Destroy and Let Lie Project Report

A project undertaken as part of the Wildlife Exotic Disease Preparedness Program

Department of **Employment, Economic Development and Innovation**
Department of Agriculture Fisheries & Forestry

Australian Government
Department of Agriculture, Fisheries and Forestry

Toward Q Tomorrow's Queensland

Queensland Government

Contents

Destroy and Let Lie Project Report

Project Coordinator – Greg Williamson
Project Officers – Murray Wingett, Elizabeth (Bec) Lake
Biosecurity Queensland
a service of
Department of Employment, Economic Development and Innovation

Aim

The aim of the project is to investigate viable methods of carcass disposal to use in extensive areas during an EAD (emergency animal disease) response.

The study addresses the question – "Will the physical conditions in a decomposing carcass inactivate infectious EAD agents in a timely manner?"

Objectives

- Assess pH and temperature changes in decomposing carcasses.
- Assess species and environmental effects on carcass degradation.
- Validate disposal of carcasses by "shoot and let lie" method in relation to documented critical values of pH and temperature for FMDV destruction.
- Relate the information to other EADs.
- Survey predation to assess level of risk of transmission via predators.

Background

The control program for an incursion of emergency animal disease (EAD) into extensive areas of Australia is likely to involve culling of feral and un-musterable animals during the emergency response to that EAD. The purpose of the Destroy and Let Lie Project is to investigate the physical conditions in carcasses of field shot animals left in situ under various environmental conditions with respect to infective agent survival. The results of the project will inform the development of risk management strategies for carcass disposal in extensive areas. Foot and mouth disease virus is used as the reference agent.

The Williams Report (Persistence of Disease Agents in Carcases and Animal Products, a report for Animal Health Australia by Scott Williams Consulting Pty Ltd, Revised - December 2003) reviews the literature on survival of pathogens in carcasses and products.

From the Williams Report –

> Persistence and inactivation:
> General characteristics: Foot-and-mouth disease has been thoroughly reviewed by Thomson (1994). FMDV is very labile in acid and alkaline conditions. Donaldson (1987) states that stability is greatest at 7.4-7.6, but with survival at 6.7-9.5 at below 4oC.

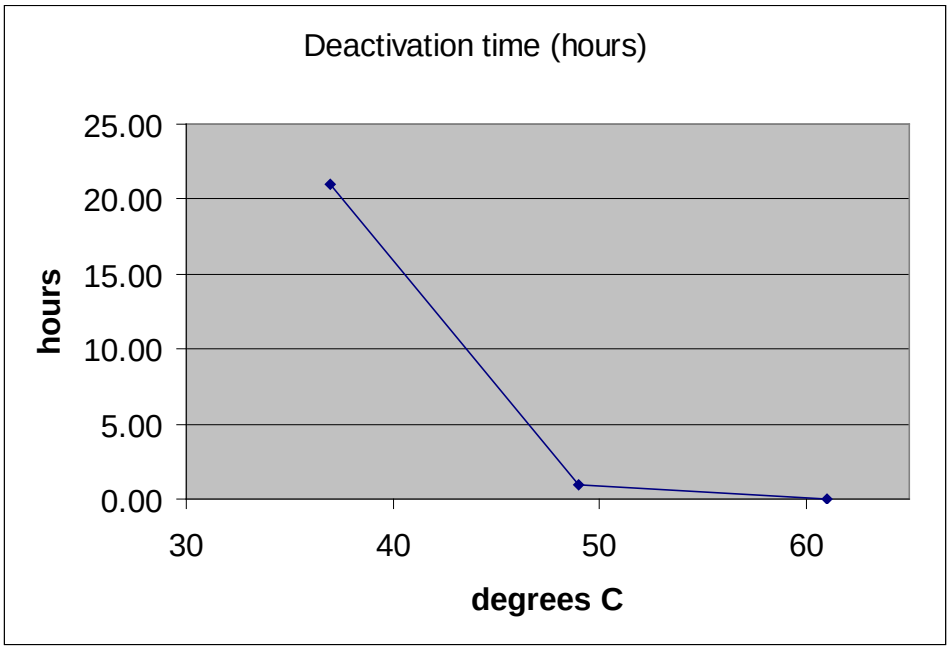
Bachrach (1968) reported that the time to reduce infectivity by 1 log10 at varying pH was:

pH	Time
5	1 second
6	1 minute
6.5	14 hours
10	14 hours

For differing temperatures, the time to reduce infectivity by 1 log10 was:

Temp	Time
4ºC	1 week
20ºC	11 days
37ºC	21 hours
49ºC	1 hour
61ºC	3 seconds

For the purposes of the project a simple interpolation of this temperature data was used as below:



Achievement of:

- a tissue pH level of 6.5 for more than 14 hours; or
- a carcass temperature of 41ºC or over for more than 14 hours

was used as the target level that will achieve FMD virus neutralisation in the field in a timely manner.

Method & Materials

The field trials were run in conjunction with aerial culling operations conducted by officers of the Department of Environment and Resource Management and Biosecurity Queensland on Queensland National Parks and Australian Defence Force land. Some trials were also conducted by Biosecurity Queensland officers in the Charleville area. All trials were run in areas where this technique would be used if it becomes validated.

pH and temperature readings of field shot carcasses of various species were recorded at regular intervals in the first 24 hours after death or until target levels of pH or temperature were recorded. Two sites were sampled on each animal – typically a deep site (abdomen or chest) and a more peripheral site (hind limb muscle or intracranial). Attempts to sample the marrow cavity of long bones were unsuccessful as the pH probes were too large to fit into the cavity.

Temperature thermistor probes, attached to a data-logger were placed in two sites per animal, as above. Due to technical problems, data-logged pH probes were abandoned in favour of hourly pH measurements taken with a hand-held pH meter. The pH probe was calibrated against pH4 and pH7 buffer solutions every two hours.

The change to a handheld pH meter reduced the expected amount of data but still provided enough data to meet the project objectives.

Results and discussion

Temperature probes attached to a data-logger were employed with success however there were severe problems with use of in-dwelling pH probes.

Firstly the physical length of wire required to run from the pH probe to the data-logger resulted in a voltage drop and prevented a stable measurement. An attempt was made to overcome this problem by utilising a transmitter device to convert voltage to current, which is more stable over a long wire, but the device could not be reliably calibrated in the field. Secondly it was found that pH electrodes became clogged with protein when left in the sampling site for more than an hour and required constant cleaning and re-calibration.

These problems with the in-dwelling pH probes necessitated a change to manual readings taken with a handheld pH meter. The limitations of manual readings and ensuing operator fatigue limited the number of animals that could be tested in the time that access to culled carcasses was available. The initial field trips were unsuccessful due to these difficulties with the pH measuring equipment; however, by the end of the project a suitable technique had been developed to collect pH data.

The pilot trial at Lochern National Park in 2006 gave some indications that the target pH level of 6.5 was exceeded (i.e. pH went lower than 6.5) within 12 to 15 hours post-mortem. Using this information as a guide and to compensate for the difficulties with sampling manually over a 24 hour period, readings were concentrated over the initial 12 hours after death and most carcasses achieved a pH of 6 within this time period. From the Williams Report, a pH of 6 neutralises FMDV in 1 minute.

Summary of trial results

Run	Month	Type	Location	Animals	Instruments	pH results (number achieving pH 6.0 or less within 24 hrs shown per total number
1	September 2006	pilot study	Western Qld	4 pigs	manual pH & temp measurement	Chest – 4/4 by 15hr Brain – 2/4 by 12 hr
2	September 2008	trial of data-logger	Western Qld	4 pigs	temperatures only	
	June 2009	trial of pH probes with transmitters	Western Qld		equipment failure - calibration	
3a	July 2009	successful run	SW Qld	4 pigs	manual pH measurements.	Chest – 2/4 by 12 hr Brain – nil
3b	July 2009	trial of pH probes with datataker.	SW Qld	4 goats	equipment failure	protein clogging
4	September 2009	successful run	Central Qld	4 pigs	manual pH measurement	Chest – 3/4 by 12hr Thigh – 4/4 by 5hr
5	September 2009	successful run	Central Qld	4 pigs	manual pH measurement	Chest – 3/4 by 5hr Thigh – 4/4 by 6hr
6	September 2009	successful run	Central Qld	4 cattle	manual pH measurement	Chest – 4/4 by 10hr Thigh – 4/4 by 3hr
7	October 2009	successful runs	SW Qld	4 goats	manual pH measurement	Chest – 1/4 by 12hr Thigh – nil
8	October 2009	successful run	SW Qld	4 goats	manual pH measurement	Chest – 1/4 by 15hr Thigh – 4/4 by 5hr
9	December 2009	successful run	SW Qld	6 sheep	manual pH & temp measurement	Chest – 6/6 by 12hr Thigh – 6/6 by 2hr
10a &b	September 2010	Successful runs	Central Qld	6 pigs	manual pH & temp measurement	Chest – 6/6 Thigh – 6/6
11	September 2010	Successful run	Central Qld	2 cattle	manual pH & temp measurement	Chest – 1/2 Thigh – 2/2

Graphs of the various runs of the experiment are reproduced later in this document.

Sufficient data has been collected to draw preliminary conclusions. The variables of species, ambient temperature and time of day, the necessity to work in with the schedules of shooters, and the problems encountered with equipment have produced a complex dataset. Further work is needed to clarify any effects that these variables may be having.

There appeared to a direct relationship between the physical activity of the animals prior to being destroyed and the rate of decline of pH. There also appeared to be a direct relationship between the release of stomach or rumen contents into the body and the rate of decline of pH.

In all cases, following death, a decrease of pH was observed in all sites, particularly the muscle tissue. In the majority of cases the target level of pH6.5 was exceeded, with most cases reaching a level of pH6 within 12 hours. The cases where there was a poor achievement of the target pH were composed of animals where there had been a low level of physical activity prior to destruction (runs 3, 7 and 8).

For comparison, in run 6, the animals destroyed had been mustered to an area to facilitate the trial. The animals in this run were rapid achievers of target pH.

Conclusions and further investigations

Preliminary conclusions from the results to date indicate that this could be a viable technique for extensive emergency response.

The trend appears to indicate that pH will control FMD virus in a carcass within 24 hours of destruction, and in many cases within 12 to 15 hours.

Temperature did not appear to be a reliable mechanism for virus control but may be useful in support of pH.

There were insufficient numbers of trials conducted on different species to draw any conclusions about species variation.

A number of areas are suggested for further investigation. The following factors may aid virus deactivation in field destroyed animals –

1. Ambient temperature – pH drops more quickly in a carcass that is kept warm. This can inform the time of day when destruction operations are carried out. Once the carcass has cooled overnight the target pH may never be reached. It would seem that animals destroyed in the morning are likely to reach optimum pH at a faster rate but this should be investigated further.

2. Physiological state of the animals – It was observed that animals that had exercised exhibited quicker pH drop than animals that were at rest at the time of destruction.

3. Species factors and other factors such as coat colour and density. It was observed that a small number of heavily wooled sheep rapidly achieved target pH.

4. Acceleration of decomposition:

    - It was observed with a few of the animals that there were gut contents present throughout the abdominal cavity, caused by the path of a bullet. It appears that presence of gut contents promotes the overall pH drop of the carcass but this requires further testing to substantiate. It would be specified in any further testing of this factor that another round would be fired into the abdomen after the animal has been destroyed;
    - Investigation of other methods to accelerate decomposition may be worthwhile.

5. Virus survival in skin and skin lesions - Peripheral pH and temperature changes were not measured but this data would be useful to assess the potential infectivity of vesicles and skin lesions in carcasses.

6. Predation – The role of predation as a means of disease spread is still not clear.

During the conduct of any further investigations, a concerted attempt needs to be made to increase the number of animals tested. This can be best achieved by overcoming the operational difficulties with the pH probes and enabling the use of indwelling pH probes with a datataker.

Consequently, further equipment sourcing will be required to obtain more suitable pH testing equipment and funding will be needed for its purchase.

It is also intended that any further trials include a range of species, particularly ruminants.

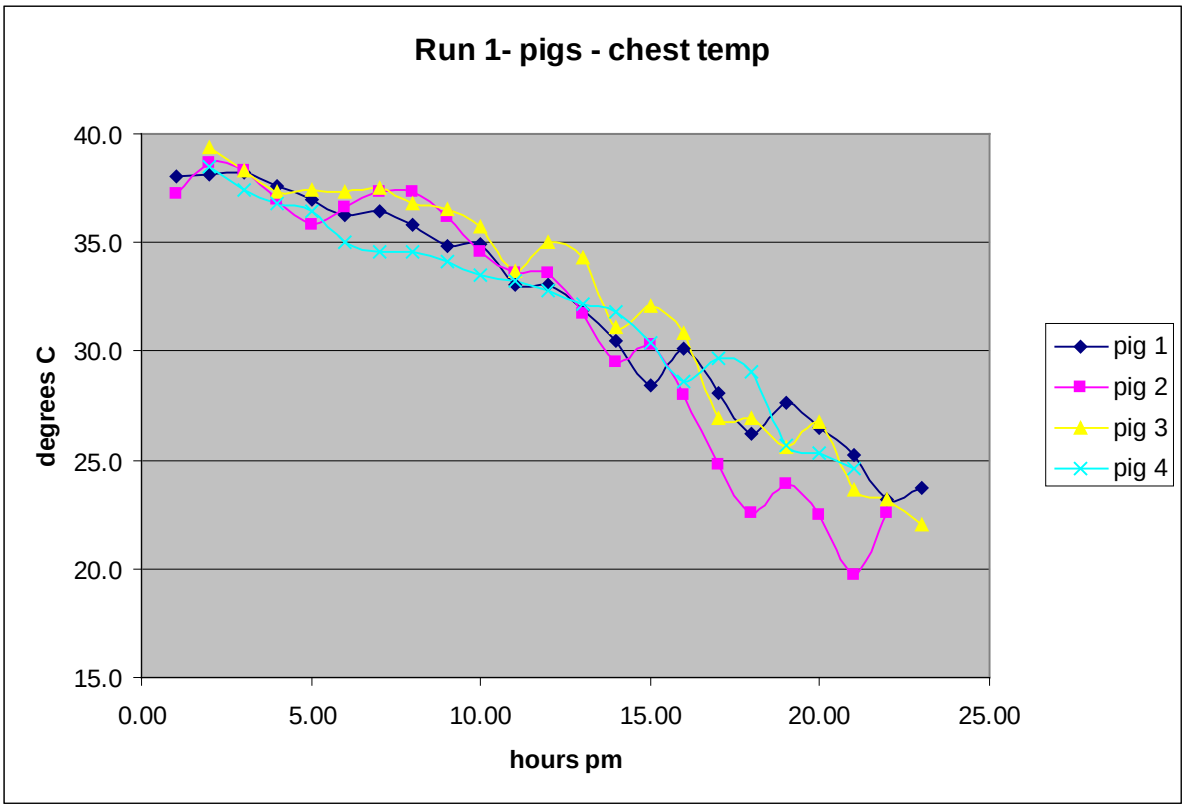
Predation trials

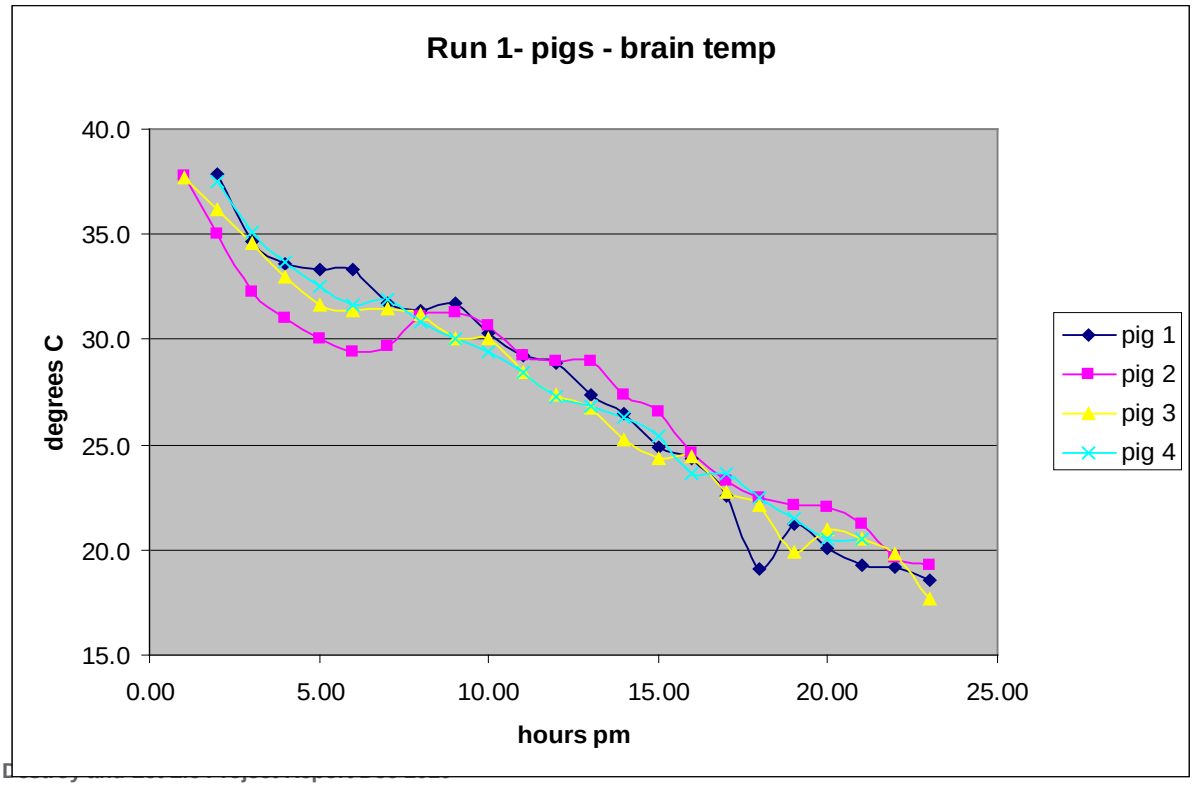
The initial project proposal included a plan to monitor predation of animals destroyed in the culling operation in parallel with the pH and temperature experiment. However, safety concerns with ground personnel in the shooting area while helicopters are operating, and the need to manually check pH readings prevented any predation monitoring during the term of this project. A proposal for predation monitoring utilising remote cameras is being considered and would be implemented if the project continues.

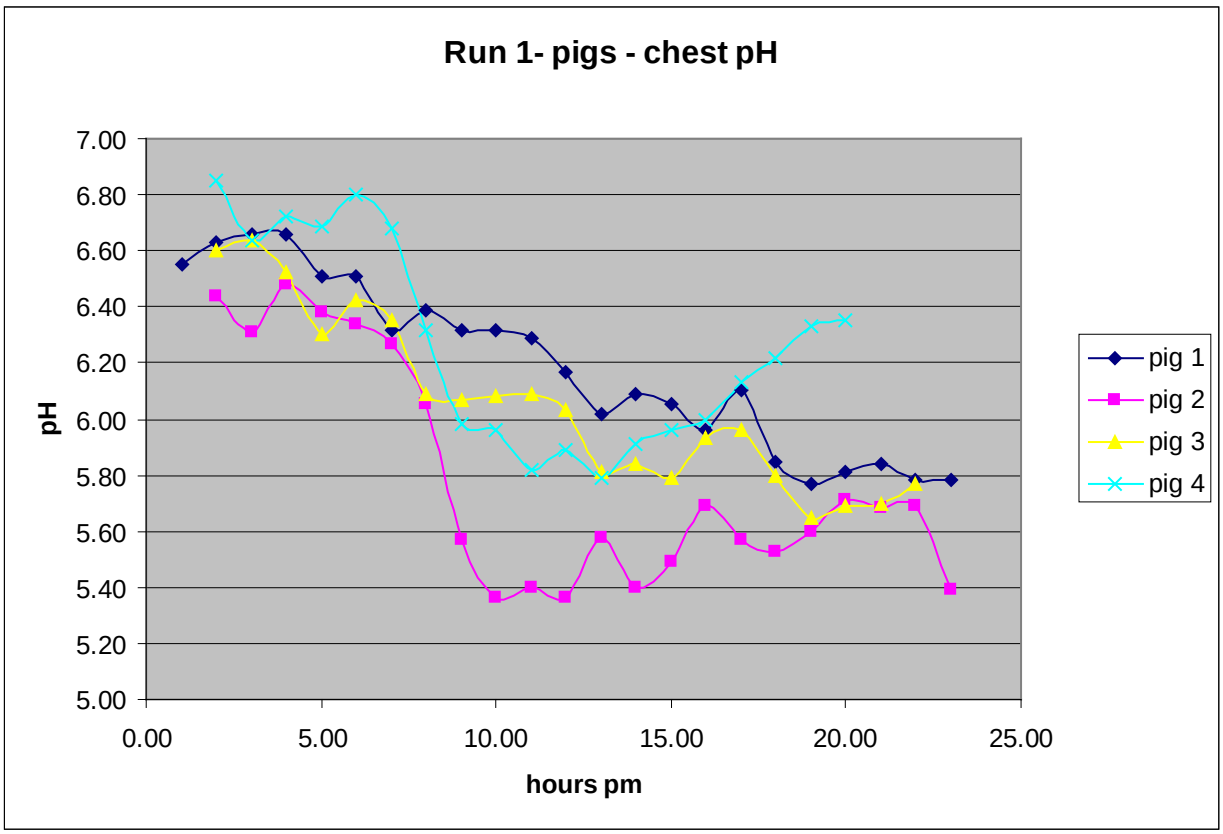
Graphed results

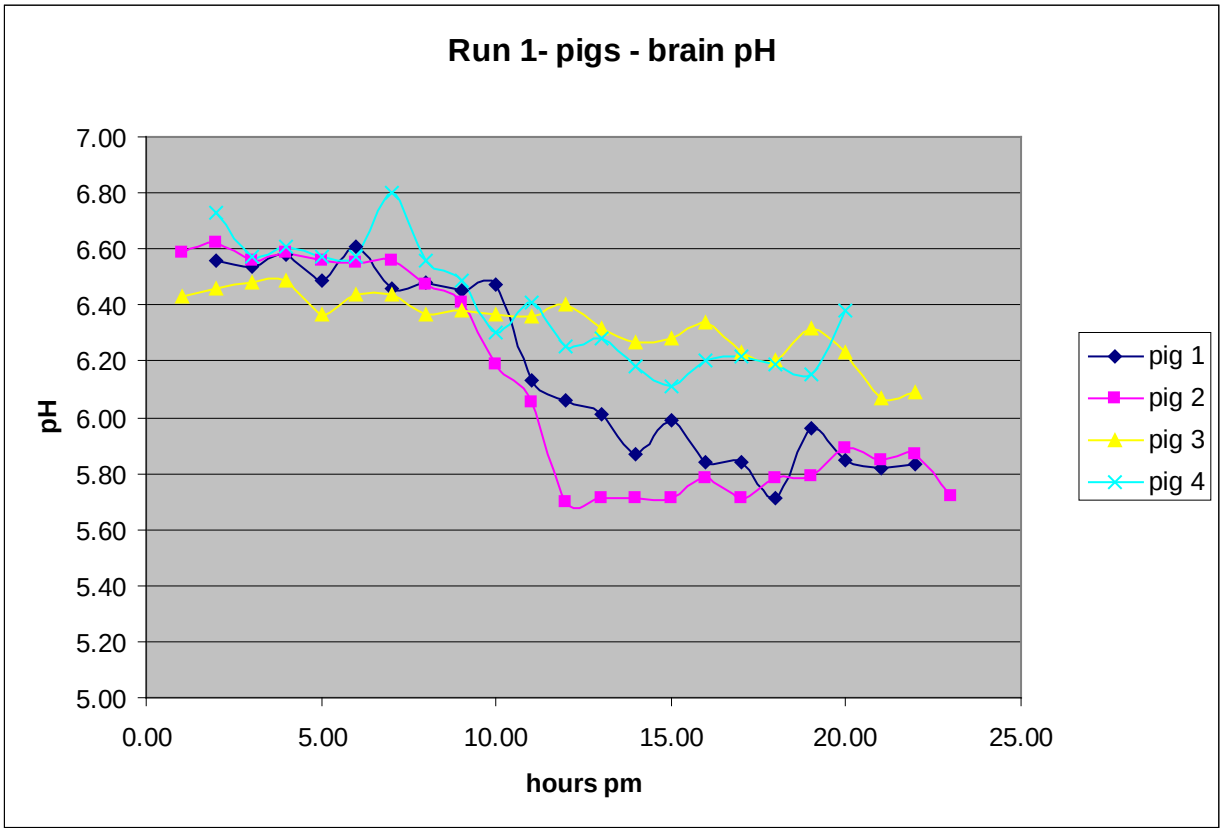
Run 1. Pilot trial, pigs 25th September 2006

Note – Ambient temperatures were not recorded. Bureau of Meteorology records for the region reported 21.4C at 9am and 31.3 at 3pm for 25/10/06. Time of death was 8:30am.



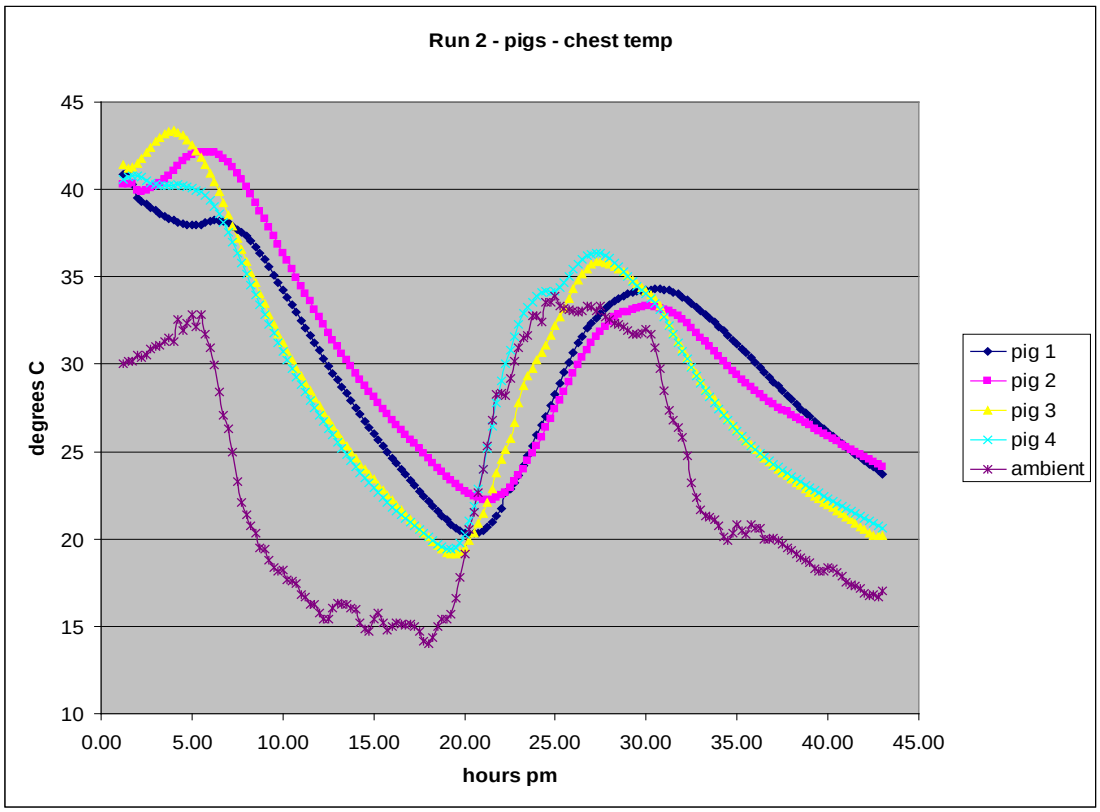


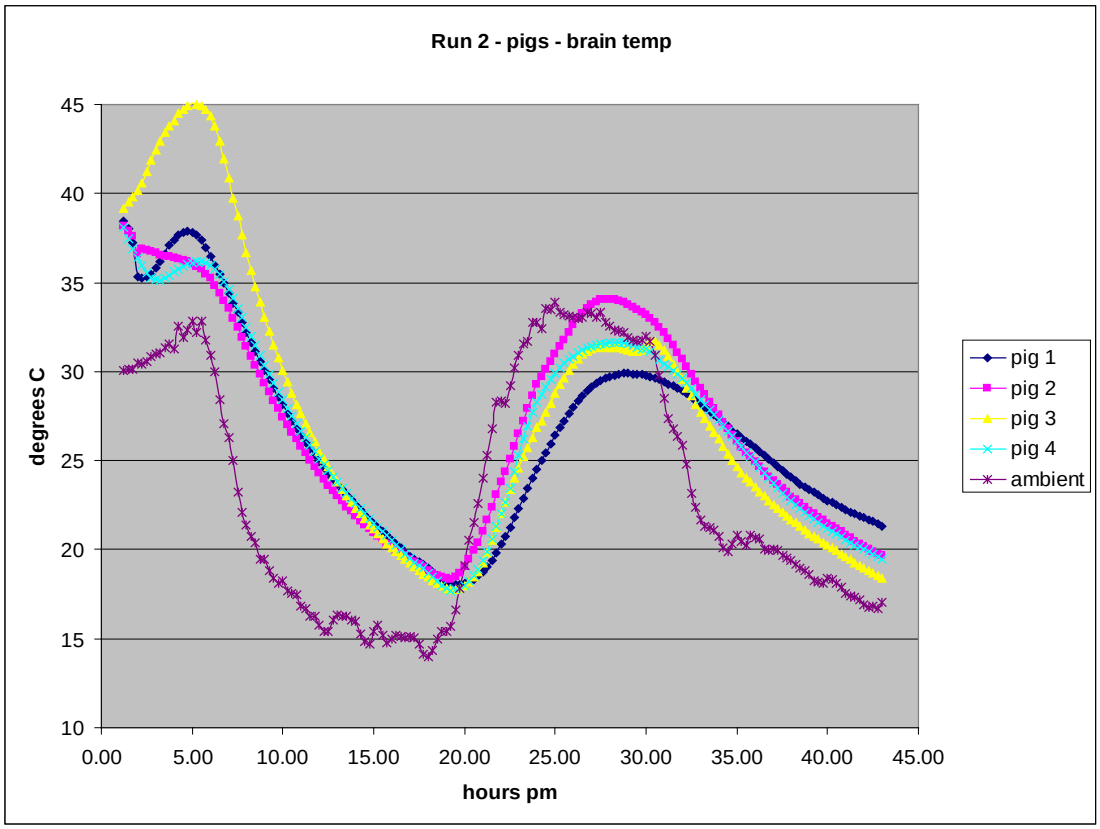

Run 1- pigs - chest pH
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4


Run 1- pigs - brain pH
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

Run 2. pigs 18th September 2008

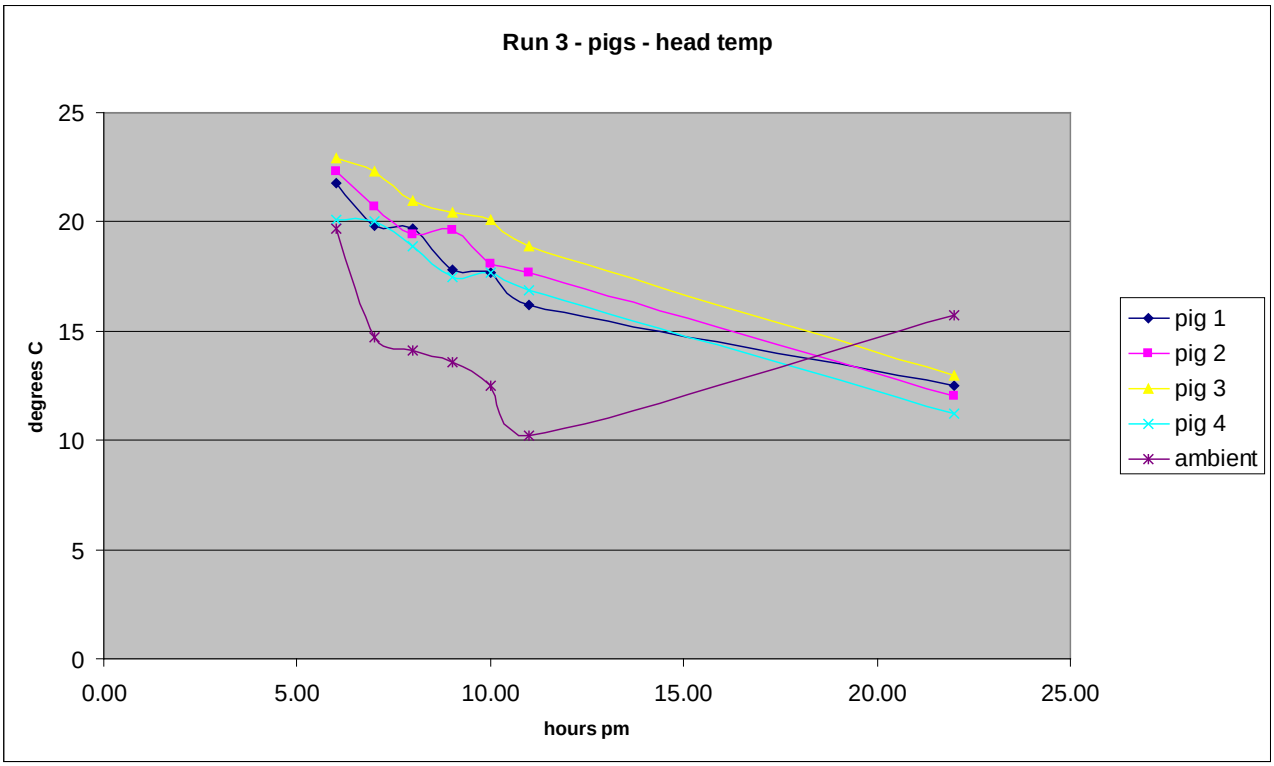
Only temperature readings were made. pH probes were tested for indwelling accuracy and found to become clogged and inaccurate after 2 hours. Time of death 11:45am.

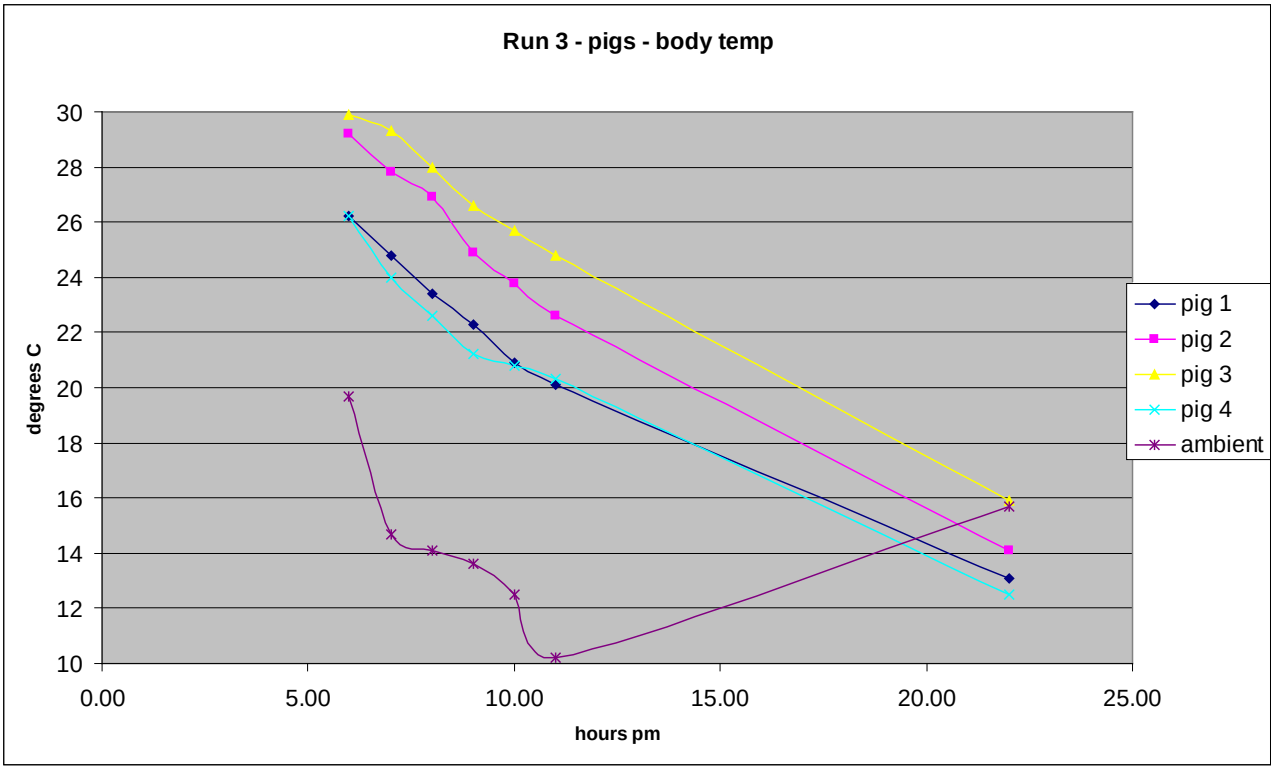


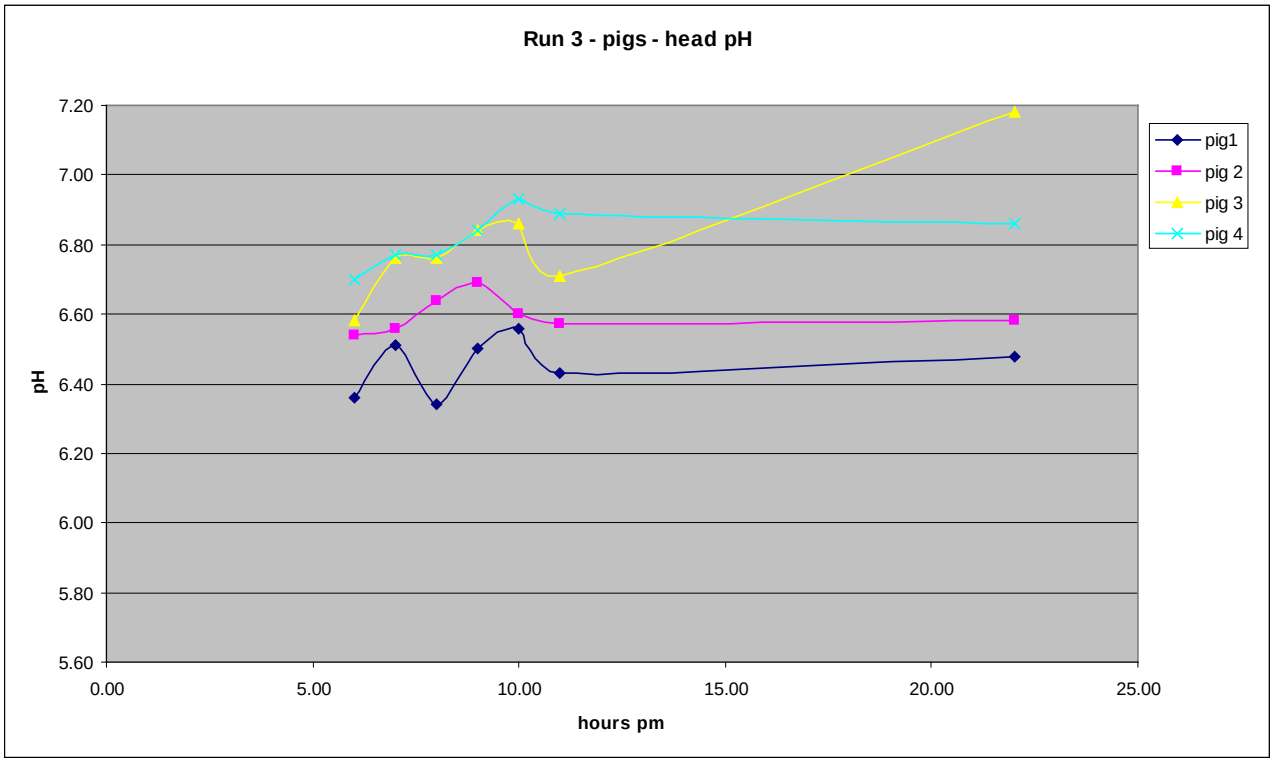


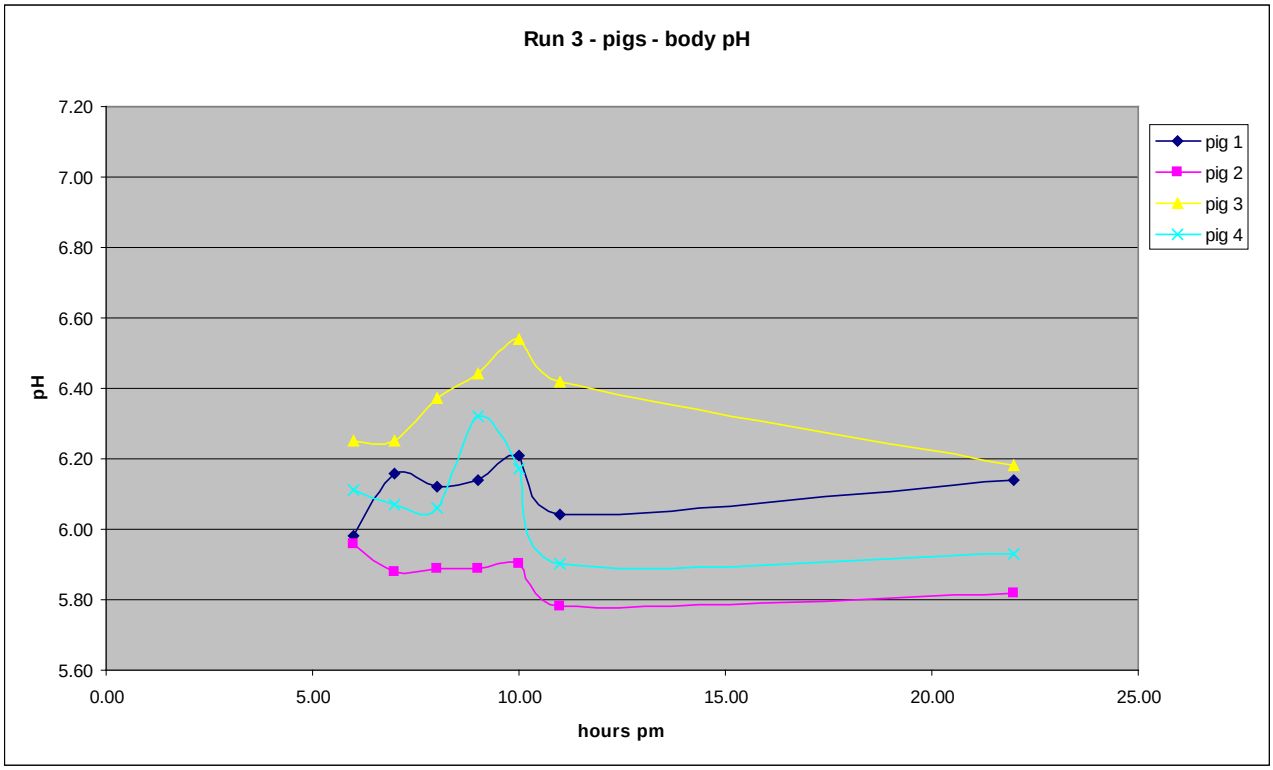
Run 3a. pigs 1, 7th July 2009

Time of death – 12 noon



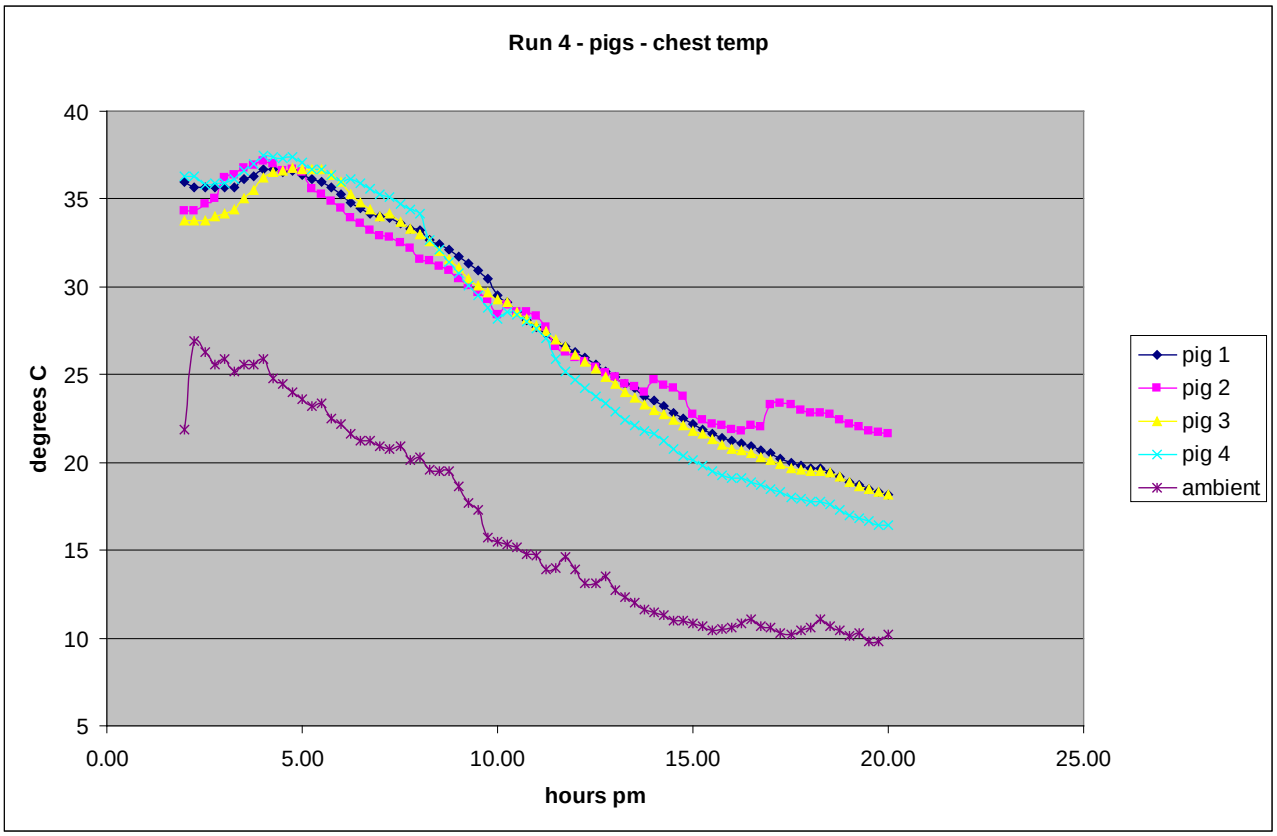


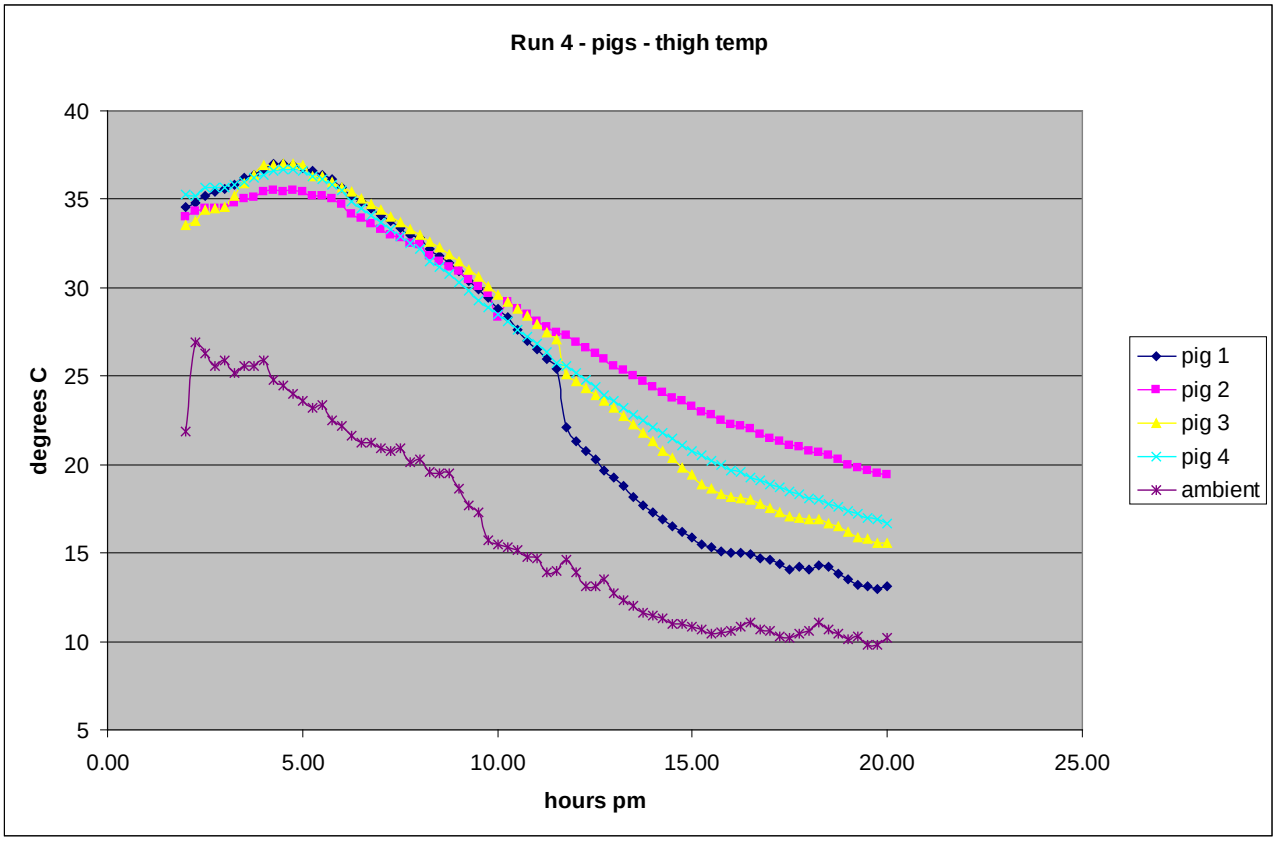

Run 3 - pigs - head pH
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig1
pig 2
pig 3
pig 4

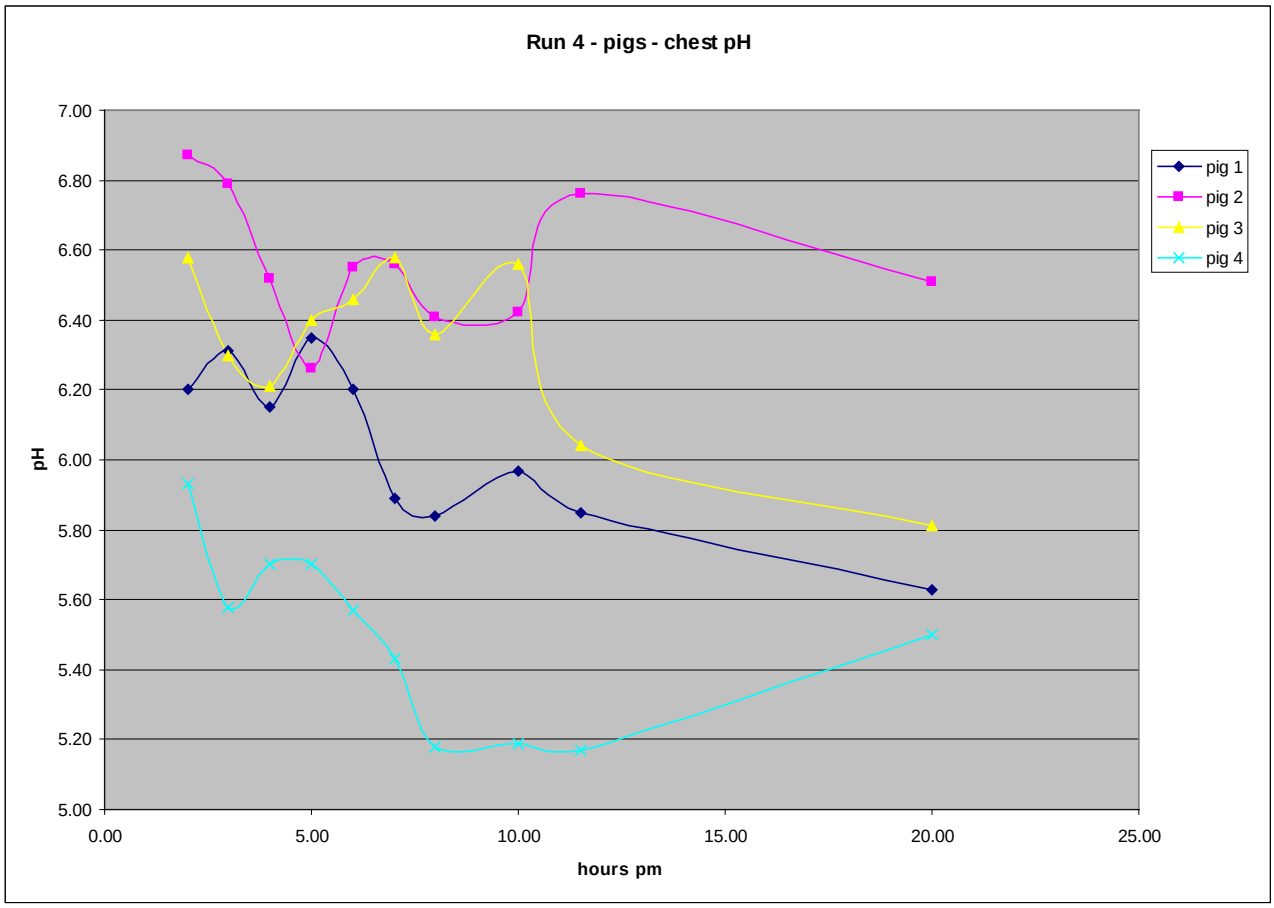

Run 3 - pigs - body pH
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

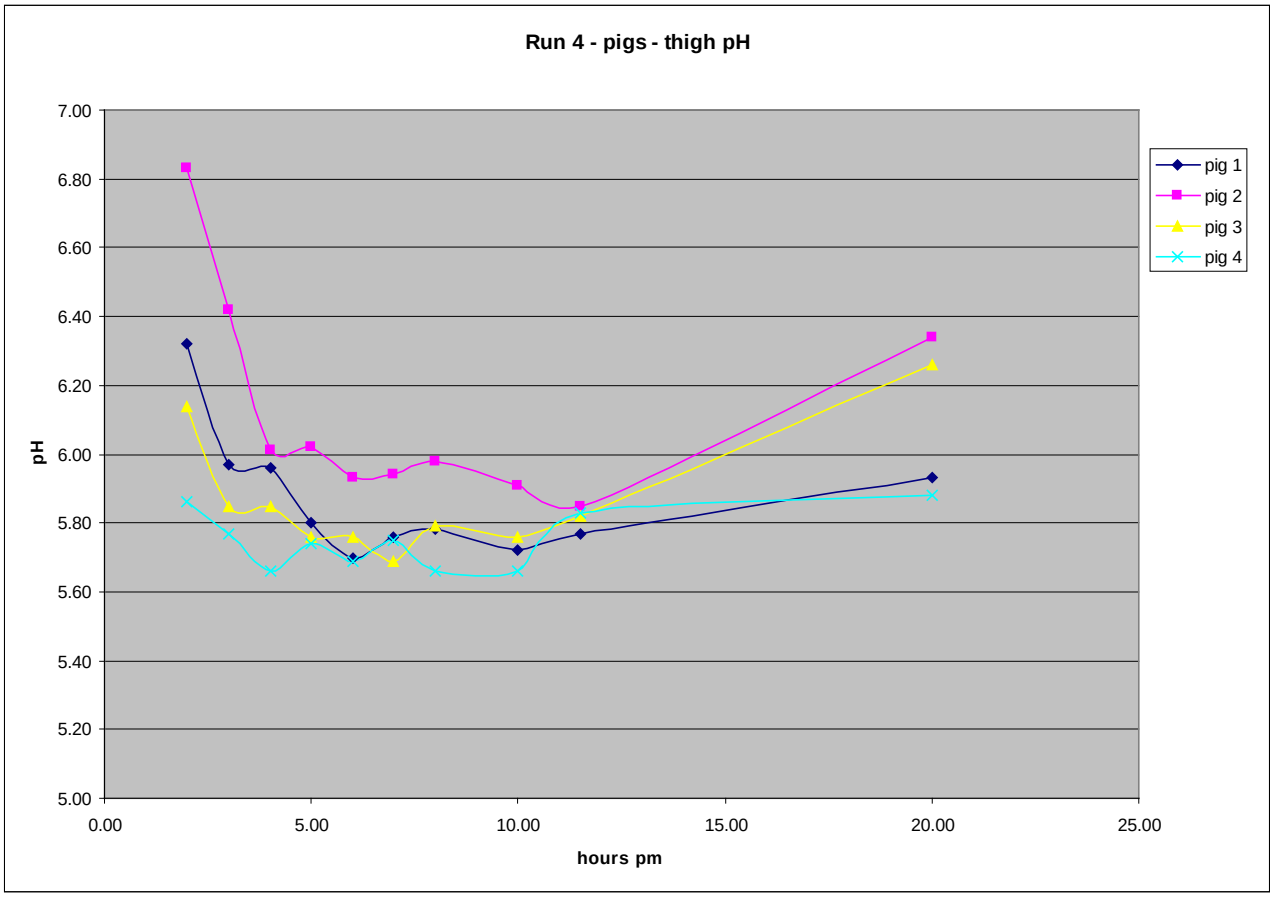
Run 4. pigs 1 – 17th September 2009

Time of death – 10:30am



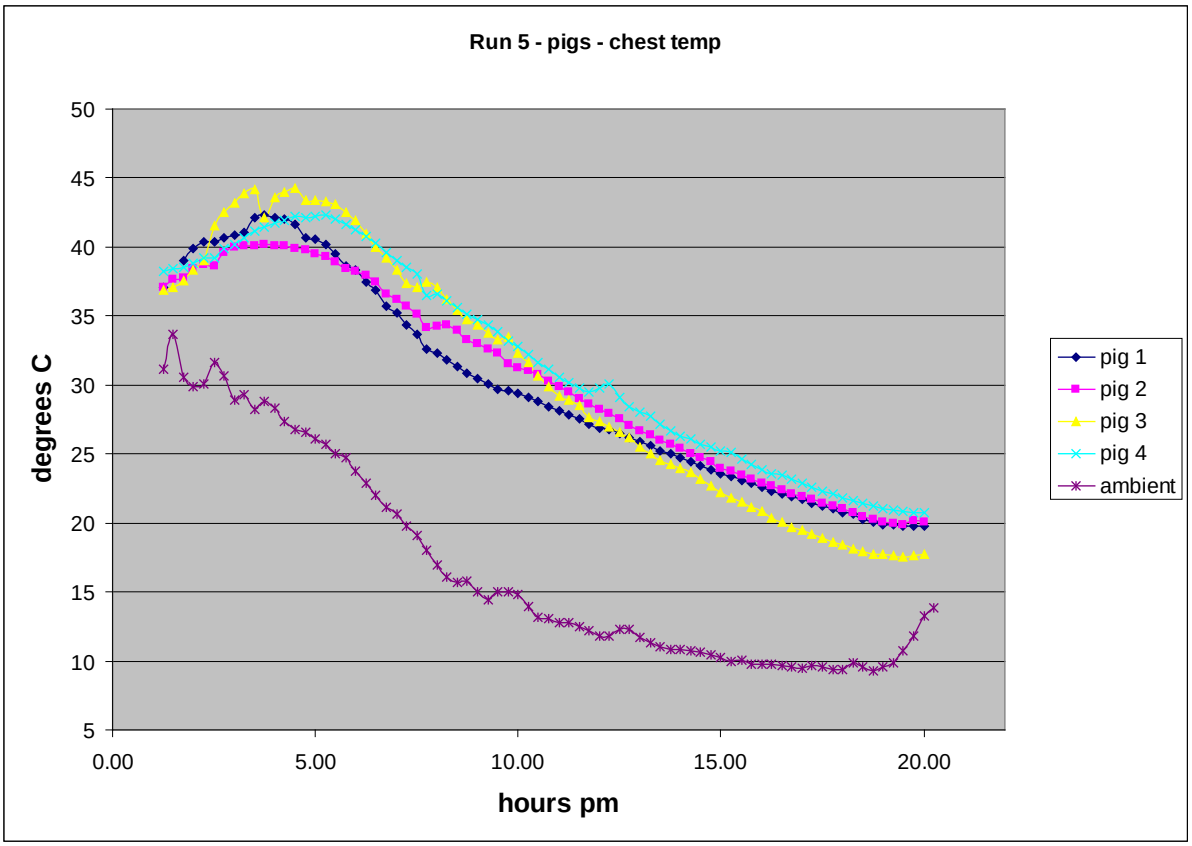


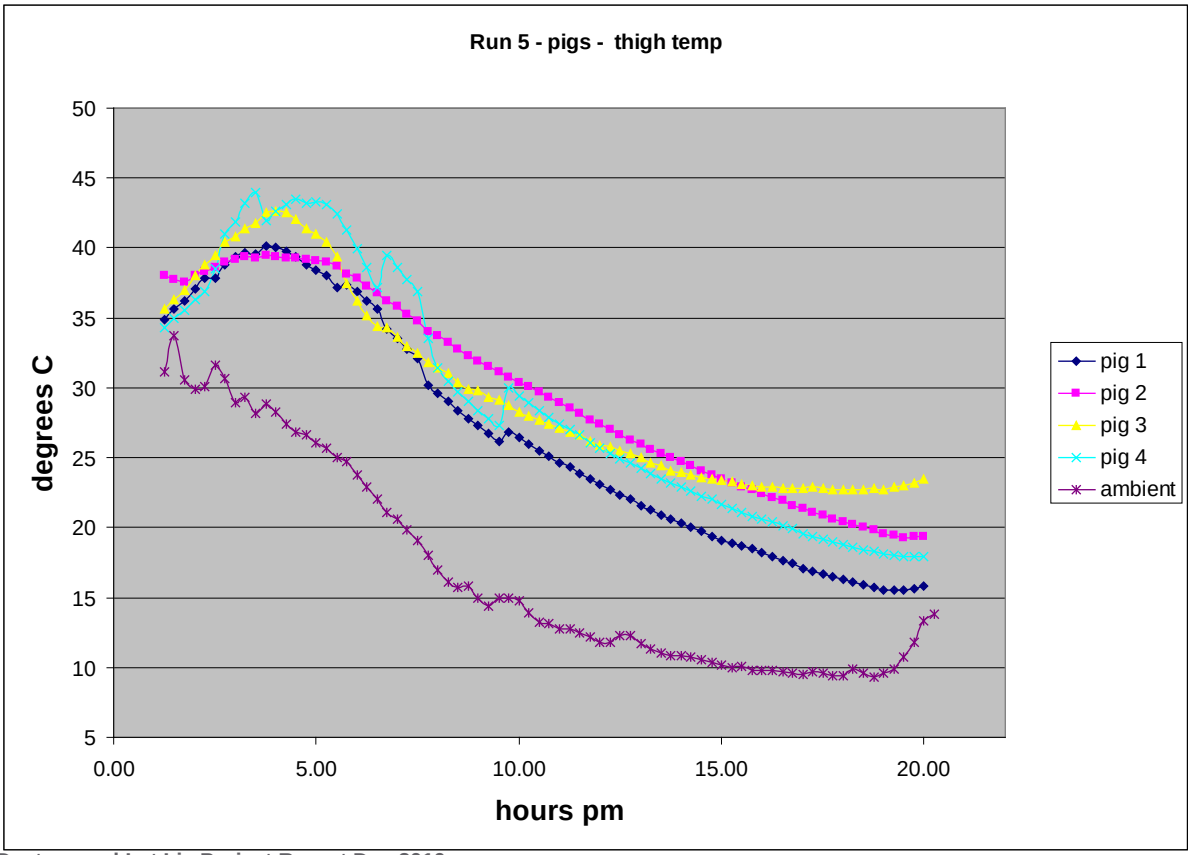

Run 4 - pigs - chest pH
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

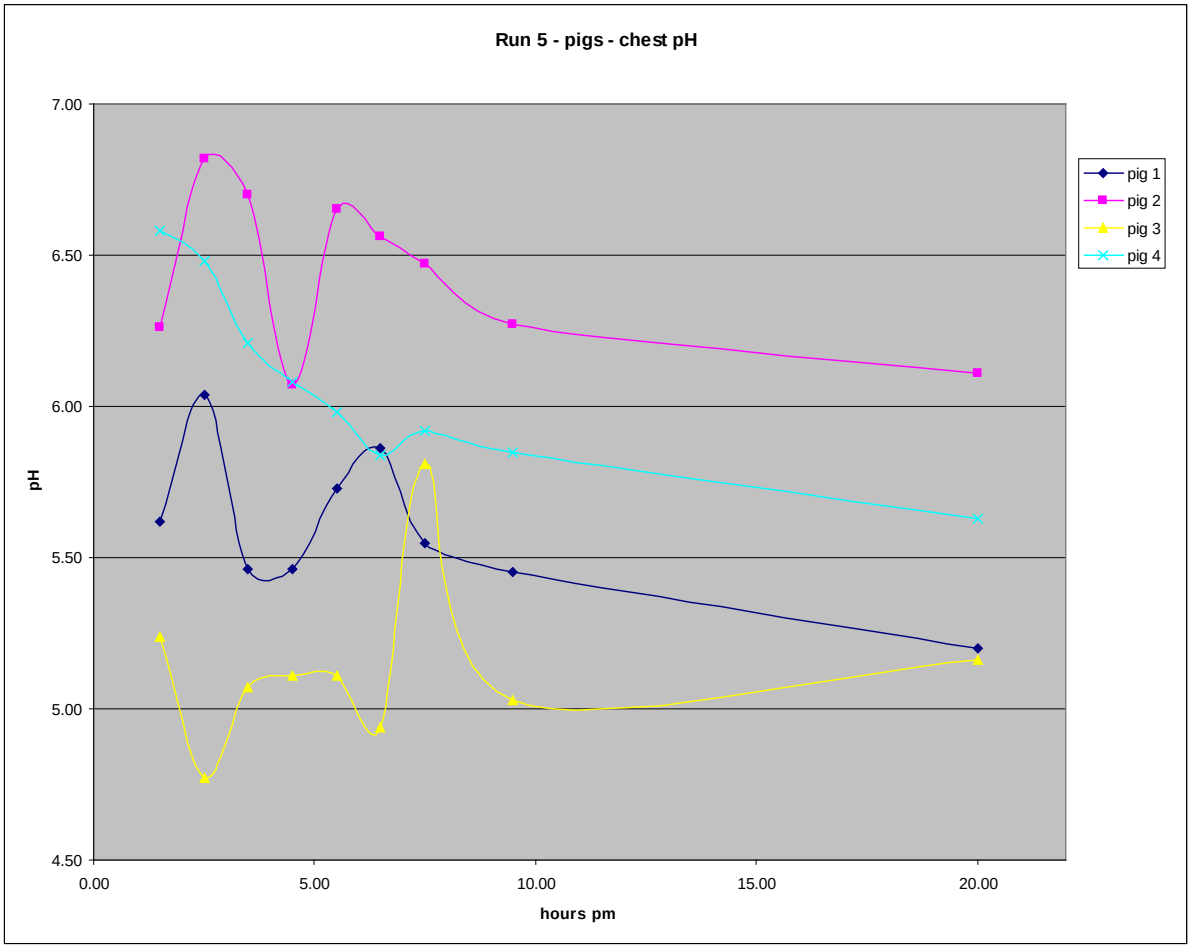

Run 4 - pigs - thigh pH
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

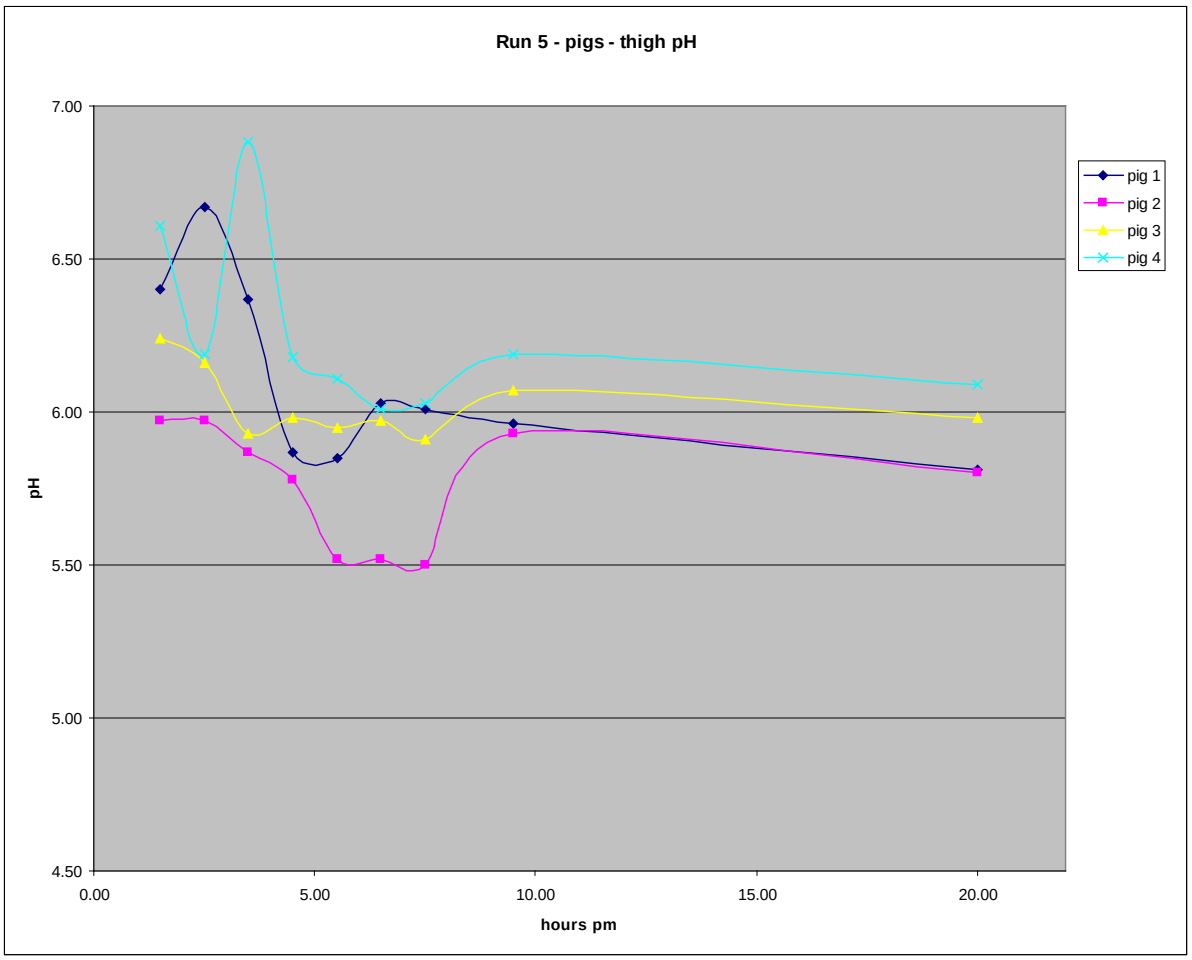
Run 5. pigs 2, 19th September 2009

Time of death 11am



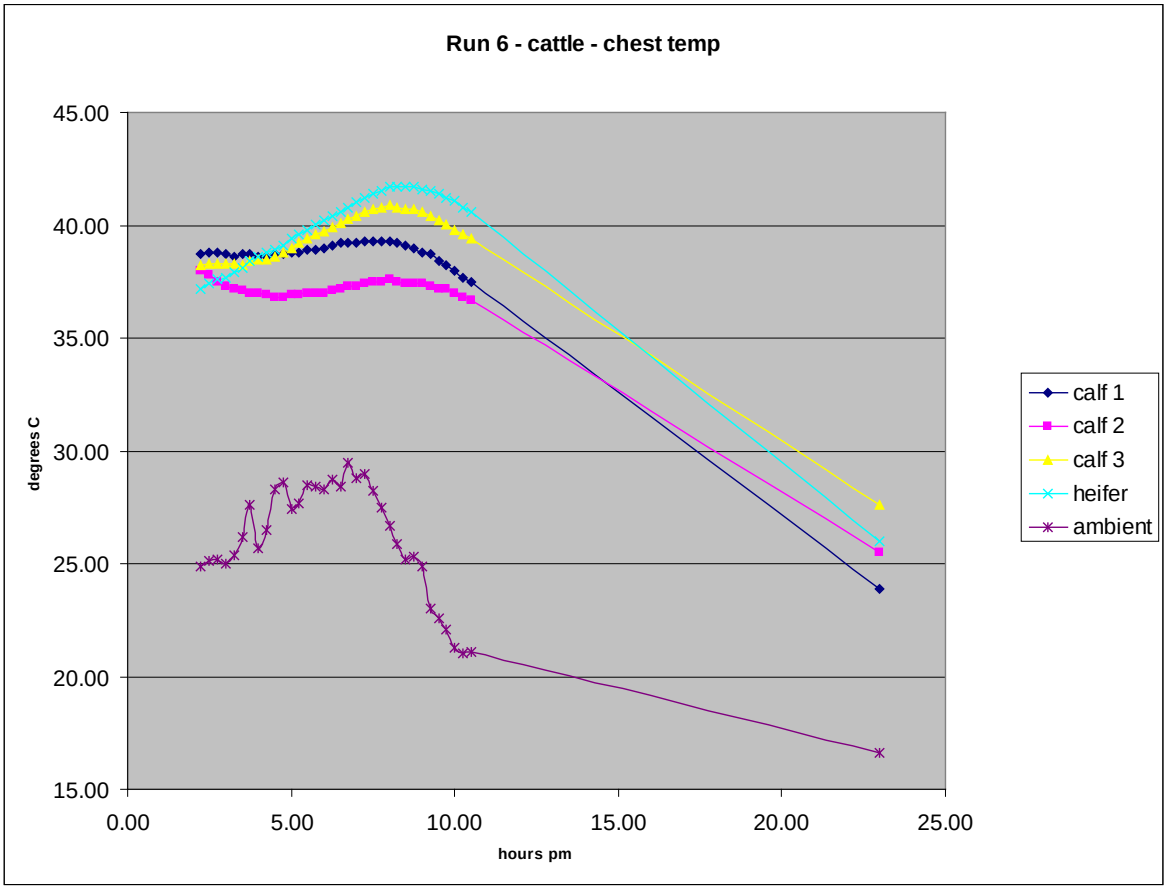


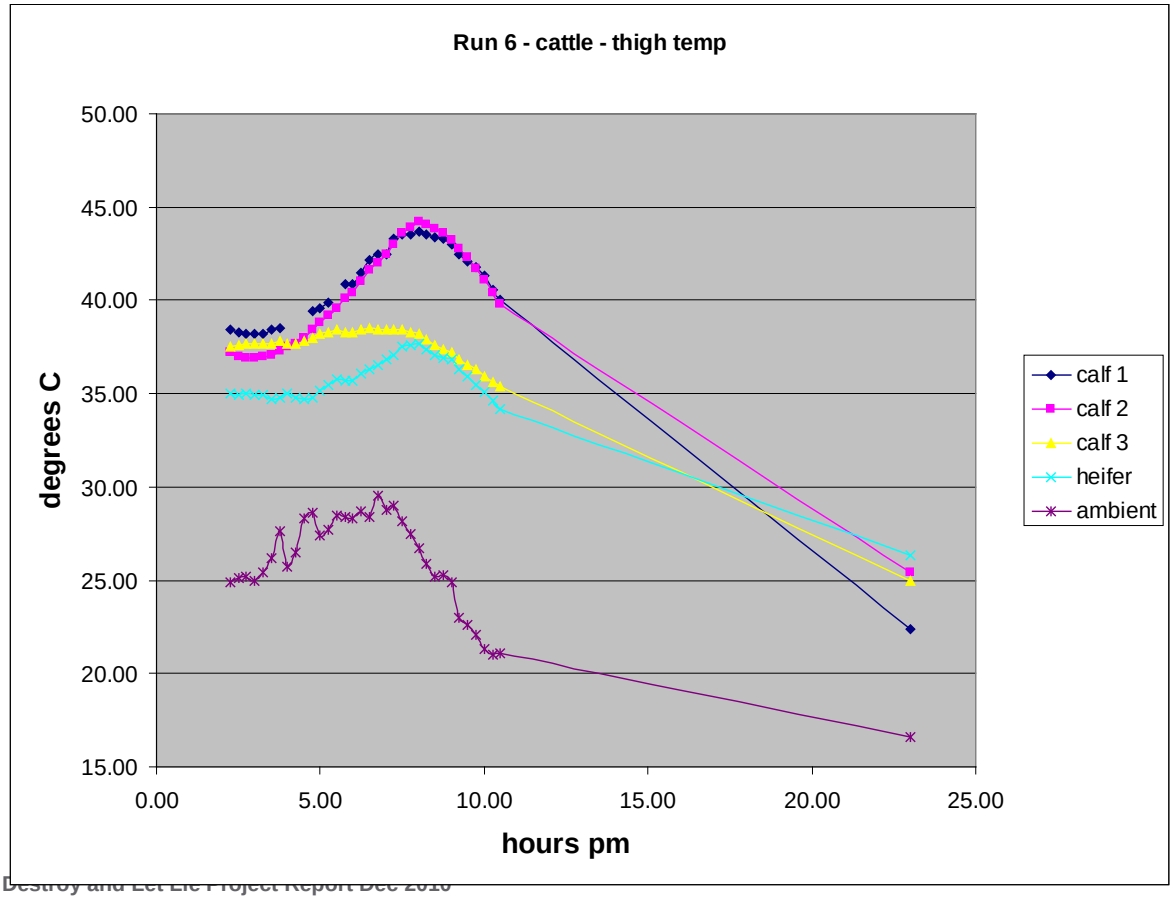

Run 5 - pigs - chest pH
7.00
6.50
6.00
5.50
5.00
4.50
pH
0.00
5.00
10.00
15.00
20.00
hours pm
pig 1
pig 2
pig 3
pig 4

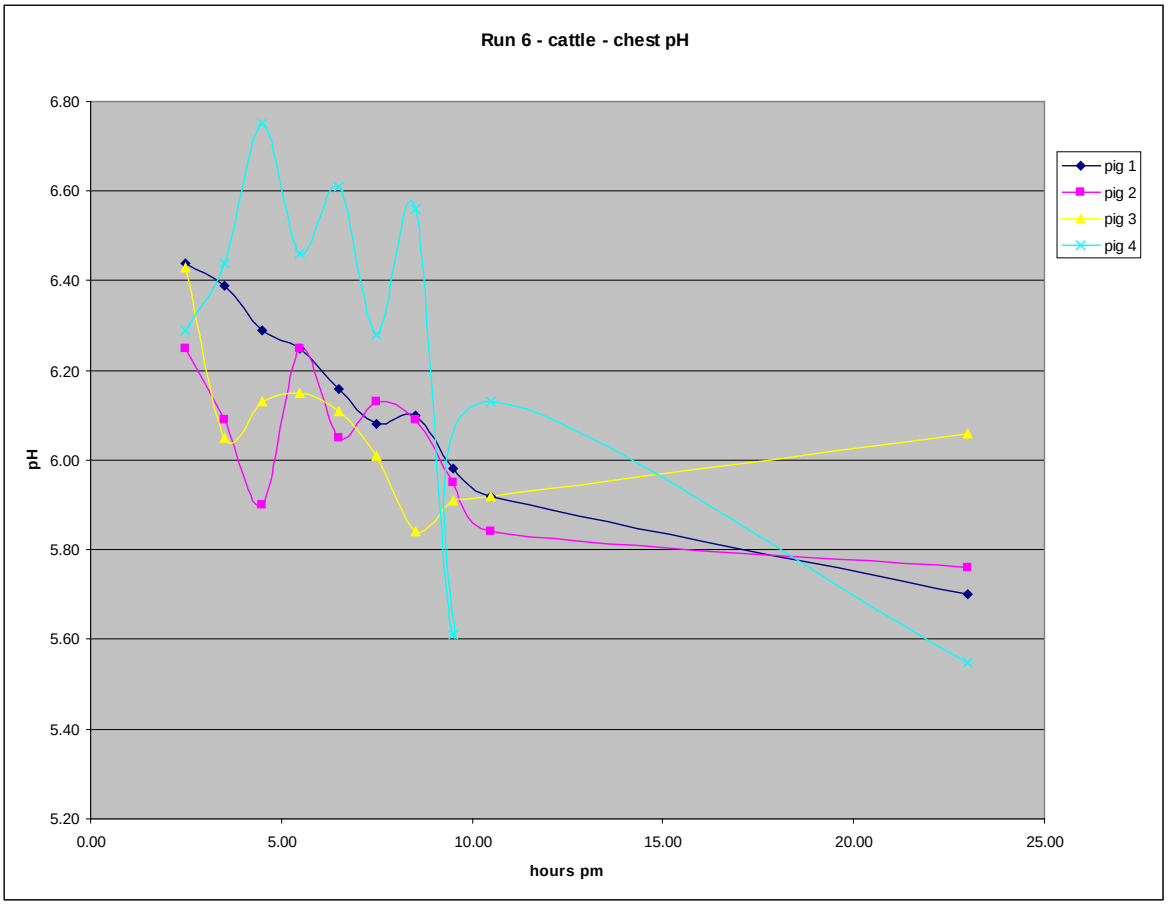

Run 5 - pigs - thigh pH
7.00
6.50
6.00
5.50
5.00
4.50
pH
0.00
5.00
10.00
15.00
20.00
hours pm
pig 1
pig 2
pig 3
pig 4

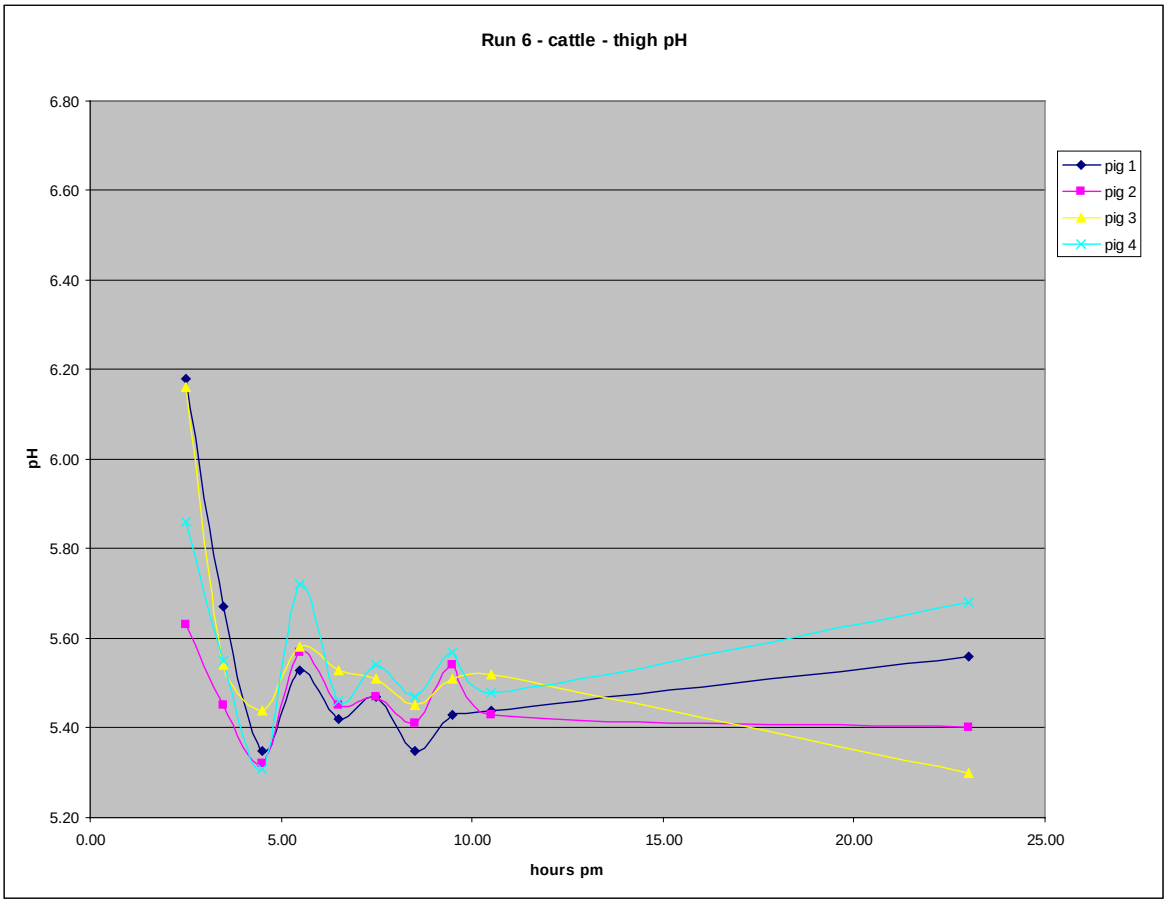
Run 6. cattle, 16th September 2009

Time of death 7:30am



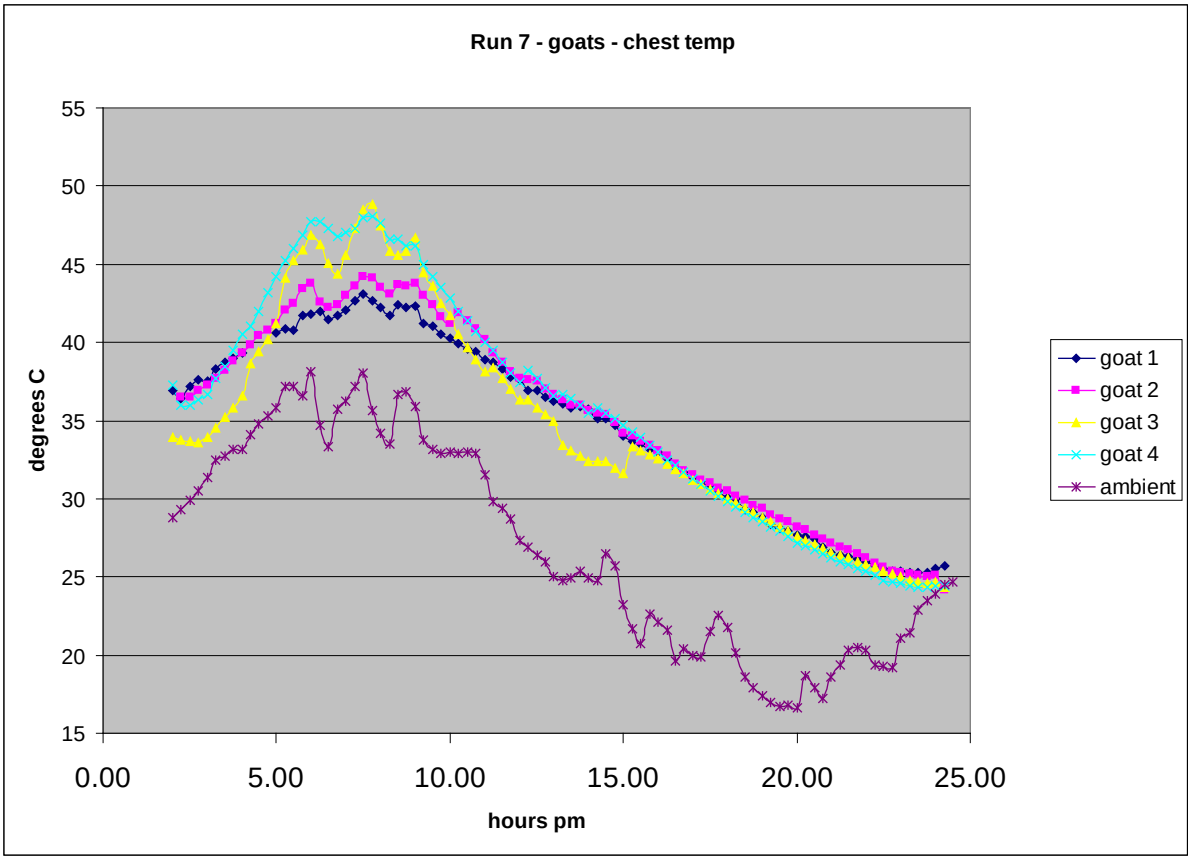


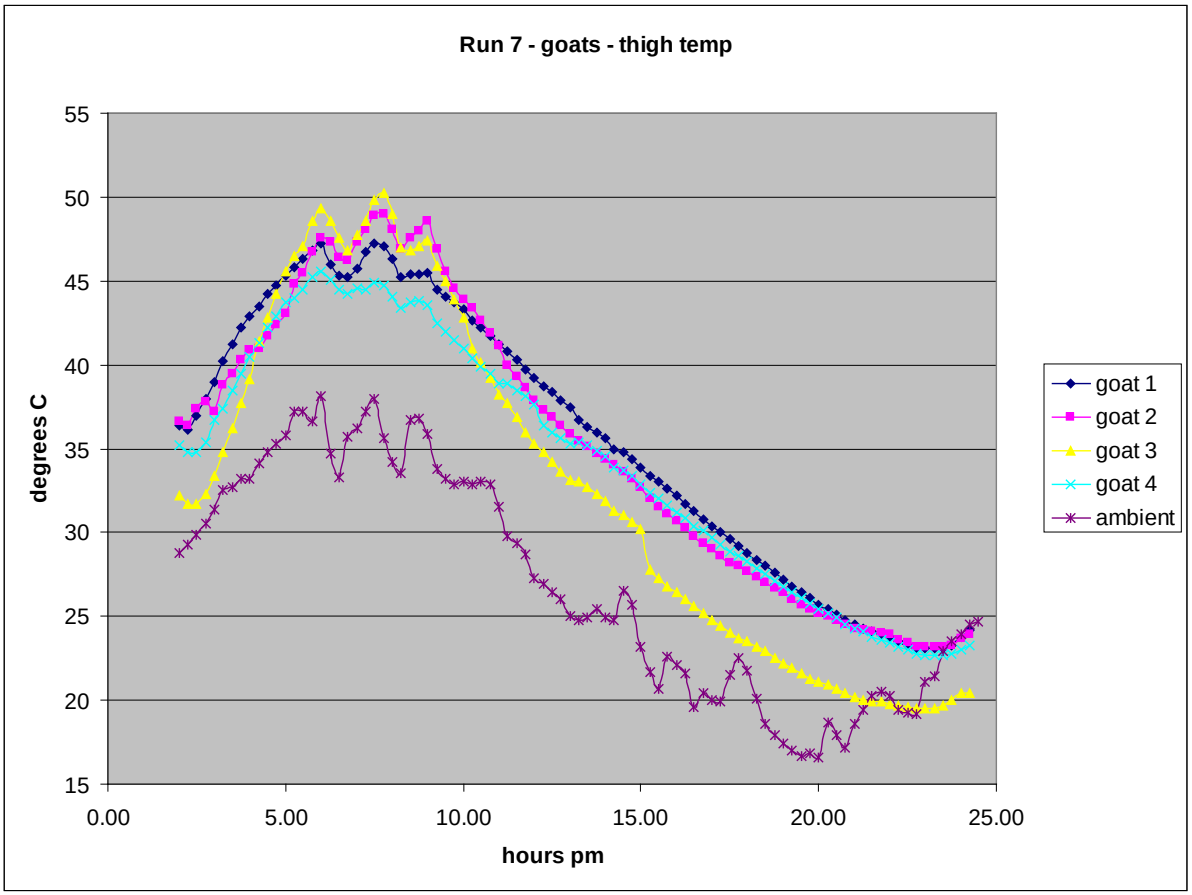

Run 6 - cattle - chest pH
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

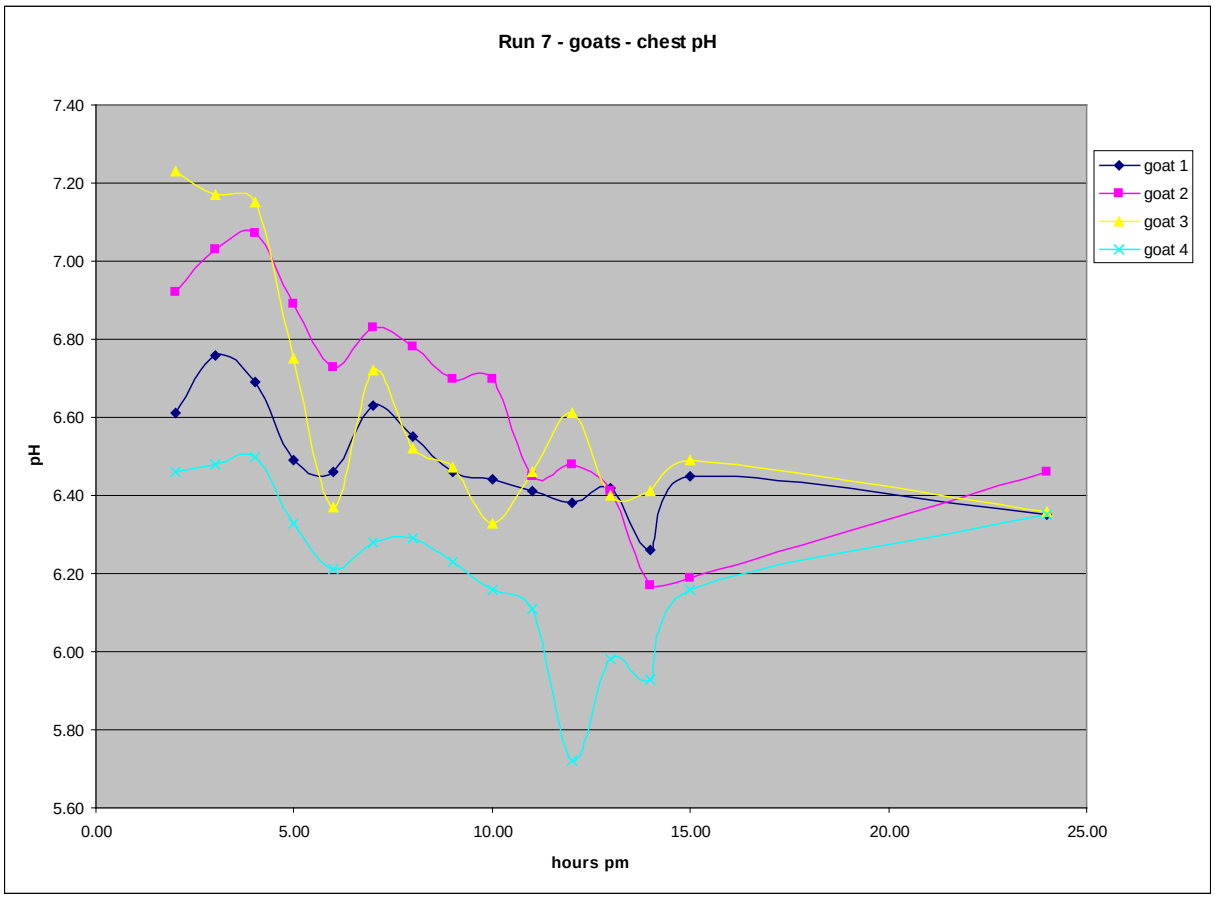

Run 6 - cattle - thigh pH
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
pig 1
pig 2
pig 3
pig 4

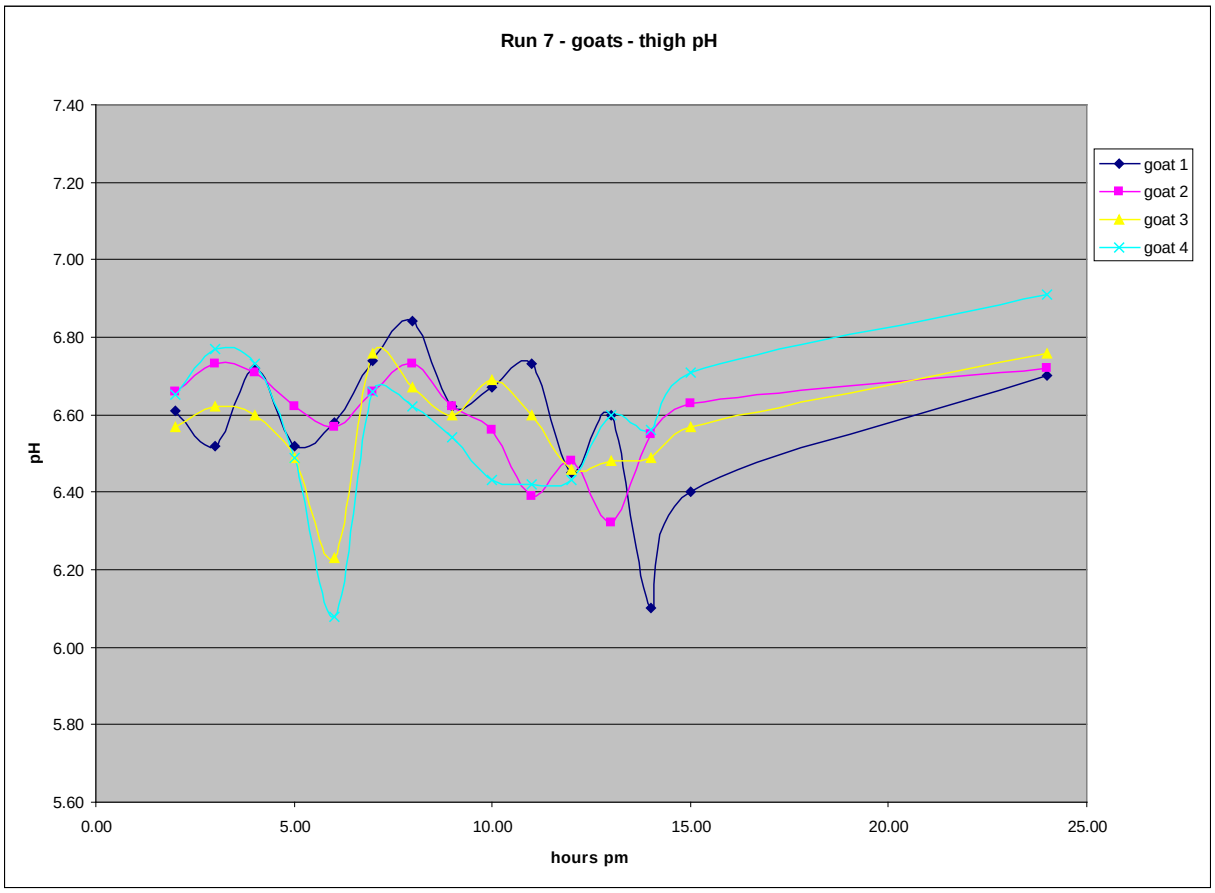
Run 7. goats 1, 22nd October 2009

Time of death 7:15am



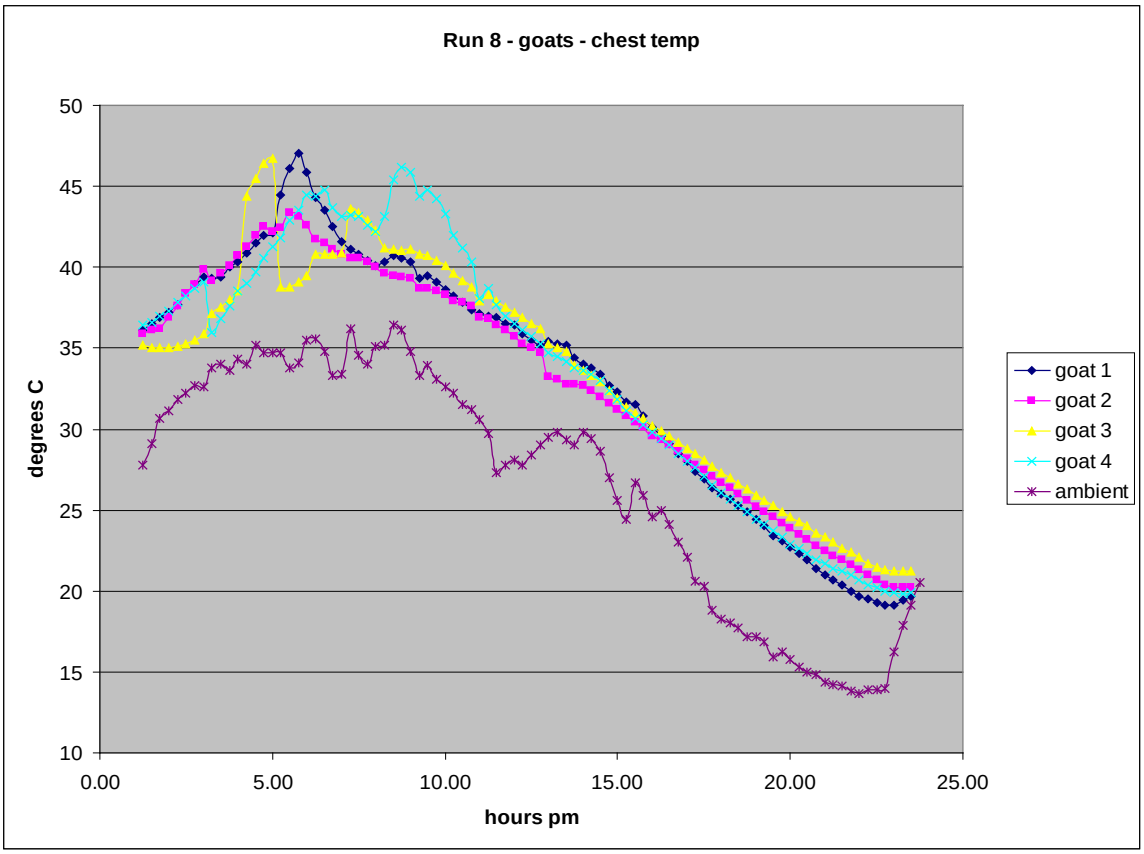


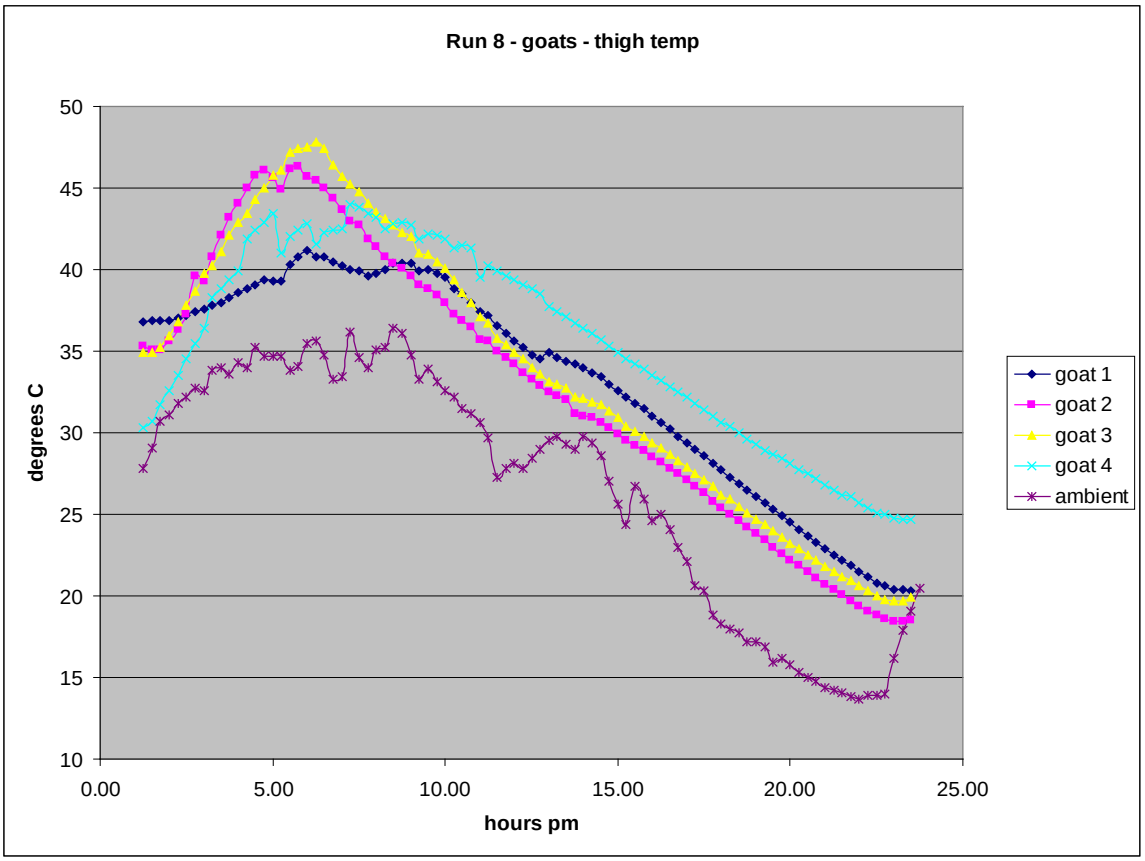

Run 7 - goats - chest pH
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
goat 1
goat 2
goat 3
goat 4

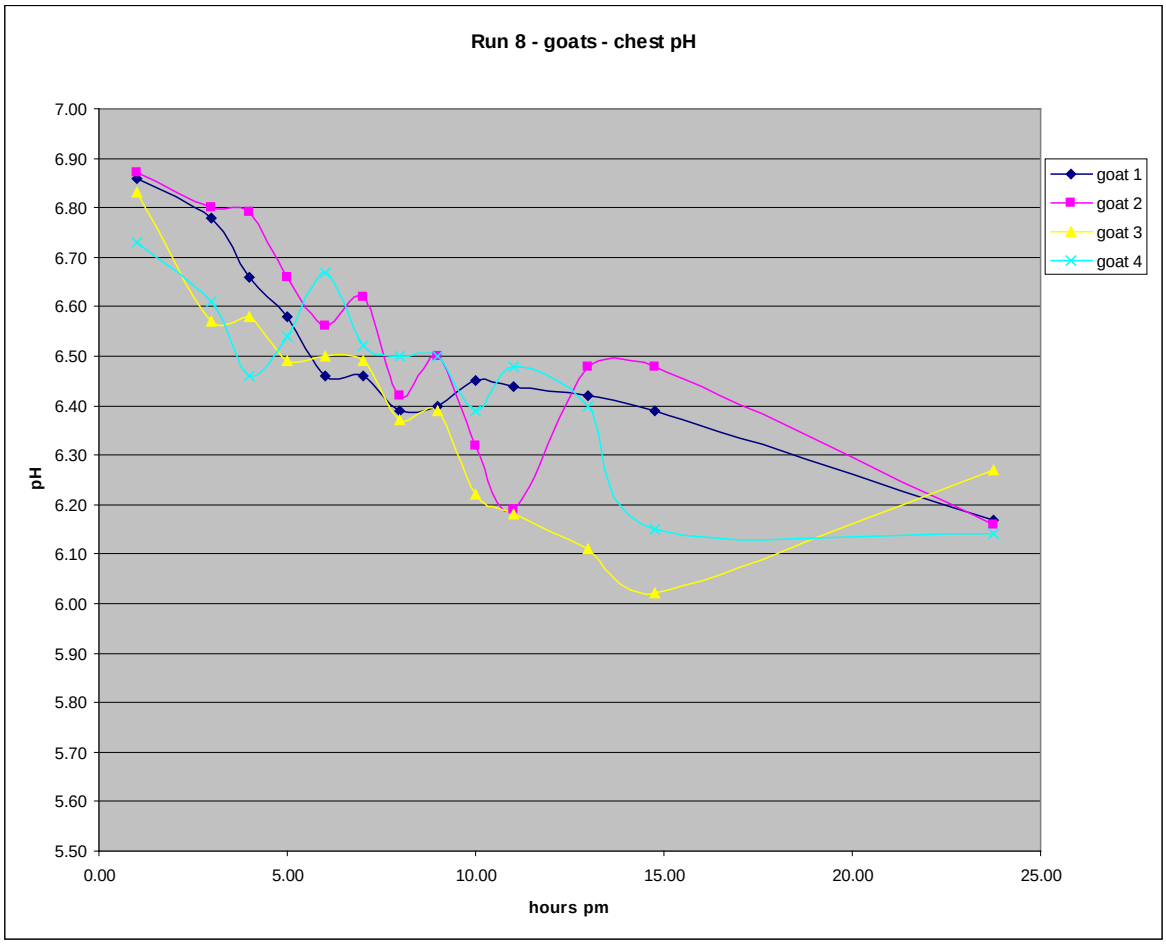

Run 7 - goats - thigh pH
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
goat 1
goat 2
goat 3
goat 4

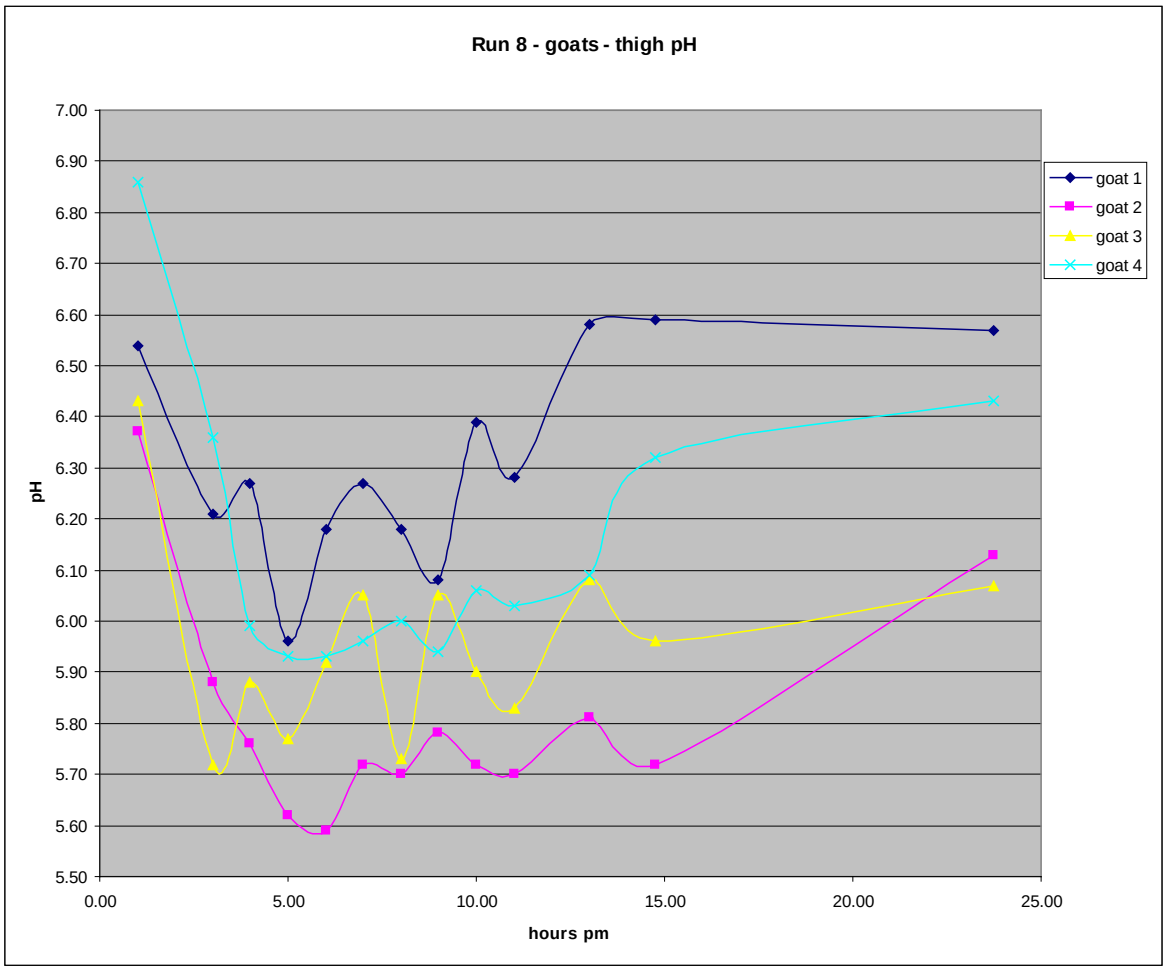
Run 8. goats 2, 23rd October 2009

Time of death 7:15am



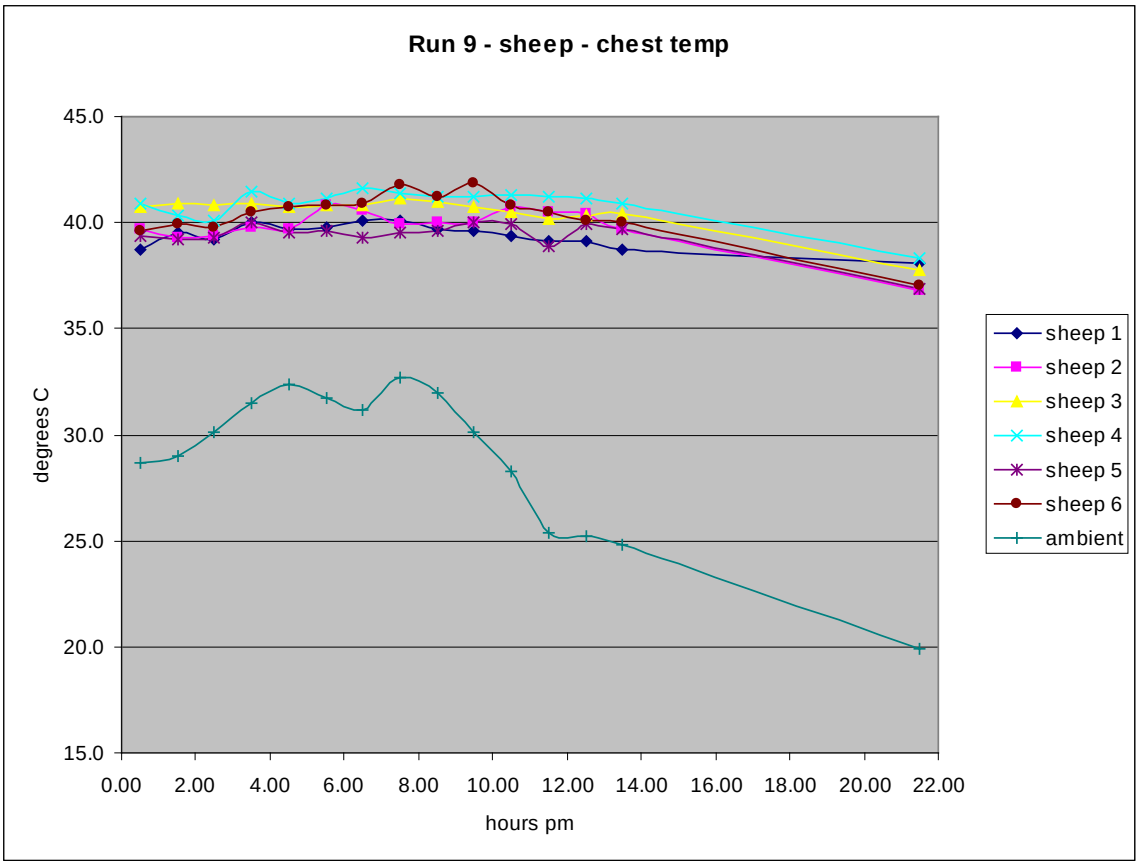


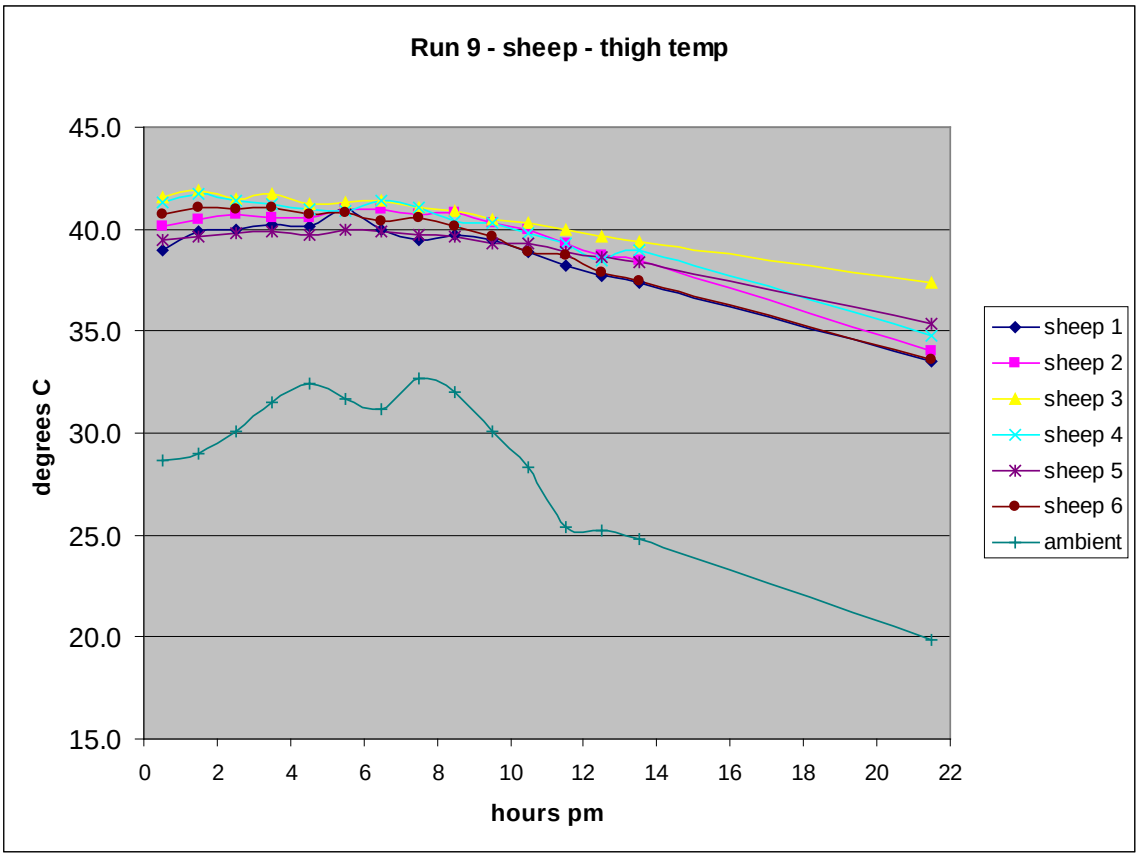

Run 8 - goats - chest pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
goat 1
goat 2
goat 3
goat 4

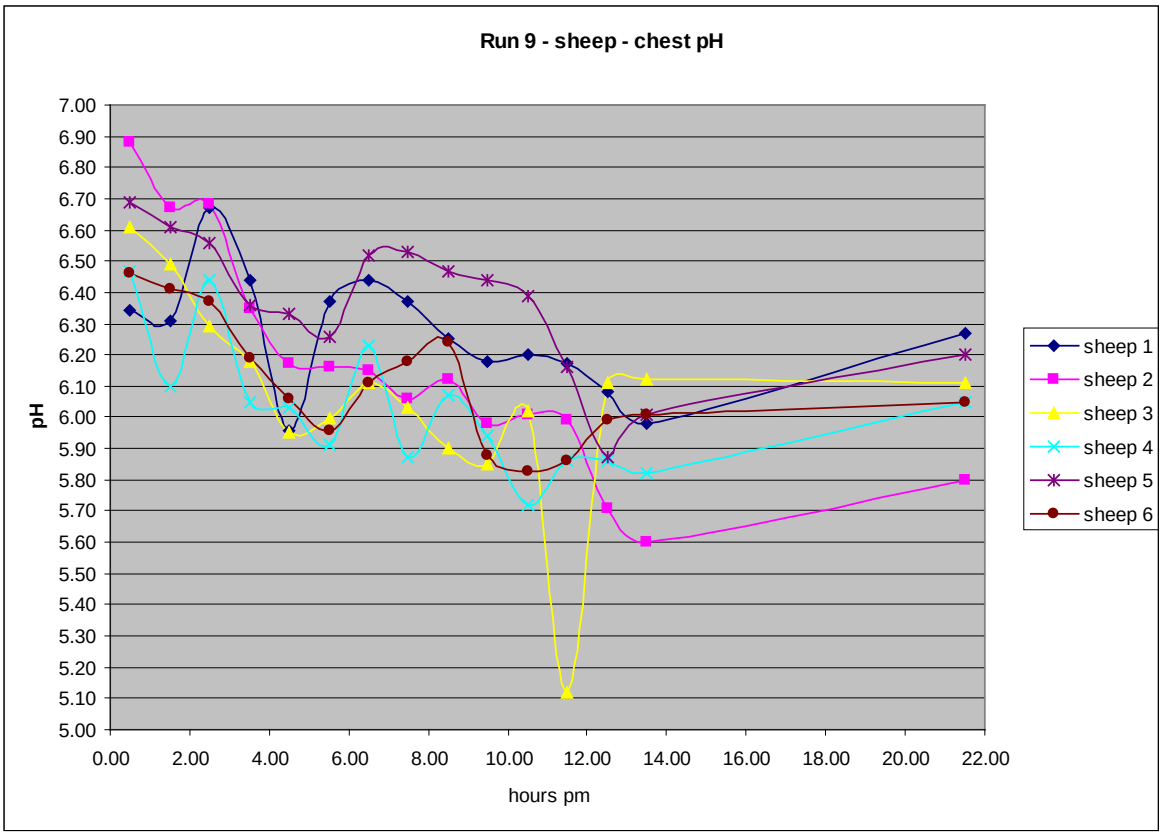

Run 8 - goats - thigh pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
pH
0.00
5.00
10.00
15.00
20.00
25.00
hours pm
goat 1
goat 2
goat 3
goat 4

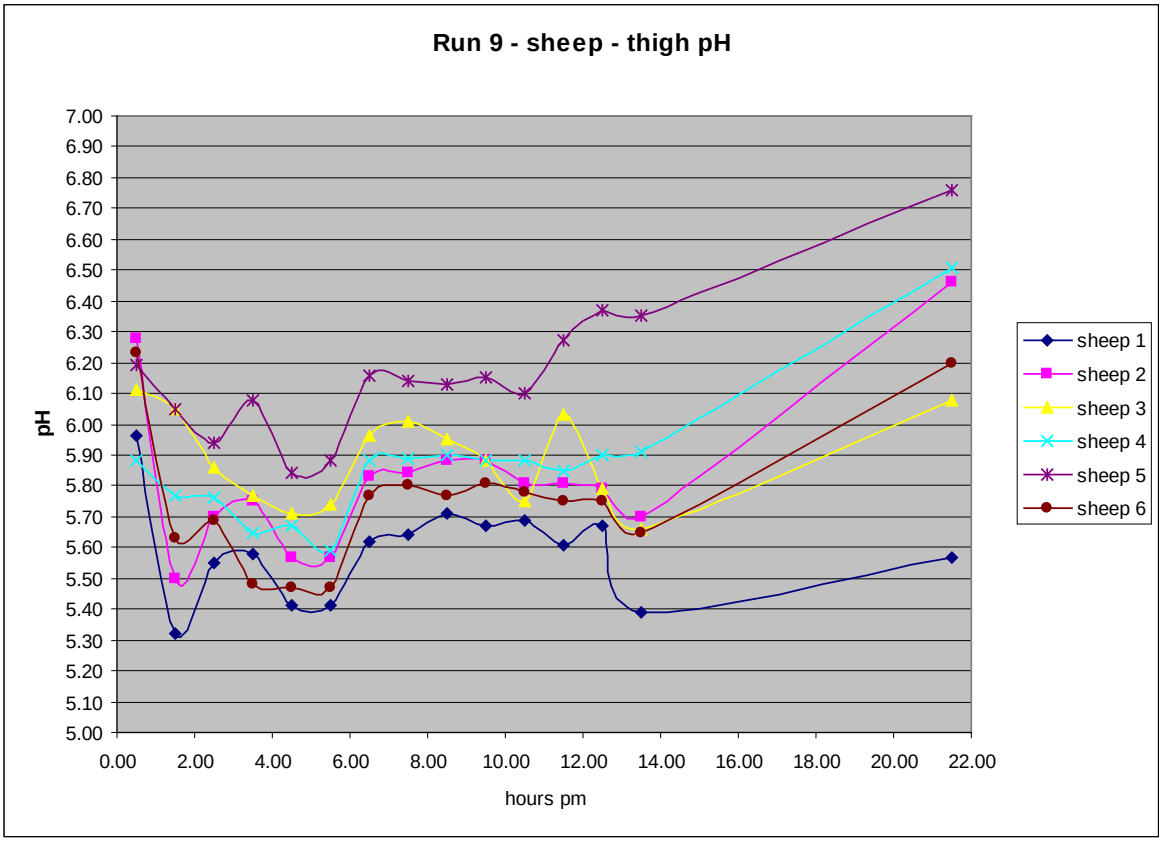
Run 9. sheep 1, 1st December 2009

Time of death 8:00am



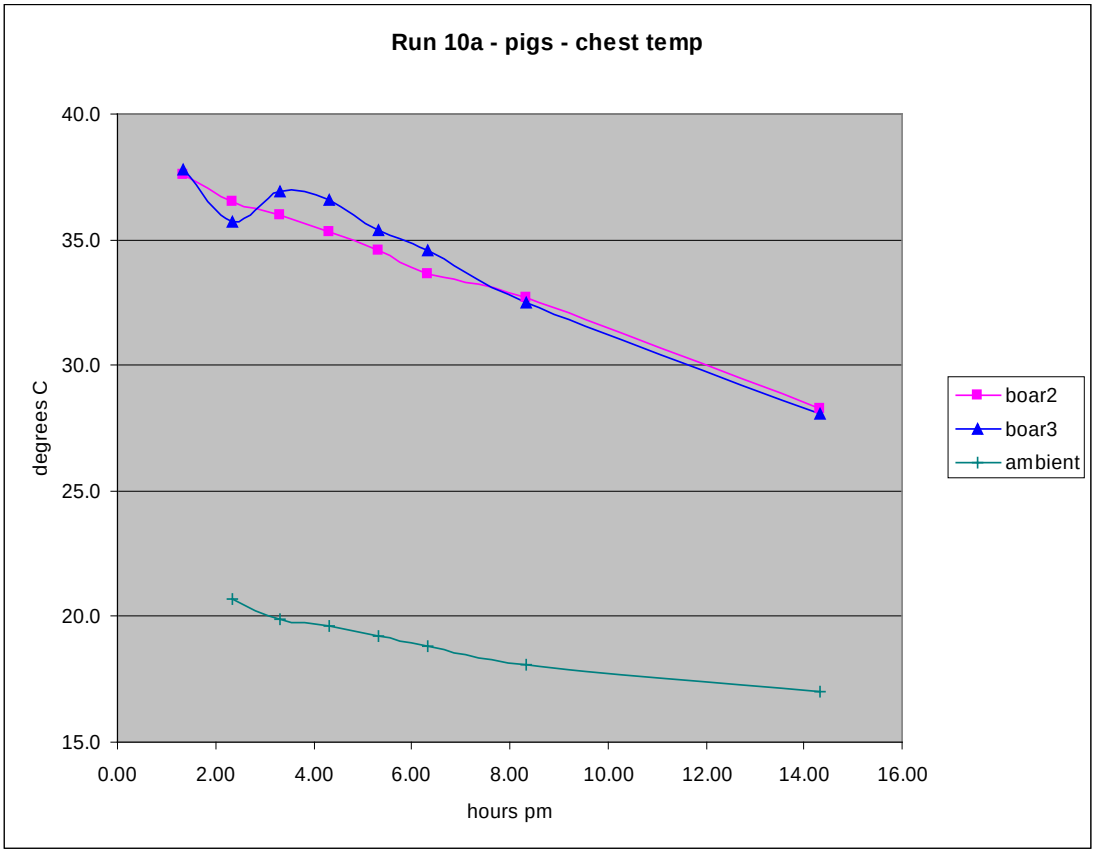


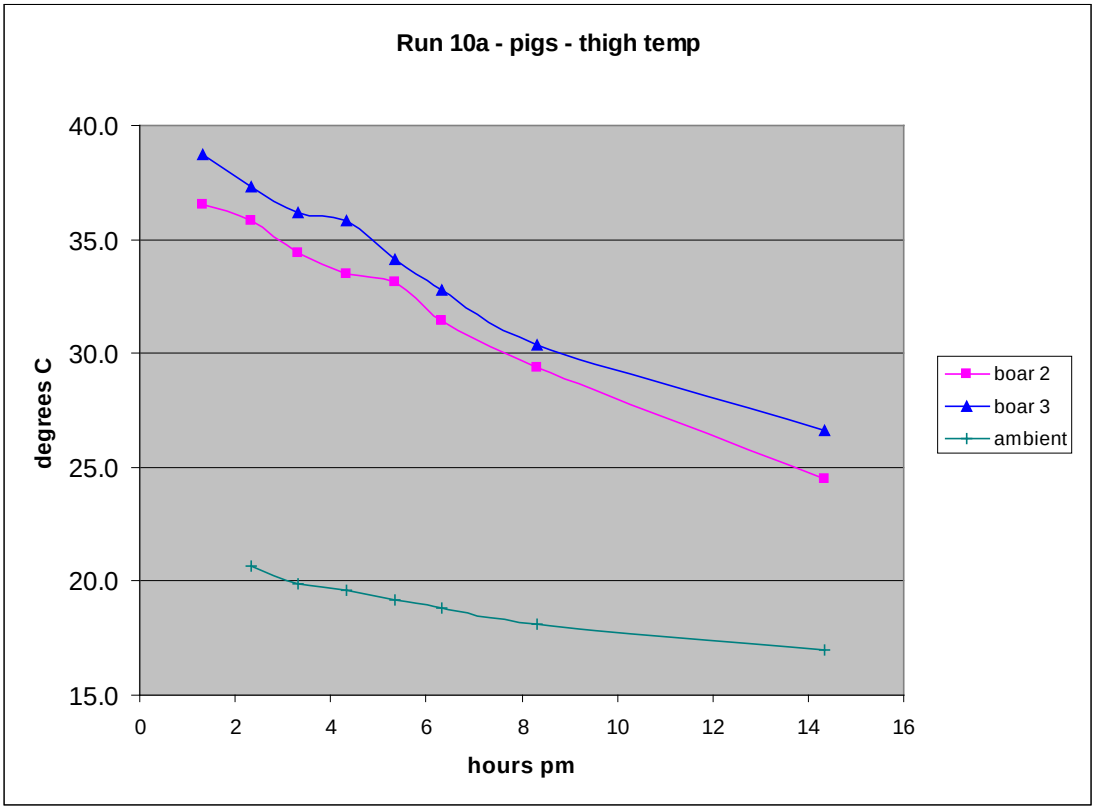

Run 9 - sheep - chest pH
pH
hours pm
sheep 1
sheep 2
sheep 3
sheep 4
sheep 5
sheep 6

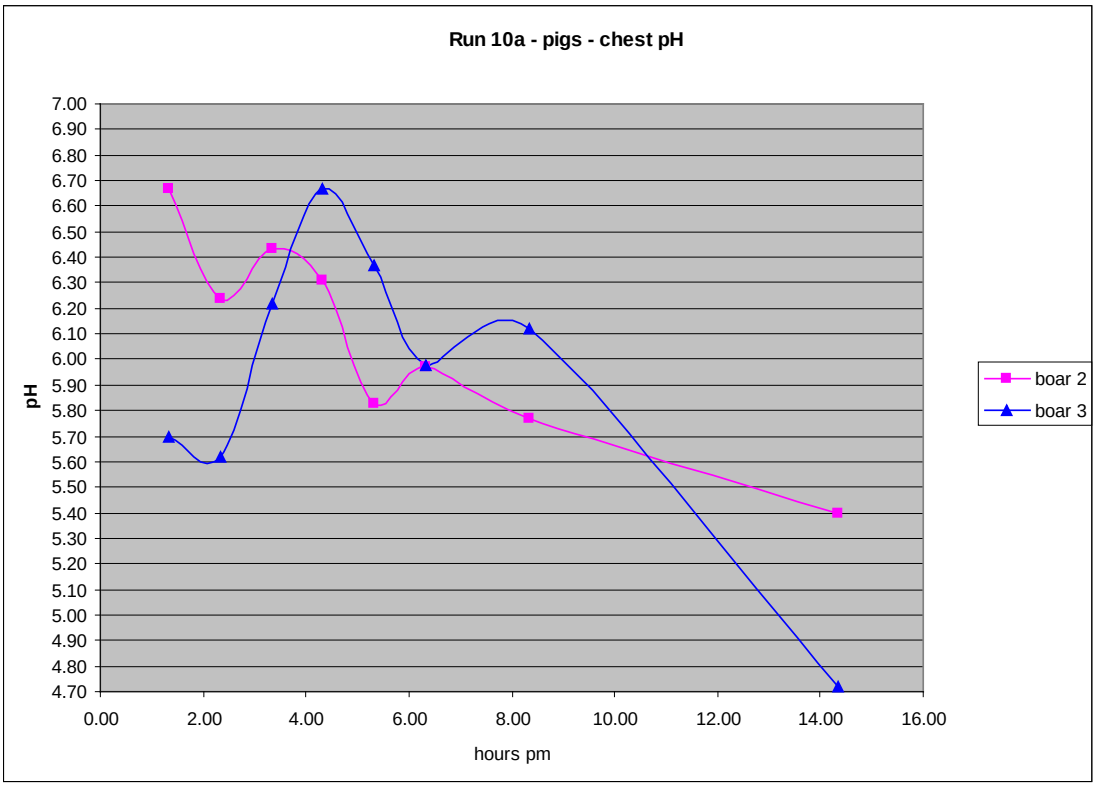

Run 9 - sheep - thigh pH
pH
hours pm
sheep 1
sheep 2
sheep 3
sheep 4
sheep 5
sheep 6

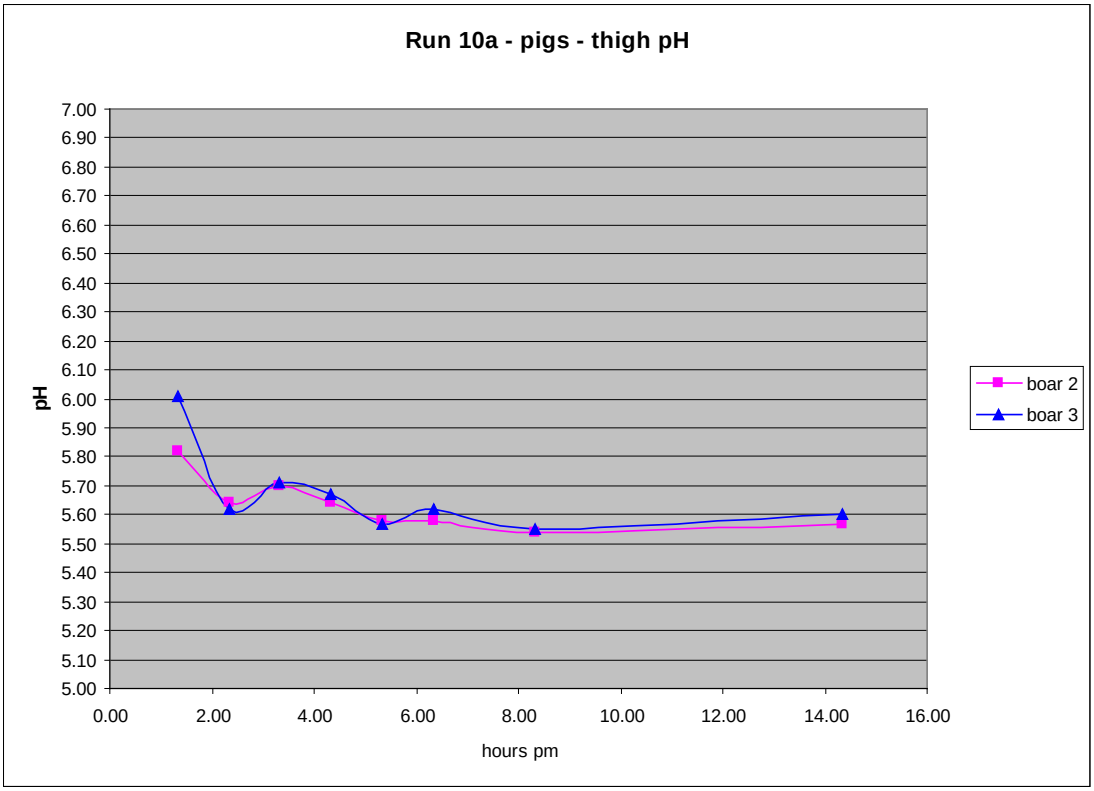
Run 10a. pigs, 8th September 2010

Time of death 5:00pm



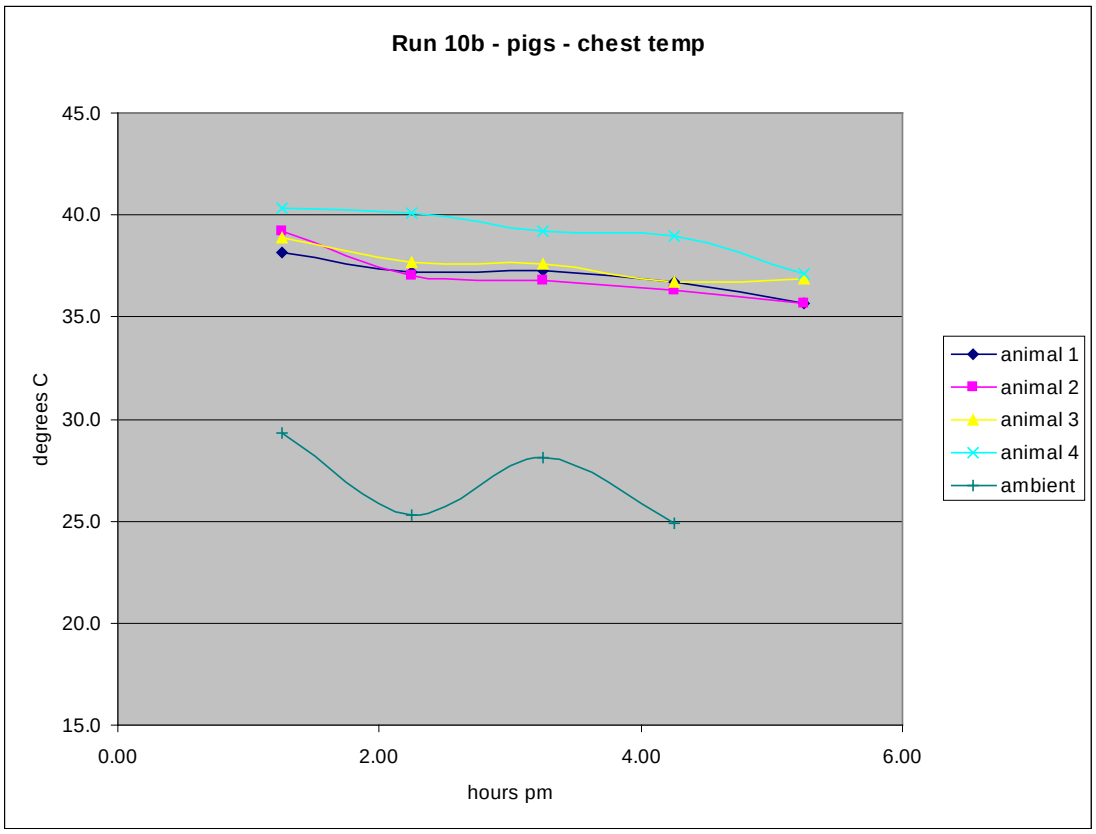


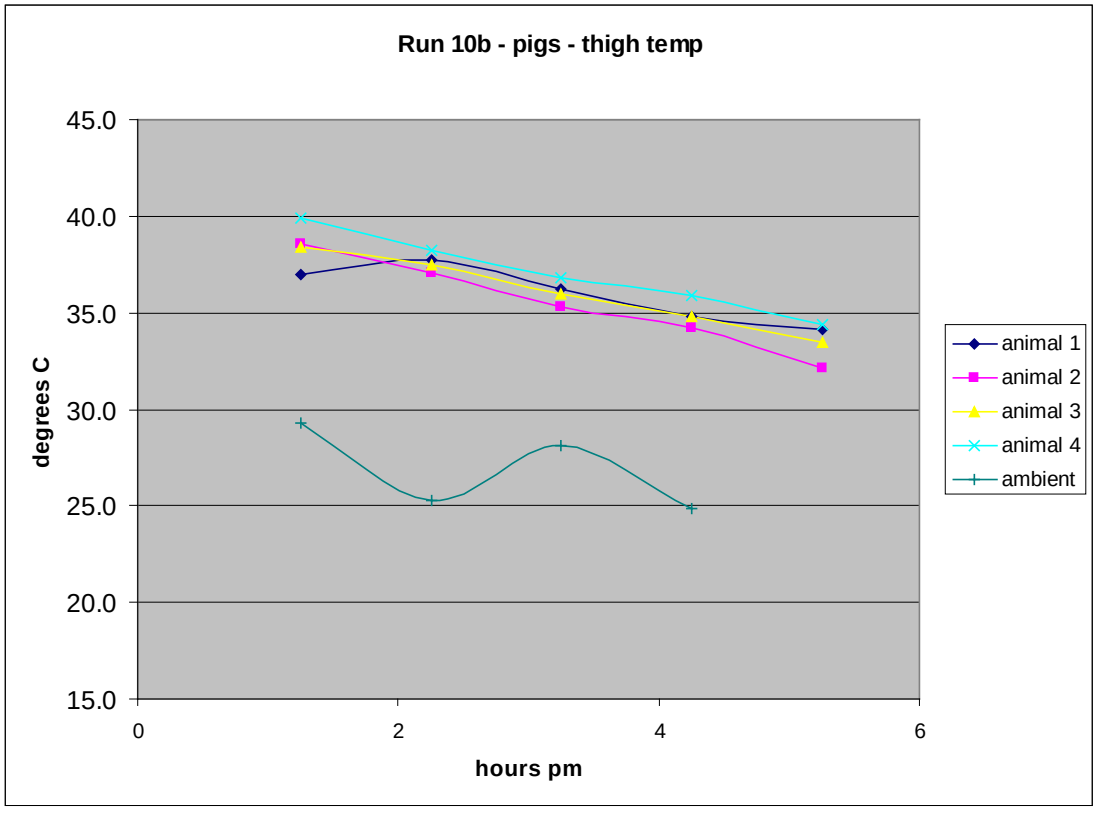

Run 10a - pigs - chest pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
pH
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
hours pm
boar 2
boar 3

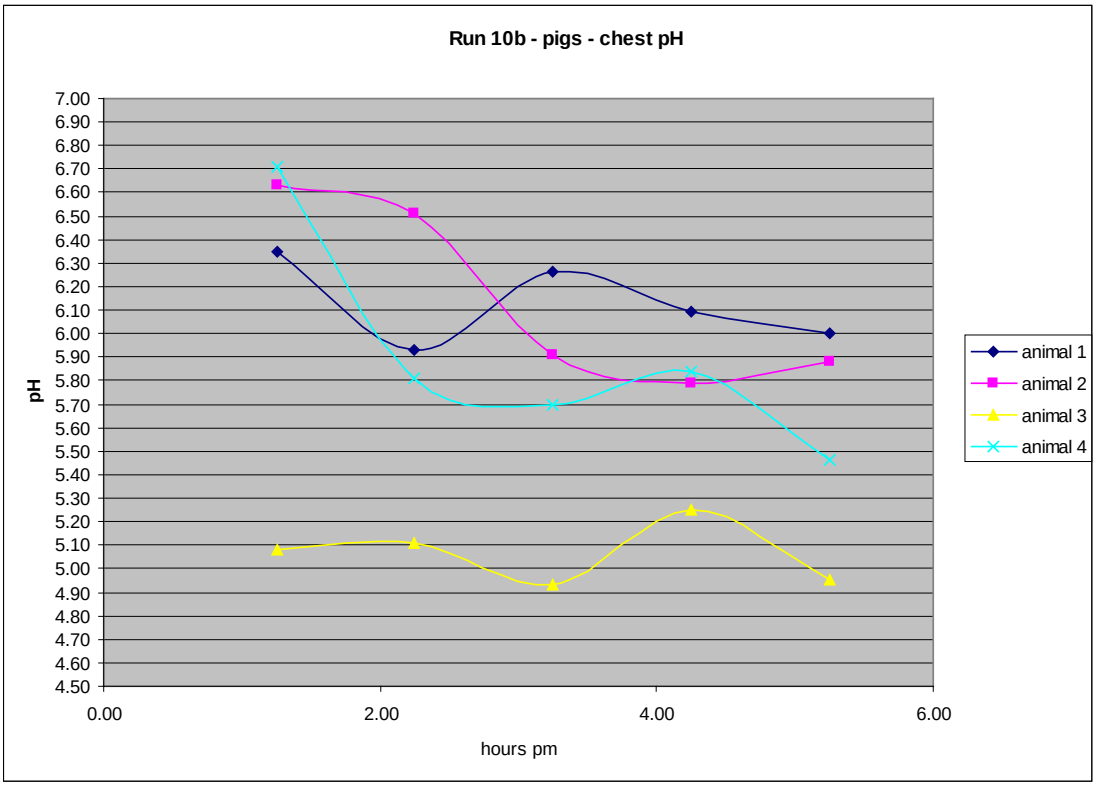

Run 10a - pigs - thigh pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
pH
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
hours pm
boar 2
boar 3

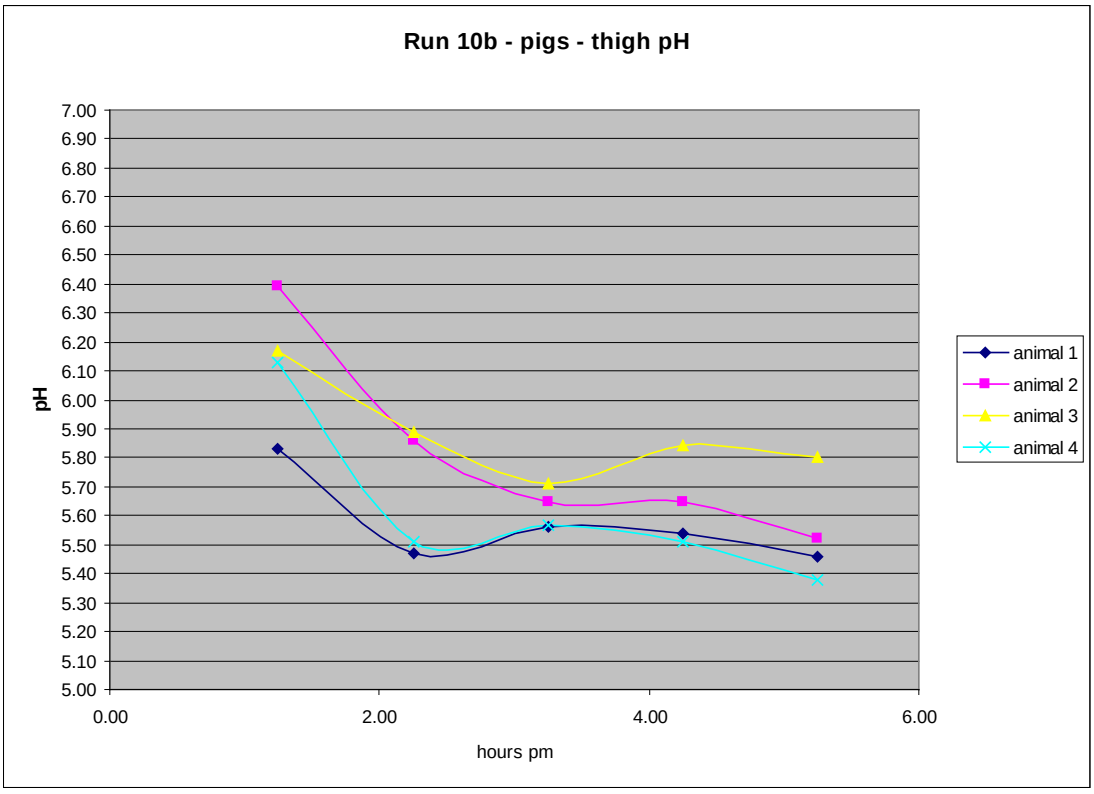
Run 10b. pigs, 9th September 2010

Time of death 1:00pm



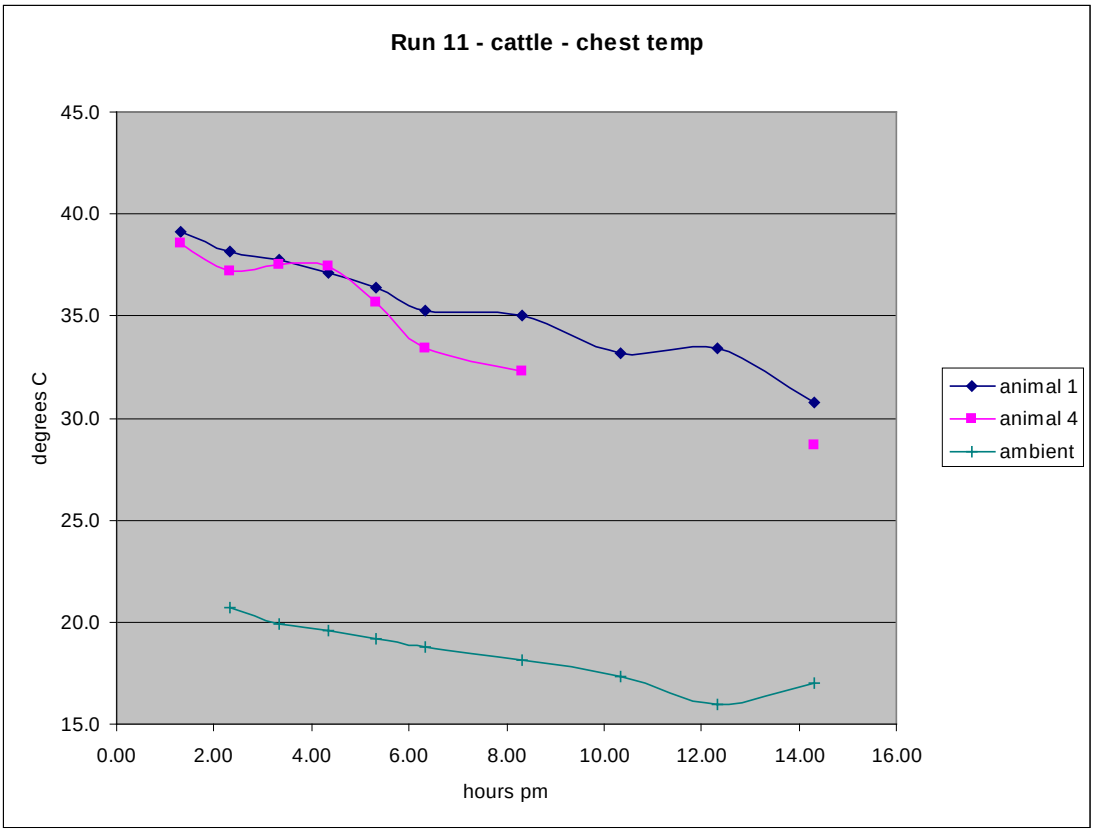


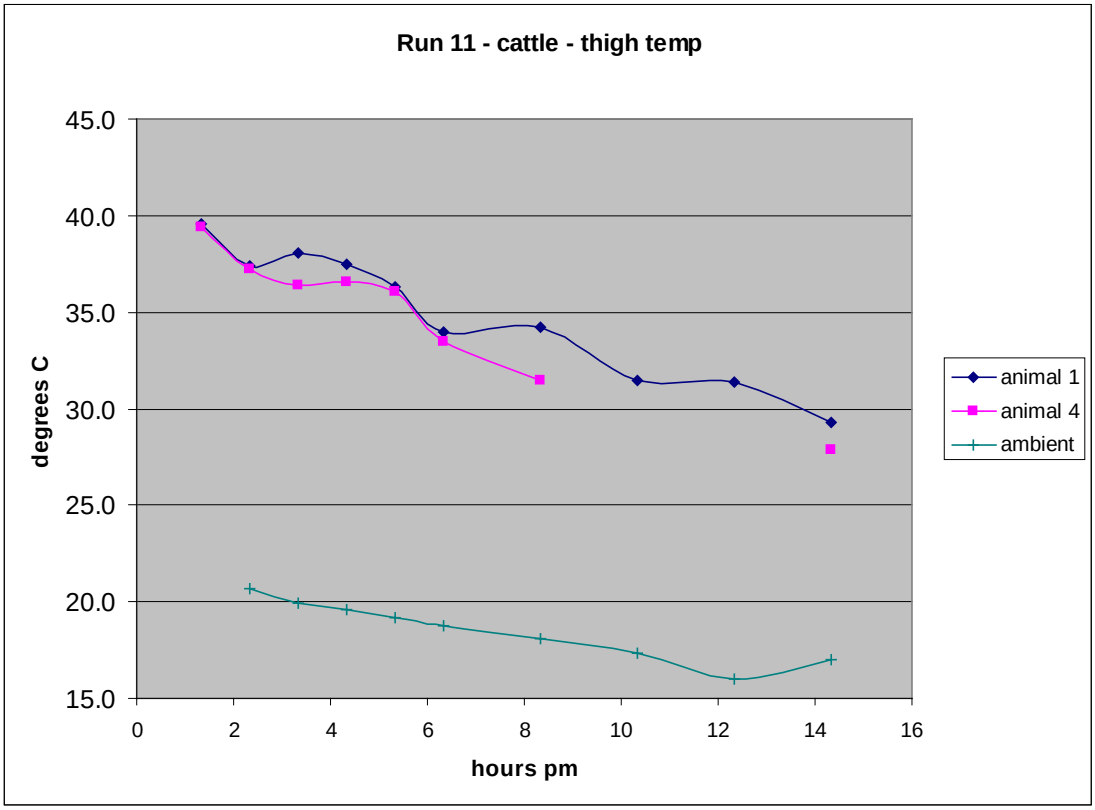

Run 10b - pigs - chest pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
4.60
4.50
pH
0.00
2.00
4.00
6.00
hours pm
animal 1
animal 2
animal 3
animal 4

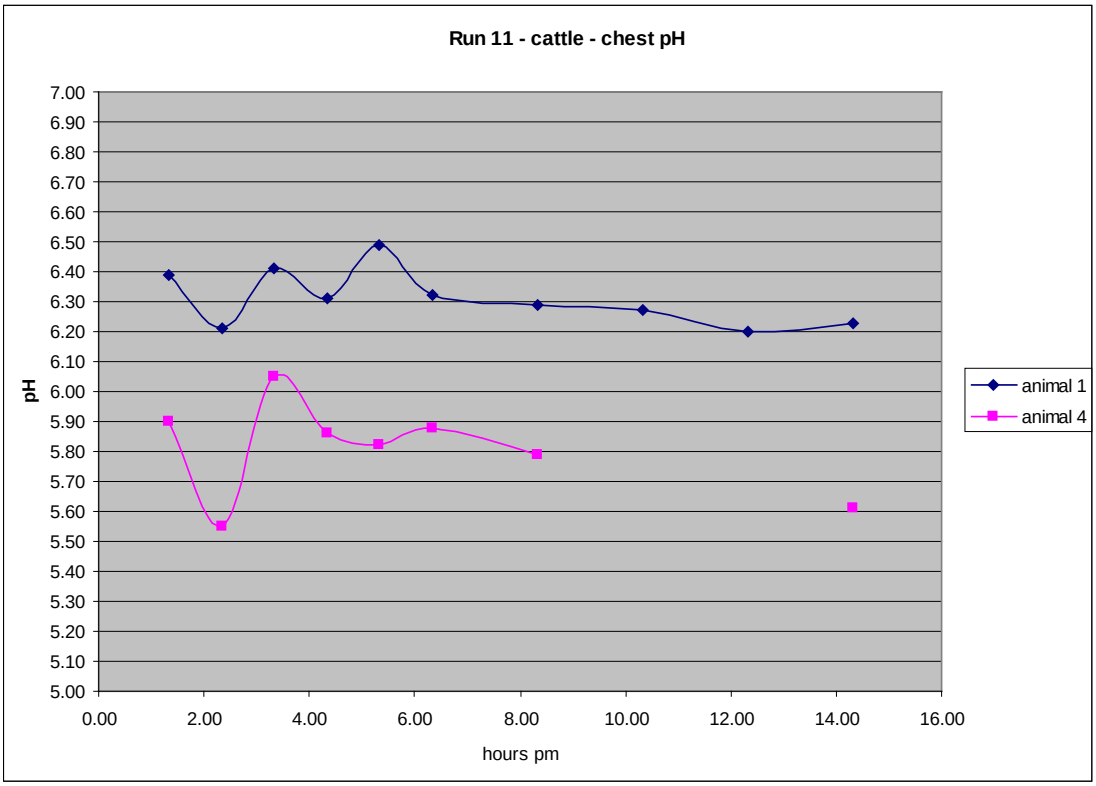

Run 10b - pigs - thigh pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
pH
0.00
2.00
4.00
6.00
hours pm
animal 1
animal 2
animal 3
animal 4

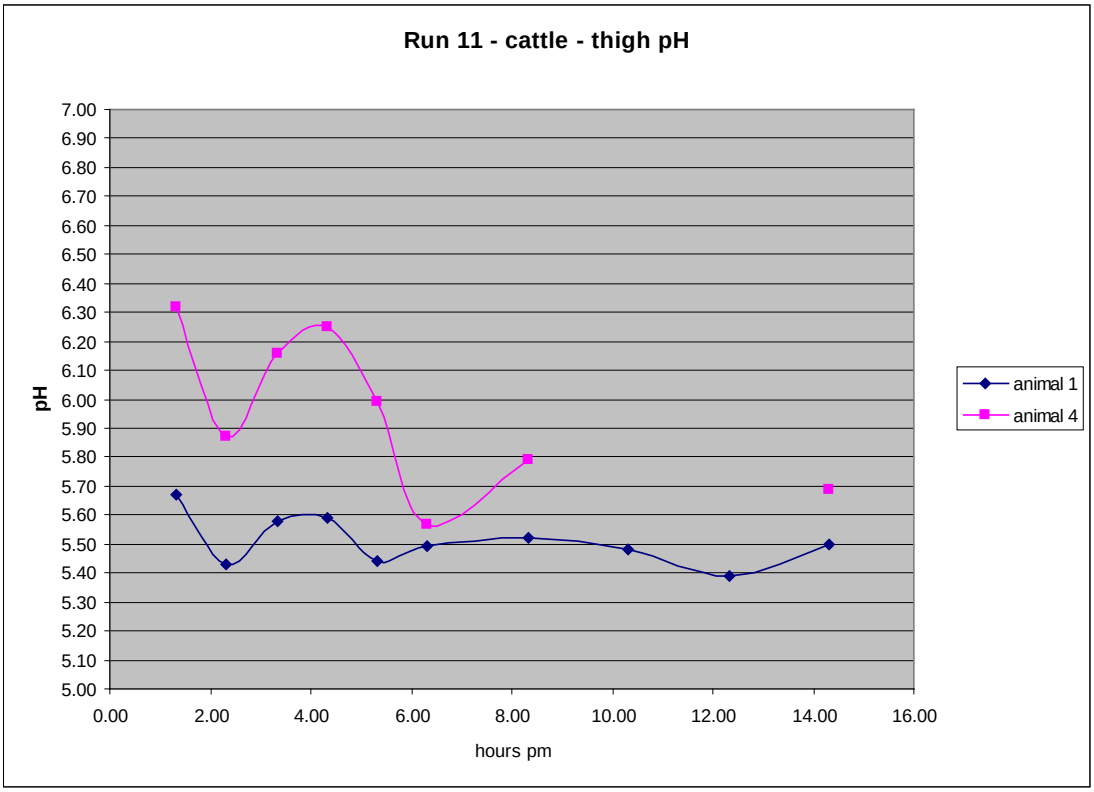
Run 11. cattle, 8th September 2010

Time of death 5:00pm






Run 11 - cattle - chest pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
pH
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
hours pm
animal 1
animal 4


Run 11 - cattle - thigh pH
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
pH
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
hours pm
animal 1
animal 4

References

1. Animal Health Australia (2005) AUSVETPLAN: Wild Animal Response Strategy
2. Animal Health Australia (2002) AUSVETPLAN: Disease Strategy - Foot and Mouth Disease
3. Productivity Commission, Government of Australia (2002), Productivity Commission Working Paper No. 1705: Impact of a Foot and Mouth Disease Outbreak on Australia.
4. Qld Department of Natural Resources, Mines and Energy (2004), Queensland Pest Animal Strategies - Feral Pig
5. Scott Williams Consulting Pty Ltd (2003), Report for Animal Health Australia: Persistence of Disease Agents in Carcases and Animal Products.
6. Williamson, G. (2006), DPI&F - “Shoot and Let Lie” Project - Preliminary Trial.

Acknowledgements

Bec Lake – Biosecurity Inspector, Charleville, Biosecurity Queensland
Murray Wingett - Regional Biosecurity Inspector, Cunnamulla, Biosecurity Queensland