Submission No 9

INQUIRY INTO NANOTECHNOLOGY IN NEW SOUTH WALES

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Friends of the Earth

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To the Standing Committee on State Development

Inquiry into Nanotechnology in NSW

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Friends of the Earth Australia submission to the NSW Parliament Inquiry into Nanotechnology

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Executive Summary

Nanotechnology will likely impact all industries and sectors of the NSW economy, and is likely to facilitate far-reaching changes in social, economic and ecological relations. Opinion is sharply divided regarding whether these changes will be largely positive or negative. Proponents suggest that nanotechnology will deliver gains in fields as diverse as manufacturing, medicine, environmental remediation and military applications. However critics argue that nanotechnology introduces serious new risks to human health and the environment, raises problematic ethical issues and is likely to result in large-scale socio-economic disruption.

The highly respected United Kingdom's Royal Society and Royal Academy of Engineering have recommended that given the emerging evidence of serious nanotoxicity risks, nanomaterials should be treated as new chemicals[1] and be subject to new safety assessments prior to their inclusion in consumer products[2]. They further recommended that factories and research laboratories should treat nanomaterials as if they were hazardous[3], and until the environmental impacts of nanomaterials are better known, their release into the environment should be avoided as far as possible[4].

Friends of the Earth recommends that in accordance with recommendations from the Royal Society, manufactured nanoparticles should be treated as new chemicals, subject to new safety assessment, and clear labelling, before being permitted in commercial use. Despite the commercial availability world-wide of over 720 products containing nanomaterials[5], not a single national government has yet introduced regulations that require nanomaterials to be subject to new safety assessments prior to commercial release. The failure of government regulators to take seriously the early warning signs surrounding nanotoxicity[6] suggests that they have learnt nothing from any of the long list of disasters that resulted from the failure to respond to early warning signs about previous perceived 'wonder' materials (like asbestos and DDT)[7].

Friends of the Earth strongly encourages the NSW Standing Committee on State Development to recommend that nanotechnology's wider social, economic, ethical and democratic implications be assessed alongside its implications for human health and environmental safety. Nanotechnology analysts predict that nanotechnology will result in wide-scale social and economic disruption. Yet issues relating to ethics, democracy and nanotechnology's broader socio-economic impacts have yet to receive even a small fraction of the research funding awarded to development of commercial applications.

Friends of the Earth feels very strongly that public participation must be a central input to the policy development and decision making process on nanotechnology. Given the low levels of public awareness and the complex issues associated with nanotechnology, novel techniques should be explored to engage the community, including those based on the deliberative design model (eg consensus conferences or citizens' juries). Despite the commendable efforts of this inquiry, nanotechnology is being commercialised largely outside of general public awareness or debate, and without any serious attempt to date to involve the community in decision making about its introduction. Given the scale of predicted nanotechnology-related change, the public has a right to be involved in nanotechnology decision making. Furthermore, there is growing recognition that public participation improves policy outcomes.

a. current and future applications of nanotechnology for New South Wales industry and the New South Wales community

Nanomaterials are "first generation" products of nanotechnology. Nanomaterials include nanoparticles (eg metal oxides), nanotubes, nanowires, quantum dots and carbon fullerenes (buckyballs), among others. There are currently hundreds, if not thousands, of products already on the global market whose manufacturers acknowledge manufactured nanomaterial content. For examples of specific products, visit the Consumer Products Inventory hosted by the Woodrow Wilson Center for International Scholars' Project on Emerging nanotechnologies: http://nanotechproject.org.

The following list includes some examples of products available on the Australian market whose manufacturers or retailers acknowledge manufactured nanomaterial content. As there is no requirement for manufacturers to acknowledge nanomaterial content, it is likely that this list represents a small fraction of the products that contain nanomaterials which are actually sold commercially in Australia:

- Transparent sunscreens (several hundred available)
- Cosmetics including lipsticks, face powders, moisturisers and anti-ageing creams (including those sold by Revlon, Avon and L'Oreal)
- Food packaging, including bottle coatings and nanobiocomposite packaging used by Cadbury and other companies in confectionery trays
- Stain, moisture, odour-repellent and antibacterial clothing (including Australian Wool Innovation Ltd clothing impregnated with silver nanoparticles, and NanoTex treated outdoor wear)
- Agricultural chemical, Syngenta's Primo MAXX plant growth treatment
- Long-lasting paints and furniture varnishes, including range sold by Bondall Paints and Dulux
- Household appliances including refrigerators sold by Samsung, LG Electronics and Hitachi, and vacuum cleaners, air conditioners and washing machines sold by Samsung
- Self-cleaning windows and building surfaces
- Industrial catalysts
- Household disinfectants and cleaning products including wipes
- Health supplements

Friends of the Earth Australia, Europe and United States have recently published a feature report on the growing use of nanotechnology in food and agriculture. This identified 104 food, food packaging, food contact materials and agricultural products that are now commercially available internationally. This report is available at our website http://nano.foe.org.au for your information.

More sophisticated applications of nanotechnology are expected in the next 5-15 years using 'active' nanostructures including 'smart' drugs for medicines; nanobiotechnology products for agriculture, environmental remediation and warfare; 'smart' foods, packaging and appliances; and nanodevices for medicine, manufacturing etc.

b. the health, safety and environmental risks and benefits of nanotechnology

Senior scientists, safety regulators and re-insurance providers have called for precautionary management of nanotoxicity risks

In 2004 the United Kingdom's Royal Society – the world's oldest scientific institution – in conjunction with the Royal Academy of Engineering made very explicit recommendations for the precautionary management of nanotoxicity risks[8]:

- "We recommend that chemicals in the form of nanoparticles or nanotubes be treated as new substances ...in the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)... (Section 8.3.2: paragraphs 18 & 19)"
- "We recommend that ingredients in the form of nanoparticles undergo a full safety assessment by the relevant scientific advisory body before they are permitted for use in products... (Section 8.3.3: paragraph 24 & 23)"
- "We recommend that the ingredients lists of consumer products should identify the fact that manufactured nanoparticulate material has been added (Section 8.3.3: paragraph 26)"
- "Until more is known about environmental impacts of nanoparticles and nanotubes, we recommend that the release of manufactured nanoparticles and nanotubes into the environment be avoided as far as possible (Section 5.7: paragraph 63)"
- "Specifically, in relation to two main sources of current and potential releases of free nanoparticles and nanotubes to the environment, we recommend:
  (i) that factories and research laboratories treat manufactured nanoparticles and nanotubes as if they were hazardous, and seek to reduce or remove them from waste streams. (Section 5.4: paragraph 41)
  (ii) that the use of free (that is, not fixed in a matrix) manufactured nanoparticles in environmental applications such as remediation be prohibited until appropriate research has been undertaken and it can be demonstrated that the potential benefits outweigh the potential risks. (Section 5.4: paragraph 44)"

Yet almost four years later, there are still no nanotechnology-specific laws at a national level anywhere in the world.

The Head of the Science Strategy and Statistics Division of the UK Health and Safety Executive has also recommended that rigorous regulation be developed to prevent nanoparticle exposure becoming the 'new asbestos'. He noted that if regulators introduce "controls that are too lax, significant health effects [will] harm many people. The history of asbestos should warn all of society of the human and financial costs of this possibility"[9].

To safeguard against a repeat of the asbestos experience, the world's second largest re-insurer, Swiss Re, has also emphasized that conservative regulation that puts health and safety first must be adopted to manage nanotechnology's risks, irrespective of uncertainties in scientific circles: "In view of the dangers to society that could arise out of the establishment of nanotechnology, and given the uncertainty prevailing in

scientific circles, the precautionary principle should be applied whatever the difficulties"[10].

Yet despite the clear need for action to protect workers, the public and the environment from nanotoxicity's risks, existing regulations in Australia and internationally still fail to differentiate between larger particles and nanoparticles. There are still no nanotechnology-specific national level regulations anywhere in the world.

Of great concern, research into nanotechnology's risks and challenges is also grossly under-funded. Highly relevant research into nanotechnology's health and environment risks receives less than 0.85% (US$11 million) of the United States NNI budget[11] and only 5% of the European Sixth Framework Programme budget (2002-2006)[12]. World-wide, a tiny 0.4% of nanotechnology research spending is on research into risks for human health and the environment[13]. Although the amount of funding dedicated to nanotoxicology research in Australia has increased recently, it is still insufficient to enable researchers to investigate the safety of many of the nanomaterials now in commercial use.

Evidence of probable harm to human health

There is a growing body of evidence demonstrating that nanomaterials used in commercially available consumer and industrial products present very serious new toxicity risks to human health. Yet countless numbers of workers and the public are being exposed to manufactured nanomaterials daily while there is a dearth of data on potential long-term or chronic effects of these materials[14].

There is a general relationship between toxicity and particle size. The smaller a particle, the greater its surface area compared to its volume, the higher its chemical reactivity and biological activity, and the more likely it is to prove toxic[15]. There is often no relationship between the toxicity of a nanoparticle and the toxicity of a larger particle of the same substance[16]. This key principle is yet to be reflected in the regulatory system.

The extremely small size of nanomaterials means that they are much more readily taken up by the human body than larger sized particles. Nanomaterials gain ready access to the blood stream following inhalation[17] or ingestion[18]. At least some nanomaterials can penetrate the skin[19], especially if skin is flexed[20] or exposed to surfactants[21] as is likely in many workplaces. Broken skin is an ineffective particle barrier[22], permitting uptake of particles 7,000nm in size.

Once in the blood stream, nanomaterials can be transported around the body and are taken up by organs and tissues including the brain, heart, liver, kidneys, spleen, bone marrow and nervous system[23]. Nanoparticles are able to cross membranes and gain access to cells, tissues and organs that larger sized particles normally cannot[24]. Unlike larger particles, nanomaterials may be taken up by cell mitochondria[25] and the cell nucleus[26]. Nanomaterials have proved toxic to human tissue and cell cultures, resulting in increased oxidative stress, inflammatory cytokine production and cell

death[27]. Test tube studies have shown that nanomaterials can cause DNA mutation[28] and induce major structural damage to mitochondria, even resulting in cell death[29]. We know very little about how long nanoparticles may remain in the body and what sort of 'dose' produces a toxic effect.

Animal studies have routinely demonstrated an increase in lung inflammation, oxidative stress and negative impacts in other organs following exposure to implanted or inhaled manufactured nanoparticles[30]. Irrespective of their chemical composition, manufactured nanoparticles are also recognized to be potent inducers of inflammatory lung injury in humans[31]. Workplace exposure to nanoscale fibres (e.g. carbon nanotubes) is of obvious concern given the well-established association of fibres such as asbestos with serious pulmonary disease. One study exposed rodents to carbon nanotubes at levels that proportionately reflected the existing permissible exposure limit for carbon graphite particles (there are no set exposure limits for nanomaterials)[32]. This resulted in inflammation, reduced pulmonary function and the early onset of fibrosis. Carbon nanotubes were more toxic than comparable quantities (by weight) of ultra-fine carbon black or silica dust. The authors concluded that if workers were exposed to carbon nanotubes at the current permissible exposure limit for graphite particles, they would be at risk of developing lung lesions[33].

Nanoparticles have proved toxic to tissue and cell cultures *in vitro* (test tube studies). Nanoparticle exposure has resulted in increased oxidative stress, inflammatory cytokine production and even cell death[34]. Test tube studies have found that even low levels of fullerene (buckyball) exposure have been shown to be toxic to human liver cells[35]. Fullerene-based amino acid nanoparticles have been found to decrease the viability of human skin cells and initiate a pro-inflammatory response[36]. In a test tube experiment 20nm nanoparticles of titanium dioxide caused complete destruction of supercoiled DNA[37]. Also in the absence of UV, in another test tube experiment titanium dioxide produced reactive oxygen species in brain immune cells[38]. Pilot data from test tube experiments show nanoparticle titanium dioxide exposure negatively affected cellular function[39] and caused death of brain immune cells after 24 hours exposure[40]. Test tube studies also demonstrate that silver nanoparticles are highly toxic to rat brain cells[41], mouse stem cells[42] and rat liver cells[43].

Size is a key factor in determining the potential toxicity of a particle. However it is not the only important factor. Other properties of nanomaterials that influence toxicity include: chemical composition, shape, surface structure, surface charge, aggregation and solubility[44], and the presence or absence of 'functional groups' of other chemicals[45]. The large number of variables influencing toxicity means that it is difficult to generalise about health risks associated with exposure to nanomaterials – each new nanomaterial must be assessed individually and all material properties must be taken into account.

Workers who handle, manufacture, package or transport products that contain manufactured nanomaterials are likely to face higher levels of exposure than the public and on a more routine basis. This is of great concern because scientists still do not know what levels of nanomaterial exposure may harm workers' health, and whether or not any level of occupational exposure to nanomaterials may be safe. Furthermore, reliable systems and equipment to prevent occupational exposure do not

yet exist, and we have yet to identify a general basis for measuring and characterising nanomaterial exposure that does occur[46].

In March 2007, the International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations (IUF) called for a global moratorium on nanotechnology. The IUF represents nearly 12 million workers from over 120 countries. The IUF cited concerns regarding occupational exposure to nanomaterials, the health and environmental risks of nanotoxicity, the broader socio-economic implications of nanotechnology, and the failure to involve the public in decision making about the introduction of this powerful new technology.

Key environmental risks and challenges

Nanotechnology could facilitate the radical expansion of resource and energy consumption, and pollution and waste emission, while introducing a whole new range of serious ecological risks.

Nanotechnology is being touted as the technological platform that will underpin the next industrial revolution. Industry is promoting nanotechnology as an essentially 'green' technology that will improve the environmental performance of existing industries, reduce our consumption of resources and energy, and allow us to achieve environmentally benign economic expansion. In other words, nanotechnology's proponents claim it will solve problems of water scarcity, pollution, climate chaos etc, while enabling us to continue unfettered economic growth. These claims should be treated with great caution. Environmental implications of nanotechnology, and research into environmentally useful applications, receive a tiny proportion of existing research funding internationally. Furthermore, history shows that many past technologies that offered efficiency gains resulted in further, more efficient growth, rather than translating into environmental savings. Perhaps of most concern, the current development trajectory of nanotechnology demonstrates that industry is committed to commercialising nanotechnology even though senior scientists have expressed concern about the toxicity of nanomaterials, and their risks for the environment and human health remain poorly understood.

Nanoparticles and devices may constitute a whole new class of non-biodegradable pollutants. Preliminary scientific studies demonstrate that some nanomaterials already in widespread commercial use pose serious toxicity risks not only to human health, but also to the environment. The little research completed cautions against broad extrapolation of results. However the preliminary findings indicate the potential for serious environmental impacts and point to the urgent need for further study.

Carbon fullerenes (buckyballs) have been found to cause brain damage in largemouth bass[47], a species accepted by United States regulatory agencies as a model for defining ecotoxicological effects. Fullerenes have also been found to kill water fleas[48] and have bactericidal properties[49]. Byproducts associated with the manufacture of single-walled carbon nanotubes caused increased mortality and delayed development of a small estuarine crustacean *Amphiascus tenuiremis*[50]. The antimicrobial properties of many nanoparticles have led to concerns that they may shift into microbial

populations and disrupt signalling between nitrogen-fixing bacteria and their plant hosts[51]. Any significant disruption of nitrogen fixing could halt plant growth and have serious negative impacts for the functioning of entire ecosystems. This would have significant ecologic and economic impacts. High levels of exposure to nanoscale aluminium have been found to stunt root growth in five commercial crop species[52]. Early studies also suggest that micro-organisms and plants may be able to produce, modify and concentrate nanoparticles that can then bioaccumulate (or even biomagnify) along the food chain[53].

Literally dozens of sites in the United States have already been injected with tens of tonnes of nanoparticles for remediation or waste treatment purposes[54], despite no study having being carried out to assess the safety of these nanoparticles for environmentally relevant species[55]. There is little published, peer-reviewed information available about the outcomes of these releases, however they of serious concern given early indications that nanoparticles present a whole new range of serious ecological threats[56]. Our investigations have not identified any mass release of nanomaterials into the Australian environment for remediation or other purposes, although the potential for this to occur is of serious concern.

Broader social challenges associated with a nanotechnology 'revolution'

The absence of a specific term of reference that addresses nanotechnology's social implications is disappointing. We often hear from industry uncritical claims of nanotechnology's potential to deliver massive social benefits. However while concerns that manufactured nanomaterials are introducing serious new toxicity risks are subject to robust testing and evaluation, claims of nanotechnology's potential to deliver social benefits usually remain untested. This is unfortunate given that the community is constantly told that it must accept the risks and challenges associated with nanotechnology in order to secure these future social benefits.

Friends of the Earth agrees that nanotechnology has the potential to deliver interesting innovations in a range of fields. However we are concerned that the net impact of nanotechnology's introduction may not be beneficial to all members of society, but rather introduce a range of new challenges, disruptions and social inequities for which we are ill-prepared. To date there has been almost no critical discussion about the important social challenges that nanotechnology presents – and no opportunity for public participation in decision making regarding the allocation of research funding or in relation to nanotechnology governance.

It is important to consider carefully the likely social, economic and political implications of nanotechnology's development, because of the scale of change that nanotechnology is predicted to bring. Governments and business leaders world wide suggest that we are on the cusp of a nanotechnology-enabled 'revolution' that will transform every sector of industry, bringing far-reaching changes to economic, social and ecological relations. The Asia-Pacific Economic Cooperation (APEC) forum notes that: "If nanotechnology is going to revolutionise manufacturing, health care, energy supply, communications and probably defence, then it will transform labour and the workplace, the medical system, the transportation and power infrastructures and the military. None of these latter will be changed without

significant social disruption"[57]. The Australian National Nanotechnology Strategy Taskforce states that nanotechnology "has the potential to fundamentally alter the way people live"[58].

The analysis of the implications of a possible nanotechnology-driven revolution remains sharply divided. Nanotechnology optimists see nanotechnology delivering environmentally benign material abundance for all, by providing: universal clean water supplies; atomically engineered food and crops resulting in greater productivity with less labour requirements; nutritionally enhanced interactive 'smart' foods; cheap and powerful energy generation; clean and highly efficient manufacturing; radically improved formulation of drugs, diagnostics and organ replacement; much greater information storage and communication capacities; and personalised interactive 'smart' appliances and computers. Some nano-proponents suggest that convergent nanoscale technologies will also enable us to expand human mental, physical and military performance and to dramatically extend life expectancy[59].

Conversely, nanotechnology sceptics suggest that it will exacerbate existing socio-economic inequity and the unequal distribution of power by: creating greater inequities between rich and poor through an inevitable nano-divide; entrenching corporate concentration and enabling its control of even the very building blocks of the natural world; further eroding food sovereignty; distorting international power relations through its military applications and trade impacts; providing the tools for ubiquitous surveillance, with significant implications for civil liberty; introducing serious and poorly understood risks to the health of humans and the environment; and breaking down the barriers between life and non-life, redefining even what it means to be human. Vandana Shiva has argued that synthesising nanotechnology alternatives to food will "accelerate existing trends of patent monopolies over life – making a few corporations 'life-lords'" [60]. Fearing that the expansion of nanotechnology into agriculture will further erode the ability of peasant, fishing and farming communities to retain local control and ownership of food production, the 2007 international 'Nyeleni Forum for Food Sovereignty' resolved to work towards an immediate moratorium on nanotechnology[61].

It's hard to comprehend just how nanotechnology will change our world and to what extent the dramatic predictions of 'revolution' will be realised. But the current development trajectory of nanotechnology suggests that it will exacerbate existing social inequities and create new ones. There is an urgent need to create mechanisms to support public participation in the determination of research priorities and the development of governance measures, and to plan how best to maximise societal benefits and to mitigate adverse socio-economic impacts. Perhaps most important, given the predictions of a 'revolution' being driven by public monies, is the challenge to democratise nanotechnology's development and governance. Rather than nanotechnology's development simply reflecting commercial and military interests, it is time for public participation and public interest priorities to shape its trajectory.

c. the appropriateness of the current regulatory frameworks in operation for the management of nanomaterials over their life-cycle

In order to ensure appropriate management of the immediate toxicity risks posed by first generation nanomaterials, the more complex biosafety and other risks of next generation nanotechnology, and its broader social challenges, a comprehensive and integrated nanotechnology-specific governance framework is required, developed following a robust program of public participation. A piecemeal approach to nanotechnology regulation will leave people and the environment exposed to serious risks and will fail to manage nanotechnology's social challenges, setting the nanotechnology industry up for a repeat of the genetically engineered food mistakes.

In its 2006 report, the European Union's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) recognised the many systemic failures of existing regulatory systems to manage the risks associated with nanotoxicity[62]. Despite its clear public interest value, the review conducted by Monash University academics of Australia's regulatory systems and their adequacy to manage the risks associated with nanotechnology has not been released publicly[63]. However academic reviews of regulatory measures in Australia, as well as England, the United States and Japan found that none of these countries require manufacturers to conduct nanotechnology-specific safety assessments of products that contain manufactured nanomaterials before they are released on to the market[64].

Existing regulatory systems treat all particles the same; that is, they do not recognise that nanoparticles of familiar substances may have novel properties and novel risks[65]. We know that many nanoparticles now in commercial use often pose greater toxicity risks than the same materials in larger particle form. However if a substance has been approved for commercial use in larger particle form, it is also legal to use it in nanoparticle form. There is no requirement for new safety testing, food labelling to inform consumers, new occupational exposure standards or mitigation measures to protect workers or to ensure environmental safety. Incredibly, there is not even a requirement that the manufacturer notify the relevant regulator, that they are using nanomaterials in the manufacture of their products.

Five reasons why existing laws are inadequate to assess the risks posed by nanomaterials in commercial use

Reason 1: Toxicity risks of nanomaterials remain very poorly understood
The current scientific evidence of the risks associated with nanomaterials is sufficient to warrant a precautionary approach to their management. However significant knowledge gaps remain, presenting a barrier to the development of effective regulation of nanomaterials in commercial use.

Reason 2: Nanomaterials are not assessed as new chemicals
Existing regulations do not treat nanomaterials as new chemicals. If a chemical has been approved in larger particle form, the new use of the substance in nanoparticle

form does not trigger any requirement for new or additional safety testing. This has also been recognized as a critical regulatory gap by the United Kingdom's Royal Society and Royal Academy of Engineering who recommended that all nanomaterials be assessed as new chemicals[66].

Reason 3: Current methods for measuring exposure are not suitable for nano
Existing regulations are based on the mass of the material as a predictor for expected exposure rates. This approach is completely inappropriate as the toxicity of nanomaterials can be far greater per unit of mass[67]. Scientists have suggested that nanoparticle surface area or the number of nanoparticles is a more valid metric for measurement of nano exposure[68].

Reason 4: Current safety testing is not suitable for nano
Even if a nanomaterial triggered new safety testing, current test guidelines are inadequate for nanomaterials as they do not assess key properties that influence nanotoxicity. These include: chemical composition, shape, surface structure, surface charge, aggregation, solubility and the presence or absence of 'functional groups' of other chemicals[69]. Nanomaterials should also face full life-cycle assessment.

Reason 5: Many safety assessments use confidential industry studies
Past assessments of nanomaterials safety by the European Scientific Committee on Cosmetics and Non-Food Products and the United States Food and Drug Administration have relied on proprietary company studies[70]. There is often no requirement for the safety of nanomaterials to be assessed by independent nanotoxicologists or for the results and methodology of this safety testing to be made public.

e. the adequacy of the National Nanotechnology Strategy in the New South Wales context

Friends of the Earth has prepared a detailed analysis of the report "Options for a National Nanotechnology Strategy" which is attached for your information. For ready reference, key deficiencies identified include:

- No proposal for a new regulatory regime capable of managing nanotechnology's many risks and challenges
- Rejection of the precautionary principle
- No recommendation for meaningful public participation in the development of the National Nanotechnology Strategy
- No discussion of the impacts of technological convergence, which most commentators believe is critical to nanotechnology's transformative potential
- No immediate action to protect workers, the public and the environment from the risks of nanotoxicity
- No discussion of the application of nanotechnology to food and agriculture
- No support for mandatory product labelling to enable consumers to make an informed choice
- No serious treatment of ethical concerns associated with nanobiotechnology, human enhancement, military applications or nano-surveillance
- No strategy to manage risks of nanobiotechnology, including to safeguard against nanobioweaponry or nanobioterrorism
- No economic analysis, or discussion of nanotechnology's potential impacts on labour markets, commodity trade, or capacity to result in large-scale economic upheaval
- Consistent failure to put public interests ahead of business interests

All of these deficiencies will have implications in the NSW context. There is an urgent need for review of the National Nanotechnology Strategy. NSW could play a useful role, along with the other states, in assisting the federal government to develop a more adequate National Nanotechnology Strategy.

f. the level of community understanding of nanotechnology and options to improve public awareness of nanotechnology issues.

The efforts of this public inquiry are commendable, providing one of the few opportunities for interested civil society stakeholders and individuals to make submissions on nanotechnology for consideration by government. However given that most Australians have never even heard of nanotechnology, let alone have an understanding of the range of its applications and implications, it is to be expected that response rates will be low. Given the extremely low levels of public awareness about nanotechnology, and the large-scale social changes that it is forecast to underpin, a broad ranging longer term process public participation process is required to enable informed public input into state and federal government policy development on nanotechnology. A new range of public participation techniques and initiatives is required to ensure robust public involvement in debate and decision making about this complex and emergent issue.

It is critical that this inquiry identifies the need for a broad ranging program that supports public participation in nanotechnology policy development, not just mechanisms to raise public 'awareness'. Unfortunately, public 'awareness' activities all too often appear to have the goal of public 'education' with a view to promoting public acceptance of decisions that have already been taken. Conversely, along with the Australian Consumers Association, the Biological Farmers of Australia, the GeneEthics Network, the Public Health Association of Australia and the SEARCH Foundation, Friends of the Earth has called for a genuine public participation process to inform nanotechnology policy development and decision making[71].

There are 3 principle reasons to support a genuine, robust program of public participation in nanotechnology decision making.

- Recognition that people have a right to participate in decision making about a technology predicted to drive such widespread and disruptive change.
- Recognition that public participation in government decision making improves outcomes.
- Recognition that if industry and government do not involve the public in decision making, they risk running a repeat of the genetic engineering backlash.

Lessons from the backlash against genetically engineered food include the importance of ensuring that: risk governance has public confidence; social and ethical issues are addressed alongside safety issues; and a two-way dialogue is established between the public and decision makers early in the technology's development to inform decision making in relation to the allocation of public funding and research priorities, governance and regulation. Studies have identified that these issues are also important in relation to nanotechnology[72].

A nanotechnology public participation program should include the following elements:

- Leadership from the top. Explicit public statements from relevant Federal and State Ministers that commit the government to a genuine, robust, transparent process of public participation, in order to inform development of future policy and governance.

- Clear goal for outcomes of public participation to inform subsequent decision making and policy development. That is, to define a goal of public *participation in decision making*, not public education with a view to promoting acceptance of decisions made by others, or unfocused 'engagement'
- Clear objective to identify public preferences and priorities for nanotechnology development, in the context of broader innovation and technology policy. Commitment to ensure that public preferences and priorities will inform subsequent decision making, including in the instance that the public does not want to pursue certain aspects of nanotechnology development.
- Commitment to the program including the following elements:
    - Participation from senior bureaucrats, representing the Federal and State Governments, throughout the program
    - Core activities to be led by an independent institution or individuals with expertise in public participation
    - Oversight from a steering group comprising a range of stakeholders (eg government, industry, research, labour, civil society)
    - Broad range of activities that include those based on the deliberative design model (eg citizen juries or consensus conferences), open public forums and stakeholder engagement
    - Transparency in process, including public reporting of the program's goals and objectives, structure, process and outcomes
    - Appropriate and adequate resourcing
    - Governments to commit to making formal response to the public participation program's findings at its close

Recommendations

Friends of the Earth Australia calls on the NSW Standing Committee on State Development to support a moratorium on the commercial use of nanotechnology until the following are achieved:

- Robust program of public participation is initiated to inform decision making regarding nanotechnology, research funding, and governance issues
- All relevant stakeholders are given the opportunity to contribute to a review of Australia's management of nanotechnology, including efforts to address its risks and challenges
- Precaution-based, comprehensive legislation is introduced to protect the public, workers and the environment from nanotechnology's risks and to manage its social challenges
- All nanomaterials are classified as new chemicals (as per recommendations from the United Kingdom's Royal Society) and subject to rigorous new safety assessment prior to commercial use
- Proactive research and monitoring regime is established
- Mandatory labelling of any approved nanomaterial and nanotechnology-based ingredients or components of commercial products

We observe that other groups internationally have also called for conditional moratoriums on nanotechnology's commercial development until concerns about health, safety and environment risks, social issues and public participation have been addressed. Groups which have called for a moratorium include:

Friends of the Australia, Europe, United States
Corporate Watch (UK)
ETC Group
GeneEthics (Australia)
Greenpeace International
International Center for Technology Assessment
International Federation of Journalists
International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations
Practical Action
The Soil Association (UK)

Appendix: An analysis by Friends of the Earth of the National Nanotechnology Strategy Taskforce report: "Options for a National Nanotechnology Strategy"

September 2006

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Executive Summary

The long awaited release of the National Nanotechnology Taskforce report "Options for a National Nanotechnology Strategy" has done little to allay fears that the government is continuing to put the interests of the nanotechnology industry ahead of those of the public.

"Options for a National Nanotechnology Strategy" consistently fails to deal with the most pressing public interest issues raised by nanotechnology, at times ignoring them completely. Key failures of the Nanotechnology Taskforce report include:

- Failure to propose an integrated new regulatory regime capable of dealing with the complex array of new risks and challenges posed by nanotechnology;
- Failure to support the Precautionary Principle in the regulation of nanotechnology. This defies the calls for precaution-based regulation made by the world's oldest scientific institution, the United Kingdom's Royal Society, and also the world's second largest re-insurer, Swiss Re;
- Failure to insist on public participation in nanotechnology decision making before the National Nanotechnology Strategy is finalised;
- Failure to investigate the impacts of technological convergence, which most commentators believe is critical to nanotechnology's transformative potential, and therefore likely to result in the most significant economic, social and environmental impacts, and pose the most complex ethical challenges;
- Failure to recommend immediate action to protect workers, the public and the environment from nanotoxicity, despite growing evidence that exposure to nanomaterials may result in serious harm;
- Failure to acknowledge and act on concerns about the use of nanotechnology in food and agriculture;
- Failure to recommend a comprehensive labeling regime of all products containing nanomaterials in order to enable consumers to make an informed choice about using these products;
- Failure to recognize the serious nature of the ethical challenges posed by nanotechnology, including those that relate to nanobiotechnology, human enhancement, military and surveillance applications;
- Failure to undertake any economic analysis, including failure to investigate nanotechnology's potential impacts on labour markets, commodity trade, or capacity to result in large-scale economic upheaval;
- Failure to recommend a strategy to grapple with the very serious risks posed the development of nanobioweaponry and nanobioterrorism;
- Consistent privileging of the interests of the emerging nanotechnology business sector ahead of those of the public.

In light of these failures, Friends of the Earth reiterates its call for an immediate moratorium on all commercial research, development and release of nanotechnological materials and products.

No proposal for a new regulatory regime capable of managing nanotechnology's many risks and challenges

Nanotechnology and the emergence of nanoscale convergent technologies (see below) presents serious new risks and challenges for which existing regulatory structures are ill-equipped. Australia urgently requires the development of a new, integrated regulatory regime that has the authority, resources and capacity to manage the social, economic, environmental and ethical issues related to nanotechnology. It is critical that this new regulatory regime has the capacity to manage near term nanotechnology and convergent technology applications, including nanobiotechnology products, human enhancement applications, 'smart' nano-based food packaging etc, in addition to the hundreds of commercial products that already contain engineered nanoparticles.

Existing regulatory structures are incapable of adequately assessing and managing the complex array of issues associated with nanotechnology's applications. For example, the use of nanobiotechnology to modify living organisms for agriculture, environmental remediation or military purposes poses a suite of disparate risks and challenges. Nanobiotechnology poses complex ethical challenges associated with its manipulation of living and non-living materials at the atomic scale. It also introduces serious risks to human and environmental health because of the potential for modified organisms to shift into non-target systems or cause unintended consequences within target systems, including but not limited to toxicological impacts or unintended high rates of replication. Nanobiotechnology also introduces complex security and political risks. Irrespective of the purpose for which organisms such as viruses or bacteria have been modified using nanobiotechnology, a potential exists for state governments or terrorist groups to access modified organisms or DNA to develop nanobioweaponry or for purposes of nanobioterrorism.

The Nanotechnology Taskforce's view that "there is currently no case for establishing any new, nanotechnology-specific regulations, but rather, existing regulations may need some adjustment"[73] is therefore both inadequate and alarming. A piecemeal revision of existing legislation will not deliver the capacity required to manage nanotechnology's risks and will fall far short of community expectations.

Rejection of the precautionary principle

The Nanotechnology Taskforce's rejection of the precautionary principle and its proposal to restrict changes to existing regulatory frameworks to those deemed necessary to manage "evidence-based risks" is also problematic. This approach assumes that an absence of evidence of harm is evidence of an absence of harm, which is entirely inappropriate in an emerging field such as nanotoxicology.

There is a small but growing body of nanotoxicological literature. The published studies indicate that nanoparticles can pose serious new risks for human health and the environment[74], but these risks remain poorly understood. Essentially, we know enough to conclude that nanoparticles present greater toxicity risks than larger

particles of the same substance, but we do not yet know enough to quantify or control these risks.

The small amount of toxicological research examining nanotechnology's implications for human health and the environment is a direct consequence of government and industry's failure to fund this research. Dr Andrew Maynard, Science Advisor to the US Project on Emerging Nanotechnologies, estimates[75] that in 2005, the US government spent US$1 billion on commercial and military nanotechnology research and development, but only about US$11 million studying potential environmental and health consequences.

Given that we have so few published studies in this important area, but preliminary studies that suggest that the risks associated with nanotoxicity may be serious, it is appropriate to take a precaution-based approach to managing these risks until greater research funding enables a better understanding. This has been recognised by the United Kingdom's Royal Society, which has called for the burden of proof of safety to be placed on the shoulders of industry.

In its 2004 report, the Royal Society recommended that nanomaterials should be treated as new chemicals[76] and be subject to new safety assessments prior to their inclusion in consumer products[77]. The Royal Society further recommended that factories and research laboratories should treat nanomaterials as if they were hazardous[78], and until the environmental impacts of nanomaterials are better known, their release into the environment should be avoided as far as possible[79].

The world's second largest re-insurer, Swiss Re, has also advocated[80] a strict application of the precautionary principle in the regulation of nanotechnology. Swiss Re emphasizes that conservative regulation that puts health and safety first must be adopted, irrespective of uncertainties in scientific circles. It warns that unless such an approach is adopted, governments and industry may leave themselves vulnerable to huge future liability should the products of nanotechnology cause serious harm to people's health, as happened with asbestos.

The Nanotechnology Taskforce is suggesting a reversal of the burden of proof supported by the Royal Society and Swiss Re. Instead of industry being required to demonstrate evidence of the safety of its products, the Nanotechnology Taskforce is proposing that the under funded emerging field of nanotoxicology be required to demonstrate evidence of harm. The privileging of business over community interests is not a sound basis for a regulatory regime established to protect public safety.

No recommendation for meaningful public participation in the development of the National Nanotechnology Strategy

The Nanotechnology Taskforce's report recognises that nanotechnology "has the potential to fundamentally alter the way people live[81]". The report suggests that nanotechnology has the capacity to transform every sector of industry, within a decade bringing changes "as significant as the impact of electricity or the microchip[82]". The report also foreshadows the use of convergent nanotechnology,

information technology, cognitive science and biotechnology to form "the basis for a range of products that will improve human [mental, physical and military] performance[83]".

Yet despite recognising that nanotechnology could quite literally reshape our future world from the atom up, and even redefine what it means to be human, the Nanotechnology Taskforce makes no recommendation to involve the public in the finalisation of the National Nanotechnology Strategy before the Industry Minister announces it in early 2007. This is particularly problematic as the Taskforce made extremely inadequate efforts to involve the community in the development of its potions report.

Most Australians have never even heard of nanotechnology, let alone have an understanding of the range of its applications and implications. Given the extremely low levels of public awareness about nanotechnology, a broad ranging longer term process public participation process is clearly required to enable informed public input into government policy development on nanotechnology. Along with the Australian Consumers Association, the Biological Farmers of Australia, the GeneEthics Network, the Public Health Association of Australia and the SEARCH Foundation, Friends of the Earth has called for[84] a genuine public participation process to include: oversight from an independent steering committee; clear links to government decision making processes; a wide range of participatory processes, including direct engagement (eg a series of public meetings and forums) as well as processes based on the deliberative design model (eg consensus conferences or citizens' juries); the involvement of a wide range of stakeholder groups; and a broad based public outreach and education program.

In stark contrast, the one-off call from the Nanotechnology Taskforce via advertisements in major metropolitan newspapers for public submissions to its work was never likely to result in a meaningful response. The inadequacy of this mechanism of 'public engagement' is evidenced by the mere four submissions the Taskforce received from individual members of the public. The meagre efforts of the Taskforce to undertake public outreach can be contrasted with its extensive and multi-faceted outreach to the business and research communities.

The failure to ensure that public participation processes inform government decision making on nanotechnology at this crucial stage suggests that the government is still pursuing a 'decide, announce, defend' approach to nanotechnology, where public 'education' takes place well after decisions have been made. The Taskforce states that "a structured and comprehensive process of informing and engaging the community on nanotechnology issues" should be initiated "as a matter of urgency"[85] – but this will take place after the Nanotechnology Strategy is finalised.

The entire discussion about public engagement is framed by a desire to promote public acceptance of nanotechnology. There is no consideration at any time by the Taskforce that an informed public may decide against pursuing certain applications of nanotechnology, or even against Australia's involvement in the industry as a whole.

No discussion of the impacts of technological convergence, which most commentators believe is critical to nanotechnology's transformative potential

Despite its stated intention to provide options for Australia's management of nanotechnology into the future, the Nanotechnology Taskforce report was almost exclusively focussed on existing or near term nanotechnology, eg nanomaterials and nanodevices. It failed to discuss nanotechnology's capacity to act as a platform technology, enabling the convergence of a wide field of existing sciences and techno-sciences capable of operating at the nanoscale. This omission was significant, as although most public attention is currently focussed on the existing first generation of nanoproducts (nanomaterials now found in cosmetics, sunscreens, fabrics, paints and some food products), industry observers suggest that it is nanotechnology's capacity for convergence that will result in the most significant technological breakthroughs, economic and social impacts, and will raise far more challenging ethical issues.

The US National Science Foundation and Department of Defence view nanoscale convergent technologies as the platform on which the most significant breakthroughs will take place:

"Convergence of diverse technologies is based on material unity at the nanoscale and on technology integration from that scale... [Nanoscience and nanotechnology] will allow us to understand and, when desirable, to control the behavior both of complex microsystems, such as neurons and computer components, and macrosystems, such as human metabolism and transportation vehicles"[86].

The ETC Group agree that technological convergence underpins nanotechnology's transformative potential and suggest that it raises important issues of access and corporate control:

"The real power of nanoscale science is the potential to converge disparate technologies that can operate at this scale. With applications spanning all industry sectors, technological convergence at the nanoscale is poised to become the strategic platform for global control of manufacturing, food, agriculture and health in the immediate years ahead"[87].

No immediate action to protect workers, the public and the environment from the risks of nanotoxicity

The Nanotechnology Taskforce acknowledged that regulatory changes may be required to ensure the safety of products that contain engineered nanoparticles. Clearly, the Taskforce recognises that health scares or environmental disasters related to engineered nanoparticles will undermine confidence in the entire nanotechnology sector. It was therefore extremely disappointing that the Taskforce did not recommend a halt to the commercial release of products containing engineered nanoparticles until an appropriate regulatory regime can be established – despite the fact that this may take years. Failure to protect workers, the public and the environment from toxicity risks associated with exposure to nanomaterials may result in serious harm, leaving government and industry vulnerable to massive future liability.

The risks of harm to health from exposure to nanomaterials are highest for workers, who are likely to be exposed at higher levels, and on a more routine basis than the general public. This is of great concern given the burgeoning number of Australian workers who may face occupational exposure to nanomaterials. Workers can be exposed to nanomaterials during the research, development, manufacture, transport and use of nanotechnology products. Exposure can also occur in cleaning of research, production and handling facilities. The Taskforce report cites an estimate by Professor Peter Andrew, The Queensland Chief Scientist, that by 2015 Australia "will need 125,000 nanotechnology workers in order to maintain a 1% share of the emerging industry"[88]. If the industry employs 125,000 people directly, it is likely that many more will come into contact with nanomaterials throughout the production and handling chain, underscoring the importance of ensuring that workers do not face unsafe occupational exposure.

Our experience with asbestos has given Australia first hand knowledge of the huge human and financial cost of failure to take action following early warning signs of harm to health associated with 'wonder materials'. In Australia, between 1987 and 2010, asbestos exposure is predicted to result in 16,000 deaths from mesothelioma and 40,000 deaths from lung cancer[89]. Asbestos liability is by far the largest cost facing the global insurance industry today. The three waves of asbestos claims have cost US insurers and re-insurers alone approximately US$135 billion, with a future fourth wave of claims estimated to be as great as an additional US$200 to $275 billion[90].

The serious health risks posed by workplace exposure to nanomaterials share some striking similarities to those presented by asbestos. Animal studies have routinely demonstrated an increase in lung inflammation, oxidative stress and negative impacts in other organs following respiratory exposure to implanted or inhaled engineered nanoparticles[91]. Irespective of their chemical composition, engineered nanoparticles are recognized to be potent inducers of inflammatory lung injury in humans[92]. The UK Health and Safety Executive note that persistent lung inflammation as a result of exposure to nanoparticles (as with other toxic dust) is likely to lead to diseases such as fibrosis and cancer[93]. However the most important similarity between asbestos and nanoparticle exposure may be the lag time before the potential onset of serious harm to health – resulting in significant human and financial cost[94].

To safeguard against a repeat of the asbestos experience, the world's second largest re-insurer, Swiss Re, has advocated[95] a strict application of the precautionary principle in the regulation of nanotechnology. Swiss Re emphasizes that conservative regulation that puts health and safety first must be adopted, irrespective of uncertainties in scientific circles. The Head of the Science Strategy and Statistics Division of the UK Health and Safety Executive has also recommended that rigorous regulation be developed to prevent nanoparticle exposure becoming the 'new asbestos'. He noted that if regulators introduced "controls that are too lax, significant health effects [will] harm many people. The history of asbestos should warn all of society of the human and financial costs of this possibility"[96].

In 2004 the United Kingdom's Royal Society recommended that factories and research laboratories should treat nanomaterials as if they were hazardous[97]. It advised

that "ingredients in the form of nanoparticles should undergo a full safety assessment by the relevant scientific advisory body before they are permitted for use in products"[98]. However there are still no regulations anywhere in the world that protect the workers who manufacture and handle products containing nanomaterials, the public who use these products, and the environmental systems in to which waste products are released.

The Taskforce's failure to support a halt to the further commercial manufacture and release of products that contain engineered nanomaterials while appropriate safeguards and regulations are introduced to protect human and environmental health is a grave disappointment.

No discussion of the application of nanotechnology to food and agriculture

The recent public backlash over genetically engineered foods demonstrated the discomfort that many Australians have with scientists' manipulation of their food at its most fundamental levels. Yet the Nanotechnology Taskforce offered no discussion of the issues or risks associated with the use of nanotechnology in food and agriculture. This was particularly disappointing given the burgeoning numbers of food products that now contain nanomaterials.

The Helmut Kaiser Consultancy Group suggests that there are now over 300 nano food products available on the market worldwide[99]. It estimates that the global nano food market was worth US$5.3 billion in 2005 and will rise to US$20.4 billion by 2010. It predicts that nanotechnology will be used in 40% of the food industries by 2015.

The failure of governments to manage the toxicity risks of nanotechnology products used in agriculture and food production is clearly a concern, as is the failure to require mandatory labelling of nanoscale ingredients in food products. But community unease regarding the use of nanotechnology in food products is not restricted to fears over health impacts and anger about the absence of consumer choice. Additional sources of concern include: the ecological consequences of large-scale environmental release of nanotechnology and nanobiotechnology products; public resistance to scientists' manipulation of seeds and food products at the atomic scale; concern about the potential for greater levels of corporate control of global food production; and the further loss of privacy as nano surveillance used in new nano packaging tracks each step in the food chain.

No support for mandatory product labelling to enable consumers to make an informed choice

In the absence of a requirement for manufacturers to identify on product labels whether or not they include engineered nanoparticles, there is no way to know if a

given sunscreen, chocolate bar or cooking oil contains nano ingredients. In its 2004 report the United Kingdom's Royal Society recommended that in order to enable people to make an informed choice about whether or not to use products that contain engineered nanoparticles, "the ingredients lists of consumer products should identify the fact that manufactured nanoparticulate material has been added".[100]

The failure of the Nanotechnology Taskforce to recommend a mandatory labelling regime is disappointing, clearly reflecting a greater desire to minimise the burden on industry than a commitment to enable Australians to make informed purchasing choices.

No serious treatment of ethical concerns associated with nanobiotechnology, human enhancement, military applications or nano-surveillance

The Nanotechnology Taskforce makes only brief mention of the serious ethical challenges posed by nanotechnology in the context of discussing possible barriers to the technology's public acceptance. The Taskforce does not make recommendations for any independent assessment or management of nanotechnology's more controversial applications, for example: the use of nanobiotechnology to develop new and even more deadly weapons of mass destruction; the use of convergent technologies to 'enhance' human mental and physical performance; the development of nano-based weapons of mass destruction; and in the emerging field of nano-surveillance.

The Nanotechnology Taskforce fails to acknowledge that military research is driving international nanotechnology development and fails to evaluate the serious risks and implications of a growing nano arms race. Military research and development is already attracting the lion's share of nanotechnology funding from the US government, which is the world's largest single investor in nanotechnology[101]. In the 2006 US$1.3billion budget for the US National Nanotechnology Initiative[102], the US Department of Defense received US$436 million (33.5% of the nanotechnology budget), which was greater than the budget for the entire National Science Foundation. As far back as 1995, Retired Admiral David Jeremiah of the US navy stated his belief that nanotechnology will prove more significant than nuclear weapons in determining future political power relations[103]. Yet the Taskforce makes no proposal for a strategy to ensure that Australia plays its role in preventing the emergence of a deadly nano arms race.

The Taskforce's failure to take seriously concerns about these applications of nanotechnology appears to be related to its own view that nanotechnology "does not yet pose ethical challenges analogous to stem cells and genetically modified organisms"[104] and its observation that ethical concerns about nanotechnology are not yet an obstacle to wider public acceptance of the technology, due possibly to low levels of community awareness[105]. The failure to discuss ethical issues associated with nanotechnology, and to propose how they could best be managed, can be contrasted with the Taskforce's much more detailed discussion of nanotechnology's implications for human health and environmental safety, which it clearly considers to be a more immediate potential source of public concern (see below).

The failure of the Nanotechnology Taskforce to take seriously the ethical issues associated with nanotechnology is disappointing. It is difficult to see how the Taskforce has drawn the conclusion that nanotechnology poses fewer ethical challenges than genetic engineering, given applications of nanobiotechnology which manipulate biological organisms at the atomic scale to incorporate synthetic material. It is similarly difficult to understand the Taskforce's failure to identify significant ethical challenges in the field of human enhancement, or practical risks associated with military and surveillance applications of nanotechnology.

The government must take seriously ethical concerns and practical risks associated with nanotechnology's more controversial applications before a crisis in public confidence erupts – not as a response to it.

No strategy to manage risks of nanobiotechnology, including to safeguard against nanobioweaponry or nanobioterrorism

The failure to propose a strategy to manage the extremely serious risks associated with the release of nanobiotechnology products into the environment for agriculture, military or environmental remediation purposes is very concerning. The brief reference to nanobiotechnology on page 30 of the report appeared to confuse living nanobiotechnological organisms with basic engineered nanoparticles.

In contrast to the production of engineered nanoparticles of familiar substances such metal oxides, nanobiotechnology blurs the boundaries between living and non living matter. Nanobiotechnology involves the manipulation of both living organisms and synthetic materials at the atomic scale. It enables manufactured materials to be incorporated into living organisms, or biological materials to be incorporated into manufactured structures.

The potential large-scale release of organisms modified using nanobiotechnology presents us with a whole new array of complex and unpredictable risks. Unfortunately, history tells us that even with the best of intentions we are simply not very good at predicting the outcomes of complex biological systems – witness the disasters that resulted from the introduction of biological control species such as the Cane Toad, or the introduction of rabbits and foxes for sport.

The potential for nanobiotechnology products released for malicious purposes to cause profound damage to human health, environmental systems, or both should be addressed as a matter of urgency. The potential for terrorists or state governments to develop nanobioweaponry should be of great concern, especially given the enormous difficulties associated with establishing reliable safeguards against its use.

It is unacceptable that the nanobiotechnology community remains self-governing, with no control measures on the purchase of engineered virus or DNA components that could be used in nanobioweaponry, and no independent assessment of the social and environmental impacts of the industry.

The failure of the Nanotechnology Taskforce to propose a strategy to manage the risks of nanobiotechnology – and possibly to even distinguish nanobiotechnology from basic engineered nanoparticles – is irresponsible and unacceptable.

No economic analysis, or discussion of nanotechnology's potential impacts on labour markets, commodity trade, or capacity to result in large-scale economic upheaval

"Options for a Future Nanotechnology Strategy" did not attempt to offer any critical analysis of nanotechnology's economic implications for Australian industry or our labour markets – a striking omission for a strategy dedicated to supporting growth of Australia's nanotechnology sector.

The Nanotechnology Taskforce report cited the PMSEIC Nanotechnology Report's citing of industry analyst Lux Research Inc.'s forecast that global sales of products incorporating nanotechnology could be worth US$2.6 trillion by 2014. The Taskforce estimated that "based on our current share of global GDP, this potentially translates into A$50billion in products and services incorporating nanotechnology in Australia."[106] However nowhere in the Taskforce report was there any reference to Lux Research Inc.'s warnings that nanotechnology will not deliver equitable profits across the board, but rather result in winners, losers and massive economic upheaval.

Lux Research Inc. has predicted that novel nanomaterials could replace markets for existing commodities, result in large-scale disruption to commodity markets and to all supply and value chains, and eliminate jobs in nearly every industry.

"Nanotech is poised to ripple through the economics and value chain of multiple industries, with every new corporate opportunity also representing a potential threat. It's riskier than ever to invest in blue-chip companies for the long haul, as only the fittest and most adaptive will survive... Just as the British industrial revolution knocked hand spinners and hand weavers out of business, nanotechnology will disrupt a slew of multi billion dollar companies and industries" [107].

A Nanotechnology Strategy based only on 'blue sky' economic forecasts, without critical analysis of nanotechnology's impacts for our political economy and labour market, will leave Australia poorly prepared to manage the significant economic disruption that nanotechnology is likely to bring.

Consistent failure to put public interests ahead of business interests

The Industry Minister has previously stated his intention to develop a Nanotechnology Strategy that delivers "business certainty and public support". However the many failures and omissions of the Nanotechnology Taskforce report suggest that the government is far more committed to delivering "business certainty" than it is to ensuring "public support" for its management of nanotechnology. The

irony is that as the experience of genetically engineered foods tells us, without public support, controversial new technologies face very uncertain business futures.

Public awareness about nanotechnology remains extremely low. However as public awareness grows, so too will public questioning and challenging of a technology that is likely to have a huge disruptive impact on our lives, but that has been commercialised without our informed consent and in the absence of regulations to protect us from its risks. The next year will be critical in determining whether the Australian government will put the public interest first in its management of nanotechnology, or whether it will continue to privilege business interests, rushing headlong into provoking a public backlash.

Recommendations and reiteration of Friends of the Earth's call for a moratorium

To date governments have shown little inclination to adequately regulate the risks posed by nanotechnology, or to involve the community in decision-making about the technology that will reshape our world. There has been a consistent failure to put public interests ahead of those of the nanotechnology industry.

To rectify the many omissions and failures of "Options for a National Nanotechnology Strategy", As a matter of urgency, the Nanotechnology Taskforce must:

- Propose an integrated new regulatory regime capable of dealing with the complex array of new risks and challenges posed by nanotechnology;
- Support the Precautionary Principle in the regulation of nanotechnology, in accordance with calls for precaution-based regulation made by the world's oldest scientific institution, the United Kingdom's Royal Society, and also the world's second largest re-insurer, Swiss Re;
- Insist on public participation in nanotechnology decision making before the National Nanotechnology Strategy is finalised;
- Investigate the impacts of technological convergence, which most commentators believe is critical to nanotechnology's transformative potential, and therefore likely to result in the most significant economic, social and environmental impacts, and pose the most complex ethical challenges;
- Take immediate action to protect workers, the public and the environment from nanotoxicity, despite growing evidence that exposure to nanomaterials may result in serious harm;
- Acknowledge and act on concerns about the use of nanotechnology in food and agriculture;
- Establish a comprehensive labeling regime of all products containing nanomaterials in order to enable consumers to make an informed choice about using these products;
- Recognize the serious nature of the ethical challenges posed by nanotechnology, including those that relate to nanobiotechnology, human enhancement, military and surveillance applications. Establish measures to independently assess and manage ethical challenges and practical risks associated with nanotechnology's more controversial applications;
- Undertake critical economic analysis, including investigation of nanotechnology's potential impacts on labour markets, commodity trade, and capacity to result in large-scale economic upheaval;
- Recommend a strategy to grapple with the very serious risks posed the development of nanobioweaponry and nanobioterrorism;
- Commit to putting public interests ahead of those of the emerging nanotechnology business sector.

Until such time as these pressing needs are met, genuine public involvement in nanotechnology decision making is supported, and an adequate and comprehensive

regulatory regime established to manage nanotechnology's environmental, social and economic impacts, and its ethical challenges, Friends of the Earth reiterates its call for an immediate moratorium on all commercial research, development and release of nanotechnological materials and products.

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