WRITTEN SUBMISSIONS ON WEST RAND DISTRICT MUNICIPALITY: INTEGRATED WASTE MANAGEMENT PLAN

PRELIMINARY COMMENTS

1. The sections highlighted in yellow have particular relevancy to the environmental situation within the West Rand and are grounded upon the academic papers which were presented at the Proceedings of the Third International Seminar on Mine Closure during the 14 to the 17th October, 2008 in Johannesburg as well as upon the findings and recommendations of the Regional Mine Closure Strategies prepared by the Council of GeoScience for the Department of Minerals and Energy.

2. Box 1 contains extracts from the recent conference jointly hosted by the National Nuclear Regulator and the South African Radiation Protection Association on the International Commission’s Radiation Protection’s recommendations and protection of non-human species from the harmful effects of ionizing radiation and the information, it is my modest opinion, has particular relevancy to the WRDM’s integrated Waste Management Plan. Please do not pass over.
INTRODUCTION

As at 1997, South Africa produced an estimated 468 million tons of mineral waste per annum. Gold mining waste was estimated to account for 221 million tons or 47% of all mineral waste produced in South Africa, making it the largest, single source of waste and pollution.

The Witwatersrand* has been mined for more than a century. It is the world’s largest gold and uranium mining basin with the extraction, from more than 120 mines, of 43 500 tons of gold in one century and 73 000 tons of uranium between 1953 and 1995. The basin covers an area of 1600 km$^2$, and led to a legacy of some 400 km$^2$ of mine tailings dams and 6 billion tons of pyrite tailings containing low-grade uranium. (Reference: “A Remote-Sensing and GIS-Based Integrated Approach for Risk Based Prioritization of Gold Tailings Facilities – Witwatersrand, South Africa” – Proceedings of the Third International Seminar on Mine Closure. 14 – 17 October 2008. Johannesburg. South Africa.)

*The Witwatersrand Mining Basin is composed of the Far East Basin, Central Rand Basin, Western Basin, Far Western Basin, KOSH and the Free State gold mines.

RISKS AND HAZARDS PERTAINING TO GOLD MINING WASTE

It is recognized that gold and uranium tailings dams, waste rocks and derelict lands have the potential to cause severe environmental damage, which includes acid mine drainage, and the dissemination of metals, naturally occurring radionuclides (NORMs) and process reagents, such as cyanide, into the environment. Starting in the mid 1980s many tailings dams in the Witwatersrand region have been, and are still being, reprocessed using a cyanide process for residual gold extraction. (Reference: A Remote-Sensing and GIS-Based Integrated Approach for Risk-Based Prioritization of Gold Tailing Facilities – Witwatersrand, South Africa by S. Chevrel et al. Proceedings of the Third International Seminar on Mine Closure. 14 – 17 October 2008. Johannesburg. South Africa.)

120 Years of gold mining activity within the gold mining areas of the West Rand and Far West Rand (Wonderfonteinspruit Catchment Area) and the non-internalisation of negative externalities, have resulted in “…the mean values for the Wonderfonteinspruit samples … to
exceed not only natural background concentrations, but also levels of regulatory concern for cobalt, zinc, arsenic, cadmium and uranium, with uranium and cadmium exhibiting the highest risk coefficients.”

Uranium is generally associated with the gold ores of the Witwatersrand. Uranium and its radiogenic progeny are therefore found in many of the residues and wastes produced in the mining and processing of gold. (Reference: “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee.)

In any pollution scenario, it is important to understand the risk posed by the pollution to the local human population, as well as to the natural environment. Unfortunately, little information is available regarding the risk to non-human species due to radionuclides, particularly at low levels, and the assumption is commonly made that effective management of the risk to humans will protect the environment. In this regard it is important for the relevant authorities to note the International Commission on Radiological Protection’s (ICRP) Recommendations and protection of non-human species from the harmful effects of ionizing radiation to which the National Nuclear Regulator and the Southern African Radiation Protection Association commit. The subjoined box (Box 1) contains extracts from the recent Conference jointly hosted by the National Nuclear Regulator and the South African Radiation on the ICRP’s Recommendations and protection of non-human species from the harmful effects of ionizing radiation.
ICRP And Protection of The Environment

ICRP 5 (Since 2005)

ENVIRONMENTAL PROTECTION

Aims to ensure that approaches are compatible with:
- RP approaches for man
- Environmental protection approaches for other hazardous agents

Objective of the ICRP Approach:

Prevent, or reduce frequency of, deleterious radiation effects so that they have negligible impact on:
- Biological diversity
- Conservation of species
- Health and status of natural habitats and communities

The ICRP P103 Position

- Builds on ICRP P91
- Protection of man: An indicator of environmental protection
- Protection of man: not always relevant, depends on environment and exposure
- Reference Animals and Plants
- Background dose rate: a benchmark
- No dose limits, but advice on considerations

Directions of C5 Work:

- Develop a framework for assessment of radiation exposure and effects on biota
- For planned, emergency, and existing exposure situations
- To serve as a benchmark for international and national efforts
- Paralleling the framework for radiological protection of man

Reference Animals and Plants (RAPs):

- As with man, necessary to examine relationships:
  - Exposure – dose
  - Dose – effect
  - Effect – consequence
- Different types of animals and plants, typical of major environments
- An approach similar to that used for man: use Reference Animals and Plants

Definition of a RAP:

- A hypothetical entity
- With assumed basic characteristics of a specific animal of plant, described to the taxonomic level of Family
- With precisely defined anatomical, physiological, and life-history properties
- To be used for relating exposure to dose, and dose to effect, for that type of organism
### The ICRP Set of RAPs

<table>
<thead>
<tr>
<th>WILDLIFE GROUP</th>
<th>RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large terrestrial mammals</td>
<td>Deer</td>
</tr>
<tr>
<td>Small terrestrial mammals</td>
<td>Rat</td>
</tr>
<tr>
<td>Aquatic birds</td>
<td>Duck</td>
</tr>
<tr>
<td>Amphibians</td>
<td>Frog</td>
</tr>
<tr>
<td>Freshwater pelagic fish</td>
<td>Trout</td>
</tr>
<tr>
<td>Marine fish</td>
<td>Flatfish</td>
</tr>
<tr>
<td>Terrestrial insects</td>
<td>Bee</td>
</tr>
<tr>
<td>Marine crustaceans</td>
<td>Crab</td>
</tr>
<tr>
<td>Terrestrial annelids</td>
<td>Earthworm</td>
</tr>
<tr>
<td>Large terrestrial plants</td>
<td>Pine tree</td>
</tr>
<tr>
<td>Small terrestrial plants</td>
<td>Wild grass</td>
</tr>
<tr>
<td>Seaweeds</td>
<td>Brown seaweed</td>
</tr>
</tbody>
</table>

For the Set of RAPs: Define and Describe

- Exposure pathways
- Dosimetry
- Radiation effects
  - Mortality
  - Morbidity
  - Reproductive problems
  - Chromosome damage
- Numerical guidance: Starting point for considering management options for all exposure situations

Provide Dose (Conversion) Coefficients:

- mGy day\(^{-1}\) / Bq kg\(^{-1}\)
- All Reference Animals and Plants
  - Some: Several different habitats
- 75 radionuclides
- External and internal exposure
LEGAL PERSPECTIVES ON RADIOLOGICAL PROTECTION OF THE ENVIRONMENT
NATIONAL NUCLEAR REGULATOR

Objective:
• To outline the legal basis underlying obligations for the protection of the environment.

Brief Background to the Protection of the Environment Principle

• Interaction between humans and the environment:
  ➢ Social Causes (increased population growth) & Economic Causes (process of industrialization) led to,
  ➢ Socio-economic causes (increased waste generation) & increased pressures on resources (environmental causes), this led to,
  ➢ Environmental effects such as environmental degradation and pollution on global, regional and local scales

This resulted in a need to regulate human activities and the effects of human activities on the total environment.

International Initiatives

• The 1987 Brundtland Report:
  This Report defined “sustainable development” as development “meeting the needs of the present without compromising the ability of future generations to meet their own needs.”
  This Report provided a starting point for sustainable development requirements.
  ➢ Rio Declaration (Agenda 21); Stockholm Convention; Basel Convention; JHB Summit

• The international initiatives and environmental instruments culminated in the development of Integrated Environmental
Management principles such as:
- The Precautionary Approach;
- The Polluter Pays Principle;
- Duty of Care from Cradle to Grave;
- Integrated & Holistic Approach;
- Participation, transparency & democracy;
- Accountability & liability;
- Environmental awareness & education;
- Continual improvement;
- Consideration of alternatives;
- Carrying capacity of environmental resources.

Radiological Protection of the Environment: Current Legal Basis

(1) The Constitution of South Africa Act, 1996
- Supreme law of SA;
- Law or conduct inconsistent with it is invalid;
- Obligations imposed by it must be fulfilled;
- Contains a Bill of Rights applicable to all law and binding upon the legislature, executive, judiciary and all organs of state & natural and juristic persons;
No other law or government action can supersede the provisions of the Constitution.

- The Bill of Rights: Section 24 – Environmental Right
  - Section 24 provides that everyone has the right-
    (a) To an environment that is not harmful to their health or well-being; and
    (b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –
      (i) prevent pollution & ecological degradation;
      (ii) promote conservation; and
      (iii) secure ecologically sustainable development & use of natural resources while promoting justifiable economic & social development.

- NEMA implements the 1997 White Paper Policy on National Environmental Management which Policy undertakes to give effect to the rights in the Constitution that relate to the environment & defines sustainable development as a combination of social, economic & environmental factors.
  - The Policy entrenches environmental sustainability in policy and practice;
- Following NEMA, DEAT undertook a law reform process to provide a consolidated legislative framework for environmental management in SA aimed at promoting sustainable development.
- NEMA Definition of ‘environment’:
  “Environment” means surroundings within which humans exist and that are made up of -
  - Land, water and atmosphere of the earth;
  - Micro-organisms, plant and animal life;
  - Any part or combination of the above, and the interrelationships among and between them; and
  - The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well being.

(3) The National Nuclear Regulator Act, 1999 (Act No. 47 of 1999)
This is the primary legislation for nuclear matters.
The NNR Act provides for the Regulator to regulate nuclear Activities. It also provides for safety standards and regulatory practices for protection of persons, property and the environment against nuclear damage.
- In terms of section 36 Regulations on Safety Standards & Regulatory Practices have been promulgated under GN R388: GG 28755 of 28 April 2006
IMPORTANCE OF SECTION 24: ENVIRONMENTAL RIGHT AND NEMA PRINCIPLES

Constitutional Case Law:

In this case the CC had to answer a question concerning the obligations of state organs when making decisions that may have substantial impact on the environment.

Facts: The Dept of Agriculture had granted authority in terms of section 22 of ECA to a Trust to construct a filling station on a property.

The RoD noted that the property had been rezoned and that all identified and perceived impacts were satisfactorily dealt with in the scoping report.

Fuel Retailers challenged the decision mainly on the ground that the need, desirability and sustainability of the proposed filling station had not been considered, a matter which they were obliged to consider.

The Dept contended that the need and desirability were considered by the local authority when it decided the rezoning, therefore it did not have to reassess these considerations.

The Pretoria High Court and the Supreme Court of Appeal agreed with the Dept. Fuel Retailers referred the matter to the CC.

Arguments at the CC:
- Fuel Retailers argued that the environmental authorities themselves were obliged to consider the socio-economic impact of constructing the proposed filling station & relied on sec 24(b)(iii) of the Constitution and sections 2(4)(a), 2(3), 2(4)(g), 2(4)(i) of NEMA.
- Dept argued that rezoning forms part and parcel of the process of an application for authorization in terms of sec 22 of ECA.
- Fuel Retailers argued that the two processes are distinct and separate: the local authority considers an application for rezoning from a town planning perspective and environmental authorities are required to consider the impact of the proposed development on the environment and socio-economic conditions.

CC Decision:
- The CC concluded that the Constitution & environmental legislation introduce a new criterion for considering future developments. Pure economic factors are no longer decisive.
- The need for development must now be determined by its impact on the environment, sustainable development and social and economic interests.
- The duty of environmental authorities is to integrate these factors into decision making and make decisions that are informed by these considerations.

Way Forward
- Adoption of international treaties and conventions:
  Process of section 231 of the Constitution – Signing/Ratification and adoption into legislation to be enforceable in SA;
  Adoption of ‘best practice’ documents/processes:
  These may be built into our legislative framework through Regulations to give them legal effect and status;
  Change of mindsets to appreciate the environmental direction undertaken by the Govt.

ICRP
RADON

The ICRP System of Protection Applied to Radon and Information from UNSCEAR
SCOPES

- Radiological protection relating to indoor exposure to radon-222 and its progeny
- Exposures in dwellings and workplaces, with uranium (and other) mines as an important workplace
- Radon-220 (thoron) may also be an issue under some circumstances
- Radon-222 exclusive of its progeny may be a concern in some very unusual circumstances

- ICRP 50: Lung Cancer Risk from Indoor Exposures to Radon Daughters (1987)
  - Sources and levels
  - Epidemiology and exposure-risk relationships
- ICRP 103: The 2007 Recommendations of the International Commission on Radiological Protection

ICRP 65: Scientific Basis

- Epidemiological and dosimetric approaches considered
- Epidemiological method chosen - more direct
- Relied heavily on miner data
- Residential results were weak at the time, but consistent with miner data
- Reviewed results from UNSCEAR, US National Research Council (BEIR), IARC, and individual studies

ICRP 65: Choosing Action Levels for Dwellings

- Depends on level of exposure and the likely scale of action with economic implications for the community and individuals
- “the best choice of an action level may well be that level which defines a significant, but not unmanageable, number of houses in need of remedial work.” (P 103)
- Emphasises intervention to protect the more highly exposed individuals

ICRP 65: Practical Protection in Dwellings

- Remedial actions generally:
  - Reduce movement of radon into the home; or
  - Dilute radon concentrations with outdoor air

ICRP 65: Application to New Dwellings

- Identify radon-prone areas
- Keep the radon concentrations in the finished buildings as low as can reasonably be achieved
- Provide for easy introduction of further remedial measures if the initial construction fails to achieve concentrations below the action level for existing buildings

ICRP 65: Workplaces

- Radon is present in all workplaces
- In some cases, it is recognized and subject to control (e.g. Uranium mines)
- In other cases it is widely ignored
- Action levels should be used to define workplaces where:
  - intervention should be undertaken
  - the system of protection for practices should apply
ICRP 65: Intervention in Workplaces

- Generally, select an action level in the range of 500 – 1500 Bq/m³
- This range implies an equilibrium factor of 0.4, which may be significantly different than the actual situation
  - e.g. some modern mines have equilibrium factors orders of magnitude lower
  - In this case, different action levels should be chosen

ICRP 65: Radon within the System of Protection for Practices

- Only when the exposures incurred at work are a result of situations that can reasonably be regarded as being the responsibility of the operating management”
- Advantages in adopting the same action level as for intervention in workplaces
- If simple countermeasures do not reduce the radon concentrations below the action level, apply the system of protection for practices

ICRP 65: Applying the System of Protection for Practices

- Designation of Areas
  - Use of supervised or controlled areas depending on levels
- Monitoring of Individual Exposures
  - Sometimes workplace monitoring is sufficient
  - Consider gross levels, not levels above “background” or above the action level
- Additivity of Exposures
  - Aggregate doses for comparison with the dose limit

ICRP 103 and RADON

- Review of the science
- Fitting into the exposure situation system
- Reference Levels vs. Action Levels
- Optimisation

ICRP 103: EFFECTS OF 222Rn Exposure

- Studies confirmed the risk of Rn-222 exposure even at relatively moderate concentrations (~100-200 Bq/m³)
- Coherence of miner and residential studies
- More emphasis now on pooled studies of residential radon exposure
- Risks other than lung cancer are likely small

ICRP 103: FUNDAMENTAL RECOMMENDATIONS

- Radon in dwellings and workplaces is an existing exposure situation
- Upper values of reference levels are still based on 10 mSv/a
ICRP 103: UPPER VALUES FOR REFERENCE LEVELS

<table>
<thead>
<tr>
<th>Existing exposure situations</th>
<th>Action levels&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Reference levels&lt;sup&gt;b,m&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radon (65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- at home</td>
<td>3–10 mSv/year</td>
<td>&lt;10 mSv/year</td>
</tr>
<tr>
<td></td>
<td>(200–600 Bq m&lt;sup&gt;−3&lt;/sup&gt;)</td>
<td>(&lt;600 Bq m&lt;sup&gt;−3&lt;/sup&gt;)</td>
</tr>
<tr>
<td>- at work</td>
<td>3–10 mSv/year</td>
<td>&lt;10 mSv/year</td>
</tr>
<tr>
<td></td>
<td>(500–1500 Bq m&lt;sup&gt;−3&lt;/sup&gt;)</td>
<td>(&lt;1500 Bq m&lt;sup&gt;−3&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Categories of exposure</td>
<td>1990 Recommendations and</td>
<td>Present Recommendations</td>
</tr>
<tr>
<td>(Publications)</td>
<td>subsequent publications</td>
<td></td>
</tr>
</tbody>
</table>

- 1990: Take action ABOVE Action Levels
- 2007: Optimise BELOW Reference Levels

<table>
<thead>
<tr>
<th>Situation</th>
<th>Upper value of reference level: Activity concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic dwellings</td>
<td>600 Bq m&lt;sup&gt;−3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Workplaces</td>
<td>1500 Bq m&lt;sup&gt;−3&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>†</sup> Head or initial radionuclide of the decay chain activity level.

- National reference levels would be selected at or BELOW these upper values
National authorities set reference levels taking into account economic and societal circumstances.

Apply optimisation, taking all reasonable efforts to reduce radon below reference levels.

ICRP 103: OPTIMISATION

- Actions taken should be intended to produce substantial reduction in radon exposures.
- Don’t aim to be just below the national reference level.
- Authorities may specify levels at which protection is considered optimised i.e. no further action needed.

ICRP 103 OCCUPATIONAL EXPOSURE TO $^{222}$RN

- Radon exposure at work above national reference level should be part of occupational exposure.
- IAEA BSS (1991) established an action level value of 1000 Bq/m$^3$.
- This globally harmonized reference value can define the entry point for occupational protection requirements.

UNSCEAR

- Established by the UN in 1955 to assess and report levels and effects of exposure to ionizing radiation.
- Provides the scientific basis for evaluating radiation risk and for establishing protective measures.
2006 Scientific report
A. Epidemiological studies of radiation and cancer
B. Epidemiological evaluation of cardiovascular disease and other non-cancer diseases
C. Non-targeted and delayed effects
D. Effects on the immune system
E. Sources-to-effects assessment for radon in homes and workplaces

UNSCEAR 2006: RADON LEVELS

- Levels indoors vary widely within and between countries
- Nominal geometric mean concentrations:
  - Less than 10 Bq/m$^3$ in the Middle East
  - More than 100 Bq/m$^3$ in some European countries
- Radon ~50% of dose received from natural sources
- In some occupations (e.g. mining) radon is the predominant source of exposure

UNSCEAR 2006: RADON IN HOMES

<table>
<thead>
<tr>
<th>Region/country</th>
<th>Population ($10^5$)</th>
<th>Indoor radon ($^{222}\text{Rn}$) (Bq m$^3$)</th>
<th>Arithmetic mean</th>
<th>Geometric mean</th>
<th>Maximum value</th>
<th>Geometric S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algeria</td>
<td>[U2]</td>
<td>28.78</td>
<td>30</td>
<td></td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>[U2]</td>
<td>63.27</td>
<td>9</td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Ghana</td>
<td>[U2]</td>
<td>17.83</td>
<td></td>
<td>34</td>
<td>140</td>
<td></td>
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<tr>
<td><strong>North America</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>[U2]</td>
<td>29.68</td>
<td>34</td>
<td>140</td>
<td>1720</td>
<td>3.6</td>
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<tr>
<td>Mexico*</td>
<td>[M39]</td>
<td></td>
<td>140</td>
<td></td>
<td>1193</td>
<td></td>
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<tr>
<td>United States</td>
<td>[U2]</td>
<td>269.4</td>
<td>46</td>
<td>90</td>
<td>25</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>South America</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>[U2]</td>
<td>35.22</td>
<td>37</td>
<td></td>
<td>211</td>
<td>2.2</td>
</tr>
<tr>
<td>Chile</td>
<td>[U2]</td>
<td>14.42</td>
<td>25</td>
<td></td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Paraguay</td>
<td>[U2]</td>
<td>4.96</td>
<td>28</td>
<td></td>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>

Table 1
Concentrations of radon in indoor air
UNSCEAR 2006: RADON EFFECTS

- Radon and its decay products are lung carcinogens
- Doses to other organs and tissues are usually at least an order of magnitude smaller than lung doses
- Epidemiological data provide little evidence of increased risk of mortality other than for lung cancer

UNSCEAR 2006: RADON RISKS

- Draws from US National Research Council Committee on Health Risks of Exposure to Radon
  - BEIR VI report: *Health Effects of Exposure to Radon*, focus on miner studies
- Also reviews updated miner studies and studies of residential radon and lung cancer
- Good agreement between miner studies and residential studies
- ERR ~ 0.16 at 100 Bq/m$^3$ (± a factor of 3)

ICRP: CONTINUING EFFORTS

- Reviewing the latest science, including (unpublished) results from UNSCEAR
- Investigating epidemiological and dosimetric approaches (as per ICRP 65)
- Reviewing the methodologies applied in ICRP 65
- Recent epidemiological evidence shows an increased risk of lung cancer per unit exposure
- Detriment per unit dose is now (ICRP 103) slightly less than previous (ICRP 60)
- Calculation of conversion coefficients is not straightforward, as the scientific results can be interpreted in various ways

ICRP: CONTINUING EFFORTS (CONVERSION COEFFICIENTS)

- Nonetheless, there is little doubt that radon conversion coefficients will increase from those in ICRP 65 (4 or 5 mSv per WLM)
- Some approaches would increase to ~ 6 mSv per WLM
  - Consistent with most recent UNSCEAR findings
- Other approaches may ~double the coefficients

ICRP: CONTINUING EFFORTS (UPPER BOUNDS FOR REFERENCE LEVELS)

- Revision of upper bounds for reference levels for radon is a related but separate consideration
- Upper bounds for reference levels may stay the same or decrease, depending on:
  - Review of the ICRP 65 methodology
  - Consideration of modified conversion coefficients

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### Table 2
Situations where doses from radon are significant [U2]

<table>
<thead>
<tr>
<th>Source/practice</th>
<th>Number of monitored workers</th>
<th>Average annual effective dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear fuel cycle (including uranium mining)</td>
<td>800 000</td>
<td>1.8</td>
</tr>
<tr>
<td>Mining (other than coal)</td>
<td>760 000</td>
<td>2.7</td>
</tr>
<tr>
<td>Coal mining</td>
<td>3 910 000</td>
<td>0.7</td>
</tr>
<tr>
<td>Mineral processing</td>
<td>300 000</td>
<td>1.0</td>
</tr>
<tr>
<td>Above ground workplaces (radon)</td>
<td>1 250 000</td>
<td>4.8</td>
</tr>
</tbody>
</table>
Together with the radioactive pollutants, a non-radioactive chemical pollution stream often enters the environment.

Pollution related to the West Rand mines poses a number of hazards to surrounding communities. The major primary pathways by which contamination can enter the environment from a mine site are the airborne pathway, where radon gas and windblown dust disperse outwards from mine sites, the waterborne pathway either via ground or surface water or due to direct access, where people are contaminated, or externally irradiated after unauthorized entry to a mine site, by living in settlements directly adjacent to mines or in some cases, living in settlements on the contaminated footprints of abandoned mines.

Direct access to mine sites may also expose the public to risk due to direct external gamma radiation, inhalation and ingestion of radionuclides and chemotoxic metals, as well as the physical dangers inherent to mining sites. To limit the risk due to external gamma radiation, the Chamber of Mines uses a guideline that each tailings deposit should have a 500 m buffer zone surrounding it, where no human settlement is allowed. In many cases, however, this guideline has not been adhered to, specifically pertaining to the development of new settlements within the West Rand. Kagiso and Sinqobele Phase 3, and the Amberfield Retirement Village are built within the 500m buffer zone surrounding slimes and sand dams. (Reference: “A Remote-Sensing and GIS-Based Integrated Approach for Risk Based Prioritization of Gold Tailings Facilities – Witwatersrand, South Africa” – Proceedings of the Third International Seminar on Mine Closure. 14 – 17 October 2008. Johannesburg, South Africa.)

It has been argued that the legislation pertaining to the management of mining waste is currently fragmented, diverse, uncoordinated and administered by a number of different government departments.

It has been noted with grave concern that the mining companies continue to exploit these weaknesses to continue to externalize their costs upon local communities and the general public. It is my respectful opinion, grounded upon the findings of public domain Reports that among the
main reasons for the non-implementation of legislation are insufficient specificity in Legislation regarding the management of mining waste, and interdepartmental disagreements about which policies are primary.

LACK OF INTERDEPARTMENTAL CO-OPERATION

Mining waste is addressed through at least two primary and eleven secondary pieces of legislation and by three primary and six secondary government departments. There is no unifying policy outlining how mining waste and mine water issues, which are interconnected, are to be addressed. As a consequence the factors driving the management of mineral residue and mine waste are heavily fragmented between economic development and environmental protection.

The delegation of powers among agencies in the Constitution regarding the management of mining waste, has resulted in ambiguities. Until existing legislation can be enforced in a logical, organized fashion at all levels, and until the various government departments can learn how to coordinate with one another to maximize overall efficiency, conflict arising from the lack of government enforcement of current policies and their cumulative impacts will persist in South Africa.

Voluntary initiatives taken by the gold mining industry to rehabilitate or mitigate environmental impacts and health risks associated with mining waste have not ameliorated the risks to local communities and the environment. Grounded upon expert opinion,

physical or real evidence, eye-witness reports and documentary evidence pollution from source is continuing and the health risks of radioactivity and toxicity to mining communities have significantly increased.

The interdepartmental conflicts are magnified by the shortage of governmental officials, the lack of political will and commitment on the part of some and the high turnover of government officials tasked to enforce policies pertaining to mining waste.

The inability to integrate across government departments through policy leads to the mismanagement or abandonment of mine abandoned residue stockpiles and dumps that scatter the West Rand and Far West Rand. Where abandoned mine dumps remain on privately owned property, property owners have neither the mandate nor finances to remine, reuse, or rehabilitate them, making the underlying land a personal liability and difficult to sell. The result is a loss in private land value due to on-site abandoned mine dumps over which the landowners has no legal right but bears environmental and social liability, and the loss in private land value due to environmental degradation from neighbouring abandoned mine dumps. Additionally, the rock dumps and tailings dams compromise local water quality though the mobilization of chemicals from run-off and airborne particulates, which accumulate in water sources or sediment.

By creating concurrent legislative competencies among different spheres of government the possibility for conflicting legislation is created.

The decision of how to handle mineral waste is driven by economic policy, environmental policy and integrated waste policy. Each of these favours different potential solutions, e.g. stock piling, rehabilitation and reuse. Please see Figure below.
It can therefore be inferred that there is currently much confusion with regards to the roles and responsibilities of the Department of Minerals and Energy (DME) and the Department of Environmental Affairs and Tourism (DEAT), with respect to the management of mining waste. Both departments have placed certain requirements on mines before a closure certificate is granted, the main requirement being an environmental management plan (EMP) which is compulsory for any mine and for which DME is the lead agent. Co-operative governance is, however, not very effective in protecting the environment against the negative impacts of mining waste and enforcement of the legal binding sections of EMPs is regrettably non-existent.

The challenges of integrated management of mining waste and co-operative governance are highlighted in Box 2.

In terms of the NNR’s “Status report on the actions arising from the study of radiological contamination of the Wonderfonteinspruit Catchment Area (WCA)” it was found:

- The study has highlighted the need for all the regulators to work closely together since the contamination includes non radiological contaminants such as heavy metals and salts.

In substantiation of integrated environmental management of the mining impacts upon local communities and the environment within the West Rand:

DEPARTMENT OF ENVIRONMENTAL AFFAIRS (DEAT)
In terms of the National Nuclear Regulator’s Report entitled “Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area” (TR-RRD-07-0006) it was found:

“The assessments of effective doses do not comprise the so-called “air-pathways”, by which significant radiation exposure can occur in the surroundings of mining legacies, due to

- Inhalation of Rn-222 daughter nuclides from radon emissions of desiccated water storage dams e.g. Tudor Dam and slimes dams,
- The inhalation of contaminated dust generated by wind erosion from these objects, and
- The contamination of agricultural crops (pasture, vegetables) by the deposition of radioactive dust particles, which can cause considerable dose contributions via ingestion.

During the sampling, strong dust emissions from slimes dams during wind events were observed. Due to the small particle size of the slimes, particulate matter can be transported over relatively long distances to agriculturally used land in his surroundings.”

In terms of the academic treatise, entitled “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee, Council for Geoscience it was found:

“The two major airborne risks will be due to airborne radon and windblown dust….However, it could be expected that the most hazardous areas will be those close proximity to mine residue deposits or other large concentrations of radioactive material.”

WEST RAND DISTRICT MUNICIPALITY/ RANDFONTEIN, WESTONARIA AND MOGALE CITY LOCAL COUNCILS

Under the Air Quality Act, local authorities will be responsible for monitoring air pollution and meeting nationally set ambient air quality limits. In order to manage and maintain air quality to fall within these limits, such authorities will be required to identify the sources contributing to non-compliance and to develop emission reduction programmes for such sources. Air quality management systems established for baseline characterization and tracking progress made by emission reduction programmes will be documented in Air Quality Management Plans, which are required to be compiled and integrated into the local authorities’ Integrated Development Plans.

The Air Quality Act designates district municipalities and metropolitan municipalities as atmospheric emissions licensing authorities. Such municipalities will be responsible for the regulation of enterprises undertaking so-called listed activities, i.e. activities associated with potentially significant atmospheric emissions. Provincial environmental departments are primarily tasked with monitoring the air quality management performance of local government.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

In terms of the academic treatise, entitled “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee, Council for Geoscience it was found:

“…..a background sampling point has been identified in the Klerkskraal Dam, on another tributary of the Mooi River, located to the north of Potchefstroom. A uranium concentration of 0.25 ppm has been measured at this site. This must be compared with concentrations in the river sediments of the WONderfonteinspruit which can exceed 1000 ppm in places. This value exceeds the concentration in most of the mine tailings in this area, suggesting that uranium is concentrated in the river sediments, most likely by sorption processes and the precipitation of sulphate crusts.”

DEPARTMENT OF MINERALS AND ENERGY

In terms of the academic treatise, entitled “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee, Council for Geoscience it was found:
“Pollution related to Witwatersrand mines poses a number of hazards to surrounding communities. The major primary pathways by which contamination can enter the environment from a mine site are the airborne pathway, where radon gas and windblown dust disperse outwards from mine sites, the waterborne pathway either via ground or surface water or due to direct access, where people are contaminated, or externally irradiated after unauthorized entry to a mine site, by living in settlements directly adjacent to mines or in some cases, living in settlements on the contaminated footprints of abandoned mines.”

NATIONAL NUCLEAR REGULATOR

In terms of the National Nuclear Regulator’s Report entitled “Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area” (TR-RRD-07-0006):

“The past and present discharges of radionuclides into the WCA as a consequence of mining activities can lead to considerable radiological impacts to the public via various exposure pathways, exceeding significantly the natural level and also the dose limit for the public of 1 mSv per annum, at numerous sites. The incremental doses for the critical group calculated on the basis of the CNS 97/IWQS 99 transfer factor set for “realistic” exposure pathways range over four orders of magnitude from about 0.01 mSv to 100 mSv per annum. For approximately 50% of the 47 sampling sites, the calculated incremental doses of the respective critical group are above 1 mSv per annum. Under consideration of exposure pathways specified as “potential”, the calculated incremental doses of the respective critical group at approximately 75% of the sites exceed 1 mSv per annum. However, the relatively high conservatism of some transfer factors with respect to radionuclide transport from soil to plant and from fodder to livestock products should be kept in mind when evaluating the incremental doses calculated on this basis.”

DEPARTMENT OF HEALTH

In terms of the academic treatise, entitled “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee, Council for Geoscience it was found:

“Together with uranium, a number of other metals present in the gold ores are found in the waste streams and may pose a threat to public health. Coetzee and Ntsume identify Co, Zn, As and Cd as exceeding European Union recommended public safety levels in soils in the Wonderfonteinspruit catchment.”

“Together with the radioactive pollutants, a non-radioactive chemical pollution stream often enters the environment.

“Pollution related to Witwatersrand mines poses a number of hazards to surrounding communities. The major primary pathways by which contamination can enter the environment from a mine site are the airborne pathway, where radon gas and windblown dust disperse outwards from mine sites, the waterborne pathway either via ground or surface water or due to direct access, where people are contaminated, or externally irradiated after unauthorized entry to a mine site, by living in settlements directly adjacent to mines or in some cases, living in settlements on the contaminated footprints of abandoned mines.”

“The past and present discharges of radionuclides into the WCA as a consequence of mining pathways, exceeding significantly the natural level and also the dose limit for the public of 1 mSv per annum at numerous sites.”

In terms of the WRC Report 1214, entitled “An Assessment of Sources, Pathways, Mechanisms and Risks of Current and Potential Future Pollution of Water and Sediments in Gold Mining Areas of the Wonderfonteinspruit Catchment” by H. Coetzee, F. Winde and P. Wade it was found:

“Exposure assessment
The Wonderfonteinspruit valley is densely populated because of its agricultural value and presence of gold mines. Potchefstroom is located downstream of the Wonderfonteinspruit, from which more than 400 000 people derive their drinking water via the Boskop Dam.

The majority of the inhabitants live in informal settlements, using contaminated ground- and stream water for personal hygiene and drinking. With above-average infection rates of HIV/AIDS and chronic and acute malnutrition, this subpopulation is particularly vulnerable to additional stress of immune system by contaminants.
Identification of exposure pathways
Uranium can enter the human via a number of pathways from the source, being largely tailings dams in the catchment, through groundwater, to soil, and to river water. Contaminated groundwater may also be used by humans. Principal modes of contact are ingestion of water and food products, and inhalation of dust and aerosols.

Toxicity assessment
The key contaminant identified in the Wonderfonteinspruit catchment was uranium; for the purposes of this example, the key exposure pathway from stream water to human through the mode of drinking water was chosen.

Types of health risk of concern
Both radiological cancer risk and chemical non-cancer hazards were investigated. The primary organ at risk from uranium chemical toxicity is the kidney, while organs at risk from chronic radiological toxicity include the lymph nodes and the bone. A recent review of uranium toxicity set minimum derived drinking-water concentrations at 31 µg/l for chemical toxicity, although values as low as 2 µg/l have been identified as a safe limit, and 63 µg/l based on 1 mSv/a, 500 l/a radiological risk, assuming secular equilibrium with its progeny. Based on the recommendation of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1988) regarding studies of uranium in the environment, the chemical toxicity of uranium formed the basis for the risk assessment in this study. Nuclide-specific analyses were not performed — making a detailed assessment of radiological dose impossible. It should be noted that there is practically no lower limit for acceptable radiological risk, based on a linear dose-response profile, and that recent research suggests that there is also no clear lower threshold for chemical toxicity.

In the risk-assessment procedure that was applied, risk quotients are determined by dividing the measured and predicted uranium concentrations in surface water, that could be used by communities as a sole drinking-water supply, by the limit or guideline value for the contaminant of concern. A significant risk is therefore determined where the risk quotient is greater than unity, with higher values indicating higher levels of risk.

The carcinogenic risk quotient for uranium in the surface water of the Wonderfonteinspruit is 2.22, based on conservative assumptions regarding secular equilibrium between uranium-series radionuclides. The chemical toxicity risk quotient for this water is 6.67.

The chemical risk quotient associated with drinking river water is 6.67, and the radiological risk quotient is 2.22. Both the numbers are above 1.00, meaning that there is a risk of ill-health effects by drinking water from contaminated streams in the Wonderfonteinspruit catchment. Studies of the Wonderfonteinspruit catchment have however established that in the dissolved fraction, uranium is not in secular equilibrium with its progeny, typically displaying activities significantly higher than its radioactive daughters. The assumption of secular equilibrium, used to calculate the radiological risk quotient will therefore lead to an overestimate of the total radiation dose. The radioactive progeny however, have no influence on the chemical toxicity of uranium in solution in water. The recommendation of UNSCEAR (1988) therefore appears to be valid, and it is recommended that the chemical toxicity of uranium be regarded as the primary health risk due to the water in the Wonderfonteinspruit.”

DEPARTMENT OF AGRICULTURE

In terms of the National Nuclear Regulator’s Report entitled “Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area” (TR-RRD-07-0006):

“It has to be mentioned that the deposition of radioactively contaminated dust on leafs of vegetable and forage plants can cause radiation exposures exceeding those from the “inhalation of contaminated dust” substantially being in the order of dose contributions of the so-called “water pathways”.

“With respect to the usage of mine waters, e.g. from discharge canals and pipes, the irrigation of agriculturally used land and pasture causes the highest radiological impacts...”
“Regarding the utilization of surface water bodies, the uptake of sediments churned up during cattle watering at the banks of water bodies presents the most important radiological pathway.”

“For contaminated soil/dry sediment, the exposure pathways related to agricultural usage yield the dominant contribution to the radiological risks and account for more than 97% of the total incremental doses of the respective critical group, ...”

“Regarding the exposure pathways representing the agricultural use of contaminated land, the growth of vegetables and the uptake of radionuclides by cattle due to contaminated pasture soil are generally the leading exposure pathways.”

DEPARTMENT OF HOUSING

In terms of the National Nuclear Regulator’s Report entitled “Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area” (TR-RRD-07-0006) it was found:

“In contrast to former studies, the scenarios “stay on contaminated sites” and “agricultural use of land contaminated in the past” (e.g. by slimes transport or desiccation of former water storage dams) were included into the environmental impact analysis. The radiation exposures caused by these realistic pathways (as observed) can also lead to high incremental doses.”

In terms of the academic treatise, entitled “Radiometric Surveying in the Vicinity of Witwatersrand Gold Mines” by H. Coetzee, Council for Geoscience it was found:

“Direct access to mine sites may also expose the public to risk due to direct external gamma radiation, inhalation and ingestion of radionuclides and chemotoxic metals, as well as the physical dangers inherent to mining sites. To limit the risk due to external gamma radiation, the Chamber of Mines uses a guideline that each tailings deposit should have a 500 m buffer zone surrounding it, where no human settlement is allowed. In many cases, however, this guideline has not always been adhered to in the development of new settlements.” (Examples: Amberfield Retirement Village, Randfontein; RDP Houses – Sinqobele Phase 3; a portion of Kagiso township.)

EXAMINING THE DEFINITION OF WASTE

The definition of waste in the current legislation is conceived as problematic. It can be inferred from the definition that mineral residue is not legally defined as waste. This will exacerbate the current situation where residue stockpiles and radioactive and toxic tailings dams are unprotected, and unfenced* causing environmental pollution and hazards to off-mine populations.

The nature of the pollutants of the mining industry is such that they do not break down and disappear naturally in the environment.
Defining mining waste and mineral residue as waste will provide a legal mandate to internalize environmental and social externalities, bringing them onto mining companies’ balance sheets, and ensuring sound budgeting and consideration for post-closure rehabilitation or reuse of mineral waste.

*There remains flagrant and widespread disregard by the gold mining companies of Section 8 of Regulations on Use of Water for Mining and Related Activities aimed at the Protection of Water Resources GN.R. 704 of 4 June 1999 whereby it is stated: “Every person in control of a mine or activity must cause any impoundment or dam containing any poisonous, toxic or injurious substance to be effectively fenced-off so as to restrict access thereto, and must erect warning notice boards at prominent locations so as to warn persons of the hazardous contents thereof”.

An understanding of the historical legacy of the management of mining waste within the gold mining areas of the West Rand and Far West Rand, to which I shall advert hereafter, can be used to address cumulative environmental and social impacts associated with mining waste, which if left unmanaged, represents a real potential for present and future conflict.

CASE STUDY: WASTE GENERATED FROM GOLD MINING (WEST RAND AND FAR WEST RAND)

I shall now argue my recommendations on historical precedent, namely the long history of gold mining within the West Rand and Far West Rand, specifically the Wonderfonteinspruit and Tweelopiespruit Catchment areas and the historical lack of environmental legislation in the management of mine waste.

In terms of the findings of public domain official reports, I here specifically allude to the Water Research Report No 1214/1/06, entitled “An Assessment of Sources, Pathways, Mechanisms and Risks of Current and Potential Future Pollution of Water and Sediments in Gold-Mining Areas of the Wonderfonteinspruit Catchment” (H. Coetzee, F. Winde and P.W. Wade), it was found that
“the mean values for the Wonderfonteinspruit samples ... significantly exceed not only natural background concentrations, but also levels of regulatory concern for cobalt, zinc, arsenic, cadmium and uranium, with uranium and cadmium exhibiting the highest risk coefficients.” It was furthermore found that: “the measured uranium content of many of the fluvial sediments in the Wonderfonteinspruit, including those off mine properties and therefore outside the boundaries of licensed sites, exceeds the exclusion limit for regulation by the National Nuclear Regulator.”

The results of public domain studies indicate that uranium poses a long term hazard\(^2\) to water users in Wonderfonteinspruit catchment because of its chemical toxicity and radioactivity. The dissolved radionuclides in water and radionuclides bound to sediment determine the current and future risks to the residents within the Wonderfonteinspruit Catchment. The Wonderfonteinspruit Catchment is densely populated. The sub-population groups most at risk are the residents of informal settlements with high percentages of HIV/Aids and chronic and acute malnutrition.

Since some of the sources of pollution are not due to direct discharge, but rather to run-off from contaminated sites, seepage from tailings dams and groundwater recharge, it can be expected that the hazards and risks identified in public domain Reports will remain for centuries after the closure of mines due to the long half life of Uranium, which is 10\(^{10}\). Uranium furthermore has decay or daughter products which are radioactive as well, such as radium, radon, radon gas, strontium, bismuth, thorium and polonium. This implies a long-term responsibility to ensure that the hazard does not translate into a risk. It is also important to remember that some of the sites where these hazards exist are off mine property\(^3\).

\(^2\) The results of the health risk characterization are as follows: Chronic radiological (cancer) risk quotient = 2.22; Chronic chemical (neprotixicity) risk quotient = 6.67. An acceptable risk quotient is below.

\(^3\) 16mg/kg uranium is equivalent to an activity concentration of 0.2Bq/g, the limit for regulatory control set by the NNR.

- Andries Coetzee Dam: 900mg/kg U
- Upper Wonderfonteinspruit: 1 100 mg/kg U
- Klerkskraal Dam: 1 mg/kg U
- Tudor Dam: 10 000 – 100 000 Bq/kg
- Sluice: 1 000 – 10 000 Bq/kg
- Andries Coetzee Dam: 1 000 – 10 000 Bq/kg
In terms of the National Nuclear Regulator’s Report, entitled “Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area”, it was found:

- The long-lasting mining related discharges of naturally occurring radionuclides from point and diffuse sources into the Wonderfonteinspruit Catchment result in a complex pattern of radioactive contamination of water bodies, sediments and soils throughout the catchment area.
- The past and present discharges of radionuclides into the Wonderfonteinspruit Catchment area as a consequence of mining activities can lead to considerable radiological impacts to the public via various exposure pathways, exceeding significantly the natural level and also the dose limit for the public of 1mSv per annum, at numerous sites.
- For approximately 50% of the 47 sampling sites, the calculated incremental doses of the respective critical group are above 1mSv per annum up to 100mSv per annum.
- Cattle watering at polluted surface water bodies in the Wonderfonteinspruit Catchment area causes the uptake of radioactivity with the suspended particulate matter and can cause radioactive contamination of livestock products (milk, meat) resulting in effective doses of the public in some orders of magnitude above those resulting in the water pathway.
- Irrigation of pasture land is a very relevant exposure pathway concerning the usage of surface water bodies. Irrigation of vegetable food and fishing are important exposure pathways.
- The stay on contaminated sites and the agricultural use of land contaminated in the past, e.g. by slimes transport or dessication of former storage dams, can lead to high incremental doses.

REMEDIATION OF CONTAMINATED LAND

- Attenuation Dam: 100 – 1 000 Bq/kg
- Donaldson Dam: 100 – 1 000 Bq/kg

Regulatory Limit: 500 Bq/kg
Closure planning as embodied in EMP reports of gold mines in South Africa is currently inadequate to protect the water resources, impacted by rock dumps and tailings dams. The status at the end of 2001 of approximately forty gold mine closure plans, as described in their EMP reports, are summarized in the WRC Report No 1215/1/05, entitled “The Development of Appropriate Procedures towards and after closure of underground Gold Mines From a Water Management Perspective” – W. Pulles, S. Banister, M. van Biljon. The pertinent misconceptions and shortcomings described by Banister et al. (2002) include that most mines recognize that tailings dams generate AMD, but it is generally and incorrectly assumed that the impact will decrease to acceptable levels when the mining operations cease. It appears to be quite widely assumed that the larger particle size of waste rock dumps makes them a lesser pollution risk. This view is erroneous, as the waste rock dumps have very large inventories of fine material and are much more permeable to oxygen than tailings dams (Bannister et al., 2002). It is also not clear if the extent of contamination plumes is known.

Any mine has a finite lifespan, because of two critical factors. Firstly, there is a given stock of minerals which, once extracted, no longer exist in a form that can be mined. Secondly, there are physical limitations to the depths that mining can occur in safety, so as engineering technology improves, new reserves are potentially viable. Both of these conditions exist in South Africa at present. The gold industry is a mature one, with most of the known reserves having been located and in many cases actively mined. This means that there are a large number of mines that have reached the end of their productive lives and are now left, often in a derelict and abandoned condition.

In terms of the public statement by the former director of environmental policy of the Department of Minerals and Energy, Ms Elize Swart, there are currently 8 000 abandoned or orphaned mines. Government is spending R80 million a year on mine rehabilitation, in addition to R39 million on dewatering forgotten mines. At the present rate of progress it would take 800 years to rehabilitate all abandoned mines.
There are more than 270 tailings dams in the Witwatersrand Basin, covering approximately 400 km$^2$ in surface area. These dams are mostly unlined and many are not vegetated, providing a source of extensive dust, as well as soil and water (surface and groundwater) pollution.

Historically impoundment on land was the preferred option for tailings disposal on the Witwatersrand. The environmental implications of this disposal option include contamination of streams by acid mine drainage, contamination of streams due to surface run-off from the impoundment area, air and water contamination due to wind erosion of dried-out tailings, possible risk of catastrophic dam failure and release of slimes, physical and aesthetic modification to the environment and difficulty of establishing vegetative cover to permanently stabilize the tailings, due to unfavourable soil conditions in the presence of pyritic tailings.

Waste from gold mines constitutes the largest single source of waste and pollution in South Africa and there is wide acceptance that Acid Mine Drainage (AMD) is responsible for the most costly environmental and socio-economic impacts.

Acid mine drainage probably presents the single most important factor in dealing with tailings and waste rock and their impact on the environment. Due to the more disaggregated (and more concentrated, in the case of tailings) nature of the acid-generating minerals in the waste materials, AMD that flows from them may be more aggressive than that which discharges from the mine itself. Another consideration here is the potential long-term pollution problem, as production of AMD may continue for many years after mines are closed and tailings dams decommissioned.

Releases of AMD have low pH (2.5), high electrical conductivity, elevated concentrations of iron, aluminium and manganese and raised concentrations of toxic heavy metals. The acid produced dissolves salts and mobilizes heavy metals, including uranium, which is both radioactive and chemically toxic, from mine workings. AMD is not only associated with surface and groundwater pollution, but is also responsible for the degradation of soil quality, for harming aquatic sediments and fauna, and for allowing heavy metals to seep into the environment.
This issue is coming to a political head in the various catchments that drain the Far West Rand, with two being the most notable in the short-term – the Wonderfontein Spruit and the Tweelopiespruit – draining into the Orange and Limpopo River Basins. The Wonderfontein Spruit is a small stream rising in Krugersdorp, at the base of a massive mine waste dump and municipal landfill, flowing past Carletonville and Potchefstroom, draining into the Vaal and ultimately the Orange River system. The Tweelopiespruit starts on mine property in Krugersdorp and flows through a game reserve and into the Limpopo Basin via the Cradle of Humankind with elevated levels of Uranium coinciding 100 percent with active mine decant from a variety of point and diffuse sources.

The groundwater and surface water quality is poor with low pH and a high acidity, owing to the elevated ferrous iron content in the decanting water. The water level is still rising in this area and may decant into the Wonderfonteinspruit. This inflow has serious impact on contaminated sites downstream as can be clearly inferred from the effects of the initial decant, where acid mine water was discharged into the Robinson Lake. The combination of pH- and redox-driven reactions resulted in a measured uranium concentration of 16mg/l, and resulted in the National Nuclear Regulator declaring the lake a radiation area.

Grounded upon the Report, entitled “Hydrological/Chemical aspects of the Tweelopie-/Riet-/Blaaubankspruit, with specific reference to the impact water, decanting from the Western Basin Mine Void, has on the system” AMD is causing accelerated void formation in the dolomite of the Zwartkrans compartment, where the Cradle of Humankind is located, with resultant ground instability and seismological activity in the area. As the dolomite within this region becomes depleted, the impacted area will gradually increase in size with catastrophic impacts upon persons and property.

The current situation, in the absence of strong institutional control and legislation, and enforcement of non-compliance of directives, is not sustainable in the long term. Water and sediment analyses indicate that the heavy-metal contaminant, with significant salt loads, does migrate downstream. The ramifications to the environment are enormous.
AMD follows the same flow pathways as water; therefore AMD can best be controlled by controlling water entry into the site of acid formation by diversion of surface water away from the residue storage areas, prevention of groundwater infiltration into the mine workings, prevention of hydrological seepage into the affected areas and controlled placement of acid-generating waste. Diversions most commonly consist of ditches, which are difficult to maintain for long periods of time. Groundwater discharge areas should be avoided as isolation and interception of contaminated groundwater is very difficult to achieve. Under-drains can be installed in locations of the dumps, and the infiltration by meteoric water can be further retarded through the use of sealing layers. It is strongly recommended that the WRDM addresses the management AMD by regulating the management of tailings dams and rock dumps during mining and for many years after mining closure.

If indeed the extent of “… problems related to mining waste may be rated as second only to global warming and stratospheric ozone depletion in terms of ecological risk” (EEB, 2000), then the Witwatersrand gold mining area of South Africa is at serious risk. Being the economic heartland of South Africa, few natural ecosystems remain and, as indicated by hundreds of Reports, the impacts of mining and other problems related with mine closure and mine water management that cannot easily be addressed over the short term, may have devastating consequences for more than just ecosystems.

RETROSPECTIVE APPLICATION OF THE POLLUTER PAYS PRINCIPLE

In view of the above, and the fact that many of the older mines were and are subjected to amalgamations and changes in ownership and in many instances the surface infrastructure, including some tailings and rock dumps that were sold to 3rd parties, there is an retrospective obligation and liability upon mining companies and affiliated parties who generally derived some direct or indirect financial benefit from their pollution activities for the costs of the removal of contamination caused prior to the inception of NEMA in 1999, and to remediate contamination, inclusive of tailings dams which generate acid mine drainage and percolate radioactive and chemical toxic substances, and waste rock dumps that have very large inventories of fine
material which are permeable to oxygen, contaminants that remain in the soil after a tailings dump has been removed and the remediation of contaminant plumes.

The retrospective application of s 28 of NEMA (duty of care in relation to environmental degradation) has been passed by Parliament (see the attached amendment Bill, section 12 - the insertion of s 1(A) into NEMA). We urge the WRDM to take cognizance of this fact.

We urgently call upon the WRDM to prescribe specific remediation standards specifying:

- Standards for the management of the long terms risks (quantity and quality) associated with post closure impacts from gold mines;
- Standards for the long term risks (quantity and quality) associated with post-closure seepage from waste residue deposits (tailings, waste rock and footprints below removed dumps);
- Standards, in collaboration with the Department of Water Affairs and Forestry for the proactive management measures that can be implemented to minimize the long term risks associated with decant from mines or acid mine drainage (AMD) and the long term impacts of flooding/rewatering of the basins after mine closure.

SUBMITTED BY:
MARIETTE LIEFFERINK.
CEO: FEDERATION FOR A SUSTAINABLE ENVIRONMENT

DATED: April 21, 2009.