Freshwater Assessment, 2008 (Dr. Barbara Gale)

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A BRIEF ASSESSMENT OF THE UPPER BOKKEMANSKLOOF RIVER, AND A COMMENT ON THE POTENTIAL IMPACT ON THE RIVER OF THE PROPOSED 76 ERVEN (83 UNITS) RESIDENTIAL DEVELOPMENT ON ERF 2224, HOUT BAY.

1. Introduction:

A residential estate comprising 83 residential units and associated infrastructure and services on Erf 2224, Hout Bay is currently in its proposal phase. Dr B Gale of Aqua Catch cc was appointed in October 2007 to undertake a preliminary assessment of the upper Bokkemanskloof River as it crosses the site, to comment briefly on the potential impact of the proposed development on the on-site and downstream ecology of the Bokkemanskloof River, and to suggest mitigation measures. A previous study of the Bokkemanskloof River along the boundary of Erf 8343, downstream of Erf 2224, was undertaken in January 2007 and the results presented as part of a basic assessment for a proposed 22 erven residential estate on Erf 8343 (see Gale 2007). Although the current state of the river differs from the previous study the recommendations for construction and operation of the proposed development remain the same.

1.1. TERMS OF REFERENCE FOR THE PRESENT STUDY:

- A brief assessment of the current state of the Bokkemanskloof River as it crosses Erf 2224.
- Brief comment on potential impact on the river of proposed 76 erven residential development.
- Brief comment on the possible presence of Leopard Toads on the site and recommendations on conservation measures should they occur.

1.2. LIMITATIONS OF THE STUDY:

There is currently no long-term or historical data available on the Bokkemanskloof River. A once-off study on a downstream section was undertaken in January 2007 and the present study has a common site viz. the most downstream site in the present study (site BK3B) and the most upstream site of the previous study (site BK1, Gale 2007). The assessment of current condition on Erf 2224 is based on a single once-off sampling session at the inflow and middle site and a single summer repeat session at the outflow site (inflow of the previous study). The 3 samples (inflow, middle and outflow from the site) were analysed for water chemistry, microbiology and invertebrates. The samples were taken in early-summer under medium-flow conditions after unusually heavy spring rains, not ideal for assessing the presence of indicator invertebrates but better conditions than the previous study. Owing to the lack of long-term data, assessment data had to be supplemented by visual observation, the previous once-off assessment and specialist knowledge of similar river systems in the area.

2. Present-day condition of the Bokkemanskloof River:

2.1. STUDY AREA

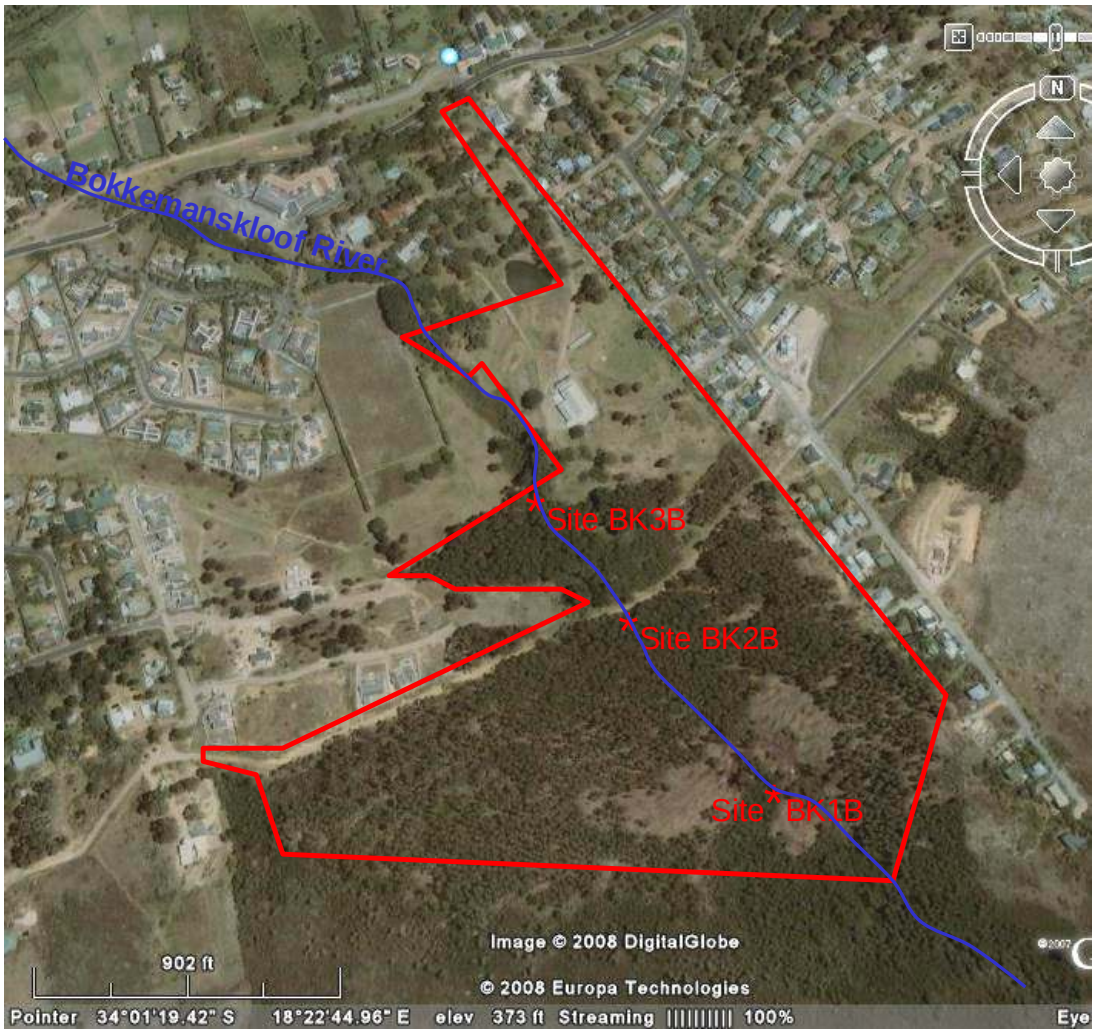
The Bokkemanskloof River is approximately 3.25 km long and rises on the southern slopes of the Vlakkenberg Mountain, part of the Constantiaberg Mountain Range. The river travels in a

southerly direction for about 0.5 km then northwesterly for the remaining 2.75 km before joining the Hout Bay (Disa) River 0.5 km north west of the Hout Bay main road. Although not investigated the upper reaches appear to rise in pristine mountain fynbos but as the river exits the Table Mountain National Park the kloof has become infested with alien trees, predominantly *Eucalyptus* species. The Study area for assessment comprises a 0.5 km stretch of river from the 160m contour in the south-east to 80m in the north-west. The area is bounded on the north-east, south-west and north-west by residential developments (part of north-west and south-west boundary still a proposed residential development) and the Hout Bay road, and on the south and east boundary by a mountainous area, part of the Table Mountain National Park (Figure 1). Botanical Assessments for proposed developments within the study area provide information on topography, geology, soils, climate and vegetation (see McDonald 2007; 2008).

2.2. SAMPLING SITES (FIGURE 1).

A once off single sample (SASS and water chemistry: see methods below) was taken from three sites on the Upper Bokkemanskloof River on 9 December 2007. Site BK1B was situated approximately 60m inside the eastern boundary of Erf2224, site BK2B was immediately upstream of the contour road approximately 240m downstream of site BK1B and site BK3B just above the boundary where the Bokkemanskloof River flows out of Erf 2224 and into Erf 8343 (coincides with site BK1 in previous study, Gale 2007). These three sites cover the inflow, middle and outflow of the Upper Bokkemanskloof River through the site.

Figure 1: Aerial photograph showing the Bokkemanskloof River, study area and sampling sites.



2.3. METHODS

The assessments undertaken and analysis methods used are as follows:

a) RIVER WATER QUALITY: CHEMICAL ANALYSES.

Water was collected from each site and delivered to the Analytical Services of the CSIR for chemical analysis. The parameters assessed included nitrogen and phosphorus (nutrients often indicating excessive enrichment from e.g. fertilizer), Chemical oxygen demand (oxygen reducing capacity of the water), conductivity (ionic status), pH, alkalinity and suspended solids. The parameters measured (underlined) and the methods used are given in Appendix A.

b) RIVER WATER QUALITY: MICROBIOLOGICAL ANALYSES.

Water was collected from each site and delivered to the Analytical Services of the CSIR for faecal coliform and *E. coli* analyses to obtain some indication as to whether bacterial health hazards are present in the water. Faecal coliforms are counted after 22 hours incubation at 44.5 °C (Membrane filtration method). *E. coli* is confirmed by sub-culturing faecal coliforms once a culture medium containing 4-methylumbelliferyl B-D-glucuronide (MUG). *E. coli* is a coliform bacterium possessing the enzyme B-glucuronidase capable of clearing the fluorogenic substrate, MUG, releasing a fluorogen (Marianne Franck, CSIR, pers. comm.).

c) RIVER HEALTH: AQUATIC MACROINVERTEBRATES.

The South African Scoring System (SASS) method was used. SASS is a biological monitoring method developed by Dr Mark Chutter for use in riverine ecosystems (Chutter 1992, 1994). Each group (taxon) of macroinvertebrates (including the larvae of many insects) is given a score based on its sensitivity/tolerance to degradation in water quality. The scores are summed to give a Total Score per site. The number of taxa is calculated and divided into the Total Score to provide an Average Score per Taxon (ASPT) value. Interpretation of the Total Score and ASPT values provides a means of establishing the quality of the water at the site (Dallas 1995). SASS is now in the fifth version, each new version having slightly modified methodology as more information is gained (Dallas 1995).

d) RIVER HYDROLOGY.

There is no available flow data for the Bokkemanskloof River. Since the Bokkemanskloof River occurs in the Winter Rainfall area of the Western Cape it's flow regime is characteristically extremely low flow summers and high flow winters with approximately 10% of the baseflow occurring in summer (November – April) and 90% in winter. The winter flow comprises approximately 25% base flow and 75% flood flows.

e) AQUATIC VERTEBRATES:

A concern has been expressed regarding the possible existence, threat to and conservation of Leopard Toads on the site. An internet search on the conservation status and distribution of Leopard Toads was undertaken, and verbal input sought from Mr. Atherton De Villiers, an amphibian specialist at Cape Nature.

2.4. RESULTS AND DISCUSSION

Although the extreme upper reaches of the Bokkemanskloof River are probably still pristine within the Table Mountain National Park, invasion by alien trees, previous farming activities and surrounding residential development, including contaminated stormwater runoff, have caused degradation in stream condition.

2.4.1. River Water Quality: Chemical analyses.

The results of the chemical analyses are given in Table 1.

Since this was a once off assessment it is difficult to make definitive conclusions on water quality. Nutrient levels are low although Conductivity (ionic concentrations) measurements are an order of magnitude higher than many pristine western Cape mountain streams but this may be due to fairly close proximity to the coast (salinity was not tested).

Table 1: Comparison of water chemistry assessments for the three sites sampled on the Bokkemanskloof River on 9 December 2007 and corresponding site sampled 31 January 2007 (CSIR Water Laboratories: Stellenbosch).

Site	*BK1B*	*BK2B*	*BK3B*	*BK1 (Jan'07)*
pH	5.1	5.1	5.9	6.4
Conductivity (mS/m)	15.5	15.5	22.5	41
Alkalinity as $CaCO_3$ mg/l	2	2	3	8.0
Ammonia as N mg/l	<0.1	<0.1	<0.1	<0.1
nitrate+nitrite N mg/l	<0.05	<0.05	<0.05	<0.1
Ortho phosphate P mg/l	<0.05	<0.05	<0.05	<0.1
Chemical oxygen demand	19	22	49	14
Suspended solids mg/l	6	14	7	8

2.4.2. River Water Quality: Microbiological analyses.

The results of the microbiological analyses (Table 2) indicate elevated levels of faecal coliforms but almost no *E. coli* at sites BK1B and BK3B but high levels at the middle site, BK2B. This indicates that some contamination is occurring downstream of BK1B but upstream of BK2B. This may be due to contamination during tree felling activities or an anomaly associated with a once off sample (unrelated contamination). This should be investigated through additional testing and if a problem exists it should be identified and remedied. All values show a high health risk for drinking water purposes. Feacal coliform counts between 130 and 600 (BK1B & BK3B) show a slight risk, and between 600-2000 (BK2B) a noticeable risk of gastrointestinal illness with full-contact recreation. Counts of <1000 are within the target range for intermediate contact recreation with counts between 1000-4000 (BK2B) posing a slight risk of gastrointestinal irritation for intermediate contact recreation.

Table 2: Comparison of microbiological assessments for the three sites on the Bokkemanskloof River sampled on 9 December 2007 and comparative site sampled on 31 January 2007.

Site	*BK1B*	*BK2B*	*BK3B*	*BK1 (Jan'07)*
Faecal coliforms per 100ml	307	1280	410	392
***E. coli* per 100 ml**	5	560	6	42

2.4.3. River health: Aquatic macroinvertebrates & River Habitat Assessment.

As a guideline a lower limit SASS5 score of 85 and an ASPT of 6.5 may be considered the scores that differentiate least impacted from impacted sites. Since SASS is affected by the region and zone of the river the scores are interpreted according to the national interpretation by Thirion *et al* (1995) and the regional interpretation for the transitional sub-region in the western Cape by Dallas (1995). SASS5 Total scores, number of taxa found and ASPT are given in Table 3.

The SASS5 scores on the upper Bokkemanskloof River are much better than those obtained from the lower sites in January 2007. Sites BK1B and BK2B SASS5 scores and ASPTs are very close to those that indicate unimpacted sites, the slightly lower than unimpacted scores are probably the result of alien tree invasion in the upper catchment and recent tree felling activities. Site BK3B showed double the SASS5 score compared with the sample of January 2007 and the highest ASPT of all sites sampled in December 2007. The improvement in Site BK3B (BK1 Gale 2007) is probably due to the time and conditions of sampling viz. higher flow and greater habitat availability ("Sampling in the very hot summer months under extremely low flow conditions tends to limit habitat availability for invertebrates", Gale 2007). The faecal contamination shown by the microbiological assessment above may also have affected the invertebrate communities. Previous farming activities and alien tree infestation have impacted on the riparian (stream side) zone causing some degeneration in habitat quality and availability.

Table 3: Comparison of SASS5 ratings for the three sites on the Bokkemanskloof River sampled on 9 December 2007 and comparative site sampled on 31 January 2007.

Site	***BK1B***	***BK2B***	***BK3B***	***BK1 (Jan 07)***
SASS5 score	78	82	64	32
No of taxa	13	13	10	6
ASPT[1]	6	6.3	6.4	5.3

[1] Average Score Per Taxon

2.4.4. AQUATIC VERTEBRATES:

The Western Leopard Toad (*Bufo pantherinus*), assigned to the IUCN Red List Category of "Endangered", may occur in the area, although no specific recorded presence was found. According to information provided by A Stewart on the website www.leopardtoad.co.za the local distribution of the toad does not include Hout Bay. However, according to Mr. Atherton de Villiers, an amphibian expert from Cape Nature, leopard toads are known from the area. Mr. De Villiers indicated that since the toads generally breed in low lying areas and forage on fynbos mountain slopes they may be breeding in the pools of the lower Hout Bay (Disa) river but could be foraging on Erf2224. A housing development with plenty of lawn space is often an advantage for toad foraging (A. de Villiers, pers comm.), but threats include impermeable barriers (e.g. solid walls), stony garden beds and busy transport routes to cross (see A Stewart, www.leopardtoad.co.za).

2.5. CONCLUSION

The above data seems to indicate that although the upper Bokkemanskloof River within the study area is not chemically contaminated it appears to be receiving faecal contamination from an unknown source. The alien infestation of the kloof, an urban estate extending to the 100m contour and historical agricultural activities have marginally impacted on the ecology of the upper Bokkemanskloof River. Although stream habitat quality is not noticeably very good there is good invertebrate taxonomic diversity including the presence of several sensitive species such as the freshwater shrimp, a sensitive caddisfly larva and a sensitive beetle larva. The presence of the highly sensitive freshwater shrimp (Amphipoda) and caddisfly larva at site BK2B despite faecal contamination is indicative of the potential for rehabilitation. A botanical survey undertaken as part of a basic assessment for the proposed development indicated that the "only indigenous plants of importance [on the site] are the trees along the drainage lines and streams. These must be

conserved. Augmentation of the tree flora along the streams with species found in the area is also highly recommended" (McDonald, 2008). This will greatly assist improvement in habitat quality for stream invertebrates. Care should be taken to ensure minimal disturbance to leopard toad foraging and migration owing to the possible existence of leopard toads on the site.

3. Potential Impacts of proposed development and suggested possible mitigation measures:

3.1. Construction phase

- *Impact:* Trampling and disturbance of riparian zone and stream bed.
  Mitigation: Demarcation of "no-go" areas.
- *Impact:* Obstruction of stream flow.
  Mitigation: The flood lines of the Bokkemanskloof River should be determined and no structures planned within the 1:20yr flood line. Residences should be placed outside the 1:100yr flood line. A suitable buffer zone should be determined and designated private open space under estate management. The proposed "green fingers" appear to address this mitigation aspect.
- *Impact:* Erosion of stream banks and excess silt entering the stream.
  Mitigation: Strict environmental controls regarding site clearing and construction activities and the installation of sediment traps in appropriate places downstream of construction activities.
- *Impact:* Disturbance of leopard toad foraging and migration routes.
  Mitigation: Care should be taken not to construct any impermeable barriers, due care on roads by construction vehicles and removal of any toads to safer areas.
- *Impact:* Liquid and solid waste pollution.
  Mitigation: Appropriate temporary waste bins and sanitation facilities.
- *Impact:* Spillage of fuels, oils, chemicals and construction materials (e.g. cement) that could runoff into the stream.
  Mitigation: Proper environmental controls including securing refueling depots to prevent seepage to the river.
- *Impact:* Short term degradation of stream ecology resulting from above-mentioned impacts.
  Mitigation: Regular visual, chemical and biological monitoring as determined by a construction Environmental Management Plan.

3.2. Operational Phase:

- *Impact:* Erosion of stream banks as a result of over utilisation for recreation.
  Mitigation: Establishment of specific use areas such as paths and crossings and measures to encourage eco-friendly Installation of sediment traps in appropriate places. The flood lines of the Bokkemanskloof River should be determined and a suitable buffer zone determined and designated private open space under estate management. The establishment of a stream monitoring programme would ensure any impacts are identified timeously and remedied.
- *Impact:* Re-infestation of riparian zone with invasive alien plants.
  Mitigation: Encourage the use of indigenous plants in gardens and remove invasive aliens as part of the alien control maintenance plan.
- *Impact:* Contamination of the stream by spillage from sewage pipes or pumps.
  Mitigation: Proper environmental controls regarding malfunction of the sewage system with backup sumps if necessary.

- *Impact:* Contamination of the stream by polluted stormwater runoff from roads and gardens.
  Mitigation: Encourage residents not to use fertilizers or pesticides and to wash and maintain vehicles off-site. Design the estate with as many permeable surfaces as possible to allow sandfiltering of stormwater before it enters the stream. Regularly monitor stream water quality.
- *Impact:* Permanent destruction of leopard toad foraging areas, barriers to toad movement and unsafe road crossings.
  Mitigation: Creation of suitable garden habitat for foraging, construction of toad permeable fences and creation of safe passage across transport routes (see Appendix B).

4. Conclusion:

The upper Bokkemanskloof River is only marginally impacted by activities within its catchment. The Bokkemanskloof River and the Hout Bay River are degraded in their lower reaches owing to farming and urban activities. In order for development alongside the upper Bokkemanskloof River not to add to the degradation of the Bokkemanskloof and Hout Bay Rivers and for it to be a positive asset to the residents of the proposed development and the local community, the proposed development should not cause additional degradation to either the Bokkemanskloof or Hout Bay rivers, or negatively impact on the conservation status of any endangered species. Construction activities should include rehabilitation of the riparian zone within the site of the proposed development and an operational management plan should prevent negative impacts. Although the landowner/developer cannot be held responsible for degradation caused by activities upstream of the site it is essential that the proposed development does not further degrade the river. If rehabilitation actions can improve the water quality and habitat condition of the river it will become a true asset to the residents of the proposed development and improve the downstream reaches of the Bokkemanskloof and Hout Bay Rivers to the benefit of the local and regional community.

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APPENDIX A

CSIR DIVISION OF WATER TECHNOLOGY

ANALYTICAL SERVICES (STELLENBOSCH LABORATORY)

WATER ANALYSIS METHODOLOGY

Determinand	Method used
pH	Electrometric
Electrical conductivity	Conductimetric (25 °C)
Turbidity	Nephelometric
Colour	Visual comparison
Suspended solids*	Gravimetric (103 – 105 °C)
Total dissolved solids*	Gravimetric (180 °C) or Calculation
Ammonia; nitrate + nitrite; orthophosphate; chloride; sulphate boron*; silica*, phenolic compounds	Automated colorimetric
Flouride	Ion-selective electrode
Dissolved organic carbon	Persulphate – UV oxidation
Chemical oxygen demand	Reflux, titrimetric
Kjeldahl nitrogen*	Digestion, titrimetric
Sulphide*	Iodometric
Alkalinity	Potentiometric titration
Magnesium; potassium; sodium; lithium*; cadmium*; cobalt*; copper; iron; lead*; manganese; nikel; zinc*	Direct flame (air-acetylene) AAS
Aluminium; barium*; strontium*; calcium; chromium	Direct flame (nitrous oxide-acetylene) AAS
Arsenic*; selenium*	Hydride generation / AAS
Mercury*	Cold vapour generation / AAS
Total hardness	Calculation

*Not NCS-accredited

AAS : Atomic absorption spectrometry

APPENDIX B: Western Leopard Toad Conservation

Extracts from: 'A. Stewart, HYPERLINK www.leopardtoad.co.za www.leopardtoad.co.za

“The Western Leopard Toad (*Bufo pantherinus*) is the largest South African Toad, the females reaching a length of 140mm. It was originally called the August Frog and is also known as the Snoring Toad.

This toad was assigned to the IUCN Red List Category of "Endangered" in 2001. Bufonids belong to the Phylum - Chordata, the Class - Amphibia and the Order - Anura. Toads are loosely termed "frogs" - a generalised term applied to all tail-less amphibians

Colouration: Large chocolate brown patches on a yellow to yellow-green background dorsally, with a yellow vertical stripe. A pink-brown parotid gland lies behind each eye, and the top of the head is the same colour.

Call:The male gives a deep snore that pulses for a second and which is repeated every three to four seconds.

Distribution:The Western Leopard Toad is endemic to the Fynbos wetlands of the Western Cape. It favours low-lying areas, which include rivers and perennial ponds, with open water more than 50cm deep. Aquatic plants are important during the breeding season.

Bufo pantherinus used to be found in abundance as far as Pearly Beach in the South East and Valkenberg in the South West. Drainage of wetlands for urban development, roads intersecting their habitat, walls blocking their movements and pollution have shrunk the toad's habitat to a few remaining isolated areas:

• Glencairn

• Fish Hoek, Sun Valley, Noordhoek

• Zandvlei Wetlands

• Areas bordering the Westlake River, especially in the Kirstenhof-Tokai area

• Bergvliet - Die Oog and Dreyersdal Farm

• Rondevlei Nature Reserve - breeding programme

• Gansbaai - breeding programme

Life Cycle: The Western Leopard Toad spends most of its life out of water, often living up to 5km away from it to forage. The toad's breeding season occurs during the first warm days of spring (usually in August), but it can take place as early as the end of July up until the beginning of September. All mature toads (approximately 4 years old) move towards still open water, the males usually arriving first. They call from the floating vegetation, preferring to be away from the riverbanks. This attracts the females, which join them in the water. The males then find females and form a position known as amplexus. The male (smaller in size-reaching approximately 9cm) climbs onto the female's back and clasps her behind her front legs using roughened areas on his thumbs known as nuptial pads. This ensures that he will be in position to fertilize her eggs when she spawns. Fertilisation is external.

The eggs are laid into the water in long, gelatinous strings and hatch into tadpoles approximately 2 weeks later. These little tadpoles feed on algae on the water plants, metamorphosing into perfect little 1cm long replicas of their parents, approximately 12 weeks later. These time spans have been observed by me over a 3 year period in the Westlake River and may vary in other areas.

The small toads leave the water to begin their predominantly terrestrial lifestyle.

Each female toad lays thousands of eggs, but only a very small number of toads survive to adulthood. Throughout their lifecycle they fall prey to predators such as fish, birds, other toads, dragonfly nymphs, snakes and water mongooses.

The Importance of the role of Frogs (this includes toads) in the Ecosystem

1. A very important link in the Food Chain

Tadpoles feed on plant detritus and algae and are in turn a food source for other animals.

Frogs (toads) prey on small invertebrates and insects, thereby keeping species numbers down, eg. Mosquito larvae.

Eggs, tadpoles and frogs are preyed upon by larger animals.

2. The Frog plays a role as an indicator of the health status of the environment

Frogs use three surfaces for gas exchange (skin, lungs and oral mucosa) and are therefore very sensitive to water and air pollution. This includes pesticides in rivers, lead from car exhaust fumes, which are deposited in rivers (South Africa has the highest numbers of cars per capita in Africa), water pollution due to mining and industrial waste as well as household waste.

A rapid rise in E. coli levels from human excrement in our wetlands and rivers all lead to deformed development and/or the death of frogs.

3. Amphibians are highly sensitive to ultra-violet radiation

Deformities have been found in frogs in areas where man-made pollutants are absent, but where ozone "thinning" is believed to have occurred such as in the Amazonian Rain Forests

Threat to the long - term survival of the toad: New threats are developing all the time for this really beautiful amphibian.

- People are replacing lawns and flowerbeds with chipped stone and paving because of water restrictions. This means that the toads' foraging grounds are still further reduced.
- "More and more cluster complexes are being built so apart from a huge increase in the number of concrete walls creating barriers to movement, the number of cars in a relatively small area is skyrocketing. This means that during the breeding season migration to water, so many more toads are killed by cars, if they have managed to negotiate the barriers.
- Another new and very worrying threat to this highly endangered animal is the power cuts. Sewerage pumps stop working with the result that raw sewerage spills over into the Cape Flats river systems (the smell was overwhelming in the Kirstenhof in February 2006. This will hopefully not have too great an impact on the toad now, but if this happens during the breeding season when all the adult toads move to water to spawn and heavy rains don't flush the rivers, the results could be disastrous for both the mature toads and tadpole.

Interesting Information

1. Toads do not actually drink water. They absorb the moisture they require through their skins. So...when you find your resident toad floating in the dog's water bowl it's actually "having a drink" or rehydrating. Bear this in mind when using insecticides and snail bait. These substances mix with the moisture in your garden and can be absorbed by the toads as they forage.

2. The toad's main defense against predation or the threat of injury is to produce a toxin from two pinkish parotid glands on the top of its head. A creamy white substance oozes out of the glands when the toad feels that its life is threatened. I have handled about 300 toads and I've only seen this substance produced when the toad has been run over by a car or stood on .

If your dog paws or stands on a toad it will defend itself. When ingested by a big dog the toxin will cause a lot of oral foaming (i.e. the dog will foam at the mouth). If possible, spray the dog's mouth out with water, but big dogs' systems seem to cope with the toxin. Small dogs can be killed by it.

The best advice I can give you here is; Build a shelter away from your house (and the dog!) - use old flower pots, bricks or paving slabs, preferably near a garden light (the toads eat moths, mosquitoes and other insects) and water. I have done this on a number of occasions (including in my own garden) and it works very well. Moving the toad off your property won't be so successful. They are very territorial and will keep coming back to your garden