Husbandry Guidelines for Plains Zebra *Equus quagga* (formerly *Equus burchelli*)

Mammalia: Equidae

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<td>Simon Husher</td>
<td>WSI Richmond</td>
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* CAUTION: Plains zebra are capable of critically or fatally injuring a person by biting with their razor sharp teeth or kicking with their hooves. They are instinctually a wild animal and know how to fight if they are cornered, stressed or want to assert their authority. So always maintain extreme caution when working with Plains zebra.

1: Introduction

This is a guide to the captive management of the Plains zebra. The manual includes information on the zebra’s natural habitat, wild status, captive requirements, general health and breeding. The Plains zebra has been split into several sub-species over the years using genetic taxonomies and traditional taxonomies and some of these are having not been fully resolved. I am following C.P.Groves and Catherine H.Bell’s traditional taxonomy and world recognized findings in their study ‘New investigations on the taxonomy of the zebra’s genus Equus, subgenus Hippotigris’ to differentiate the sub species of the Plains zebra in this manual. These are the following sub-species Equus quagga quagga, Equus quagga boehmi, Equus quagga bovensis, Equus quagga crawshayi, Equus quagga chapmani, Equus quagga burchelli, the most conspicuous morphological differences that divide these are body size and width, cranial size, presence of mane and also the intensity and coverage of dark stripes on the adult pelage. Plains zebra are native to the following countries Botswana; Congo, The Democratic Republic of the; Ethiopia; Kenya; Malawi; Mozambique; Namibia; Rwanda; Somalia; South Africa; Sudan; Swaziland; Tanzania, United Republic of; Uganda; Zambia; Zimbabwe and are possibly extinct in Angola. They have unfortunately become regionally extinct in the following countries Burundi; Lesotho.

IUCN have categorized the conservation status of the Plains zebra as of Least Concern having numbers of around 660 000 in 2002 and a population trend of ‘Stable’. These numbers and status seem comforting, but until we have sure Plains zebra taxonomies and population numbers of the sub species we just may lose an important sub species like the Equus quagga quagga. At present current information on population sizes are limited and stating from The IUCN Red List website is that information gathered from an Aerial survey data in Tanzania indicate there may have been a population decline of approximately 20% from the late 1990s to the mid-2000's (Hack et al. 2002; TAWIRI/TWCM pers comm. 2008). This is concerning seeing that 70% of the global population is found in only 2 countries – Tanzania and Kenya – showing that the preservation of this species relies entirely on their fate in this region of East Africa.

The threats to plains zebra are not listed as major and have not resulted in a range-wide population decline, but localized declines have resulted in some areas, due to overhunting and habitat loss. Every country where Plains zebra are found are effected by these 2 problems, although it happens to be more one problem than the other in some countries,
for example; loss of habitat seems to be more of a concern in the southern half of the range, while poaching appears to be more prominent in the northern half. If problems like these start to escalate, but detected early, and then followed by the appropriate actions the populations of Plains zebras can be given a chance to recover. This has been shown in the past due to their resilient nature and remarkable ability to recover from population declines when provided with the suitable habitat and protection from overhunting. (Hack et al. 2002) This is fortunate but not something to rely on, especially when it is too late. For example; this is what happened to Equus quagga quagga, this subspecies was driven to extinction in the late 19th century by overhunting and competition with livestock.

Plains zebra already live in a large number of protected areas including the Serengeti National Park (Tanzania), Tsavo and Masaai Mara (Kenya), Hwange National Park (Zimbabwe), Etosha National Park (Namibia), and Kruger National Park (South Africa). It was proposed by Hack et al. (2002) that the following conservation actions for the species take place: 1) Improve coverage and frequency of monitoring; 2) Improve risk assessment; 3) Quantify and manage genetic diversity both globally and locally; 4) Increase the understanding of the species' basic biology; and 5) Investigate the economics of alternative utilization strategies. The Current conservation actions are Land/Water management and Site/Area management.

Plains zebra are one the most popular features in Open-range zoos around the world. In Australia this much loved ungulate is under strict captive population management to ensure Australia’s population of Plains zebra doesn’t die out and maintains high genetic diversity. Our breeding is species specific but not subspecies specific due to the aged captive population and the difficult importation laws due to Quarantine. So in this case Plains zebra in Australia are used as a Flag ship species to educate the Australian people about the plight of all zebra in the wild.

1.1 IUCN Category
Plains zebra are listed as of Least Concern on the IUCN Red list as of 2002.

1.2 ASMP Category
Population Management Level 1 a

1.3 Species Coordinator
The Species Coordinator for Equus quagga is Lorraine Jolly. Lorraine Jolly works for Zoos Victoria. Contact email is: ljolly@zoo.org.au

1.4 Studbook holder
Studbook compiled by: Lorraine Jolly
Scope of Data: Australasia
Date first compiled: 2003
Data now current: 1st May 2007
2: Taxonomy

2.1. Nomenclature
Kingdom : Animalia
Phylum   : Chordata
Sub Phylum : Vertebrata
Class    : Mammalia
Order    : Perissodactyla
Family   : Equidae
Genus    : Equus
Subgenus : Hippotigris
Species  : Equus quagga

2.2 Subspecies
Equus quagga quagga
Equus quagga boehmi
Equus quagga borensis
Equus quagga crawshayi
Equus quagga chapmani
Equus quagga burchelli

2.3 Important Synonyms:
Asinus burchelli Gray 1825
Equus burchelli Smuts 1832
Hippotigris burchelli Smith 1841
Equus quagga burchelli Pocock 1904

2.4 Common Names:
Plains zebra, common zebra, Burchell’s zebra, painted quagga

2.5 Indigenous Names:
Punda milia (Kiswahili), itiko (Kichagga), eutulege (Luganda, Runyoro), etuko (Karamojong), lagwar (Lwo), entorege (Runyankore), injiga (Ishinyika), hares (Kiliangulu), eloidigo (Maasai), iqwaha (Xhosa), idube (Zulu, Ndebele), mangwa (Tsonga), pitsi (Sotho, Tswana), mbidi (Venda), mbizi (Karanga), bontsebra or bontkwagga (Afrikaans).
3. Natural History

3.1 Morphometrics

Depending on subspecies, adult Plains zebras of both sexes stand about 1.4 meters high at the shoulder, are approximately 2.3 meters long, and weigh around 220-322 kg. The morphological differences that divide the subspecies are body size and width, cranial size, presence of mane, and also the intensity and coverage of dark stripes on the adult pelage. Standout differences are found with a couple of subspecies:

- Equus quagga crawshayi: They have extremely narrow body stripes that are amazing and more of them reach the median ventral line.
- Equus quagga borensis: They are the only group that stands out in cranial size; it is larger in size than all the others. They are the only group that exhibit slight sexual dimorphism; the adult males of the group are maneless.

It was also found in Malawi specimens that shadow stripes between the black stripes are hardly present and leg stripes are never complete or well developed in southernmost zebras, whereas in the northernmost zebras the leg stripes were always complete. (GROVES & BELL 2002)

Diagram 1: Comparison to man: http://www.wildliferanching.com/content/plains-zebra-equus-quagga

Description

Table 1: Here is a good description of the following subspecies from the following website: http://www.wildliferanching.com/content/plains-zebra-equus-quagga

<table>
<thead>
<tr>
<th>Descriptive Differences Between The Zebras</th>
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<tbody>
<tr>
<td>Species</td>
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<tr>
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<tr>
<td></td>
</tr>
<tr>
<td>Species</td>
</tr>
<tr>
<td>--------------------------</td>
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<tr>
<td>Crawshay's Plains Zebra</td>
</tr>
<tr>
<td>Grant's Plains Zebra</td>
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<tr>
<td>Selous Plains Zebra (Borensis)</td>
</tr>
<tr>
<td>Chapman's Plains Zebra</td>
</tr>
<tr>
<td>Burchell's Plains Zebra</td>
</tr>
<tr>
<td>Quagga</td>
</tr>
</tbody>
</table>
Stripes are faded towards their ends.

Stripes change in colour from black to brown towards the hind quarters.

No shadow stripes and no stripes on lower half of buttocks and shoulder.

Upper parts of the body have a red-brown tone.

Table 2: Thorough information table of Plains zebra (Equus quagga chapmani):
http://www.wildliferanching.com/content/plains-zebra-equus-quagga

<table>
<thead>
<tr>
<th>Chapman's Plains Zebra information table</th>
<th>Stallion</th>
<th>Mare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult body weight: kg</td>
<td>290-340</td>
<td>290-340</td>
</tr>
<tr>
<td>Adult shoulder height: cm</td>
<td>130-138</td>
<td>130-138</td>
</tr>
<tr>
<td>Expected longevity: years</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Age of sexual maturity: months</td>
<td>36</td>
<td>16-20</td>
</tr>
<tr>
<td>Age of social adulthood (1st mating)</td>
<td>5</td>
<td>2-2.5</td>
</tr>
<tr>
<td>Gestation: months</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>1st foal born at: years</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Foal interval: months</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Post maturity age (last mating): years</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Rutting season</td>
<td>Year round</td>
<td></td>
</tr>
<tr>
<td>Foaling season:</td>
<td></td>
<td>Year round</td>
</tr>
<tr>
<td>Weaning age: months</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Gender ratio: natural (all ages)</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Gender ratio: production (all ages)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Mating ratio: natural (adults)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Mating ratio: production (adults)</td>
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<td>6</td>
</tr>
<tr>
<td>Re-establishment: Absolute minimum number needed</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Re-establishment: Smallest viable</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Population size</td>
<td>Spatial behaviour: home range</td>
<td>Spatial behaviour: territory range</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>ha</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>10000-26000</td>
<td>None</td>
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<tr>
<td></td>
<td>7000-26000</td>
<td>None</td>
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</table>

<table>
<thead>
<tr>
<th>Population size</th>
<th>Browsing unit (adult): Dietary ratio: (browse):</th>
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<tbody>
<tr>
<td></td>
<td>BU</td>
</tr>
<tr>
<td></td>
<td>2.2 per animal (5% of diet)</td>
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<td></td>
<td>2.2 per animal (5% of diet)</td>
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</table>

<table>
<thead>
<tr>
<th>Maximum stocking load</th>
<th>40 animals per 1000 ha (at 450-550 mm annual rainfall)</th>
</tr>
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<tbody>
<tr>
<td>Minimum habitat size required</td>
<td>ha</td>
</tr>
<tr>
<td>Annual population growth</td>
<td></td>
</tr>
<tr>
<td>Optimal annual rainfall:</td>
<td></td>
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<tr>
<td>Optimal vegetation structure:</td>
<td></td>
</tr>
<tr>
<td>Grass height:</td>
<td></td>
</tr>
<tr>
<td>Woody canopy cover:</td>
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</tbody>
</table>

### 3.2 Distribution and habitat

#### 3.2.1 Distribution
Plains Zebra range from southern Sudan and southern Ethiopia, east of the Nile River, to southern Angola and northern Namibia and northern South Africa (formerly ranging south of the Orange and Vaal Rivers to the Cape) (Hack *et al*. 2002; Klingel in press). They are now extinct in two countries in which they formerly occurred: Burundi and Lesotho. There is no information on their status in Angola, where they may also be extinct.

The six morphologically defined subspecies are distributed as follows (*following Groves and Bell 2004, and Klingel in press*):

*E. q. crawshaii* (Crawshay’s Zebra) occurs in Zambia, east of the Luangwa River, Malawi, south-eastern Tanzania from Lake Rukwa east to Mahungoi, and Mozambique as far south as the Gorongoza district;
E. q. borensis ranges in north-west Kenya, from Guas ngishu and Lake Baringo, to the Karamoja district of Uganda and south-east Sudan, east of the Nile River to the northern limit of the species at 32°N;

E. q. boehmi (Grant’s Zebra or Boehm's Zebra) is found in Zambia, west of the Luangwa River, west to Kariba, Shaba Province of DR Congo north to Kibanzao Plateau; Tanzania north from Nyangau and Kibwezi into south-west Uganda, south-west Kenya as far as Sotik, and east Kenya, east of the Rift Valley, into southern Ethiopia and perhaps to the Juba River in Somalia.

E. q. chapmani (Chapman's Zebra) ranges from north-east South Africa, from about 24°S, 31°E, north to Zimbabwe, west into Botswana at about 19°S, 24°E, the Caprivi Strip in Namibia, and southern Angola;

E. q. burchellii (Burchell’s Zebra) formerly occurred north of the Vaal/Orange Rivers, extending north-west via southern Botswana to Etosha National Park and the Kaokoveld, south-east to KwaZulu-Natal and Swaziland. It is now extinct in the middle of its range. E. b. antiquorum is now included in this subspecies;

E. q. quagga (Quagga) occurred in the former Cape Province, south of the Orange and Vaal Rivers and west of the Drakensberg. Now extinct.

Countries Plains zebra are native to: Botswana; Congo, The Democratic Republic of the; Ethiopia; Kenya; Malawi; Mozambique; Namibia; Rwanda; Somalia; South Africa; Sudan; Swaziland; Tanzania, United Republic of; Uganda; Zambia; Zimbabwe
Countries Plains zebra are possibly extinct: Angola
Countries Plains zebra are regionally extinct: Burundi; Lesotho

Diagram 2: Map of the overall distribution of Equus quagga: http://www.iucnredlist.org/apps/redlist/details/41013/0/rangemap
Diagram 3: Distribution of Plains Zebra: Subspecies specific: http://www.wildliferanching.com/content/plains-zebra-equus-quagga
Diagram 4: The following map shows the historic, current and introduced ranges of Equus quagga. (Status Survey and Conservation Action plan, Equids: Zebras, Asses and Horses)

3.2.2 Habitat
Plains Zebra are one of Africa’s most adaptable and successful grazers. They are found in a broad range of savannah habitats, from treeless short grassland to tall grassland and open woodland. The zebras are known as the ‘Pioneers’ usually being the first to lead the way into these new pastoral habitats. Clearing the way to allow fresh re-growth for all the more selective ruminants like wildebeest and Thompson’s gazelle by moving through and eating the older growth of lignified stems, sheaths and seed heads. The zebras achieve this by utilizing a hind-gut digestive system which allows them to process their food at a relatively faster rate, therefore allowing coarse vegetation of low nutritional value to sustain the energy levels of the zebra as long as it is abundant. Other ruminants of similar size would starve on the same diet. This allows their populations to be found anywhere from sea level to 4300m on Mount Kenya, across the Somali-Masai Arid Zone, through the Southern Savannah and marginally in the South West Arid Zone from southeastern Sudan to South Africa and Angola. Plains zebra are also one of the most water dependant, they will correlate their movements to the availability of water. They will migrate to grazing areas during the rains and remain close to permanent rivers or pools during the dry season. (Hack et al. 2002) & (R.Estes 1991)
3.3 Conservation Status
IUCN have categorized the conservation status of the Plains zebra as of Least Concern having numbers of around 660,000 in 2002 and a population trend of ‘Stable’. These numbers and status seem comforting, but until we have sure Plains zebra taxonomies and population numbers of the sub species we just may lose an important sub species like the Equus quagga quagga. At present current information on population sizes are limited and stating from The IUCN Red List website that information gathered from an Aerial survey data in Tanzania indicated that there may have been a population decline of approximately 20% from the late 1990s to the mid-2000’s (Hack et al. 2002; TAWIRI/TWCM pers comm. 2008). This is concerning seeing that 70% of the global population is found in only 2 countries – Tanzania and Kenya – showing that the preservation of this species relies entirely on their fate in this region of East Africa.

3.4 Diet in the wild
Plains zebra are one of Africa’s most adaptable and successful grazing herbivores they pave the way to allow fresh re-growth for all the more selective ruminants like wildebeest and Thompson’s gazelle by moving through and eating the older growth of lignified stems, sheaths and seed heads. The zebras achieve this by utilizing a hind-gut digestive system which allows them to process their food at a relatively faster rate, therefore allowing coarse vegetation of low nutritional value to sustain the energy levels of the zebra as long as it is abundant. They graze through a broad range of savannah habitats, from treeless short grassland to tall grassland and open woodland equipped to deal with both long tough stems and the early stages of flush. (Hack et al. 2002) & (R.Estes 1991) Research amongst the zebra in the Serengeti by Grogan’s (1973) research showed that Pennisetum mezianum was a preferred species. He compared proportions ingested to their availability in the sward and found that there was significant selection and rejection of grass species. Other grasses especially favored are Themeda triandra, Cynodon dactylon, Eragrustis superba, and Cenchrus ciliaris. (website: Animal Diversity Web) Plains zebra have also been seen browsing occasionally on the fire-scorched leaves and twigs of mopane and round-leaved kiaat trees. (website: Ultimate Field Guide)

3.5 Longevity

3.5.1 Wild
The average lifespan of Plains zebra is 9 years, the number is reasonably low in comparison to the lifespan in captivity. This is because the population growth and average longevity is relentlessly impacted by predation. 50% of juveniles annually die due to predation; this high juvenile mortality rate is contributory to disease, death of mothers, low nutrition, and drought.
   Average lifespan: 9yrs
   Extreme lifespan: 20yrs
   (website: Animal Diversity Web)

3.5.2 Captivity
The average lifespan of plains zebra in captivity is 35 to 40yrs
   (website: Animal Diversity Web)
4.0 Housing Requirements

4.1 Exhibit Design
The exhibit structure for Plains zebra needs to be large and open. When planning an exhibit it needs to have the feel of a large open savannah that provides sufficient open space for the zebra to explore, graze and gallop. Off exhibit holding yards must also provide sufficient room. Shelters must be provided in all enclosures including holding and main exhibit, for protection from the elements. It is advised that all enclosures be enclosed by suitable fencing eg. A 2mtr (6-7 foot) high fence with post and chain wire fencing; the chain wire mesh must be no more than 5cm wide so the zebra can not get a hoof stuck or any holes anywhere they could get a head stuck; the wire mesh should also have a little flexibility to stop fatal injuries if the zebra run straight into it, when startled or first released into the enclosure. All gates onto the exhibit should open inwards and there should be sufficient room to drive a truck through for ease of maintenance, veterinary care and all other procedures.

Exhibits should have large flat areas for running and playing without this, the insufficient locomotion amongst the zebras would be detrimental to hooves, limbs and body shape. Ideally the flat areas should consist of a well drained pasture, providing a ground surface that has good elasticity and secure footing. Exhibits that have entirely hard surfaces will then cause the zebra to have painful joints over time. A mixture of both types of surface would be perfect, if you provide hard and rough surfaces in some daily walking areas this will aid in the natural trimming of hooves, possibly canceling out or limiting the need for hoof trims under anesthesia. A study on providing natural or man made rocky outcrops with enrichment hidden amongst them in a zebra enclosure to aid natural hoof trim has had great success, the study was ‘Controlling zebra hoof overgrowth through enclosure modification’ by Erica Lynn Maulhardt, Nina Quinley, Ann Goody PhD and is well worth a look. Large lying tree trunks can also be added to an exhibit to provide obstacles for running and playing around (especially for young foals), an obstruction to deter aggressors in chases and also a good rubbing post. Trees can serve as a great secondary shelters, so if deciding to plant new trees on an exhibit or there are existing trees, they must be cleared for suitability for the animals to browse on and precautions then need to be made so the zebra do not ring bark the trees.

Other enclosure essentials are water troughs, they must be provided in all yards. There should be designated feeding areas in all yards; feed troughs should be placed at their deepest point of 20 to 40 cm off the ground. If not using a long trough but several single troughs, they should be placed no less than 80cms apart from each other. Always monitor at feeding times to watch for greedy individuals hogging the area in case changes need to be made to the feeding arrangements. Also always remember never to fit any fixtures lower than 2mtrs over feed stations to prevent any fatal accidents if the zebra get startled while eating or to allow any protruding objects or gaps between objects around the enclosure which may cause injury when a zebra is being chased.

Diagram 5:
For better public viewing at the front of an exhibit a dry moat system with an electric fence at the bottom is ideal. It promotes a sense of being apart of the herd by allowing the public to see the animals on their level with no obvious fencing in the way. The only caution is when building the moat system is to create a gradual slope inside the exhibit so it is easy for the zebra to climb in and out. An enclosure always must have an area not accessible by the public so the zebra are able to find areas around the enclosure they can find safe and not stressful.

**Exhibit Plan 1: Savannah 1 Exhibit (Diagram 5)**
The Savannah exhibit is our largest exhibit at TWPZ and a mixed species exhibit holding 3 Dwarf Forest Buffalo, 3 Giraffe, 8 Eland, and 4 Plains zebra. 1 hippo is within his own enclosure inside the Savannah exhibit. The giraffe have access to about three quarters of the exhibit, which is divided by 1 electric wire only to stop the giraffe so we have an area we are able to feed all of the other species without complications from the giraffe and all species are free to retreat or mix with the giraffe. An electric wire surrounds the entire enclosure, and then most of the enclosure is surrounded by a 7 foot wire mesh fence, whereas the public areas have a shorter fence with a moat. The public only have access to one side of the perimeter fence, an area for lodge guests and an area for visiting public. Here visitors are able to see the animals on their level with no obvious fencing in the way, or they are able to view from a large viewing tower on the main circuit. All work is done by a keeper in a vehicle that can enter through the automatic gate; the gate is also protected by an electric wire grid system to stop animals running in or out. This is a perfect enclosure for displaying zebra and observing all the natural behaviours, but due to the mixed exhibit and size it is not ideal if you were to breed zebras. Foals may be killed by other species and it is difficult if you need to manage the zebra group more closely. This why we hold our 3 neutered males here and 1 young female and we do our breeding on our smaller zebra exhibit as seen below. The Savannah exhibit has two lots of holding yards, one for the giraffe and another large holding yard for the rest of the species including zebra. These larger holding yards have been made to hold many or larger animals with lots of slides and doors to separate individuals. Due to the natural shelters on exhibit and the no need for intense management of the taxon on this exhibit, we only open the Night Yards up for the animals in detrimental weather and all of the Winter months.

The zebra in this enclosure are quite relaxed in their surroundings, they are not stressed by the animals or each other and don’t show any aggression. The zebra move freely around wherever they like grazing. I found it interesting to see how alert they were to what was happening outside their perimeter fence and not the Keeper truck driving all over the exhibit doing Keeper duties and disturbing the tranquility. This proves how the zebra and the other animals can be conditioned to something that happens everyday whereas something new, like myself standing outside the enclosure, can create something very interesting for the zebra or a bit stressful for the Eland.

**Diagram 6: Exhibit Plan 2: Zebra exhibit on main circuit and rear holding yards**
The enclosure is a medium sized enclosure which has 2mtr high perimeter wire fencing at the back and sides. The front of the enclosure sits on the main circuit of the zoo it has electric fencing along the front (at the bottom of moat system) and a 2 to 3 mtr deep easement with a high embankment. The public viewing is from the front only. You can stand at the top of the embankment so you can either see the zebra from above when they’re at the bottom of the easement or at eye level when the zebra are standing in the middle of the enclosure. Cars can also drive past the front of the exhibit and view from there. The enclosure has a partial slope towards the rear with a couple of plateaus and is partially covered with trees and grass. The rear of the enclosure leads to the Night Yard and Keeper work area. We are able to manage our zebra more intensely here with use of the Night Yards, so this is why we hold our breeding group here. At present on this exhibit we have 1 stallion, 3 mares and 1 foal.

The zebra group in the ‘main exhibit’ enclosure doesn’t have as good of a lifestyle as those on the Savannah exhibit. They might show the same behaviours and are not visually stressed but they don’t move around the same amount and are less stimulated by their surroundings. They spend most of their time eating at what grass they can find in a smaller enclosure. What was also interesting is the difference in the zebra groups in relation to what they have become conditioned to. This group shows no interest in what’s happening outside their perimeter fence due to the amount of conditioning they have to the amount of public passing through (apart from a member of the public owning the same car as the Keepers and driving past sent zebra D and E into a stomach driven reaction) and even less interest on the inside of the exhibit. Whereas the Savannah exhibit zebra are the opposite. This is why enrichment program are used or are needed.

4.2 Holding Area Design
Exhibit plan 2 shows a raceway and 3 separate holding yards for the zebra group (EAN01A, EAN02 & EAN01B), all yards and gates have 2 mtrs high wire mesh fencing. These 3 holding yards are all used every evening and are capable of giving each zebra enough room to feed or retreat away from other individuals if necessary. Each area also has its own separate facilities should we need to separate the animals whenever necessary. EAN01B has a gradual slope with a few rocky areas which help natural hoof trimming. Each yard has vehicle access and gates that can be opened externally allowing the keeper to never enter the area with the animal. Water troughs are concrete and feed troughs are metal.

4.3 Spatial Requirements
Plains zebra should be kept in social groups of one adult male and several females with their offspring. Also the keeping of groups of compatible bachelors is possible. For up to five adult animals an outdoor enclosure of at least 800 m² is required, which should be enlarged by 80 m² for each additional adult. There must be an easily accessible shelter of sufficient size. No indoor facilities are required. Where Plains zebra are kept indoors at times, either a common stable of 20 m² for the first two adult animals is required, which has to be enlarged by 2 m² for each additional adult or, if the animals are individually stabled, there must be stalls of at least 8 m² each. Group shelters are suggested to be large
enough to accommodate at least 6 m² of floor per individual. All entrances to stalls, shelters or exhibits are recommended to be at least 2 zebra lengths. *(website: WAZA)*

*All spatial requirements at TWPZ adhere to the following laws and regulations in the ‘General Standards for Exhibiting Animals in New South Wales: Clause 18; Spatial Requirements. Exhibited Animals Protection Act’ which state the following:

1) The size and shape of enclosures must provide freedom of movement, both horizontally and vertically.
2) An enclosure must be of sufficient size, and the animals in the enclosure must be so managed, as to:
   a) avoid undue domination of a herd or group by an individual or individuals; and
   b) avoid the risk of persistent and unresolved conflict between herd or group members or between different species in enclosures containing different species; and
   c) make it possible for an animal to avoid, or withdraw from, contact with other animals or with people; and
   d) ensure that the carrying capacity of the enclosure is not exceeded; and
   e) prevent an uncontrolled accumulation of parasites and other pathogens; and
   f) encourage and permit exercise and behavioural enrichment.
3) Each animal must be provided with sufficient space in all directions to enable it:
   a) to take exercise; and
   b) to be protected from undue dominance and conflict; and
   c) to be provided with its social, breeding and husbandry needs.


### 4.4 Position of enclosures

If possible enclosures should be positioned to provide access to areas of both shade and full sunlight simultaneously throughout the day. Providing shade in hot weather and sunny areas in cold weather, so each individual zebra has the opportunity to choose their desired environment.

### 4.5 Weather Protection

Shelters must be accessible in all enclosures for protection against the elements. Preferably these shelters will be enclosed with three walls for wind protection, the roof insulated for heat protection, and roof gutters to prevent muddy ground around the shelter. A water tank could also be fitted to the guttering to help conserve water and fill water troughs. Each individual zebra in your care should always be protected from conditions detrimental to their well-being.

### 4.6 Temperature Requirements

No heating needs to be made available unless the environment the plains zebra are housed in reaches constant temperatures of 0°C and below. If this is the case a simple heat bar in the stables or shelter area should suffice. Some of the native areas of the Plains zebra in East Africa for example the Serengeti National Park will reach 0°C
overnight in Winter but will warm up the next day to around 20°C. This is quite similar to our climate at TWPZ so no heating is required.

Diagram 7*An example of temperatures in the Serengeti National Park. Tanzania. Africa. (website: My Weather 2)

4.7 Substrate

Ideally areas should consist of well drained pastures, providing a ground surface that has good elasticity and secure footing. Exhibits that have entirely hard surfaces will then cause the zebra to have painful joints over time. A mixture of both types of surface would be perfect, if you provide hard and rough surfaces in some daily walking areas this will aid in the natural trimming of hooves, possibly canceling out or limiting the need for hoof trims under anesthesia. A study on providing natural or man made rocky outcrops with enrichment hidden amongst them in a zebra enclosure to aid natural hoof trim has had great success, the study was ‘Controlling zebra hoof overgrowth through enclosure modification’ by Erica Lynn Maulhardt, Nina Quinley, Ann Goody PhD and is well worth a look at website: www.threeringranch.org/articles/swava_zebra_feet.pdf
5.0 General Husbandry

5.1 Hygiene and Cleaning
As with any species, all enclosures must be cleaned daily to remove any faeces, uneaten food, old browse and any other waste material. All waste must be removed and disposed of according to institutional policy and procedures. Best practices are to clean as early as possible and to provide food directly before giving the zebra access to a Night Yard when Night Yards are used. This prevents any pests from eating or soiling the food. Water troughs should be monitored daily and kept clean; cleaning can be simply achieved by using water and a scrubbing brush. Regular scrubbing and dropping of water will limit the build up of algae.

In cases of extremely soiled troughs cleaning products can be used sparingly. The following products recommended are Red Gum disinfectant* and F10*, but always remember that these products must be thoroughly washed off before next using the trough.

*See Appendice I and II for MSDS

In situations where Plains zebra are housed in extremely large Open range paddocks the placement of food is less strict. If the exhibit is covered with grass the diet of hay may be thrown in piles on grassy patches of ground free from faeces around the exhibit. Drinking troughs hygiene and cleaning is the same as above.

5.2 Record Keeping
It is vitally important to establish an information system to monitor and record the health condition and reproductive status of captive Plains zebra. Records should be kept of each individual’s:

1. Identification number, common name, scientific name, any personal name, and any distinctive markings. All individuals should be identifiable.
2. Details of the individual’s place and date of birth, parents and their origin being wild or captive.
3. Weights and measurements
4. Changes in Diet
5. Results of any veterinary examinations conducted; details and dates of the treatments and then the results of prescribed treatment.
6. Reproductive behaviour or condition.
7. Behavioral history, positive, negative and conditioned.
8. Movements between enclosures or institutions.
9. Births with mare or stallion if known
10. Death, including results of post-mortem.

5.3 Methods of Identification

5.3.1. Visual identification
The pattern of a Plains zebra stripes is as unique as a human fingerprint.(\textit{website: African Wildlife Assoc.}) Visual identification is therefore an ideal and preferred form of
identification in a zoo institution. It is neither harming to the individual and there is nothing to leave an unpleasant view to the public. A photo file is recommended to minimize mistakes. Visual identification is best paired with a Passive Integrated Transponder tag as a backup to mistakes or loss of information.

5.3.2. Passive Integrated Transponder tag.
These can be used as a secondary permanent identification, they are an excellent form of identification but in most institutions you are unable to get close enough to a zebra to check the tag unless they are anaesthetized during a veterinary procedure. So a visual identification system is the best primary identification for the day to day husbandry and monitoring of Plains zebra in captivity and PIT tagging a secondary identification precaution. The PIT tag is implanted subcutaneously and then is able to be read by a scanner.

Below is an example from the ‘EEP. Asiatic Equids. Husbandry Guidelines’ of where and how to implant a PIT tag.

Diagram 8:

Implantation of the transponder is fast, easy and not painful for the animal and is comparable to an injection or a vaccination.

The procedure itself is simple:

- Shave the hair on the left side halfway between the ears and the withers, approximately 2 fingers down from the line of the mane

- Disinfect this area

- Implant only intramuscularly as transponders often get lost when placed subcutaneously. With the implanter needle positioned at a 90° angle (perpendicular) to the skin surface, pierce the skin. Once the skin is pierced, continue steady penetration into the muscle until the needle is inserted to the face of the depth limiter. After deposition of the transponder, withdraw the needle. Apply finger pressure to the implantation site for 30-60 seconds using antiseptic- and antimicrobial- saturated cotton.

- Confirm proper placement by reading the code with the scanner.

5.3.3 Ear tags
Ear tags are not recommended as they will be pulled out, most likely by biting from other individuals.
5.4 Routine Data Collection

A thorough routine data collection of each individual’s physical and behavioural patterns is pivotal in moving the husbandry of this species forward, creating better welfare. It enables an opportunity to share each individual zebra’s history to other institutions if necessary, creating a cooperative approach to data collection amongst institutions. In most large institutions ARKS (for general information on births, transfers, and deaths), SPARKS (breeding studbook for species) and MedARKS (veterinary information) are used. These systems have been developed by the International Species Information System (ISIS), which is part of the Conservation Breeding Specialist Group (CBSG) software. As these are standardized there is a high degree of efficiency in transferring information between these institutions.
6.0 Feeding Requirements

6.1 Captive Diet

The zebra is a non-selective, grazing non-ruminant. Non-selective grazers tend to consume between 1-3% of their body mass of dry matter daily. Diets provided to horses in captivity tend to contain approximately 12-13% protein. The plains zebra at TWPZ are fed a diet of 2 kg meadow hay (Ryegrass/ clover) per individual (1 biscuit each) daily. Grazing is also available on exhibit. Additional Lucerne hay is given at different times depending on available grazing and quality of meadow hay. (*TWPZ records*)

*Always monitor the amount of hay being eaten and the body condition of the zebra in your care. Too obese, decrease the diet and if too skinny, increase the diet.*

I have added the following as a guide to help monitor the Plains zebra condition.

Henneke Body Condition Scoring System (*website: Habitat for horses*)

**Including Diagram 9 and Table 3**

Don Henneke, PhD, developed the Henneke Body Condition Scoring System during his graduate study at Texas A & M University. It is based on both visual appraisal and palpable fat cover of the six major points of the horse that are most responsive to changes in body fat. The Henneke Chart is a standardized scoring system, whereas the terms, "skinny", "thin", "emaciated" or "fat" are all subjective terms that have different meanings to different people.

The Henneke Scoring System is a scientific method of evaluating a horse's body condition regardless of breed, body type, sex or age. It is now widely used by law enforcement agencies as an objective method of scoring a horse's body condition in horse cruelty cases. The Chart is accepted in a court of law.

Six parts of a horse are checked in this system—the neck, withers (where the neck ends and the back begins), shoulder, ribs, loin, and tailhead. When using the Henneke system, you should always make physical contact with these parts, and the kind of touch you use is important. Simply stroking the animal lightly won't provide an accurate idea of the horse's condition; you have to apply pressure to each part in turn.

The pressure you apply should be much like that of a massage; if you press a horse's side with your hand, you'll be able to feel the fat covering his ribs, and get an idea of how much fat is present. Likewise, when checking the withers, feel all around the area, as if you were squeezing firm clay. It is possible to be firm and gentle at the same time, and both traits are necessary to properly score a horse.
After pressing each part of the horse with your hands to feel for body fat. You then assign each area of the body the numerical score that corresponds with the horse's condition. When a horse has a long haircoat it is imperative that you use your hands to feel the horse. The horse's long haircoat will hide the protrusion of bones, all except in the most extreme cases. The scores from each area are then totaled and divided by 6. The resulting number is the horse's rating on the Henneke Body Scoring Condition Chart.

Conformational differences between horses may make certain criteria within each score difficult to apply to every animal. In these instances, those areas influenced by conformation should be discounted, but not ignored when determining the condition score.

Conformation also changes in pregnant mares as they approach parturition (birth). Since the weight of the conceptus tends to pull the skin and musculature tighter over the back and ribs, emphasis is placed upon fat deposition behind the shoulder, around the tailhead and along the neck and withers in these cases.

The Chart rates the horses on a scale of 1 to 9. A score of 1 is considered poor or emaciated with no body fat. A 9 is extremely fat or obese. Horse veterinarians consider a body score of between 4 and 7 as acceptable. A 5 is considered ideal.
<table>
<thead>
<tr>
<th>Condition</th>
<th>Neck</th>
<th>Withers</th>
<th>Shoulder</th>
<th>Ribs</th>
<th>Loin</th>
<th>Tailhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Poor</td>
<td>Bone structure easily noticeable</td>
<td>Bone structure easily noticeable</td>
<td>Bone structure easily noticeable</td>
<td>Ribs protruding prominently</td>
<td>Spinous processes projecting prominently</td>
<td>Tailhead, pinbones, and hook bones projecting prominently</td>
</tr>
<tr>
<td>2 Very Thin</td>
<td>Bone structure faintly discernible</td>
<td>Bone structure faintly discernible</td>
<td>Bone structure faintly discernible</td>
<td>Ribs prominent</td>
<td>Slight fat covering over base of spinous processes. Transverse processes of lumbar vertebrae feel rounded. Spinous processes are prominent</td>
<td>Tailhead prominent</td>
</tr>
<tr>
<td>3 Thin</td>
<td>Neck accentuated</td>
<td>Withers accentuated</td>
<td>Shoulder accentuated</td>
<td>Slight fat over ribs.</td>
<td>Fat buildup halfway on</td>
<td>Tailhead prominent but</td>
</tr>
<tr>
<td>4</td>
<td>Moderately Thin</td>
<td>Neck not obviously thin</td>
<td>Withers not obviously thin</td>
<td>Shoulder not obviously thin</td>
<td>Faint outline of ribs discernible</td>
<td>Negative crease (peaked appearance) along back</td>
</tr>
<tr>
<td>---</td>
<td>-----------------</td>
<td>------------------------</td>
<td>---------------------------</td>
<td>----------------------------</td>
<td>----------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Moderate (Ideal Weight)</td>
<td>Neck blends smoothly into body</td>
<td>Withers rounded over spinous processes</td>
<td>Shoulder blends smoothly into body</td>
<td>Ribs cannot be visually distinguished, but can be easily felt</td>
<td>Back is level</td>
</tr>
<tr>
<td>6</td>
<td>Moderately Fleshy</td>
<td>Fat beginning to be deposited</td>
<td>Fat beginning to be deposited</td>
<td>Fat beginning to be deposited</td>
<td>Fat over ribs feels spongy</td>
<td>May have a slight positive crease (a groove) down back</td>
</tr>
<tr>
<td>7</td>
<td>Fleshy</td>
<td>Fat deposited along neck</td>
<td>Fat deposited along withers</td>
<td>Fat deposited behind shoulder</td>
<td>Individual ribs can be felt with pressure, but noticeable fat filling between ribs</td>
<td>May have a positive crease down the back</td>
</tr>
<tr>
<td>8</td>
<td>Fat</td>
<td>Noticeable thickening of neck</td>
<td>Area along withers filled with fat</td>
<td>Area behind shoulder filled in flush with body</td>
<td>Difficult to feel ribs</td>
<td>Positive crease down the back</td>
</tr>
<tr>
<td>9</td>
<td>Bulging fat</td>
<td>Bulging fat</td>
<td>Bulging fat</td>
<td>Patchy fat</td>
<td>Obvious</td>
<td>Bulging fat</td>
</tr>
</tbody>
</table>
Zebra; Exhibit Group 1.3.1 at Taronga Western Plains Zoo get 2 kg meadow hay (Ryegrass/ clover) per individual (1 biscuit each) daily.
NOTE: Graze is available on exhibit.

Zebra; Savannah 1 Exhibit Group 1.3: at Taronga Western Plains Zoo get 2 kg meadow hay (Ryegrass/ clover) per individual (1 biscuit each) daily, but also manage to get access to Lucerne hay and chaff when fed out to other species on exhibit.
NOTE: Graze is available on exhibit.

Browse should be offered daily: Salt bush, kurrajong, casuarina and eucalypt are suitable. Clean water must be available to animals at all times.
(*TWPZ Division Manual*)

6.2 Supplements
SUPPLEMENTS: Calcium Access to Calcium Molasses Stock blocks at ALL times.
(*TWPZ Division Manual*)

6.3 Presentation of Food
The Plains zebra diet of hay and chaff must be presented in appropriate troughs for hygiene reasons. Browse can be placed around exhibit or night yards on clean ground, it may also be hung up around yards or exhibit as an enrichment item. There must be a sufficient number of troughs to give ‘all animals’ equal access to feed, if using single troughs for each individual they should be no less than 80cm apart. In situations where Plains zebra are housed in extremely large Open range paddocks the placement of food is less strict. If the exhibit is covered with grass the diet of hay may be thrown in piles on grassy patches of ground free from faeces around the exhibit. Food should never be placed on a sandy ground; this causes a high risk of ingesting sand while eating which causes Colic.

(*These are the standards we all must adhere to, they are the ‘General Standards for Exhibiting Animals in NSW’ (website: DPI NSW)*

**Part 8 - Nutrition and Hygiene**

**Clause 36 Diet**

1) Each animal must be offered a variety of wholesome and palatable food and water in quantities that are sufficient to provide for its good health and normal growth.

2) The diet must be prepared with consideration of the age, size, condition and previous history of the animals.

3) Nutritional advice from professional sources must be obtained in relation to the addition of food supplements to the ordinary balanced diet of animals.
4) Food must be unspoiled and free from chemical and bacterial contamination.

5) Food supplements must be appropriately handled and stored, and stocks appropriately rotated.

6) Care must be taken not to include food that is known to have deleterious effects to the animal.

Note
For example, improperly thawed fish can contain high levels of thiaminase, which can destroy dietary thiamine.

Clause 37 Food Quality

1) Food must be clean, fresh, wholesome, palatable and of a standard fit for consumption.

2) The food items' nutritional value must be sufficient to keep the animals healthy.

3) Food must be free of pests or disease.

4) The following must NOT be fed to animals:

   a) any animal that has died from any toxic material, including euthanasia chemicals (CO2 is acceptable), insecticides and rodenticides; or
   b) animals showing clinical signs of being infected by disease; or
   c) laboratory animals that have been used in those research programs that lead to the animals containing chemicals different from control animals; or
   d) a diet consisting solely of muscle or organ meats; or
   e) plant material that is toxic to the animals.

Clause 38 Food Preparation

1) The area in which food for the animals is prepared:

   a) must be indoors or completely screened; and

   b) must be constructed of materials that will withstand steam-cleaning and chemical disinfection. Walls must be non-porous and without cracks or crevices.

2) All chemical and bacterial contamination must be avoided when preparing food.

3) Thawing and preparation of the food must be done so that it retains its nutritive and wholesome qualities.

4) A toxic chemical or other harmful material must not be used or stored in the area used for preparing the food.

5) Toxic chemicals or other harmful materials must not be allowed to contaminate food provided to animals.

6) Subclause (4) does not apply to cleaning products or disinfectants used in cleaning the
area, the food containers or the food preparation utensils.

7) All foods must be fed to the animals within 24 hours of removal from freezers for thawing, or properly discarded. Discarded food must not be kept in fresh food storage areas.

8) The thawed product must be kept iced or refrigerated until just before feeding.

Clause 39 Cleanliness Relating to Food and Drink

1) High standards of cleanliness must be observed:

a) by staff engaged in the preparation of food and drink for the animals; and

b) in relation to the utensils and equipment used, and adequate equipment must be provided to enable this to be done.

2) Utensils and equipment used in preparing and distributing the food and drink must be cleaned after use and kept clean when not in use.

3) Food preparation areas must be washed down daily and treated with appropriate non-toxic cleaning products.

4) Boots, aprons and brooms used in the food preparation area must be cleaned after use and kept clean when not in use.

5) Utensils and other equipment used in preparing the food and drink must not be used for any other purpose.

Clause 40 Food Storage

1) Supplies of food for the animals must be stored in enclosures in which they are adequately protected against deterioration, mould, contamination and pests.

2) Toxic substances, live animals, unrefrigerated dead animals and discarded foodstuffs must not be kept in a food storage area.

3) Stocks of food supplements must be handled, stored and rotated in a way that minimises nutritional loss.

4) Frozen food must be stored at a temperature that is not higher than 18 degrees below zero Celsius.

5) No non-food cadavers must be placed in food storage areas.

Note

Food should be protected from rodent access, as many species of mammals such as primates, elephants and tree kangaroos, are susceptible to diseases such as Encephalomyocarditis (EMC) virus (a virus which causes heart failure and is spread in the urine of feral rodents).

Clause 41 Food Presentation

1) Utensils and equipment used for the offering of food and drink to animals:
a) must not be used for any other purpose;

b) must be easy to clean and designed to avoid risk of injury to the animals;

c) must, when in an enclosure, be placed in such a position that each animal in the enclosure has easy access to sufficient food and water and the risk of contamination from soiling by the animals is minimised. The exception is where food is being used to entice animals into a catching cage, nest box or night area;

d) must be kept in a sanitary condition and, except in the case of a self-feeder, must be washed daily following use; and

e) in the case of a self-feeder, must be inspected daily to ensure that it is working effectively and does not contain caked or unwholesome food.

2) Food items must be presented on an uncontaminated surface that is covered and not exposed to weather. Exception: Carcass feeding and enrichment feeds can be provided in areas that are not covered.

3) Where appropriate to encourage animal activity, at least some food must be scattered across substrate or included in wood chips, hay, paper, feeding puzzles or other suitable material or presented amongst the climbing structures for arboreal animals.

4) Activity feeds must not promote weight gain or dietary imbalances.

5) Only food supplied by the exhibitor may be fed to animals and visitors must be discouraged from feeding any food to animals except food supplied by the exhibitor.

6) The provision of live vertebrate animals as food is not permitted. With the approval of the Director-General an exhibitor may be exempt from this requirement for up to six months in relation to wild caught predatorial animals that are being fed live captive-raised fish or live captive-raised tadpoles while being trained to eat dead food items. This period may be extended if the Director-General considers it to be essential to the maintenance of the species.

Clause 42 Drinking Water

1) Clean potable water must at all times be available for the animals to drink.

2) Animals must be provided with sufficient fresh drinking water daily to meet each animal’s requirements and must:

a) be either reticulated to, or changed daily in, each enclosure; and

b) not be allowed to become stagnant.
7. Handling and Transport

* CAUTION: Plains zebra are capable of critically or fatally injuring a person by biting with their razor sharp teeth or kicking with their hooves. They are instinctually a wild animal and know how to fight if they are cornered, stressed or want to assert their authority. So always maintain extreme caution when working with Plains zebra.

7.1 Timing of capture and Handling

The best time to capture Plains zebra is first thing in the morning or last thing in the afternoon depending on the purpose of capture. Cool mornings are good if you need to do something in house with the individual like a routine general anesthesia. Late afternoons are considered better if you need to move the animal over long distances by vehicle. This avoids the warmer temperatures and congestive traffic, minimizing travel time and stress on the animal.

7.2 Catching bags

Catching bags are not useful with Plains zebra unless they are used to throw over the eyes like a towel to cause less stress on the animal.

7.3 Capture Techniques

7.3.1 Chemical sedation

Perphenazine and Haloperidol are long term acting sedatives; they work efficiently in keeping stress levels down during transportation and avoiding injuries. Always plan when to administrate these drugs in preparation for transport because they need 24 to 36 hrs to take effect. This will help the stress levels throughout the whole transportation ordeal from moving into a transport container, traveling in modes of transport and then being released into the zebra’s new location. The amounts should always be administered by a trained veterinarian. The amounts of Perphenazine suggested by Flugger M, Jurcynskiv K (2005) are as follows; 0.56mg > 1.3mg of Perphenazine/kgBW for young zebra and 0.68mg > 0.83mg of Perphenazine/kgBW for adult zebra.

7.3.2 Float Training

- One simple yet time consuming way to capture the animal is to float train it. The idea being the animal is less stressed and not drug affected. This is ideal for short trips. However the training will take some time especially depending on the animal.

  The first step is to condition the zebra to be calm around people, by feeding it through a fence. Once the zebra begins is happy distancing itself from the zebra group the next step is to get the zebra used to the float. First allow the zebra to just get used to its presence by leaving the float in the enclosure and then slowly progress by opening the float and trailing hay and browse up inside the float. The zebra then needs to be conditioned to stay in there while there are people moving around outside making noise and finally having
the door closed. Always remember to keep a record of your conditioning, take small steps and be patient. It can be time consuming but it helps if you don’t want to chemically restrain the zebra whenever it needs to be moved.

7.3.3 Rounding up into float or Container
If there is no time for conditioning rounding up is one of your next options apart from anesthesia. Remember this can be dangerous and stressful for all involved and if care is not taken injuries can happen.
At TWPZ we rounded up several przewalski horses for an internal movement to another enclosure. I recommend the following process also for Plains zebra:

STEP 1:
- Construct temporary fencing to build two small holding pens, and then a funnel down to a raceway that leads up to the loading ramp into the TWPZ new specialized animal transport vehicle. A suitable loading ramp is a race 760 mm to 790 mm wide, rails 1.60 m high and a head clearance of at least 2.75 m. The ramp needs to be 4.60 m long. It rises from ground level to a height of 1.15 m. A tailboard is fitted on the outlet to bridge the gap between ramp and truck. The ramp can run off an extension of the race or from its own separate forcing yard. Ideally as well if you have gates all the way down the raceway this will help in shutting the zebra closer and closer down to the vehicle. (We were able to do this at the end of a long wide raceway that connected onto the exhibit the P.Horse were residing ready for movement).

STEP 2:
A team meeting is law before the round up; make sure everyone is aware of their job; the risks involved and when too cease rounding up if the zebra get too stressed. If the zebra are covered in sweat and you have missed the first few tries to round up and the morning
is warming up I would suggest calling it a day and trying again tomorrow. Everyone must communicate efficiently for this to work.

STEP 3: There are a few options to try and move the zebra into the race way:

(i) Place the morning feed in the raceway and wait, if they venture in on their own accord close them in the raceway. This is great if it works.

(ii) I find at first to move the line of keepers towards the zebra and towards the direction of the raceway and if the zebra move towards the raceway back off (everyone must pay attention to someone’s lead). As soon as the zebra start walking away from the raceway put the pressure on again, firm but slow and when they move again towards the raceway pressure off. Keep repeating this until you have them in the raceway and close them in, if they get by you by running around and behind chase the zebra back towards the raceway. As soon as the zebra start to move back towards the raceway pressure off again. The idea is too make the raceway a good place for the zebra to be and the rest of the enclosure not so nice. Decide on parameters, where it is the worst for the zebra to be so clap and yell in this area, if it’s a fairly bad area maybe just clap and then an ok area just walk towards zebra. When the zebra are in the perfect area and moving in the right direction, I’ll repeat again, back off as the zebra walk towards the raceway and give them space.

(iii) You may just put hard pressure on the zebra. This can or can not work. When everything runs well like a well oiled machine its great but if it doesn’t it can stress the zebra a lot quicker and you only get a few chances before the zebras are too stressed and you may have to call it a day.

These 3 rounding up routines can all work, it is just a matter of experience, the available time you are given for movements and finding what works best for the safety and welfare of yourself and the zebra in your care.

STEP 4:
Someone should be manning the door into the container in the case you are lucky enough to have a zebra run straight down the raceway and onto the truck. When the zebra are in the raceway you may try any of the above 3 options to lure them further down and onto the truck. Closing the gates and holding yards behind them getting closer to the truck. Extreme caution is advisable if you need to be in the raceway while herding the zebra down, make sure you have an appropriate escape route or a gate to hide behind if they run back up the raceway.

STEP 5:
Close the zebra in the container and lock securely, this container has a divider so the decision to take either 2 zebra at a time, each in a separate chamber or a few in one chamber is your choice. I think a short trip within the institution a few zebra in the one room should be ok but anything is possible. Longer trips outside the institution’s grounds I would move the zebra singularly in each room.
STEP 6:
Monitor the zebra throughout the trip. (A surveillance camera fitted in container).

7.4 Weighing and Examination

Training and Conditioning
Plains zebra can be trained or conditioned to walk into a race and over a large set of scales with much persistence. This is less stressful on the animal in the long run and can help in providing regular information on the animal’s weight. Visual examination can occur whilst animals are in a race or holding yard.

Plains zebra can be weighed whilst under the effects of an anesthetic on a stretcher. It is not recommended that an animal be anaesthetized for the sole purposes of weighing, this is just an option whilst the animal is undergoing another procedure. Weighing while under anesthesia is only possible if you have the equipment to do so, for example a foal might be ok but a fully grown adult is around 300kgs. Whilst a Plains zebra is under anaesthetic it is possible to do a thorough physical examination of the animal including bloods and x-rays.

* Here are some websites I highly recommend researching, when it comes to training and conditioning zebra. This will help in transporting, veterinary examinations and personal interaction with the zebra in your care.

3. (Riding a zebra) http://www.youtube.com/watch?v=Ph8Vag9VxRU
7.5 Release

**Float or container release**
When a plains zebra is traveling by float or container the best way to release the individual into the new yard is as follows:

- Back the float or container up the gates ensuring there are no gaps for it to escape back through the gates.
- Make sure everyone is out of sight when released.
- Zebras are known to charge out when released straight into fencing and fatally injuring themselves, so as a precaution it is advised to put up visual barriers on fences.
- It is recommended if an enclosure the zebra is being released into is very large a temporary fence with visual barriers should be erected not too far away from transport container prior to release to stop the zebra from bolting out and reaching high speeds when released and seeing as the individual is unfamiliar with its new surroundings may again fatally injure itself.
- Ensure there are no obstacles if possible in new enclosure until settled
- When opening the float allow the individual to exit into the enclosure in its own time.
- If the zebra has to exit off the back of a truck here is a suggestion for the offloading ramp. Widening the ramp to make it another 1.80 m to 2.40 m wide will allow an easier and not so cramped position for unloading. For example, the zebra can be unloaded without the restriction of a race.
- If possible give the zebra a chance to recover from sedation and settle into its new surroundings before doing any testing in country of import. It is difficult and the zebra will need time to rest.

**Chemical release**
Plains zebra when recovering from being under chemical influence should be positioned in its yard or enclosure depending on where the procedure took place in an open space with no hazards. The yard/enclosure should be cleaned of all unnecessary debris or equipment and all staff except the vet and/or vet nurse should leave. Upon being given the reversal to the drug ALL staff should leave the yard/enclosure and monitor the animal from outside. These procedures of course are ultimately up to the veterinary staff of the institution.

7.6 Transport Requirements

**Domestic Transport**
Horse floats can be used for travel such as the one below. Conditioning is essential when transporting this way and the timing and release principles still apply. Sedation may be needed depending on the stage of conditioning or demeanor of each individual zebra. It is still recommended to travel one animal at a time however if training has taken place and it is a short distance 2 animals can be considered especially mother and foal.
International Transport

IATA (The Air Transport Association) regulations state that the height and width of the container must allow the animal to stand erect with its head extended. The size of the container must sufficiently restrict movement so that the animal cannot turn around and in doing so trap or injure itself (zebras have died this way), nor have the space to kick and damage the container. Usually allow the width of the box for each zebra just exactly as their body width, maybe few cm more. The box should be dark; the zebra should not be allowed to see through the ventilation holes. You can solve the problem of ventilation by putting plenty of holes that is out of their eye level -one third from the height of the box and in the level above the head plus we put the slats on the roof, and then cover all with burlap. This will make the box comfortable for traveling.

: 7.6.1 Box Design

A roof of a transport box for zebra should be padded as a precaution and never be low enough for a zebra to jump and hit their head. Containers in the past have been too low and zebra have jumped and broken their neck and died. (Pers. Com. John Davis 2010)

Diagram 10:
This is the box design from IATA
Box height – 2.4m
Box length – 3.2m
Box width – 1.4m
Frame must be made of a minimum of 2.5sm solid wood or metal parts bolted or screwed together. Because the animal exceeds a weight of 60kg additional metal framing must be present around the whole container.

Sides suitable plywood or similar material must closely line the frame to a level slightly above the animal's eye over which there must be a louvered or slatted area for ventilation extending to the roof. The interior must be completely smooth.

Floor the base must be solid and leak proof, there must be either pegboard or slats bolted to the solid base for a firm foothold. A droppings tray must be provided under the pegboard or slats to prevent the excreta escaping.

Roof must be slatted.

Doors hinged or sliding entry and exit doors must be provided, they must be fastened in such a way that they cannot be accidentally opened. They must have similar ventilation opening as on the sides.

Ventilation louvers or slots, with 2.5sm spacing between the louvers/slats or holes, with a minimum diameter of 2.5cm, must be present above eye level on all four sides and the roof of close boarded containers. Slots and holes must be covered with a fin wire mesh that will not allow any part of the animal, including horns, to protrude.

Spacer bars/Handles must be made to a depth of 2.5sm and formed from the framework of the container.

7.6.2 Furnishings

Feed/Water containers must be provided with outside access from a hinged bolted flap that must be large enough for the entry of a large water dish and/or quantities of appropriate food such as grass hay, roots etc.

It is recommended that absorbable material is placed underneath container such as wood shavings to prevent spillage of excreta.
7.6.3 Water and Food
Food should be provided as the normal ration before being placed in the container. It is advisable that access to water be restricted no less than 2 hours before loading into the container.
Animals do not normally require additional feeding or watering during 24 hours following time of dispatch.
If feeding is required during transport or due to an unforeseen delay food must be provided through feed and water containers in transport box.

* Plenty of water is suggested to be kept up to the zebra while transporting, water is to be kept in rubber bowls so the zebra don’t hurt themselves.

7.6.4 Animals per box
There must be only 1 Plains zebra per box when transporting long distances. If there are a mother and foal it is recommended that unweaned animals are not transported. Zebras must only be transported once separated from the mother and able to travel on their own.

At TWPZ we have successfully transported several Przewalski horses from one side of the zoo to another side in a specialized transport vehicle and container. The container is large and monitored by a surveillance video inside the container to ensure the safety of the occupants during transportation. If the distance was any longer the horses would not be housed together.

7.6.5 Timing of transport
Late afternoons are considered better if you need to move the animal over long distances by vehicle. This avoids the warmer temperatures and congestive traffic, minimizing travel time and stress on the animal. If the transport involves a vehicle and then transferred onto a plane, some organization is necessary so the zebra is not contained for a long period of time at the airport or contained longer than necessary for the overall trip. Consideration on the climate where the zebra is from and traveling too is important to minimize stress, for example you don’t want to move an individual from a hot climate to a freezing climate. The zebra has enough to acclimatize to. If you can organize to transport when the temperatures from both locations are similar, this would be ideal.

7.6.6 Release from the box
Release should happen as soon as possible once the animal has reached its destination. The box should be placed at the opening of the holding yard with no gaps around and opened to allow the animal to exit in its own time. Gates should be closed and the box removed once the animal has settled into the yard. There should be no clutter in the yard only necessary furnishings such as food and water trough and shelter whilst releasing the animal from the box.
8.0 Health Requirements

8.1 Daily Health Checks

Each individual Zebra should be visually examined daily to ensure quick response to illness or injury. The most appropriate and achievable time to do this is during the early morning feed out;

Particularly on large or free range savannah exhibits, major feed lots of hay and chaff can be put out. If the animals do not respond initially, bread can be used to entice them closer. This process usually results in the animals moving quickly which allows the keeper to assess movement and herd behaviour. Once the animals are feeding the keeper is able to approach closely for a more thorough individual assessment. During the assessments of both herd behaviour and movement and the individual animal condition, key health factors should be observed, these can include:

- All limbs appear to be moving freely, with no evidence of lameness or uneven weight distribution while standing or moving.
- Feeding well, able to chew horse cubes well and have no compaction or growth areas in their jowls.
- General appearance is good; body condition – the ribs and hips should not be visible. Coat – the coat should be smooth and have a good lustre
- Eyes full open and clear
- Discharges – there should be no nasal, ocular or rectal or vaginal discharge.
- Behaviour should be normal with no signs of unusual aggression or depression
- Faecal matter should be checked for its consistency and free from blood— it should be formed and round, loose or sloppy faeces and the presence of blood should be noted.

8.2 Detailed Physical Examination

Detailed physical examination is most effective and safest when the animal is sedated and examined by a veterinarian.

8.2.1 Sedation and Anaesthesia

Consistent daily gun conditioning is a highly useful and easy preparation tool for chemical sedation; when doing feed out carry a mock gun to acclimatise the zebra(s) to the presence of a gun. If not personally firearms licensed, closer to sedation procedures, bring a firearms licensed staff member into the equation for a week during feed out to acclimatize the zebra to the multiple personnel. If they are highly conditioned to the
presence of a gun and are able to be approached closely, a blow dart sedation technique may be possible.

**Chemical sedation:**

The agent of choice for chemical immobilisation is the potent opiate etorphine. Eorphine at 2.45 mg/ml in combination with acepromazine 10 mg/ml is available. Eorphine is also available as a mono substance at 4.9 mg/ml and 9.8 mg/ml. For prolonged procedures, intubation and inhalation anaesthesia with isoflurane or halothane is recommended. Walzer (2003) recommends the following anaesthetic protocols for Plains Zebra:

**Table 4:** (C. Walzer 2003)

<table>
<thead>
<tr>
<th>Species</th>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Antagonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plains Zebra</td>
<td>0.0085-0.01 mg/kg etorphine</td>
<td>0.035-0.04 mg/kg ACP</td>
<td>0.045 mg/kg diprenorphine IV</td>
</tr>
<tr>
<td>(E. Burchelli)</td>
<td>5.5 – 8.3 mg/kg TZ</td>
<td>0.06-0.08 mg/kg detomidine</td>
<td></td>
</tr>
</tbody>
</table>

**Vital signs under anaesthetic:**

- Ensure zebra doesn’t overheat by keeping temperature under 39°C
- Respiratory rate must remain between 4 to 12 breaths per minute
- Heart rate must remain between 40 and 90 beats per minute
- Ensure mucous membrane colour is pink and when pressed has a capillary refill of within 2 seconds. (Per. Com. Ben Bryant 2010)

**8.2.2 Physical Examination procedure**

Once the animal is chemically sedated the following physical and chemical assessments can be performed:

- Faecal float looking for worms
- Good general dental health – to ensure teeth are not overgrown & do not have sharp edges (if teeth are not in good condition the mouth can be held open with the tongue restrained and a file used to removed sharp edges)
- Body condition
- Hoof condition – check for foot overgrowth and possible club feet
- Eye condition
- Body Temperature
- Look inside ears for general muck and colour
- Rectal exam
- Pregnancy test if female may be in foal
- Blood glucose levels
- Urine glucose
- Enzymes which reveal liver function
- Protein levels indicate well being
- BUN which indicates kidney function

The following are selected reference ranges for serum biochemical and haematologic parameters that should be examined during detailed physical exams.

**Table 5: (C.Walzer 2003)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Common Zebra Mean Standard Deviation</th>
<th>Parameter</th>
<th>Common Zebra Mean Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Selected reference ranges for serum biochemical parameters based on ISIS 2002</strong></td>
<td></td>
<td><strong>Selected reference ranges for haematologic parameters based on ISIS 2002</strong></td>
<td></td>
</tr>
<tr>
<td>Total Protein (g/dl)</td>
<td>6.3 ± 0.8</td>
<td>Glucose (mg/dl)</td>
<td>158.4 ± 46.8</td>
</tr>
<tr>
<td>Globulin (g/dl)</td>
<td>3.7 ± 0.7</td>
<td>Cholesterol (mg/dl)</td>
<td>139.21 ± 54.14</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>2.3 ± 0.28</td>
<td>Triglyceride (mg/dl)</td>
<td>70.8 ± 79.65</td>
</tr>
<tr>
<td>Fibrinogen (g/L)</td>
<td>250 ± 150</td>
<td>CK (U/L)</td>
<td>309 ± 303</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>10.8 ± 0.8</td>
<td>LDH (U/L)</td>
<td>604 ± 463</td>
</tr>
<tr>
<td>Phosphorus (mg/dl)</td>
<td>5.3 ± 1.6</td>
<td>AP (U/L)</td>
<td>272 ± 440</td>
</tr>
<tr>
<td>Sodium (mEq/l)</td>
<td>137 ± 4</td>
<td>ALT (U/L)</td>
<td>15 ± 12</td>
</tr>
<tr>
<td>Potassium (mEq/l)</td>
<td>4.1 ± 0.6</td>
<td>AST (U/L)</td>
<td>303 ± 125</td>
</tr>
<tr>
<td>Chloride (mEq/l)</td>
<td>99 ± 4</td>
<td>GGT (U/L)</td>
<td>48 ± 35</td>
</tr>
<tr>
<td>Iron (mg/dl)</td>
<td>189 ± 77</td>
<td>Amylase (U/L)</td>
<td>9.9 ± 10.9</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.84 ± 0.48</td>
<td>Lipase (U/L)</td>
<td>4.4 ± 3.6</td>
</tr>
<tr>
<td>Blood Urea N (mg/dl)</td>
<td>17.14 ± 5.90</td>
<td>Total T-3 (ng/dl)</td>
<td>-</td>
</tr>
<tr>
<td>Total Bilirubin (mg/dl)</td>
<td>0.58 ± 0.41</td>
<td>Total T-4 (ng/dl)</td>
<td>13.21 ± 0.78</td>
</tr>
<tr>
<td>Erythrocytes (x10⁶/μL)</td>
<td>10.5 ± 2.3</td>
<td>Lymphocytes (x10⁹/μL)</td>
<td>2.9 ± 1.7</td>
</tr>
<tr>
<td>Haemoglobin (g/μL)</td>
<td>14.6 ± 2.2</td>
<td>Monocytes (x10⁹/μL)</td>
<td>0.3 ± 0.2</td>
</tr>
<tr>
<td>Haematocrit (%)</td>
<td>42 ± 6</td>
<td>Eosinophils (x10⁹/μL)</td>
<td>0.12 ± 0.1</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>41.3 ± 7</td>
<td>Basophils (x10⁹/μL)</td>
<td>0.05 ± 0.09</td>
</tr>
<tr>
<td>MCH (gl)</td>
<td>14.4 ± 3</td>
<td>Neutrophilic bands (x10⁹/μL)</td>
<td>0.13 ± 0.16</td>
</tr>
<tr>
<td>MCHC (g/μL)</td>
<td>34.6 ± 3.8</td>
<td>Platelet count (x10⁹/μL)</td>
<td>0.22 ± 0.08</td>
</tr>
<tr>
<td>Leukocytes</td>
<td>8.8 ± 2.7</td>
<td>Nucleated RBCs</td>
<td>2 ± 9</td>
</tr>
</tbody>
</table>
8.3 Routine Treatments

Key things to keep on top off and continually monitor are:

- Presence of worms. This can be determined by routine faecal floats and dealt with using equiban or similar product as prescribed by veterinarian. Treatment is always followed up by another faecal float in 2 weeks.
- Tetanus vaccinations should be administered annually.
- Equine Flu Vaccination should be administered if animals are held in a country with this disease.

8.4 Known Health Problems

(C. Walzer 2003)

Institutions should be aware that internationally common zebra have been documented to suffer from, carry or be potentially susceptible to the following ailments, however, these ailments have not been recorded within Australia:

Table 6: (C. Walzer 2003)

<table>
<thead>
<tr>
<th>Bacterial Diseases</th>
<th>Viral Diseases</th>
<th>Fungal Diseases</th>
<th>Endoparasitic Diseases</th>
<th>Ectoparasitic Diseases</th>
<th>Non Infectious Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinobacillus equuli</td>
<td>African Horse Sickness (carrier)</td>
<td>None</td>
<td>'Sarcocystosis (endoparasite)</td>
<td>Mange</td>
<td>Equine degenerative myeloencephalopathy</td>
</tr>
<tr>
<td>Anthrax</td>
<td>Equine encephalitis</td>
<td>Trypanosomiasis (endoparasite)</td>
<td>Gadfly larvae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listeriosis (Pasteurella multocida)</td>
<td>Equine Infectious anemia</td>
<td>Besnoitiosis (endoparasite)</td>
<td>Various ticks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colitis-X</td>
<td>Equine viral arteritis</td>
<td>Toxoplasmosis (endoparasite)</td>
<td>Equine piroplasmosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dourine</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mal-de-Caderas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nagana</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Habronema spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Filarial parasites</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lungworms (Dictyocaulus spp.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tapeworms
(Anoplocephala spp.)

In Australia, a number of common health problems within plains zebra should be monitored and managed. These include colic, cyathostomes, .

8.4.1 Colic

Colic is defined as the presence of abdominal pain. It is a non-specific, overarching term that includes a range of causes, symptoms and treatments.

Causes:

Most zebra colic is caused by some form of gastrointestinal dysfunction, however dysfunction of the heart, musculoskeletal system or urogenital tract can also result in colic. Some of the more common causes of colic are:

- stomach ulcers,
- distension,
- tumours,
- and impactions

Colic can occur in many abdominal regions. Locations and typical colic causes include:

**Small intestine**
- Impactions,
- Enteritis (inflammation of the intestinal tract),
- displacements,
- torsions (twists),
- ileus (lack of gut motility),
- infarctions (obstruction of blood supply to the intestine),
- obstructions,
- and intussusception (one section of the intestine telescopes inside another part and becomes entrapped).

**Cecum**
- Perforations,
- torsions,
- intussusceptions,
- infarctions,
- and impactions.

**Large intestine**
- Gas distension,
- impactions,
- enteroliths (formation of “stones”),
- torsions,
- displacements,
- obstructions,
Some of the more common factors believed to contribute to colic include:
- inadequate water intake;
- consumption of poor-quality feeds
- abrupt changes in diet (e.g., over-consumption of high energy feeds);
- pica (consuming non-food items);
- ingesting sand;
- exposure to (and consumption of) toxins, poisons, or moulds;
- and stress secondary to changes in housing or daily routine/exercise or transportation.
- Zebras with a history of colic are more at risk for future episodes.

**Signs:**
Some typical signs or indicators of colic include:
- Lying down more than normal or getting up and lying down repeatedly;
- Standing stretched out or urinating frequently;
- Sweating, anxiety, trembling;
- Flank watching;
- Inappetite and depression;
- Pawing the ground;
- Decreased faecal output or diarrhea;
- Kicking or biting the abdomen;
- Curling the upper lip repeatedly;
- And rolling or thrashing.

**Diagnosis:**
Diagnosis of colic usually requires an awareness of the usual behaviours and temperament of the zebra as well as ongoing daily observations. If colic symptoms are observed the following examinations should be done:
- Consideration of the signs and history of this and previous colic episodes of this individual and others in the same herd.
- A veterinarian should perform a detailed physical examination of the anaesthetised zebra (as above) to:
  - investigate heart and respiratory rates,
  - assess hydration
  - assess blood flow (perfusion)
  - listen to the abdomen to determine if the gut sounds are increased, decreased, or absent.
  - A tube might be passed through the zebra’s nose to the stomach to determine the presence/absence of reflux. It is important to ensure that fluid from the small intestines is not “backing up” into the stomach, causing distension, pain, or rupture. If a large volume of reflux is present, you might elect to fasten the nasogastric tube to the halter to allow for repeated refluxing (rather than repeatedly passing the tube).
rectal examination to feel for impactions, displacements, or gaseous distensions.
- Ultrasound the region of concern if necessary

**Treatment:**
Pain medications and sedatives are commonly used to treat colic symptoms. Intravenous fluids or oral fluids and/or a laxative (e.g., mineral oil) are often included in the routine management of colic. In general, zebra that don’t respond to one or two doses of analgesics or sedatives or have other signs indicative of severe disease typically require advanced diagnostics and treatment and will likely need surgical or more indepth medical treatment.

**Surgical Treatment:**
Surgery can be used to relieve pain, correct fluid and electrolyte imbalances, identify and repair the cause of colic (e.g., untwisting a section of bowel, removing a section of dead intestine, etc), and stimulate and maintain intestinal movement. Despite successful surgery, post-operative complications—such as incisional infections and swelling, laminitis, scar tissue formation, and ileus (lack of gut motility) are important causes of morbidity and mortality.

**Medical management:**
Zebras treated non-surgically can be treated by:
- holding off food and water
- routinely administering analgesics
- Given fluids to restore and maintain appropriate hydration and electrolyte levels.
- Given additional medications (depending on the underlying cause) it may include antispasmodics, laxatives, and pro-motility agents.

**Prevention:**
Ways to minimise colic incidents include:
- maintaining a regular exercise program,
- ensuring free access to water,
- keeping a consistent feeding schedule,
- controlling internal parasites.
- Institute any changes in diet or routine slowly, and avoid changing more than one factor at a time.

**8.4.2 Club foot**

**Cause:**
A club foot is the result of a problem in that limb. The primary problem is a deep digital flexor contraction syndrome originating in the deep digital flexor muscle located between the elbow and the back of the knee. This muscle tapers into a long tendon that attaches to the bottom of the coffin bone. When the muscle fibres contract more often than they should, the result is a shorter-than-normal length of
musculotendinous unit and a constant upward pull on the coffin bone and internal structures of the heel. The upright, boxy hoof capsule shape is a product of the unrelenting pull of the abnormal muscle contraction.

**Signs:**
Club foot can be identified by the overgrowth of hooves and the eventuation of lameness. Tell tale signs of club foot development include:
- Uneven weight distribution or lameness.
- Awkward mobility while galloping.
- Overgrown or disproportionate growth of individual hooves (compared to the other hooves of that individual)

**Diagnosis:**
Club foot can develop through a number of grades of severity from grades 1 through to 4 and visual observations of the hoof structure can be used to diagnose the onset and severity based on these grades.

**Diagram 11:**

Grade 1--The hoof angle is three to five degrees greater than the opposing foot and a characteristic fullness is present at the coronary band due to partial luxations (partial dislocation) of P2 and P3 (the second phalanx bone and coffin bone).

Grade 2--The hoof angle is five to eight degrees greater than the opposing foot with growth rings wider at the heel than at the toe. The heel will not touch the ground when trimmed to normal length. (Redden noted that Grade 1 and 2 club foot characteristics can appear very quickly, and that abscesses usually occur between grades 2 and 3.)

Grade 3--The anterior hoof wall is dished and growth rings at the heel are twice as wide as on the toe. Radiographically, P3 exhibits demineralization and lipping along the apex.

Grade 4--The anterior hoof wall is heavily dished and the angle is 80 degrees or more. The coronary band is as high at the heel as at the toe and the sole is below the ground surface of the wall.
Treatment:
Early diagnosis is the key for treatment of club foot. Early treatment can be a hoof trim by an experienced Farrier. If diagnosis and or treatment is delayed surgery or therapy on the may be required.

Prevention:
- Regular hoof trims if required
- Careful and regular observations leading to early detection.
- Regular and adequate exercise
- In some enclosures it may be appropriate to have a concrete slab at feed areas, in raceways or in a regular walkway to induce hoof wear.
- Some organisations have used granite slabs on slopes or in one instance a fake termite mound used simultaneously as enrichment and hoof wear.

(website: the horse. Article by R.F. Redden, DVM May 01 2008)

8.4.3 Endoparasitic Worms:

8.4.3.1 Roundworm (Parascaris equorum)
The roundworm is an ascarid. It is a rigid, heavy-bodied worm up to 50cm long.

Cause:
The swallowed ova hatch in the intestine, and the larvae penetrate the wall of the intestine, and are carried to the liver and lungs. They then follow a pattern of tracheal migration. Larvae that have been coughed up and swallowed mature in the small intestine. The eggs can remain viable in the environment for long periods of time.

Signs:
In heavy infections, adult worms can cause obstruction of the intestines which can occasionally lead to perforation. Damage is more widespread in foals, which have low resistance and may quickly accumulate massive worm burdens. Large numbers of larvae breaking into the lungs cause haemorrhage. Acute parascariasis is also accompanied by severe enteritis, which is characterized by alternating constipation and foul-smelling diarrhea. Infected foals become debilitated and lethargic and lose weight. Lung damage in foals can cause “summer colds,” with coughing, fever, anorexia, and pneumonia from secondary infections. Mature zebras rarely show clinical signs, as previous infections confer good resistance.

Diagnosis:
Identification of round, pitted, thick-walled eggs in faeces is diagnostic.

Treatment:
- Ivermectin; in the past, some veterinarians believed that this was not effective in controlling ascarid infections. However, clinical data have since proved this perception to be incorrect.
- Panacur
- Marantal
Prevention:
As well as regular medical dewormers, a number of husbandry procedures can be practiced to minimise occurrences of roundworm. These can include:
- picking up faeces (that can contain parasite eggs) from paddocks on a regular basis
- Rotating enclosures and feeding zebra away from potentially contaminated areas or using feeders to avoid feeding on the ground.
- Organisations that manage manure by composting need to ensure that the manure “cooks” at sufficient temperatures and for adequate times to avoid spreading parasite-ridden compost onto enclosures.
- All Staff should maintain high hygienic standards and minimise cross contamination and spread by their person and equipment.

(website: equine_vteq)

8.4.3.2 Blood Worm (*Strongylus vulgaris*)

*Strongylus vulgaris* is one of the most dangerous equid parasites and is found in temperate regions of the world. It is a nematode (round worm) intestinal parasite and infects a range of equid species, including zebra. *S. vulgaris* is also known as blood worm, red worm, palisade worm, or just a *large strongylus*. Infestation with *S. vulgaris* is serious, and often fatal. While adult worms can cause significant blood loss in the intestine, it is the larvae that do the most serious damage. Migrating in the arteries, primarily the anterior mesenteric artery, larvae damage blood vessel walls causing inflammation and increasing the risk of blood clots and aneurisms (weak bulging vessel walls that can burst). Clots breaking away into the bloodstream can result in blockage of the artery.

Cause:
The life cycle of *S. vulgaris* depends on zebra grazing where droppings from infected zebra contaminate the grass. Infective larvae present on vegetation in the pasture are swallowed by grazing. Worms mature in the intestine after six to eight weeks where they suck blood and produce eggs that are passed in the zebra’s droppings. Eggs deposited outside in warm moist conditions soon hatch. Larvae develop to the infective stage in one to two weeks.

Signs:
Symptoms of *S. vulgaris* infection include:
- Fever
- Loss of appetite
- Weight loss
- Abdominal discomfort
- Constipation
- Depression
- Anemia

Diagnosis:
Faecal flotations and identification of eggs in faecal deposits.
Treatment:
Antiparasitic drugs can be used to cure *S. vulgaris* infestations eg.:
- Ivermectin
- Panacur
- Marantel
However some drugs are only effective against adult worms.

Prevention:
Early stages of larvae in the pasture—before they reach the infective stage—are quite susceptible to drying; therefore, a spell of hot dry weather, and breaking up of zebra droppings, can greatly reduce the numbers of larvae. In addition to this the same preventative measures as for *Parascaris equorum* (as above) can be used.

(Website: suite 101)

8.4.3.3 Equine Intestinal Threadworm (Strongyloides westeri)

Cause:
*Strongyloides westeri* are a hair-like threadworm, 8-9mm long that infect the small intestine of equid species. Embryonated eggs are passed in faeces. Once on pasture, the eggs hatch quickly and moult to the infective stage in 24 to 48 hours; these infect animals by skin penetration or ingestion. *Strongyloides westeri* may also be passed as larvae in colostrum and nursing is one of the most important means of transmission of threadworm infections to young foals.

Signs:
Migration of larval *Strongyloides* through the lungs can cause severe hemorrhage and respiratory distress. Skin penetration may result in irritation and dermatitis. If adult worms are numerous, erosion of the intestinal mucosa causes sloughing and interference with digestion. Foals with heavy worm burdens suffer from:
- acute diarrhea,
- weakness,
- and emaciation.
Older animals may harbor large worm burdens without clinical manifestations.

Diagnosis:
Eggs and larvae can be identified in fresh faecal samples by faecal flotation.

Treatment & Prevention:
Treatment and prevention are the same as for other endoparasitic infections such as *Strongylus vulgaris* and *Parascaris equorum*as outlined above.

8.4.3.4 Cyathostomes

Cause:
Small strongyles (cyathostomes): These are common and cause direct damage to the gut wall. The immature stages can encyst in the wall of the intestine for 1-2 months, and when they are released in spring result in clinical symptoms.
Signs:
Cyathostomes can cause Colic and diarrhoea

Diagnosis:
Faecal float and identification.

Treatment & Prevention:
Treatment and prevention are the same as for other endoparasitic infections such as *Strongylus vulgaris* and *Parascaris equorum* outlined above. However, resistance to anthelmintics in these worms is becoming a serious problem.

8.4.4 Tetanus

Cause:
Tetanus, or lockjaw, is an often fatal disease caused by the bacterium, *Clostridium tetani*. The spores of *C. tetani* are commonly present in the soil and can contaminate puncture wounds, crushing wounds, open lacerations, surgical incisions, and the umbilici of foals. Zebra of all ages can be affected.

Signs:
Upon gaining entrance to the body spores produce a powerful neurotoxin that blocks neurotransmission, resulting in unopposed muscle contraction and spasm (tetany). Horses often adopt a "saw horse" posture.
- Muscle rigidity
- Tetanic cramping
- Anxiety
- Anorexia
- A prolapsed third eyelid

Diagnosis:
Recognition of symptoms and blood analysis.

Treatment:
Prevention is the key to managing tetanus and few treatment options are available. Zebras suffering from tetanus can be administered with 200,000-250,000 IU quid tetanus antitoxin in combination with 30 Mio IU procaine-penicillin but it is difficult and offers a very poor prognosis.

Prevention:
Vaccination and correct wound management should adequately prevent tetanus infection. Formalin-inactivated, adjuvanted toxoids are readily available and often combined with other vaccines. Preventative vaccination with a toxoid vaccine with yearly boosters is suggested to ensure active immunity. In surgical procedures and wound management the use of tetanus antitoxin in non-vaccinated individuals is recommended to provide short lived, immediate, passive protection however such passive immunity only lasts 2-3 weeks.
8.4.5 Neurologic EHV-1

Cause:
Neurologic EHV-1 refers to the Equine herpesvirus-1 (EHV-1) that causes many problems in equids, including abortion, respiratory disease, neurologic disease, death in newborn foals, and a newly recognized syndrome described as peracute pulmonary vasculitis of adult horses (which strikes adult horses in their lungs and kills them almost overnight).

Signs:
The first clinical signs of EHV-1 infection might be a
- watery nasal discharge,
- mild fever,
- sometimes a cough. There might be
- petechiations (pinpoint hemorrhages) on mucous membranes.
- Some zebra develop edema (fluid swelling) in the limbs or abdomen.
- After several days the nasal discharge becomes thicker, sometimes making a “crusty” patch on the zebra’s nose. If secondary bacterial infections set in, the discharge might become yellowish.

Neurologic signs are caused when the virus reaches the lymph nodes and spreads through the circulatory system causing damage to blood vessels results in death of neurons from a lack of oxygen. The most common neurological signs of EHV-1 include:
- hind limb weakness and incoordination (ataxia), which can progress to recumbency (inability to rise). Ataxia in the hindquarters can lead to paralysis, with the zebra going down and remaining recumbent for up to three weeks. The prognosis for non-recumbent horses is favourable, but the prognosis is poor for animals that remain recumbent longer than two days. The paralysis usually is symmetrical (occurring on both sides).
- poor tail tone
- urinary leakage due to partial or complete bladder paralysis
- poor anal tone (with faecal incontinence or inability to pass faeces).

Diagnosis & Treatment:
Knowledge around the diagnosis and treatment of this disease is limited. Currently, it takes weeks to conduct testing that identifies the mutated neurologic strain; however, the Gluck Equine Research Center is working on the development of a one-day assay for detecting neurologic EHV-1—a 24-hour turnaround test.

Research is being conducted to develop understanding and it is likely that vaccinations will become available in the future so that management of the disease resembles that of the management of tetanus in zebra.

Prevention:
There are currently no agreed precautionary measures for stopping the infection of EHV-1 beyond adequate quarantine procedures. Prevention measures will develop as research progresses and more is known about the nature of the virus.

8.5 Quarantine Requirements
Implementing appropriate quarantine practice is the most effective technique for preventing the introduction of any disease agent. The consequence of not following quarantine procedures is the risk of spreading any number of potential disease agents to other individual animals and people that would not usually come into contact with the infected animal or area and also risk spreading a new disease onto our native land. Also with reference to the Quarantine Act 1908, if you do not employ quarantine procedures when needed, you may suffer a maximum penalty of 2 years imprisonment.

When acquisitioning a new animal it is advisable to quarantine it before placing it in with others. With regard to the quarantine of Plains Zebras, the following criteria should be met:

- The animal(s) should be in general good health before it is sent.
- The animal(s) should undergo a minimum 30 day quarantine period.
- During quarantine a range of detailed physical examinations should be conducted to include the following, as required:
  - The individual should be positively identified and can be marked for identification, if required.
  - Routine blood samples should be taken for common disease diagnostics and to establish baseline haematological and biochemical values (see tables above) particular attention should be given to ruling out the presence of Equine herpes virus (EHV1).
  - 3 consecutive negative faecal floats, to test for endoparasites, should be taken at weekly intervals.
  - The animal(s) should be in good general condition.
- If any animal dies during post-arrival quarantine, AQIS must be promptly notified and the animal must be autopsied by a veterinarian to determine cause of death, AQIS must then be notified of any disease incident and it outcome.
- Quarantine may be extended in the case of any adverse events until such events are investigated and resolved and no evidence of transmission of infectious agents exists within the quarantine group.
- At the satisfactory completion of post-arrival quarantine the animals must meet state DEH requirements, and must only be released within appropriate premises that are approved by State or Territory governments for the holding of perissodactyls.

Even if the animal has been cleared of all health issues by previous holding facility it is important that it be retested as part of the incoming institution’s quarantine, as the animal could have been exposed to disease during transport.
9. Behaviour

9.1 Activity

The daily activity pattern of a Plains zebra relies entirely on the nature of the surrounding habitat, the grazing and weather conditions. They spend the best part of their daylight hours grazing, occasional dust baths, rubbing, drinking and short rest periods at any time of the day. Plains zebra have bedding grounds in the wild and on a fine day from sunrise can travel up to 17 kms as a group to grasslands and upon reaching the pastures spread out independently grazing. Movements to water are often coordinated at intervals during the day, they are the most water dependent animal on the plains. When afternoon arrives and grazing is over they make the long haul back to the shorter grass of their bedding grounds, this is the time with full bellies and energy to spare the social activity is at its highest. The bachelor males enjoy running and play fighting in preparation to adulthood. Upon reaching the bedding grounds all zebra will lie down and sleep with one who will remain standing and keep watch. On poor weather days the zebra group may leave later in the morning, not travel as far and return early. These wild activity behaviours show the need for large enclosures for the holding of the plains zebra in captivity. At TWPZ our plains zebra on the Savannah exhibit move around the entire enclosure exhibiting these behaviours. (Estes. R 1991)

9.2 Social Behaviour

Plains zebra are predominately non-territorial and are mostly found in nomadic herds, 1-male harems or bachelor herds of 2-15 males usually under 5 years old. Within these herds they display a range of social behaviours including:

(Estes. R 1991)

Social grooming:

Social grooming is a common behaviour amongst plains zebra herds. Displays of social grooming usually occur between two familiar individuals who simultaneously scrape and nibble each others neck shoulders and back using the incisors and lips. All members of the herd will groom each other, however, it is most commonly seen between mothers and foals as well as siblings. How often they groom other individuals reflects their personality preferences. Social grooming is used to strengthen social bonds, it usually occurs between individuals of unequal rank as it is mostly initiated by the lower ranking individual.

(Estes. R 1991)

Standing in pairs:

Pairs of familiar zebra will often stand head to tail or looking over each other’s shoulder. This allows them to see in any direction as well as swish flies away from each other’s faces.

(Estes. R 1991)

Greeting / Challenge Rituals:

When meeting for the first time or after a separation, individuals will perform a ritual that involves nasal contact, chewing movements and sniffing (Diagram 12 & 13), followed by cheek rubbing then moving alongside and touching and sniffing the genitalia. The ritual
usually continues into pressing or rubbing shoulders and involves a lot of dominance and aggressive behaviour. Overall the ritual is more challenging than friendly and is usually performed by herd or territorial stallions or playful bachelors. However, it does not usually involve extended threat displays or fighting. For example, a herd stallion may come out to meet a potential rival with his head outstretched and ears cocked and if the rival is of equal status the above ritual will occur. If the rival is of lower status such as a bachelor male, they would assume a submissive posture and the ritual would stop at nasal contact.

The challenge ritual often serves as a test of fitness and strength. If a fit stallion engages an injured, sick or very old stallion with a harem in the challenge ritual and determines that he is ripe for replacement he will then shadow the herd and gradually take control usually pushing the original stallion out without a fight. However, it may then take weeks for the mares to accept the new stallion. (Estes. R 1991)

**Diagram 12**: (Estes. R 1991)

**Diagram 13**: (Estes. R 1991)

**Dominance / Threat displays:**
Dominance behaviour can include a range of threat displays including: an erect posture with head high and ears pricked, high-stepping gait, arched tail, teeth bared with ears back, biting threats and advances, kicking threats, stamping, tail lashing, squealing, rearing and the above challenge ritual. (Estes. R 1991)

**Defensive / submissive displays:**
Submission in Plains Zebra is usually communicated by a lowered neck, extended tail, ears back and chewing with lips retracted. Defensive behaviours usually include kicking with the hind feet, grooming initiative and assuming the above submissive posture. (Estes. R 1991)
Fighting:
Fighting is most common between territorial stallions, it mostly involves biting and wrestling. Flailing with the front feet and kicking is only seen occasionally. Biting is usually aimed at getting a hold of the ears, mane or legs and then with jaw clenched grinding in. During a fighting display individuals may be seen jostling and neck wrestling and may even drop to their knees and circle each other trying to get a knee hold. (Diagram 14)

Anti-predator behaviour:
Plains zebra are usually alert with their heads high and their ears pricked. If disturbed they will make an alarm call and the group will run away in a tight group with any young, injured or weak individuals protected in the centre. The group will adjust their running speed to suit the weak individuals and the stallion will guard the rear and attack any pursuing predators. The stallion will then actively search for any missing members of the herd.

Communication:
Plains zebra are quite a communicative species, they communicate with a range of sight, smell and sound. Visual communication plays an important role in social queues, facial expressions, body posture, ear position, lip mobility, display of teeth and tail movement are all important signals used throughout all social interactions.

Vocal communication is also important and plains zebra use a combination of about six different vocalisations. These include, 2 alarm calls (a loud snort and a quiet gasp), a short squeal if bitten and a drawn out call if captured or injured, a barking contact call and blowing with loose lips as a sign of contentment.

Olfactory communication is used particularly by the stallion, they will sniff during the greeting/challenge ritual, will mark their property with dung middens and will regularly urine check the females.

(Estes. R 1991)

**Parental Behaviour**

From the moment they can walk, foals follow their mothers at her heel. The mother will keep all other individuals away until the foal has imprinted on her smell, stripe pattern and voice. Foals will then stay with the natal herd until adolescence when the bachelor males will leave of their own accord to find a bachelor herd and fillies will stay until abducted by another stallion.

(Estes. R 1991)

### 9.3 Reproductive Behaviour

**Securing a mate**

The Plains zebra forms stable harems where a fit and healthy stallion’s ownership of the harem is hardly ever disputed and if it is, the harem itself remains intact under the new ownership.

To find a harem, a stallion must abduct a filly from her herd and fend off other rival males for up to 12 months whenever she comes into heat (for up to 5 days once a month). Once she has conceived, she will remain in the harem of the stallion that impregnates her. Competition during this time from rival stallions means that it is usually unlikely that the stallion who originally abducted her will be the one who impregnates her. Mares already in the harem can show aggression and hostility toward the new filly for several weeks after her arrival.

(Estes. R 1991)

**Signs of oestrus and mating rituals**

The urine of a female in oestrus is a milky colour, she will urinate more regularly and the hormones contained in the urine will arouse a stallion’s sexual interest 3–4 days before the female becomes receptive. Courtship involves the stallion following the mare sniffing her vulva, nipping and muzzle rubbing her neck, back and croup. She will often discourage these attempts by kicking him in the chest and running away.

The stallion will either urinate or defecate on top of the mare’s defecations and urination (after urine testing).
When the mare is in full oestrus she will assume a full oestrus display with her mouth gaping open, hind legs spread and tail raised and she may back towards the stallion when he mounts (Diagram 15). Ejaculation follows shortly after and is marked by tail flagging and the male will move off and start to graze. This is repeated at 1-3 hourly intervals for about one day.

**Diagram 15: (Estes. R 1991)**

Higher ranking females sometimes react with aggression toward the mare following mating and may even drive her out of the herd.

(Estes. R 1991)

### 9.4 Bathing

Dust bathing and rubbing on trees, rocks and termite mounds are routinely used in Plains zebra bathing rituals. Social grooming is also used for grooming purposes as well as social bonding.

(Estes. R 1991)

### 9.5 Behavioural Problems

Zebra are a restless and flighty animal. They require a lot of consistent conditioning work to make it easier to work with these animals. If the time is put in, this can be a rewarding process. Just remember to start small and reward positive or good behaviour.

Behavioural problems surrounding this species can include:

- Dominant stallions stealing mares from a new brooding stallion (not a problem if housed in harem groups or bachelor groups)
- Brood mares without fouls stealing their inexperienced daughters foals
- Stallions killing foals born to family groups whose own stallion has been removed

### 9.6 Signs of Stress

The major signs of stress in Plains Zebra that should be monitored and addressed include:

- alarm calls
- pacing fence line
- loss of body condition
- extended exclusion from herd or social grooming activities
- lethargy and/or slow reactions can be a result of boredom or over stimulation and should also be avoided and addressed.
9.7 Behavioural Enrichment
Plains zebra are easily enriched. Things such as horse balls, browse placed around the exhibit, fruit and vegetable scatters, scent smears, faecal piles from other zebra or other African animals placed around exhibit and conditioning sessions are all great ways to enrich the life of a captive zebra. It is best if one of these things can be done daily and also mix up the times to keep the mind active and change the day in day out routine of a captive animal.

9.8 Introductions and Removals
When introducing Plains zebra, beginning with fence contact is optional but a safe one. When using fence contact as a soft introduction, the individual zebra will have time to get to know other zebra before joining the group. This prevents the possibility of injury during the introduction process. It is a good idea to allow fence contact for about a week and then depending if all individual Plains zebra involved continue to show signs of aggression towards each other, do not introduce until only positive signs are appearing. Introductions in large open exhibits are always recommended if possible, so that they have space to sort out their issues. Introductions at Taronga Western Plains Zoo have all been successful without using fence contact first, as long as zebra groups are maintained with only bachelor groups and harem groups. Plains zebra groups should not be housed within earshot or smelling distance of other equids. Removals from the group usually involve separating an animal which can sometimes be opportunistic or other times be conditioned.

9.9 Intraspecific Compatibility
Good social compatibility and few problems as long as the composition of captive herds are kept in similar arrangements to wild social structures, that is either one stallion harems or bachelor male groups. If captive bachelor male groups are kept it is important that they are not housed near any sensory input from any female zebra or other female equids.

9.10 Interspecific Compatibility
Plains zebra are a passive and social species and are frequently kept as a mixed species display animal. Taronga Western Plains successfully houses Plains Zebra in a mixed exhibit with Giraffe, Dwarf forest buffalo and Eland and with close proximity contact with a hippo.

9.11 Suitability to Captivity
Plains Zebra can be held successfully in captivity so long as provided with the right environment. There needs to be a lot of space to have a large open enclosure and suitable access to shelter, shade, food and water. Holding areas or Night yards need to be accessible. This species is not suitable for a small city zoo. It is better suited to a large open range zoo.
10 Breeding

10.1 Mating System
Plains zebra are highly social animals, but they do congregate in two very distinct groups. The first group of the plains zebra society is the ‘harem’ a Polygnous relationship that is the core of their breeding system. It consists of one fit stallion and one to six adult females. The harem may also include their male and female offspring of ages two to three years.

The second group consists of young bachelor males looking for a chance to take over a harem or start a new one. The bachelor herds also consist of the overthrown stallions who are not fit enough to protect their harem or ward off any young up and comers. These groups are known to reach numbers of around fifty in the wild.

10.2 Ease of Breeding
Plains zebra breed well in captivity. There have been 146 births recorded in Australasia over the past twenty-five years until 2007 and more up to 2010. Breeding can be easily accomplished as long as the introductions are approached with the correct strategies. For example the best breeding scenario in captive institutions is to hold ‘harem’ groups, as mentioned in 10.1 which is 1 male and a group of females. Suggestions would be to have larger enclosures for more females. It is also essential to have another enclosure that is non adjacent for bachelor groups or other available institutions for the excess or unwanted genders. (website: Zoo and Aquarium Association)

10.3 Breeding Condition
It is recommended that Plains zebra be in peak condition prior to breeding. Good quality feed should be used and if necessary the quantity could be slightly increased.

The following are the suggested peak breeding ages:
- The male Plains zebra is 5 to 23 yrs
- The female Plains zebra is 3 to 18 yrs

Although these are the suggested peak breeding ages, it is a concern that a lot of captive institutions are leaving breeding some individuals too long. If you want to breed a mare that is 10 yrs old, she may be in the middle of her peak breeding condition, but if she has never bred before, you just may run the risk of her becoming barren and never being capable of breeding. I suggest breeding is started young and not left too long between conceptions otherwise you may run the risk of losing a very genetically viable mare. This may also be a concern for males also.

(website: Zoo and Aquarium Association)

10.4 Techniques Used to Control Breeding
The best method of controlling breeding is to separate the male from the female group. If the zebra is not suitable for breeding, the male can be castrated but this is irreversible and not recommended unless necessary. Entire males can be held in bachelor groups.
### 10.5 Occurrence of Hybrids

Plains zebra belong to the equidae family. They are able to breed with any member of the equidae family. Strict breeding and housing plans must be maintained in all captive institutions to ensure the genetic viability of captive populations in years to come. All zebra hybrids are classed under the generic name of Zebroid. The different hybrids are generally named using the portmanteau convention of sire's name + dam's name. No distinction is made between the different zebra species when naming Zebroids. Potentially when zebras are cross-bred they tend to develop some form of dwarfism.

Examples of different types of Zebroids are:
- Zebra (stallion) + horse (mare): zorse, zebra mule, zebrule or golden zebra
- Zebra (stallion) + pony (mare): zony
- Zebra (stallion) + Shetland pony (mare): zetland
- Zebra (stallion) + any ass species (jenny): zebrass
- Zebra (stallion) + donkey (jenny): zedonk, zeedonk, zonkey, zebroney, zebradonk
- Zebra (mare) + donkey (jack): zebret, zebrinny
- Zebra (mare) + horse (stallion): hebra, horbra

(website: Wikipedia)

### 10.6 Timing of Breeding

In the wild or captive institutions breeding is not strictly seasonal. It can occur all year round, but the birth and mating peak usually coincides with the rainy season due to the nutritional factors that coincide with this time. In the case of captive institutions where nutrition is monitored and maintained, breeding can be all year round. At Taronga Western Plains Zoo we like our breeding and birthing season to coincide with Spring, September to November. This can be monitored and if breeding and birthing does occur naturally like this in captivity we are able to house our breeding male with the females as a natural harem indefinitely, as long as numbers are needed. If breeding does not coincide with the Spring months, the male will have to be removed and re-introduced during the Spring period.

(Pers. Com. Pascale Benoit 2010)

### 10.7 Age at First Breeding and Last Breeding

The age of first possible conception of a female is:
- 2yrs as stated in the ARAZPA 2007 Captive Management Plan for Plains Zebra
- 16 to 22 months stated ‘Smuts 1976a’
- 13 to 15 months stated ‘Klingel 1969’

(Hack et al. 2002)

The age of last possible conception of a female is:
- 26 yrs as stated in the ARAZPA 2007 Captive Management Plan for Plains Zebra

The age of first possible conception from a male is:
- 21 months as stated in the ARAZPA 2007 Captive Management Plan for Plains Zebra
The age of last possible conception from a male is:
- 25 yrs as stated in the ARAZPA 2007 Captive Management Plan for Plains Zebra
(website: Zoos and Aquarium Association)

10.8 Ability to Breed Every Year
It is possible for the Plains zebra to breed annually. The ability is totally reliant on the condition of the individual, availability of a nutritional diet and the individual’s age or amount of times bred before.

10.9 Ability to Breed More than Once Per Year
The Plains zebra’s 12 month gestation rules out any possibility of breeding more than once every year.

10.10 Nesting Requirements
A mare and foal should be provided with a shelter in the enclosure with 3 walls and a roof to protect from the rain and wind. During the winter months, institutions holding zebra in conditions colder than their usual climate, should provide a heated shelter and a pile of rice hulls to lie in.

10.11 Breeding Diet
It is recommended that Plains zebra be in peak condition prior to breeding. Good quality feed should be used and if necessary the quantity could be slightly increased. At Taronga Western Plains Zoo we like to feed varying amounts of Lucerne and Meadow hay. Access to larger pastured enclosures is always recommended.

10.12 Oestrus Cycle and Gestation Period
- The oestrus phase is 2 to 9 days and the Ovulatory cycle is 19 to 33 days for the Plains zebra. ‘Wackernagel 1965’
- The gestation period of a Plains zebra is 12 months ‘Wackernagel 1965’
- There is 8 to 10 days between Latency and foal heat in Plains zebra. ‘Wackernagel 1965’
(Hack et al. 2002)

10.13 Litter Size
A Plains zebra mare is able to have one foal per year if in peak condition. It is advisable to monitor brood mares without foals because there have been cases where they have stolen foals from their inexperienced daughters. A new stallion should not be introduced to a ‘harem’ from a former stallion with young foals. The foals that are not his own, he may kill.

10.14 Age at Weaning
The young foal should suckle from their mother for up to a year. During this year the foal will be gradually eating grass more and more as the year goes on and after about a year will be totally weaned off milk and grazing grass.
10.15 Age of Removal from Parents
The young should be removed when they start to reach sexual maturity: The females around 16 to 22 months and the males at around 24 months. Aggression is not an issue but the young females usually wander off with a new male before there is an opportunity for conception by her father, which would happen in captivity if not removed. This is also similar with the young males, although again aggression is not an issue but inbreeding is, so removal is suggested to maintain a high variation in genetics.

10.16 Growth and Development
Once the foal is born it is able to extricate itself unassisted, it can climb to its feet in around 11 minutes, it can walk in around 19 minutes, and walk with confidence in about 32 minutes and then amazingly canter after 44 minutes. The mother should then be happily nursing the foal around 67 minutes.

Some important stages of the growth and development from neonatal to adult stage are:
- The growth of the vertebral column, excluding the tail, can increase by 59% within the first two years of life. By the time adulthood is reached at 5 years, the vertebral column will have doubled in length.
- The growth of shoulder height can increase by 48.1% within the first two years of life. The contrast in growth between these two dimensions is important and helpful to remember as being normal when monitoring a foal. This is due to a number of noted concerns of Plains zebra foals being disproportionately tall at the shoulder between birth and adulthood. This is just the growth that eventually builds the balance between vertical and horizontal dimensions in adulthood.

Diagram 16: The growth and development of the Plains zebra: (Kodoe, 1975)
Fig. 4. Curves depicting growth with age phenomena for eight selected body dimensions routinely collected from zebra. In all cases data for stallions and mares were pooled and means calculated. The circles indicate means for each age class. The figures in brackets give approximate age at which the mean dimension for adults is attained and the sample size. All curves were fitted by eye. (y = years; m = months).
11. Artificial Rearing:

11.1 Housing
Orphaned zebra foals are best housed in an enclosed shelter for the first 2-3 weeks and care should be taken to avoid exposure to cold or wet weather ensuring the foal stays warm and dry. Clean low dust straw or hay bedding is soft and easy to turn and clean. An overhead heater that the foal cannot reach can also be provided if necessary.

Room should be provided for the foal to move around and practice using its legs. The foal should be allowed a minimum of 2 hours outside in the sun each day in an
appropriately fenced yard such as a post and rail yard with chain mesh or covered plain wire. Outside yards should be well drained and sheltered from high winds.

11.2 Temperature Requirements
The body temperature of a healthy foal should be 37°C. It is important that the foal be kept sheltered, dry and warm particularly for the first 2-3 weeks.

11.3 Diet
Orphaned zebra foals can be reared using a foster mother. Another zebra mare can be used if available, otherwise a Draught Horse or a Warmblood mare are appropriate because of their “quiet, maternal nature and higher milk production”.

Whether the foal is hand reared or foster mothered, if a foal is orphaned very soon after birth it is important that it receives an adequate amount of colostrum. Blood tests should be taken 12 and 24 hours after birth to ensure that adequate colostrum has been up taken and absorbed.

Hand reared zebra foals can be fed with one of a number of commercially available horse milk replacers. There are 3 types of formula for raising equids: Biolac, Di-Vetelact and Wombaroo. You should choose which formula you are going to use and stick to it unless you are having problems with the formula and need to change.

Contacts for Milk Formulas in Australia

**Biolac**
PO Box 93
BONNYRIGG NSW 2177
Phone / Fax: (02) 9823 9874

**Sharpe Laboratories** Di-Vetelact
Animal Health Division
12 Hope Street
ERMINGTON NSW 2115
Phone: (02) 9858 5622
Fax: (02) 9858 5957

**Wombaroo Food Products**
8 Oborn Road
MT BARKER SA 5251
Phone (08) 8391 1713
Website: [www.wombaroo.com.au](http://www.wombaroo.com.au)

Feeding the foal with fresh cows milk based replacements can lead to digestive upset, such as colic or diarrhoea, as cows milk contains more fat and less sugar and calcium than mare’s milk. Foals should be bottle fed for the first 5-7 days, although most foals can begin to be taught to drink from a bucket from 2-3 days old.
Supplementary concentrate feeds and or “starter” pellets can be fed to the foal from 7-10 days old. 16-18% crude protein starter feeds are available and suitable as pellets, meal or crushed sweet feed.

Most foals will start to supplementary graze at 2-3 weeks of age on either fresh pasture or dampened lucerne chaff or hay.

**Temperature of food**
For the first 2-3 drinks the milk should be fed at 37°C, this can be gradually lowered to the ambient temperature of 20-23°C after the first 1-2 days. Do not feed refrigerated milk without warming. To heat the milk put the required amount into a bottle and sit the bottle in a jug with hot water gently swirl the bottle every few minutes to ensure the milk is heated evenly and there are no hot spots. Once suitable temperature has been reached feed the foal immediately to prevent cooling of the bottle. It may help if the foal is still learning to drink to have the jug of warm water there when feeding so you can keep the milk warm.

**Methods used to feed**
Milk formula should be made up fresh prior to each feed. For bottle feeds a commercial baby’s bottle or a lamb’s teat can be used. The hole in the teat should be large enough that a drip of milk collects and hangs when the bottle is held upside down. When feeding hold the bottle at a height where the foal’s nose is lower than its forehead while drinking to avoid aspiration problems. If a foal refuses to drink dip a finger in warm milk and then move it against the foal’s palate and tongue to initiate the sucking reflex, once the foal starts to suck introduce the teat or a shallow dish of milk.

When moving the foal from a bottle to bucket feed it is best if the foal has not been fed for 4-6 hours prior, as it is more likely to try drinking from the dish or bucket if it is hungry. Again, use a finger dipped in warm milk to simulate drinking and initiate the sucking response. Once the foal is sucking, lift the dish of milk up so the foal’s mouth (but not nostrils) is in the milk. It may initially take several attempts. Start this process using a shallow dish. Once the foal learns to drink from the dish replace with a light coloured plastic bucket 30cm in diameter, approximately 20-25cm deep and secured at a height of about 60cm (just below the foal’s chest height). Avoid dark coloured buckets as foals will be reluctant to put their head into a dark space. Also provide a bucket of clean, fresh water next to the milk.

Devise a schedule and stick to it. Routine is extremely important, begin with one person feeding and introduce others as soon as possible to prevent the zebra imprinting on one person

**Frequency and Amount of Feed**
Foals require up to 20 litres of liquid a day. Foals require feeding between 5 and 10 times daily. So divide evenly what the foals total daily intake should be with the number of feeds you are going to offer and this gives you the amount required at each feed.
Always **weigh** the young immediately and continue to monitor weight every 2\textsuperscript{nd} day until satisfied it is consistently gaining then once a week is enough. Studies indicate that an orphaned foal can drink from 15-20% of its body weight in litres of milk each day without digestive upset, however, always monitor and adjust the diet for the individual foal based on the foal’s demands and their digestive efficiency.

The following table from *Growing Horses* outlines the frequency, amounts and methods for the diets of hand reared horse foals. The same guidelines can be used for hand rearing zebra foals.

<table>
<thead>
<tr>
<th>Age</th>
<th>Volume/Day</th>
<th>Suggested Feeding Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3 days</td>
<td>First 3-3 days feed by bottle or stomach tube (1st week)</td>
<td>Feed every 3 hours on days 1-3 (8 feeds) Ensure foal has passed meconium and is bright and alert.</td>
</tr>
<tr>
<td>3-7 days</td>
<td>Change to bucket feeding</td>
<td>Feed every 4 hours 6.00 am-10.00 pm (5 feeds) (A 2.00 am feed may be given to a weak or dehydrated foal).</td>
</tr>
<tr>
<td>7-14 days</td>
<td>Bucket feeding. Provide 1 kg of 16-18% crude protein mix or pellets in a shallow dish near feeding bucket for the foal to nibble between milk feeds</td>
<td>Feed every 4 hours 6.00 am-10.00 pm (5 feeds). If diarrhoea or colic results from milk overload, reduce to 50% volume for 2 feeds, gradually reinstate volume over 24-36 hours. Check dehydration level by skin pinch test before each feed.</td>
</tr>
<tr>
<td>14-21 days</td>
<td>Provide 1.5 kg of 16-18% crude protein concentrate mix for free choice consumption each day</td>
<td>Feed every 6 hours 6.00 am-10.00 pm (4 feeds) See comments regarding diarrhoea and colic above.</td>
</tr>
<tr>
<td>21 days-6 weeks</td>
<td>Provide free choice 16-18% crude protein concentrate mix and access to grazing if available each day</td>
<td>Provide milk in bucket 3 times daily (6.00 am, 2.00 pm, 10.00 pm) Discard leftovers before refilling bucket.</td>
</tr>
<tr>
<td>8 weeks to weaning</td>
<td>As above for free choice feed and grazing</td>
<td>Provide milk in bucket twice daily during cool weather, three times daily under warm conditions.</td>
</tr>
</tbody>
</table>

### 11.4 Specific Requirements

It is advised not to transport young foals until they are weaned, strong on their feet and able to travel on their own. Then the same transport requirements and considerations of adult zebras should be used for foals.

### 11.5 Identification methods

The same consideration for the identification of adult zebras should be used for zebra foals.
11.6 Hygiene and Special Precautions
Cleanliness of feeding equipment is important to avoid gastric upsets, bowel infection and diarrhea. Always use clean sanitised bottles and wash dishes and buckets in warm water with detergent then rinse with boiled water to sanitise. Bottles should be sanitised using an approved solution such as Milton. Also ensure any feeding regimes are stuck to and that any dietary changes are made gradually over a 5-7 day period.

Monitor the faecal output of the foal. A newborn foal should pass its first dung within 203 hours after drinking. For the first 10-14 days foals should pass droppings 2-3 times per day, after starting to eat solids this should increase to up to 5 times per day. Diarrhea can have serious consequences such as dehydration, debilitations, depress and exhaustion in a young foal. Care should be taken to ensure this is prevented and or treated. Increases in fibrous feeds (such as green grass), milk overload or intestinal threadworm are all possible causes of diarrhea in young foals. Foals can be first wormed at 4-6 weeks old with a paste formula.

It is also important that foals no receive too much energy in their diets as this can lead to overgrowth and pre-dispose the foal to Developmental Orthopaedic Disease (DOD) and future limb unsoundness problems.

11.7 Behavioural Considerations
It is important for an orphan foal to be provided with companionship to prevent fretting, imprinting and demanding behaviour. Another foal of a similar age is best; however a small calf, old ewe or quite lambs may also be suitable. A quiet trained pony is also good for the zebra foal to bond with and learn from the pony how to respect their human provider.

A hand reared foal should also, ideally, be weaned with a group of other weanlings at approximately 4 months of age as soon as it is grazing and growing well. This will allow normal psychological development that might otherwise be hard to teach without the demonstration of its mother’s discipline. It will also teach the foal heard position.

I recommend a great article by Nancy Nunke ‘Bottle Feeding Zebra Babies. A Definite No – No’ it explains the dangers of allowing a zebra to imprint on you as its mother. It covers how a young foal when it reaches maturity will vie for dominance over its mother and if you have been imprinted as its mother it will always vie for dominance over you and see all other humans as its herd and vie for dominance over them. This is a very dangerous situation if you would like to work closely with the zebra; Nancy suggests a bottle reared zebra will always be a potential fatal danger to humans. So think twice before bottle rearing.(website: Spots and Stripes)

Imprinting yourself a human as its mother and without seeing any other zebra relates to humans as its herd also creates many complications if you want to introduce the zebra back to a zebra group. The zebra will most likely never be part of the group and in many situations be subjected to aggression from the group.
11.8 Use of foster species
A mare does not fully imprint on her foal until about 3 days old. If the mare and foal are to be separated, doing so at about 6 hours old will minimise fretting while still allow colostrum uptake.

As mentioned above, an orphaned zebra foal can be reared using a foster mother. Another zebra mare can be used if available, otherwise a Draught Horse or a Warmblood mare may be appropriate.

11.9 Weaning
Foals can be offered solids from 2 weeks of age. These include hay and chaff. Some fruits and vegetables can be offered also with veterinary approval. Generally as the foal begins to eat more solids the amount of milk intake will drop. However you can start weaning from 3 months up to 6 months of age. After 2 months a foal will not get sufficient energy and protein from milk alone and the diet should be supplemented with fresh pasture grazing, hay, chaff, some fruit and vegetables or concentrate feeds. It is a good idea to start providing browse for the foal to eat from about 5 weeks of age. This will help with the weaning process. Once you have begun this process the foal’s weight and condition must be monitored closely. Below are two graphs showing the growth weights, diet contributions and weight gain for a horse with a mature weight of 500kg. A zebra’s mature weight is around 320kgs but the graphs below can also be used as a guide for zebra foals.

![Figure 3.2: Foal growth to weaning.](image)

![Figure 3.3: Weight gain for a growing horse with a mature weight of 500 kg](image)
12.0 Acknowledgements

Thanks to the Taronga Western Plains Zoo Life Sciences and Veterinary Dept
Thanks to Kira Husher for giving me assistance in this Husbandry Manual.
Thanks to Supervisor Pascale Benoit for comments 2010 and help with collecting information.
Thanks to Senior Keeper John Davis for comments 2010, teaching of temporary fence building and rounding up techniques.
Thanks to Keeper Addy Watson who taught me a rounding up technique taught to her by Senior Keeper Scott Smith.
Thanks to Senior Veterinarian Ben Bryant for comments 2010.
Thanks to Taronga Western pains Zoo for use of photos. (Taken by Shallon McCreadie)
13. References

13.1 Books and Scientific Papers

   G.L. Smuts
   Division of Nature Conservation
   Private Bag X404
   Skukuza
   1350.

13.2 Websites and websites for accessing Scientific Papers

3. (http://www.waza.org/virtualzoo/factsheet.php?id=118-001-001-005&view=Equids
4. www.threeringranch.org/articles/swava_zebra_feet.pdf
6. http://www.awf.org/content/wildlife/detail/zebra

General Standards for Exhibiting Animals in New South Wales: Exhibited Animals Protection Act

R.F. Redden, DVM  
May 01 2008, Article # 11882

2008 IUCN Red List of Threatened Species: Equus quagga.

Plains Zebra  
*Equus burchellii* Lorraine Jolly  
Melbourne Zoological Gardens

- Program Outline
- Annual Report & Recommendations 2010
- Captive Management Plan

Strongylus vulgaris – Bloodworm: A Dangerous Global Intestinal Parasite of Horses.  
Oct 19, 2007 Rosemary Drisdelle

Horse roundworm *Parascaris equorum*

Nancy Nunke ‘Bottle Feeding Zebra Babies. A Definite No – No’2005

13.3 Other

- 1. Hand Rearing procedure manual by Janet Gamble for Taronga Western Plains Zoo
14.0 Appendix

Appendice I MSDS Red Gum Disinfectant

Page 1 of 2

MATERIAL SAFETY DATA SHEET
CUSTOM CHEMICALS INTERNATIONAL PTY LTD Date of Issue: 13/4/05
103-107 Potassium Street, Narangba QLD 4504 Telephone: 07 3204 8300 Facsimile: 07 3204 8311

PRODUCT : RED GUM DISINFECTANT
NOT CLASSIFIED AS HAZARDOUS ACCORDING TO THE CRITERIA OF WORKSAFE AUSTRALIA.
Product Code: 0010053
Other names: N/A
UN Number: Not regulated Shipping Name: None allocated
Hazchem Code: None allocated DG Class : Not regulated
Subsidiary Risk: None allocated Poison Schedule: None allocated
Packaging Group: None allocated

PHYSICAL DESCRIPTION/PROPERTIES
Use: Used as a disinfectant, a deodorant and a cleaner for hygiene standard maintenance.
Appearance : Transparent red, non viscous liquid Odour: Eucalyptus scent
Specific Gravity: Not applicable Vapour Pressure: Not determined
Solubility in water: Not applicable Flash Point : Not applicable
Boiling/Melting Points: Not applicable Flammability Limits : Not applicable
Other Properties: Nil pH : 11.5 – 12.0

INGREDIENTS
Chemical CAS Number Proportion (w/v)
Quaternary ammonium compound 6824-85-1 1.5%
Eucalyptus Oil 8000-48-4 0.4%
Materials not considered hazardous Not required >90%

FIRST AID:
Swallowed: DO NOT induce vomiting. Observe the patient carefully. Never give liquid to a person showing
signs of being sleepy or with reduced awareness; ie, becoming unconscious. Give water (or milk) to
rinse out mouth. Then provide liquid slowly and as much as casualty can comfortably drink. Seek
medical advice.
Eye: Immediately irrigate with copious quantities of water for at least 15 minutes. If pain persists or
recurs, seek medical attention.
Skin Contact: Remove contaminated clothing and wash affected area with soap and water.
Inhaled: If fumes or combustion products are inhaled: remove to fresh air. Seek medical advice.

Advice to Doctor: Treat symptomatically.

WORKSAFE AUSTRALIA CLASSIFICATION
CATEGORY : Not required
RISK PHRASES : NA
SAFETY STATEMENT: NA

PRODUCT: RED GUM DISINFECTANT

HEALTH EFFECTS
ACUTE: A low hazard material generally considered safe if handled in accordance with this MSDS.
Swallowed: Considered mildly toxic. Acute oral LD50’s in rats quoted as 350 – 600 mg/kg of the 100%
quaternary ammonium compound. Irritation of the mouth and gastrointestinal tract may occur if
high concentrations of undiluted product is swallowed.
Eye: A moderate eye irritant.
Skin Contact: Very low irritation. Extended or prolonged contact may lead to dermatitic effects.
Inhaled: Generated mists of the product may irritate the respiratory system.
CHRONIC: No data.

PRECAUTIONS FOR USE:
Exposure Standards: No value assigned for the specific material by the National Health and Medical Research Council or by the National Occupational Health and Safety Commission (Worksafe Australia).
Engineering Controls: No special requirements
Personal Protection: Use good Occupational work practice. The use of protective clothing and equipment depends on the degree and nature of exposure. The following should be available: Gloves, safety eye glasses (particularly when pouring undiluted product).
Flammability: Non-flammable liquid.

SAFE HANDLING INFORMATION:
Storage and Transport: Not defined as a Dangerous Good by the Australian Code for the Transport of Dangerous Goods by Rail and Road. Store in a cool, dry place and out of direct sunlight. Store in a well ventilated area. Keep dry – keep containers closed at all times.
Spills and Disposal: Prevent large spills from entering sewer systems, waterways, etc. Mop up with absorbent material. Collect and seal in properly labelled containers for disposal. Small spills may be rinsed away with water. Disposal – Refer to State Land Waste Management Authority. Normally suitable for disposal at approved land waste site.
Fire/Explosion: Non flammable.
Other information: Nil.

CONTACT POINT: Industrial Chemist - phone: 07 3204 8300
This material safety data sheet is compiled from the best information currently available to the company. The company accepts no responsibility for the accuracy of the information contained in this data sheet, or any results obtained by customers or end-users. Good industrial hygiene should always be used when handling chemicals.

END OF MSDS

Appendice II F10 MSDS

MATERIAL SAFETY DATA SHEET

COMPANY DETAILS MANUFACTURER:
AUSTRALIAN DISTRIBUTOR: Health and Hygiene (Pty) Ltd
COMPANY: Chemical Essentials (Pty) Ltd P O Box 347. Sunninghill 2157,
Address: 13 Abelia Str, Doncaster East, South Africa.
Victoria 3111 Tel:+27 11 474-1668
Emergency Telephone number:+03 9841 9901 Fax: +27 11 474-1670
Fax: +03 9841 9909 e-mail: info@healthandhygiene.co.za

IDENTIFICATION
PRODUCT NAME: F10 SUPER CONCENTRATE DISINFECTANT
UN Number: None
D G Class: None

Hazchem code: None
Poisons Schedule: 5
HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA IN THE PACK CONCENTRATE ONLY (eyes and skin irritant)
USE: Biodegradable multi purpose Disinfectant for all hard surfaces, equipment and airspaces

PHYSICAL DESCRIPTION/PROPERTIES
Appearance: Clear, colourless liquid, with a slight natural odour.
Boiling Point: 110°C
Vapour Pressure: Not known
Specific Gravity: 1.00
Flash Point: Not flammable
Flammability Limits: Not flammable
Solubility in water: Soluble

INGREDIENTS
CAS Number Quantity (w/w)
Benzalkonium Chloride 68424-85-1 5.4%
Biguanide 27083-27-8 0.4%
Ingredients not determined to be hazardous to 100%

HEALTH HAZARD INFORMATION

HEALTH EFFECTS:
Acute
SWALLOWED: Low. Substantial ingestion may cause irritation to mouth, throat and digestive tract.
EYE: Low. Will cause irritation but not serious damage.
SKIN: Low. Concentrate may act as mild degreasant to sensitive skin.
INHALED: Low. No significant hazard.
Chronic
INHALED: Low. No significant hazard

FIRST AID
SWALLOWED: DO NOT induce vomiting. Give milk or water to drink. Seek medical advice where necessary.
EYE: Rinse eyes with water. Seek medical advice where necessary.
SKIN: Wash affected area with soap and water.
INHALED: Non-toxic. Avoid long term inhalation of neat liquid. Remove to fresh air.
FIRST AID FACILITIES: Contact a doctor or Poison Information Centre (phone 131126)

ADVICE TO DOCTOR: Treat symptomatically

PRECAUTIONS FOR USE

EXPOSURE LIMITS: No data found
Engineering controls: None required
PERSONAL PROTECTION: Not required
FLAMMABILITY: Not Flammable

SAFE HANDLING INFORMATION
Storage and Transport: Store below 30 °C in dry conditions
SPILLS AND DISPOSAL: Soak up on an inert material e.g. dry earth and dispose of in an area approved by local
authority by-laws. Flush small spills with copious amounts of water
FIRE/EXPLOSION HAZARD: The product is not flammable or explosive.
OTHER INFORMATION: Ensure good industrial hygiene.
DO NOT mix with soaps or other chemicals.

CONTACT POINT: Managing Director, +03 9841 9901
Chemical Essentials Pty Ltd

KEEP OUT OF THE REACH OF CHILDREN

Issue number: 2
Issue Date: August 2004