science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

South African Research Infrastructure Roadmap (SARIR)

Research Infrastructure (RI) Proposal

BIOGEOCHEMISTRY **R**ESEARCH **I**NFRASTRUCTURE **P**LATFORM - **BIOGRIP**

EXECUTIVE SUMMARY

"Biogeochemistry" is the study of how biological, geological, chemical, and physical processes interact to shape natural environments over time and space. It covers a range of interdisciplinary research foci, from the origin and diversification of life, to how anthropogenic drivers alter modern environments, to the response of natural systems to environmental change. Biogeochemistry was identified by the 2016 South African Research Infrastructure Roadmap (SARIR) document as an emerging interdisciplinary field of strategic importance. SARIR recommends that the central objective of biogeochemical research in South Africa should be to gain "further insight into the interactions of human activity and the environment over the past several hundred millennia and to determine how the environmental impact of anthropogenic activity has contributed to the change in Earth system dynamics (chemical, physical and biological). This includes the search for an understanding of the behavior of well characterized and emerging pollutants and their current impact on the environment". There are a number of strong research groups in South Africa already investigating various aspects of this broad research objective, but their efforts to-date have been isolated and/or fragmented. Moreover, biogeochemistry requires high precision data and measurements of a vast range of inorganic and organic chemical components, including isotope ratios and trace elements, some of which cannot currently be made in South Africa and many of which cannot be run at the volume and quality required. The investment in BIOGRIP will provide the platform to drive biogeochemical knowledge creation through investment in (1) technical capacity, training and scientific leadership in biogeochemical research, (2) world-class analytical facilities, and (3) improved monitoring of biogeochemical environmental variables through the generation and compilation of statistically meaningful datasets.

IMPACT

BIOGRIP will provide significant opportunities to advance South Africa's research infrastructure and technical capacity in the field of biogeochemistry, while also facilitating a high level of scientific impact on a range of temporal and spatial scales. BIOGRIP will extend the practical research questions that address specific South African problems to include those that are purely curiosity-driven, creative, and/or risky, while also deepening the extent to which ongoing research themes can be probed. An additional impact of developing analytical capacity in-country is the potential for creative methods development, particularly South African-specific applications (e.g., for research questions relevant to the Cape floristic kingdom, hominin evolution, water availability and quality, Antarctic ecosystems, etc.). This will allow the South African research community to push the frontiers of knowledge in a variety of fields where biogeochemical techniques have yet to be applied (or have yet to be applied at the resolution offered by BIOGRIP).

The flow-through impact of BIOGRIP to the South African economy and population is extensive. Countries that invest in research and development (R&D) do better economically, and innovation has been shown to yield a major competitive advantage for developing economies. BIOGRIP will feed into both the National Development Plan as well as the National Innovation Plan by creating an environment

that drives innovative job creation opportunities. Many of these opportunities fall within the Sustainable Development Goals and include access to clean water and sanitation through new techniques for the bioremediation of municipal waste water, zero hunger through biogeochemical management of soil fertility and marine ecosystem productivity, and good health and well-being through innovative business development that drives poverty reduction.

BIOGRIP will also make a significant contribution to the knowledge economy through the graduation of > 300 postgraduate students, >300 peer-reviewed journal articles, high-level technical training of postdoctoral researchers and mentoring of interns. Many of these developments will also impact secondary and primary school education, and foster the next generation of biogeochemical scientists, climate activists and palaeoanthropologists.

SCIENTIFIC EXCELLENCE

BIOGRIP will provide the novel, cutting-edge, and international-standard analytical capabilities required to address the plethora of research questions born of the SARIR goal of understanding how human activities have shaped the past and increasingly shape the present and future environment. Specifically, BIOGRIP seeks to enhance South Africa's existing biogeochemistry research capabilities by modernizing, integrating, and optimizing extant facilities, as well as developing new infrastructure where essential measurement capacity is lacking. BIOGRIP will consist of a network of new and existing research laboratories housed in one of four nodes each hosted by a South African university. Each node specializes in an aspect of biogeochemical research, with a central hub that manages and coordinates the platform. The nodes will support both discipline-specific research and larger-scale integrated and interdisciplinary efforts. The resultant facility will be internationally competitive in its scope and capacity and will integrate with and support other RI platforms in South Africa (specifically, EFTEON, SMCRI, SAMARF, and the Natural Sciences Collection Facility).

MANAGEMENT PLAN

BIOGRIP has a Life Cycle of 15 years. Although the set-up phase is 3 years, the platform is exploiting a number of existing facilities and hence the running phase will also start in year 1. At the end of the set-up phase in year 3, all the nodes will be established and running. However, expansions of some laboratories will continue until year 7. Because of the nature of the platform and the value that it will bring to the wider research community, it is not envisaged that BIOGRIP will shut down. Rather, it will continue to apply for funding support. If this is not possible, the infrastructure will be handed over to the various hosts in order to keep all the facilities running. The facilities that make up BIOGRIP will all be open access but not free. South African academic and student users will be subsidized, while commercial and international users will be charged a full cost-recovery fee. Researchers will be encouraged to access BIOGRIP facilities on a collaborative basis, but non-collaborative research projects will also be accommodated. All research projects will be registered on a centralized project management database

coordinated by the BIOGRIP Hub; to help facilitate this, BIOGRIP will invest in a Laboratory Information Management System.

GOVERNANCE AND STAKEHOLDER ENGAGEMENT

BIOGRIP will be physically hosted at higher education institutions in South Africa. These institutions already contain the largest concentration of scientific capacity in the country and are the logical choice for managing equipment-intensive infrastructure. The BIOGRIP nodes will each have their own management/scientific/technical advisory committees, but BIOGRIP as a whole will be governed by a management steering committee that is made up of the BIOGRIP Director, the DVC Research at UCT where the BIOGRIP Hub will be based, representatives of each node, and external stakeholders. The management of BIOGRIP will be guided by a scientific advisory committee and a technical advisory committee. BIOGRIP has an extensive network of stakeholders and beneficiaries. For this proposal, contact was made with 17 of the 26 universities in South Africa. Additional support was received from Centres of Excellence, other SARIR platforms, national and provincial government departments and other research entities. Engagement with stakeholders will continue through the research activities of BIOGRIP scientists, which are very broad in scope, while engagement with beneficiaries will occur through both scientific activities and social and multi-media, and through the production and distribution of an annual report.

CAPACITY DEVELOPMENT

BIOGRIP will employ a total of 27 permanent full-time staff and create positions for a minimum of 45 1- to 3-year postdoctoral researchers over the 15 years of the RI who will focus on method developments in each of the four nodes. The BIOGRIP staff will comprise 5 employees in the Hub at UCT (Director, Project Manager, Financial Manager, IT Manager and an Administrative Assistant), 4 employees in the Isotope Biogeochemistry Node at UCT (2 Senior Analysts and 2 Junior Analysts), 7 employees in the Water and Soil Biogeochemistry Node at SU (Node Manager, Administrative Assistant, Financial Assistant, 2 Senior Analysts and 2 Junior Analysts), 5 staff in the Atmospheric Biogeochemistry Node at NWU (Node Manager/Director, Field Station Manager, Administrative Assistant, Junior Analyst, Research Technician) and 6 staff in the Mineral Biogeochemistry Node at UFS (Node Manager/Director, Administrative Assistant, Financial Assistant, 3 Junior Analysts). One of the atmospheric biogeochemistry technicians will be placed at SAWS and will assist with high-level maintenance of the Cape Point GAW monitoring station. In addition to these new appointments, the nodes are all supported by existing high-level scientific capacity.

It is envisaged that, at a minimum, scientists directly involved in BIOGRIP will supervise a minimum of 16 Honours students, 16 M.Sc. students and 10 Ph.D. students per year for the duration of the RI Life Cycle. This equates to 240 B.Sc. Honours students, 120 M.Sc. students and 50 Ph.D. students over the 15 years of the RI. A key goal of BIOGRIP will be to transform the racial and gender makeup of this postgraduate

cohort along with that of the postdoctoral researchers, in line with the National Development Plan. Through these training and development actions, it is anticipated that the RI will also produce a wide range of peer-reviewed articles published in both national and international journals. Over the 15 years of the RI, this should exceed 300 research papers that will extend across method development, novel applications to biogeochemistry, and blue skies research relevant to environmental change. The scientific knowledge generated will have spin-offs in small- and medium-sized business opportunities that will drive job creation, particularly in the field of waste effluent bioremediation, and help to address the scourge of inequality in South Africa.

Cyber-infrastructure requirements for BIOGRIP are not substantial and are largely met by the existing SANReN PoP network.

MONITORING, EVALUATION AND RISK MANAGEMENT

BIOGRIP is hosted at higher education institutions (HEIs) and as such, will be governed by the structures, policies and regulations of each host HEI, which are shaped by the Department of Higher Education. Performance management, financial management, supply chain management, and facilities management will thus have slight variations depending on where each node is hosted. The relationship between the nodes and the Hub will be governed by service level agreements that will form part of the performance evaluation of each node manager or director. However, it is anticipated that BIOGRIP will rapidly become self-monitoring and evaluating because of the need for scientists working for BIOGRIP and scientists affiliated with BIOGRIP to publish research findings as one of their important yearly key performance indicators. BIOGRIP will produce an annual report that will be presented to the scientific and technical steering committees in addition to funding agencies and all stakeholders. BIOGRIP progress will be managed using the stage gate process established in the BIOGRIP proposal document. The critical stages in the Life Cycle of BIOGRIP include: (1) approval of the proposal; (2) appointment of the BIOGRIP Director and establishment of the BIOGRIP Hub; (3) appointment of staff; (4) construction works to upgrade and establish nodes; (5) procurement, installation and commissioning of specialized scientific equipment; (6) 5-year critical review of progress; (7) 10-year critical review of progress and application for additional funding to extend the RI; and (8) handover or extension of BIOGRIP functions. The key risks to BIOGRIP are considered to be: (1) the financial climate in South Africa driven by economic slowdown, which might result in a decline in funding levels; and (2) technical capacity in South Africa to operate and maintain the scientific equipment in which BIOGRIP will invest.

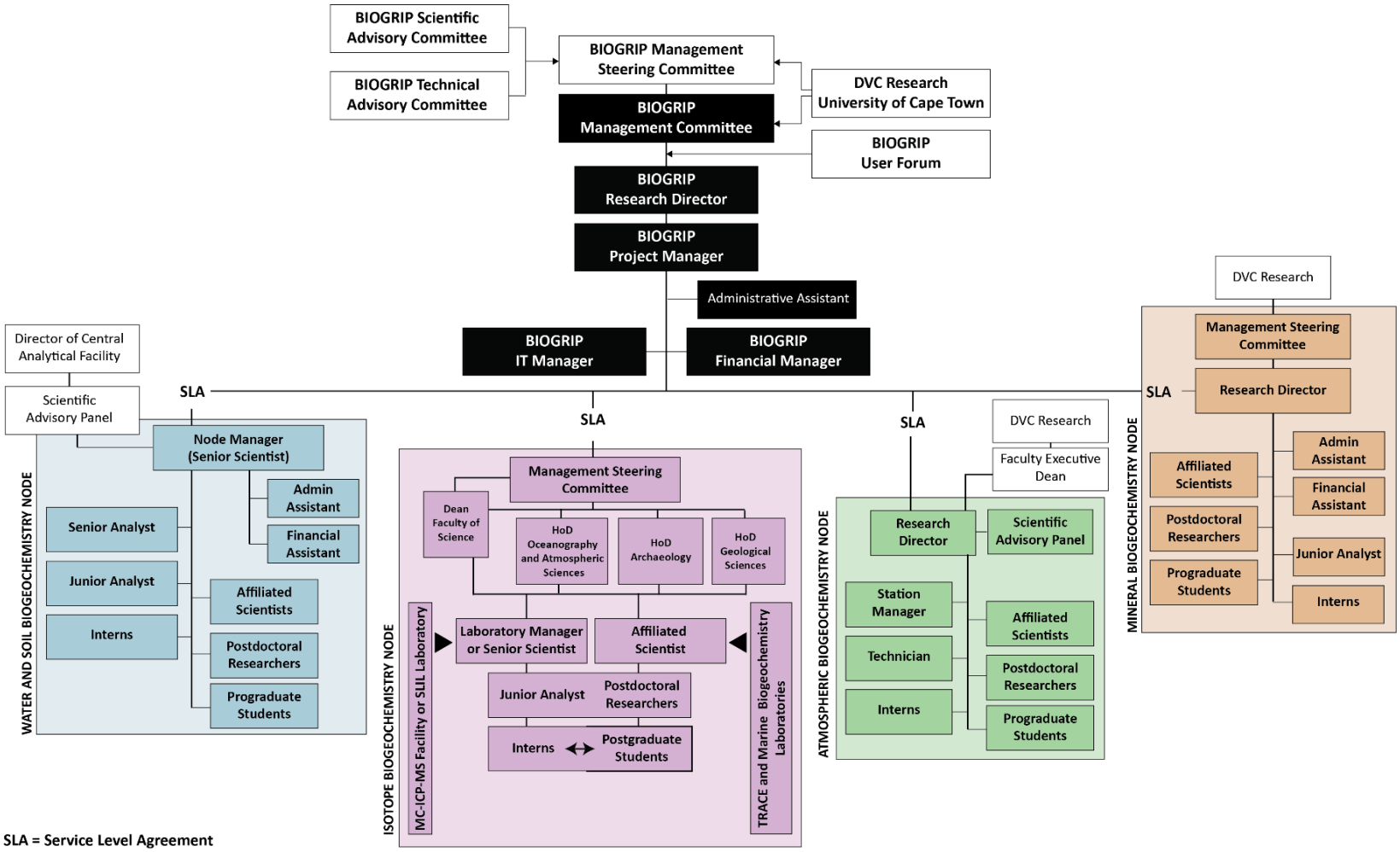
FINANCIAL PLAN AND BUDGET

BIOGRIP is requesting a capital budget of ~R 310 million and a running budget of ~R 500 million over the 15-year Life Cycle of the RI. In-kind contributions of capital equipment and infrastructure (~R 90 million) from the host HEIs further strengthen BIOGRIP. The proposed budget and financial plan is reliant on the National Government Capital and Baseline Funding Grant from the DST. The financial plan and proposed

budget for BIOGRIP is high but realistic for this type of investment in state-of-the-art analytical equipment. The only possible deviation from the budget could be that the income generated through the BIOGRIP nodes is higher than anticipated. In principle, the BIOGRIP project balance should approach break-even, but in-kind contributions show a positive cash flow.

BIOGRIP will require capital and baseline funding from the DST throughout its 15-year Life Cycle. Specialised equipment, equipment expansions and equipment replacements collectively represent 91% of the capital budget, with the remainder going almost wholly to building works to establish new laboratories, as well as to upgrade older laboratories for BIOGRIP. The additional investment to maintain the BIOGRIP facilities at state-of-the-art level until year 15, through equipment replacements, means that the RI will be able to operate for a further 5-10 years on a smaller baseline and capital grant. One of the biggest costs of BIOGRIP is staff salaries, which make up 70% of BIOGRIP's running costs. However, it will be these scientists and postdoctoral researchers that will yield the highest return on the equipment investment. In particular, investment in the technically-oriented postdoctoral researchers as part of this platform will facilitate the potential for methodological developments that can significantly raise the profile of South African research and development in biogeochemistry, drive transformation in the biogeochemistry sector and create economic opportunities to alleviate poverty and inequality.

Note: The Executive Summary above is drawn from the proposal for the BIOGRIP initiative, approved in 2019. We have subsequently been faced with the covid19 pandemic. While the Department of Science and Innovation remains committed to supporting the SARIR programme, some flexibility in roll-out will be required due to additional calls on government funding.



SLA = Service Level Agreement

Figure 1: Overall structure of BIOGRIP including management line functions. The four nodes are located at the Universities of Cape Town (focussing on isotope biogeochemistry), Stellenbosch (water and soil biogeochemistry), Free State (mineral biogeochemistry) and North-West University (atmospheric biogeochemistry). The administrative hub is at UCT.

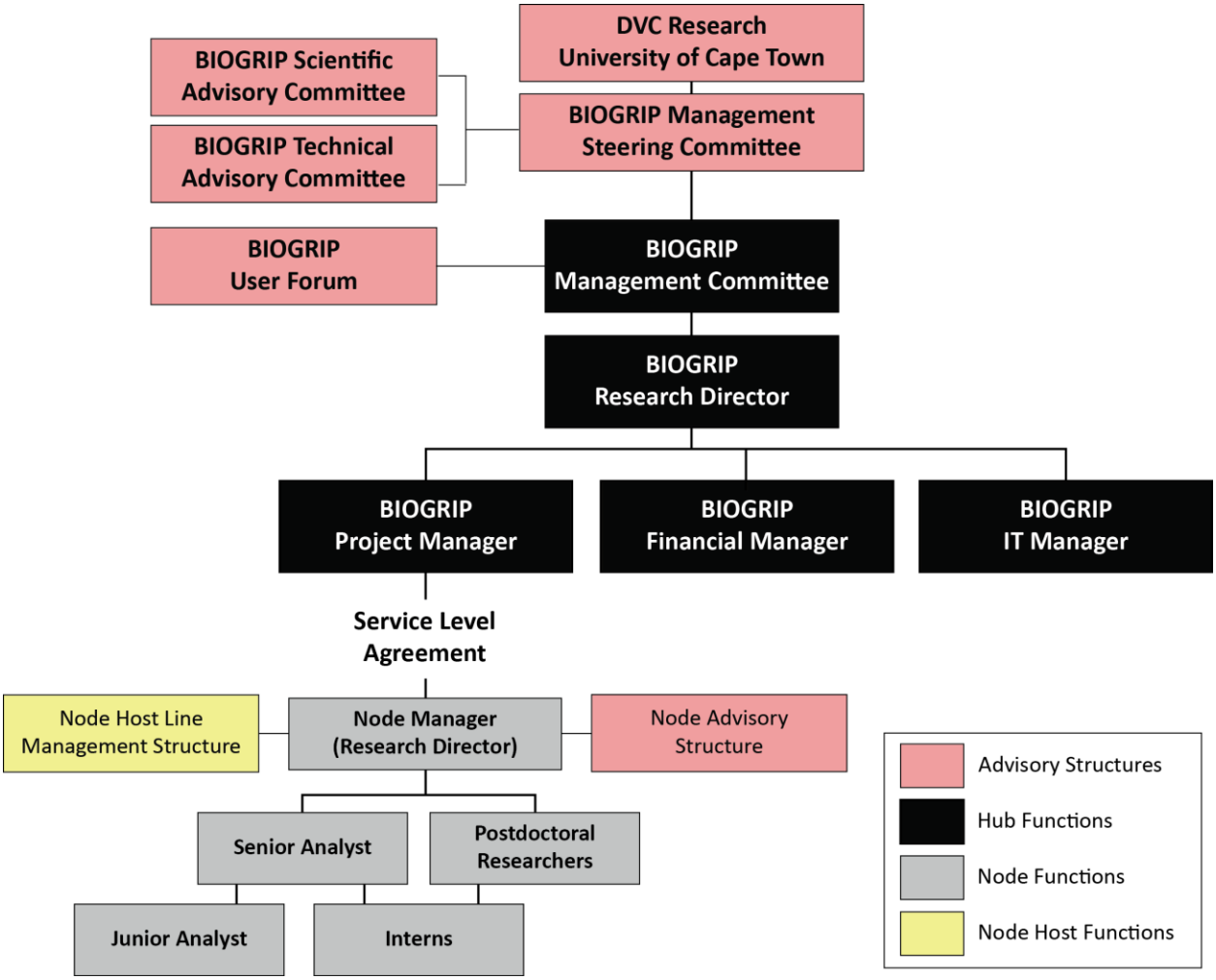


Figure 2: Management line functions for the hub and nodes