EXECUTIVE SUMMARY

PROPOSAL TO IMPORT *BOMBUS TERRESTRIS* INTO MAINLAND AUSTRALIA FOR CROP POLLINATION PURPOSES

PROPONENTS –

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1. The purpose and scope of the document

This document is the culmination of over 10 years investigation into the proposed importation of a European bumblebee, *Bombus terrestris*, into Australia in managed hives for pollination purposes. While originally use in a wide range of field and greenhouse crops was envisaged, the proposal has been narrowed down to pollination of greenhouse crops, particularly tomatoes, in fully enclosed structures. This final document sets out detailed information on all the Terms of Reference agreed to with the DEH, now DEWHA, and addresses all comments received during a public and government consultation process in 2006. In addressing the many issues that were raised, a further extensive literature search was undertaken and several key researchers were contacted on the biology and ecology of this bumblebee. While a strong and prolonged lobbying campaign against importation has prejudged this application, the AHGA believes, through thoroughly reviewing all the evidence available pertinent to the arguments received, that there is a strong case to be made for managed importation, with negligible risk of any of the environmental consequences predicted.

2. The proponents of the request

The AHGA represents the Australian greenhouse industry nationally. The original application to import bumblebees was made by Goodwin and Steiner in 1997, to encourage uptake of biological pest management and thus reduce pesticide use, while greatly increasing yields in targeted crops. The AHGA took over responsibility for the application in 1999. The Australian greenhouse vegetable industry is the fastest growing food producing sector in Australia, with a $600 million farm gate value per annum, currently expanding at 4-6% per annum, yet currently has only an estimated 350-400 ha in tomato production, very small by world standards. It employs over 10,000 people throughout Australia. As an industry that makes use of advanced greenhouse and environmental systems technology, it has the highest capital cost of any agricultural sector, with state-of-the-art glasshouse/greenhouse structures, hydronic heating, and computer-controlled environmental and hydroponic systems, costing on average $2 million per hectare. This represents a considerable and unprecedented investment into the industry, yet the potential growth remains a long way from being realised, and lags far behind other countries with a greenhouse industry. For a country where water is a precious commodity, perhaps the major benefit of this industry is its water use efficiency. Its environmental footprint is very small compared with other food producing industries, with considerably higher yields per unit area.

3. The need for a biological pollinator

Bumblebees have been reared commercially since the late 1980's. There are over 30 production companies in 19 countries, servicing 40 countries in Europe, North America, South America, New Zealand, and Asia. Bumblebees greatly improve pollination of greenhouse crops (e.g. tomato, capsicum, eggplant, berry fruit), in field crops (e.g. strawberry, blueberry, cranberry, kiwifruit, zucchini, bean, eggplant) and in tree fruit (e.g. almond, apple, stone fruit, avocado). Ninety five percent of use is in greenhouse tomato crops, because not only are bumblebees excellent buzz pollinators, but tomatoes are a high value crop, needed to justify the cost of bumblebee production. Their use not only saves on manual pollination costs, but results in greatly increased yields of better quality fruit. Overall in Australia, it is estimated that the economic benefit of bumblebee pollination would be A$40 million per year. There has been very rapid uptake of bumblebee technology by growers where they are available. Australia is one of the few countries in the world without access, and this puts us at an increasingly severe disadvantage in a free market economy. It has delayed the expansion of the industry in Australia by several years, and inhibited foreign and local investment. This technology is sophisticated and proven, and is used by all of Australia's major competitors, including New Zealand. This is a major concern to the Australian greenhouse industry.

4. The proposal for importation of *Bombus terrestris*

The AHGA proposes to import bumblebees within secured hives on a weekly basis for distribution to growers. The hives are placed within the crop and worker bees allowed to leave to effect pollination. Several measures will be put in place to mitigate against possible escapes. Bees can only leave the hive through a single exit hole which can be closed, of a size which is too small to allow the larger queen to escape. Thus only worker bees are in the crop, and further breeding is not possible. Greenhouses will be netted over all openings, and hives will be replaced and destroyed after no longer than 8 weeks. Greenhouse operations will be pre-approved, will have to undergo training of staff, and if required by DEWHA, will be monitored regularly by AQIS to ensure compliance with agreed protocols for use and containment. The commercial rearing operation will be sited probably in northern Tasmania, so that quarantine, rearing, packing and shipping operations are conducted where there are no environmental concerns should any breaches in containment occur. The facilities will be regularly inspected to ensure disease-free status.

The rearing stock will most likely be derived from Tasmanian bees, which are proven disease-free, although of limited genetic diversity. The subspecies will most likely be *B. t. audax*, which was derived from English and thence New Zealand stock. It is thus unlikely to adapt to non-temperate climates.

5. Concerns expressed by opponents of importation

The concerns expressed have been wide ranging. They include the following:

- Increased rates of pollination, gene flow and seed set among agricultural and environmental weeds
- Impacts on seed set of native plants caused by nectar and pollen removal by *B. terrestris* and by potential failure of *B. terrestris* to correctly contact the anthers or stigmas
- Impacts on native bee and native insect pollinators from competition for nectar and pollen
- Impacts on native vertebrates, especially threatened species, that utilize nectar and pollen resources from competition with *B. terrestris*
- Impacts on native animals or bees from competition for nest sites
- The potential impacts on the lifestyle and health of humans should *B. terrestris* establish in or near human settlements.

There have also been claims that bumblebees will not be restricted by climate or to one generation a year on mainland Australia, so that they will spread extensively. Their likely impact has been likened to that of cane toads, European wasps, rabbits and foxes. There have also been claims that the native blue-banded bee is an alternative commercial pollinator, so there is no need of bumblebees.

6. Research for and against the proposal

Most local research has been conducted in Tasmania:

- A three-year Environmental Impact Study (EIS) was conducted by the Tasmanian Museum 1999-2002, following an industry workshop in Hobart in 1999 that brought

together representatives of the greenhouse industry and other interested parties, including conservationists and apiarists. It was funded by a $275,000 grant from the former Horticultural Research & Development Corporation, now Horticulture Australia Ltd. The EIS report presented in 2002 found little cause for concern.

- Dr Andrew Hingston, University of Tasmania, who is very much opposed to importation and who, with several co-authors, published several papers claiming substantial negative impacts, which were not verified by many of the EIS studies of Hergstrom *et al.* (2002).
- UK researchers Prof. D. Goulson and Dr J. Stout conducted limited studies on distribution of *B. terrestris*, competition with native bees and seed set of weeds in Tasmania.

Worldwide, as a result of interest in bumblebees as pollinators, and alarm over the widespread decline of bumblebee species around the world, a great deal of research has been conducted on the biology and ecology of bumblebees, *B. terrestris* in particular. Over 500 references have been accumulated and referenced in this report, but many others more peripheral to this issue have been published. This bee is very well researched, and much about its biology and ecology are known. Within this wealth of material, only very few authors point to potential problems with bumblebees rather than regarding them as a critical asset, and all have to do with transport of bumblebees to areas outside their natural range.

A great deal of credence has been given to these few papers by environmentalists opposed to importation. While there are valid concerns, these are context-dependent, and almost exclusively relate to countries where native bumblebees already exist. Negative publicity has emanated primarily from establishment of feral populations of *B. terrestris* in Hokkaido, Japan, with concerns being transfer of pathogens and parasites to native bumblebees, usurpation of their nest sites, competition for resources, interference with pollination mechanisms, and hybridisation with native bumblebees. Of these, only pathogen and parasite transfer (manageable) and possible competition for nest sites (not yet proven) appear to have any substance there. Other strong opposition has come from Prof. Amos Dafni in Israel, who became concerned about displacement of native bees in fire-burnt areas after a temporary range expansion of *B. terrestris* in the early 1980's. In New Zealand, where *B. terrestris* and three other bumblebee species were introduced over 130 years ago, there have been no negative impacts, despite the much more suitable climate than in mainland Australia, and many positive impacts recorded.

The opposition to importation led the AHGA to secure the services of a wide range of experts on bumblebees and related technologies to examine claims of negative impact. These include the following initiatives:

- 'A Critical Study on the Introduction onto Mainland Australia of the Bumblebee (*Bombus terrestris*) for the Commercial Pollination of Protected Tomato and Other Crops', authored by Dr Don Griffiths. Dr Griffiths is a world-respected authority on bumblebees - one time Director of Research at the Ministry of Agriculture Central Science Laboratory, UK, for 10 years; member of the Board of Directors of the International Bee Research Association, Cardiff, UK; responsible for the trials and initial introduction of commercial pollination management systems into Holland, UK, France, Spain, Italy and Japanese commercial glasshouses. Dr Griffiths also contributed to the submission.
- Funding of two climatology studies using the CLIMEX™ model, (Dr K. Hergstrom, 2003 and Dr A. McClay, 2005) to predict where *B. terrestris* is likely to establish should it arrive by any mechanism on the mainland. The more definitive study by McClay is appended to the submission, with extensive discussion on its implications.
- Analysis of three Tasmanian studies by McClay to assess the validity of the scientific methodology and statistics.
- Biocontrol Solutions (M. Steiner & Dr S. Goodwin) were retained in 2007 to undertake an extensive review of information and literature relating to *B. terrestris* and to complete the final report and respond to public and government comments. The AHGA secured a grant of $100,000 from HAL to complete this undertaking.

7. Examination of claims

Both the EIS and CLIMEX studies indicate bumblebees will not dramatically change the status of native and agricultural eco-systems should bumblebees succeed in establishing in the wild. The McClay CLIMEX study indicates the likelihood of only limited distribution of *B. terrestris* (subspecies *audax*) on mainland Australia should it arrive either by accident or design. The study predicts these areas will be restricted to the wetter areas of Victoria, the southwest corner of Western Australia, and a limited area of NSW across the northeastern border of Victoria, most likely in irrigated areas and urban gardens where there is an abundance of year-round nectar from preferred introduced plant species. The pertinent questions answered by the EIS and by other published studies are as follows:

7.1. Claims of negative effect

Bumblebees will compete with native bees and animals for nectar and pollen? Bumblebees have a strong preference for exotic (introduced) plant species over native species. Only Hingston in Tasmania claims otherwise, but has no data to support this contention. This does not preclude favouring some native Myrtaceae offering high nectar rewards, such as some Eucalypts, Banksias and Grevilleas. While bumblebees may access a range of native plants, and have been shown to have a presence in native bush, they have not been shown to be abundant there. Native bees prefer to forage on native plants in native bush at times when these resources are abundant. There is thus little likelihood of any significant competition for floral resources.

Bumblebees are highly invasive pests?
Bumblebees are not regarded as pests anywhere in the world where they are native, nor in New Zealand where they were introduced and have been established for 130 years. Many heavily funded and researched schemes to preserve their diversity and increase their

abundance have been established in recent years across Europe and North America. Broad establishment is only possible where the climate and vegetation is suitable. This includes areas of known establishment such as New Zealand, Tasmania and northern Japan, but would include only the coastal south of the Australian mainland. Spurious claims that bumblebees are another cane toad, fox, European wasp, etc., are based on a lack of familiarity with bumblebees and an attempt to distort the truth. New Zealand has imported seven species of exotic bees over the years, and Australia has imported exotic honeybees and carpenter bees, with overall beneficial impacts. Honeybees will in any case always have a much greater presence than other bees, because of their perennial and very large colonies, broad foraging range and subspecies adapted to a range of climates.

Bumblebees will spread sleeper weeds?
Conjecture and suppositions abound alluding to the potential of *B. terrestris* to awaken so-called 'sleeper weeds'. This claim has not been substantiated for any of the weed species named by the CRC and by Hingston as being most likely to be sleeper weeds. The EIS found, in a limited, short term study, that there was only some increase in the seed set of two minor weeds, however, a decrease in the seed set of a major weed (Scotch thistle). Where pollinators are needed for weed spread, honeybees are already ubiquitous and performing that service. The limited potential distribution of bumblebees on the mainland will also limit any potential for weed spread.

Bumblebees will carry parasites and pathogens, including Varroa?
There is *no possibility* of transmission of Varroa to honeybees. They do not live on bumblebees. Most pests, parasites or pathogens associated with *B. terrestris* are unique to bumblebees. Very few parasites and pathogens are shared with honeybees, and these can be screened for. There is no known or likely risk to native bees. Therefore, no deleterious health effects on honeybees or Australian native bees are expected. Two studies have confirmed that Tasmanian bumblebees are parasite- and pathogen-free. Nevertheless, as a matter of routine, bumblebees will be quarantined and screened prior to addition to breeding stock.

Bumblebees will escape and populate the entire Australian mainland?
Not so. Agreed protocols that will be put in place will minimise the possibility of escapes from imported hives. Even should this occur, successful establishment in the environment is unlikely. Previous deliberate releases in the late 1800's and early 1900's failed, and no establishment has occurred from periodic accidental arrivals via ships and planes, a few recently documented by AQIS. *Bombus terrestris s. l.* would be at the latitudinal limit (30^{o}) of its known range in southern Australia. A commissioned CLIMEX study indicates a restricted distribution for the subspecies *B. t. audax* in the cooler, wetter areas of the mainland, limited to Victoria, just over the NSW border, and the southwest corner of WA. Temperatures over 30^{o}C are detrimental. Other subspecies will also be limited to more coastal temperate areas with good floral resources during colony development. An extensive review of information available on diapause has been undertaken and concludes that a long resting period (diapause) is innate in *B. terrestris*. It will limit the species to one or two generations a year, and a primarily spring- or summer-active population, as is evident in Tasmania and New Zealand.

Bumblebees will compete with the swift parrot and other endangered birds?
Not so. The threat to the survival of the swift parrot, helmeted honeyeater and regent honeyeater has everything to do with land clearing, wood chipping and habitat destruction, and absolutely nothing to do with bumblebees. EIS studies show bumblebees represent only

2% of visitors to Tasmanian blue gum, the preferred nectar source of swift parrots, compared with visits by honeybees (56%) and birds (25%).

Bumblebees will affect seed set of native plants?
No impact has been shown or is expected, given the limited potential distribution on the mainland, and the low visitation rate to native plants except to those well serviced by other pollinators. A positive effect is just as likely as a negative one.

Bumblebees will competitively displace native bees?
There is no evidence for this. Hingston's single, two-day study purporting to show this has several flaws and does not support this contention. Similarly, Dafni's prognosis of dire effects in Israel has not been realised and pertained to habitat alteration by fires and not to temporary presence of indigenous *B. terrestris*. Most plants are visited by a broad range of pollinators, not limited to bees and birds. Resource partitioning normally ensues so that overlap is minimised in time and space. Bumblebees are blenders, not usurpers.

Bumblebees will displace native animals from nest sites?
Quite the contrary. Bumblebees utilise *abandoned* rodent nests. In fact, rodents, ants, lizards and other animals are known to destroy bumblebee nests. Lack of suitable nest sites may well limit both abundance and area of establishment of bumblebees.

Bumblebees are aggressive and sting repeatedly, leading to severe reactions and possible death?
Bumblebees are not aggressive, but will defend a nest if disturbed. However, nests are seldom encountered as they are sited below ground and away from domiciles. While bumblebees are capable of stinging, and in rare cases inducing anaphylactic shock, the public is very rarely affected. As with honeybees, this is an occupational hazard for those working closely with bees in closed environments. Incidence of stings is much lower than for honeybees, and treatment is similarly available.

Bumblebees are a Key Threatening Process?
State Governments of NSW and Victoria have declared bumblebees a "Key Threatening Process" due to intense lobbying over a 10 year period by a small segment of the conservation lobby. Conclusions of the Committees were premature and based on speculation emanating from a single source in Tasmania. It is a disappointment that a decision was reached in advance of evidence and contrary to known biology and ecology of this species. Conversely, the Federal Government in 2001 declined to support this unfair claim due to 'insufficient evidence to support the claim.' Good science must be allowed to prevail and not suppositions. Frequent use of words such as 'could, possibly, might and maybe' infers a lack of substantiating evidence.

7.2. Claims of positive effect

Bumblebees are very efficient and cost-effective pollinators
Studies show that the cost of pollinating a tomato crop is approximately $25,000/ha for manual pollination compared with $7,000/ha for bumblebees. Manual pollination is achieved through mechanical hand-held vibrators touching each plant three times per week (a huge impost on manual labour). Bumblebees also achieve a higher % of pollination success (approximately 95% *vs.* 85%).

Bumblebees deliver potentially up to 28% crop yield increase

Bumblebees work over a wide range of conditions found in typical greenhouse installations and select flowers at the optimum time for good pollination, resulting in high yields of quality fruit. Several overseas studies have shown that this optimum pollination can deliver a crop yield increase of up to 28% at the low cost of 1% of production. Even with a conservative 10% increase in yield, it is projected that the greenhouse tomato industry would benefit by $40 million/year on 250 ha.

Bumblebees will deliver much improved fruit set

Good fruit set is always important, even more so given the move towards truss production. This system also provides an increase in tomato fruit size (around 5%), improves quality and extends shelf life.

Bumblebee pollination is proven technology, is hassle-free and is available year round on demand

The technology has been improving over the last 15 years and is now very advanced. All growers need to do is place the hive in the crop and change it within a set time frame or when it is no longer productive. Usage is well established in many countries under varying conditions, and is not limited seasonally. Three companies have been producing bumblebees in New Zealand for more than 10 years, with usage in both greenhouse and field crops.

Bumblebee technology is available to almost every country on the planet, except Australia

Over one million colonies were produced globally in 2004 for pollination purposes, demonstrating that this technology is very much in demand and is very reliable. With current pressure from New Zealand imports (with recent approval for importation of Dutch produce), access to this technology is mandatory if Australian growers hope to match production standards with our international competitors.

Consumers can be assured of pesticide-free produce
Due to the low tolerance of bumblebees to pesticides, Australian greenhouse growers would be required to adopt IPM strategies involving the usage of arthropod biocontrol agents, as is strongly practiced overseas by the protected cropping industry. The availability of bumblebees would ensure a 100% compliance rate. Bumblebee images on produce tags overseas are used to signify 'clean, green, pesticide-free' produce.

8. Alternative pollinator proposals

Claims have been made that native bees able to buzz pollinate tomatoes can replace bumblebees. Research has focused for several years on blue-banded bees, *Amegilla* spp. Native bee research is encouraged; however, growers must be practical. So far no commercial outcome is on the horizon, and the level of difficulty in commercialising a solitary bee such as this is prohibitive. Can this be accomplished in a reasonable time frame (5, 10, 20 years), if at all? Can they adapt to artificial enclosed rearing systems and transportation systems? Are they reliable and obtainable year round? Can enough be produced to sustain a viable commercial enterprise? Is the biology well-known, and can diapause be controlled? Can pathogens and parasites be managed? Can a species indigenous to all Australian growing areas be found? How much research money will be spent with the possible result of no suitable alternatives at the end of it all? Ultimately, many years of study and substantial financial input may yield a negative result that will further delay the competitiveness of Australian growers, whereas growers could be using bumblebees within two years of approval to import being granted.

9. Conclusions

The AHGA is entirely satisfied that certified clean stock can safely be brought to the Australian mainland for pollination of greenhouse crops, while presenting negligible risk to the environment, even should escapes occur. Only two of the 40 countries currently enjoying bumblebee technology, Japan and Israel, claim deleterious effects on their local flora or fauna, and none of these claims has been substantiated. Importation of bumblebees into Japan has been permitted to continue, and concerns in Israel have abated while use of its native bumblebee species continues. New Zealand has been successfully rearing and using bumblebees for many years, with no negative effects identified. These facts are entirely at odds with claims by Australian opposition groups that "all hell will break loose" if bumblebees are allowed to leave Tasmania for the mainland, and that their impact has been "devastating" in Tasmania. There is no evidence to substantiate this doom and gloom scenario. Bumblebees will not change their benign character when they reach the mainland.

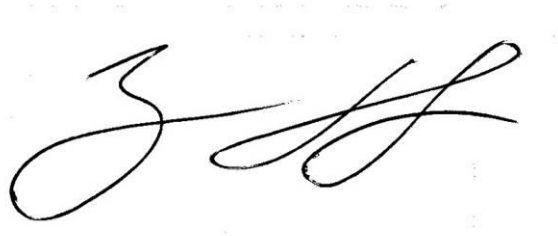
Each area of the TOR has been carefully addressed to ensure that no environmental issue was missed. This definitive study confirms that importation, particularly with the safeguards outlined, should be approved as representing no risk to the Australian environment while conferring substantial benefits to the greenhouse domestic and export sector and to the health of the general public through reduced pesticide use.

10. Recommendation

That the Australian Department of Environment, Water, Heritage and the Arts approves the

live import of the European bumblebee *Bombus terrestris* onto the Australian mainland for the purposes of greenhouse crop pollination, on the basis that it is satisfied with reasonable certainty that the risk of environmental impact will be negligible.

Graeme Smith



President - Australian Hydroponic & Greenhouse Association
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