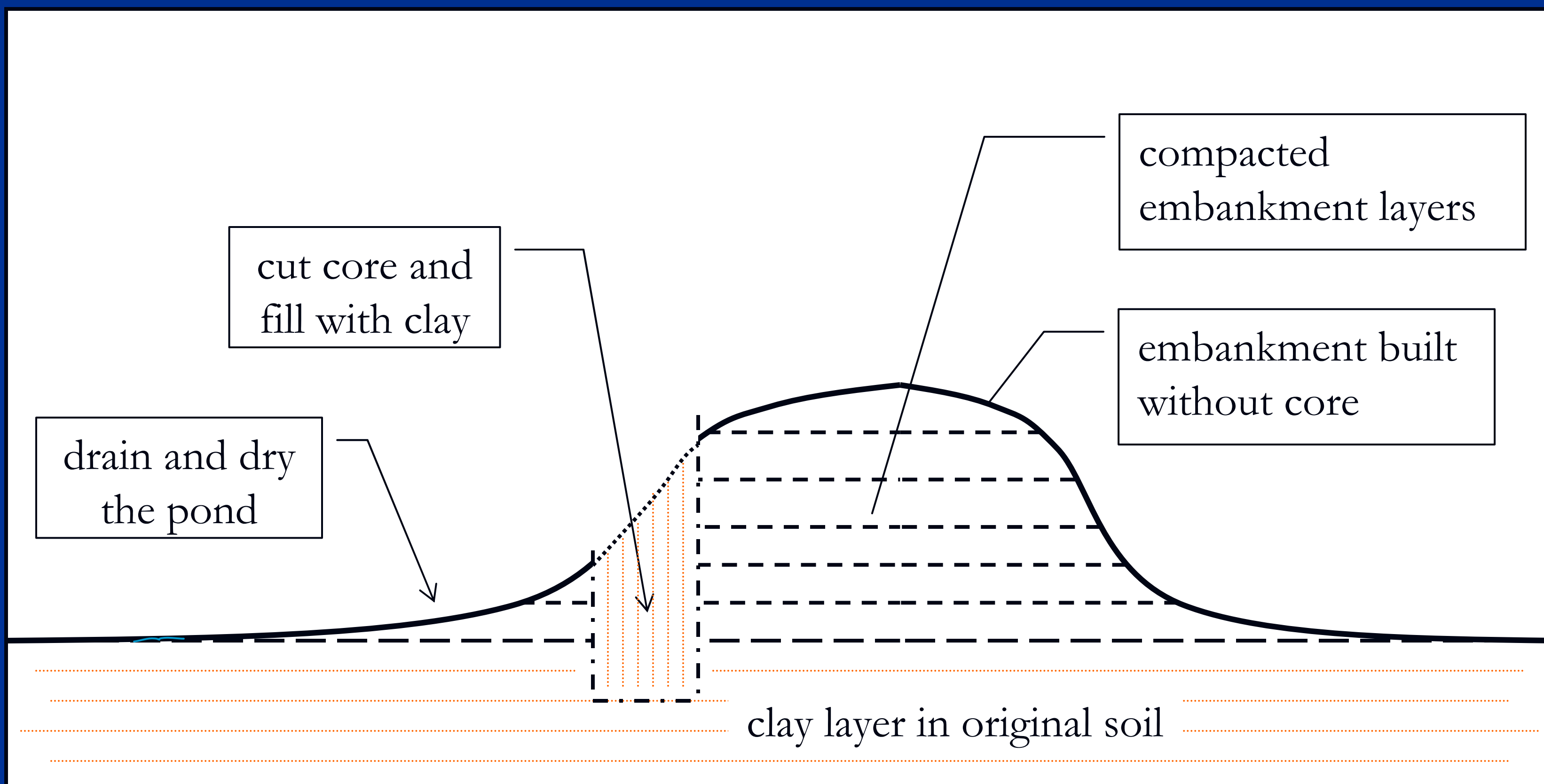
Adding core trenches to existing ponds:

- Work during the dry season
- Drain the pond and allow it to dry
- Cut a trench part way up the inside slope of the embankment
- Back-fill core trench with high-clay soil (≥ 30% clay)
- Compact backfill soil in 4” layers

Seepage due to lack of core trench:



Adding a core trench to an existing pond:



Using plastic liners to seal ponds:

- Work during the dry season
- Drain the pond and allow it to dry
- Lay plastic material and seal all seams
- Tuck edges back down under the soil on top of the embankments
- Cover liner with with soil if desired—no sharp-cornered pieces, though!

Using plastic liners to seal ponds:

Happy Fishing!

Don’t let this happen to your pond