Proceedings of the Workshop on South African Mining-Related Landscape Rehabilitation Status Quo: Identifying Research Work Required to Close Knowledge Gaps
(16 – 17 March 2015)

Report to the Water Research Commission
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1. EXECUTIVE SUMMARY

The Water Research Commission and the Land Rehabilitation Society of Southern Africa hosted a workshop to assist in identifying knowledge gaps and prioritising research work needed in the South African mining and rehabilitation landscape. The objectives of the workshop were to consolidate existing guidelines, tools, models, etc. available in South Africa for rehabilitation in the mining business; identify gaps in knowledge in the four focal landscape rehabilitation areas of surface profiling, land ecosystems, water ecosystems and air; conceptualise specialist work required to close identified knowledge gaps; and prioritise and develop a research plan in the short-, medium- and long-term. The workshop was based on a series of presentations, followed by a panel discussion on existing guidelines, tools and models, the future desired state, as well as current constraints during a panel discussion. This culminated in a research plan with short-, medium- and long-term knowledge gaps in the four focal landscape rehabilitation areas.

Key issues that need to be addressed within the short term (two years) include a decision support system to define land uses and setting long term performance criteria; a research project to understand why guidelines are not implemented; the linkage between legislation and guidelines; how to decide what plants to use for rehabilitation; standardised monitoring programmes (including academic and practical training for applied monitoring); including the full hydrological cycle in environmental impact assessments; guidance and assessment tools to address pans; lack of buffer zones; dust regulations need to include geo-chemical analysis and analysis of the impact of radio-active dust; lack of standards for rehabilitation and understanding the economic cost of not rehabilitating; as well as central entry points to access data sources.

Key issues that need to be addressed within the medium term (five years) include how to combine economic efficient mining and economic efficient rehabilitation; a better understanding of weathered material profiles; the linkage between legislation and guidelines; how to rehabilitate without soils; whether offsets are delivering what they are supposed to (and how to measure no net loss); the lack of epidemiological studies in health risk assessments; as well as the socio-ecological impacts of not rehabilitating.

Key issues that need to be addressed within the long term (ten years) include how to decide what plants to use for rehabilitation; how to follow a whole ecosystem approach; how to reach a no net loss; how to deal with transfer of landownership issues after rehabilitation or closure; the impact of dust deposition on the environment; the knowledge gap in ambient air monitoring data in South Africa; interaction between industries and areas; the impact of climate change; as well as the impact of acid rain on biodiversity.

The priorities identified above can be used by the mining sector to improve the way that they address land rehabilitation issues in the mining context. Furthermore, it can also be used by the Water Research Commission and other agencies for future research projects to address the specified knowledge gaps.
2. INTRODUCTION

2.1 Background

The Water Research Commission (WRC), together with the Land Rehabilitation Society of Southern Africa (LaRSSA) hosted a one-and-a-half day workshop to assist in identifying knowledge gaps and prioritising research work required to close these gaps, related to South African mining-related landscape rehabilitation. The outcomes will be used to focus research scope and projects over the short-, medium- and long-term.

2.2 Workshop Objectives

The objectives of the workshop were as follows:

- To consolidate existing guidelines, tools, models, etc. available in South Africa for rehabilitation in the mining business;
- To identify gaps in knowledge in the four focal landscape rehabilitation areas of surface profiling, land ecosystems, water ecosystems and air;
- To conceptualise specialist work required to close identified knowledge gaps; and
- To prioritise and develop a research plan in the short-, medium- and long-term.
3. WORKSHOP PROCESS

3.1 Background on the Process Followed During Facilitation

The workshop\(^1\) was facilitated by Dr Marius Claassen from the Council for Scientific and Industrial Research (CSIR). After each session the participants posed questions of clarification to the presenters. After the individual presentations, a panel discussion followed which provided an opportunity to all participants to contribute inputs towards the objectives of the workshop.

3.2 Day 1 (Monday 16 March 2015)

3.2.1) Overview of Presentations
The slides used by the presenters are provided in Appendix C, with a few headlines of each presentation provided hereunder.

Session 1
1. Mr Bonani Madikizela:
   Opening and Welcome

2. Dr Victor Munnik:
   Setting the Scene – Conflicts between Mining and Water in South Africa

3. Mr Philip Barnard:
   Surface Profiling and its Valuable Contribution to Mining Rehabilitation

4. Mr Johan van der Waals:
   Land Capability and Wetland Rehabilitation Commitment in a Mining Environment – Conflicts, Challenges and Opportunities

5. Mr John Dini:
   Water Ecosystems – Mapping and Rehabilitation of Wetlands in Mpumalanga Including Review of Rehabilitation Tools

Session 2
1. Mr Douglas Macfarlane:
   Water Ecosystems – Preliminary Guideline for Buffer Zone Determination – Relevance and Applicability to Mining

2. Mrs Hanlie Liebenberg-Enslin:
   The Air Landscape as an Aspect of Rehabilitation

3. Dr Paul Oberholster & Mr Arno De Klerk:
   Water Ecosystems – Lessons Learnt on Rehabilitation in Mpumalanga

\(^1\) The agenda and list of participants are available in Appendix A and B, respectively.
3.2.2) A Consolidation of the Feedback Received During the Panel Discussion Based on the Workshop Objectives

Participants gave their inputs regarding existing guidelines, tools and models, the future desired state, as well as current constraints during a panel discussion.

Plenary Session 1: Existing Guidelines, Tools, Models, etc. for Mining-Related Landscape Rehabilitation

1. Enough funding for monitoring programmes.
3. Environmental Offset Discussion document (DEA).
5. DWA Best Practice Guidelines (Mine water closure).
8. Mining & Biodiversity Guideline.
10. Gold Sim Water Model.
13. COM guideline for rehabilitation of opencast mined land.
15. Mining & Biodiversity Guideline.
18. Wetland Rehabilitation Guidelines.
19. Buffer zone (but needs to be improved to include groundwater flow dimension).
21. CSIR-AMD tox tool to prioritise rehabilitation sites.
22. “Principles of Rehabilitation of Disturbed Environments” as module (Post-graduate level) for students or “entry-level” professionals in the discipline.
23. NFEPA National Freshwater Ecosystem Priority Areas Maps.
25. Definition of rehabilitation as defined by law.
27. Wetland Management Series (WRC).
   “Conceptual hydrological flow models per HGM (hydrogeomorphic) wetland type in South Africa” WRC K5-2191.
30. Procedures to developed and implement resource quality objectives.
32. Australian Guidelines for the Construction of Dump Covers.
33. Landscape Modelling Software.
   Wonderfonteinspruit Catchment.
37. Biodiversity Guidelines.
38. FEPA.
39. Implementation Manual for Freshwater Ecosystem Priority Areas contains guidelines for land-use practices or activities that impact on water quality in river and wetland FEPA’s.
40. NEMA, NEMBA, NEMPA, National Biodiversity Framework, NWA- Legislative & policy framework.
41. Land use classification standard – (DRD+LR). (In draft at present.) Weak on mining chapter; some other land use types are well developed.
42. GDARD guidelines (July 2011) – on rehabilitation strategy for MRA within the Witwatersrand goldfields.
44. DMR regional mine closure strategy (2008) for the Witwatersrand goldfields.
45. Wetlands report (council of geoscience) 2005.
46. COM Namibia, Mine closure framework.
47. Capacity to rehabilitate, restore in an ecologically sound way have been created.
48. Irrespective of planned post-closure land use, biodiversity and ecosystems form the basis of all rehabilitation approaches.
49. All rehabilitation and restoration based on regional, ecologically sound land use plans.
50. Anglo American mine closure tool box.
51. LEAF – Leaching Environmental Assessment Framework and model (International).
52. National wetland monitoring programme (underway) – WRC.
53. Decision support system for design of tailings disposal (WRC 2006).
54. United Nations Environmental Programme - Mine rehabilitation for environmental and health protection.
55. DMR Guideline for determining the quantum of financial provision for mine closure.
56. Tennessee valley authority guidelines for the construction of wetlands to manage AMD (defines areas needed for water quantity / type).
57. Biodiversityy GIS (SANBI).
58. SDF’s, eIDPs, Provincial biodiversity sector plans.
59. Bioregional plans.
60. River rehabilitation (being finalized, WRC-project).
62. India – Closure planning guideline (topsoil management and abandonment costing).
63. China – Cost benefit analysis and economics for closure.
64. Australia – Rehabilitation handbook: Leading practice for the mining industry.
67. Framework for management of contaminated soils.
68. Acid mine drainage guideline.
69. Risk based approach (S-P-R, etc.) versus an absolute rehabilitation solution (norms and standards, etc.) - who decides when to use which approach, or should we be using a uniform approach across all industries and services?
70. ICCM Guide to Catchment-Based Water Management. ICMM has published a comprehensive new approach to managing water around mining and metal
operations, in guidance that details the priorities of all water users throughout the water catchment, as well as the water usage of the operation itself.

71. The new practical guide to catchment-based water management. (http://www.icmm.com/document/8329) sets out a collaborative approach to water management that considers the needs, concerns and priorities of other water users and promotes inclusive and ongoing engagement with all stakeholders.


73. Besides the Chamber of Mines of South Africa/CoalTech’s Guidelines for the Rehabilitation of Mined Land (November 2007), there are a number of academic reports and Governmental Reports that may have relevance to restoration / rehabilitation, e.g.:


e. With reference to the legislation pertaining to restoration / rehabilitation:
   - Humby, T. School of Law, University of the Witwatersrand, South Africa. ‘One environmental system’: Aligning the laws on the environmental management of mining in South Africa (2013).
   - Bosman, C. and Kotze, L. Responsibilities, Liabilities and Duties for Remediation and Mine Closure under the MPRDA and NWA.


h. With reference to the background to the rehabilitation of radioactive mine residue areas:

Plenary Session 2: Future Desired State (20 Year Vision) - Where Would we Like to be within 20 Years from Now

1. Commodity price.
   a. Low price,
   b. No funds to rehab, reduced time to rehab, mine close early, reducing concurrent rehabilitation.
2. Health Issues.
   a. Externalities carried by communities.
3. South Africa is a global leader in wetland and mining rehab research and implementation.
4. Commodity price changes alter life-of-mine planning. Rehab plans should be revised with LOM planning.
5. Public health system that takes care of pollution induced health burdens.
6. Environmental courts.
7. Functioning water tribunal.
8. Training and education (Curriculum on land rehabilitation).
9. We need to deal with uncertainty with the best tools in the world. Models will never be 100% accurate. We need admin/insurance type approach to deal with this uncertainty.
10. Rehabilitation related soil and waste movement is part of life of mine planning and NPV calculation.
11. A biodiverse rehabilitated mine with socially accepted norms.
12. Well documented, up to date freely available “rehabilitation library / database”.
13. 100% closure certificates issued. P.T.O.
15. Fully functional CMA’s.
16. Mining companies are internalising all externalities into their balance sheets and operations.
17. Identify key species to pioneer ecosystems in harsh environments to re-vegetate these disturbed environments.
18. Government departments working together effectively.
19. New / additional wetlands created as part of mine closure / rehabilitation (offset the legacy of mining wetland loss).
20. Decision making in relation to land use is done through participatory and reflective processes.
21. Decision making processes are informed by full-cost accounting (internalization).
22. Decision making processes are informed by a full understanding of the risks of inequity (the ethical need for equity).
23. Decision making processes include systems-understanding approaches.
24. A site is ecologically stable and has socio-economic value.
25. Legal protection of critical habitats, wetlands, rivers and high potential agricultural land against mining.
26. Aquatic life in all rivers (including the Braamfonteinspruit).
27. No exceptions – sound environmental compliance to national law by foreign nationals (India, Russia, China, etc.), or else no mining or development.
28. Greater understanding by IAP’s about how a development affects them in the long term (water, air quality, pollution, etc.) and how to protect their natural assets.
29. Wilderness areas still protected.
30. Properly designed, scientifically robust monitoring programmes as part of adaptive resource management plans for all mine rehabilitation programmes.
31. Viable end land use options and viable livelihood opportunities with associated resource use (e.g. water).
32. Pre-determined and agreed upon by interested and affected parties (as end land users).
33. Diligent enforcement of environmental legislation (i.e. polluter pays principle including the retrospective application of the polluter pays principle).
34. If more than one polluter, apportionment and enforcement of liability.
35. When TSFs are re-mined, the entire dump must be removed with rehabilitation of the footprint and the entire area.
36. Land use should be soft land uses for example footprints e.g. lined landfill sites, graveyards, biomass.
37. Financial provisions for latent and residual impacts (e.g., AMD) and for the lifetime of the impacts not just lifetime of the mining operations.
38. Rehabilitation should be ring-fenced for the rehabilitation with the liquidator prevented from distributing rehabilitation funds amongst creditors - alignment of MPRDA with Companies Act & Insolvency Act.
39. An East Rand without those ugly white tailings (i.e. citizens who have not inherited a buggered environment).
40. Tailings Storage Facilities should be completely removed and rehabilitated footprint. After re-mining the tailings footprint must be used for soft land uses (not high risk).
41. EIA’s are conducted from a central fund which companies pay into central EIA fund.
42. All Environment Management plans are known to be public.
43. Simple, practical, risk-based guidelines for the rehabilitation and closure of mines.
44. Shift from command and control to awarding of incentive for good environmental practices.
45. Better equipped to deal with climate change (due to current activities).
46. One government department to deal with environmental authorisations (air, water, land, etc.).
47. Rehabilitated mines, no derelict & ownerless mines.
48. Detailed closure plan required upfront: at planning (EIA) stage (as opposed to decommissioning stage when it is too late), to be signed off by DMR, DEA, DWS.
49. Mining no-go areas are identified and enforced.
50. Wetlands assessment at a sub-catchment level to be done at planning (EIA) stage.
51. Strict monitoring and compliance enforcement by regulators.
52. Scope of environmental assessment to be determined by site and project specifics, not list of activities, facilities, to be guided by regulator.
53. Land rehabilitation institute of South Africa.
54. Mined areas rehabilitated to a useful piece of land with no more abandoned mine sites.
55. Responsible and realistic environmental legislation and political will to implement it.
56. Regional landscape models with predicted water flows + qualities for the major mining centres.
57. Economically sustainable and productive land use.
58. Rehabilitated landscapes are value-generating assets (environmentally, socially and economically).
59. Desired future state where the action of an individual today is still the responsibility of the individual in future.
60. “Planning with the end in mind” (integrated, upfront specialist planning at the start of mine planning, toward eventual closure and rehabilitation).
61. Establishment of a risk-based fund for the management of latent and unpredicted adverse events following closure.
62. Rehabilitated mining sites provide new ecological infrastructure (that incorporate tree resources as appropriate and provide a diversity of ecosystem services).
63. Reliant on renewable energy.
64. All South Africans know about, care about and insist on the protection of our natural capital, including wetlands.
65. New Department: Department of Mining and Environmental Affairs.
66. Wetland mitigation banks are established in which key wetland ecosystems have been rehabilitated to help address key water quality impacts.
67. Rehabilitated land suitable for sustainable agricultural production.
68. To define future ecological state, you need to define “rehabilitation”.
69. A corporative and transparent DMR (Department of Mineral Resources).
70. Integrative, sustainable, multifunctional post mining landscapes that support the environment and society.
71. Conscious mining, rehabilitation, closure and socio-environ-economic prosperity.
72. Integrated environmental management (air, water, biodiversity, etc.).
73. Government is able to successfully implement / enforce rules, guidelines, etc.
74. Reduce emissions by 80% by 2035.
75. Rehabilitated land with productive use.
   a. Industrial,
   b. Energy,
   c. Food.
76. Reduce impacts of mine closure to more than 80%.
77. Well-developed SLA based literature development on resource economics.
78. Rehabilitation vs. value of money analysis.
79. Ministry of mine closure.
80. Cooperative governance between relevant departments.
81. Area specific rehabilitation closure criteria, integrated and outcome based.
82. Criteria for mine closure certificate.
83. Case study based end land use or second life options as a selection tool.
84. Cradle to grave mine closure protocol.
85. Standard soil testing / mapping procedures.
86. By 2035 all mining companies to do rehabilitation according to existing guidelines.
87. Enough trained professionals.
88. All South Africans care about and insist on protection of our natural capital, including wetlands.
89. Mining towns with citizens who have fully benefitted from the mining activities.
90. Citizens who have not inherited a buggered environment.
91. It is vital that the rehabilitation is relevant to the end land-use objectives as stated in closure plans.
92. Sustained accountability.
93. Accumulative societal commitment to the cause.
94. EMP’s that are practical.
95. Environmental compliance for international participants.
96. Transparent environmental management.
97. Compliance by mines with current guidelines.
98. It is impossible to determine the rehabilitation measures or objectives with the aim of achieving mine closure unless the future land use has been determined in the context of societal and economic expectations.
99. It is necessary to understand the biochemical limitations for the development of a self-sustaining vegetation community and viable end land uses.
100. It must be accepted that some areas will never be suitable for unrestricted development and that these areas will need to be demarcated as such and appropriate land-uses should be proposed and implemented.
101. Measures such as sloping, grassing, revegetation, phytoremediation, woodlands and stockpiling cannot be regarded as reasonable measures for remediation and are at best measures for interim stabilisation.
102. The land must be rehabilitated to a land use or standard which conforms to the concept of sustainable development (Reg. 56 of the MPRD Regulations) or to a predetermined and agreed standard or land use.
103. Since IAPs are the ultimate recipients of potential, ongoing and historical pollution and the future land users, interested and affected parties must be involved in the agreements regarding future land use and rehabilitation.
104. Many mining companies still follow the BATNEEC approach for remediation (e.g., remediation to “wilderness” status) and not the BPEO approach that is the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society in the long term as well as in the short term.
105. Rehabilitation funds must be sufficient to provide for residual and latent impacts (e.g. AMD) and in the case of the winding up of a mining company, the winding up provisions ought to accommodate the financial provision for rehabilitation as a special call on the company’s assets that should be set aside before any other creditors are satisfied.
106. Wetlands are prioritised and rehabilitated to strategically address water quality impacts (individual vs. combined).

Plenary Session 3: Constraints - What is Currently Preventing Us from being at the Desired State?
1. Lack of political will.
   a. Lack of communication between departments.
   b. Hesitance to take accountability by leaders.
   c. Not enough trained professionals in government to be accountable (also a Knowledge Gap - proper, combined synthesised training material).
   d. Different priorities by current constituency (also a Knowledge Gap - how do we get the general public to care).
   e. High turnover of government officials to do the job properly.
   f. Socio-economic inequalities and other issues that are larger.
   g. Corporate will of also smaller organisations.
   h. Industry inertia to respond to political will.
   i. Understanding political drivers.
      • Job creation is still the main driver for decision making.
      • Short term priorities.
• Short term priorities in large companies.
  j. Poor decision making by politicians (legislation) and lack of response to public comment to address poor decisions.
  k. Political interference.
   • Conflicts of interest (politicians and families are shareholders of companies).
   • Balancing mechanisms are not functioning to bring balance (public participation).
   • Mining entitlement.
   • Psychological dependence on mining.
   • Perverse economic incentives.

2. Insufficient trained professionals.
   a. High turnover of government officials to do the job properly (need to retain young people so that they can have an influence on the long-term).
   b. Relationship between qualification and experience.
   c. Mentoring of young professionals (university and working) by aging (almost retired) experts and sharing lessons learnt and networks.

3. EMP’s are written by academics but must be implemented by mines (also a Knowledge Gap – need a usable format, how to and budgeting).

4. Documents produced must not be complicated (must be easy to apply and enforce).

5. Legislation, regulations, plans must be simple, real and open (legislation documents are often contradictory).

6. Authorisations issued must not be contradictory, extensive and unpractical.

7. Accessibility (capacity / message delivered must be clearly communicated) to understand documents: Ordinary people must be able to comment meaningfully and intelligently to environmental processes – simplify documents. It is often impossible for local communities (I&AP) to understand and comment on documents.

8. Difficulty to attract new employees and invest in new staff. New staff needs to stay around long enough to gain experience (grow capacity over the long term).

   a. Develop appropriate curricula - collaboration of universities with industry / implementers / consultants in practice.
   b. Exchange between universities and industry (exchange students).
   c. Lack of central access point for rehabilitation information.
   d. Pulling resources together for effective research and guidelines (like Coaltech).
   e. Lack of funding for fundamental research (small pool of funding for research available). Funding cut up to small pieces, competed for and reduce research effectiveness. Distinguish between fundamental and applied research. Applied research is funded by industry, but fundamental research is lacking.
   f. Lack of trust and risk aversion between organisations / companies and government.
   g. Research exists in vain if it is not implemented. The loop is not closed. The basic research needs to be translated into practice (also a Knowledge Gap).
   h. Approaches are insular and local while the drivers of that system are regional. Understanding that the drivers are cross boundary, collaboration needs to be cross boundary.
i. Inviting international experts to share their knowledge, case studies and lessons learnt that can be applied in South Africa. We are not the only country grappling with these issues.

10. Proprietary information (also a Knowledge Gap).
   a. Who does information belong to?
   b. What is commercially protected information?
   c. Who makes the decision for distribution / paying for it?
   d. Intellectual property / ownership of the data. Work currently being done by consultants is owned by the mines. EIAs are not widely distributed. The unwillingness to share data is a key constraint.
   e. Issues around custodian of data. Who has the mandate to collate EIA data? It should be the government department’s responsibility, but how can we assist them to fulfil their mandate as a custodian of the data?

11. Lack of understanding of complexity.
   a. Old linear approaches are still used to solve complex issues.

12. Proper use of risk assessments (also a Knowledge Gap).
   a. Application of risk and opportunity assessments (not only risk assessment).
   b. Proper risk assessment for complex issues needs proper time, which is not spent.
   c. Poor risk assessments taking place.
   d. Use the risk assessment tool to prioritise our focus areas properly.
   e. No protocol of how to do the risk assessment and no generic probability and consequence framework against which to rank risk (also a Knowledge Gap).

13. Role of consultant / environmental assessment practitioner.
   a. Clarification of the role of consultants / practitioners.
   b. Different approaches by different consultants.
   c. Cost driver allowing improper evaluation / studies.
   d. Professional bodies / board required.

14. Rehabilitation plans are used to obtain approval and is not used as a tool for sustainable rehabilitation.

15. Rehabilitation requires a land manager (just like the mine has a general manager).

16. Media / NGO roles. We need to create an environment where media assist in sending the correct bottom-up message around rehabilitation (also a Knowledge Gap).

17. Reporting at national level on research works / status of water resources in the country.

18. Regulatory capacity.


20. Mine engineering training. Focussed mine closure training required on tertiary level.

21. Limited heavy prosecution or fines to mine owners for environmental non-conformances.

22. Mining culture.

23. Ecosystem services lack of values (cost of replacements).

24. Chamber of mines rehabilitation guidelines are very applicable and relevant. However, it does not seem to be used in practice.

25. EMP’s are written by academics, but have to be implemented by mines.


27. “Linear scientific approaches”.
28. Fully understand the risk (consequence level; probability level). 100% certainty NEVER!
29. Lack of transparency (e.g., EMPs and rehabilitation funds – public access website).
30. Corruption.
31. The ability for well-established companies to change (for new legislation) is more difficult than for new companies.
32. A lack of norms and standards for rehabilitation.
33. Lack of a rehabilitation handbook in South Africa.
34. Static, equilibrium view of ecology still dominates ecological restoration thinking, leading to an oversimplified concept of restoration success.
35. Minimum spatial data requirements for an EIA. Which dataset should be used for wetlands? There are various datasets which give different answers and depending on which one you use you might or might not get a wetland. The same applies for rivers. Which rivers should be used? 1:50 000 or 1:250K, and what are the limitations of the dataset (for example, 1:50K are cartographic rivers and not hydrologically correct)?
36. Mining rehabilitation guidelines are not sufficient to address the challenge. There is a gap that needs to be addressed.
37. It is not possible to have a guideline that focusses on every land-use aspect; it must deal with the complexity.

3.3 Day 2 (Tuesday 17 March 2015)

3.3.1) A Roadmap of the Knowledge Gaps and Specialist Work Required Relating to the Short, Medium and Long Term

Plenary Session 4: The Identification of Knowledge Gaps in the Four Focal Landscape Rehabilitation Areas

Key:
Number of ☺ = Importance of the specific knowledge gap

Surface Profiling (Land)
1. ☺☺☺☺☺☺☺☺ How to design with the end in mind, to marry economic efficient mining and economic efficient / sustainable rehabilitation.
2. ☺☺☺☺☺☺☺ A research project to understand behaviour of mines / manager – why guidelines are not implemented.
3. ☺☺☺☺☺☺ A fuller understanding of weathered material profile. Currently, soil survey is done of the surface, but the layers below that is really valuable to deal with drainage and other issues. This should be understood and specified.
4. ☺☺☺☺☺☺ Linkage between legislation and guidelines (guidelines not mentioned in legislation, not applied).
5. ☺☺☺☺ A gap for a decision support system / framework to define achievable land uses and setting long term performance criteria to achieve the set land uses.
6. ☺☺☺☺ How to re-engineer the landscape to perform the function it performed before.
7. ☻☻☻☻ How does the profile affect the hydrology of the catchment, beyond the boundaries of the mine. Regional profiling with interrelation between mines and other areas (border pillars).

8. ☻☻☻☻ Why is everybody so unaware of the knowledge gaps if the guidelines of the Chamber of Mines are available to address this. The gap of available tools not being used (application).

9. ☻☻☻ The challenge how to deal with large / extensive open pits.

10. ☻☻☻ How to persuade the decision makers to plan with the end in mind. Communication by media / NGO and relationship between public and decision makers.

11. ☻☻☻ The 2007 Chamber of Mines rehabilitation guideline was a first version and needs to be updated as a priority.

12. ☻☻☻ Regional closure strategies exist, but are not finalised or implemented. Regional closure strategies only exist in some catchments.

13. ☻☻ Knowledge gap of the role of profiling of waste rock dumps or any profiling in rehabilitation in arid areas.

14. ☻ Do we train engineers also to be ecologists or do we train ecologists to also be engineers to address the landscape profiling challenges.

15. ☻ How to deal with uncertainties in the future (life of mine) with the different mine owners and mine context.

16. ☻ Lack of education, lack of ownership of the plans created.

17. ☻ The guideline is not a one-size-fits-all and it is a guideline and cannot be applied directly in all areas. Implementation is not a matter of duplication.

18. ☻ Capacity constraints to address knowledge gaps: lack of people with a social science background, when the desired state is social ecological sustainability, this expertise is required.

19. ☻ The relationship and integration of landform design and cover design.

20. ☻ Lack of geochemical risk profiling expertise currently and going forward (soon to retire experts).

21. Standardised way of evaluating ecosystem services.

22. How to bring / link / integrate all the knowledge items together.

23. How to do the trade-off between mine landform shapes – height vs area covered by equivalent volumes and topsoil stockpile surface areas. Disturbed and then also needing rehabilitation.

24. What do we do with big holes?

**Land Ecosystems**

1. ☻☻☻☻☻☻☻ How do we rehabilitate without soils (topsoil and subsoil)?
   a. Topsoil management and expertise available to translate the information to the people on the mine to ensure implementation.

2. ☻☻☻☻☻ How do we reach no-net loss, if the principles do not apply? Rehabilitation is only creating a substitute; we cannot recreate what was lost. What is the land-use objective? Where is the final land-use decision made?

3. ☻☻☻☻☻☻☻ Connectivity of water systems and land when doing rehabilitation. Understanding this while achieving rehabilitation objectives.

4. ☻☻☻☻☻ How do you decide what plants to use for rehabilitation under the new profile conditions?
5. How do you know what ecosystems should be established? How do we follow a whole ecosystem approach?

6. Standardised monitoring program. And standardised for specific biomes and robust enough to allow for partial closure. Monitoring process needs a playbook for everybody to play by.

7. Landownership - how to deal with transfer of landownership issues after rehabilitation / closure (liability transfer).

8. Academic and practical training for applied monitoring.
   a. Understanding what monitoring must be applied to what monitoring objective and habitat type.
   b. Academic degrees and general short courses.
   c. Potential partnership between universities and practitioners to have relevant training material linked with experience in field.

9. The potential of novel ecosystems exist and should be investigated for application. (Where does it fit, if it fits?)

10. What are the true no-go areas for different disciplines?
    a. Big challenge to achieve on political / national / local level.
    b. Need to look at alternatives to look at the no-go approach (binary approach). An alternative to consider achieving the right objectives (conservation / mining).
    c. Multiparty agreement, not a government official making a single decision.
    d. Consider systematic conservation costing approach as applied now in Namibia.

11. Underestimating what makes a land ecosystem work. You must look at the whole suite, relate to interconnectivity / function.

12. How to look at conflicting interests / risks / objectives (area critical for biodiversity and mining).

13. Too little understanding of ecological dynamics of reference areas and rehabilitation areas. Having long term views of the dynamics.


15. How do we implement the legal requirements for rehabilitation / closure and what is the punitive litigation to ensure enforcement.

16. Clarity of the right of the individual to mine rehabilitated areas. No end state of rehabilitation is reached. Future status of areas defined as offsets (legal status).

17. Impacts of artisanal / illegal mining on rehabilitation. What are the rehabilitation options?
    a. WRC has two reports (first order reports) addressing this issue. Reports: 1150/1/04 and KV231/09.

18. The engineers need to be aware of potential of wind erosion and dust generation in design.

19. Quantifying and comparing actual impact on biophysical environment by mining vs. agriculture vs. industry.

20. There is a lack of long-term data because most projects have very short-term perspectives.

21. The application of remote sensing to determine reference conditions for catchment monitoring, and general application of remote sensing in landscape rehabilitation as a less expensive option for where monitoring is not taking place.
22. Article by ecologist, Dan Simberloff, on novel ecosystems. (http://ensia.com/voices/novel-ecosystems-are-a-trojan-horse-for-conservation/).

**Water Ecosystems**

1. ☺☺☺☺☺☺☺ Pans – very little current guidance and assessment tools address pans. What can we do around the rehabilitation of pans? This is a completely different ecosystem.
2. ☺☺☺☺☺☺☺ Full hydrological cycle is not always included in the EIA.
3. ☺☺☺☺☺☺☺ Are offsets delivering what they are supposed to? How do we measure no-net loss for these systems? Are there any case studies?
4. ☺☺☺☺☺ Buffer zones for mining – we don’t have buffer zones for mining.
5. ☺☺☺☺☺ Understanding the hydrology of wetlands, understanding and identifying how wetlands are fed and how this will be affected by the mining process.
6. ☺☺☺☺☺ Proper target water and sediment quality criteria needed in wetlands for different wetland types.
7. ☺☺☺☺ No traction on research that provide solutions (coal water [15 years ago] / gold water research [current] to use decant water for irrigation). What are the used options in spite of work completed? How do we take evidence forward to policy?
8. ☺☺☺☺☺ Lack of proven (convincingly demonstrated) technology. Regulator does not recognise technology not implemented in South Africa even if proven elsewhere.
10. ☺☺ Is there potential for re-instatement for water ecosystems in disturbed areas? (What if we can put the wetland back at the end of mining?)
11. ☺☺ Potential or impact to use of voids for hydro-energy production. (Using head of shaft for hydro-energy).
12. ☺☺ Identify where heavy clays are to allow for compaction and lateral movement of water. Relook at 1/7 ratio applied historically to ensure water balance is kept. Determine impacts of what water outflow will now have.
13. ☺☺ Understanding the impact of water on plants and understanding the value of plants on waste areas / wetlands on taking out metals / chemicals. Identification of key plants for rehabilitation of wetlands.
14. ☺☺ Effective use of ingress control to eliminate existing decant or prevent future mine drainage from being generated.
15. ☺☺ River rehabilitation guidelines (specifically for mining sector).
16. ☺ What is the water feeding and near surface water system in arid areas / pans.
17. ☺☺ Lack of pro-active management plans to address flooding of Transvaal areas.
18. ☺ Understanding political will for implementing rehabilitation – why, how, mechanisms.
19. ☺ Delineation of pans (semi-arid areas) – not the same as wetlands.
21. ☺ Importance of ephemeral rivers.
23. ☺ Lack of water treatment technologies, particularly to reduce liability (brine issues).
24. Sandy river rehabilitation / sand mining of rivers.
25. Lack of continuous water monitoring of diurnal fluctuations.
26. Will we have viable water sources to produce water / treat water and the market to use the water?
27. Geochemical water quality monitoring can use different lab methods and these should be clearly recorded so that like is compared to like in long-term monitoring, esp. for “Priority Areas”.
29. Current water quality monitoring only includes standard physico-chemical parameters and not biological indicators.

Air
1. ☺☺☺☺☺☺☺☺☺☺ Impact of dust deposition on water bodies, plants and animals.
2. ☺☺☺☺☺☺☺☺☺☺ Dust regulations need to be amended to include geochemical analysis and analysis of impact of radio-active dust on human health and ecosystems.
3. ☺☺☺☺☺☺☺☺☺☺ Impact of acid rain on biodiversity.
4. ☺☺☺☺☺☺☺☺☺☺ Impact of / from climate change. How does this impact larger processes?
5. ☺☺☺☺☺☺☺☺☺☺ Health risk assessments lack of epidemiological studies.
6. ☺☺☺☺☺☺☺☺☺☺ The knowledge gap in ambient air monitoring data in South Africa.
7. ☺☺☺☺☺☺☺☺☺☺ Interaction between industries and areas. This is the purpose of the air quality management plans, this gets done at a basic level and not adequately address main sources and impacts. The plans are compiled, but not implemented.
8. ☺☺☺☺☺☺ Isolated, disjointed EIA data / mapping / studies to be centralised for future planning and decision making. Central entry point to access data sources. How to configure this.
9. ☺☺☺☺☺ Understand the drivers / impacts of development of settlements along waste stock piles / tailings.
10. ☺☺☺ Specifiy what monitoring method / analysis method must be specified for chemical analysis for health impacts (one issue is the monitoring program on site and the other issue to consider is the analysis of the data).
11. ☺☺☺ How to quantify the impacts of spontaneous combusting coal residues. Lack of understanding the significant of the POC’s and VOC’s for both air and soil and adjacent communities.
12. ☺☺☺ Understand the origin of dust by evaluating the particle size, shape and mineralogy.
13. ☺ A lack of understanding about on the nuisance value of dust (visibility, furniture, building impacts, traffic). Quantification of impacts (cleaning roads, buildings). This is not accounted for in environmental assessments.
14. ☺☺ The assessment and potential response to these impacts need to be addressed.
Cross Cutting Area (Applicable to Surface Profiling, Land Ecosystems, Water Ecosystems and Air)

1. ☺☺☺☺☺☺☺☺ Post closure monitoring is essential (does not exist, or not enough currently).

2. ☺☺☺☺☺☺ Understanding the cost of not rehabilitating (economic cost of not rehabilitating).

3. ☺☺☺☺☺☺ Lack of clear norms and standards for rehabilitation.

4. ☺☺☺☺☺☺ Socio-Ecological impacts / consequences of not rehabilitating.

5. ☺☺☺☺☺ Toxicity monitoring.

6. ☺☺ Criteria for impact measurement are not standardised to risk level. This is key for rehabilitation risk management.

7. ☺☺ Need to identify closure criteria (for example Australian guidelines that use abandonment criteria). Criteria to meet to get closure certification. Measureable items.

8. ☺☺ Lack of peer review and peer review capabilities. What is the specification / process for peer review of work in rehabilitation?

   a. Understanding using rehabilitation for carbon sinks. Is there a potential to manage it to be a carbon sink.
   c. Use of trees as carbon sink and risk of fire – do not only consider standing biomass (actual mitigation value of growing trees on disturbed land goes beyond just the standing biomass because it can be harvested).

    a. Water Affairs stopped monitoring in 2013. This should not happen again and controls put in place to ensure continuous monitoring. Funds should be available to allow for full water monitoring parameters. The results must be presented as full analysis and not just a summary graph.
    b. How do we get monitoring of radiological aspects to ensure the protection of public health.
    c. DWA is monitoring water, including radio-activity.
    d. Conduct resource quality services query about water monitoring.

11. ☺ Consider and compare South African guideline approaches with global models / guidelines in taking knowledge gaps forward.
    a. Two WRC reports to address closure criteria for water risk items to achieve closure are being published April 2015.

12. Understand and consider risk averse approach of industry to prioritise actions. This is not a linear process and need to consider industry approach.

13. How to strengthen professionals.
3.3.2) Consolidation of Information

**Key:**
Short- / Medium- and Long Term = Indication of whether the specific knowledge gap should be addressed in the 2-year, 5-year or 10-year time frame.

*Only knowledge gaps with 5 or more ☺ in the previous section are prioritised as short-, medium- and long-term.

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Long-term knowledge gaps do not necessarily mean that it can’t be addressed immediately! It must be addressed NOW, but it may only be resolved in the long term.

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### Surface Profiling (Land)

**Short Term**
- A gap for a decision support system / framework to define achievable land uses and setting long term performance criteria to achieve the set land uses.
- A research project to understand behaviour of mines / manager – why guidelines are not implemented.
- Linkage between legislation and guidelines (guidelines not mentioned in legislation, not applied).

**Medium Term**
- How to design with the end in mind, to marry economic efficient mining and economic efficient / sustainable rehabilitation.
- A fuller understanding of weathered material profile. Currently, soil survey is done of the surface, but the layers below that is really valuable to deal with drainage and other issues. This should be understood and specified.
- Linkage between legislation and guidelines (guidelines not mentioned in legislation, not applied).

**Long Term**
**Land Ecosystems**

- How do you decide what plants to use for rehabilitation under the new profile conditions?
- Standardised monitoring program. And standardised for specific biomes and robust enough to allow for partial closure. Monitoring process needs a playbook for everybody to play by.
- Connectivity of water systems and land when doing rehabilitation. Understanding this while achieving rehabilitation objectives.
- Academic and practical training for applied monitoring. Understanding what monitoring must be applied to what monitoring objective and habitat type. (Academic degrees and general short courses). Potential partnership between universities and practitioners to have relevant training materials linked with experience in field.

**Medium Term**

- How do we rehabilitate without soils (topsoil and subsoil)? Topsoil management and expertise available to translate the information to the people on the mine to ensure implementation.

- How do you decide what plants to use for rehabilitation under the new profile conditions?
- How do you know what ecosystem should be established? How do we follow a whole ecosystem approach?
- How do we reach no-net loss, if the principles do not apply. Rehabilitation is only creating a substitute; we cannot recreate what was lost. What is the land-use objective? Where is the final land-use decision made?
- Landownership: how to deal with transfer of landownership issues after rehabilitation/closure (liability transfer).

**Water Ecosystems**

- Full hydrological cycle is not always included in the EIA.
- Pans – very little current guidance and assessment tools address pans. What can we do around the rehabilitation of pans? This is a completely different ecosystem.
- Buffer zones for mining – we don’t have buffer zones for mining.

**Medium Term**

- Are offsets delivering what they are supposed to? How do we measure no-net loss for these systems? Are there any case studies?
Air

**Short Term**

- Dust regulations need to be amended to include geo-chemical analysis and analysis of impact of radio-active dust on human health and ecosystems.

**Medium Term**

- Health risk assessments lack of epidemiological studies.

**Long Term**

- Impact of dust deposition on water bodies, plants and animals.
- The knowledge gap in ambient air monitoring data in South Africa.
- Interaction between industries and areas. This is the purpose of the air quality management plans, this gets done at a basic level and not adequately address main sources and impacts. The plans are compiled, but not implemented.
- Impact of / from climate change. How does this impact larger processes?
- Impact of acid rain on biodiversity.

Cross Cutting Area (Applicable to Land Profiling, Land Ecosystems, Air Ecosystems and Water)

**Short Term**

- Lack of clear norms and standards for rehabilitation.
- Understanding the cost of not rehabilitating (economic cost of not rehabilitating).
- Post closure monitoring is essential (does not exist, or not enough currently).
- Isolated, disjointed EIA data / mapping / studies to be centralised for future planning and decision making. Central entry point to access data sources. How to configure this.

**Medium Term**

- Socio-Ecological impacts / consequences of not rehabilitating.

**Long Term**
## 4. APPENDIX A: AGENDA OF THE WORKSHOP

### Monday, 16 March 2015 (Day One)

<table>
<thead>
<tr>
<th>Time</th>
<th>Topics</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00</td>
<td>Registration and tea</td>
<td>All</td>
</tr>
<tr>
<td>08:30</td>
<td>Opening and welcome</td>
<td>Bonani Madikizela</td>
</tr>
<tr>
<td>08:40</td>
<td>Setting the scene – Conflicts between mining and water in South Africa</td>
<td>Victor Munnik</td>
</tr>
<tr>
<td>09:00</td>
<td>Surface profiling and its valuable contribution to mining rehabilitation</td>
<td>Philip Barnard</td>
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<tr>
<td>09:20</td>
<td>Land capability and wetland rehabilitation commitments in a mining</td>
<td>Johan van der Waals</td>
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<tr>
<td></td>
<td>environment: conflicts, challenges and opportunities</td>
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<tr>
<td>09:40</td>
<td>Water ecosystems – mapping and rehabilitation of wetlands in</td>
<td>John Dini/Coaltech</td>
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<td></td>
<td>Mpumalanga including review of rehabilitation tools</td>
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<tr>
<td>10:00</td>
<td>Questions of clarification</td>
<td>Bonani Madikizela</td>
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<tr>
<td>10:20</td>
<td>TEA</td>
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<tr>
<td>10:35</td>
<td>Water ecosystems – Preliminary guideline for buffer zone determination:</td>
<td>Doug Macfarlane</td>
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<td></td>
<td>Relevance and applicability to mining</td>
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<tr>
<td>10:55</td>
<td>The air landscape as an aspect of rehabilitation</td>
<td>Hanlie Liebenberg-Enslin</td>
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<tr>
<td>11:15</td>
<td>Water ecosystems – lessons learnt on rehabilitation in Mpumalanga</td>
<td>Paul Oberholster / Arno</td>
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<td>de Klerk</td>
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<td>11:35</td>
<td>Department of Mineral Resources and Council for Geo-science:</td>
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<td></td>
<td>Science into mining guidelines and restoration?</td>
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<tr>
<td>11:55</td>
<td>Questions of clarification</td>
<td>Bonani Madikizela</td>
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<tr>
<td>12:15</td>
<td>LUNCH</td>
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<tr>
<td>13:10</td>
<td>Policy and licensing view: successes and challenges, including off</td>
<td>Fundzo Hlanathi</td>
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<td></td>
<td>set guidelines – Department of Water Affairs</td>
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<tr>
<td>13:30</td>
<td>Assessment of employees' perceptions of approaches to sustainable</td>
<td>Stanley Liphadzi</td>
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<tr>
<td></td>
<td>water management by mining companies</td>
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<tr>
<td>13:50</td>
<td>Questions of clarification</td>
<td>Bonani Madikizela</td>
</tr>
<tr>
<td>14:00</td>
<td>Panel discussion on all topics</td>
<td>Marius Claassen</td>
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<tr>
<td></td>
<td>Identify guidelines, tools, models, etc.</td>
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<td></td>
<td>Future desired state (20 year vision?)</td>
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<td></td>
<td>Key constraints to achieving the future desired state</td>
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<tr>
<td>16:00</td>
<td>Closing</td>
<td>Stanley Liphadzi</td>
</tr>
<tr>
<td>Time</td>
<td>Topics</td>
<td>Facilitator</td>
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<tr>
<td>08:00</td>
<td>Tea</td>
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<tr>
<td>08:30</td>
<td>Summary of Day One</td>
<td>Raina Hattingh</td>
</tr>
<tr>
<td>08:45</td>
<td>Group discussion / breakaway (x2)</td>
<td>Marius Claassen</td>
</tr>
<tr>
<td></td>
<td>- Room 1: Profiling / land ecosystems - prioritising knowledge gaps</td>
<td>Phil Tanner</td>
</tr>
<tr>
<td></td>
<td>- Room 2: Water / air ecosystems - prioritising knowledge gaps</td>
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<tr>
<td>10:30</td>
<td>TEA</td>
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<tr>
<td>10:45</td>
<td>Combine knowledge gaps and specialist work required from sessions</td>
<td>Marius Claassen</td>
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<tr>
<td></td>
<td>Prioritise and map the above to short, medium and long term</td>
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<tr>
<td>11:45</td>
<td>Way forward</td>
<td>Jo Burgess</td>
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<tr>
<td>11:55</td>
<td>Closing and workshop outcomes</td>
<td>Stanley Liphadzi</td>
</tr>
<tr>
<td>12:00</td>
<td>LUNCH</td>
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</tbody>
</table>
## 5. APPENDIX B: PARTICIPANTS LIST

<table>
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<th>E-mail address</th>
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6. APPENDIX C: PRESENTATIONS

Bonani Madikizela: Opening and Welcome

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**WRC Mission**

To be a global water knowledge node and South Africa's premier water knowledge hub operating across the innovation value chain that:

- Informs policy and decision making,
- Creates new products, innovation and service for socio-economic development,
- Develops human capital in the water science sector,
- Empowers communities and reduces poverty,
- Supports the national transformation and redress project, and,
- Develops sustainable solutions and deepens water research and development in South Africa, Africa and the developing world.

---

**Mission translated into a Knowledge Tree**

- **WRC-Mandate-1971:**
  - Promoting co-ordination, co-operation and communication in the area of water research and development
  - Establishing water research needs and priorities
  - Stimulating and funding water research according to priority
  - Promoting effective transfer of information and technology
  - Enhancing knowledge and capacity building within the water sector

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**4-Key strategic areas focused on R&D**

- **WRC 1: Water Resource Management**
- **WRC 2: Water-Sensitive Ecosystems**
- **WRC 3: Water Use and Water Management**
- **WRC 4: Water Utilization in Agriculture**

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**Mining in SA**

1. More than 127 years
2. Second largest global producer of gold
3. Third largest exporter of coal
4. Arguable one of leading employers
5. Unsustainable mining exacerbates pollution
6. Licensed vs unlicensed mining
7. Environmental impacts - Biosphere

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**Why Mining and ecosystem restoration W/Shop?**

**WORKSHOP OBJECTIVES**

- Mining is a temporary land use, ceasing when the economically viable resource is exhausted. Today's society demands that the environmental consequences of mining are also temporary, expecting the mine to restore the post-mining environment to an acceptable status...
- The objectives of the workshop are as follows:
  1. To reestablish existing guidelines, tools, models, etc. available in South Africa for rehabilitation in the mining business
  2. To identify gaps in knowledge in the four focal landscape rehabilitation areas: surface profiling, land ecosystems, water ecosystems and air
  3. To prioritize research required to close identified knowledge gaps
  4. To prioritise and develop a research plan in the short-, medium- and long-term.

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**Logistics over two days**

1. Discussion document...
2. LaRossa
3. Open and Fair discussion
4. Facilitator for Water/Air break away session?
5. Registration
6. Display material
7. Speakers/Time
8. All
INTRODUCTIONS
Victor Munnik: Setting the Scene – Conflicts between Mining and Water in South Africa

Setting the scene – Conflicts between mining and water in South Africa

Dr Victor Munnik, Rhodes University, Water Research Commission
Project K5/2355

Political ecology

- My contribution comes from the field of political ecology. I am a geographer studying the politics of knowledge & application of social science to water issues
- Involved in projects on:
  - water quality & social learning in Inkomati CMA
  - a Green Drop Support Campaign
  - support to catchment management forums revitalisation
  - building civil society voice in monitoring NWRS 2 &
  - bringing the value of ecological infrastructure into decision making on coal mining

Conflict as a messenger

- Social learning and activity theory see conflict as growth point, looking for release of tension when activity system is out of sync with itself, or needs to go to a next level
- Conflict can also be seen as a valuing action - something is worth fighting over (or defending)
- Parties in conflict state their case in an adversarial way - one can learn from one’s opponent
- Conflict is between people and institutions about mining and water decision making

Mining, water and conflict

- Anglo-Boer war, intention was to structure a new state, South Africa, to suit mining interests. Included creation of Rand Water
- Cabinet decision under John Vorster to sacrifice vegetable farming (and dolomitic aquifer) on West Rand to gold mining
- Abandoned mines, Fanie Botha accord – to define who takes responsibility

Current conflicts

- Legacy costs: between 5000 and 6000 abandoned mines, example: Transvaal and Delagoa Bay in Witbank, can this burning piece of earth, with sinkholes, be rehabilitated? What would it cost?
- Acid Mine Drainage in gold and coal – who pays, what technology, neutralising pH or desalination?
- Salinity in Crocodile East (Kaap River) and in Upper Olifants – Loskop Crocodiles, fruit exporting farms
- Mpumalanga salinity – Kaap river mines
- Lack of closure certificates – state protecting the taxpayers’ money?
- Passing on legacy costs (closure costs) to naive buyers of worked out mines?

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2 Map references are available from the author.
Some see coalfields (WWF)

Some see water & fish (WWF)

Restoration of eco-infrastructure could play crucial knowledge role
• Give policy makers correct costs to set rehabilitation funds requirements
• Monitor rehabilitation/restoration needs as mining operations proceed
• Could rule out some mining as impossible or too expensive to restore, and thus avoid damage to eco-infrastructure
• Difference between rehabilitation for agreed use and restoration to previous status creates gap in or loss of eco-infrastructure... professional judgement
• Example from K5/2355

Valuing eco-infrastructure & including it in decision making
• WRC handed us an interesting challenge
• Golfview biggest ever fine paid by a mine for environmental crime – October 2012
• for damaging a wetland, diversion of water resources, inadequate pollution control and transformation of three hectares of indigenous vegetation
• Needs to rehabilitate the damaged wetland at an expected cost of between R50 million and R100 million
• R4 million fine for research to WRC
• Fine indicates that attitude towards enviro mine damage has changed

Court set this objective
“The full social and environmental costs of any permanent, residual wetland loss will be internalised into the balance sheets of mining projects, in order to ensure no net loss of wetland functions at a landscape scale”

This funds our research, together with SANBI wetlands atlas etc.

AIMS (1)
1. To conduct an analysis of available resource and catchment based tools aimed at sustainable development of water resources and management.
2. To investigate and evaluate the decision making processes followed in issuing mining authorization.
3. To determine the relationship between licensing processes and ecological infrastructure from a landscape and connectivity perspective.
4. Propose an integrative decision making process and institutional arrangement required to support licensing for sustainable use of natural capital.

AIMS (2)
4. Develop guidelines necessary to understand the socio-economic value of selected wetlands demonstrating their importance to society.
5. Develop and test a multi-sectoral integrative monitoring framework linked to a decision support system that will cater for bio-physical, economic and societal needs.
6. Develop appropriate capacity for officials involved in licensing, business, and affected communities.
Research question: How do we

- put a value on wetlands, rivers and other water resources?
- in a way that is able to enter decision making about land use choices that have not only economic, but also ecological implications?
- in a way that is inclusive, efficient, and sustainable so that coming generations inherit the natural capital that we are currently the custodians of?
- ensure that these issues become a central part of economic and regulatory decision making?

What are ecosystem services?

- **Provisioning services** are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water.
- **Cultural services** are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values and aesthetic enjoyment.
- **Regulating services** are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards.
- **Supporting services** are the natural processes such as nutrient recycling, soil formation and primary production that maintain the other services (DEA, 2013).
- Ecological infrastructure is the natural capital that provides these services. That is what we protect and restore.

The problem with monetary valuation

- Can ecosystems like wetlands be valued? How?
- Economic valuation can understate – e.g. how much are you prepared to preserve a rare species, or special place?
- Translating everything into money assumes substitutability – but ecosystems are unique
- Do we know enough to calculate the value?
- What will ecosystems be worth in future? More or less?

Value

- BUT if we don’t give it a value how do we include it in decision making? How do we make it count?
- Replacement value? The full cost of restoring it? Do we know what that value is?
- How would we know what an ecosystem is worth?

People who use ecosystem services can tell us what they are worth

Stakeholders and experts combine

Valuation of ecosystem services

Coal mines in Upper Olifants
Why Carolina?

- Carolina experienced a dramatic Acid Mine Drainage pollution event in January 2012.
- There is extensive material available, including administrative-legal records, such as the first inspection report (MTFA, 2012), and IUCMA records, a biophysical analysis (McCarthy and Humphries, 2012), as well as social analysis of the impact of the event on the town (Templehoff et al., 2013).
- In response to the incident, the IUCMA also installed a number of monitoring points. As a result of the legal directives to 5 coal mines in the area, a consultant firm undertook a detailed study (Goldier, 2014).

Yellowboy on Carolina dam wall

Why research in Carolina?

- In contrast to the crowded Upper Olifants, this is a smaller space than Olifants, with between 6 and 12 mines (operative, closed, rehabilitated, abandoned and decanting), some prospecting
- In Komati-Usuthu Water Management Area, and as a result supervised, regulated and studied (e.g. in the information gathering and consultation for the ICMA CMS, 2012).
- Upper Komati Catchment Management Forum
- CMA plus Forum gives us a view of the future – with more dedicated, resources regulation

Carolina residents collecting water from mosque

Boesmanspruit, Carolina

Why Carolina?

- We can look at “before and after picture” of the event, and the regulatory response to it, which should reveal the underlying mechanisms and dynamics, as well as the involved institutions.
- a case study of which legal instruments were used to respond to the event, based on what considerations, and what the results were.
- IUCMA CMS (2012), there are advanced efforts to understand the ecological infrastructure in the area, as part of projects for wetlands mapping (WRC Atlas project, for example), as well as literature on the NEPFA areas, and the Mpumalanga Biodiversity Conservation Plan.

Mines in Carolina area

Mining properties and prospecting rights (grey and pink)
What we want to see (1)

an integrated, participatory process of valuing, making
decisions, monitoring and ongoing, inclusive adaptive
management that has as its objective to balance the
exploitation of coal resources with the sustainability of
wetlands and other water-related ecological infrastructure.

Using ideas of ecosystem services and the ecological
infrastructure that produces them,
complex social-ecological systems,
social learning and building social capital,
framework of Integrated Water Resources Management and
adaptive management within the Inkwenkwezi CMA.

What we want to see (2)

strengthen the emerging catchment management
architecture, and citizens participation in it;
balance water resource and biodiversity protection with water
use for mining;
Identify and develop (review) regulatory instruments for coal
mining, through its entire life cycle,
that can adequately take into account the protection of
ecological infrastructure with an emphasis on water
resources;
legislative requirements and the institutional arrangements
that should be in place from the point of view of the relevant
management institutions

From conflict to
participatory decision making

• There is conflict because currently, decision
  making is one-sided and not transparent
• The trade-offs are not clearly expressed and
  understood
• The heart of the conflict: that the damage is
  not repaired
• I look forward to the discussions!
Philip Barnard: Surface Profiling and its Valuable Contribution to Mining Rehabilitation

A

1. Backfilled voids
2. Levelled steep areas to predetermined slopes
3. Topsoil to 300mm
4. Vegetated with grass

Grazing

B

1. Backfilled voids
2. Levelled steep areas to predetermined elevations
3. Topsoil to 300mm
4. Vegetated with grass

Grazing

A

Area = 600ha

B

1. Difference?
   - 300mm → 800mm
   - Slopes → Landform design → Elevations

Landform design and material balance

Growth medium volume

Erosion properties

Infiltration properties

Landform design and material balance

Growth medium volume

Erosion properties

Infiltration properties
Status Quo?

Shortcomings?
- Land use descriptions: Grazing to arable
- Topsoil management
- Compaction and Settlement
- Translations of commitments → measures → KPI's

Thank you
Johan van der Waals: Land Capability and Wetland Rehabilitation Commitment in a Mining Environment – Conflicts, Challenges and Opportunities
John Dini: Water Ecosystems – Mapping and Rehabilitation of Wetlands in Mpumalanga Including Review of Rehabilitation Tools

Towards improved mapping and rehabilitation of wetlands in the Mpumalanga Highveld

John Dini
SANBI

Projects

1. Improving wetland spatial data in the Mpumalanga Highveld coal belt

Classification results

• 49 wetland types identified
• 1 type new to SA:
  – Mesic Highveld Grassland Group 7_Floodplain
• 2 types new to study area:
  – Central Bushveld Group 1_Floodplain wetland
  – Central Bushveld Group 2_Seep

Changes in ecosystem threat status

Implications for FEPAs

Changes in ecosystem protection level

Wetlands in FEPAs have increased from 27% of the wetland area in Mpumalanga Highveld to 36%
Projects

2. Limiting and mitigating the impact of coal mining on wetlands

Biodiversity priority areas and mining

Rehabilitation guidelines

- User needs assessment
- Lessons learnt from rehabilitation field experiment at Zaalikopspuit
- Integration of the key mining related wetland rehabilitation principles, methods and approaches from the existing Wetland Management Series
- Identification and filling gaps of particular relevance to mining (e.g. relevance of the guidelines for pans).

Intended result

Guidance for mines and regulators on:
- appropriate practical and strategic approaches to wetland rehabilitation,
- setting realistic and achievable wetland rehabilitation commitments and license conditions.
Douglas Macfarlane: Water Ecosystems – Preliminary Guideline for Buffer Zone Determination – Relevance and Applicability to Mining

**FOCUS OF PRELIMINARY GUIDELINES**
- Defining setback requirements to limit risks of landuse activities on water resources;
- Emphasizes the importance of catering for species of conservation concern and ecological processes (corridors) when delineating setback requirements;
- Flags risks that cannot be mitigated through buffer zones & which require additional forms of mitigation;
- Emphasizes the importance ensuring effective management of setback areas.

**STRUCTURE OF THE GUIDELINES**
- Step-wise process for defining setback requirements.
- Supported by spreadsheet tools used to define buffer requirements

**WHAT ARE BUFFER ZONES**
- Buffer zone: A strip of land with a use, function or zoning specifically designed to protect one area of land from impacts from another.

**KEY FACTORS CONSIDERED**
- The threat posed by adjacent landuses or activities
  - Construction & operational phases considered
  - Based initially on desktop studies for sectors & subsectors
  - Room for specialist interpretation based on more accurate information
- Climatic factors that affect pollution potential
  - MAP & rainfall intensity
- The importance and sensitivity of the receiving environment
  - Water resource attributes
  - Important species / habitats

**WHY ARE BUFFERS IMPORTANT?**
- Maintain basic aquatic processes
- Reduce impacts on water resources from upstream activities and adjoining lands
- Provide habitat for aquatic and semi-aquatic species
- Provide habitat for terrestrial species
- Provide ancillary societal benefits
**KEY FACTORS CONSIDERED**
- Implementation of complementary mitigation measures
  - These can also address impacts and so reduce the need for a large buffer zone.
  - Tool developed to help identify other potentially suitable mitigation options.
- Species of conservation concern
  - The need for additional mitigation measures to address biodiversity requirements must be assessed in proscribed.
- Practical management considerations
  - A minimum aquatic impact buffer zone of type is required to address potential long-term failure.

**LIMITATIONS & CHALLENGES**
- Risk is central to defining appropriate buffer widths
  - This has been informed by available information but is quite generic in nature.
  - Would ideally be supported by site-level risk assessments, particularly for high-risk activities.
  - Risks associated with mine closure are not specifically addressed.
- Buffer zone effectiveness is dependent on sound management & monitoring
  - Critical that long-term management & rehabilitation efforts seek to maintain & enhance these characteristics to maintain buffer zone effectiveness

**WHAT BUFFERS DON’T DO**
- Buffer zones are far from a “silver bullet” – they cannot address all water resource related problems:
  - Hydrological changes caused by mining activities
  - Point-source discharges (e.g., mine-water discharges)
  - Use or contamination of groundwater

**WAY FORWARD**
- The WRC has funded a second phase of this project
  - National workshops will be held to raise awareness and provide hands-on training.
  - Feedback obtained from stakeholders will be used to update and finalize the guidelines.

**THANK YOU**
Hanlie Liebenberg-Enslin: The Air Landscape as an Aspect of Rehabilitation

The Air Landscape as an Aspect of Rehabilitation

16 March 2015
Water Research Commission, Rietfontein, Pretoria
Hanlie Liebenberg-Enslin, Ph.D

WHAT IS MEANT BY AIR QUALITY?

- **Air pollution:** means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.
- **Ambient air:** is defined as any area not regulated by the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).
- **Atmospheric emission or emission:** means any emission or entrainment process emanating from a point, non-point or mobile source, which results in air pollution.

LEGAL REQUIREMENTS

Air quality (ambient) standards:
- Criteria pollutants including fine particulates (PM₂.₅ & PM₁₀), SO₂, NO₂, CO, Benzene, Lead, Ozone.

Emission (source) standards:
- Listed Activities - require an Atmospheric Emissions License to operate (industrial operations)
- Dust Control Regulations - dust fallout limits:
  - Residential - \( D < 600 \text{ mg/m}^2\text{/day} \) (two within a year, not sequential months)
  - Industrial - \( 600 < D < 1200 \text{ mg/m}^2\text{/day} \) (two within a year, not sequential months).

LEGAL REQUIREMENTS (2)

- Pollution Prevention Plans
  - Greenhouse Gasses including carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆)
  - By-Laws
  - Priority Areas Air Quality Management Plans

LEGAL REQUIREMENTS (3)

SOURCES OF AIR POLLUTION

Gold-, Platinum-, Chrome-, Iron ore-, Manganese-, Uranium-mines:
- Windblown dust from mine waste facilities – significant source of dust emissions influencing human health
- Mine waste facilities remain after mine closure – type of rehabilitation and cover?
- Windblown emission quantification methods from mining have not been widely investigated

SOURCES OF AIR POLLUTION (2)

Coal Mines:
- Majority of fires in coalfields due to spontaneous combustion of coal – shallow workings (along outcrops and abandoned opencast mines)
- The exact mechanism of reaction of oxygen with coal - not yet well understood
- Various technologies available to prevent and control of spontaneous heating

Protection and enhancement of the quality of air in the Republic providing reasonable measures for preventing pollution and ecological degradation securing ecologically sustainable development while promoting justifiable economic and social development.

\[ \text{Object} \text{ of the Air Quality Act is to protect the environment by:} \]

40
POLLUTANTS OF CONCERN

Mine waste facilities – primarily due to wind erosion:
• Dust (PM<sub>10</sub> & PM<sub>2.5</sub> and dust fallout also silica)
• Metals (e.g. arsenic, hexavalent chromium, cadmium and nickel),
• Radionuclides (gold, uranium).

Coal dumps – spontaneous combustion:
• Toxic emissions such as particulates, CO, SO<sub>2</sub>, H<sub>2</sub>S, polynuclear aromatic hydrocarbons and volatile organic compounds (VOCs),
• Greenhouse gas emissions of CO<sub>2</sub> and methane,
• Odours

CONTROL OF AIR POLLUTION SOURCES

Mine Waste facilities (wind erosion)
• Surface treatment techniques to reduce dust generation (i.e. wet suppression, chemical stabilisation, covering of surface with less erodible aggregate material and the vegetation of open areas),
• Rock capping of the sides of Waste facilities – an effective way reduce wind erosion of slopes,
• Vegetal cover retards erosion by binding the residue with a root network, by sheltering the residue surface and by trapping material already eroded,
• Removal of the Mine Waste facility – the most effective mitigation measure, providing the exposed footprint be vegetated and rehabilitated.

Coal dumps (spontaneous combustion)
• Prevention & control of spontaneous heating/fire are site specific – fire in open cast benches and coal stacks spread more rapidly than underground,
• Controllable by removing either Fuel, Heat or Oxygen – removing oxygen is the most practical approach,
• Surface sealing (by applying cover layers of inert material which reduce the rate at which oxygen can penetrate the spoil pile), trench cutting, digging out of the hot masses, water injection under pressure, application of fire protective coating as well as chemical inhibitors,
• Best prevented by carefully managing the placement of high carbon content material within spoil piles.

CONCLUDING REMARKS

Non-rehabilitated Mine Waste Facilities and Coal dumps can have detrimental impacts on air quality. Prevention is better than cure – continuous rehabilitation throughout the Life of Mine is vital.

It is therefore important that the overall management plan for a mine include appropriate measures for:
• Rehabilitation measures for Mine Waste Facilities – sustainable vegetation cover, glazing, removal,
• dealing with spontaneous combustion and identify reactive materials and inert materials that can be used as cover layers.

RISK ASSOCIATED WITH THESE SOURCES

• High concentrations of particulates pose a risk to human health, WHO indicates no safe threshold with linear dose response relationship for PM<sub>2.5</sub> and PM<sub>10</sub>,
• link between increased morbidity and mortality, especially amongst children and the elderly,
• CO affects the lungs – it interferes with the oxygen carrying capacity of blood and weakens the contraction of the heart,
• SO<sub>2</sub> is an irritant that is absorbed in the nose and upper respiratory tract – associated with reduced lung function and increased risk of mortality and morbidity.

ACKNOWLEDGEMENTS


Paul Oberholster: Water Ecosystems – Lessons Learnt on Rehabilitation in Mpumalanga
Hybrid passive treatment system for treatment of mine water in temperate regions

The key benefits of the proposed hybrid concept is the following:
- Artificial wetlands and integrated algae pond systems is less expensive to build than other treatment options.
- Utilization of natural processes.
- Simple construction, operation and maintenance.
- Cost effectiveness (low construction and operation costs).
- Disposal of macrophyte and algae material can be used for biofuel or fertilizer.
- Create process stability during seasonal changes.
Arno de Klerk: Water Ecosystems – Lessons Learnt on Rehabilitation in Mpumalanga

### Principle

- A wetland consists of various levels of organization working together, which lead to improved water quality.

- In order to understand how to improve the functioning of a system, we need to understand how these various levels work together.