South African Heritage Resources Agency (SAHRA)
Head Office
111 Harrington Street
CAPE TOWN
8001 3/3/2015
info@sahra.org.za

HERITAGE AND ARCHAEOLOGICAL IMPACT ASSESSMENT: CASE: FS 30/5/1/1/2/10300 PR

Dear sir/ madam

Hereby request for the inclusion in the HERITAGE AND ARCHAEOLOGICAL IMPACT ASSESSMENT – specific reference to bath house and hot spring research site

The proposed project CASE: FS 30/5/1/1/2/10300 PR (De Beers Consolidated Mines Limited) with reference to sections **1.1.7** and section **1.2** of the ENVIRONMENTAL MANAGEMENT PLAN SUBMITTED IN TERMS OF SECTION 39 AND OF REGULATION 52 OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002, (ACT NO. 28 OF 2002) (The Act)

Section 1.1.7 refer to:

There are farmhouses present, although their ages are unknown, and graves may be present near these. Existing or known graves have been reported on the farm Lynfontein 356 (RE). In addition; old farm buildings and archaeological excavations have been reported on portion 3 of the farm Baden-Baden 1363.

However, the greatest extent of the area is used for farming. Initial geophysical surveying may be within 50m of a farmhouse and/or grave but these activities have no impact; however heritage and archaeological impact assessment will be done if the prospecting project proceeds to advanced phases and if graves are found to be present will be reported in the progress report.

Section 1.2 refer to:

The specific environmental features on the site applied for which may require protection, remediation, management or avoidance. Due to the fairly dry nature of the area and the existing land use, the vegetation, soil and groundwater are the main elements that need protection in general. In particular, damage to small farm dams and water boreholes (wind pumps) must be avoided. Prospecting activities will be well away (at least 50 metres) from afore mentioned sites. Damage to farmhouses (with associated graves) and other structures such as fences, gates, farm roads or tracks should be avoided. During drilling activities water strike depth is noted and any significant changes in water volumes are recorded. In cases where drilling goes through the aquifer plugging of the hole will be investigated as an option. Moreover, during extensive drilling water quality can be monitored to mitigate contamination of water. Ground water pollution must be avoided through the use of only environmentally friendly drilling additives and the proper closing of boreholes on completion.

MOTIVATION FOR REQUEST

The proposed development may impact on:

- Thermal spring unique composition
- Balneological value
- Heritage and indigenous knowledge of thermal springs
- Building structure on portion farm Baden-Baden (bath house) older than 60yrs
- Micro and Archea micro organisms
- Research potential

1. BACKGROUND

Thermal springs are still some of the most under-researched and under-utilised of all natural resources in South Africa

A series of field trips were conducted during the period 2010 to 2013 as part of a **Water Research Commission Project** K5/1959/1 on the optimal use of thermal springs in South Africa with aim the optimal utilisation of geothermal springs in South Africa.

The team consisted of inter- and multidisciplinary experts:

Dr Shafic Adams	Water Research Commission	Project Coordinator
Prof Jana Olivier	UNISA (Environmental Science)	Team Leader
Prof Memory Tekere	UNISA	Microorganisms and Archea bacteria in thermal springs
Prof Hannes Rautenbach	University of Pretoria	Climatology and Meteorology
Dr Isaac Rampedi	University of Johannesburg	Tourism and Geothermal Department of Geography, Environmental Management and Energy Studies
Dr Ernest Tshibalo	UNISA	Environmental Management and curriculum development
Dr Bisrat Yibas	Council for Geoscience	Exploration geology and Geochemistry
Mr Peter Nyabeze	Council for Geoscience	Geophysicist
Mr Jaco Venter	Exxaro Resources	Geologist and Ventilation Practitioner
Mr Humberto Seaze	Council for Geoscience	Isotope studies
Mr Tshepo Motlakeng	Council for Geoscience	Environmental Technician
Ms C Jonker	UNISA	Algae and optimal uses of springs

COLLABORATIONS

Prof Don Cowan (Enzymologist)
Institutional Research Theme (IRT) in Genomics and its Centre for Microbial Research
University of Pretoria

Prof Fanus Venter
Head of Department Microbiology

University of Pretoria

Dr Carin van Ginkel
Cipress Environmental Consultant
Expert Algae and wetland systems

PLEASE NOTE:

Our aim in the research project was to ensure that hot springs were developed for the benefit of local communities and the economy. We will be more keen to let De Beers drill and avail data to us through the WRC, for mineral and renewable energy research purposes. Our main challenge in the research that we undertook was to have someone who could finance drilling close to our research sites. What we need from De Beers is access to data and the ground water aquifer for future water related research.

We are not against the proposed development, but anticipate consideration of the on-going research and the bath house on the site.

Prof Olivier will propose thermal spring research as flagship project for UNISA on the 19th March 2015

2. REASEARCH IN PROGRESS

LIST OF CURRENT OUTPUTS ON THERMAL SPRINGS IN SOUTH AFRICA

ARTICLES

OLIVIER J, VENTER JS, JONKER CZ 2011: Thermal and chemical characteristics of hot water springs in the northern part of the Limpopo Province, South Africa. Water SA, 37(4), 427-436.

OLIVIER J & JONKER CZ (2013) Halogen content of thermal spring waters in Limpopo Province, South Africa: possible origin and impact on game. Unpublished.

TEKERE M, LOTTER A, OLIVIER J, JONKER CZ, VENTER S 2011: Metagenomic analysis of bacterial diversity of Siloam hot water spring, Limpopo, South Africa. African Journal of Biotechnology. 10, 18005 – 18012.

TEKERE M, LOTTER A, OLIVIER J, JONKER CZ, VENTER S 2012: An evaluation of the bacterial diversity at Tshipise, Mphephu and Sagole hot water springs, Limpopo Province, South Africa. Journal of Microbiology Research. 6 (11) 1.

NYABEZE PK, VENTER JS, OLIVIER J & MOTLAKENG TR: Geophysical characteristics of the Siloam thermal spring aquifer in Limpopo, South Africa. Submitted: Journal of Alternative Energy.

NYABEZE P & GWAVAVA O (2013) Determination of depth models for the vadose zone and shallow groundwater aquifer at Siloam hot spring in Limpopo province of South Africa: results from modelling of electromagnetic and electrical resistivity data. Unpublished .CGS

NYABEZE PK & CHIRENJE E (2011) Results of Electrical and Electromagnetic Depth Soundings at Siloam and Sagole Thermal Springs, Limpopo Province, South Africa. 23rd Colloquium of African Geology, Johannesburg, South Africa, January 8 - 14, 2011, pp314.

NYABEZE PK, GWAVAVA O, CHIRENJE E & SEKIBA M (2011) Characterization of the groundwater aquifer and vadose zone associated with the hot spring at Sagole Village, Limpopo province of South Africa: results from geophysical investigations. Kenya Geothermal Conference, Safari Park Hotel, Nairobi, November 21-23, 2011

JONKER CZ, VAN GINKER C, OLIVIER J (2013): Association between physical and geochemical charactersitics of thermal springs and algal diversity in Limpopo Province, South Africa. Water SA 39 (1) p1-10. ISSN 0378-4738

YIBAS B, OLIVIER J, TEKERE M, MOTLAKENG T, & JONKER CZ (2011): Preliminary health risk analysis of some of the thermal springs in Limpopo Province, South Africa. Proceedings, Kenya Geothermal Conference, Safari Park Hotel, Nairobi, November 21-23, 2011

SAEZE H & RIKHOTSO C (2013): Hydrogeochemistry of thermal spring of Limpopo Province assessed by water chemistry and environmental isotopes in hydrology. Unpublished.

TSHIBALO E 2011: Health spa tourism: a potential use of Sagole thermal spring in Limpopo, South Africa. Proceedings, Kenya Geothermal Conference, Safari Park Hotel, Nairobi, November 21-23.

SHEPPARD L 2013: Environmental Risk assessment of geothermal springs – A case study of “Die Eiland’ in Limpopo Province. MSc Environmental Management. University of Johannesburg.

MAGNABOSCO C, LAU CYM, ONSTOTT TC, KIEFT TL, TEKERE M, OLIVIER J, LINAGE B, KULOYO O, ERASMUS M, CASON E, VAN HEERDEN E & BORGONIE G 2014. Comparison of the composition and biogeographic distribution of the bacterial communities occupying South African thermal springs with those inhabiting deep subsurface fracture water. *Frontiers in Microbiology, 5,* 1-16. doi:103389/fmicb.2014.00679.

TSHIBALO AE, OLIVIER J, NYABEZE P. South African geothermal country update (2010-2014). Proceedings, World Geothermal Congress 2015, Melbourne, Australia.

TSHIBALO AE, DHANSAY T, NYABEZE P, CHEVALLIER L, MUSEKIWA L & OLIVIER J. Evaluation of the geothermal energy potential for South Africa. Proceedings, World Geothermal Congress 2015, Melbourne, Australia.

SHABALALA A, NYABEZE PK, MANKAYI Z & OLIVIER J 2015: An analysis of the groundwater chemistry of thermal springs in the Soutpansberg Basin in South Africa: Recent data. *South African Journal of Geology,* 118(1), 49-56.

CONFERENCES

IV INTERNATIONAL CONFERENCE ON ENVIRONMENTAL, INDUSTRIAL AND APPLIED MICROBIOLOGY (BioMicroWorld 2011). Evaluation of bacterial diversity of some hot water springs in the Limpopo Province of South Africa. Tekere M, Lotter A, Olivier J, Jonker CZ, Venter S. Malaga, Spain. 14 -16 September 2011.

INTERNATIONAL GROUNDWATER CONFERENCE: BIENNIAL CONFERENCE OF THE GROUND WATER DIVISION (GWD) OF THE GEOLOGICAL SOCIETY OF SOUTH AFRICA (GSSA) AND THE INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IAH) 2011: Geophysical characteristics of aquifers associated with thermal springs in Limpopo, South Africa. P.K. Nyabeze, O. Gwavava, J. Olivier, E. Chirenje and M. Sekiba. 19th to 21st September 2011 at the CSIR International Convention Centre, Pretoria, South Africa, p123.

KENYA GEOTHERMAL CONFERENCE 2011: Preliminary health risk analysis of current uses of undeveloped thermal springs in Limpopo Province, South Africa. Yibas B, Motlakeng T, Olivier J, Tekere M Jonker CZ. Nairobi, Kenya, 21-23 November 2011.

GEOSYNTHESIS 2011 CONFERENCE & EXHIBITION: “Geophysical Characteristics of a Shallow Aquifer Associated with a hot Spring in the Limpopo Province, South Africa”. 29 August – 1 September 2011, Cape Town Int. Convention Centre, South Africa. P.K. Nyabeze.

KENYA GEOTHERMAL CONFERENCE 2011: Characterization of the groundwater aquifer and vadose zone associated with the hot spring at Sagole village, Limpopo Province of South Africa: Results from geophysical investigations. P.K. Nyabeze, O. Gwavava, E. Chirenje, M. Sekiba. 2011: Nairobi, Kenya, 21-23 November 2011.

INTERNATIONAL GEOTHERMAL CONFERENCE – to be held in Melbourne Australia, 2015.

STUDENTS

LIST OF STUDENTS INVOLVED IN PROJECT K5/1959/1			
NAME	RACE/	DEGREE	TITLE

	GENDER		
Tshibalo, Azwindini Ernest	M/B	PhD completed	Strategy for the sustainable development of thermal springs: a case study for Sagole in Limpopo Province
Tuwani, Patrick	M/B	MA completed	Success factors for the development of natural resource-based resorts: a comparative analysis of Mphephu, Sagole and Tshipise thermal springs, Limpopo, South Africa.
Sheppard, Linda	F/W	MSc completed	Environmental risk assessment of geothermal springs: a case study of "Eiland" in the Limpopo Province
Nyabeze, Peter	M/B	PhD pending	Characterisation of thermal aquifers in the Limpopo Province of South Africa: Evidence from geophysical and geological investigations.
Motlakeng, Tshepo	M/B	BSc hons completed	To characterise hot springs using environmental, geophysical, geology and geochemical methods with special reference to the Brandvlei spring in Western Cape.
Grove, Francois	M/W	MSc completed	The beneficiation of carbonate rich coal seam water through the cultivation of *Arthrospira maxima (Spirulina)*
Jonker Nelia Currently registered UNISA	F/WF	PhD commenced	Balneological classification of thermal springs in South Africa
B = black; W = white; M = male; F = female			

COMMUNITY DEVELOPMENT

Since most of the thermal springs are located in rural areas, the outcome of their development would have a positive impact rural development while the use of geothermal resources for agriculture and aquaculture, would necessarily bring about food security. Not only would such developments benefit the surrounding communities, but the use of heat to manufacture products such as cheese and beverages from local produce would be advantageous to the region in general.

Water mining of minerals and salt could also be extremely lucrative with the added advantage of being environmentally friendly. This would be in sharp contrast to current mining activities that are one of the most destructive to the environment. The use of geothermal energy helps to offset the overall release of carbon dioxide into the atmosphere, as well as its effects. Green mining and geothermal energy generation – albeit on a small-scale - could be used to source funding from carbon offset. The success of such a venture would also require the involvement of both industry and government. Most ventures should not be exorbitantly expensive and could be of direct benefit to a participating company – especially in view of mounting consumer awareness of environmental and social issues. Nevertheless, a thorough SWOT and cost benefit analysis would be required to before investing in any development.

It is thus important to note is that the envisaged outcomes of this project will be used for **small-scale development,** taking social, environmental and economic factors into consideration. Care should be taken to preserve the quality of the resource and to maintain the integrity of wetlands. The importance of the preservation of springs with cultural or customary significance should not be overlooked. With this aim in mind a project proposal entitled: *Indigenous knowledge on the discovery, custodianship, history, legend, belief, customs and uses of thermal springs in South Africa: Using the past as a basis for sustainable future development* was submitted to the National Heritage Council through the Kara Institute.

PARLIAMENTARY BRIEF 2014

WATER RESEARCH COMMISSION

BRIEF

February 2014

The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support and develop as well as the building of a sustainable water research capacity in South Africa

TECHNICAL

Development of Natural Resources

Optimal Use of Thermal Springs

PROTECTION, USE, DEVELOPMENT, CONSERVATION, MANAGEMENT AND CONTROL OF SOUTH AFRICAN THERMAL WATER RESOURCES

TERMAL SPRINGS AS GEOTHERMAL RESOURCES

The National Water Act (Act 36 of 1998) (NWA) requires that water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. Water resources are usually assumed to be surface water bodies and groundwater resources to be used for domestic and agricultural purposes. Thermal (hot) springs are rarely recognised as being a resource. However such springs have been used for religious and/or medicinal purposes for hundreds, if not thousands of years and developed into flourishing centres of culture, health and tourism in the Far East, Europe and Africa. During the last few decades, their potential as versatile natural resources has become apparent. In addition to being popular tourist and health resorts they are used internationally for the generation of electricity, (geothermal power), agriculture, aquaculture, bottling, the extraction of rare elements, and the use of thermophilic (heat loving) bacteria for industrial purposes. However, in South Africa, about half of the documented 74+ thermal springs have been developed as leisure and recreational resorts, while the rest remain undeveloped. Thus, in comparison with global trends, South African geothermal resources appear to be under-utilized.

The aim of this report is to determine the optimal uses for each of the thermal springs in South Africa in terms of their chemical, physical and biological characteristics. Such uses included their potential for geothermal energy production, bottling, agriculture (greenhouses, crop drying and irrigation) and aquaculture (production of tilapia, spirulina and oysters), as well as for niche markets such as the cosmetic industry, mineral extraction, the health and wellness industry and for the specialised tourism market.

THERMAL SPRINGS IN SOUTH AFRICA AND THEIR USES

The most thermal springs are located in Limpopo Province, followed by the Western Cape, KwaZulu Natal; the Eastern Cape, Mpumalanga, the Free State and the Northern Cape.

The suitability assessment revealed that **each thermal spring can be used for a number of different purposes while, conversely, one or more of the thermal springs can be used for each of the potential uses investigated.**

The most viable uses include greenhouse heating and crop drying. The former would enable crop production throughout the year. This would result in sustained supply to markets and ensure premium prices during off-seasons. The use of heated greenhouses could stimulate the production of exotics that could boost small-scale export to neighbouring African countries. Geothermal energy resources could also be used for **agro-processing** of locally produced produce. This would not only bring about sustained food security and enhance the resilience of people and the economy to climate change, but could boost the local and regional economy by, for example, the creation of home-based cottage industries for niche products such as local cheeses, beverages, vegetables and herbs. Similar benefits could also accrue from **aquaculture**. The production of fish in inland rural areas would provide a rich source of protein to people and impact directly on the health status of communities. Fish wastes make an excellent organic fertiliser for local use and for sale elsewhere, while all agricultural and agro-processing waste could be used for the generation of fuel in the form of **biogas**. *Spirulina* algae production, using geothermal energy resources alone, could be developed into small enterprises supplying the local **pharmaceutical industry.** *Spirulina* is also a rich source of nutrition for humans and animals. All algal waste can be fashioned into building materials with high insulation properties – contributing to the **energy efficiency** and comfortable homes. Beneficiation could occur on-site or raw products could be supplied to other outlets. Thermal spring waters could also be used for small-scale irrigation projects without harming the environment.

It is important to note that the very properties of spring waters that prohibit its use for some purposes may make it eminently suitable for another. This implies that water that might be unfit for drinking purposes due to high mineral content could be suitable for **water mining**. Recent technological advances have made it possible to extract only specific minerals from brines. Although the concentrations of minerals in South African spring waters are low in comparison to the very hot geothermal resources in countries with volcanic springs, **small scale mineral extraction** may be feasible, especially for the extraction of boron, titanium and strontium. These minerals have industrial use. Water mining has the added advantage of being environmentally friendly.

Only the hottest springs, namely Brandvlei and Tshipise, could be suitable for **power generation** at present**,** but the rate of development of this technology could soon increase the viability of geothermal energy production in South Africa.

In the majority of the cases it is the thermal **energy that is useful rather than the water itself**. Consequently the water can be **cascaded** through a multitude of different tiers of uses - with benefits accruing at each – without depleting or contaminating the resource itself.

Many thermal springs are located on existing tourism routes, but have not been exploited optimally for this purpose. Thermal springs have a rich heritage of legends, beliefs and customs. Moreover, salt from thermal springs, is one of the most ancient industries in the country and formed the basis for extensive trade throughout African. This knowledge should not be lost and should be incorporated into future tourism development plans. The role of an African Health and Wellness tourism centre at thermal springs, is self-evident.

THERMAL SPRINGS AND THE NATIONAL DEVELOPMENT PLAN

This project and its possible outcomes address the goals of the NDP which aims to eliminate poverty and reduce inequality by 2030. Since most of the thermal spring resources are located in rural areas, any development should contribute to the economy and create jobs.

Another one of the goals of the NDP is to provide access to the electricity to citizens. Geothermal energy resources are not mentioned in this Plan. However, geothermal energy production is used extensively internationally and modern technology has eliminated the need for high temperature resources. It has been found to have the least environmental impact, since no combustion is required. It eliminates the production of Greenhouse gases and does not impact negatively on existing water sources. Since only the heat energy is used for energy production, the water quality is not affected. All water can be returned to the aquifers via re-injection wells. Such developments would necessarily qualify for the proposed incentives for the use of greener technologies.

A large part of the NDP focuses on the need for education. Thermal spring resources could be used to promote **education and training.** Benefits of establishing a resource-based educational center in a rural area would be advantageous at all levels of education - from primary school through secondary and eventually tertiary levels. Skills development would form an integral part of the functions of the center as would the incorporation of traditional knowledge into learning material. Research aimed at exploiting thermal spring resources will encourage **innovation**. Indeed, this WRC project has been the first to investigate the bacterial and algal diversity of South African thermal springs. Here is a possibility that some thermal springs might contain novel species. If so, they could have considerable **industrial potential**.

CONCLUSION

It must be emphasized that development of thermal spring resources would result in **small-scale rural development where** the sustainable development of thermal spring resources could impact significantly on the health and wellbeing of communities; contribute to the production of food and fuel throughout the year; provide clean source water that could be used to fulfil basic sanitation needs; be a source of a renewable energy; and stimulate the establishment of new enterprises and expand existing ones; and lead to job creation in rural areas. The latter can be generated from expansion of tourism projects, small- scale water mining, niche product developments, agricultural and aquaculture ventures as well as from the establishment of educational centres.

However, care should be taken to preserve the quality of the resource and to maintain the integrity of wetlands. The importance of the preservation of springs with cultural or customary significance should not be overlooked.

Most importantly, it must be borne in mind that, geothermal spring developments could only become a reality of both industry and Government are prepared to commit to such small-scale development projects.

Further reading:
To obtain the report, Optimal Use of Thermal Springs (**Report No: TT 577/**) contact Publications at Tel: (012) 330-0349; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or visit: www.wrc.org.za to download a free copy.

---

3. THERMAL SPRINGS AS NATURAL RESOURCES

METEORIC ORIGIN

When the hot, circulating underground water encounters an impermeable dyke or a fault, it may be forced to the surface as a thermal spring (Kent, 1969; Hoole, 2001). Such springs are said to be meteoric in origin, and the waters are usually cooler than those of volcanic origin.

The mechanism for the development of a non-erupting or meteoric thermal spring is illustrated in Figure 1. Drilling may affect secondary thermal aquifer….xxxx (Bisrat please)

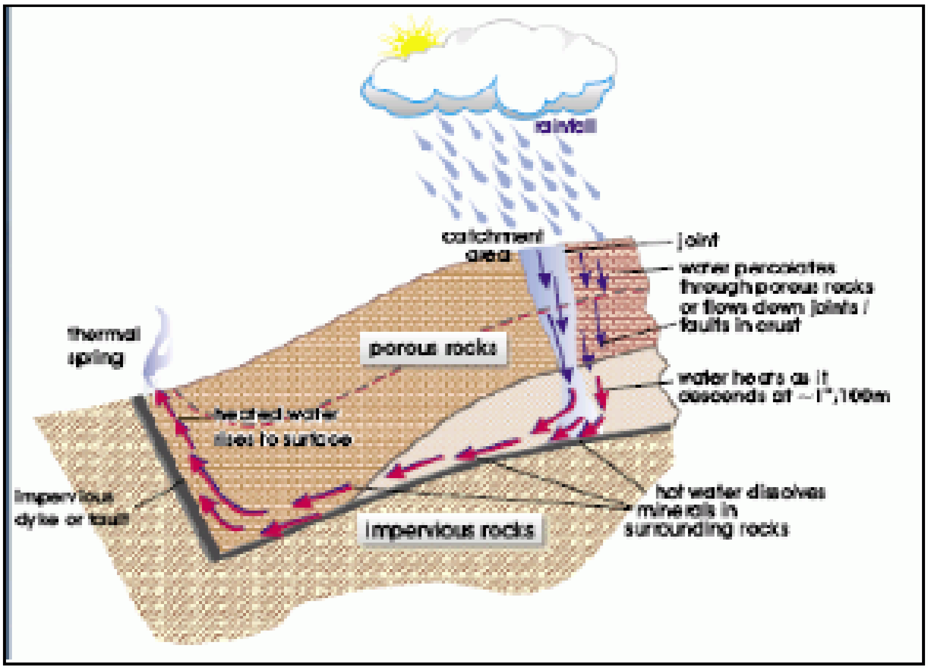


Figure 1 Diagrammatic representation of the formation of meteoric thermal springs

BADEN BADEN THERMAL SPRING UNIQUE COMPOSITION

The majority of South Africa's hot springs is located in the Western Cape and the Northern Province. There are very few in the Free State. Each thermal spring is unique with regard to its physical characteristics and chemical composition.

ARC • LNR

INSTITUTE FOR SOIL, CLIMATE AND WATER
INSTITUUT VIR GROND, KLIMAAT EN WATER

Client : Prof J. Ollivier
Kliënt :
Dept Environmental Sciences
Unisa

0003

Tel : 012 3524284
Fax / Faks : 012 3524117
Date / Datum : 06/07/2012

RESULTS FOR REPORT No:
RESULTATE VIR VERSLAG Nr WATER 201213 10042

		Baden Baden	Aliwal Spa	Eagles Nest	Rapsfontein	PSW	PW	Florisbad	Florisbad Medicinal	Florisbad Shop
Element	**Dilution Verdun**	**W342**	**W343**	**W344**	**W345**	**W346**	**W347**	**W348**	**W349**	**W350**
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Co	10	0.049	0.074	0.102	0.065	0.399	0.376	0.101	0.131	0.06
Rb	10	17.04	6.785	7.242	7.188	5.767	5.946	88.77	87.02	0.596
Se	10	12.6	11.2	6.294	3.044	3.658	7.428	4.876	10.71	5.434
Br	10	2689	892.7	833.7	785.4	646	487.9	2429	2359	193.9
As	10	2.467	1.898	1.329	0.588	1.785	2.321	0.569	1.954	1.059
Zn	10	2.295	2.491	1.623	0.468	14.89	24.73	0.882	1.04	1.281
Li	10	1069	692.3	603.1	571.8	2.991	2.513	913.9	917.3	44.54
Ni	10	0	0	0	0	0	0	0	0	0
Cd	10	0.005	0	0	0	0	0	0	0	0.036
Mn	10	24.29	1.713	2.945	1.825	7.907	2.949	2.743	2.759	2.199
Cr	10	1.086	0.55	0.446	0.417	2.141	1.712	1.056	1.095	0.741
V	10	24.17	14.98	14.17	12.69	30.32	11.36	22.85	21.54	3.513
Ti	10	0.173	0.5	0	0	0.234	0	0.864	0	0
B	10	584.1	265	241.1	257.1	11.89	8.711	530.8	531.8	423.8
Be	10	0.025	0	0	0	0	0	0	0	0
Cu	10	2.331	0.435	0.211	0	4.945	2.002	0	0.591	0
Ba	10	265.8	18.44	20.4	16.24	34.79	36.55	194.7	189.7	4.998
Bi	10	0.868	0.021	0.259	0	0	0	0	0	0
Pb	10	0.822	0.14	0	0	0.211	0	0	0	0.117
Tl	10	0.093	0.02	0.006	0.007	0	0	0	0	0
Hg	10	2.716	1.4	0.719	0.685	0.242	0.095	0.863	0.978	0.122
Au	10	12.73	5.564	0.989	2.134	0.767	0.058	0.795	0.669	0.062
Pt	10	0.012	0.064	0	0.014	0.43	0.439	0	0	0.606
Sr	10	2251	1166	1154	977	103.6	86.46	2671	2617	18
La	10	0.028	0.001	0	0	0.004	0	0	0	0
Mo	10	0.387	0.583	0.461	0.59	1.102	1.136	0.372	0.401	0.044
Cs	10	15.25	0.443	2.234	0.277	0	0	8.333	7.689	0
I	10	3198	214	474.9	156.2	204.1	70.39	2506	3248	461.4
Te	10	0.025	0.086	0.083	0.079	0.089	0.072	0.089	0	0.059
Sb	10	0.014	0.268	0.321	0.291	0.406	0.399	0	0.2	0.388
Sn	10	4.12	0	0	0	0	0	0	0	0
U	10	0.018	0.003	0.001	0	0.39	0.37	0	0	0
W	10	44.69	25.03	23.03	24.81	0.635	0.474	49.37	48.52	0.807

Figure 2 Chemical analysis Baden Baden

AGE OF THE THERMAL WATER

Geophysical and isotope studies may add to the body of knowledge regarding the origin and age of thermal spring. The age of the waters before the Holocene. The distribution of the hot springs in South Africa is associated with the geological formations and faults in the rocks found in the country. Geophysical surveys to be carried out in order to provide information on subsurface groundwater thermal aquifers; the most important hydrogeochemical process controlling the chemical composition of thermal groundwater is found to be water-rock interaction

THERMAL BIODIVERSITY AND THERMOPHILIC WETLANDS SYSTEM

Thermal springs comprise unique and fragile ecosystems with rare microclimatic conditions created by and wholly dependent upon geothermal activity. Exploitable microbial diversity in the environment is inexhaustive and microorganisms represent the largest reservoir of understudied biodiversity. Thermal hot springs in different parts of the world have been studied for their thermophilic microbial diversity and often serve as a source of novel microorganisms for various biotechnological applications. A large component of each thermal spring ecosystem is found underground. The environment associated with a thermal spring can be divided into two types of ecosystems, the first, comprising the thermal spring itself and the other, wetland arising from the spring flow.

With the exception of a recent article that was published on the bacterial population at Siloam hot spring in Limpopo Province (Tekere et al., 2011), virtually nothing is known about the variation in the diversity of microbes in other hot springs in South Africa. Molecular approaches are used to analyse the microbial diversity of these un-culturable microorganisms. There also seems to be a high degree of specificity of the algae with regard to the geochemical environment. Variations in temperature, pH and geochemistry of the lithostratigraphic units appear to be the governing determinant in community structure of the species abundance and distribution of the algae species. Few studies on the identification of algae in thermal springs and their geochemical distribution have previously been documented in South Africa.

Preliminary studies indicate a biotic ecosystem (Figure 3). Further studies may reveal the possible existence of fungi and archaic microorganisms. The presence of these organisms may provide knowledge relating to micropaleaontology and Paleobiogeochemistry.

Figure 3 Diatoms (Jonker 2013)

BALNEOLOGY (MEDICINAL USE OF THERMAL SPRING WATER)

Hot spring waters were believed to have supra-natural properties, especially if they were peculiar in respect to their taste, colour or temperature (http://www.paracelsus-badhall.at/en/balneology, 2013). The ill have sought to cure a variety of physical and mental ills through the use of this special water administered over the body or taken internally (Shalinsky, 1985).

Balneo-therapy is a broad term that literally means bath therapy. This water therapy is usually practice through water immersion of part or all of the body, drinking certain amount of water, sprays, inhaling vaporized or dispersed water or is applied externally in many forms of muds or peats and douches.

Medicinal waters can be singled out on account of the concentration of the dissolved salts, gases, temperature and organic matter that allows it to be used for treatments. Different types of water may have different therapeutic effects, depending on the content of elements such as bicarbonates, sulphur, sulphates, chlorides, radon, iron, calcium, magnesium, potassium, lithium, arsenic and silica.

Indications of balneotherapy include: chronic rheumatic disease, functional recovery of central and peripheral neuro-paralysis, metabolic disease, especially diabetes, obesity and gout, chronic gastrointestinal diseases, chronic mild respiratory diseases, circular diseases, especially moderate and mild hypertension, peripheral circulatory disease. Cure for this diseases using hot springs have been known in South Africa for a very long time. The best known medical practitioner to contribute to our general literature on medicinal use of thermal springs, was C Louis Leipoldt (1946). However, Daniell (1895); Dr. W. Darley Hartley (1908), Rindl (1916); Cawston (1936); Booyens (1981); Heimann (1940); Leipoldt (1940) and Kent (1952) and more described the properties of 67 medicinal springs and boreholes located in South Africa (Figure 1) (including Baden Baden).

Baden Baden water has a unique composition and is one of a few tepid springs (21° C) in South Africa that was historically used for balneology treatment (Figure 4). The relative high concentration Lithium and Selenium and Iodine concentrations in the water render it useful for treatment of clinical depression, dermatological disorders, such as eczema, psoriasis, acne, burns blood rheology, thyroid function and lipid metabolism respectively. There are also relative high concentrations of Rubidium in the waters, a rare trace mineral, essential for the proper absorption of glucose in the body, thus assisting in the prevention of diabetes

Figure 4 Medicinal springs of South Africa (Booyens, 1981)

CULTURAL HISTORICAL BUILDING- THE OLD BATH HOUSE

The South African bathhouse history had humble beginnings. Bathers merely dug holes in the ground and used reeds or wild plants as shelters. The original bathhouse at Baden Baden can be seen important cultural historical heritage site (Figure 5).

Figure 5 Bath house at Baden Baden

INDIGENOUS KNOWLEDGE OF THERMAL SPRING

Through history hot water springs have remained the realms of many beliefs, stories, myths and traditions (Olivier et al., 2013).

In South Africa thermal springs were often revered by rural communities and some were believed to be sacred sites. Unfortunately, the Indigenous Knowledge (IK) associated with thermal springs has not been documented but exist in the oral tradition.

A risk is that the interest being expressed in the development of thermal springs for geothermal energy production, together with large-scale urbanisation could lead to the loss of the rich cultural heritage associated with thermal spring. It is imperative that IK around thermal springs be documented before it is too late. Ideally, this traditional knowledge should also be used to guide future development. However, the lack of a systematic IK base prohibits wise decision-making and the design of development guidelines on undeveloped thermal springs.

Indigenous knowledge on the discovery, custodianship, history, legend, belief, customs and uses of thermal springs in South Africa: using the past as a basis for sustainable future development was submitted to the **National Heritage Council through the Kara Institute (Refer Dr.Matshega)**

One of the highly respected traditional healers in Africa, Joseph Mususumeli Mulaudzi (80), commonly known as Maine Vho-Tshikovha, received the highest honor ever bestowed on a traditional healer in the country. Tshikovha, who stays at Tshipise-Sagole village (Sagole thermal spring/Spa) outside Musina, was the proud recipient of the Living Heritage Treasure award from the National Heritage Council (NHC) in recognition of his role in the preservation and promotion of the country's intangible cultural heritage, more specifically Indigenous Knowledge Systems. The event took place at Musina Hotel and Conference Centre 10 October 2014.

Distinguished traditional healer Joseph Mususumeli Mulaudzi (80), commonly known as Maine Vho-Tshikovha, receives the Living Heritage treasure award from the chief executive officer of the National Heritage Council, Adv Sonwabile Mancotywa (right)

.

CASCADE OF USES

A thermal spring development should exploit the full potential of a spring as natural resource. The use of geothermal water resources has many advantages. Most of the thermal springs in South Africa are located in rural areas. Unemployment is a major problem in many of these areas. Geothermal developments are labour intensive and could provide a stable source of employment for a wide variety of skills.

Suitability of the Baden Baden springs for alternative uses in terms of their physical and chemical properties may include:

1. Agriculture (Green house) and mushroom production)
2. Aquaculture (Fish production)
3. Small scale mining of minerals
4. Cosmetics
5. Medicinal use

Thermal spring developments could be implemented; the outcome could contribute – albeit in a small way – to problem of rural unemployment.

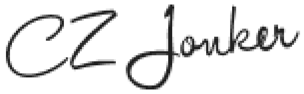
EDUCATIONAL

Thermal springs could also be used to promote education and training. Benefits of establishing a resource-based educational centre in a rural area would be advantageous at all levels of education - from primary school through secondary and eventually tertiary levels. Skills development would form an integral part of the functions of the centre as would the incorporation of traditional knowledge into learning material.

DISSEMINATION OF KNOWLEDGE

South African National Geophysical Data Centre Thermal Springs Database

It is of National interest to preserve our resource and heritage



____

ON BEHALF OF THE INTERESTED AND AFFECTED PARTIES
CZ Jonker

Contact detail : 0836202378
jonkecz@gmail.com