

## **Flexible Pen Design for Special Needs and Transition Cows**

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### **Introduction**

Facilities designed for the special needs and transition cows should facilitate the management plan developed by the dairy team. There has been an increasing movement to consider the needs of these cows in a better planned and better defined design. Many producers and agricultural professionals are recognizing that managing these groups of animals more intensely can have a significant impact on total herd health and performance during lactation. Recent research and experience is showing the importance of considering animal behavior in the facility design to minimize the associated metabolic and production problems that occur with the typical declining dry matter intake of the cow as she gets close to the calving event. A management plan and defined protocols along with appropriate facility design creates an opportunity to develop a specialized facility with the appropriate environment to better meet the needs of transition and other special needs cows. Properly designed facilities should also consider the labor required for managing, working with, and caring for these cows.

### **The Design Process**

The design process is important in developing a functional and practical facility design. It allows for input from all the dairy design team members. The design process also makes it easy to investigate and consider alternatives and evaluate how different components work together and interact to produce an overall system design. The design process includes several distinct steps.

1. Develop a special needs and transition cow management plan
2. Investigate and develop alternative designs that will help to implement the management plan
3. Evaluate alternatives and options
4. Choose the “best” system design
5. Troubleshoot and implement the design

## **Special Needs and Transition Cow Management Plan**

The special needs and transition cow management plan addresses the first step in the design process. The management plan describes:

- Number of defined management groups
- Number of cows in a management group
- Pen design for the group
- Housing system and environment for the group
- Nutritional needs of group
- Health needs of group
- Working protocols of group
- Handling and restraint needs of the group
- Cattle movement between groups

The management plan helps to identify the design specifications for the building, penning, and environment of the facility. A well designed facility will include the desired elements to develop a functional and labor efficient facility.

## **Dairy Design Team**

This management plan is developed by a dairy team which might include:

- Owner
- Herd Person
- Farm managers
- Labor
- Agricultural professionals such as:
  - Nutritionist
  - Veterinarian
  - Agricultural Engineer

## **Prioritizing Design Features to Implement the Management Plan**

A discussion of design features and choices by the team will require that information be collected. Information can be analyzed by the team to determine what problems or issues need to be addressed in the current system. Herd health records such as calving difficulty, displaced abomasum, cows off feed, ketosis, milk fever, or mastitis at freshening can be used to identify design features and management protocols that can be implemented to prevent these occurrences. These occurrences may be associated with either a limitation in the facility design, not providing design features that allow the desired management protocols, or not implementing the protocol defined in the management plan.

It is important to get the design team's input on what features are needed (required) or wanted (desired) and prioritize these features to manage the animals in these groups. The plan can then implement the prioritized features in the facility design. When decisions need to be made with a limited budget the prioritized list will help determine those features that are necessary to the management plan as compared to those that "would be nice" if the money is available.

### **Cow Care Tasks**

A description of the jobs that need to be done with each group is also helpful in determining the facility features required to perform the particular task. A list of the activities or jobs that need to be done and what facility features are needed to get the job done conveniently should be developed for each transition group

### **Cow Comfort Design**

Cow comfort is especially important for the transition cow groups. Cows heavy with calf, during calving, and just fresh are all subject to high stress. Inadequate facility design can result in metabolic problems and injuries that keep the cows from entering the milking herd at the appropriate time and in the best condition possible. A list of cow comfort features desired in the management plan and a short description of the building design feature that meet the comfort features desired should be developed for each transition group. Freestall platforms may need to be larger than the typical lactating cow herd, plenty of resting space in a bedded area, and less competition at the feed bunk are all features that may be necessary to make the pen design functional.

Write these features down on a list and keep the list handy for reference in the facility planning and design phase. Identify the required (must have) features and the desired (would be nice to have) features. Prioritize the lists. This will help in making decisions during the design phase. It is especially important when the budget has to be met and some features must be left out. Required features that are absolutely necessary can be retained and other desired features that would be nice can be kept in priority order if you have adequate funds.

### **Grouping Transition Cows**

Special needs cows is a general term which includes transition cows as well as other cow groups that may need to be segregated from the main lactating cow groups. Stone (2000) defined the special needs cows as those needing individual attention.

The cow groups to be managed and the number of cows in each group needs to be defined for a specific farm's management plan. The time frames identified for a group are somewhat arbitrary and should be defined in the management plan. Time frame

guidelines are based on recommended practices and experience. Heifers are usually allowed an additional week longer in a management group to ease the transition.

Typical cow groups that fit into this definition are:

- Far-off dry cows (first 40 days)
- Close-up (prefresh) dry cows (3-4 weeks before calving)
- Closeup (prefresh) heifers
- Maternity (calving) cows (1-3 days)
- Maternity (calving) heifers (1-3 days)
- Fresh cows (2-4 weeks after calving)
- Fresh heifers (2-4 weeks after calving)
- Lame and injured cows (1-7 days)
- Treated Cows (1-10 days)
- Mastitis Cows (1-7 days)
- Sick Cows (1-7 days)
- Cull Cows (1-7 days)
- Quarantine cows (1-7 days)

A balance must be made between developing too many groups and still meeting the individual cow's needs at this stage. For large herds a management group size even for a short time frame such as 14 days can be a large number of cows managed as a pen. For small herds it may be necessary to consolidate several cow groups into a management group or pen to be more efficient in use of space and labor and provide a more practical design.

### **Using Herd Records to Determine Group Sizes**

The best design information on management group sizes for a specific farm should come from the farm's own records. A report of monthly calvings for cows and heifers from a herd management software package over a 24-36 month period will help in developing realistic numbers for the average number of calvings and the variation of the number of calvings over time which can help in making a decision on capacity of pens and a barn. With this information one can estimate the number of cows in a management group over other time frames.

For example Table 1 shows a summary of the monthly calvings for three different herds of various sizes from data obtained through AgSource. The total number of cows and heifers that calved each month ranged from 8.0 % - 8.7% depending on the herd size. The standard deviation within a herd over that time period was 1.2 % - 3.3% depending on herd size.

Figure 1 shows a chart of the monthly total calving percentage for three example herds over a 24 month period. As the chart shows there were approximately 8-12 months out of

the 24 months that the number of calvings was higher than average number. In practice if a barn were designed for the average calvings per month then there would have been inadequate pen space or an overcrowding of the pen space approximately 30-50% of the year. The design capacity should be higher than average to match the risk of overcrowding that the farm is willing to manage. Figure 1 also shows the group size needed to provide between 10%-50% more space than the average percentage of calvings. Note that on the 1700 cow herd 10% additional capacity would have met the calving needs for all but two months of the 24 month period. For the other two herd sizes a 40% additional capacity would have been needed to meet the same criteria. This information can be used to determine how much additional capacity could be designed to meet a desired risk level that the pen space may be overcrowded some times of the year. Further analysis of additional herds may help to develop realistic planning guidelines that could be used when individual herd records are not available.

### **Herd Table and Group Size makeup**

When individual farm information is not available the assumptions will need to be based on other available data. To determine the group size for a specific farm the size of the herd and the time frame for each group needs to be identified in the management plan.

Dairy producers and agricultural professionals have identified that variation in management group numbers and the subsequent overcrowding of pens during the transition period is the biggest challenge in facility design. The inability of management to compensate for inadequate pen space creates many of the metabolic and health related problems that are supposed to be minimized with the facility design. But it is also expensive to build for the extreme conditions that occur only for 1-2 months of the year.

Recent research and experience is identifying that many existing pens and barns may be overcrowded and not allow implementation of the desired management plan. Overcrowding may not be an issue for a dominant cow but the submissive cows in a large group may not be able to compete for feed at the bunk and subsequently are not able to maintain dry matter intake because dominant cows take over the feed space.

When accurate specific herd data is not available other information and guidelines can be used for planning. The number of cows in a management group will change depending on calving interval, conception rate, culling rate, other management practices and the natural variation within the herd. These factors should be considered when planning facilities to avoid overcrowding.

Many estimates are available using these assumptions to determine the expected average number of cows in a particular group timeframe. Table 2 shows design guidelines from several references. The MWPS column makes several assumptions and calculates an average herd makeup. Nordlund and Cook as well as Smith et al. suggest another set of

guidelines. The AgSource column uses the data collected from the herd discussion above to determine average herd data. Values were rounded up.

Facility design should meet the conditions beyond the average expected numbers for a particular group. Some have suggested that designs should accommodate approximately 20% over capacity to more adequately meet typical variation in a herd. The MWPS Design guidelines were adjusted by +20% to reflect that suggestion. The AgSource Design guidelines also reflects a +20% adjustment to suggest a more realistic need for additional capacity at the calving peaks that occur several months over the year.

### **Relation between feeding space and resting space**

Lactating cow pen and barn design has focused on trying to balance resting space and feeding space needs. The priority has usually been maximizing cow numbers for a pen and comparing that capacity to feeding space available. Many times the pen will be overstocked with more cows than freestall platforms to maximize the resting space up to the point where it may limit feed bunk space and possibly dry matter intake.

While that may be suitable for some lactating cow groups, some dairy professionals are recognizing that this may not be a suitable pen design for transition cows. Much of the work on addressing the cow's health during this period has focused on trying to minimize facility design that might contribute to the typical dry matter decline that occurs as cows and heifers go through the transition period. Competition at the feed bunk including the amount of bunk space available to these cows and the possible overcrowding of these cows has been identified as a possible design flaw in some pen designs.

For transition cows the pen and barn design may need to maximize feeding space available to the cows in the pen as the first priority in design and then adjust the resting space needs according to the feeding capacity of the pen. Recommendations from Nordlund and Cook suggest that the transition cows should have access to 30" of bunk space with a head lock of 30" or that pens with 24" headlocks be stocked to only 80-85% of the feeding space capacity no matter what the number of stalls in the pen may be. Post and rail feeding fences can artificially reduce the accessible feed bunk for other submissive cows when a dominant cow commands more of the usable bunk space than she needs. Headlocks will reduce the potential loss of feed bunk space by other cows since a dominant cow can not guard more headlock spaces than she can enter.

### **Freestall Pen Design**

Freestalls can be used to provide a clean and dry place for the cow to lie down. They should be sized to prevent unnecessary forces on the cow or injury as cows get up and down. They also should be easily accessible from walk alleys. The freestall dimensions should be sized according to the larger cows that will typical be in a transition cow group. (Nordlund Cook) If the transition pens can be managed around the clock to reasonably assume a cow will be able to be moved to calve in a clean bedded pen rather than in

freestall or manure alley then freestall pens will be a cost effective and labor effective option.

### **Bedded Pen Design**

A bedded pen resting area is another option for transition cows. This option is best used when management can not monitor cows round the clock or the calving date is uncertain. In this case it is likely a cow calving will not be able to be moved into a maternity pen for calving. A large group bedded pen will provide a better calving area. The bedded pack should be sized to provide a minimum of 100 ft<sup>2</sup> / cow for transition cows. The additional space needed per cow will largely be dependant on bedding frequency and ability to keep the animals clean. This resting space does not include the feed alley used for accessing feed and water. Bedding needs to be added regularly to provide a clean and dry place for cows to lie and potentially calve on. The pen arrangement should allow easy bedding addition and manure pack removal with a skidsteer or front end loader. Bedding should be cleaned and replaced with fresh dry bedding after every calving.

### **Maternity Pen Design**

Individual maternity pens should be approximately 12' x 12' or 10' x 14' (~140 ft<sup>2</sup> /cow). They can have a concrete, clay or sand base with at least 6 inches of organic bedding placed on top. Although concrete floors are more easily cleaned they may not provide the best footing surface for the cow. Clay, dirt or sand bases allow better footing for the cow and allow relatively easy cleaning of the pen when accessed by a skid steer. Sanitation is an important design consideration in individual pens used for maternity pens and treatment areas. In maternity pens especially, manure must be removed frequently to prevent the transmission of diseases such as Johnes through contact with the cow's manure by the newborn calf. The maternity pen design should include a water space and a headlock with gates positioned to allow funneling the cow into the headlock for treatment and milking after calving. A vacuum line can be placed above the pen to allow milking out colostrum in the pen before moving the cow. Calving cows may only need less than 1 day of housing in a maternity pen, but some flexibility in time frame for this group is warranted due to calving difficulty and /or the possibility that the due date is uncertain.

### **Herdsperson Office**

Many dairy farm owners and managers are recognizing that the herdsperson office needs to be near the transition cow management groups since this is where a lot of their time will be spent with cows calving and monitoring health of the fresh cows. This office space can be located adjacent to the transition cow pen or barn space to allow easy access and additional support such as storage, surgery areas, hot water and heat for sanitation and other management needs.

## **Flexible Pen Design Concept**

A flexible pen space design may help management of the transition cow groups without building too much unused capacity. These pen designs also attempt to reduce the number of times a cow needs to be moved as she goes through the transition period. Nordlund and Cook suggest that minimizing the number of pen moves can reduce competition and social stress that occurs during the moves. Figure 2 show a conceptual pen design that allows the pen area to be used by the groups of cows on either side of the maternity pen or group. The management groups are adjacent to each other in a pen separated by a gate. The pen space for each group would be adjusted depending on the number of cows in either group as needed. When a cow is moved from one part of the pen it moves across a gate separating the cow groups for management purposes but from a social behavior the cows are still pen mates able to interact with each other.

Additional crossovers in a pen allow the pen to be subdivided into pen areas and also adjust the number of cows in a particular management groups with movable gates. This can minimize the social stress of separating pen mates. The additional crossovers also help to increase the bunk length for a pen space lessening competition at the bunk for the groups and provide additional water location options.

Movable gates allow the groups within the pen to be adjusted based on the specific needs of the group and desire of the manager. A separate calving pen is also provided in the design to isolate and handle a calving cow as needed.

## **Flexible Pen Design Options**

The following pen designs attempt to develop a single transition pen that can be adjusted for group size between closeup, maternity, and fresh cows and heifers. Rather than move a cow between pens separated by a long distance these pen designs attempt to design a flexible pen layout so that the cow moves from one part of the pen to another part of the pen and still can interact with the previous and future pen mates at the gates that separate the management areas of the pen. When a cow is showing signs of imminent calving she can be isolated into a calving pen by one person easily.

Drover lanes or alleys are another addition that can ease the labor and management of the groups that need attention in the transition cow barn. With a well laid out pen system and a drover lane one person can move and manage cows as compared to needing several people at the correct time to deal with the cows that need attention.

Figure 3 shows a transition cow 3 row freestall pen with a capacity of 23 cows and heifers designed for 100 cow herd for cows from 21 days before to 21 days after calving. Closeup cows and heifers, maternity, and fresh cows and heifers are housed in single pen. Management groups are separated by gates within the pen. The number of cows within a group can be adjusted according to need by simply moving or swing gates into a

particular arrangement. Each group size can be adjusted by +/- 3 cows. Feeding space varies between 29-48 inches of bunk space per cow. The maternity area can handle up to two cows calving at any time. The maternity pen is centered between the two areas.

As a closeup cow or heifer moves into a the maternity pen and then into a fresh cow area they essentially stay in the same pen divided into their management groups by only a set of gates. Alternatively this pen design could be used as a closeup and calving pen with separate areas for cows and heifers for approximately a 200 cow herd. In this case the post fresh pen would be in another area of the barn. A drover lane could be added to allow moving cows between pens by one person easily.

Figure 4 shows a transition cow 2 row freestall pen with free stalls in a head to head arrangement designed for a herd of 100 cows. The pen has a capacity of 24 cows and heifers from 21 days before to 21 days after calving. A drovers lane is also included to allow moving cows between pens by one person easily. Closeup cows and heifers, maternity and fresh cows and heifers are housed in a single pen. Management groups are separated by gates within the pen. The number of cows within a group can be adjusted according to need by simply moving a set of gates into a particular arrangement. Each group size can be adjusted by +/- 10 cows. Feeding space is approximately 38" of bunk space per cow. The two maternity pens can handle up to two cows calving at any time in each pen which allows cows to stay in the pen longer if calving dates are uncertain.

Cows ready to calve can be moved from closeup area of the pen to the maternity pen and return to the fresh cow pen area adjacent to the closeup area. This allows cows to maintain contact with their pen mates separated by only a gate for keeping the management groups desired. Alternatively this pen design could be used as a closeup and calving pen with separate areas for cows and heifers for approximately a 200 cow herd. In this case the fresh cow pen would be in another area of the barn accessible by the drovers lane.

Figure 5 shows a transition cow 2 row freestall pen with free stalls in a head to tail arrangement designed for a herd of 100 cows. The pen has a capacity of 23 cows and heifers from 21 days before to 21 days after calving. A drover lane is also included to allow moving cows between pens by one person easily. The gate positions at the exit to the drover lane allow a single cow to be separated and moved out of the pen easily by one person. (Nordlund Cook) The head to tail freestall platform arrangement allows easy observation of the rear of the animals by the manager as they walk up the feed lane. Closeup cows and heifers, maternity and fresh cows and heifers are housed in a single pen. Management groups are separated by movable gates within the pen. Additional crossovers allow the group sizes to be adjusted with movable gates according to the needs of the manager. Each group size can be adjusted by +/- 11 cows. Feeding space is approximately 30" of bunk space per cow. The maternity area can handle one cow calving at any time. Additional maternity pens can be added which will allow some flexibility in calving pressure of the herd.

Cows ready to calve can be moved from closeup area of the pen to the maternity pen and return to the fresh cow pen area adjacent to the closeup area. This allows cows to maintain contact with their pen mates separated by only a gate for keeping the management groups desired. Alternatively this pen design could be used as a closeup and calving pen with separate areas for cows and heifers for approximately a 200 cow herd. In this case the fresh cow pen would be in another area of the barn and accessible by the drovers lane.

Figure 6 shows two different options for a closeup and maternity flexible pen design for cows and heifers as separate management groups designed for herd of 100 cows. The pen has a capacity of 10 cows and heifers 21 days before calving. A drover lane is also included to allow moving cows between pens by one person easily. A group bedded pack or freestall area is provided for closeup cows and heifers. For larger herds the pen could be sized for heifers or cows only. More frequent monitoring of the closeup area may be needed in the freestall design pen area to insure cows can be moved to the clean maternity pen to calve.

Figure 7 shows two different options for a closeup and maternity flexible pen design for cows and heifers as separate management groups designed for a herd of 300 cows. The pen has a capacity of 30 cows and heifers 21 days before calving. A drover lane could also be included to allow moving cows between pens by one person easily. Cow and heifer management groups are separated by gates within the pen. The number of animals within a group can be adjusted according to need by simply moving a set of gates into a particular arrangement. Each group size can be adjusted by +/- 12 cows. Feeding space is approximately 29" of bunk space per cow. The two maternity areas can handle up to two cows calving at any time in each pen which allows cows to stay in the pen longer if calving dates are uncertain.

Cows ready to calve can be moved from closeup area of the pen to the adjacent maternity pen. This allows cows to maintain contact with their pen mates separated by only a gate for keeping the management groups desired. In this case the fresh cow pen would be in another area of the barn accessible by the drover lane. More frequent monitoring of the closeup area may be needed in the freestall pen design area to insure cows can be moved to the clean maternity pen to calve.

### **Develop alternative designs**

The design lists and other information can be used to develop creative ideas and options. Farm visits, popular press articles, and visits with agricultural professionals can also fine tune design decisions. Find those designs and specifications that best fit into your management plan. Use MidWest Plan Service (MWPS) and Natural Resource, Agriculture, and Engineering Service (NRAES) publications, and Extension publications for design recommendations.

## **Choose the “best” system design**

There is no single “best” design. Every design involves trade-offs. The task is to incorporate as many of the design criteria desired into a functional, practical and reasonable plan. Some design principles may have to be compromised slightly to be part of the overall design. If the design principles have been prioritized, the job of deciding which features to keep or eliminate for whatever reason can be made more easily because the decision process is already in place.

Assess the trade-offs of each design option. Try to determine which combination of design choices provides the most balanced design. The “best” solution should meet all of the required criteria set forth in the management plan and building specifications, and most of the highest ranked desired features. The overall layout should be somewhat “better” than the other alternatives.

## **Implement the design**

A transition cow facility should be designed and built to implement the chosen management plan and provide a clean, dry environment with plenty of fresh air and feed and water for the animals. A well-designed facility should also be labor efficient, economical, safe for both workers and cows, and environmentally friendly.

A scaled plan or sketch can be developed for bidding or building purposes. The plan helps define the space and conveys the specifications of what is to be built to the builder and to others involved. The specifications of the building will describe the facility in terms that a builder or contractor can understand. A complete plan will help the builder and other contractors to build the facility the way you planned it. The scaled plan can be used to evaluate the overall design and its impact on all aspects of the management plan. The dairy design team can review and critique the design. The herd manager and other employees can consider how they will perform their assigned tasks. The scaled plan can be used to evaluate cow flow from pen to pen, feed equipment traffic, manure handling traffic, and work protocols and routines.

## **Summary**

Facility design is a fluid process involving give and take. It is easy to lose sight of the original intent along the way. Design the facility to implement the transition cow management plan. Consider each of the design features to develop a comprehensive facility design. Keep the lists developed during the design process and use them as a guide when considering design changes during construction.

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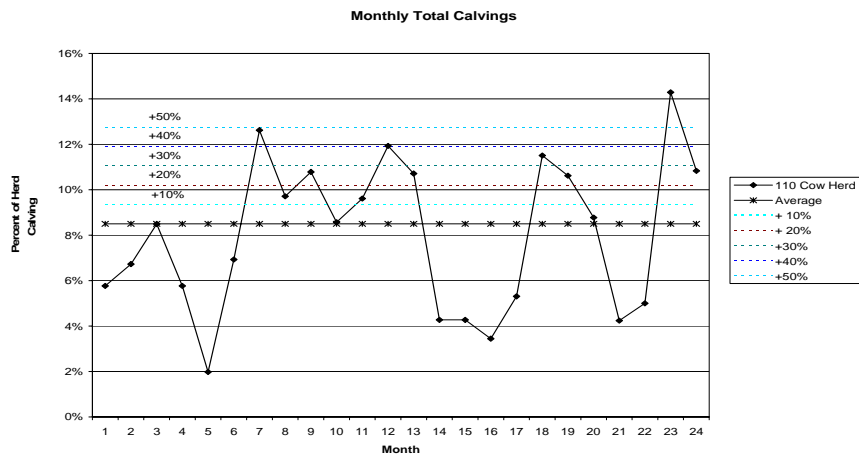
Table 1. Milking and Transition Cow Groups for Three Example Herd Sizes.

| Total Cows | Milk Cows | Dry Cows | Calving Cows | Percent Calving Cows | Calving Heifers | Percent Calving Heifers | Calving Total | Percent Calving Total | Standard Deviation |
|------------|-----------|----------|--------------|----------------------|-----------------|-------------------------|---------------|-----------------------|--------------------|
| 110        | 96        | 14       | 6            | 5.6 %                | 3               | 2.3 %                   | 9             | 8.0 %                 | 3.3 %              |
| 262        | 224       | 38       | 15           | 5.7 %                | 8               | 3.1 %                   | 23            | 8.7%                  | 2.5%               |
| 1699       | 1505      | 194      | 81           | 4.8 %                | 64              | 3.8 %                   | 145           | 8.5 %                 | 1.2 %              |

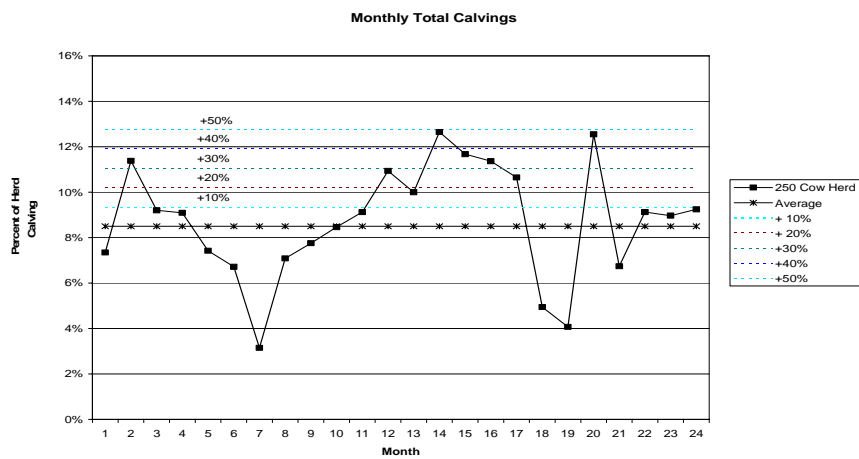
AgSource date from August 2004 through July 2006. Percent of herd based on total cows.

| Transition Group name         | Timeframe                                | 100 Total Cows               |                            |               |                     |                        |
|-------------------------------|--|------------------------------|----------------------------|---------------|---------------------|------------------------|
|                               |  | MWPS                         | Cook Nordlund Smith et al. | AgSource Data | MWPS Design (+ 20%) | AgSource Design (+20%) |
|                               |  | Number of Cows in each group |                            |               |                     |                        |
| <b>Far-off dry cow group</b>  | 60 to 21 days prepartum (before calving) | 12                           | 11                         | 12            | 14                  | 14                     |
| <b>Close-up dry cow group</b> | 21 days prepartum                        | 5                            | 6                          | 5             | 6                   | 6                      |
| <b>Total Dry Cows</b>         | 60 days prepartum                        | 17                           | 17                         | 17            | 20                  | 20                     |
| <b>Closeup Heifers</b>        | 21 days prepartum                        | NR                           | 3                          | 3             | NR                  | 4                      |
| <b>Maternity cow group</b>    | 3 days during calving                    | 1                            | 1                          | 1             | 1                   | 1                      |
| <b>Maternity heifer</b>       | 3 days during calving                    | 1                            | 1                          | 1             | 1                   | 1                      |
| <b>Fresh cow group</b>        | 21 days postpartum (after calving)       | 5                            | 6                          | 5             | 6                   | 6                      |
| <b>Fresh Heifers</b>          | 21 days postpartum (after calving)       | NR                           | 3                          | 3             | NR                  | 4                      |
| <b>Total Calvings</b>         | 28 day period                            | 8                            | 8                          | 9             | 10                  | 11                     |
| <b>Cow Group A</b>            | 3 day period                             | 1                            | 1                          | 1             | 1                   | 1                      |
| <b>Cow group B</b>            | 7 day period                             | 2                            | 2                          | 2             | 2                   | 3                      |
| <b>Cow Group C</b>            | 28 day period                            | 8                            | 8                          | 8             | 10                  | 10                     |

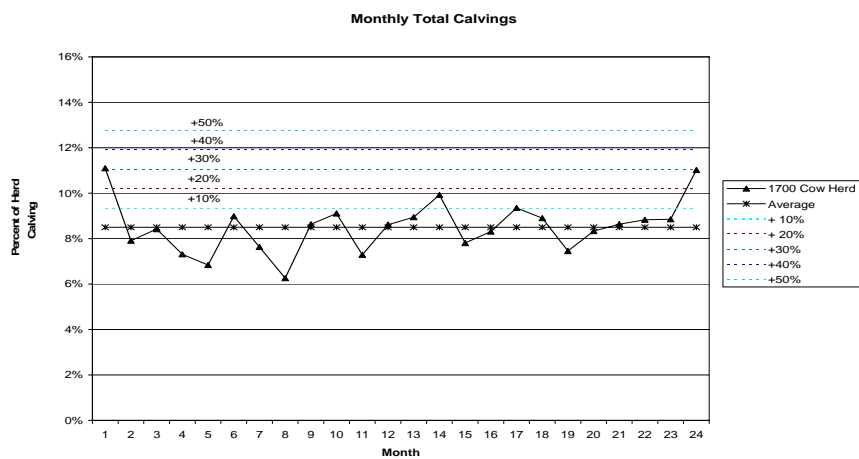
Table 2. Transition Cow Group Design Guidelines. NR- No Recommendation. MWPS (2), Cook-Nordlund (5), Smith et. Al (6), AgSource (7).



100 Cow Herd Calving Percentages



250 Cow Herd Calving Percentages



1700 Cow Herd Calving Percentages

Figure 1. Example Herds Calving Percentages Over a 24 month Period

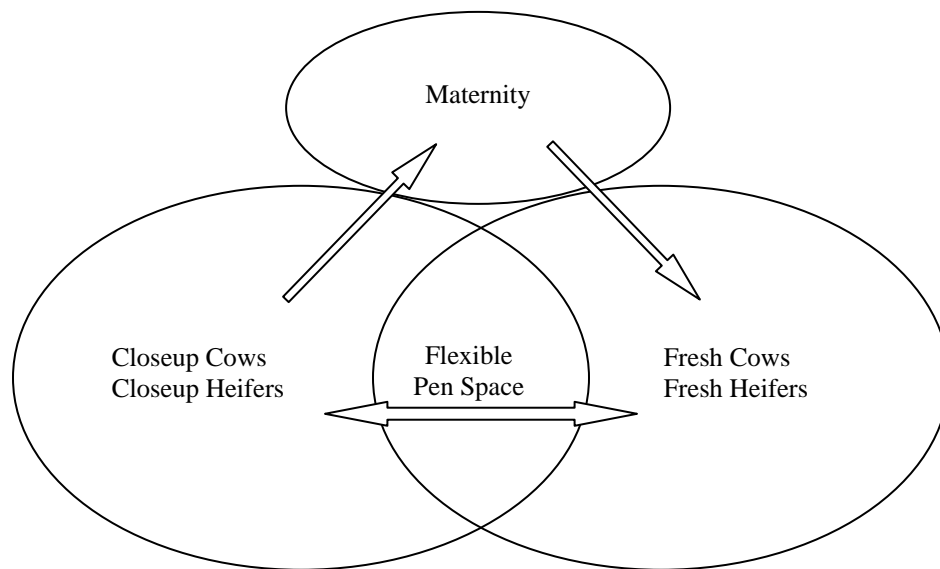
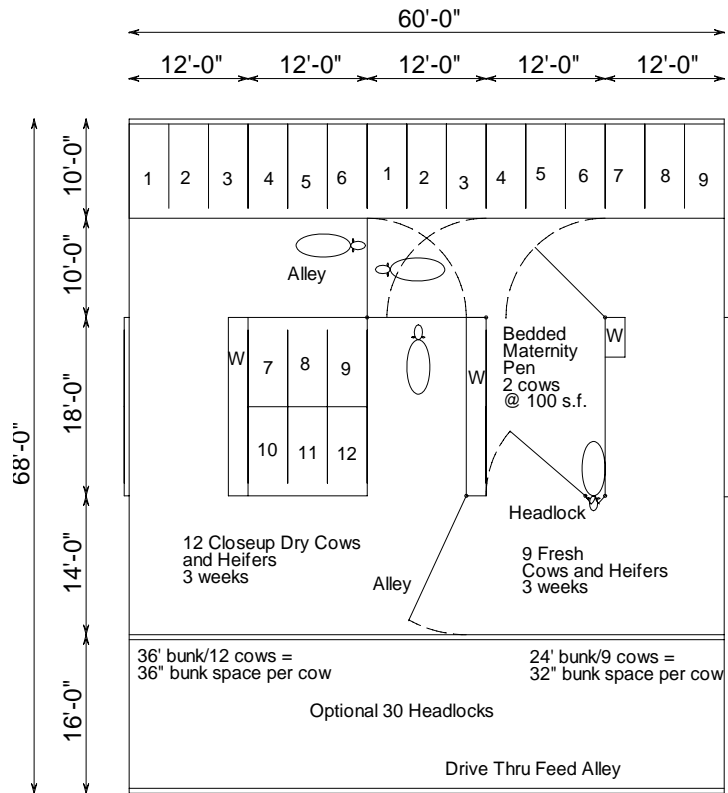
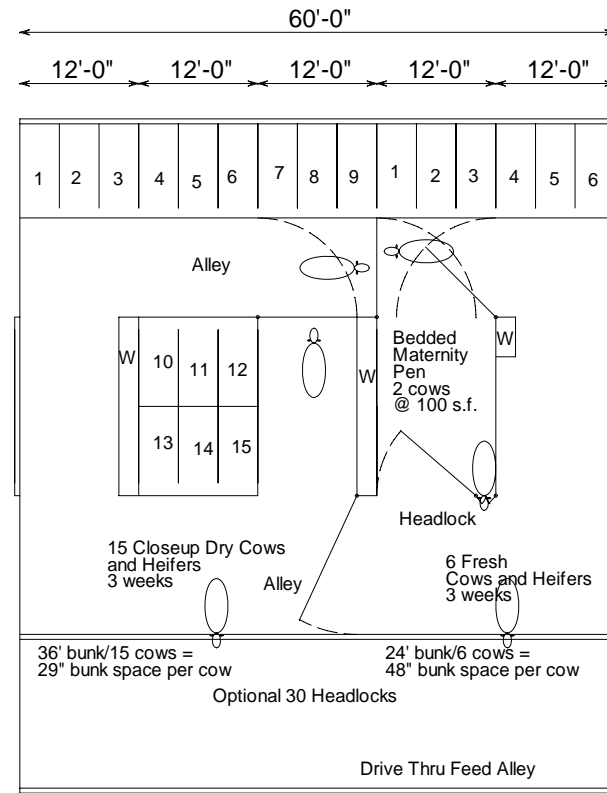


Figure 2. Flexible Pen Design Concept with Adjacent Pen Areas and Shared Pen Space



100 Cow Herd Transition Cows  
3 row barn flexible pen design  
12 closeup cows and heifers  
9 fresh cows and heifers  
2 maternity cows and heifers  
23 cows total



100 Cow Herd Transition Cows  
3 row barn flexible pen design  
15 closeup cows and heifers  
6 fresh cows and heifers  
2 maternity cows and heifers  
23 cows total

Figure 3. 3 Row Flexible Pen Design for 100 Cow Herd

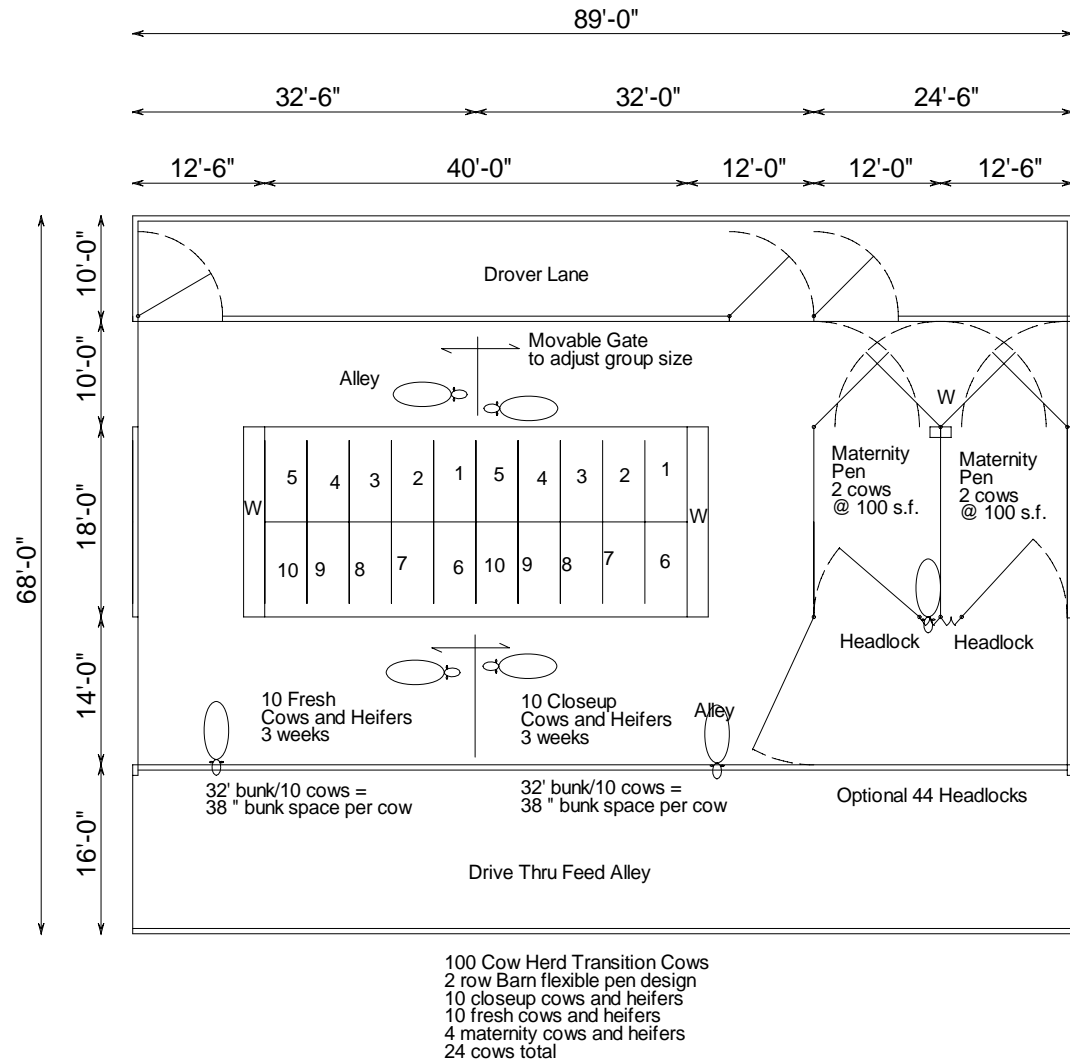


Figure 4. 2 Row Flexible Pen Design for 100 Cow Herd

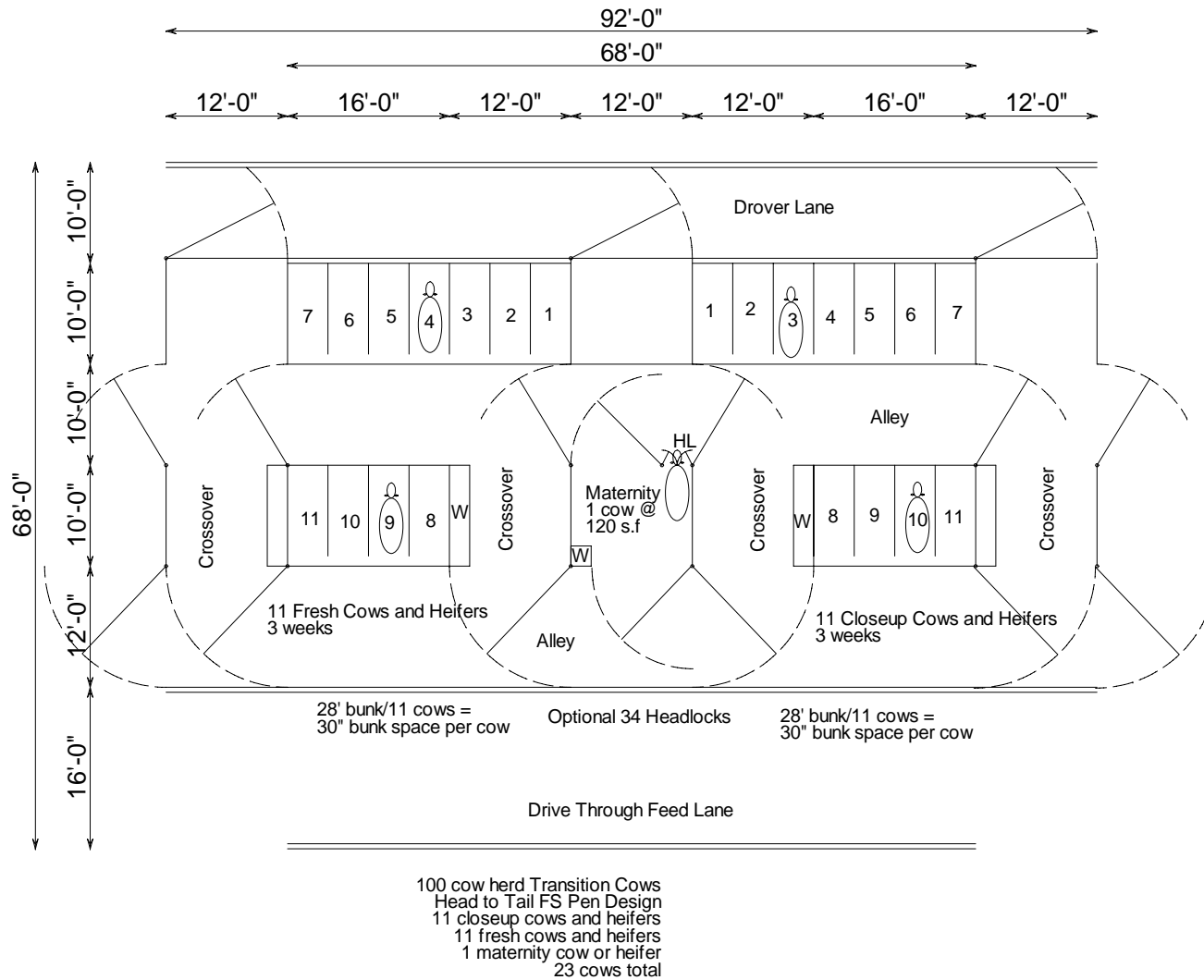
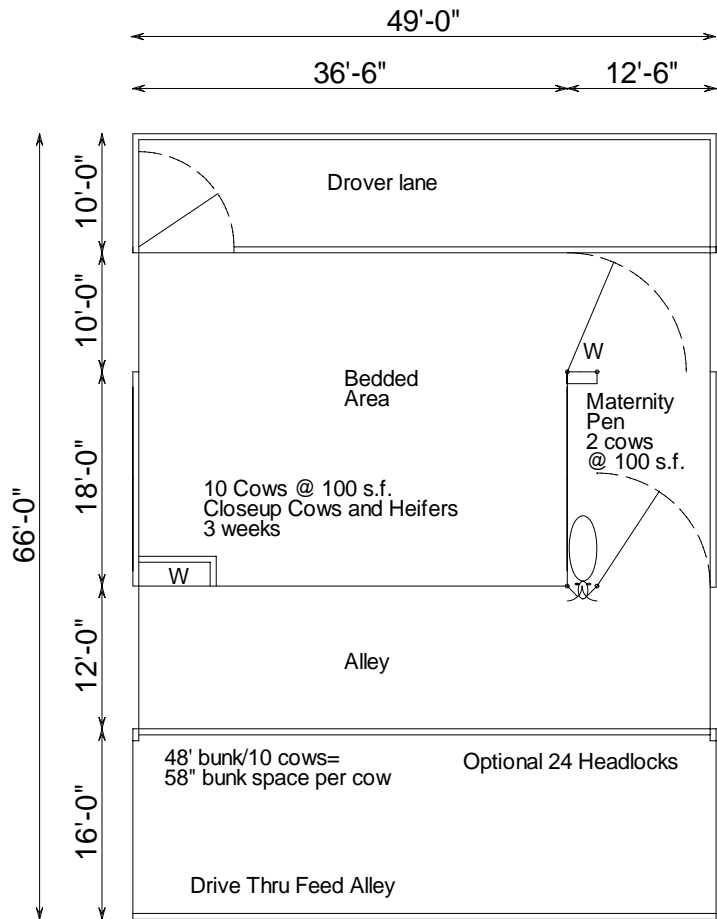
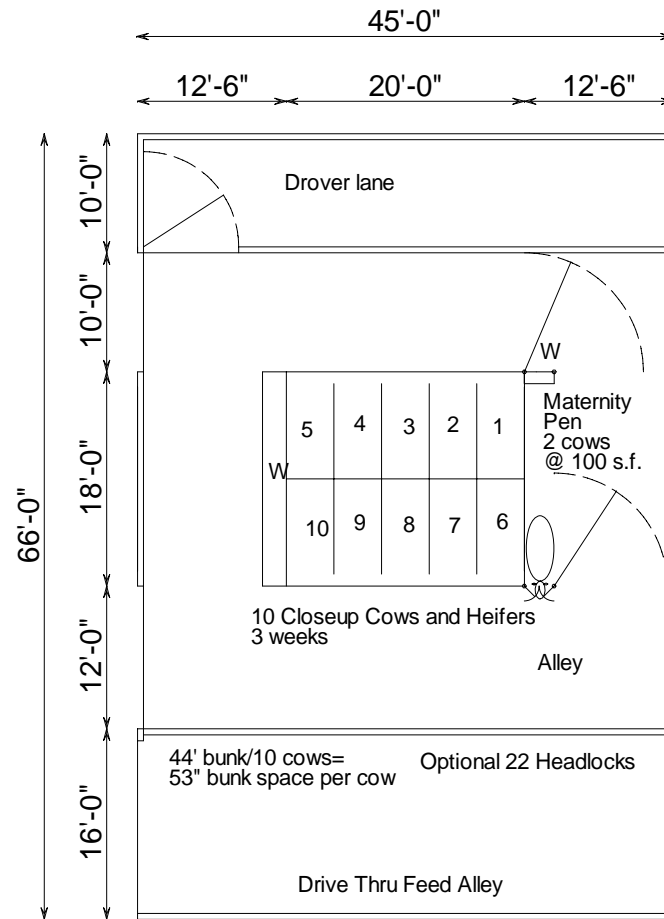


Figure 5. 2 Row Head to Tail Flexible Pen Design for 100 Cow Herd

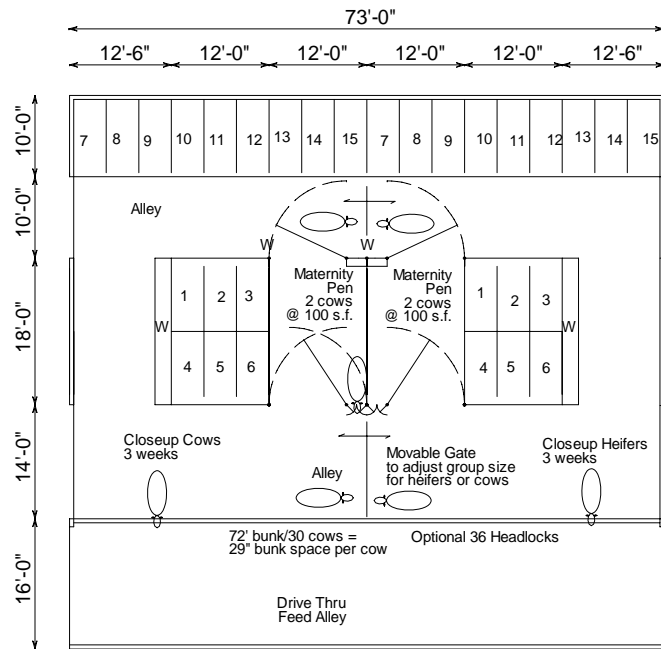


100 Cow herd  
 Bedded Pen Design  
 Freshening Pen  
 10 closeup cows and heifers  
 2 maternity cows  
 12 cows total

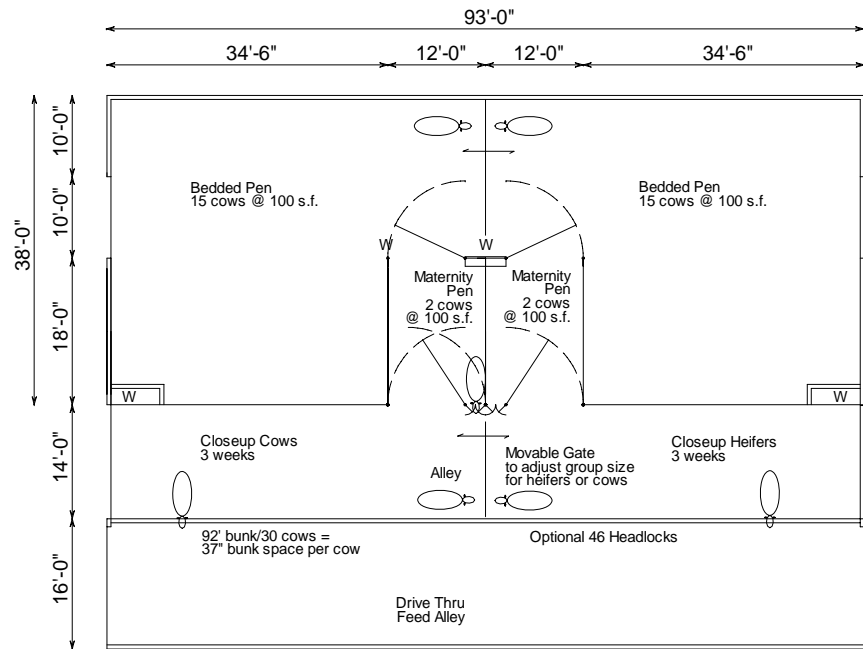


100 Cow herd  
 Freestall Pen Design  
 Freshening Pen  
 10 closeup cows and heifers  
 2 maternity cows  
 12 cows total

Figure 6. Closeup and Maternity Bedded Pen and Freestall Pen Design for 100 Cow Herd



Flexible Freshening Pen  
 300 cow herd  
 30 closeup cows and heifers  
 4 maternity cows  
 34 cows total



Flexible Freshening Pen  
 300 cow herd  
 30 closeup cows and heifers  
 4 maternity cows  
 34 cows total

Figure 7. Closeup and Maternity Flexible Pen Designs for 300 Cow Herd