

Project Concept Note

High Confidence Study of Children Potentially Affected by Radionuclide and Heavy Metal Contamination Arising from the Legacy of Mine Water Management Practices on the Far West Rand of South Africa

Short Title:

Tooth Fairy Project



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Introduction

South Africa has a water-constrained mining-based economy (Ashton & Turton, 2008; Turton & Ashton, in press). The gold-mining industry was established after the Anglo-Boer War (1899 – 1902) (Evans, 1999; Spies *et al.*, 1997; Tempelhoff, 2003) and has been a strategic pillar of the economy since then (Turton *et al.*, 2006). Significantly, during the Apartheid years, an alliance emerged between the gold mining industry and the Government whereby revenues from mining sustained the country in the face of international sanctions (Adler *et al.*, 2006; 2007; Turton, in prep). A sub-set of that process was the extraction of Uranium, which went into the West's nuclear weapons program during the Cold War. This aspect explains why comprehensive sanctions were not applied to South Africa during Apartheid (Geldenhuys, 1984; 1990; Turton, in prep). The significance of this historic aspect of the gold mining industry is that there has never been a culture of oversight and accountability (Adler *et al.*, 2006; Turton *et al.*, 2006), so the industry has been allowed to make massive profits over time, largely by externalizing its costs onto society (Adler *et al.*, 2007; Turton, in prep).

Background to the Problem

When South Africa became a democracy in 1994, a new culture of accountability and transparency was introduced. Embedded in a virulent democratic process, the concept of “sustainable development” was enshrined in the **Bill of Rights of the Constitution** (1996), which achieved two important objectives:

- Development that is “sustainable” became a mandatory legal objective.
- People were given the right to an environment that is not harmful to their health or well-being.

In the water sector, government responded by making public-domain funding available for the research of human health-related issues arising from more than a century of gold mining. This was a historic transition, because prior to that most funding for research into the water management practices of the mining industry, generally resulted in reports that were classified and thus not in the public domain. Any report containing any contentious aspect was thus “censored” and removed from

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public knowledge. Unclassified public domain reports were therefore only of a non-contentious nature.

Driven by the euphoria of a fledgling democracy, a number of **first generation public-domain reports** were generated. These include the following:

- *Radioactivity and the Leakage of Radioactive Waste Associated with Witwatersrand Gold and Uranium Mining* (Coetzee, 1995).
- *Overview of Radioactivity in Water Sources: Uranium, Radium and Thorium* (Kempster et al., 1996).
- *The Association of Groundwater Chemistry and Geology with Atypical Lymphocytes (as a Biological Indicator) in the Pofadder Area, North Western Cape, South Africa* (Toens et al., 1999).
- *Report on the Radioactivity Monitoring Programme in the Mooi River (Wonderfonteinspruit) Catchment* (IWQS, 1999).
- *Radioactivity Study on Sediments in a Dam in the Wonderfonteinspruit Catchment* (Coetzee et al., 2002a).
- *Reliance on Existing Wetlands for Pollution Control Around the Witwatersrand Gold/Uranium Mines in South Africa – Are They Sufficient?* (Coetzee et al., 2002b).
- *Tier 1 Risk Assessment of Selected Radionuclides in Sediments of the Mooi River Catchment* (Wade et al., 2002).
- *The Significance of Groundwater-Stream Interactions and Fluctuating Stream Chemistry on Waterborne Uranium Contamination of Streams – A Case Study from a Gold Mining Site in South Africa* (Winde et al., 2004).
- *Contamination of Wetlands by Witwatersrand Gold Mines – Processes and the Economic Potential of Gold in Wetlands* (Coetzee et al., 2005).
- *Impacts of Gold-mining Activities on Water Availability and Quality in the Wonderfonteinspruit Catchment* (Winde, 2005).
- *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* (Coetzee et al., 2006).
- *The Changing Relationship between the Government and the Mining Industry in South Africa: A Critical Assessment of the Far West Rand Dolomitic Water Association and the State Coordinating Technical Committee* (Adler et al., 2006) (**Note:** not fully public domain by virtue of funding restrictions).
- *Water, Mining and Waste: A Historical and Economic Perspective on Conflict Management in South Africa* (Adler et al., 2007).
- *A Hydrogeological Assessment of Acid Mine Drainage Impacts in the West Rand Basin, Gauteng Province* (Hobbs & Cobbing, 2007).
- *Radiological Impacts of the Mining Activities to the Public in the Wonderfonteinspruit Catchment Area* (NNR, 2007).
- *The Pollution and Destruction Threat of Gold Mining Waste on the Witwatersrand: A West Rand Case Study* (Oelofse et al., 2007).

From these reports it has become apparent that **there is a heavy metal and radionuclide contamination problem associated with gold mining**, at least in the Wonderfontein Spruit Catchment in South Africa.

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Key Conclusion from this Public-Domain Science

While it is possible to argue that before 1994, one did not know of the existence of possible human health problems arising from heavy metal and radionuclide contamination in water sources downstream of gold mining activities in South Africa, that argument is no longer valid given the sheer weight of credible, peer-reviewed science.

As a direct consequence of this **first-generation public-domain reporting**, there has been a **public health scare**, with various media reports driving this issue to the point where it became the subject of international media coverage on 18 February 2008 (IRIN, 2008). As a build-up to the internationalization of this problem, the local media interviewed the CSIR (Dr. Anthony Turton – Talk Radio 702, 4/2/08), who went on the record as saying that South Africa needs two specific studies in order to assess the true impact and scope of human health risk arising from heavy metal and radionuclide contamination in the Wonderfontein Spruit:

- A **high confidence study of the fate and pathway of heavy metal and radionuclides** in the Wonderfontein Spruit catchment.
- A **high confidence epidemiological study of the health impact on off-mine human populations** in areas closely associated with the gold mining industry.

The CSIR's position in this regard was first reported to a public meeting held in Potchefstroom on 6/12/07, to which Dr. Turton was an invited speaker. This position was reported in the international media on 18 February 2008 (IRIN, 2008). This has also been the foundation of CSIR's diplomatic engagement with various German authorities, which has resulted in a formal project entitled **Mitigation of Mining Impacts on Natural and Socio-Economic Environments (MMINE)**, to be carried out within the **German-South African Framework for Research and Development in Mining and the Environment**. These interventions are all designed to build the core capacity of the CSIR to enable it to tackle the strategic-level problem arising from the mine water contamination in the Wonderfontein Spruit (and elsewhere in the country).

This remains the CSIR objective at this moment in time – the **development of core skills** needed to tackle a problem of this complexity and potential magnitude – in **partnership** with any stakeholder that has common objectives or capacity.

The Proposed “Tooth Fairy Project”

Kalckar first suggested that the radioactive content of deciduous teeth could be used as an index of the accumulation of radioactivity and the body burden of various nuclides in children (Kalckar, 1958 cited in Rosenthal *et al.*, 1963). This led to a study conducted in the St. Louis area of the USA between 1959 and 1970, known as the **St. Louis Baby Tooth Survey** (Rosenthal Collection – Washington University in St Louis Archives, see <http://beckerexhibits.wustl.edu/dental/articles/babytooth.html>). During this project, a high correlation was shown to exist between certain radioactive

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isotopes (Strontium-90) found in human milk-teeth and bone, meaning that milk-teeth are a viable indicator for what is happening inside bone (Rosenthal *et al.*, 1963).

Given the existence of a large number of children in the areas known to be contaminated by heavy metals and radionuclides associated with the gold mining industry, a project is being conceptualized by the CSIR that will seek to achieve the following objective:

- To do a **high confidence human health study** in the Wonderfontein Spruit area, **using human milk-teeth** that are naturally discarded and therefore generally considered to be valueless as a potential source of specimens, **in order to inform a possible policy reform process.**

Sole Objective of the Proposed Study

The sole objective of this proposed study is to determine, with a high level of confidence, if there is any evidence of human health risk within a population that has had chronic exposure to heavy metals and radionuclide contamination in subsets of the geographic areas that have been reported in *Water Research Commission Report No. 1095* (Wade *et al.*, 2002), *Water Research Commission Report No. 1214* (Coetzee *et al.*, 2006), and the National Nuclear Regulator's *Brenk Report* (NNR, 2007), in order to address public concern, restore eroding investor confidence and form the foundation of effective public policy intervention.

Given that **such a study has never been done before in South Africa**, there are many unknowns, and no core capacity exists within any one research institution. This means that it is impossible to do an accurate costing at this moment in time, simply because we do not know a number of key elements on which a high confidence study would be based. It also means that the only way to begin moving in a positive direction is to build coalitions and partnerships between research institutions, funders and other key stakeholders, both locally and abroad. A non-exhaustive list of these missing elements includes the following:

- **What is the most appropriate test protocol** to use for such a study?
- Is Strontium-90 a suitable proxy indicator for the type of contamination that has been reported in the Wonderfontein Spruit catchment? If not, then what is better?
- **Is a stratified cluster sample using children's milk-teeth as an indicator capable of forming the foundation on which generalizations can be made** for a larger population?
- Is the harvesting of children's milk-teeth culturally acceptable in all of the communities present in the Wonderfontein Spruit catchment?
- If the Wonderfontein Spruit catchment is to become a suitable experimental site, then what is the most appropriate control site for a high confidence outcome?

These are vexing technical questions indeed, with no apparent answer. Yet, the absence of this level of scientific detail is not an excuse to simply do nothing. The body of evidence presented in this Project Concept Note (PCN) is compelling enough

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to convince us that we need to do something in the short-term to develop the scientific capacity needed to inform the public, the mining industry and the government, on what appropriate mitigation strategies and resultant policy reform might be.

It must be noted that there are already high levels of political tension in the Wonderfontein Spruit catchment. Khutsong, a densely populated human settlement close to Carletonville, one of the mining towns in the centre of the Wonderfontein Spruit catchment, is a hotbed of political tension. The core drivers of this political discontent are complex and many, but at the heart of these is the absence of consultation, the perception that the democratically elected government is becoming corrupt, and poor access to water and sanitation facilities in a community that feels marginalized with a high prevalence of HIV/AIDS (Johnston & Bernstein, 2007) (for more information see http://www.cde.org.za/article.php?a_id=246).

The Khutsong Riots - November & December 2005

Interviews conducted for a major study by the Conflict and Governance Facility (CAGE) revealed that, “the dolomite issue was characterized by poor communication, confusion, and mistrust. According to community members and leaders of the protests, it was ‘simply a ploy used by the mining companies not to invest in Khutsong.’” The study went on to show that, “confusion among residents about the dolomitic condition of the area was exacerbated by the actions of the municipality and individual councillors which contradicted their public statements. While the councillors warned residents about the unstable land in Khutsong, some of them were extending their own homes”. One respondent noted that, “the amount of hurt, anger, distress and hatred we experience at the hands of our own government is immeasurable” (Johnston & Bernstein, 2007: 36 - 39).

Running concurrently with this is a gradual loss of investor confidence, which was predicted for the area in the original *Jordaan Commission of Enquiry* that was conducted to determine whether the dolomites of the Far West Rand Basin should be dewatered to make way for gold mining in the area (Jordaan *et al.*, 1960). Victims of this process include farmers along the Wonderfontein Spruit, who have now lost their total livelihood as public fears, driven by media reports, have led to a collapse of the market for their commodities and produce (Tempelhoff, 2007a; 2007b; IRIN, 2008).

This means that the proposed study will take place against a background of heightened political tension, in which emotions are running at levels of near-hysteria, and in which **trust in the perceived “neutrality” of science will be a key factor** (Kantey, 2008). For this reason, the proposed study will have a very tight delimitation, simply to allow progress to be made. In order to be viable, the project will need to have the following specific elements if it is to be successful:

- The highest level of **scientific integrity** will need to be maintained at all times.
- **Peer-review** will have to be stringent and by the best available specialists in the world.

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- The technical aspects of the project will have to be conducted against a solid backdrop of **public scrutiny**, in order to maintain the *bona fides* of the scientists and technical processes involved, if the objective of a high confidence study is to be realistically achievable.
- The **communication of complex science** to a deeply concerned and potentially hostile society will be a major challenge.
- The **problem of perceived bias** arising when **funding** comes from either government or the mine industry will need to be carefully managed.
- **Partnerships** will be needed between South African and foreign scientists, simply **to build technical capacity** and maintain the scientific credibility needed to achieve a high confidence study.
- The **political processes** in which this project is embedded will therefore be as demanding as the **scientific processes** are, with both being equally important.

In order to achieve the objective of a high confidence study, the proposed project will consequently be structured in terms of a key methodology that has been developed by the CSIR. Known as the **Triologue Model**, this approach is based on the understanding that in order to achieve viable public policy outputs, there are three actor-clusters that are involved in a “Triologue” (Hattingh *et al.*, 2007; Turton *et al.*, 2007a; 2007b). The **Triologue Model** is presented schematically in Figure 1.

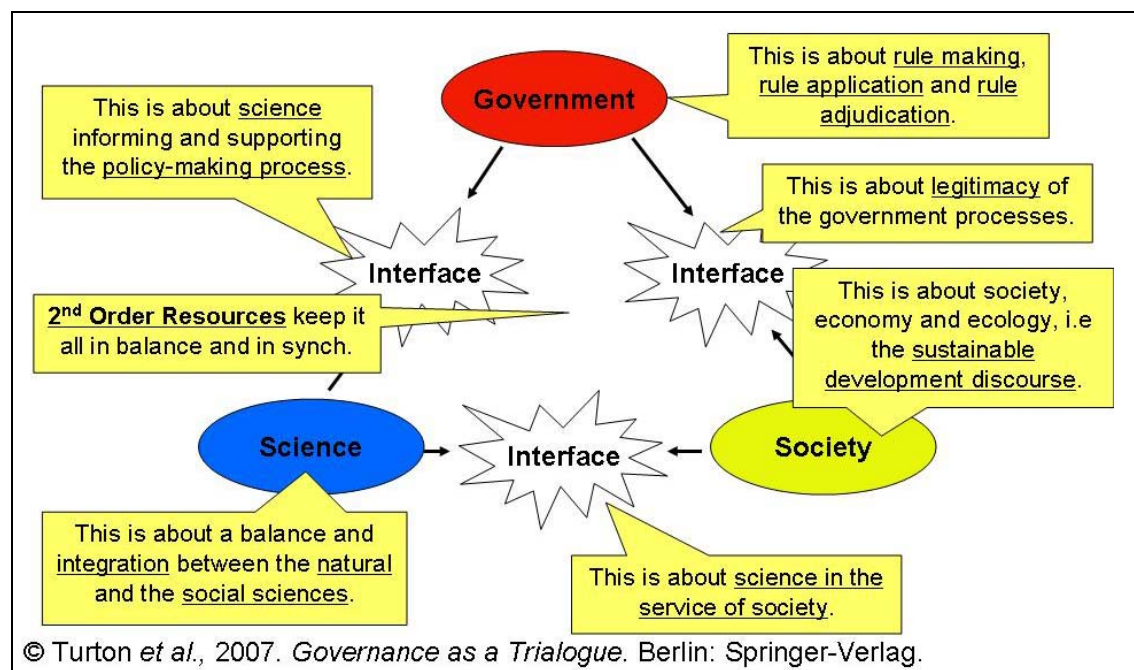


Figure 1. Schematic representation of the Triologue Model (Turton *et al.*, 2007a).

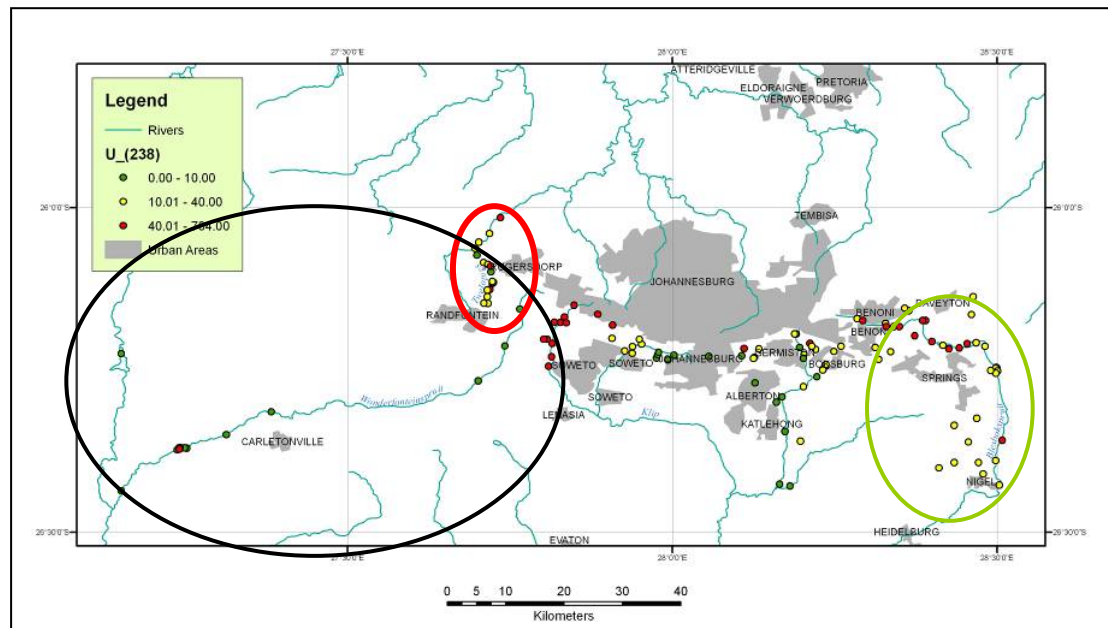
Government makes authoritative decisions by way of policy prescriptions and laws, sanctioning non-compliance where appropriate. Society consists of citizens and corporations, each mutually co-existing in the same space and time. Science, including both the natural and social sciences (and traditional knowledge systems), informs the public on matters of concern, but also provides inputs to Government as they consider policy reform. Together, these three actor-clusters are linked by means of a set of interfaces, the quality of which determines the outcomes, in a dynamic relationship called the Triologue (Hattingh *et al.*, 2007; Turton *et al.*, 2007a; 2007b).

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The **Triologue Model** is therefore deemed to be a suitable approach for the proposed project, because it allows for the participation of a wide range of interested and affected parties, in a way that can be considered as being **Science in the Service of Society**.

Delimitation of the Study Area

The proposed project will be limited to the Wonderfontein Spruit catchment as defined by Map 1, which shows Tier 1 Risk Classes for Uranium as reported by Coetzee *et al.*, (2005: 16). This map is useful to delimit the study area, because the elevated levels of Uranium have a clearly defined pattern that correlates directly with mining (as opposed to other possible industrial sources of contamination).



Map 1. Tier 1 Risk Classes for Uranium as Reported by Coetzee *et al.*, (2005: 16).

The black circle covers the Wonderfontein Spruit catchment, but the red circle highlights a technical issue that is relevant to this particular study. The groundwater compartment that feeds the Wonderfontein Spruit also feeds into the Tweeloop Spruit, which is in a different catchment. The name “Wonderfontein Spruit” literally means “Miracle Fountain Stream”, which was given to it when early settlers observed how the stream would appear in a spring and then disappear again into the dolomite, only to reappear somewhere else in a reliable and predictable way (i.e. it was seen to be evidence of a “miracle”). This appearance and disappearance of the flow is due to dolerite dykes that have compartmented the dolomites, so the Western Basin is the name given to the groundwater aquifer that lies under the Wonderfontein Spruit, but also the Tweeloop Spruit (Hobbs & Cobbing, 2007). **There is a hydraulic connection between these two, and given the distinct pattern of Uranium deposition in the Tweeloop Spruit, closely associated as it is with active mine decant at Harmony, it helps us to factor out other industry as a possible cause** (see the green circle that shows Uranium distribution on the East Rand, where mines and heavy industry co-exist).

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This means that the study area roughly demarcated by the black circle will cover the area that has been found to be contaminated by *Water Research Commission (WRC) Report 1095* (Wade *et al.*, 2002), *WRC 1214* (Coetzee *et al.*, 2006) and the *Brenk Report* (NNR, 2007). This will be the **spatial delimitation** of the proposed project.

The **temporal limitation** will be defined by the public domain documents *WRC Report 1095* (Wade *et al.*, 2002), *WRC 1214* (Coetzee *et al.*, 2006) and the *Brenk Report* (NNR, 2007).

In order to make significant progress in this project, and to avoid becoming side-tracked by other areas of major public concern, it is necessary to further delimit this study. To achieve this objective, **three Golden Rules have been developed**. These three rules will delimit the scope of work in terms other than space and time. There will be no deviation allowed at any time, by any participant in the project, from these **Golden Rules**, because that could destroy the capacity to deliver a high confidence outcome. The three **Golden Rules** are presented in the text box below.

Golden Rule # 1

This project works on the assumption that prior to the *WRC Report 1095* (Wade *et al.*, 2002), *WRC 1214* (Coetzee *et al.*, 2006) and the *Brenk Report* (NNR, 2007) (the **Three Foundation Reports**), no party knew that public health risks were possibly present, but now that these three reports are in the public domain, it is inexcusable for any party to continue to deny that possible health risks might arise from mine water management practices that until now have been accepted as the norm.

Golden Rule # 2

Because of Golden Rule # 1, this project is not about pointing any finger of accusation at any party, or about finding a basis for apportioning the legal liability of any party, but rather to determine if there are any grounds for human health concerns for off-mine populations that might have been inadvertently exposed to heavy metal and/or radionuclide contamination in the areas demarcated by the **Three Foundation Reports**.

Golden Rule # 3

Any attempt, by any member of any of the three organs within this proposed project (see Figure 2), to open a debate, or steer the data collection process in a direction that liability or blame becomes an objective, will be a disciplinable offence that will lead to immediate sanction by the Oversight Committee (OC). The full scope and reasons for this sanction will be recorded in the final public domain report. The purpose of this rule is not to cover up potential liability, but merely to gain cooperation between critical stakeholders that would not be possible if fears of potential prosecution were allowed to creep into the overall scope of work. So while liability might be of great concern to certain stakeholders, this project is not an appropriate forum in which to pursue those objectives, and as such cannot be tolerated, if a high confidence outcome is to be genuinely viable.

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These three **Golden Rules** consequently **form the normative basis on which the proposed project is to be delimited**, and they will be diligently applied at all times.

Primary Research Question and Hypothesis

The proposed project will be guided by one research question only. This is presented in the text box below:

Primary Research Question

Is there any evidence of human health risk within a population that has had chronic exposure to heavy metal and/or radionuclide contamination as defined by *WRC Report 1095* (Wade *et al.*, 2002), *WRC 1214* (Coetzee *et al.*, 2006) and the *Brenk Report* (NNR, 2007)?

The working hypothesis to the Primary Research Question is presented in the text box below:

Primary Working Hypothesis

If a human population has experienced chronic exposure to radionuclide and/or heavy metal contamination as defined by *WRC Report 1095* (Wade *et al.*, 2002), *WRC 1214* (Coetzee *et al.*, 2006) and the *Brenk Report* (NNR, 2007), then traceable evidence of this will be found in the milk-teeth of children (Rosenthal *et al.*, 1963) that can be reliably sampled by non-intrusive means.

If this Primary Research Question is answered in the affirmative – i.e. if evidence of radionuclide and/or heavy metal contamination is discovered in the teeth of infants – then a Secondary Research Question will become relevant as well. This is presented in the text box below:

Secondary Research Question

If there is solid evidence of elevated levels of radionuclides and/or heavy metals found in the population being sampled, then what public policy intervention is appropriate in both the short and long-term?

The working hypothesis to the Secondary Research Question is presented in the text box below:

Secondary Working Hypothesis

If there is solid evidence of elevated levels of radionuclides and/or heavy metals found in the population being sampled, then immediate and far-reaching policy interventions are needed if the affected parties are to be given the level of protection stipulated in Chapter 2, Paragraph 24 (a) & (b) of the **Bill of Rights of the Constitution** (1996).

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Structure of the Proposed Study

Given the technically complex nature of the proposed study, compounded by the need for high levels of transparency if public confidence is to be won, a highly dynamic management structure is needed. In essence there will be the **need for checks and balances to be hard-wired into the project, both structurally, but also procedurally**, if the outcome is to serve the useful purpose of **addressing public concern, restoring eroding investor confidence, and forming the foundation of effective public policy interventions**. The proposed Organogram of the project is presented in Figure 2 below.

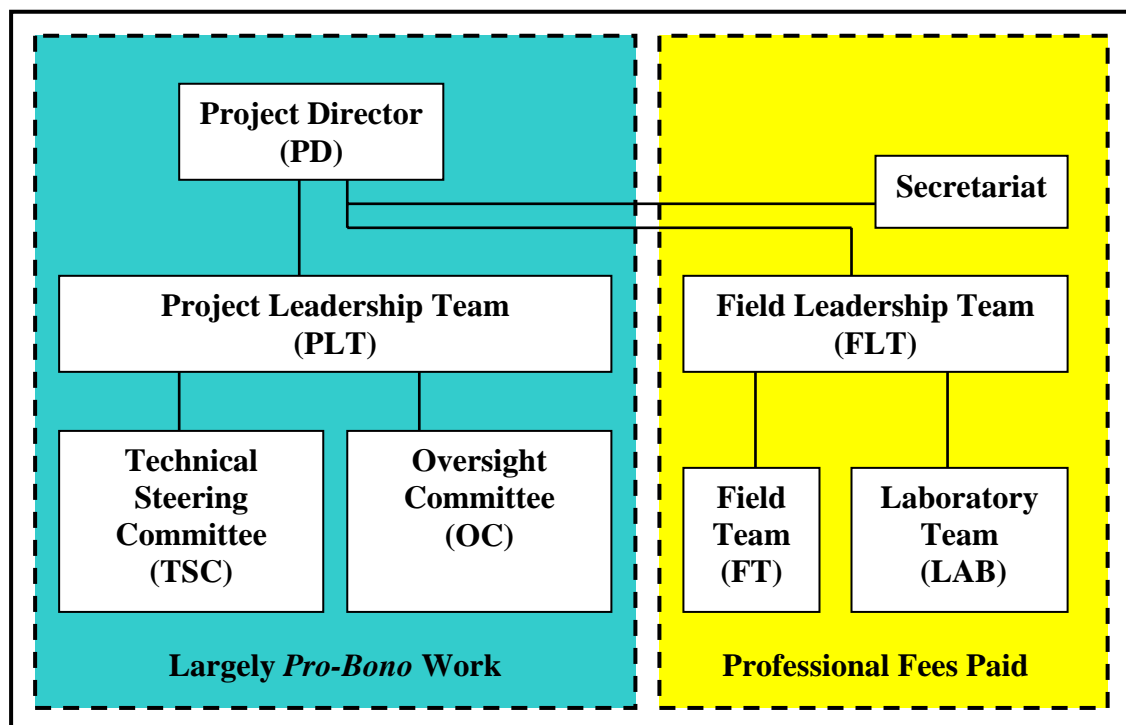


Figure 2. Organogram of the proposed project showing the various organs that will be expected to do largely *pro-bono* work (oversight), and those that will do purely professional work, for which standard professional fees will be paid.

In order to make this happen, a set of clearly defined procedures will be needed, based on the **checks and balances** that are central to modern democratic processes and intrinsic to what we know as “good science”. These procedures are as follows:

- A Technical Steering Committee (TSC) will consist of recognized **technical experts** in a wide range of core disciplines needed to make this study reach its objective, whose one core output will be the development of a ***Protocol that will define the exact technical procedures and processes needed***. They will perform a secondary task of technical oversight by monitoring deviations from the defined and approved *Protocol*. All of the activities of the TSC, specifically where they oversee the activities of the Field Team and Laboratory Team, will be subject to scrutiny by the Oversight Committee (OC). The TSC will be subject to the *Code of Conduct* developed by the OC. As far as possible the TSC will do *pro-bono* work, but where specific core skills are needed and are unavailable on a *pro-bono* basis, then professional

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fees will have to be paid. The *Protocol* is a purely **technical document** that will form the **procedural foundation** of the work to be done.

- An Oversight Committee (OC) will consist of **people with impeccable *bona fides***, representing key constituencies and institutions that bring **moral authority** to the overall process. Their core function will be to approve the *Protocol* that has been developed by the TSC, but also to monitor any deviation from that *Protocol* that might undermine the overall integrity of the final product. In addition to this, the OC will have a secondary function of opening access to interested and affected parties in the study area, where “normal” access might be denied for reasons of existing mistrust, cultural barriers or likewise. The OC will also be tasked to develop a *Code of Conduct*, which will become the normative set of rules to which all participants in the final project will be subjected, including the activities of the OC. The *Code of Conduct* is a **normative document**, which will define the **moral foundation** on which the project will be based and will thus **confer legitimacy to the final outcome**. The OC will also act as an organ of governance, sanctioning non-compliance with the *Code of Conduct*.
- A Project Leadership Team (PLT) will consist of the Chairpersons of both the TSC and the OC, working under the direction of the Project Director (PD).
- A Field Team (FT) will consist of suitably trained professionals, tasked with the responsibility of collecting samples as defined by the *Protocol*, and processing them strictly in accordance with the procedures stipulated therein. They will be subject to oversight scrutiny by the TSC. The FT will be subject to the *Code of Conduct* developed by the OC, but for ease of management, will be answerable to the Project Director (PD) rather than to the Project Leadership Team (PLT), simply to avoid a situation where unnecessary “micro-management” undermines their capacity to work effectively.
- A Laboratory Team (LT) will consist of suitably accredited laboratories, both local and international, tasked with the responsibility of analysing samples collected by the FT in strict compliance with the *Protocol*. They will be subject to oversight scrutiny by the TSC.
- A Field Leadership Team (FLT) will consist of a suitably qualified member of the FT and liaison links with the respective components of the LT, working under the direction of the Project Director (PD).
- A Secretariat will consist of the necessary administrative staff, including the Auditor, needed to support the overall process. They will answer directly to the PD only.

With this structure in mind, **a set of rules are needed to underpin the processes and maintain the overall functioning of the various organs in order to achieve the one stated objective of a high confidence study** as defined above. These rules are as follows:

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1. This project will be 100% in the **public domain**, so no classified documents will result, and all aspects of the work will be subject to intense scrutiny.
2. **Funding** will be from a consortium of interested parties, both local and international, but no funding will be accepted if there is any restriction placed on the final dissemination of the findings and proceedings of the project team.
3. This project will be conducted under the full **scrutiny** of both an Oversight Committee (OC) and a Technical Steering Committee (TSC).
4. For ease of management, the OC and TSC will meet separately, but **each committee will have three permanent representatives from the other committee** at all meetings in order to achieve effective **oversight** and to build **trust**.
5. The **TSC will draft a Protocol** in which technical details of all sampling, analytical, peer-review and reporting procedures will be stipulated. This *Protocol* will be sent to the OC for approval, after which the TSC will be tasked with the responsibility of oversight of the implementation of the *Protocol* by the FT and the LT. This *Protocol* will form the **technical foundation** of the project and will give the final product the **legitimacy** it needs to achieve **high impact**.
6. The *Protocol* developed by the TSC will be approved by the OC and an external **Ethics Committee** before being implemented.
7. The **OC will draft a Code of Conduct**, which will be circulated to all members of the entire project. All members will be asked to sign this document and adhere to the spirit of the values encapsulated therein, as well as commit the institutions they represent to cooperation within the spirit of the *Code of Conduct*. The OC will also sanction deviation by any member from that *Code of Conduct*, full details of which will appear in the final public-domain report. This *Code of Conduct* will form the **normative foundation** of the project and will give the final product the **legitimacy** it needs to achieve **high impact**.
8. The detailed record of all meetings will be maintained by the **Secretariat**, and will be circulated to both the TSC and OC. These will also be included in the final public-domain report that will be compiled by the Project Director at the end of the project.
9. The project will be conducted to the **highest professional and ethical standards** possible, with all parties signing a *Code of Conduct* to this effect.
10. The *Code of Conduct* developed by the OC will be approved by simple majority of the OC. Once so approved, it **will become the law** for the rest of the project members and will be strictly sanctioned by the OC.
11. Once the *Protocol* has been signed off by simple majority of both the TSC and OC, it **will become the only set of procedural rules that will apply** to

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the entire project, but amendments can be made if the technical need arises, by following the same procedure.

12. The OC will decide, by simple majority vote, how to deal with **parties that choose not to agree with the *Code of Conduct***. That decision will be implemented and will be final, details of which will be included in the final public-domain report.
13. Both the TSC and OC will elect a Chairperson, who will serve for the entire duration of the project. These Chairpersons, along with the PD, will also comprise the **Project Leadership Team (PLT)**.
14. Where possible all **decisions by both the TSC and OC will be by consensus**, but where critical and pivotal decisions need to be made in the interest of the overall integrity of the final outcome, then a simple majority will suffice. Both Chairpersons will have casting votes within their respective Committees in the event of deadlocked decision-making. All decisions taken, either by consensus or by majority vote, will become part of the formal Record of Decision.
15. Given the high level of mistrust that forms the background of this proposed project, **the TSC will consist of people of high integrity and technical expertise** drawn from core scientific disciplines, defined as follows:
 - a. Radiotoxicology.
 - b. Chemotoxicology.
 - c. Dentistry.
 - d. Biochemistry.
 - e. Physiology.
 - f. Anthropology.
 - g. Epidemiology.
 - h. Survey methodology.
 - i. Statistics.
 - j. Law & ethics.
 - k. Geochemistry.
 - l. Geohydrology.
 - m. Geology.
 - n. Sedimentology.
 - o. Speciation chemistry.
 - p. Political science / sociology.
 - q. Environmental science.
 - r. Others as determined when the *Protocol* is being developed.
16. Given the high level of mistrust that forms the background of this proposed project, **the OC will consist of people of high integrity and legitimacy drawn from specific constituencies**, defined as follows:
 - a. Mining industry (one person representing the overall industry).
 - b. Mining industry (one person representing all of the mines in the study area).
 - c. Government (one person representing national government).
 - d. Local Government (one person representing each of the local governments in the study areas).

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- e. National NGO (one person representing a National NGO).
 - f. Local NGO's (one person representing one of the local partner NGO's in each of the study areas).
 - g. National person of influence (one person representing a national-level special interest group that has a high moral foundation).
 - h. Local person of influence (one person per cluster sample as needed to gain access to specimens).
 - i. International NGO with extensive experience in this field (one representative).
 - j. International professional body with experience in this field (one representative).
 - k. National professional body with experience in this field (one representative).
17. All **work by the OC will be *pro-bono***, and will represent the co-investment of each body/organization/institution/constituency into the overall project. This will prevent allegations of people engaging because of personal financial interests.
18. All **work by the TSC will be *pro-bono where possible***, but given the skills shortage in the specific technical fields needed to make the outcome legitimate, it might be necessary to pay professional fees for key specialists. This matter will be dealt with on a needs-driven basis, with the Project Director making a written recommendation to the OC for approval. This will be entered into the Record of Decision and will form part of the final public domain report.
19. **Funders will not have any representation by right**, but the Project Director will be fully accountable for the disbursement of funds to the full satisfaction of the funding agencies, under full scrutiny by the OC.
20. All **funding will be subject to both an internal and external audit** of the highest standards. A detailed Audit Report will form an annexure in the final public-domain document.
21. The **Project Director** will be a senior CSIR employee, subject to the full disciplinary procedures of the CSIR, including the Public Financial Management Act, but who will also take written instructions from both the TSC and OC, which will be fully implemented to the satisfaction of both of these Committees.
22. There will be **full transparency** at all stages of this project, with the Project Director tasked with the responsibility of overseeing the writing of a **public domain report** that includes as an appropriate annexure, all of the various outputs and procedures of the various teams. This public-domain report will consist of the following annexures:
- a. List of names and details of the institutional affiliation of each of the members of the TSC and OC, along with a one page CV of each member.

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- b. Schedule of the *Minutes* of each meeting of both the TSC and OC, including all written correspondence appropriate to the workings of each Committee.
 - c. *Record of Decision* listing every formal decision taken by both the TSC and OC in the execution of this project.
 - d. The *Protocol* developed by the TSC and approved by the OC.
 - e. The *Code of Conduct* developed by the OC, along with any record of sanctioning non-compliance as appropriate.
 - f. *Technical Report* of the findings to the level of detail stipulated by the external Ethical Oversight panel.
 - g. All *Peer Review Reports* including details of areas of concerns.
 - h. Report by the authors of the Technical Report listing each concern raised by the Peer Review Reports, along with the author's response to each item.
 - i. *External Auditor Report* listing all donors, the size of their individual donation and what that money was used for. This report will also list all disbursements to the level of detail stipulated by the OC.
 - j. A *Policy Report*, highlighting the relevant policy-issues that might have arisen, for consideration by both Government and Industry decision-makers.
23. The **Field Team (FT) will be under the direct control of the Project Director**, and will be insulated from the OC and TSC, but their work will be conducted strictly according to the *Protocol* and *Code of Conduct* that will be rigorously overseen by the appropriate Committee.
24. There will be **no direct contact between members of the FT and LT and the two relevant oversight committees (TSC and OC)**, except when such contact is expressly authorized by the Project Director, and then only for purposes of implementing the *Protocol* and *Code of Conduct*. The purpose of this is simply to protect the technical workers from unnecessary distraction and not for purposes of cover-up.
25. All **costs of the FT will be paid at standard professional rates** stipulated by each individual's home institution, supported by time sheets subject to external audit as specified by the OC. A full schedule of these costs will form an Annexure to the final public-domain report to be co-ordinated by the Project Director.
26. All **costs of the Laboratory will be paid at standard professional rates stipulated by each**, supported by invoicing subject to external audit as specified by the OC. A full schedule of these costs will form an Annexure to the final public-domain report to be co-ordinated by the Project Director.
27. All **costs of the External Peer Review Team will be paid at standard professional rates** stipulated by each individual's home institution, supported by time sheets subject to external audit as specified by the OC. A full schedule of these costs will form an Annexure to the final public-domain report to be co-ordinated by the Project Director.

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28. All costs of the Secretariat will be paid at standard professional rates stipulated by each individual's home institution, supported by time sheets subject to external audit as specified by the OC. A full schedule of these costs will form an Annexure to the final public-domain report to be co-ordinated by the Project Director.

Task Scheduling for the Proposed Project

While many of the specific tasks are as yet unknown until such time as the *Protocol* has been developed by the TSC, the proposed project can be divided into four core phases as presented in Figure 3.

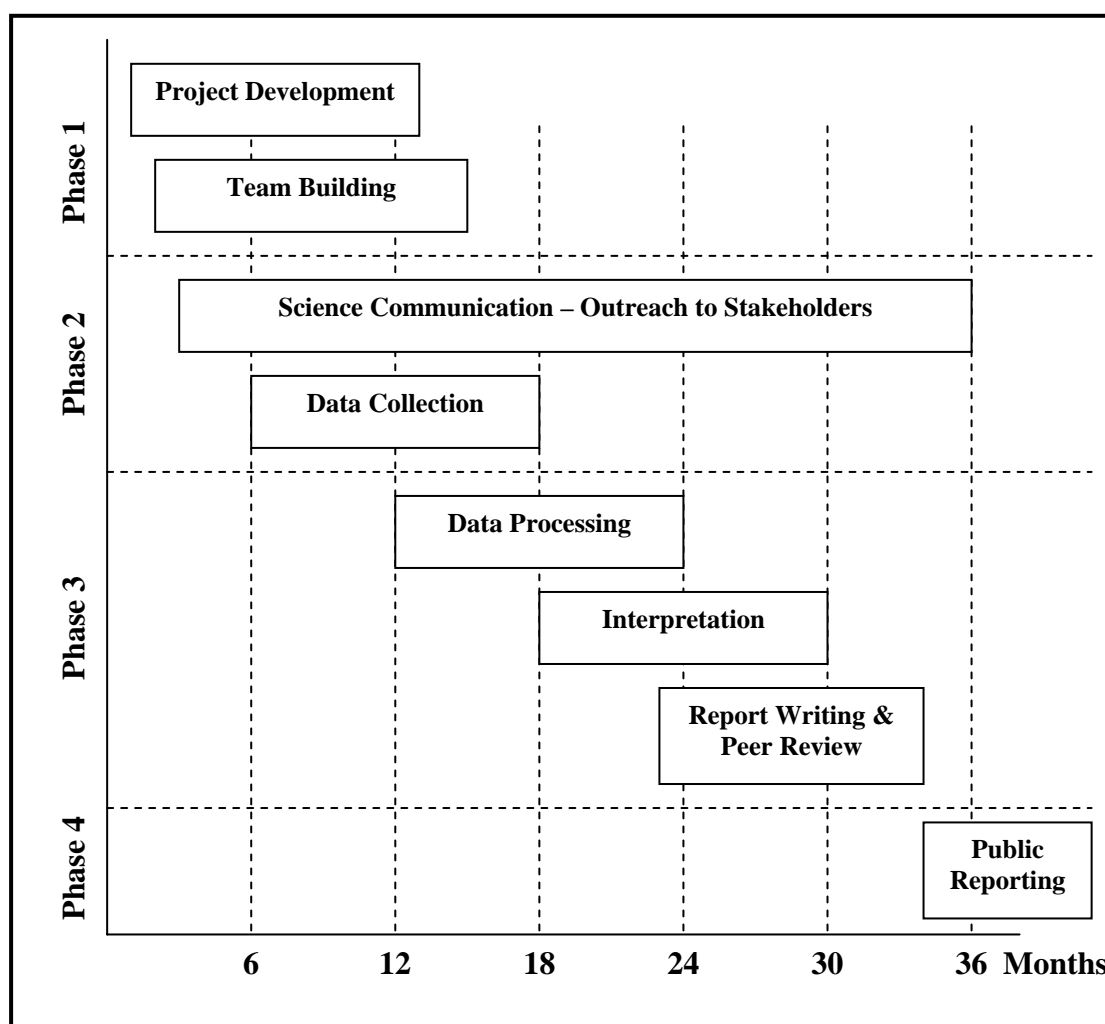


Figure 3. Probable phasing of specific tasks for the proposed project using optimistic timelines assuming core funding and technical capacities are not limiting factors.

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