

# Managing Heat Stress

Atlantic Poultry Conference  
2018

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# Managing Heat Stress

- Is it Fans?
- Is it Water?
  - is it water for the birds?
  - is it water for the ventilation?
- There's an App for that!



# Cooling Options for Your Barn

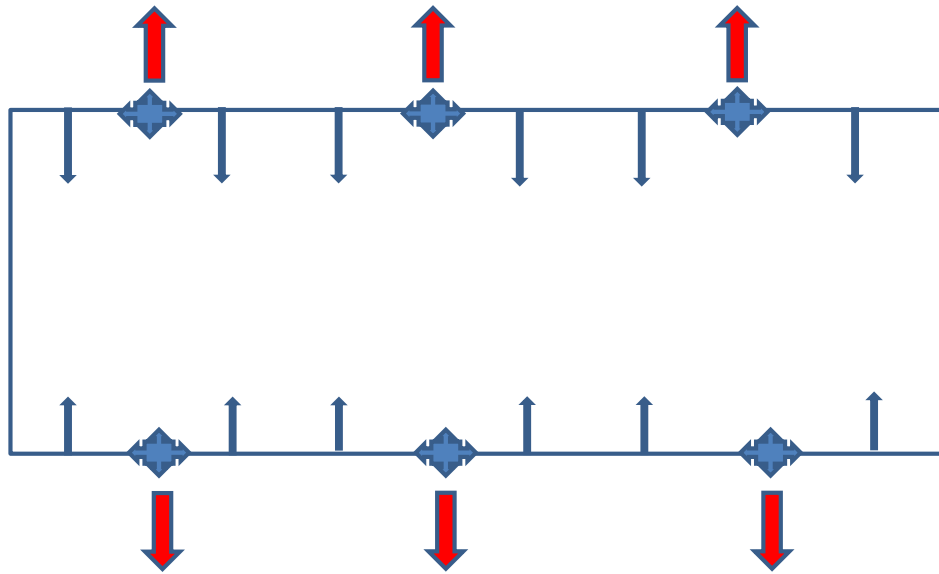
1) Air Based Cooling - Tunnel Ventilation

2) Water Based Cooling

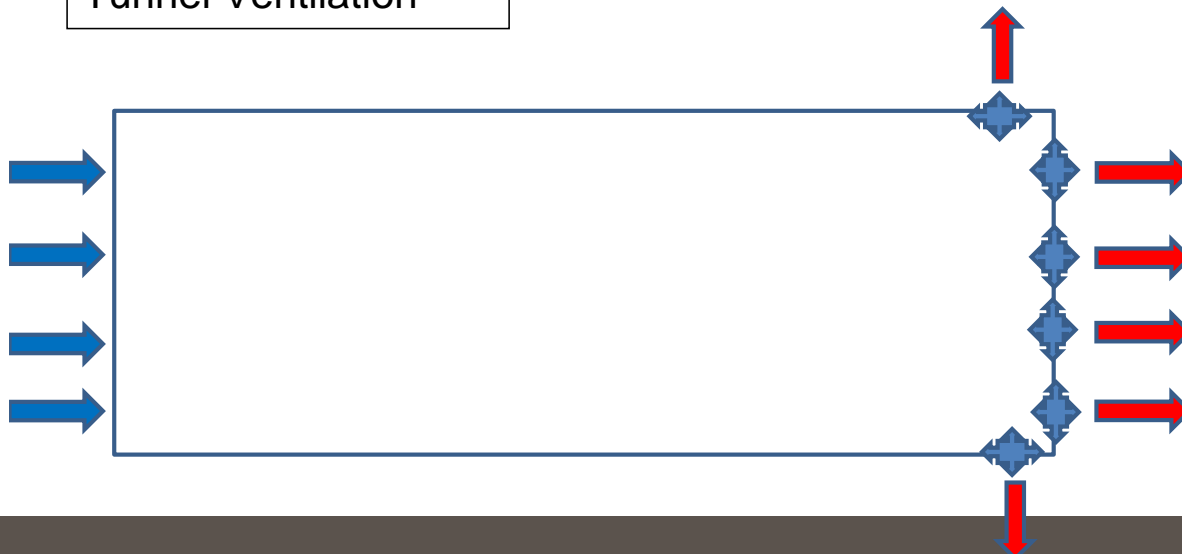
- Sprinklers
- Misters
- Evaporative Cooling pads



# Cross Flow Ventilation – Hot Weather, generally design for > 1 air exchange per minute



Tunnel Ventilation



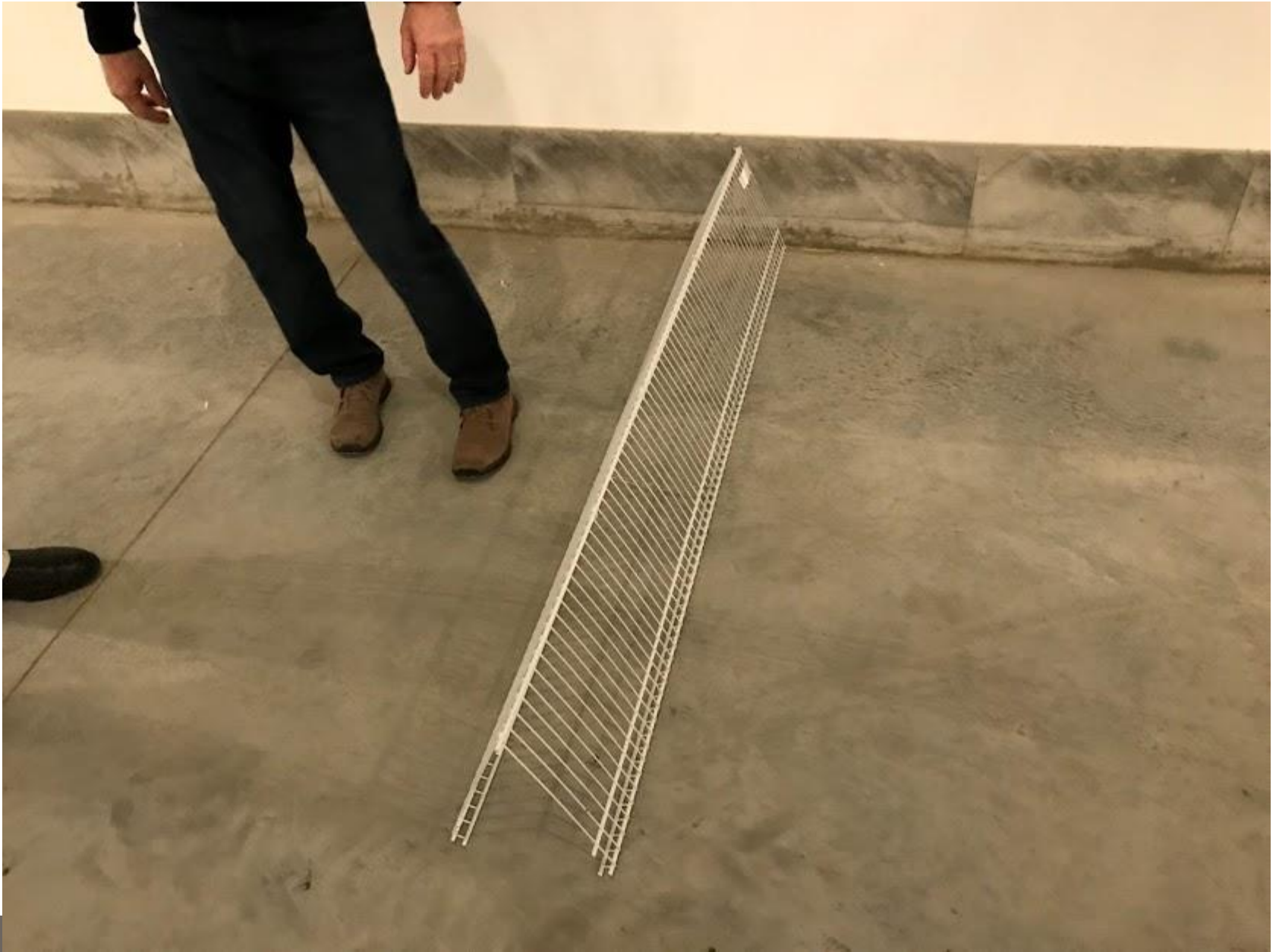


# Tunnel Ventilation Principle

- Create a high velocity air flow down the length of barn
- Animal feels cooler due to “wind chill” effect of standing in a fast moving air stream.
- Target airspeeds of 1.0 – 2.5 m/s (200- 500 ft/min) or higher
- Airspeed of 2 m/s (400 ft/min) creates a wind chill of 3.7C for broilers



# Migration Fences?













# Tunnel Ventilation Design

- Formula to determine total fan capacity required for barn

$$\begin{aligned}\text{Airflow } Q &= \text{Air Velocity} \times \text{Barn Cross section Area} \\ &= \text{Target air speed} \times (\text{width of barn} \times \text{ceiling height})\end{aligned}$$



# Example

- 60 ft x 400 ft x 9 ft ceiling broiler barn
- Target airspeed 400 ft/min
- Fan Capacity =  $400 \text{ ft/min} \times (60 \text{ ft} \times 9 \text{ ft})$   
= 216,000 CFM
- Tunnel fans 10 – 48 inch fans  
OR 8 – 57 inch fans



# Fan Considerations

- Fan Selection – historically large, single speed, belt drive fans as these are more energy efficient (CFM/W) than direct drive fans
- Addition of fan cones on exhaust improve airflow/fan performance by 10-15%
- Normally single speed tunnel fans are staged, e.g. if full airflow requires 10 fans, the controller may have 3 stages. Stage 1 = 4 fans, Stage 2= Stage 1 +3 fans and Stage 3 = all 10 fans
- Some newer tunnel fans ( 48-72 inch diameter) are belt drive with variable frequency drives. This option changes control settings since fans no longer single speed. More efficient but higher cost (Driver Unit), DC vs AC



# Trend in Tunnel Fans

**Chore Time – 57 inch Fan**



**Acme – 72 inch Fan**





Fan Model	HP	CFM vs Static Pressure 0.10 (inch water gauge)		CFM vs Static Pressure 0.15 (inch water gauge)	
		CFM	CFM/Watt	CFM	CFM/Watt
Acme 48- inch BDR48J2-C	1	22,300	19.0	21,100	17.1
Acme 54- inch BDR54J1-C	1	25,863	22.7	24,134	20.1
ChoreTime 57- inch 53464-22	1.5	27,100	23.0	25,100	20.1
Acme 72-inch BDR72M	3	48,500	20	45,600	19

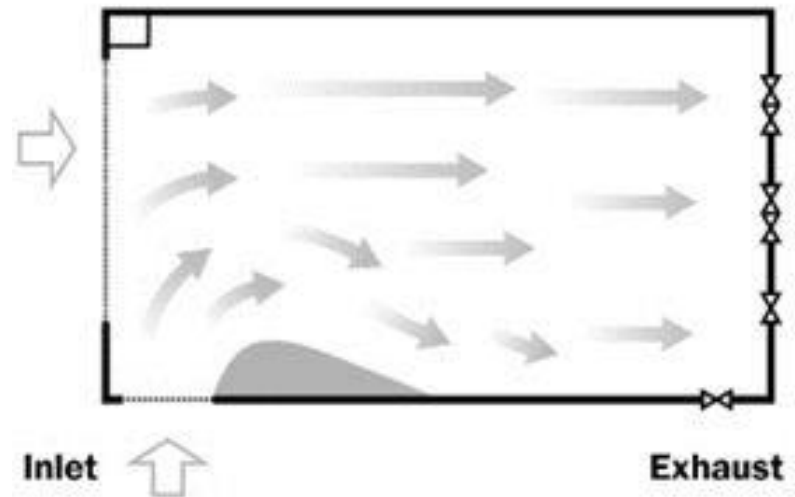
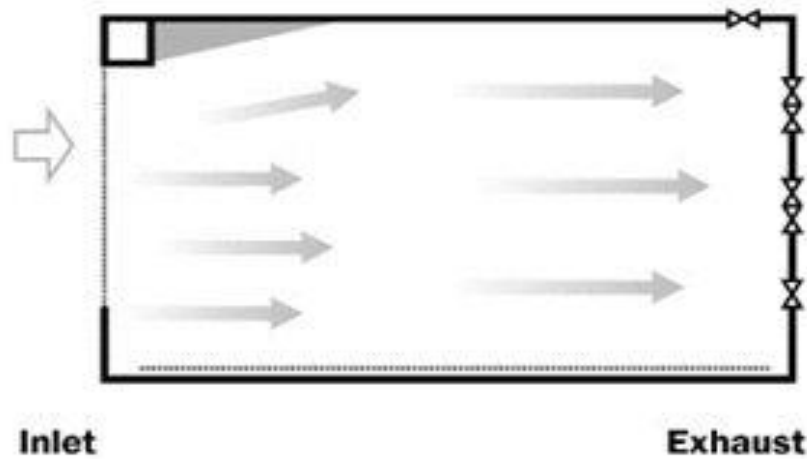


# Other Considerations for Tunnel

- Airflow tends to “Laminar” – air flows in straight lines the length of barn from inlet to exhaust fans. Airspeed is highest at mid-height and lowest along floor and near the ceiling
- Location of inlets, service entrances, etc. could result in “dead air “ spots in barn
- Majority of airflow may be above birds – possible remedy is the inclusion of deflectors spaced along length of barn to direct air down onto birds

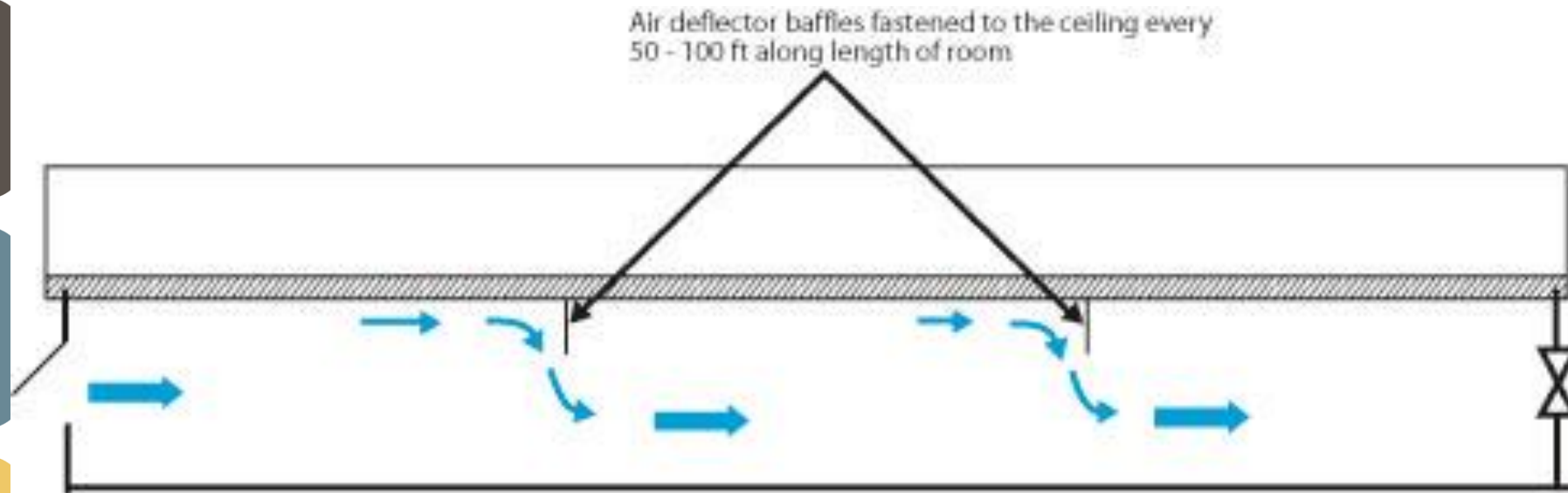


# Dead Air Zones





# Deflector Slide





# Water Functions

- Water is needed for bird consumption, reducing air temperature (including evaporative cooling pad and fogging systems) and facility sanitation.
- For all three, volume and quality of water is important.
- Birds can double their water consumption in hot weather.
- Good quality water is important for bird health.
- Good water quality and volume is important for water based cooling also!



# Poor Water Quality

- Water is a critical nutrient in bird metabolism and nutrition.
- From a physiology perspective, water consumed by the bird is used for nutrient transportation, enzymatic and chemical reactions in the body, body temperature regulation and lubrication of joints and organs.
- Poor water quality can interfere with proper digestion, bird performance, vaccine efficacy, bird cooling, can cause leaky water nipples and increased microbial growth.



**Table 1. Drinking Water Quality Standards for Poultry**

Contaminants	Average Levels	Maximum Acceptable	Remarks
<b>BACTERIA</b> Total bacteria Coliform bacteria	0/mL 0/mL	100/mL 50/mL	0/mL is desirable 0/mL is desirable
<b>ACIDITY/HARDNESS</b> Total Hardness pH	60-180 ppm 6.8-7.5	110 ppm 6.8-8.0	< 60 is unusually soft; > 180 is very hard. < 6.0 is undesirable; < 6.3 may degrade performance
<b>NITROGEN COMPOUNDS</b> Nitrite (NO <sub>2</sub> ) Nitrate (NO <sub>3</sub> )	0.4 mg/L (NO <sub>2</sub> -N) 10 mg/L (NO <sub>3</sub> -N)	4 mg/L 25 mg/L	- - - Levels of nitrate from 3 to 20 mg/L may affect performance.
<b>NATURAL CHEMICALS</b> Calcium (Ca) Chloride (Cl)  Copper (Cu) Iron (Fe) Lead (Pb) Magnesium (Mg)  Sodium (Na)  Sulfate (SO <sub>4</sub> )  Zinc (Zn)	60 mg/L 14 mg/L  0.002 mg/L 0.2 mg/L - - - 14 mg/L  32 mg/L  32 mg/L  - - -	- - - 250 mg/L  0.6 mg/L 0.3 mg/L 0.02 mg/L 125 mg/L  50 mg/L  250 mg/L  1.5 mg/L	- - - Even 14 mg/L may be detrimental if sodium level is higher than 50 mg/L Higher levels of copper produce bitter flavor Higher levels of iron produce bad odor and taste. Higher levels of lead are toxic. Higher levels of magnesium have laxative effect. Levels > 50 mg/L may affect performance if sulfate level is high > 50 mg/L of sodium may affect performance if sulfate or chloride is high Higher levels of sulfate have laxative effect. Levels > 50 mg/L may affect performance if magnesium and chloride are high. Higher levels of zinc are toxic.

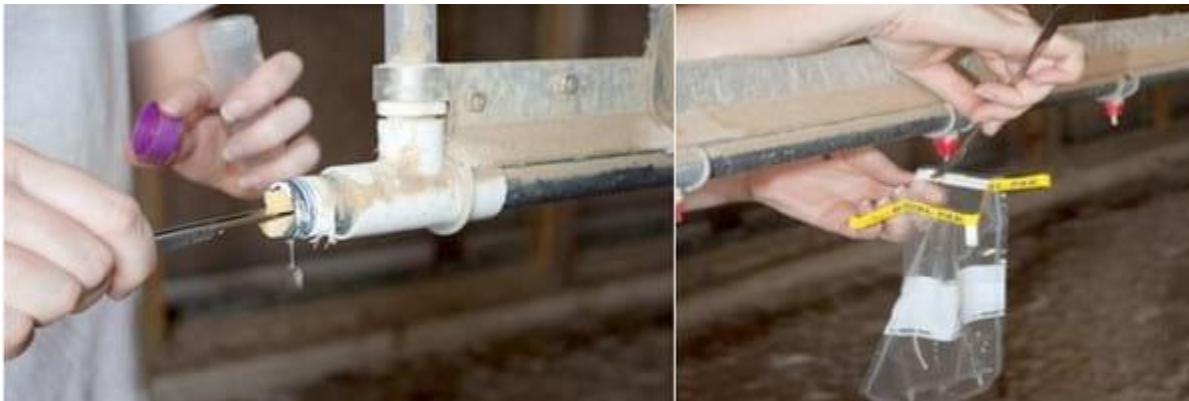
Adapted from T.A. Carter and R.E. Sneed, *Drinking Water Quality for Poultry*, PS&T Guide No. 42, Extension PoultryScience, North Carolina State University, Raleigh NC, 1987.



# Water Management Tips

## 1. Conduct water tests

- Each farm should have its well water tested regularly, beyond OFFSAP requirements and looking at more than the total coliform and E. Coli counts.
- Samples should be taken at well head and furthest line from well
- This should include draw down and recharge to make sure you have well capacity for your farm.





# Water Management Tips

## 2. Change filters regularly

- Sediment and other particulates can cause leaky water nipples that can have negative effects on litter quality.
- Clogged filters restrict water flow to the drinker and cooling systems
- In some cases, you go beyond simple filters, (i.e. iron)





# Water Management Tips

## 3. Flush water lines regularly

- A high pressure flush should help with ridding your lines of biofilm.
- Make sure there is fresh water. Do not want water to get >30C for bird consumption.
- After adding supplements through the medicator (e.g. vaccines, medications, vitamins, electrolytes, etc.)
- At 20-40 psi, 1 minute flush = 30 Metres (100 Ft) of line.



# Water Management Tips

## 4. Plan ahead before treating water

- Know what you need to treat, plan on what equipment and products you need.
- Have your water treatment stock ready, make sure you have enough product, mix it properly, have a working and calibrated injection pump or stock tank.
- Make sure that your water quality will not effect anything added to your water system. (negative chemical interactions that can clog your system).



# Water Requirements

## Drinking Water



## Water Based Cooling





# Drinking Water

- Water requirements of poultry is directly tied to feed consumption and air temperature

Once air temperatures exceed 30C (87F) expected water consumption can increase by 50% above normal rates.

Birds are unable to sweat as a means of regulating body temperature. Their method of heat control involves panting to expel surplus heat from their body. This releases large amounts of moisture from the bird that must be replaced or the bird will become dehydrated.

## Water consumption of Broiler Chickens By Age

Chicken Broiler Age ( weeks)	Water Requirement ( L/1000 birds/day)	
	21 C	32 C
1-4	50-260	50-415
5-8	345-470	550-770



# Drinking Water

## Layers, Pullets, Broiler Breeders

Chicken Type	Weight Range (kg)	Water Requirement Range (L/1000 birds/day)
Laying hens	1.6-1.9	180-320
Pullets	0.05-1.5	30-180
Broiler Breeders	3.0-3.5	180-320

## Water Consumption of Turkey by Age

Turkey Age ( weeks)	Water Requirement (L/1000 birds/day )	
	10 C -21 C	27 C -35 C
1-7	38-327	38-448
8-14	403-737	508-1063
15-21	747-795	1077-1139



**Example – Barn (60ft x 400ft) housing 19,200 heavy roaster birds at 47 days old when ambient temperature is 32 C**

- From the Broiler Table expected water requirement is 770 L/ 1000 birds/day
- Total Water required = 19,200 birds x 770L /1000 birds/day  
$$= 14,784 \text{ L /Day}$$
- Assuming 16 hr lighting this works out to 924 L/hr or 244 US gal/hr when birds are drinking
- Expected flow rate = 4 US gal/min



# Water Based Cooling Theory

- Incoming air stream is pulled through a fine spray of water (high pressure mister) or a saturated medium (evaporative cooling pad) or over a wetted animal (sprinkler system).
- Phase conversion from liquid water to water vapour removes heat energy from incoming air lowering the air temperature but raising the Relative Humidity (%RH).



# Air temperature drop – Table 7.3

Ambient Temperature and Relative Humidity	Potential Temperature Drop Caused by Vaporizing Water		
	10% RH Increase in Room	20% RH Increase in Room	30% RH Increase in Room
30 °C and 40% RH	2.2 °C	4.3 °C	6.0 °C
30 °C and 50% RH	2.0 °C	3.8 °C	5.4 °C
30 °C and 60% RH	1.8 °C	3.4 °C	Room RH too high
30 °C and 70% RH	1.6 °C	Room RH too high	Room RH too high

Source: Psychrometric Chart, Normal Temperatures, SI Metric Units, American Society of Agricultural and Biological Engineers, ASAE D271.2 APR1979 (R2005).



# Water Quality for Cooling Systems

- Water needs to be very clean – free from any sediment to prevent blockages so a filter is generally added to the water feed line.
- Hard water should be treated through a softener to avoid issues of scaling.
- Water containing high levels of minerals should be treated.



# Low Pressure Sprinkler System

- Low pressure system  
(30 – 50 psi)
- Usually placed in front of air intake openings on outside of barn but could be in animal area.
- Add least amount of water to air (raise RH 5-10%) –least efficient, due to large droplet size.



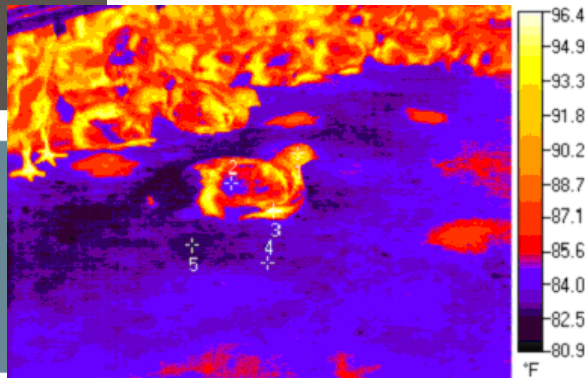


# Understanding the Concept

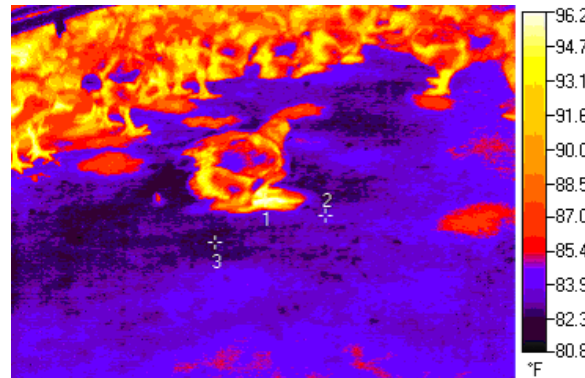
**And then there is the Weeden Sprinkler System...**

**Captured heat is released when birds get up**

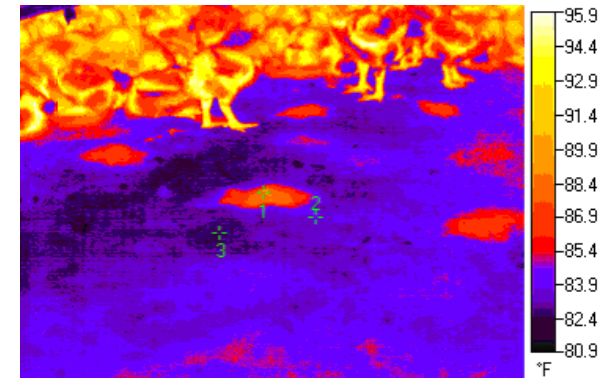
**(see infrared images below)**



Notice that the back of the bird is 10° cooler than it's head. This infrared image shows the ability of the feathers to insulate the bird and withhold heat.



The sprinkler causes the bird to stand up. The temperature of the litter is the same as the body due to heat being released through the breast of the bird.



Within 10 seconds the temperature of the litter beneath the bird drops in excess of 5°.



# High Pressure Mister Line

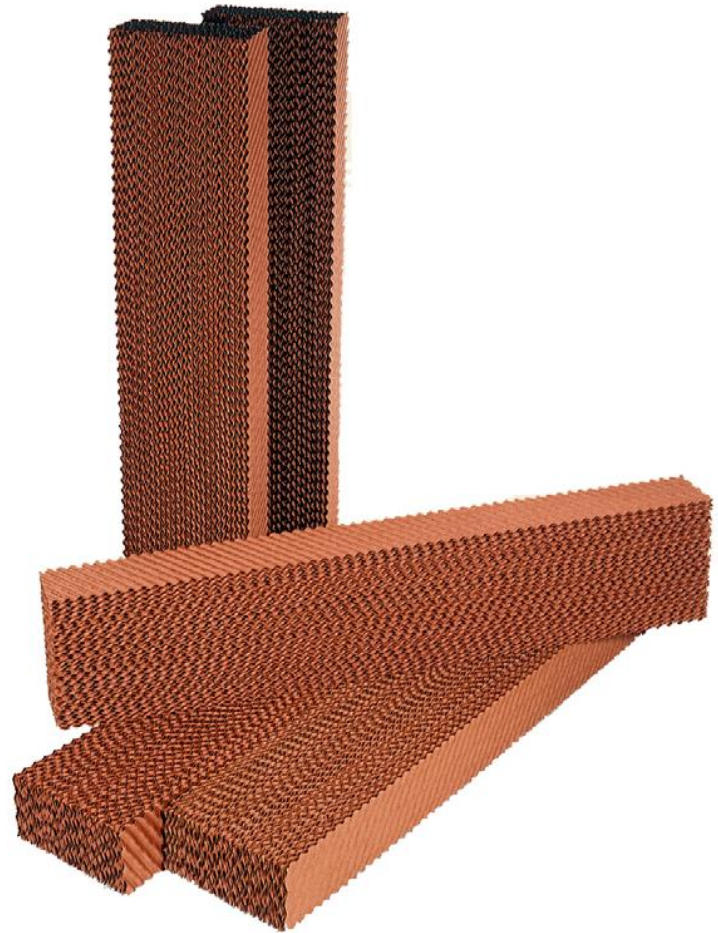
- System operates at very high pressure – 1000 psi.
- Requires special pipes, fittings and nozzles.
- Equipment is usually suspended in front of air inlets on the inside of barn.
- Can raise RH 10-30%





# Evaporative Cooling Pads

- Very common cooling system in many parts of the world.
- Can raise RH of air stream 10-30%
- Cooling Pads are normally 4 or 6 inches thick.
- Renewed interest in Ontario in past several years.





















# EC Design Recommendations

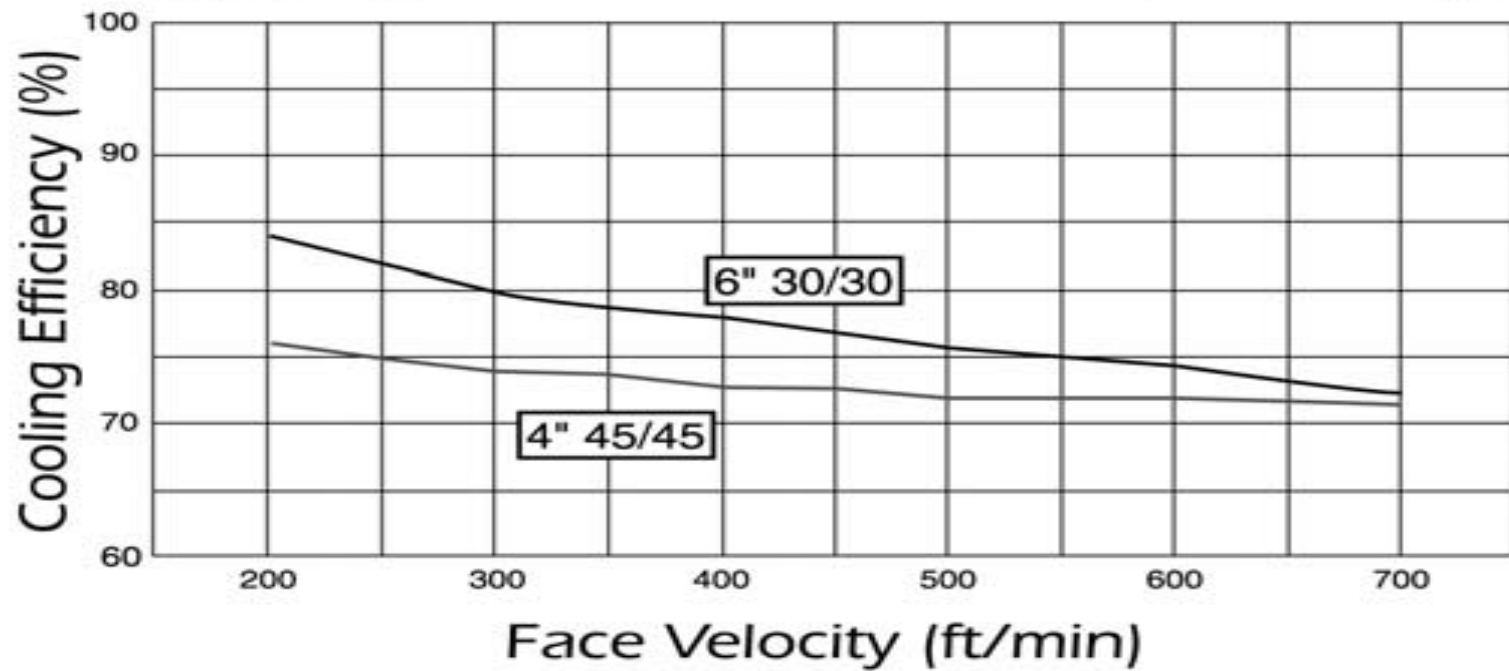
- For best cooling efficiency most pad manufacturers recommend design air velocity of 250-350 ft/min (1.25 -1.75 m/s) through pad.
- To limit static pressure drop across pad to less than 0.10 inch w.c. provide 2.5 sq ft of opening area /1000 CFM fan capacity.



**kool-ceil.**

HIGH EFFICIENCY  
EVAPORATIVE PADS

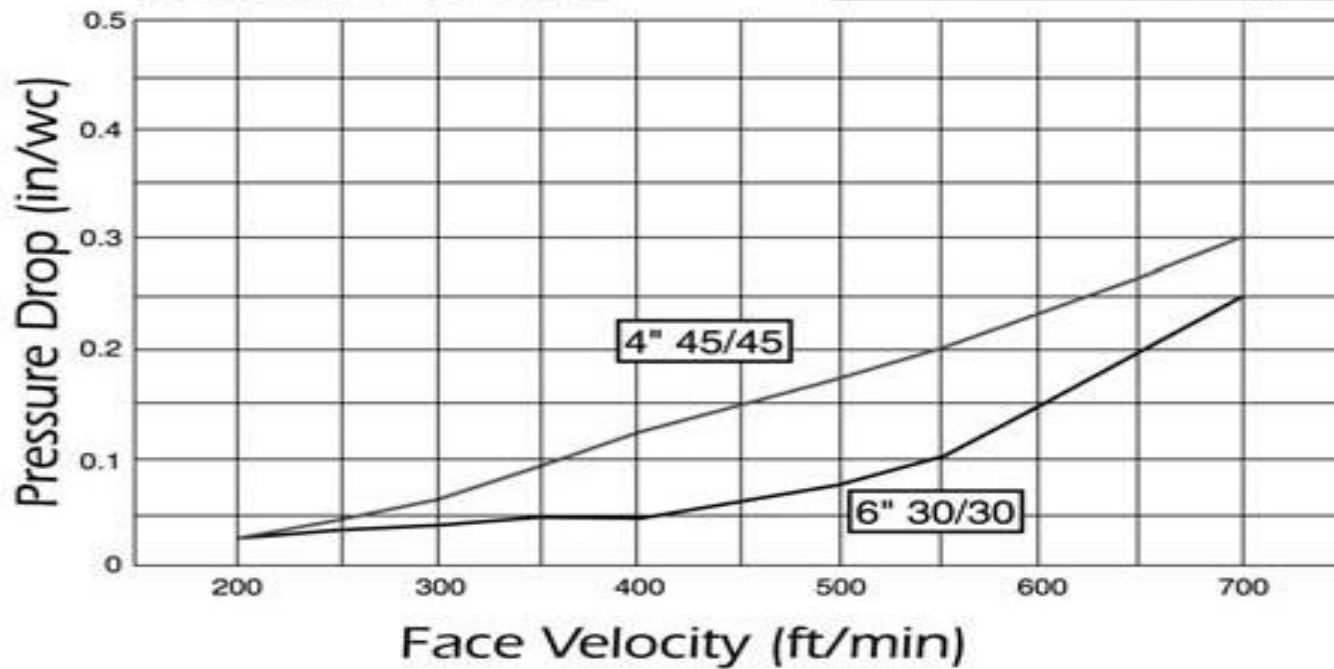
**Efficiency**





**kool-ceil.**

**Pressure Drop**





# Water Supply

- To lower air temperature 1 F (0.55 C) requires evaporating 0.125 gallons (0.5 L) of water per hour for every 1000 CFM of airflow.
- Example 60 ft x 400 ft x 9 ft broiler barn with target air speed of 350 ft/min to lower barn temperature 9F (5 C).

$$\begin{aligned}(350 \times 60 \times 9) / 1000 \times 9 \times 0.125 &= 213 \text{ gal/hour} \\ &= 3.55 \text{ gal/min}\end{aligned}$$



# Ongoing Maintenance

- Blockages in top feed pipe – resulting in dry zones on the pad. If pad is not kept wet then incoming air is not cooled.
- Algae growth. Pad is made from organic materials (fibrous cardboard type material) and kept in moist state during warm temperatures. It is recommended to allow pad to dry out at least once daily or use approved algaecide in system (check with manufacturer).



# Winter Maintenance Issues

- Drain all plumbing components.
- Install insulated panels on inside of barn to reduce heat loss from barn during colder times of year.
- Install exterior protection over cooling pad to protect from Ultraviolet light, and precipitation (rain, snow).





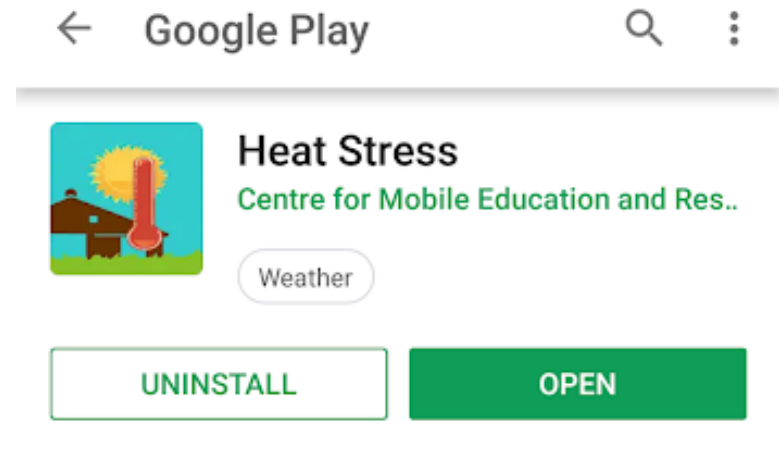






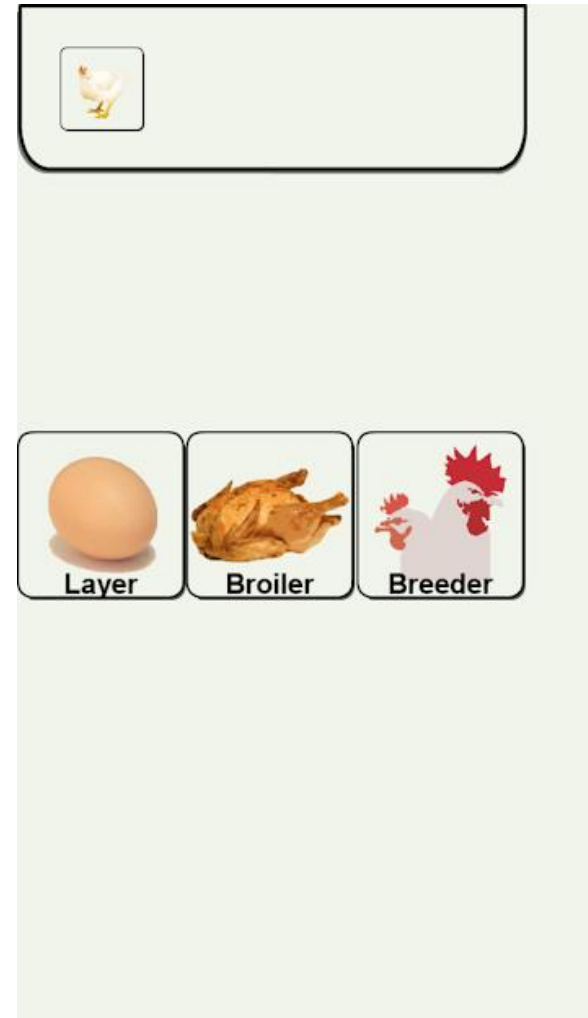
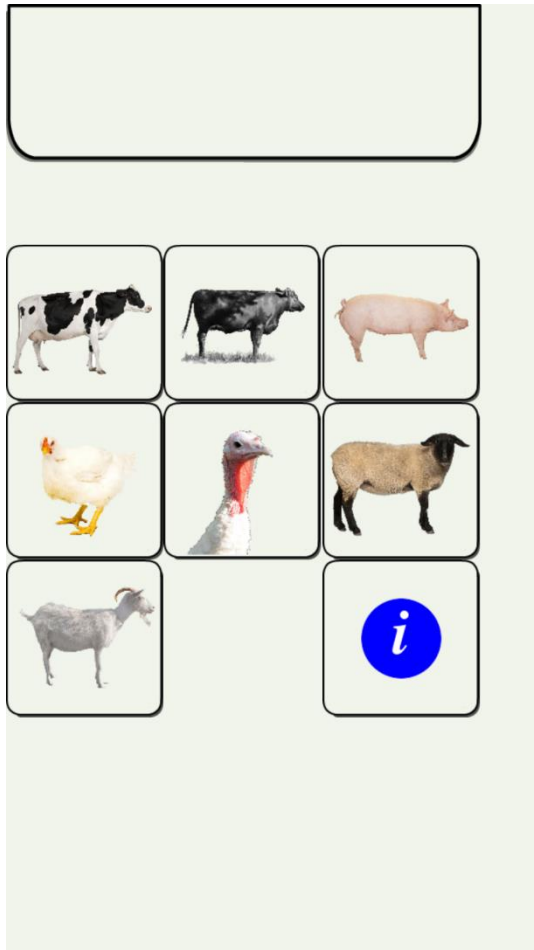
# Heat Stress App

- Blackberry and Android Only! (Blame Apple for not being able to get it on the App Store).
- App Developed with University of Guelph.
- Pick Species, Temp and Humidity.
- Gives you a Temperature Humidity Index and Management Options.





# Heat Stress App





# Heat Stress App



20C  
68F

22C  
71F

24C  
75F

26C  
78F

28C  
82F

30C  
86F

32C  
89F

34C  
93F



36C  
96F

38C  
100F

40C  
104F

42C  
107F

44C  
111F

46C  
114F


48C  
118F

50C  
122F






# Heat Stress App



30C  
86F

40%	45%	50%
55%	60%	65%
70%	75%	➡ Humidity



30C  
86F

80%	85%	90%
95%	100%	⬅
Humidity		



# Heat Stress App



30C  
86F

60%

## Heat Stress: **Emergency**

Temperature Humidity Index: 80

### Relief actions:

[Cross Ventilation](#)

[Tunnel Ventilation](#)

If no sprinkler, walk the birds so they will stand and release the heat

Flush water lines to ensure birds are drinking fresh cold water

Add electrolytes to water

Reduce barn density if possible

Schedule feeding for cooler times of the day



30C  
86F

60%

## Heat Stress: **Emergency**

Temperature Humidity Index: 80

### Cross Ventilation:

[Back](#)

Ensure greater than 1 air exchange/minute

Run sprinkler system for 5 min on and 15 min off

Spray water on the barn roof (ventilation air is coming from the attic)

Spray water on the outside of the air intake (if drawing air from the sidewall) or operate high pressure misting system



30C  
86F

60%

## Heat Stress: **Emergency**

Temperature Humidity Index: 80

### Tunnel Ventilation:

[Back](#)


Operate at maximum tunnel ventilation (> 400 ft/min)

Run sprinklers

Turn on misting system or evaporative cooling panels to humidify incoming air



# Heat Stress App



Layer

30C  
86F

60%

## Heat Stress: **Emergency**

Temperature Humidity Index: 80

### Relief actions:

Ensure greater than 1 air exchange/minute


Flush water lines to provide fresh cool water

Add electrolytes to water

Turn on water misters/foggers in front of air inlets

Schedule feeding for cooler times of the day





Tom

30C  
86F

60%

## Heat Stress: **Emergency**

Temperature Humidity Index: 80

### Relief actions:

[Cross Ventilation](#)

[Natural Ventilation](#)

[Tunnel Ventilation](#)

If no sprinkler, walk the birds so they will stand and release the heat

Flush water lines to ensure toms are drinking fresh cold water

Add electrolytes to water

Reduce barn density if possible

Schedule feeding for cooler times of the day





# Questions?