TECHNICAL NOTES

US DEPARTMENT OF AGRICULTURE **NATURAL RESOURCES CONSERVATION SERVICE**

AGRONOMY – 63 revised **Albuquerque, New Mexico**
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NEW MEXICO DAIRY POND SIZING SOFTWARE

USE OF MICROSOFT© EXCEL© SPREADSHEET

Mike Sporcic
State Agronomist
Albuquerque, NM
Michael.Sporcic@nm.usda.gov

Roger Ford
Planning Engineer
Albuquerque, NM
Roger.Ford@nm.usda.gov

Mark Butler
State Design Engineer
Albuquerque, NM
Mark.Butler@nm.usda.gov

- **Purpose:** This note will help dairy planners use the New Mexico Dairy Pond Sizing Software (Microsoft© Excel© spreadsheet) to estimate a 2-month minimum storage requirement for ponds, evaporative ponds (milkhouse), and now total evaporative combined ponds. This software is for use in New Mexico. It does not estimate the volume needed for treatment lagoons since additional volume is needed for those pond designs. The software can be downloaded at: http://www.nm.nrcs.usda.gov/techserv/TechNotes/agro/ag63.xls the volumes from the software are to be used for conservation planning purposes only. The actual volumes will change as the engineering design is developed.

- **Background:** An Agricultural Feeding Operations/Confined Animal Feeding Operation technical working group made up of NM State University, NM Environment Dept. (Ground Water and Surface Water Bureaus), Livestock Industry Groups, and NRCS have worked for at least 5 years to address the needs for Comprehensive Nutrient Management Planning. The group has considered using a spreadsheet from UT, National Software from Purdue, Animal Waste Management software from the NRCS Water and Climate Center in Portland, and some old software that has been used by NRCS field offices. Most of the programs we reviewed were complicated and data hungry. One of them did not allow the use and management of our own data for NM. After this 5-year period, the technical group decided to use the software that has been used in New Mexico by NRCS.

- **General:** The software is very simple to use and requires very little inventory to size the storage pond(s). Its usefulness is limited to dairies where there is no frozen ground, little runoff from normal precipitation (16-inches or less), and fairly level land. The planning method follows the NRCS Animal Waste Field Handbook (AWFH), Chapter 10. Users should first visit the dairy site to inventory needed input data. Use the New Mexico inventory sheets from http://www.nm.nrcs.usda.gov/technical/water/cnmp-sample-plan/inventory-data-sheet.doc.

  Make sure that you have a computer with Microsoft© Excel© and internet access (to download the software) or a disk which includes the software files. You will also need a basic level of understanding of spreadsheets. Only the tan colored boxes allow data to be entered. The clear boxes have formula or text that should not be changed.

  In the April, 2006 version 2.5, we added two new sheets related to a total evaporation system, where lot runoff and milkhouse water are combine into one evaporation pond. NRCS now

uses the Soil-Plant-Air-Water Field and Pond Hydrology (SPAW) model to estimate the volume of water generated by the total evaporation system. This is run at the NRCS-NM State Office level now. The spreadsheet now has an input sheet that will be used to run SPAW. These type systems will have the inventory done in the field and the data (software) sent to the NRCS State Engineer for processing the SPAW run. It also has a separate design sheet for the pond since some of the volume calculations change in this type of pond.

This new method of design for the total evaporation ponds uses at least 20-years of daily rainfall data and at least one daily rainfall event approximating the 25-year 24-hour rainfall event. If one is not in the climate data records, one will be added to the record. This new design volume therefore contains the regulatory required volume for the storm water.

The rest of this note will lead you through an example of how to use this software. Any problems with the software should be reported to one of the authors or the person in their position at the NRCS-NM.

DATA NEEDED

- **Planning Data Sheet**

Dairy Name: Name of the dairy the plan is developed for.

Location: Location of the dairy

Dairy Manager: The person that can make the management decisions required for planning.

Planner: The name of the person developing the overall plan. This could be the CNMP planner or the specialist that developed the worksheet.

Flush System used?: This is a yes or no question with a pull-down. It turns off and on the flush part of the worksheet.

Number of cows: This is the number of milking cows that will use the system and the number of dry cows to determine CAFO type.

Average weight of cows: This is the average weight of the milking cows.

% waste from the milking center: Think of this as the time the milking cows spend on the area where the manure will end up in the pond storage area. Typically this is about 15% of the time.

Wash water used in milking center: This is the amount of water used per cow in the milking operation. It can be a number from the Nutrient Mgt. Specification, or an amount from the water meter going into the milk house if it all flows into the waste stream.

Number of months of storage needed: Minimum here is 2 months. It may be wise to consider more storage if there is not enough soil moisture storage capacity available to receive additional water when there is no crop growing. The goal here is to have room in the soil for the pond water **without** leaching or runoff. Indicate here 12 months if an evaporation pond is being planned.

Flush water added: This is **only** used when there is an alley flush system. This is **only** added water not recycled water. The AWFH has some estimates. The dairy producer should have some idea.

Dairy Data for the Flush System: The next four rows of data are used in the flush system. The milking cows and weight come from the above section. The dry cows have the same weight as above.

Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Lot Runoff Sheet**

Pond/Lagoon #: Type in an identifier for the pond being sized.

Practice Name: List the practice being designed (Pond 378, Waste Storage Facility 313, etc.).

Pond Location: Select the climate location for the structure from the pull down.

Acre in WS area (column): Enter the acres of the watershed that will drain into the pond**.**

RUNOFF CURVE NUMBER: Runoff curves are used to determine how much runoff will come from the lot. Unpaved feed lots will use **90,** and paved or concrete areas will use **95.** The first two lines of the table are for the paved and unpaved areas of the watershed. The remaining lines can be used to add areas with different curve numbers. Each line in the table will be a different curve number and are used to make up the average weighted curve number. Fill in the table to match the watershed inventory.

CHANNEL-LOSS FACTOR: This will always be one (1) for dairies.

RAINFALL 24-HR, DIRECT RUNOFF, and NET RUNOFF (Q*CLF): is now calculated.

VOLUME OF RUNOFF: The output used for sizing the runoff pond is the acre-feet needed for the 25-yr, 24-hr storm.

Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Pond Vol Sheet**

Pond Location (Climate): This is a pull-down that will select the annual rainfall and the percent lake evaporation by month to be used in the volume calculation.

Annual Lake Evap map: This is the annual lake evaporation at the site of the pond. Click on the Evap-NM tab and read evaporation from the map for the location being planned. Enter the direct number of inches of evaporation from the map.

Pond/Lagoon Surface Area: This is the estimated amount of surface area of the pond at the mid-depth of the pond storage volume. Except when using the SPAW model, in that case it is the bottom area of the pond.

The sheet will give an estimate of the depth in feet for the storage period. On this page the volume is calculated to a cube shaped structure. Find depth on the lower right hand side of the table. The goal here is to adjust the surface area to make a reasonable depth to build the pond. Since this depth represents storage volume only not including freeboard, storm rainfall, runoff and sludge, a practical depth for this sheet is 6-feet or less.

If you want to design an **evaporation pond** (where the milkhouse is the only source of water), select the "Evaporation" pond type. Then adjust the surface area until there is at least one zero in column J. This will establish the needed area for an evaporation pond

If you want to design a **total evaporation pond** (milkhouse and barnlot runoff) using the SPAW runoff model, you must select an evaporation pond type and increase the surface area so that 6 months of the year the pond is dry (at least 6 zeros in column J). This will give a correct starting area at the bottom of the pond. The larger surface area value will be used in the SPAW model.

Note: This sheet calculates the storage required for greatest two months or four months of storage over a year as well as a one year evaporation pond (milkhouse only) and with aid of the SPAW model, a total evaporation pond where both the milkhouse and the barnlot water are combined into one pond.

Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **SPAW**

If the user wants to design a total evaporation pond, the pond vol sheet must be filled out with 6 zeros in column J as explained above.

The partially filled out sheet then must be emailed to the NRCS state office to have the SPAW model run. Email the NRCS State Engineer with the pond design workbook attached. He will then forward it to the appropriate staff member and let you know that the request has been forwarded. It should not take long to receive the volume of the needed pond size and a text file output for your records.

The only user entered data for this sheet is the soil map unit number, name, and texture, and the side slopes of the pond to be designed. All other data is filled in for you.

- **Rec. Pond Size Sheet**

Note: This sheet can design either a square or rectangular pond. Select the correct type of design by clicking in the check boxed to indicate a milkhouse only or a combined type of pond.

ESTIMATE NUMBER OF YEARS BEFORE CLEANING POND: Planners must estimate the number of year before the pond will be cleaned. The dairy producer should make this decision based on his management and equipment available.

SOLID SEPERATION: If there are one or more separators in the waste stream they can be selected using the pull-down. Then the default value of separation can be adjusted as appropriate. This will calculate the volume of the solids delivered to the pond in one year.

SLUDGE VOLUME: The sludge volume is calculated by using a factor, listed in Chapter 10 of the AWMFH, for solid accumulation in lagoons. **Solid accumulation is based entirely on management of the waste stream and how the pond is dewatered.** If the dairy manager agitates the pond before dewatering, few solids will build up. If little or no separation is done and the pond is dewatered from the top without agitation, then solids will accumulate.

POND STORAGE CAPACITY: Shows the four required storage volumes and their total. The lot storm volume is only added into the total if this is a combined pond (one that captures water from the milking center, flush system, and feedlot). The user selects this option at the top of the sheet.

WASTE WATER STORAGE REQUIREMENT:

POND LENGTH: Enter the desired Length. An estimated length is given to start the process for a square pond. Any shape rectangular pond can be designed by changing the length to match a particular site.

POND WIDTH: Set by the calculation of the surface area from the Pond Vol sheet.

SIDE SLOPE: Enter the desired side slope. Slopes can be no steeper than 3H:1V.

POND Depth: Enter a depth (nearest 0.1 foot) to calculate the POND Volume. The spreadsheet compares this computed volume to the required volume, which is shown in the Pond Storage Capacity section. A note on the right tells the user that either the depth must be increased or the volume is ok. When the volume is ok, the note is lit the there is enough pond depth.

STORAGE OF THE 25 YR-24 HOUR STORM:

STORM Depth: Enter a depth to calculate the STORM Volume. The spreadsheet compares this computed volume to the required volume. A note on the right again tells the user that either the depth must be increased or the volume is ok.

STORAGE OF SLUDGE:

SLUDGE DEPTH: Enter a depth to calculate the SLUDGE Volume. The spreadsheet compares this volume to the required volume. Again, a note on the right tells the user that either the depth must be increased or the volume is ok. When the volume is ok, the note is lit the there is enough pond depth.

FINAL POND DIMENSIONS:

Note: This section summarizes the depth, length, width, and surface area of the pond.

DEPTH OF 21-DAY STORAGE WITHIN THE 60 DAY STORAGE:

Depth of 21-Day Storage: Enter a depth to calculate the 21-day storage volume. The spreadsheet compares this to the required volume and display a note telling the user to either increase the depth or the depth is ok. This volume is a portion of the 60-day storage and is required to remain empty by Surface Water Bureau of the NMED.

CROSS SECTION:

Note: Shows a not to scale graphic of the pond cross section.

Pond Depth (Staff Gauge) – Volume Table: Provides a table of depth versus volume. This table is used to estimate volumes in the finished pond.

Lining Area: Estimates the area (in square feet and square yards) of lining material needed.

System Planning Notes: Write any notes needed to explain the calculations.

Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Lot Runoff Pond Sheet**

Note: This sheet operates very similar to the Rect. Pond Size sheet and is used to size runoff ponds or any other ponds needed for the dairy. Sometimes the milking center waste is stored in more than one pond. This sheet can size the volumes of each pond assuming that the established depth on the single pond design (Rect. Pond Design) is maintained in the three ponds.

Existing ponds can be evaluated if the average length, width, depth, and side slopes are known.

Note: For Lot Runoff Ponds and other ponds, changes may be needed on the Lot Runoff or Pond Vol sheets. The user must revisit those spreadsheet tabs and print all changes in order to fully document each pond design.

Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

- **Total Evap Pond Size**

This is similar to the rectangular pond size sheet except that the volume for the 25-year 24-hour storm is included in the SPAW Volume that is enter by hand from the SPAW run printout. The sludge storage time is set to the life of the liner, a minimum of 20 years, unless cleaning will be done.

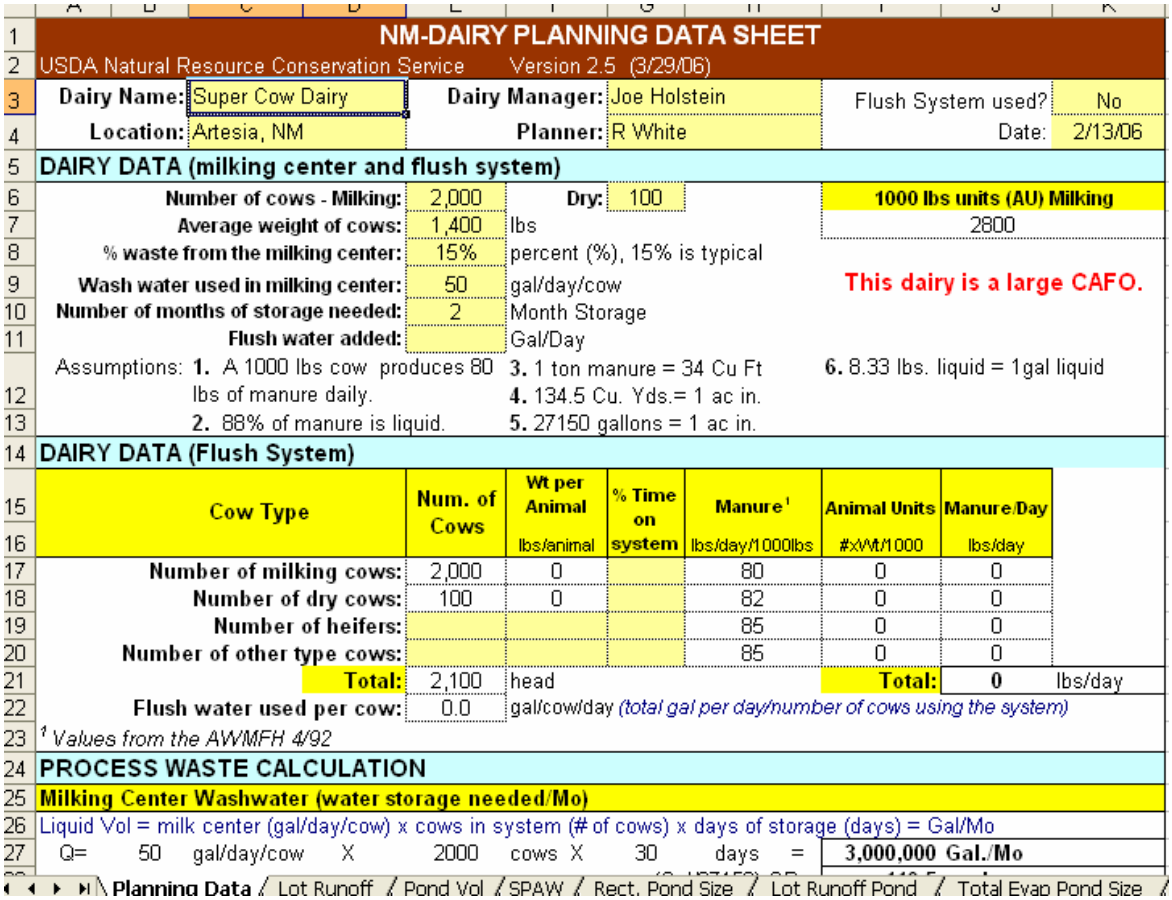
Print Sheet: After filling out this sheet, print it to document and record decisions. Also print if changes are made to this sheet.

Example Problem

Inventory Data: The Super Cow Dairy managed by Joe Holstein has a 2000 cow milking herd and 100 head of dry cows near Artesia, NM. Mr. Holstein wants to size a pond for 2 months storage of his milking center manure and determine how large the runoff pond for his barn lot will have to be. He wants the runoff pond to be a square and the milk center to be a square shape. We have visited the site and determined that there is about 15 acres of unpaved lot where the cows spent about 85% of the time. There is about 2 acres of concrete allies and paved lot. There is also 5 acres in drive ways that are gravel. The cows are in the milking area 15% of the time, and he uses about 50 gal/cow in his spray wash system (100,000 gal/day (water meter)/2000 cows) = 50 gal/day. The average weight of the cows is 1400 lbs. He plans to clean the pond every five years. He thinks that an incline screen will save about 25% of the solids in the waste stream.

Step 1 – Open the NM-Dairy Planning Excel spreadsheet, select the **Planning Data** sheet, and enter the row 3 and 4 data: Dairy Name, Dairy Manger, Location, Planner, and No for the Flush System Question.

Step 2 – Enter the Dairy Data on row 6 through 11: Number of cows, weight per cow, time at the milking center, wash water added, number of months of storage, and zero for flush water added. Flush data would be added if the dairy uses a flush system (Be sure to enter "yes" in the box for flush system on row 3).



NM-DAIRY PLANNING DATA SHEET

USDA Natural Resource Conservation Service Version 2.5 (3/29/06)

Dairy Name:	Super Cow Dairy	**Dairy Manager:**	Joe Holstein	Flush System used?	No
Location:	Artesia, NM	**Planner:**	R White	Date:	2/13/06

DAIRY DATA (milking center and flush system)

Number of cows - Milking:	2,000	**Dry:** 100		**1000 lbs units (AU) Milking**
Average weight of cows:	1,400	lbs		2800
% waste from the milking center:	15%	percent (%), 15% is typical		
Wash water used in milking center:	50	gal/day/cow		**This dairy is a large CAFO.**
Number of months of storage needed:	2	Month Storage		
Flush water added:		Gal/Day		

Assumptions: **1.** A 1000 lbs cow produces 80 lbs of manure daily. **2.** 88% of manure is liquid. **3.** 1 ton manure = 34 Cu Ft **4.** 134.5 Cu. Yds.= 1 ac in. **5.** 27150 gallons = 1 ac in. **6.** 8.33 lbs. liquid = 1gal liquid

DAIRY DATA (Flush System)

Cow Type	Num. of Cows	Wt per Animal lbs/animal	% Time on system	Manure[1] lbs/day/1000lbs	Animal Units #x/Wt/1000	Manure/Day lbs/day
Number of milking cows:	2,000	0		80	0	0
Number of dry cows:	100	0		82	0	0
Number of heifers:				85	0	0
Number of other type cows:				85	0	0
Total:	2,100	head			**Total:**	**0** lbs/day
Flush water used per cow:	0.0	gal/cow/day *(total gal per day/number of cows using the system)*				

[1] *Values from the AWMFH 4/92*

PROCESS WASTE CALCULATION

Milking Center Washwater (water storage needed/Mo)

Liquid Vol = milk center (gal/day/cow) x cows in system (# of cows) x days of storage (days) = Gal/Mo

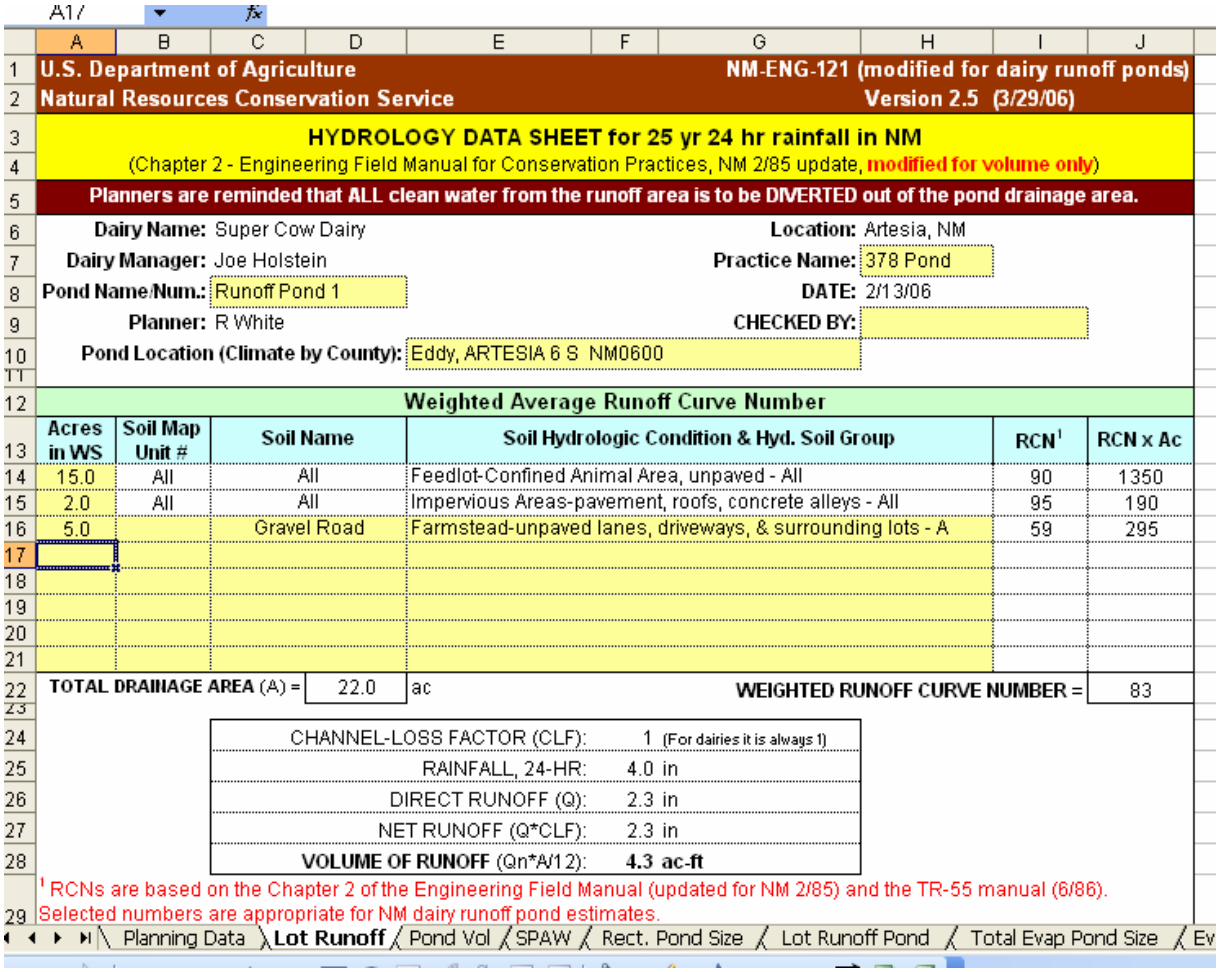
Q= 50 gal/day/cow X 2000 cows X 30 days = **3,000,000 Gal./Mo**

Planning Data / Lot Runoff / Pond Vol / SPAW / Rect. Pond Size / Lot Runoff Pond / Total Evap Pond Size /

Step 3 – Print this Planning Data tab before moving to the next sheet (or tab).

Step 4 – Change to the **Lot Runoff** sheet. Identify the Pond type in the Pond Name/Num. filed (for example: Runoff Pond 1), and in the Practice Name field, enter the practice number and name (for example, 378 Pond). Click in the yellow box to the right of Pond Location (Climate by County) and use the dropdown list to select the climate station closest to the pond's location. For our example, select "Eddy, Artesia."

Enter the three different areas within the watershed. Select the gravel road area as "Farmstead-unpaved lanes, driveways, & surrounding lots - A". Call the soil "Gravel".



U.S. Department of Agriculture — NM-ENG-121 (modified for dairy runoff ponds)
Natural Resources Conservation Service — Version 2.5 (3/29/06)

HYDROLOGY DATA SHEET for 25 yr 24 hr rainfall in NM
(Chapter 2 - Engineering Field Manual for Conservation Practices, NM 2/85 update, modified for volume only)

Planners are reminded that ALL clean water from the runoff area is to be DIVERTED out of the pond drainage area.

Dairy Name:	Super Cow Dairy	**Location:**	Artesia, NM
Dairy Manager:	Joe Holstein	**Practice Name:**	378 Pond
Pond Name/Num.:	Runoff Pond 1	**DATE:**	2/13/06
Planner:	R White	**CHECKED BY:**	
Pond Location (Climate by County):	Eddy, ARTESIA 6 S NM0600		

Weighted Average Runoff Curve Number

Acres in WS	Soil Map Unit #	Soil Name	Soil Hydrologic Condition & Hyd. Soil Group	RCN[1]	RCN x Ac
15.0	All	All	Feedlot-Confined Animal Area, unpaved - All	90	1350
2.0	All	All	Impervious Areas-pavement, roofs, concrete alleys - All	95	190
5.0		Gravel Road	Farmstead-unpaved lanes, driveways, & surrounding lots - A	59	295

TOTAL DRAINAGE AREA (A) = 22.0 ac — **WEIGHTED RUNOFF CURVE NUMBER** = 83

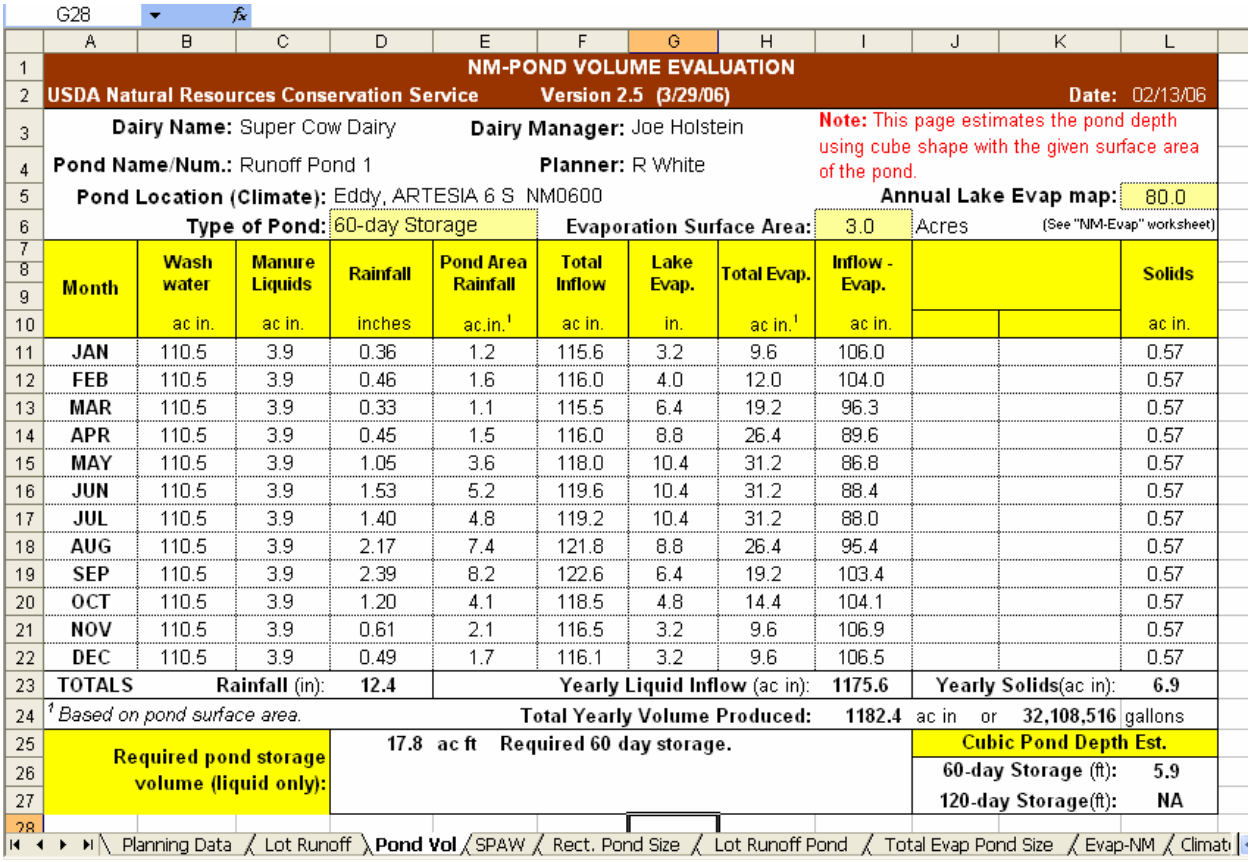
CHANNEL-LOSS FACTOR (CLF):	1	(For dairies it is always 1)
RAINFALL, 24-HR:	4.0	in
DIRECT RUNOFF (Q):	2.3	in
NET RUNOFF (Q*CLF):	2.3	in
VOLUME OF RUNOFF (Qn*A/12):	**4.3**	**ac-ft**

[1] RCNs are based on the Chapter 2 of the Engineering Field Manual (updated for NM 2/85) and the TR-55 manual (6/86). Selected numbers are appropriate for NM dairy runoff pond estimates.

Planning Data | Lot Runoff | Pond Vol | SPAW | Rect. Pond Size | Lot Runoff Pond | Total Evap Pond Size | Ev

Step 5 – Print this Lot Runoff tab before moving to the next sheet (or tab).

Step 6 – Change to the **Pond Vol** sheet. Select 60 day storage. Move to the Annual Lake Evap map cell and enter 80.0 inches per year. This is the annual lake evaporation found on the Evap-NM tab for the location of the pond. Look at the High 2 Mo. Cubic Pond Depth in cell L26 and adjust the Evaporation Surface Area until the depth is reasonable (<6 ft). Since this depth represents the volume of required storage but does not include volumes for freeboard, storm runoff, or sludge, a practical limit for this depth is about 6 feet. For our example, use 3.0 acres which computes a depth of 5.9 feet. Note that this volume calculation assumes vertical side slopes or a cube shape. Also note that the required pond storage volume is computed at the bottom of this sheet. For our example, it computes 17.8 ac-ft as the required 60-day (2-month) storage.

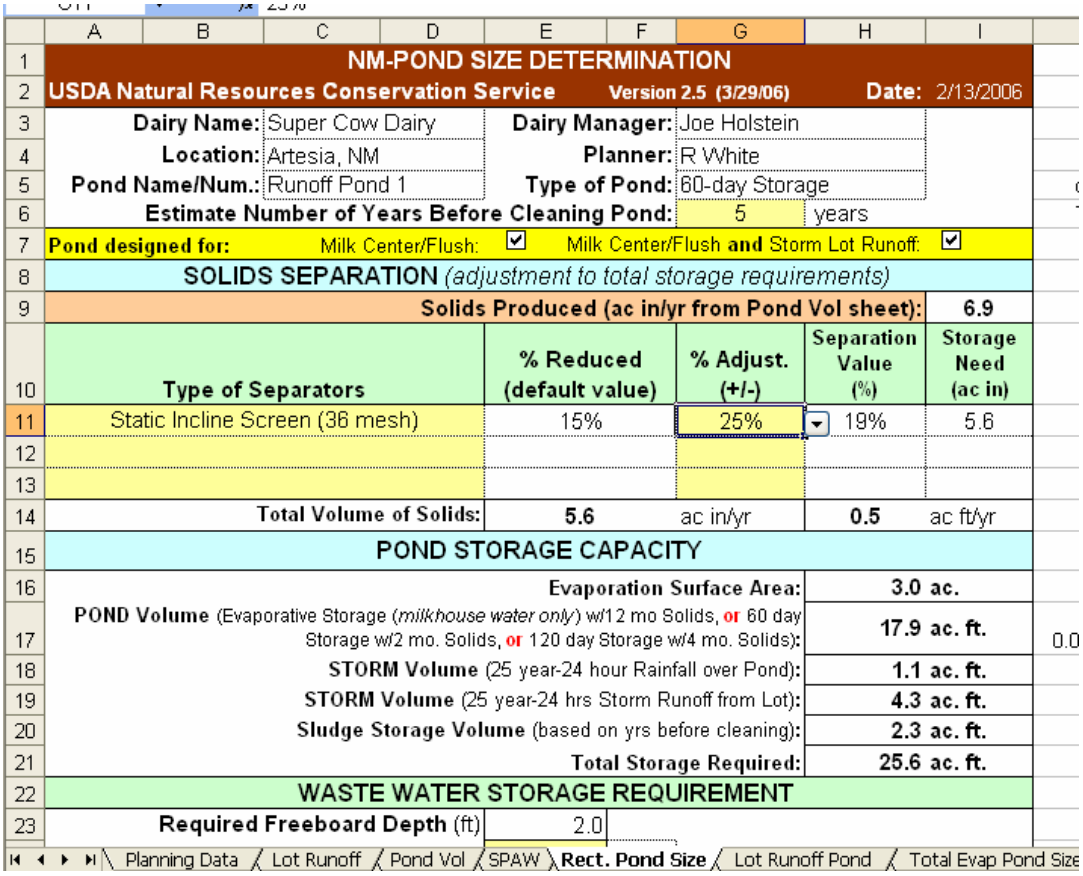


	A	B	C	D	E	F	G	H	I	J	K	L
1	NM-POND VOLUME EVALUATION											
2	USDA Natural Resources Conservation Service			Version 2.5 (3/29/06)							Date:	02/13/06
3	Dairy Name: Super Cow Dairy				Dairy Manager: Joe Holstein				Note: This page estimates the pond depth using cube shape with the given surface area of the pond.			
4	Pond Name/Num.: Runoff Pond 1				Planner: R White							
5	Pond Location (Climate): Eddy, ARTESIA 6 S NM0600								Annual Lake Evap map:			80.0
6	Type of Pond:	60-day Storage			Evaporation Surface Area:				3.0	Acres	(See "NM-Evap" worksheet)	
7												
8												
9	Month	Wash water	Manure Liquids	Rainfall	Pond Area Rainfall	Total Inflow	Lake Evap.	Total Evap.	Inflow - Evap.			Solids
10		ac in.	ac in.	inches	ac.in.[1]	ac in.	in.	ac in.[1]	ac in.			ac in.
11	JAN	110.5	3.9	0.36	1.2	115.6	3.2	9.6	106.0			0.57
12	FEB	110.5	3.9	0.46	1.6	116.0	4.0	12.0	104.0			0.57
13	MAR	110.5	3.9	0.33	1.1	115.5	6.4	19.2	96.3			0.57
14	APR	110.5	3.9	0.45	1.5	116.0	8.8	26.4	89.6			0.57
15	MAY	110.5	3.9	1.05	3.6	118.0	10.4	31.2	86.8			0.57
16	JUN	110.5	3.9	1.53	5.2	119.6	10.4	31.2	88.4			0.57
17	JUL	110.5	3.9	1.40	4.8	119.2	10.4	31.2	88.0			0.57
18	AUG	110.5	3.9	2.17	7.4	121.8	8.8	26.4	95.4			0.57
19	SEP	110.5	3.9	2.39	8.2	122.6	6.4	19.2	103.4			0.57
20	OCT	110.5	3.9	1.20	4.1	118.5	4.8	14.4	104.1			0.57
21	NOV	110.5	3.9	0.61	2.1	116.5	3.2	9.6	106.9			0.57
22	DEC	110.5	3.9	0.49	1.7	116.1	3.2	9.6	106.5			0.57
23	TOTALS		Rainfall (in):	12.4			Yearly Liquid Inflow (ac in):		1175.6		Yearly Solids(ac in):	6.9
24	[1] Based on pond surface area.						Total Yearly Volume Produced:		1182.4	ac in or	32,108,516	gallons
25	Required pond storage volume (liquid only):			17.8 ac ft	Required 60 day storage.						Cubic Pond Depth Est.	
26											60-day Storage (ft):	5.9
27											120-day Storage(ft):	NA

Planning Data | Lot Runoff | Pond Vol | SPAW | Rect. Pond Size | Lot Runoff Pond | Total Evap Pond Size | Evap-NM | Climat

Step 7 – Print this Pond Vol tab before moving to the next sheet (or tab).

Step 8 – Size the two needed ponds. Move to the **Rect. Pond Size** sheet. Enter the number of years between pond cleanings. Select the appropriate "Pond designed for:" box. For our example, click the box following "Milk Center/Flush." This will place a check mark in the box. Next select the type of separator using the drop down menus. For this example, select the "**static incline screen separator**", and adjust the separation value using the pull down adjustment, use +25%. Note that the required 60-day storage is 17.9 ac ft (brought from the Pond Vol tab).



	A	B	C	D	E	F	G	H	I
1	NM-POND SIZE DETERMINATION								
2	USDA Natural Resources Conservation Service				Version 2.5 (3/29/06)			Date:	2/13/2006
3		Dairy Name:	Super Cow Dairy		Dairy Manager:		Joe Holstein		
4		Location:	Artesia, NM		Planner:		R White		
5		Pond Name/Num.:	Runoff Pond 1		Type of Pond:		60-day Storage		
6			Estimate Number of Years Before Cleaning Pond:				5	years	
7	Pond designed for:		Milk Center/Flush: ☑				Milk Center/Flush and Storm Lot Runoff: ☑		
8	SOLIDS SEPARATION *(adjustment to total storage requirements)*								
9							Solids Produced (ac in/yr from Pond Vol sheet):		6.9
10			Type of Separators		% Reduced (default value)		% Adjust. (+/-)	Separation Value (%)	Storage Need (ac in)
11			Static Incline Screen (36 mesh)		15%		25%	19%	5.6
12									
13									
14				Total Volume of Solids:	5.6	ac in/yr		0.5	ac ft/yr
15	POND STORAGE CAPACITY								
16							Evaporation Surface Area:		3.0 ac.
17							POND Volume (Evaporative Storage (*milkhouse water only*) w/12 mo Solids, or 60 day Storage w/2 mo. Solids, or 120 day Storage w/4 mo. Solids):		17.9 ac. ft.
18							STORM Volume (25 year-24 hour Rainfall over Pond):		1.1 ac. ft.
19							STORM Volume (25 year-24 hrs Storm Runoff from Lot):		4.3 ac. ft.
20							Sludge Storage Volume (based on yrs before cleaning):		2.3 ac. ft.
21							Total Storage Required:		25.6 ac. ft.
22	WASTE WATER STORAGE REQUIREMENT								
23					Required Freeboard Depth (ft)		2.0		

Planning Data | Lot Runoff | Pond Vol | SPAW | **Rect. Pond Size** | Lot Runoff Pond | Total Evap Pond Size

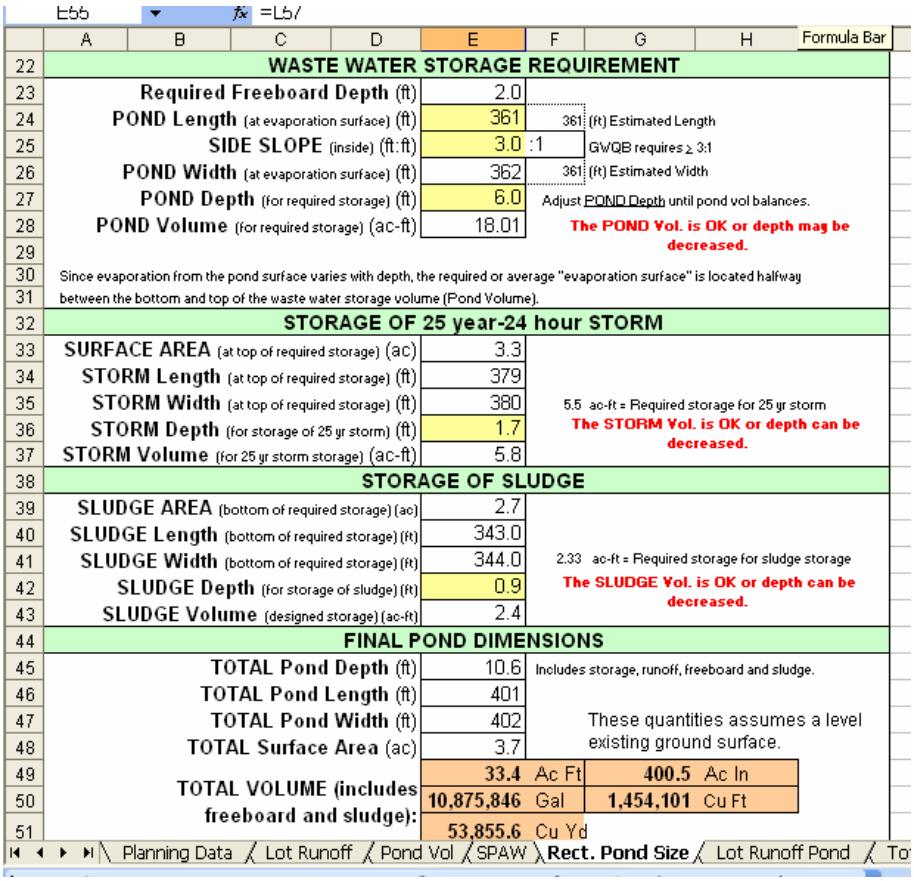
The next three calculations use a trial and error method to balance computed pond volumes with the required storage volumes while establishing a shape that fits within site requirements. Enter the freeboard requirement, which is most likely 2.0 feet. This requires you to have the all three volumes with the label saying that the vol is "OK".

Step 8 (Continued) – The first required storage volume is the **waste water storage**. Enter a POND Length and side slope. The spreadsheet calculates the POND Width. Enter a depth using feet and tenths of a foot. The sheet calculates the volume and compares it with the required volume shown in the POND STORAGE CAPACITY section and displays a note, in red, which directs the user to either increase the depth or accept the depth as ok. In our example, enter 361 for length, 3 for side slope, and 6 for depth. The calculated volume is 18.0 ac ft which is slightly larger than 17.9. The user can check a depth of 5.9 feet, but, in this example, it will not provide sufficient storage.

– Next set the storage volume for the **25-year, 24-hour storm**. This volume includes the rainfall falling on the surface of the pond and runoff from a feeding lot, if included on row 7 above). Enter a depth to calculate the pond volume allocated to storm water. The spreadsheet compares the computed volume to the required volume shown in the POND STORAGE CAPACITY section and, by red note, directs the user to increase depth or accept current depth. For this example, 1.7 ft balances the computed and required volumes of 5.5 ac ft.

– The last required volume is for storage of sludge. Enter a depth and adjust that depth until the computed sludge volume balances with the required volume. For our example, 0.9 foot provides the required storage of 2.3 ac ft.

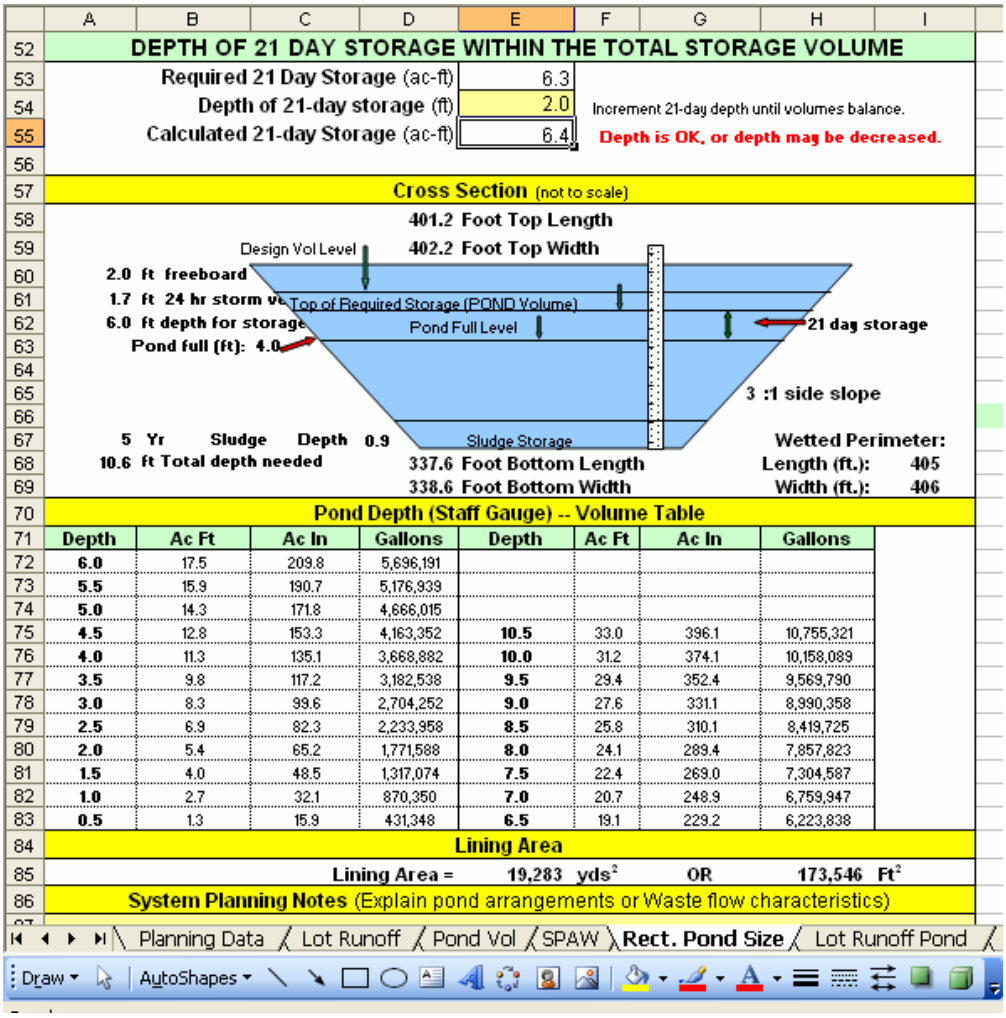
– The above calculations are summarized in the FINAL POND DIMENSIONS section. Note that the Total Pond Depth is almost 9.0 feet compared to the initial 6.0 feet calculated on the Pond Vol tab. Also note that the TOTAL Pond Length and Width is 401 ft. x 402 ft. compared to the 361 x 362 initially used.



	A	B	C	D	E	F	G	H
22	**WASTE WATER STORAGE REQUIREMENT**							
23				**Required Freeboard Depth** (ft)	2.0			
24				**POND Length** (at evaporation surface) (ft)	361	361	(ft) Estimated Length	
25				**SIDE SLOPE** (inside) (ft:ft)	3.0	:1	GWQB requires ≥ 3:1	
26				**POND Width** (at evaporation surface) (ft)	362	361	(ft) Estimated Width	
27				**POND Depth** (for required storage) (ft)	6.0		Adjust POND Depth until pond vol balances.	
28				**POND Volume** (for required storage) (ac-ft)	18.01		**The POND Vol. is OK or depth may be decreased.**	
29								
30	Since evaporation from the pond surface varies with depth, the required or average "evaporation surface" is located halfway							
31	between the bottom and top of the waste water storage volume (Pond Volume).							
32	**STORAGE OF 25 year-24 hour STORM**							
33				**SURFACE AREA** (at top of required storage) (ac)	3.3			
34				**STORM Length** (at top of required storage) (ft)	379			
35				**STORM Width** (at top of required storage) (ft)	380		5.5 ac-ft = Required storage for 25 yr storm	
36				**STORM Depth** (for storage of 25 yr storm) (ft)	1.7		**The STORM Vol. is OK or depth can be decreased.**	
37				**STORM Volume** (for 25 yr storm storage) (ac-ft)	5.8			
38	**STORAGE OF SLUDGE**							
39				**SLUDGE AREA** (bottom of required storage) (ac)	2.7			
40				**SLUDGE Length** (bottom of required storage) (ft)	343.0			
41				**SLUDGE Width** (bottom of required storage) (ft)	344.0		2.33 ac-ft = Required storage for sludge storage	
42				**SLUDGE Depth** (for storage of sludge) (ft)	0.9		**The SLUDGE Vol. is OK or depth can be decreased.**	
43				**SLUDGE Volume** (designed storage) (ac-ft)	2.4			
44	**FINAL POND DIMENSIONS**							
45				**TOTAL Pond Depth** (ft)	10.6		Includes storage, runoff, freeboard and sludge.	
46				**TOTAL Pond Length** (ft)	401			
47				**TOTAL Pond Width** (ft)	402		These quantities assumes a level	
48				**TOTAL Surface Area** (ac)	3.7		existing ground surface.	
49				**TOTAL VOLUME (includes**	**33.4** Ac Ft		**400.5** Ac In	
50				**freeboard and sludge):**	**10,875,846** Gal		**1,454,101** Cu Ft	
51					**53,855.6** Cu Yd			

Planning Data | Lot Runoff | Pond Vol | SPAW | **Rect. Pond Size** | Lot Runoff Pond | To

Step 8 (Continued) – The last step is to establish the 21-day storage depth. As before, the user changes the depth while the spreadsheet compares the computed and required volumes and, by note, directs the user to increase the depth or accept the computed volume. For our example, 2.0 feet is the proper depth. Print the design sheet for the milk center pond. Note that with top Length and Width is increased to 401 ft by 402 ft because of the 10.6 feet depth including the freeboard requires the additional top width.



DEPTH OF 21 DAY STORAGE WITHIN THE TOTAL STORAGE VOLUME

Required 21 Day Storage (ac-ft)	6.3
Depth of 21-day storage (ft)	2.0
Calculated 21-day Storage (ac-ft)	6.4

Increment 21-day depth until volumes balance.
Depth is OK, or depth may be decreased.

Cross Section (not to scale)

401.2 Foot Top Length
402.2 Foot Top Width
Design Vol Level
2.0 ft freeboard
1.7 ft 24 hr storm vo
6.0 ft depth for storage
Pond full (ft): 4.0
Top of Required Storage (POND Volume)
Pond Full Level
21 day storage
3 :1 side slope
5 Yr Sludge Depth 0.9
10.6 ft Total depth needed
Sludge Storage
337.6 Foot Bottom Length
338.6 Foot Bottom Width
Wetted Perimeter:
Length (ft.): 405
Width (ft.): 406

Pond Depth (Staff Gauge) -- Volume Table

Depth	Ac Ft	Ac In	Gallons	Depth	Ac Ft	Ac In	Gallons
6.0	17.5	209.8	5,696,191				
5.5	15.9	190.7	5,176,939				
5.0	14.3	171.8	4,666,015				
4.5	12.8	153.3	4,163,352	10.5	33.0	396.1	10,755,321
4.0	11.3	135.1	3,668,882	10.0	31.2	374.1	10,158,089
3.5	9.8	117.2	3,182,538	9.5	29.4	352.4	9,569,790
3.0	8.3	99.6	2,704,252	9.0	27.6	331.1	8,990,358
2.5	6.9	82.3	2,233,958	8.5	25.8	310.1	8,419,725
2.0	5.4	65.2	1,771,588	8.0	24.1	289.4	7,857,823
1.5	4.0	48.5	1,317,074	7.5	22.4	269.0	7,304,587
1.0	2.7	32.1	870,350	7.0	20.7	248.9	6,759,947
0.5	1.3	15.9	431,348	6.5	19.1	229.2	6,223,838

Lining Area

Lining Area = 19,283 yds² OR 173,546 Ft²

System Planning Notes (Explain pond arrangements or Waste flow characteristics)

Planning Data | Lot Runoff | Pond Vol | SPAW | Rect. Pond Size | Lot Runoff Pond

Draw | AutoShapes

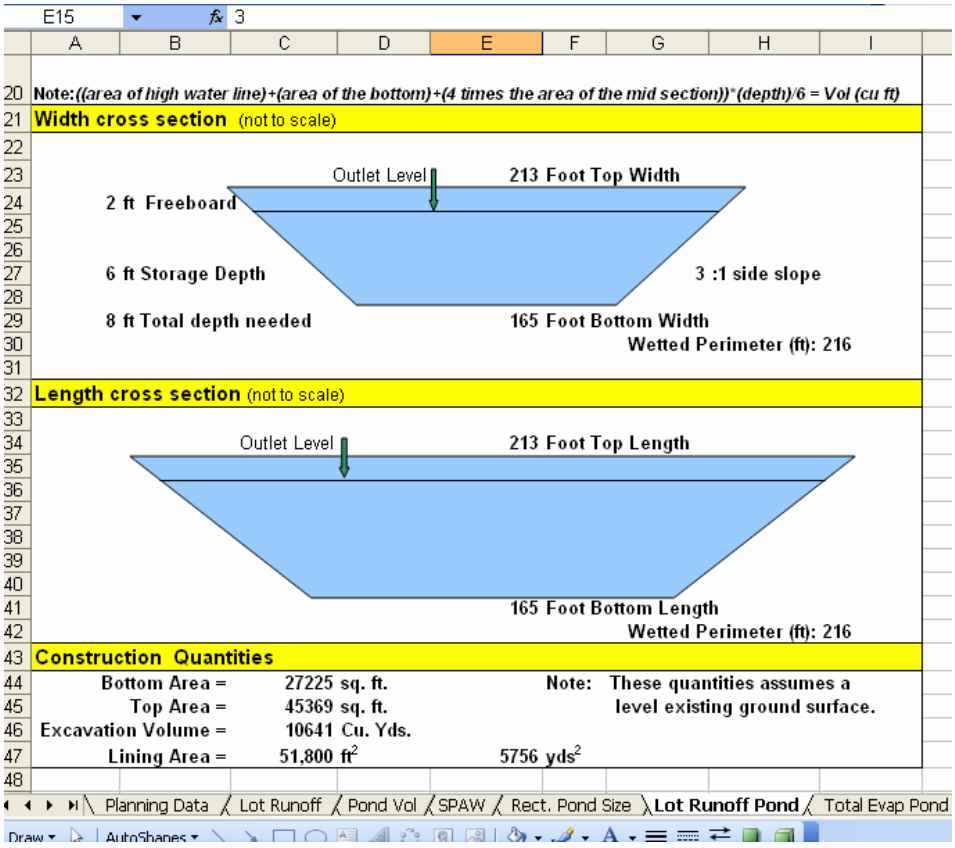
Step 9 – Print this Rect. Pond Size sheet. It is the design for the milk center pond.

Step 10 – Move to the tab for **Lot Runoff Pond**. Describe the pond type (runoff, multi-cell main, etc.). This sheet is more flexible than the Rect. Pond Size sheet and can be used to try different pond sizes and other alternative solutions. The user can alter the Lot Runoff sheet and compute alternatives. If the user tries several or many alternatives, they should print each Lot Runoff and Lot Runoff Pond sheets in order to maintain a record of each alternative.

– For our example, this sheet will size the lot runoff pond. Step 8 sized the milking center pond. For the lot runoff, it is practical to start with the previous initial depth. Therefore, enter 6 for depth. Using the same side slope, enter 3. Now, change the Length and Width to establish a computed pond volume equal to or slightly larger than the required volume, which for our example is 4.4 ac ft. A note with red lettering directs the user to increase the pond depth or dimensions, or if the computed and required volumes balance, the note indicates that the pond size is ok. A 202-foot square pond will hold the required volume. The length, width, and depth should be varied to fit the pond into existing site conditions.

– Note that the final top width and length increased to 213 feet due to freeboard requirements.

– The Construction Quantities section provides estimates for excavation volume and area of lining materials needed to construct the pond. These estimates are based on level ground across the pond location. Actual construction quantities are a matter of a complete site built design process.



Step 11 – Print this Lot Runoff Pond sheet. It is the design for the pond which will contain the feeding lot runoff.