



ANNUAL REPORT 2022/2023

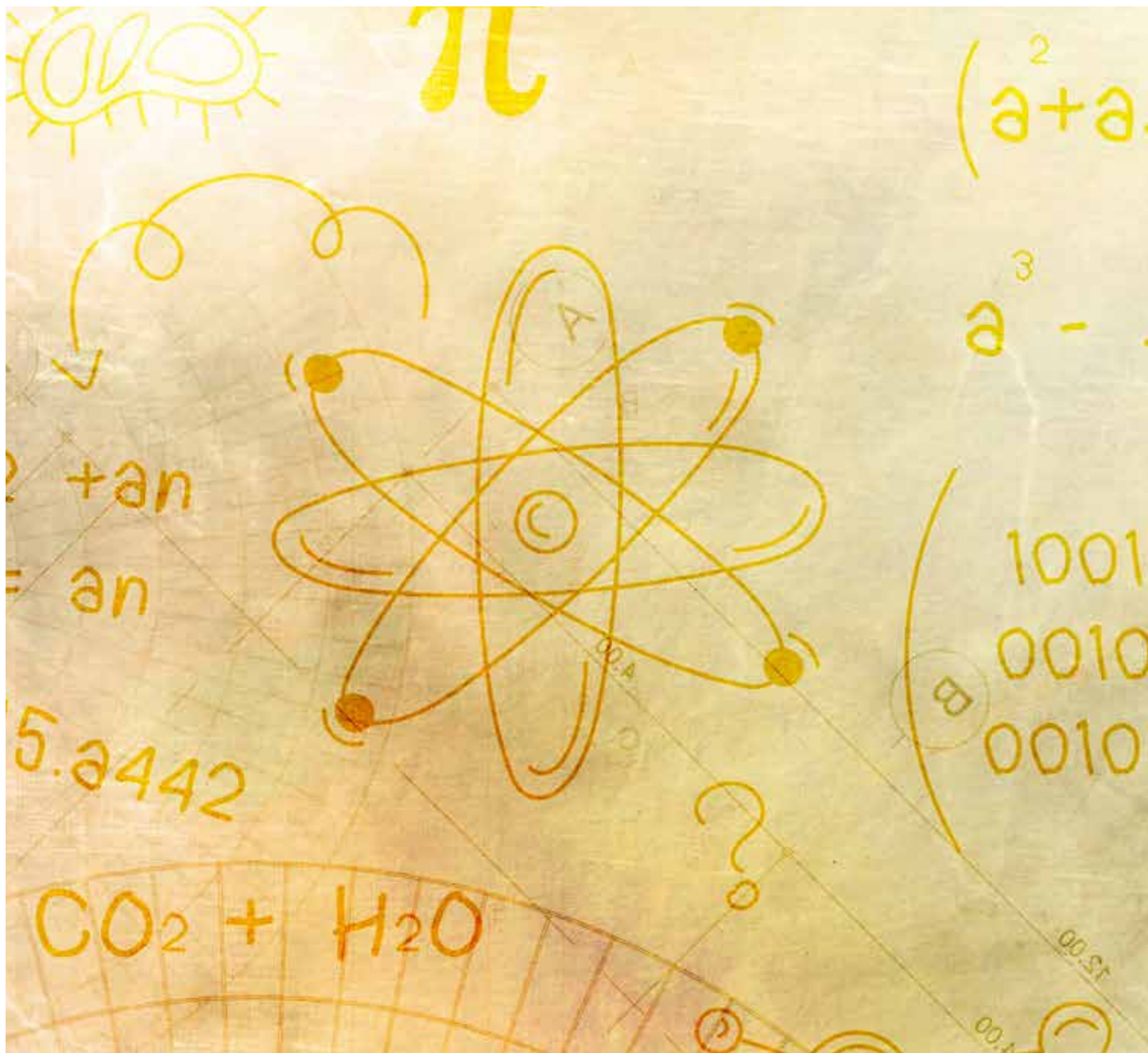


science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



CSIR
Touching lives through innovation

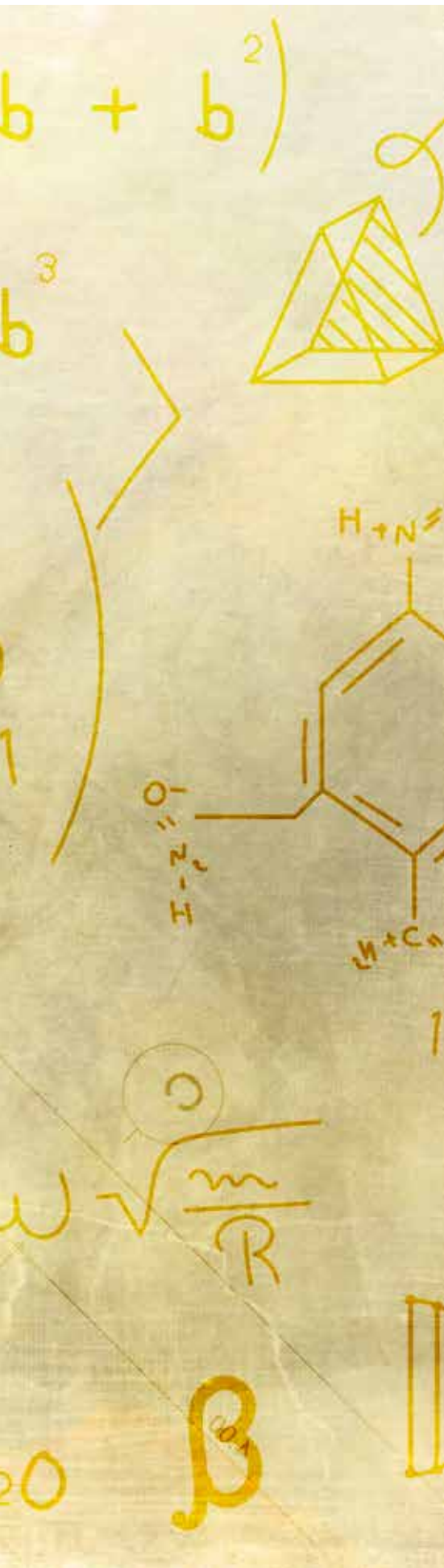


"The Council for Scientific and Industrial Research (CSIR) is a leading scientific and technology research organisation that researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa. The organisation's work contributes to industrial development and supports a capable state. The organisation plays a key role in supporting government's programmes through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competences."

(Scientific Research Council Act, 1988 (Act 46 of 1988), as amended by Act 27 of 2014)



Cover image: Moloko Mathipa-Mdakane, a postdoctoral research fellow at the CSIR.



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GENERAL INFORMATION

The CSIR is a leading scientific and technology research organisation that researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa. The organisation's work contributes to industrial development and supports a capable state. The organisation plays a key role in supporting government's programmes through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competencies.

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CSIR GENERAL INFORMATION

Registered name: Council for Scientific and Industrial Research

Physical address: Meiring Naude Road
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Pretoria

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South Africa

Telephone number: 012 841 2911

Email address: Enquiries@csir.co.za

Website address: www.csir.co.za

External auditors: Auditor-General of South Africa

Bankers: ABSA

LIST OF ABBREVIATIONS/ACRONYMS

AF	African Female
AGSA	Auditor-General of South Africa
AM	African Male
ARC	Audit and Risk Committee
ATC	Announcements, Tablings and Committee Reports
B-BBEE	Broad-based Black Economic Empowerment
BD&C	Business Development and Commercialisation
CBD	Cannabidiol
CEO	Chief Executive Officer
CF	Coloured Female
CM	Coloured Male
CSIR	Council for Scientific and Industrial Research
DSI	Department of Science and Innovation
ECD	Enterprise Creation for Development
EL	Environmental Laboratory
EPIC	Excellence, People-Centered, Integrity, Collaboration
ERRP	Economic Reconstruction and Recovery Plan
EVP	Employee Value Proposition
EXCO	Executive Committee
FF	Foreign Female
FM	Foreign Male
FPP	Fraud Prevention Plan
FY	Financial Year
GDRT	Gauteng Department of Roads and Transport
GIT	Graduates-in-Training
HC	Human Capital
HRSEC	Human Resources, Social and Ethics Committee
IF	Indian Female
IM	Indian Male
IBS	Inter-Bursary Support
ICT	Information and Communications Technology
IP	Intellectual Property

KPIs	Key Performance Indicators
LFs	Learning Factories
LMPD	Leadership and Management Development Programme
merSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
Mzesi	Mzansi Energy Solutions and Innovations (Pty) Ltd
NEAP	National Economically Active Population
NSA	National Skills Authority
NSI	National System of Innovation
PFMA	Public Finance Management Act
RDIC	Research, Development and Innovation Committee
R&D	Research and Development
RD&I	Research, Development and Innovation
RIR	Recordable Incident Rate
SABS	South African Bureau of Standards
SAIBA	Southern African Institute of Business Accountant
SANSA	South African National Space Agency
SET	Science, Engineering and Technology
SETAs	Sector Education and Training Authorities
SHEQ	Safety Health Environment and Quality
SMMEs	Small, Medium and Micro Enterprises
SO	Strategic Objective
STI	Science, Technology and Innovation
TVET	Technical Vocational Education and Training
UCT GSB	University of Cape Town Graduate School of Business
UK	United Kingdom
USA	United States of America
WF	White Female
WM	White Male
WIL	Work Integrated Learning
WRC	Water Research Centre
YES	Youth Employment Service



CHAIRPERSON'S OVERVIEW

Vuyani Jarana
CSIR Board Chairperson

The CSIR's mandate seeks to foster scientific and industrial development through directed multidisciplinary research and technological innovation to improve the quality of life of South Africans. The work that the organisation does is always underpinned by this mandate, as well as a renewed focus on contributing to industrial development, securing long-term growth and sustainability for the organisation, making impact and remaining relevant. Thus, as the Board, we have been working closely with executive management to provide informed and objective oversight over the organisation's delivery on its mandate.

On behalf of the Accounting Authority, I can, with confidence, say that the CSIR has performed admirably during this financial year. The organisation has achieved or exceeded more than 90% of its key performance indicators for the 2022/23 reporting year.

The CSIR's research programmes address national priorities and are aligned with various national strategies and frameworks, such as the National Development Plan, the Medium-Term Strategic Framework 2019-2024, and national policies, in addition to support industrial development.

The CSIR strategy also seeks to give meaning to the 2019 national policy on Science, Technology and Innovation. Considering the imperative of supporting the state, it is heartening to see that the number of projects that contributed to increasing the capability of the state increased by 51% compared to the previous financial year. The CSIR also responds and contributes to the implementation of our government's Economic Reconstruction and Recovery Plan (ERRP). The ERRP is the guiding policy framework in response to the impact of the Covid-19 pandemic on the South African economy.

While there is a strong drive to ensure that procurement by government departments, constitutional institutions and public entities guarantees value for money, as well as open and transparent competition and fairness, there are several instances in which direct contracting of the CSIR's strategic capabilities, albeit it serving the national interest, has not been without challenges.

The current Board was appointed by the Minister of Higher Education, Science and Innovation, Dr Bonginkosi 'Blade' Nzimande, in January 2023. With the new Board of Directors, we have had the opportunity to oversee quarter 4 of this financial year;

therefore, I would like to acknowledge the contributions of the previous Board of Directors, led by Professor Thokozani Majozi.

The CSIR's performance is commendable, given the current tough local and global economic climate. Despite this, the organisation has consistently improved its performance. I want to express my gratitude to CEO, Dr Thulani Dlamini, his executive team and CSIR staff for their dedication to improving the quality of life for South Africans.

I also want to acknowledge the continuous support and guidance that we receive from Minister Nzimande and his department, as well as the dedication of my fellow Board members to the organisation's success.

Vuyani Jarana

CSIR Board Chairperson

AMAZWI KASIBHLALO WEBHODI

Umgomo we-CSIR uhlose ukugqunguzela ukuthuthukiswa kwezesayensi nezimboni ngocwaningo oluqondiswe emikhakheni eminingi kanye nokusungula izinto zobuchwepheshe ukuze kuphuculwe izingampilo labantu baseNingizimu Afrika. Umsebenzi owenziwa yinhlangano uhlale usekelwe kulo mgomo, kanye nokugxila okusha ekubambeni iqhaza ekuthuthukisweni kwezimboni, ukuthola ukukhula kwesikhathi eside kanye nokusimama kwenhlangano, ukuba nomthelela nokuhlala sihamba phambili. Ngakho-ke, njengeBhodi, besisebenza ngokubambisana nobuholi obuphezulu ukuhlizeka ngokwengamela okunolwazi nokunenhloso mayelana nokuzeza kwenhlangano umsebenzi wayo.

Egameni lesiKhulu Esiphezulu, ngingasho ngokuzethemba ukuthi, i-CSIR isebenze ngendlela encomekayo kakhulu kulo nyakamali. Inhlangano isizuze noma ize yeqa ngaphezu kwama-90% ezinkombeni zayo zokusebenza ezisemqoka kunyakamali wokubika wezi-2022/23.

Izinhlelo zocwaningo ze-CSIR zibhekana nezinto eziseqhulwini kuzwelonke futhi zihambisana namasu nezinhlelo zikazwelonke ezihlukahlukene, njengoHlelo Lukazwelonke Lwentuthuko, uHlaka Lwesu Lokusebenza Lwesikhathi Esimaphakathi 2019-2024, kanye nezinqubomgomo zikazwelonke, ngaphezu kokweseka ukuthuthukiswa kwezimboni.

Isu le-CSIR liphinde lihlose ukunikeza incazelo yenqubomgomo kazwelonke kwezeSayensi, Ubuchwepheshe kanye Nokusungula yangowezi-2019. Uma kubhekwa ukubaluleka kokweseka umbuso, kuyajabulisa ukubona ukuthi inani lemiklamo ebe neqhaza ekwandiseni amandla kahulumeni lenyuke ngama-51% uma kuqhathaniswa nonyakamali odlule. I-CSIR iphinde isabele futhi ifake isandla ekuqalisweni kokusebenza koHlelo lukahulumeni Lokwakha Kabusha Umnotho Nokubuyisela (ERRP). I-ERRP iwuhlaka lwenqubomgomo oluyisiqondiso ekubhekaneni nomthelela wobhubhane lwe-Covid-19 emnothweni waseNingizimu Afrika.

Nakuba kunomkhankaso omkhulu wokuqinisekisa ukuthi ukuthengwa kwempahla okwenziwa yiminyango kahulumeni, izikhungo zomthethosisekelo kanye nezikhungo zikahulumeni kuqinisekisa ukusetshenziswa kwemali okunenzuzo, kanye nokuncintisana okuvulelekile nokungafihli lutho kanjalo nokungenzeleli, kunezimo eziningana lapho ukunikezwa kwezinkontileka okuqondile ngokwesu namakhono e-CSIR, kube futhi kufeza izidingo zesizwe, akusho ukuthi azibi khona izinselele.

Ibhodi ekhona njengamanje yaqokwa nguNgqongqoshe wezeMfundo ePhakeme, ezeSayensi kanye nokuSungula, uDkt Bonginkosi 'Blade' Nzimande, ngoJanuwari 2023. Sikanye neBhodi Labaqondisi elisha, sibe nethuba lokwengamela ikota yesi-4 yalo nyakamali, ngakho-ke ngithanda ukubonga iqhaza leBhodi Labaqondisi langaphambilini, ebeliholwa uSolwazi Thokozani Majazi.

Ukusebenza kwe-CSIR kuyancomeka ikakhulukazi uma sibuka isimo esibhekene naso njengamanje kwezomnotho wakuleli nasemhlabeni-jikelele. Phezu kwalokhu le nhlangano iye yaqhubeka nokubonisa intuthuko ekusebenzeni kwayo. Ngifuna ukudlulisa ukubonga kwami kuMphathi Omkhulu, uDkt Thulani Dlamini, ithimba lakhe labaphathi kanye nabasebenzi bakwa-CSIR ngokuzinikela kwabo ekwenzeni ngcono izingampilo labantu baseNingizimu Afrika.

Ngithanda futhi ukubonga ukwesekwa okuqhubekayo kanye neziqondiso esizithola kuNgqongqoshe Nzimande nomnyango wakhe, kanjalo namalungu eBhodi engisebenza nawo ngokuzinikela okuncomekayo empumelelweni yenhlangano.

Vuyani Jarana
USihlalo weBhodi

KAKARETŠO YA MODULASETULO WA BOTO

Taolelo ya CSIR e nyaka go godiša tlhabollo ya saense le intasteri ka dinyakišišo tša dikarolo tše dintši le kaonafatšo ya theknolotši tšeo di laolwago go kaonafatša boleng ya bophelo bja Mafrika Borwa. Mošomo woo mokgatlo o o dirago nako le nako o thekgwa ke taolelo ya wona, gammogo le nepišo ye e mpshafadišwego mo go kgatheng tema tlhabollong ya intasteri, go boloka kgolo ya nako ye telele le tshwarelelo ya mokgatlo, go dira khuetšo le go dula o le maleba. Ka gona, bjalo ka Boto, re dutše re šoma kgauswi le bolaodiphethiši go fa taolo ya tsebo le nepo go kabo ya mokgatlo go taolelo ya wona.

Legatong la Taolo ya Boikarabelo, nka bolela ka boitshepo, gore CSIR e šomile gabotse kudu ngwageng wo wa dišhelete. Mokgatlo o fihleletše goba o fitile kudu go feta 90% ya dipalopalo tša phethagatšo ya wona tša motheo mo ngwageng wa go bega wa 2022/23.

Mananeo a dinyakišišo a CSIR a bolela ka dilo tše bohlokwa tša setšhaba gape di sepelelana le mekgwa ya go fapana ya setšhaba le ditlhako, go swana le Leano la Tlhabollo la Setšhaba, Tlhako ya Peakanyo ya Kotara ya Gare ya 2019-2024, le dipholisi tša setšhaba, go tlaleletša go tlhabollo ya intasteri ya thekgo.

Mokgwa wa CSIR gape o nyaka go fa tlhalošo go pholisi ya setšhaba ya 2019 ka ga Saense, Theknolotši le Tlhabollo. Go lebeletšwe bohlokwa bja go thekga mmušo, go a hlohleletša go bona palo ya diprotšeke tšeo di kgathilego tema mo go godišeng bokgoni bja mmušo di gotše ka 51% ge go bapetšwa le ngwaga wa go feta wa dišhelete. CSIR gape e arabela le go kgatha tema go phethagatšo ya Leano la Tsošološo le Kagolefsa ya Ekonomi (ERRP). ERRP ke tlhako ya pholisi ya tlhahlo go arabela khuetšo ya leuba la Covid-19 go ekonomi ya Afrika Borwa.

Mola go na le maitapišo a maatla go kgonthiša gore theko ka dikgoro tša mmušo, diinstitušene tša molaotseo le makala a setšhaba di kgonthiša boleng bja tšhelete, gammogo le phadišano ya pepeneng le ya toka, go na le ditragalo tše mmalwa tšeo ditumelelano tša thwii tša mabokgoni a peakanyo a CSIR, le ge e le gore a aba dikgahlego tša setšhaba, ga se a ba bonolo, ka ge a bile le ditlhohlo.

Boto ya gonabjale e thwetšwe ke Tona ya Thuto ya Godimo, Saense le Tlhabollo, Ngaka Bonginkosi 'Blade' Nzimande, ka Pherekong 2023. Ka Boto ya Balaodibagolo ye mpsha, re bile le sebaka sa go laola kotara ya bone ya ngwaga wo wa dišhelete, ka gona ke rata go leboga go kgatha tema ga Boto ya Balaodibagolo, yeo e bego e etilwe pele ke Profesa Thokozani Majosi.

Mošomo wa CSIR o a retega go lebeletšwe klaemete ya ekonomi ya gonabjale ya boima ya gae le ya lefase. Ntle le se mokgatlo nako le nako o kaonafadiše go šoma ga wona. Ke rata go leboga CEO, Ngaka Thulani Dlamini, sehlopha sa gagwe sa taolo le bašomi ba CSIR ka boikgafo bja bona mo go kaonafatšeng boleng bja bophelo bja Mafrika Borwa.

Ke rata gape go lemoga thekgo ye e tšwelago pele le tlhahlo tšeo re di amogelago go tšwa go Tona Nzimande le kgoro ya gagwe, gammogo le boikgafo bja maloko a Boto ya gešo ka katlego ya mokgatlo.

Vuyani Jarana

Modulasetulo wa Boto



MESSAGE FROM THE CHIEF EXECUTIVE OFFICER

Dr Thulani Dlamini
CSIR Chief Executive Officer (CEO)

The CSIR Annual Report serves two purposes. Firstly, it is customary and secondly it is legislated. It accounts for the organisation's use of its resources, from financial and human to infrastructure, and the prudent governance of the myriad building blocks that contribute to achieving its mandate.

The organisation's 2022/23 overall performance improved compared to the previous financial year. We have exceeded several of our KPI targets and achieved 28 out of 31 KPI targets for 2022/23. To mention a few highlights, we realised an achievement of:

- 137% in the number of joint technology agreements being implemented for industry;
- 161% in the number of small, medium and micro enterprises (SMMEs) supported;
- 145% in the number of new localised technologies;
- 156% in the number of standards delivered or contributed to support the state; and
- 289% in the number of projects implemented to increase the capability of the state.

This performance demonstrates the CSIR's commitment to supporting re-industrialisation in the country through technological support, as well as the deployment of capabilities in support of service delivery.

"We have exceeded several of our KPI targets and achieved 28 out of 31 KPI targets for 2022/23."

With regard to human capital, it is worth noting that the size and demographic profile of the SET base remained unchanged during the financial year. There has been a marked increase in the percentage of chief researchers who are black, as well as those who are female; the proportion of principal researchers who are black and female has increased by 14% and 7%, respectively; the number of exchange programmes with industry has increased by 35%, in line with our intention to work more closely with industry; and property, plant and equipment investment has also increased by 55% compared to the previous financial year.

The issue of unemployed youth has been highlighted as one of the country's key challenges. In response and as part of our commitment to the inclusive advancement of society through youth empowerment, we partnered

with the Youth Employment Service (YES) programme in 2020. The YES initiative prepares young people for employment by providing them with technical skills and relevant work experience. During the reporting year, 66 youths (61% female and 47% people with disabilities) were appointed and started on the YES programme on 1 March 2023. In addition, the CSIR is working with SETAs to support skills development and digital transition.

This performance happened against the backdrop of a constrained economy. In the last three years, there has been nominal baseline Parliamentary Grant growth to sustain and grow our strategic capabilities. With high inflation on input costs and above-inflation increases on utilities, the CSIR is under pressure to grow contract R&D income to remain financially sustainable. By aligning our offerings with market needs, we address funding constraints by increasing private sector and international income. However, income from the public sector remains key as services and technology solutions to public institutions enable the fulfilment of the CSIR mandate and our strategic objectives.

Financially, the CSIR is in a stronger position compared to the same period in the previous year. The organisation made a net profit of R142.3 million, before short-term incentives. This is R147.7 million better than the budgeted loss and R5.34 million higher than the previous financial year. Private sector income grew by 14%, although it fell below our target of 12% of total revenue. International income increased by 21%.

The CSIR performed exceptionally well regarding good governance during 2022/23. The organisation achieved a commendable safety milestone, with a full year without a reportable lost time accident and a recordable incident rate of 0. This achievement aligns

with our focus on zero harm, which is at the forefront of all our programmes and initiatives. Furthermore, the organisation has maintained a B-BBEE rating of 1, the best among public sector entities, and maintained an unqualified audit opinion from the Auditor-General.

Income diversification remains a key objective for the organisation to reduce the financial risk associated with significant reliance on a single sector and improve the CSIR's operational profitability. Commercialisation and technology transfer will be intensified to achieve impact, in line with our strategic intent, but also to grow our royalty and licensing income.

For the reporting year, the CSIR had two Boards of Directors. I would like to acknowledge and thank the previous Board, whose term ended on 31 December 2022, for their support and guidance. I would also like to welcome the new Board of Directors, who oversaw the remaining quarter of this financial year, for their oversight. I look forward to a strong and productive relationship in our effort to touch lives through innovation.

All our achievements and highlights in the past financial year would not have been possible without a competent and committed leadership and the hard working and resilient CSIR employees who continue to live and embody our EPIC values of excellence, being people-centred, integrity and collaboration. I thank you for your contribution and commitment to our pursuit of touching lives through innovation.

Dr Thulani Dlamini
CSIR CEO

UMLAYEZO OVELA KUMPHATHI OMKHULU

Umbiko Wonyaka we-CSIR ufeza izinhloso ezimbili. Okokuqala, njengoba kuwumkhuba nomthetho, ubhekelela ukusetshenziswa kwenhlangano nezinsiza zayo, kusukela kwezezimali kanye nabasebenzi kuya kungqalasizinda, kanye nokuphatha ngobuhlakani inqwaba yamabhulokhi okwakha anomthelela ekufezeni umsebenzi wenhlangano.

Ukusebenza kwenhlangano kukonke onyakeni we-2022/23 kube ngcono uma kuqhathaniswa nonyaka wezimali odlule. Seqe izinjongo zethu ezimbalwa ze-KPI futhi sazuzo izinjongo ezingama-28 kwezingama-31 ze-KPI ngoyaka we-2022/23. Ukusho amaphuzu avelele ambalwa, sithole impumelelo kilokhu:

- I-137% enanini lezivumelwano zobuchwepheshe ezisetshenziswayo ezimbonini;
- I-161% enanini lamabhizinisi amancane, aphakathi nendawo nasafufusayo asekelwayo;
- I-145% enanini lobuchwepheshe obusha bendawo;
- I-156% enanini lamazinga alethiweyo noma anikelelwe ukweseka umbuso; futhi
- I-289% enanini lamaphrojekthi aqalisiwe ukukhulisa amandla kahulumeni.

Lokhu kusebenza okukhulu kukhombisa ukuzibophezela kwe-CSIR ekwesekeni ukubuyiswa kwezimbongi ezweni ngokwesekwa kwezobuchwepheshe, kanye nokusatshalaliswa kwamakhono ukuze kusekelwe ukuhlizelwa kwezidingongqangi.

Maqondana nenani labantu, kubalulekile ukuqaphela ukuthi ubukhulu kanye nephrofayili yezibalo zabantu besisekelo se-SET kuhlale kungashintshile phakathi nonyaka wezimali. Kube nokukhula okuphawulekayo kwephesenti labacwaningi abakhulu abamnyama, kanye nalabo abangabesifazane; ingxenye yabacwaningi abakhulu abamnyama nabesifazane ikhule ngo-14% no-7%, ngokulandelana; inani lezinhlalo zokushintshisana nezimbongi likhule ngama-35%, ngokuhambisana nenjongo yethu yokusebenzisana ikakhulukazi nezimbongi; kanye nokutshalwa kwezimali kwezakhiwo, amafekthri nemishini nakho kwenyuke ngama-55% uma kuqhathaniswa nonyaka wezimali odlule.

Udaba lwentsha engasebenzi lugqanyiswe njengenye yezinselelo ezibalulekile zezwe. Ekuphenduleni

futhi njengengxenye yokuzibophezela kwethu ekuthuthukisweni komphakathi okubandakanya wonke umuntu ngokufukula intsha, sibambisene nohlelo lwe-YES ngonyaka ka-2020. Uhlelo lwe-YES lulungiselela abantu abasha ukuqashwa ngokubanikeza amakhono obuchwepheshe nolwazi olufanele lomsebenzi. Kulo nyaka wokubika, intsha engama-66 (abesifazane abangu-61% kanye nabangu-47% abantu abakhubazekile) baqokwa futhi baqala ohlelweni lwe-YES mhla zingu-1 kuNdasa 2023. Ngaphezu kwalokho, i-CSIR isebenzisana nama-SETA ukusekela ukuthuthukiswa kwamakhono kanye noguquko lwedijithali.

Lokhu kusebenza kwenzeka ngaphansi kwesizinda somnotho esinezingqinamba. Eminyakeni emithathu odlule, kube nokukhula okuyisisekelo kweSibonelelo Sephalamende ukuze sisimamise futhi sikhulise amakhono ethu. Ngenxa yokwehla kwamandla emali ezindlekweni zokufakwayo kanye nokwenyuka ngaphezu kokwenyuka kwamandla emali ezinsizeni, i-CSIR ingaphansi kwengcindezi yokukhulisa imali engenayo yenkontileka ye-R&D ukuze ihlale izinzile ngokwezimali. Ngokuvumelanisa iminikelo yethu nezidingo zemakethe, sibhekana nezingqinamba zokuthola imali ngokwandisa imboni ezimele kanye nemali engenayo yamazwe ngamazwe. Kodwa-ke, imali engenayo evela embonini kahulumeni isalokhu ibalulekile njengoba izinsizakalo nezixazululo zobuchwepheshe ezikhungweni zikahulumeni zisiza ukufezeka kwengunya le-CSIR kanye nezinjongo zethu.

Ngokwezimali, i-CSIR isesimweni esinamandla uma iqhathaniswa nesikhathi esifanayo ngonyaka odlule. Le nhlangano yenze inzuzo elinganiselwa ku-R142.3 million, ngaphambi kokuthi kube nemihlomulo yesikhashana. Lena yimali engu-R147.7 million engcono kunokulahlekelwa obekuhleliwe kanye no-R5.34 million ngaphezu konyaka wezimali odlule. Imali engenayo yemboni ezimele ikhule ngo-14%, nakuba yehle ngaphansi komgomo wethu ka-12% wesamba semali engenayo. Imali engenayo yamazwe ngamazwe inyuke ngo-21%.

Inhlangano izuze ingqopho-mlando yokuphepha encomekayo, ngonyaka ogcwele ngaphandle kwengozi yesikhathi esilahlekile kanye nezinga elirekhodekayo lesigameko elingu-0. Le mpumelelo ihambisana nokugxila kwethu ekungalimalini,

okuhamba phambili kuzo zonke izinhlelo zethu nemizamo yethu. Ngaphezu kwalokho, le nhlangano igcine isilinganiselo soku-1 sokuThuthukiswa Okunabile Kwabamnyama Kwezomnotho, esingcono kakhulu ezinkampanini zikahulumeni, futhi yagcina nombono wocwaningimabhuku ongenagcobho ovela kuMcwangingi Mabhuku-jikelele.

Ukwehlukahlukana kwemali engenayo kusalokhu kuyinhloso ebalulekile yenhlango ukunciphisa ubungozi bezezimali obuhambisana nokuthembela okubalulekile emkhakheni owodwa kanye nokwenza ngcono inzuzo yokusebenza kwe-CSIR. Ukuhweba nokudluliswa kobuchwepheshe kuzoqiniswa ukuze kuzuzwe umthelela, ngokuhambisana nenhloso yethu yamasu, kodwa futhi nokukhulisa imali yethu ezuzisayo neyokuthola amalayisensi.

Ngonyaka wokubika, i-CSIR ibe namaBhodi amabili waBaqondisi. Ngithanda ukubonga lBhodi yangaphambili, isikhathi sayo esiphele zingama-31 kuZibandlela wezi-2022, ngokungeseka nokuqondiswa kwalo. Ngithanda futhi ukwamukela iBhodi labaqondisi elisha, elengamele ikota esele yalo nyaka wezimali, ukuze yengamele nayo. Ngibheke ngabomvu ubudlelwano obuqinile nobukhiqizayo emzamweni wethu wokuthinta izimpilo zabantu ngokusungula izinto ezintsha.

Konke esikuzuzile nokugqamile onyakeni wezimali odlule bekungeke kwenzeke ngaphandle kobuholi obunekhono nobuzibophezele kanye nabasebenzi be-CSIR abasebenza ngokuzikhandla nabaqinile abaqhubeka nokuphila futhi bahlanganise amagugu ethu e-EPIC okusebenza kahle, ukugxila kubantu, ubuqotho nokusebenzisana. Ngiyabonga ngeqhaza lakho nokuzibophezela ekuphishekeleni kwethu ukuthinta izimpilo zabantu ngokusungula izinto ezintsha.

UDkt Thulani Dlamini
Isikhulu Esiphezulu se-CSIR

MOLAETŠA GO TŠWA GO CEO

Pego ya Ngwaga le Ngwaga ya CSIR e na le dinepo tše pedi. Ya mathomo, ka ge e le setlwaedi gape e le molao, e hlaloša tšhomišo ya methopo ya mokgatlo, go tloga go dišhelete le batho go ya go infrastraktšha, le taolo ya bohlae ya dikarolo tša go fapana tšeo di dirago phihlelelo ya taolelo ya yona.

Phethagatšo ka kakaretšo ya 2022/23 ya mokgatlo e kaonafetše ge go bapetšwa le ngwaga wa dišhelete wa go feta. Re fetišitše dilebanywa tša KPI tša rena tše mmalwa gomme ra fihlelela 28 godimo ga dilebanywa tša KPI tše 31 tša 2022/23. Go bolela dikarolo tše bohlokwa tše mmalwa, re lemogile phihlelelo ya:

- 137% mo palong ya ditumelelo tša theknolotši tšeo di kopanego di phethagatšwa go intasteri;
- 161% mo palong ya dikgwebo tše dinnyane, tša magareng le dikgwebopotlana e a thekgwa;
- 145% mo palong ya ditheknolotši tša gae tše difsa;
- 156% mo palong ya mekgwa ye e abilwego goba e dirilwego go thekga mmušo; le
- 289% mo palong ya diprotšeke tše di phethagaditšwego go oketša bokgoni bja mmušo.

Phethagatšo ye e bontšha boikgafo bja CSIR mo go thekgeng go mpshafatša intasteri mo nageng ka thekgo ya theknolotši, gammogo le peakanyo ya mabokgoni go thekga kabo ya ditirelo.

Malebana le mabokgoni a batho, go swanetše go lemogwa gore bogolo le profaele ya temokrafi ya motheo wa SET ga se ya fetoga nakong ya ngwaga wa dišhelete. Go bile le koketšego ya go bonagala ka phesente ya banyakišišibagolo bao e lego bathobaso, gammogo le bao e lego basadi; karolo ya banyakišišibagolo bao e lego bathobaso gammogo le bao e lego basadi e oketšegile ka 14% le 7%, ka tsela yeo; palo ya mananeo a go šomišana le intasteri e oketšegile ka 35%, go sepelelana le maikemišetšo a rena a go šoma kudu le intasteri; le thoto, peeletšo ya dimela le didirišwa le yona e oketšegile ka 55% ge go bapetšwa le ngwaga wa dišhelete wa go feta.

Taba ya bafsa bao ba hlokago mošomo e tšweleditšwe bjalo ka ye nngwe ya dihlhlo tša motheo. Go arabela gape bjalo ka karolo ya boikgafo bja rena go kaonafatšo ya kakaretšo ya setšhaba ka matlafatšo ya bafsa, re dirišane le lenaneo la YES ka 2020.

Lenaneo la YES le beakanyetša bafsa mešomo ka go ba fa mabokgoni a go dira mošomo le maitemogelo a maleba a mošomo. Ngwageng wa pegu, bafsa ba 66 (61% ya basadi le 47% ya batho bao ba phelago ka bogolofadi) ba thwetšwe gomme ba thoma ka lenaneo la YES ka la 1 Hlakola 2023. Go tlaletša, CSIR e šoma le SETA go thekga tšhabollo ya mabokgoni le phetogo ya tišitale.

Phethagatšo ye e direga kgahlanong le mabaka a ekonomi ye e gwahlafetšego. Mo mengwageng ye meraro ya go feta, go bile le kgolo ya Thušo ya Dišhelete ya Palamente ya palo ya motheo go swarelela le go godiša mabokgoni a peakanyo. Ka infleišene ya godimo go ditheko tše di tsentswego le infleišene ya godimo e oketšega go didirišwa, CSIR e ka fase ga kgatelelo go godiša letseno la kontraka ya R&D go dula e swareletše ka dišhelete. Ka go beakanya dikabo tša rena le dinyakwa tša mmaraka, re šogana le mathata a thekgo ya dišhelete ka go oketša lekala la praebete le letseno la boditšhabatšhaba. Le ge go le bjalo, letseno go tšwa go lekala la setšhaba le dula e le la motheo ge ditirelo le diharollo tša theknolotši go diinstitušene tša setšhaba di kgontšha phethagatšo ya taolelo ya CSIR le dinepo tša peakanyo.

Ka dišhelete, CSIR e maemong a maatla ge go bapetšwa le nako ya go swana mo ngwageng wa go feta. Mokgatlo o dirile poelo ye botse ya R142.3 milione ya godimo go feta ngwaga wa dišhelete wa go feta. Se ke R147.7 bokaone go feta tahlegelo ye e lekanyeditšwego le R5.34 milione go feta ngwaga wa go feta wa dišhelete. Letseno la lekala la praebete le gotše ka 14%, le ge e le gore le ka fase ga selebanywa sa rena sa 12% sa palomoka ya letseno. Letseno la boditšhabatšhaba le oketšegile ka 21%.

CSIR e šomile gabotse kudu go lebeletšwe taolo ye botse nakong ya 2022/23. Mokgatlo o fihleletše leswao la polokego la go retega, ka ngwaga wa go tšala ntle le kotsi ya go lahlegelwa ke nako ye e begilwego le tekanyo ya tiragalo ya go begwa ya 0. Phihlelelo ye e sepelelana le nepo ya rena ya go se be le kgobalo., yeo e lego pele ga mananeo le dipeakanyo tša rena ka moka. Gape, mokgatlo o swere Matlafatšo ya Ekonomi ya Bathobaso ya Kakaretšo ya tekanyo ya 1, ye kaone go feta ka moka

mo mekgatlong ya makala a mmušo, gomme ya swara tlhakišo ye botse go tšwa go Motlhakišimogolo.

Phapanišo ya letseno e dula e le nepo ya motheo ya mokgatlo go fokotša kotsi ya dišhelete ye e amanago le thekgo ye bohlokwa go lekala le tee le go kaonafatša katlego ya phethagatšo ya CSIR. Go tšweletša setšweletšwa se sefsa kgwebong le phetišetšo ya theknolotši go tla matlafatšwa go fihlelela khuetšo, go ya le ka peakanyo ye e lebeletšwego, eupša gape le go godiša letseno la ditefo le dilaesense tša rena.

Mo ngwageng wa pego, CSIR e na le Baloadibagolo ba Boto ba babedi. Ke rata go amogela le go leboga Boto ya maloba, yeo nako ya yona e fedilego ka la 31 Mantshole 2022, ka thekgo ya bona le tlhahlo. Ke rata gape go amogela Baloadibagolo ba Boto ba bafsa, bao ba laotšego kotara ye e šetšego ya ngwaga wo wa dišhelete, ka taolo ya bona. Ke lebeletše kamano ye maatla gape ya dipoelo mo maitapišong a rena a go kgwatha maphelo ka kaonafatšo.

Diphihlelelo ka moka le dikarolo tše bohlokwa mo ngwageng wa dišhelete wa go feta nkabe di se a kgonagala ntle le boetapele bjo bo ikgafilego bja bokgoni le bašomi ba go šoma ka maatla le mafolofolo ba CSIR bao ba tšwelago pele go phela le go emela maitshwaro a rena a bokgoni, a go hlokomela batho, a go tshepagala le a tirišano. Ke le leboga ka seabe sa lena le boikgafo go phegelelo ya rena ya go kgwatha maphelo ka kaonafatšo.

Ngaka Thulani Dlamini
Mohlankedimogolophethiši

Statement of responsibility for and confirmation of accuracy of the annual report

To the best of our knowledge and belief, we confirm the following:

All information and amounts disclosed in the annual report are consistent with the annual financial statements audited by the Auditor-General.

The annual report is complete, accurate and free of any omissions.

The annual report has been prepared in accordance with the guidelines on the annual report as issued by National Treasury.

The annual financial statements (Part F) have been prepared in accordance with the International Financial Reporting Standards applicable to the CSIR.

The accounting authority is responsible for the preparation of the annual financial statements and the judgements made in this information.

The accounting authority is responsible for establishing and implementing a system of internal control that has been designed to provide reasonable assurance as to the integrity and reliability of the performance information, the human resources information and the annual financial statements.

The external auditors are engaged to express an independent opinion on the annual financial statements.

In our opinion, the annual report fairly reflects the operations, performance information, human resources information and financial affairs of the CSIR for the financial year ended 31 March 2023.

Yours faithfully



Chief Executive Officer

Dr Thulani Dlamini

25 August 2023



Chairperson of the Board

Vuyani Jarana

25 August 2023

Strategic overview

CSIR VISION

We are accelerators of socioeconomic prosperity in South Africa through leading innovation.

CSIR MISSION

Collaboratively innovating and localising technologies, while providing knowledge solutions for the inclusive and sustainable advancement of industry and society.

CSIR strategic intent

GROWTH

The CSIR contributes to the inclusive growth of the country's economy. The CSIR will use its capabilities in, e.g., skilled human capital and infrastructure to assist in growing the economy, but will also grow to become a world-class organisation.

SUSTAINABILITY

CSIR-developed technologies will lead to the advancement and sustainability of South Africa's enterprises. Consequently, this will lead to the financial sustainability of the organisation in the resource-constrained environment.

IMPACT

Focuses on the commercialisation of our technologies and innovations for industrial development, as well as technology and knowledge transfer that enable a capable state.

RELEVANCE

Addresses the CSIR's role in driving the relevance of innovation in inclusive sustainable industrial development and the creation of a capable state.

CSIR values



We strive for excellence and quality in everything that we do. We always strive to deliver solutions that surpass the expectations of our stakeholders. We hold each other to the highest possible standard in RD&I, as well as all other facets of CSIR business. We believe that excellence is a product of investing in the continuous development of our people, processes and ways of doing business.



Our business is about touching the lives of people — our employees and business partners. We care about people. We respect each other's diversity and conduct ourselves in a manner that upholds the dignity of every person. We believe in continuous personal development and encourage one another to seize opportunities for personal growth. We treat our stakeholders the way we like to be treated.



We act with integrity. We are honest and fair when dealing with one another and our business partners. We respect the trust that our colleagues and stakeholders place in us, and commit to ethical decision-making, delivery and governance.



We are keen to learn from one another, and collaborate across the organisation and with external partners to ensure that our work has the best chance of innovating a better future for South Africans. We actively share our knowledge and expertise by design, formally and informally, so that we can realise large-scale impact.

Organisational structure



science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



Vuyani Jarana

Chairperson of the Board



Dr Thulani Dlamini

CEO



Dr Kaven Naidoo

Group Executive:
Business Excellence
and Integration

Andile Mabindisa

Group Executive:
Human Capital and
Communication

Esteé Opperman

Acting Chief
Financial Officer

Adv. Esmé Kennedy

Group Executive:
Legal, Compliance
and Business
Enablement

Dr Rachel Chikwamba

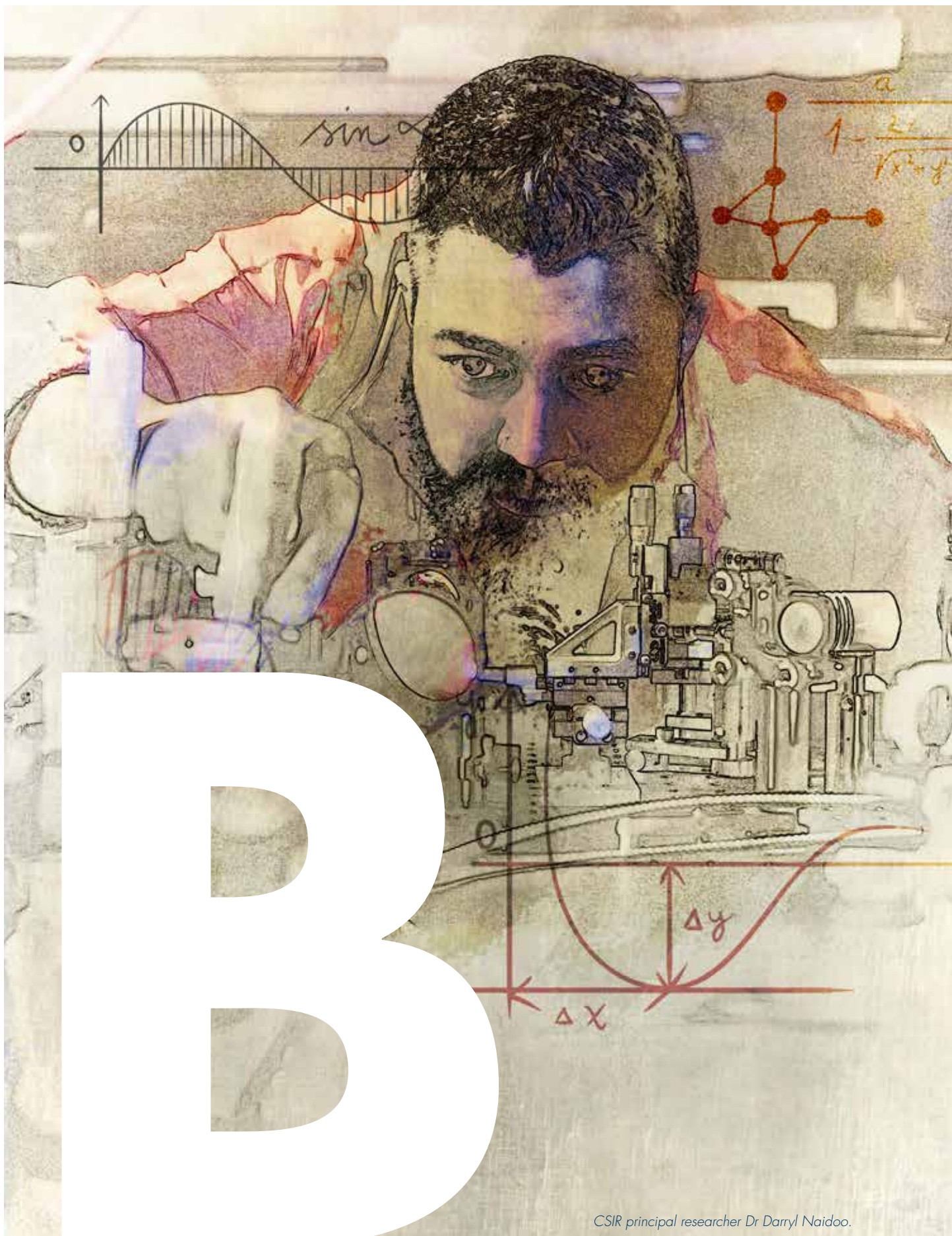
Group Executive:
CSIR Advanced
Chemistry and Life
Sciences

Dr Sandile Malinga

Group Executive:
CSIR Smart Society

Dr Motodi Maserumule

Group Executive:
CSIR Advanced
Production and
Security



CSIR principal researcher Dr Darryl Naidoo.

ORGANISATIONAL HIGHLIGHTS

The CSIR's strategic objectives are well defined and guide the organisation's research, development and innovation investments and activities. This section highlights a small sample of the organisation's work against these objectives.

Conduct research, development and innovation of transformative technologies and accelerate their diffusion	22
Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology	29
Drive socioeconomic transformation through research, development and innovation that supports the development of a capable state	41
Build and transform human capital and infrastructure	49
Global relevance: Partnering internationally	54

NEW TECHNOLOGIES FOR SEA RESCUE AND AQUACULTURE

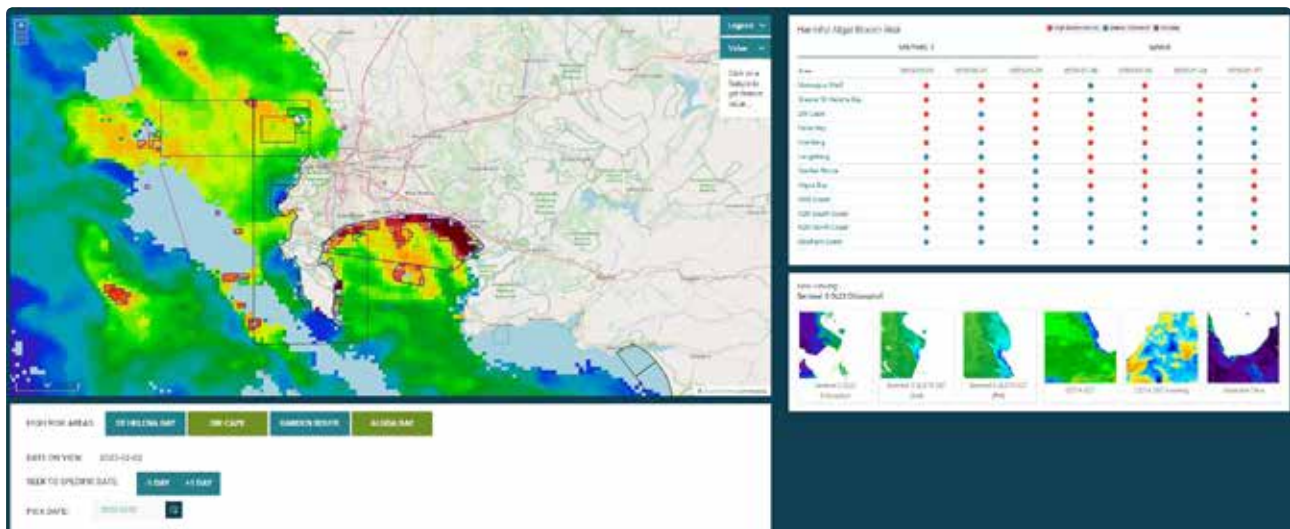
Earth observation researchers have developed technologies that support socioeconomic activities around the southern African coasts. A new sea rescue tool and an aquaculture tool use Earth observation and other data, algorithms and models to create technologies that transform decision-making and operations along the southern African coast.

The sea rescue tool, developed in collaboration with the National Sea Rescue Institute and the South African Weather Service, uses predefined calculations, as well as location data and weather-specific parameters to calculate the search area during a search and rescue operation. The tool completes this calculation up to 25 minutes faster than traditional means. Keeping in mind that multiple search area calculations are done during a single search and rescue operation, this can make the difference between life and death.

The aquaculture support tool focuses on monitoring harmful algal bloom along the South African west coast. These red tide events not only cause red lobster walkouts but can have a grave impact on the operations of aquaculture farms when these often toxic waters are

pumped through their systems. Using the European Space Agency's Copernicus satellite constellation and Sentinel-derived products (that include sea surface temperature and chlorophyll A indicators), harmful algal bloom risks are identified and monitored to adequately manage farm operations to limit impact during such events.

The tools were developed and implemented as part of the National Oceans and Coastal Information Management System, as well as the African Union grant-funded Global Monitoring for the Environment and Security for Africa project, Marine and Coastal Operations for Southern Africa and the Indian Ocean project.



Above: Harmful algal bloom (red) detected using the CSIR-developed tool. Below: A sea rescue undertaken by the National Sea Rescue Institute and (right) a crayfish walkout caused by a red tide event.



MULTIDECADAL STUDY ON IRON-STRESSED PHYTOPLANKTON IN THE SOUTHERN OCEAN PUBLISHED IN SCIENCE



CSIR senior researcher Dr Thomas Ryan-Keogh (left) and CSIR research group leader for the Southern Ocean Carbon-Climate Observatory Dr Sandy Thomalla on the S. A. Agulhas II research ship with a Slocum glider. Ryan-Keogh and Thomalla are co-lead authors of a paper published in *Science* indicating an increase in iron stress in the phytoplankton of the Southern Ocean.

Research undertaken by a climate science group at the CSIR has revealed an increase in iron stress in the phytoplankton of the Southern Ocean over a period of 26 years.

The study published in the highly rated journal *Science* raises concerns that the increase in iron stress may lead to a decline in the productivity of these microscopic marine plants, which would have a negative impact on the future of Earth's climate and ecosystem energy supplies.

As part of the study, the researchers developed a new method that looks at the physiological response of phytoplankton to iron availability to determine whether it is limiting. They applied the method retrospectively to data collected from the Southern Ocean by research ships and underwater robotic platforms between 1996 and 2022.

The Southern Ocean absorbs a significant proportion of the human-made carbon dioxide emitted through the burning of fossil fuels, as well as the excess heat generated by the greenhouse effect. The research findings, which point to a disruption of the natural carbon cycle at a significant scale, generated discussion among oceanographers and climate scientists around the world.

The research paper was one of 12 peer-reviewed publications produced by the Southern Ocean Carbon-Climate Observatory in 2022/23.

BIODEGRADABLE MULCH FILMS TESTED FOR SUB-SAHARAN AGRICULTURE

The CSIR is contributing to the move from conventional plastics to environmentally sustainable alternatives through the development of fully biodegradable mulch films.



CSIR principal researcher Dr Sudhakar Muniyasamy inspects a sample biodegradable mulch film produced at the CSIR.

The development of new biodegradable mulch films for the agricultural sector has been undertaken in collaboration with Elizade University in Nigeria, under the United Kingdom-based Sustainable Manufacturing and Environmental Pollution Programme.

Mulch films are an essential part of many forms of crop farming. Using these plastic films, farmers are able to enhance their crop yield through weed control, water retention, decreased use of pesticides and prevention of soil erosion. Biodegradable mulch films are an environmentally sustainable alternative to conventional mulch films, with notable benefits such as biodegradability to carbon dioxide, water and biomass – ultimately enriching the soil post crop life.

The CSIR research team has developed three types of biodegradable mulch films for short-term crops with a life span of one to three months, medium-term crops with a life span of up to nine months and long-term crops that last more than a year. The team is undertaking industrial manufacturing trials and will commence field testing of the films on natural soil in sub-Saharan countries to determine the films' efficiency.

RECOVERING USEFUL FIBRES FROM USED POTATO BAGS

The CSIR has developed a technology to recover fibres from used potato bags to manufacture paper-based packaging materials such as fluting, a corrugated medium used in paper packaging materials.

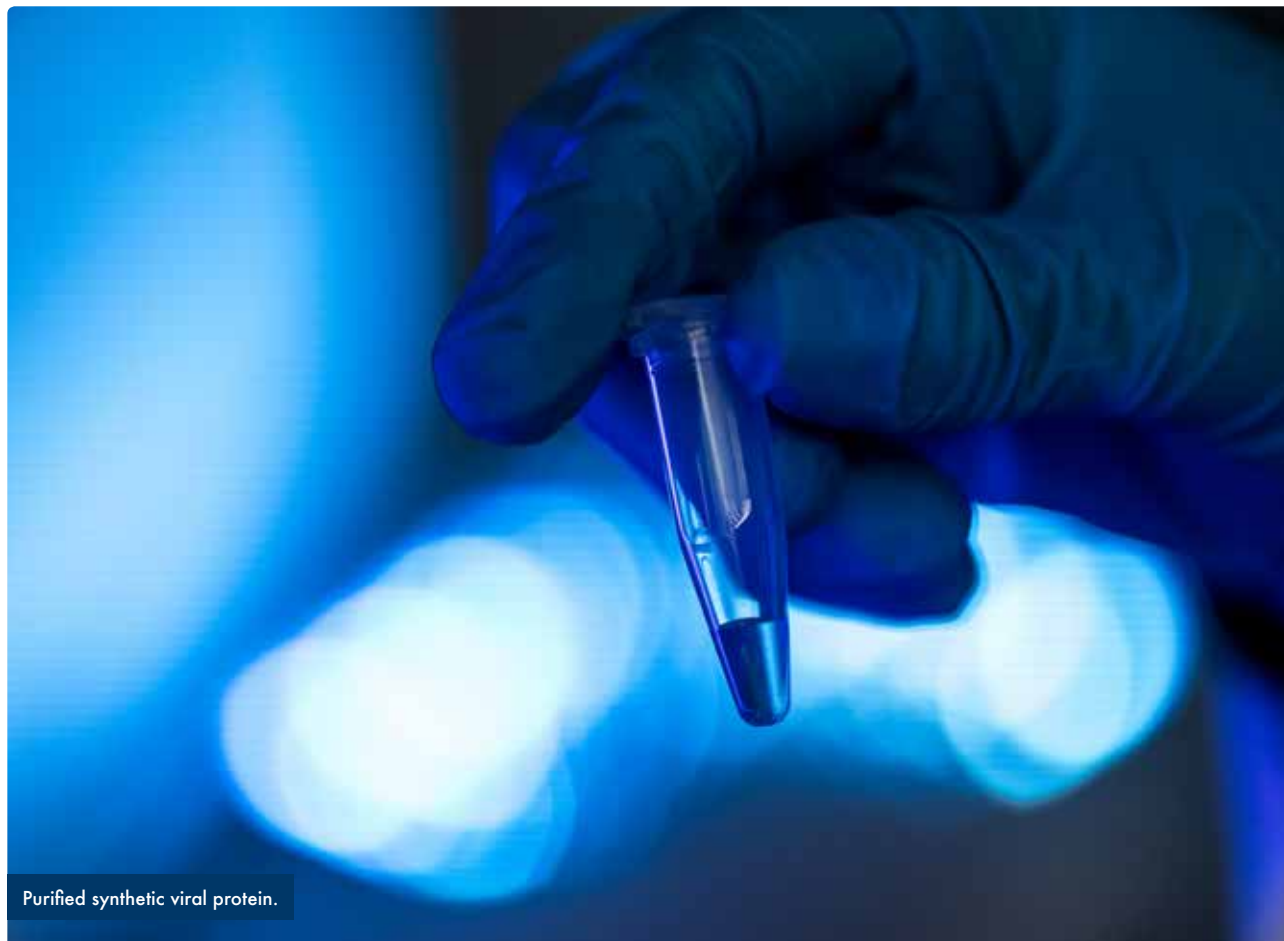


CSIR chemical engineering technologist Londani Mbambo oversees potato bag pulping. As part of this work, the CSIR has designed a fibre recovery pilot plant for paper-based waste streams.

The use of wastepaper offers economic and environmental benefits and is a cornerstone for a circular economy. Fibres procured from wastepaper are less expensive compared to virgin fibres, and the use of waste fibres downsizes the requirements of the upstream processes in the pulp production process value chain, resulting in significant reduction in chemicals, energy and water usage.

The Paper Manufacturers Association of South Africa (PAMSA) and the Department of Science and Innovation co-funded the project, aiming to generate reliable research and design data to assist PAMSA in designing and implementing a series of commercial-scale plants in South Africa, with a potential benefit for small, medium and micro enterprises.

CSIR RESEARCHERS DEVELOP NEXT-GENERATION HORSE SICKNESS VACCINE



CSIR researchers have developed a next-generation African horse sickness vaccine that holds great promise for the veterinary vaccine industry in South Africa and internationally.

African horse sickness is caused by an arbovirus infection, characterised by respiratory distress and/or cardiovascular failure, and is lethal to horses. Mandatory annual vaccination in endemic areas curtails disease occurrence and severity; however, the development of a next-generation safe and efficacious vaccine for the disease has been an objective globally for years.

The CSIR has developed virus-like particles and soluble viral protein 2 against African horse sickness serotype 5 in modified tobacco plants. The researchers have demonstrated protective efficacy of both the plant-produced monovalent virus-like particle and viral protein 2 vaccine candidates in preclinical studies, leading to a new provisional patent application and publication.



REAL-TIME UAV SYNTHETIC APERTURE RADAR SENSOR DEMONSTRATED ABOARD A LIGHT-WING AIRCRAFT



The CSIR has developed and demonstrated specialised synthetic aperture radar (SAR) sensors that can acquire images in real time onboard airborne platforms such as light-wing aircrafts and unmanned aerial vehicles (UAVs).

The technology is designed to be scalable in performance, customisable, easy to integrate in different platforms and low-cost.

As part of the research and development, the CSIR has developed a processor that can produce high-resolution SAR images, as well as detect, track and geo-locate moving targets in a scene in real time. The latter is accomplished using a multichannel ground-moving target indicator technique.

CSIR radar experts conducted a measurement flight with the real-time technology demonstrator of one of the UAV SAR sensors, called C-Owl, installed on a light-wing aircraft, and successfully demonstrated the real-time SAR and ground-moving target indicator processing capability. It was the first time that a locally produced radar did joint SAR imaging and ground-moving target indication in real time. The real-time processor is also integrated with a situational awareness display, which allows real-time visualisation of the SAR imagery and geo-located plots of detected target tracks.

On the spaceborne front, the CSIR is developing satellite SAR payload technology, with the goal of creating a lower cost SAR constellation for Earth observation of the African continent and its maritime assets. This is done in partnership with the local space industry.

The Department of Science and Innovation supports the CSIR in its ongoing research, development and innovation into SAR applications. SAR can be used in many industries, such as defence, security, mining, disaster management and agriculture. It can be used to detect very subtle changes that are difficult to detect with other sensors, and it can do it in all weather conditions, as well as during the day and night. As an example, SAR can be used to detect millimetre-level movements in the Earth's surface over time, which makes it valuable for disaster management as it can be used to detect subsidence early on.

ACCELERATED PAVEMENT TESTING OF NEW ROAD MATERIALS AND TECHNOLOGIES



CSIR researcher Michandre Smit uses the CSIR-developed heavy vehicle simulator to test unconventional roadmaking materials and techniques.

The CSIR has conducted the first test of a new geogrid design intended to strengthen and stabilise material used in road construction. The test was done for an international client, using the CSIR-developed heavy vehicle simulator (HVS).

The HVS completed the test at the new South African National Roads Agency test track located at the University of Pretoria's Engineering 4.0 facility. Road researchers are preparing to also start testing conventional road construction materials modified with plastics, ash and organo-silane emulsions. Recent HVS testing has shown that new road-building technologies, involving the use of organo-silanes, can save up to 50% in construction costs, while increasing road pavement life by up to 90%.

Organo-silanes, which can be created by blending the chemistry of silicon with the chemistry of carbon,

improve marginal materials on a nanoscale by improving distribution, coverage and stabilisation characteristics, which helps to obtain the required design strength criteria and assists with waterproofing. Thus, organo-silanes have the potential to improve the long-term performance of roads and reduce the cost of road construction and maintenance.

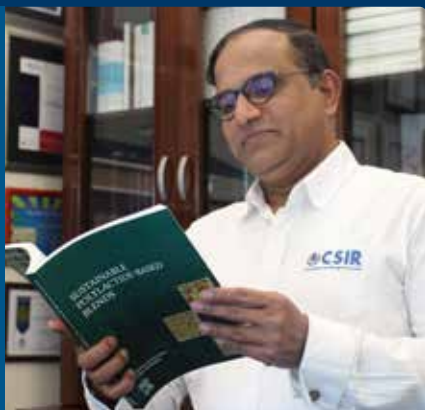
The HVS has had a major impact on the design, construction and maintenance of roads locally and abroad for many years and continues to serve as a key technology for accelerated pavement testing.

NEW BOOK ON DEEP-LEVEL GOLD AND PLATINUM MINING



CSIR principal researcher **Dr Michael van Schoor** with a copy of the *Deep-level Gold and Platinum Mining* handbook. Van Schoor led a team of CSIR mining experts in publishing the guidebook, which focuses on geophysical methods targeted at decision-makers who are not trained in geophysics within the mining industry. Through this book, the research team aimed to educate and equip South African mining professionals with a better understanding of the various geophysical methods of addressing common deep-level gold and platinum mining problems.

BOOK ON SUSTAINABLE POLYLACTIDE-BASED BLENDS FOR SUSTAINABLE FUTURE DEVELOPMENT



CSIR chief researcher **Prof. Suprakas Sinha Ray** has co-authored a book with Ritima Banerjee from the Calcutta Institute of Technology, titled *Sustainable Polylactide-Based Blends*. The book provides a critical overview of the latest developments in polylactide-based blends, addressing the latest advances, innovative processing techniques and fundamental issues that persist in the field. These kinds of biopolymers hold potential as an alternative for conventional plastics, as they are more environmentally friendly, and are not petroleum-based. This type of material will address end-of-life issues of after-use plastic product-based wastes and makes the current production and use of polylactide-based products in society sustainable.

BOOK CAPTURES APPROACHES TO BUILDING SMART COMMUNITIES



CSIR chief researcher **Dr Jackie Phahlamohlaka** edited a book titled *Approaches to building a smart community: An exploration through the concept of the digital village*. The book was commissioned by the Siyabuswa Educational Improvement and Development Trust (SEIDET) and brought South African researchers together to develop a handbook that provides practical approaches to building smart communities for underdeveloped and information-deprived communities in developing countries. The 12 contributors are from the CSIR, University of Pretoria, Nelson Mandela University, Moses Kotane Local Municipality, SEIDET and LEMEG Architects. The book was launched in September 2022.

CSIR CANNABIS HUB CRITICAL IN SUPPORTING THE CANNABIS AND NATURAL PRODUCTS INDUSTRY



The CSIR has set up a cannabis research hub for small, medium and micro enterprises (SMMEs) in the cannabis sector to de-risk early phase research, development and commercialisation.

Supported by government departments such as the Department of Science and Innovation, Department of Small Business Development and the Gauteng Department of Agriculture, Rural Development and Environment, the CSIR is already assisting 23 SMMEs and industry players to develop and market high-quality, regulatory-compliant, safe and efficacious products that can compete in local, regional and international markets.

The cannabis-based products under development include herbal remedies, cosmetics, nutraceuticals and food. Through such interventions, the CSIR is helping with skills transfer, as well as the quality, safety and efficacy of products – thereby providing strategic support to the cannabis industry in the region.

Services offered at the hub include cannabis extraction, using supercritical carbon dioxide extraction, as well as process and method development for various cannabis strains. The extraction method is environmentally benign

and considered the gold standard for cannabis/hemp oil extraction. Purification services include winterisation and decarboxylation steps for the removal of lipids and conversion of phytocannabinoids into active molecular forms to increase oil quality and value.

In respect of training, services include access to a facility for integrated learning for current and prospective workers in the cannabis and natural products industry in South Africa and the sub-region. The focus is on chemistry, engineering and pharmaceutical training via internships and workplace training for students and entrepreneurs.

Product and process development services centre on taking an idea from proof of concept, through development and optimisation, to pilot-scale manufacturing of products such as cannabis-based herbal remedies, food, nutraceutical and cosmetic products.

CAPE ALOE PROJECT ADVANCES AGROPROCESSING AND COMMERCIALISATION IN THE EASTERN CAPE



Aloe ferox-based cosmetic products formulated and produced with assistance from the CSIR are, from left, a hair spray, body lotion, hand wash and hair food.

The CSIR handed over market-ready samples and product information files for six cosmetic products, based on Aloe ferox (Cape Aloe), to three enterprises in the Eastern Cape.

The laboratory-scale cosmetic product prototypes include a face wash, body lotion, hand cream, hand wash, hair food and hair spray. CSIR biotechnologists validated the processing of the Aloe ferox material and tested the ingredient quality to ensure regulatory compliance. This means that the plant material can be processed and produced at commercial scale close to source.

In addition to the training of communities and the development of small, medium and micro enterprises in the area, the CSIR also developed high-quality stabilised Aloe ferox gels for the cosmetic industry.

Nozulu Aloe Cooperative, Karibu Construction and General, as well as Ziyanda Enterprise benefitted from

the opportunity to produce a stable gel and associated cosmetic products, which have undergone industry evaluation, passed quality tests and now adhere to regulatory standards.

The research and development work and subsequent technology transfer advance agro-processing technologies and the commercialisation of cosmetics made with natural ingredients, such as Aloe ferox, to the benefit of local enterprise development.

The project was funded by the Department of Science and Innovation, through the Technology Innovation Agency, under the Agriculture Bioeconomy Innovation Partnership Programme.

ASSISTING AN SMME TO OPTIMISE TECHNOLOGY TO PRODUCE SOUGHT-AFTER INSECTICIDAL COMPOUND



Noot-a-bug was produced by the CSIR from citrus oil. It was developed for APBIO as an insect repellent. Fanie Marais, the company's Chief Executive Officer, says the market sample exceeded agreed specifications.

The CSIR drew on its skills in biocatalysis to help a protein engineering biotech small, medium and micro enterprise, Applied Protein Biotechnologies (APBIO), to optimise a technology using citrus oil to produce a new product, called Noot-a-bug.

An enzyme system is used to bioconvert compounds in the citrus oil into other more useful compounds with insect repellent activities.

A second product, called nootkatone, was also developed for APBIO. This product is normally obtained commercially through the extraction of approximately 400 000 grapefruit to obtain 1 kg of nootkatone. Nootkatone is a sought-after natural organic compound in the flavours and fragrance sector and is also an insecticidal compound that repels and kills insects. The CSIR technology uses a much cheaper compound found in orange oil, which is then bioconverted with an enzyme system to nootkatone at significant yields.

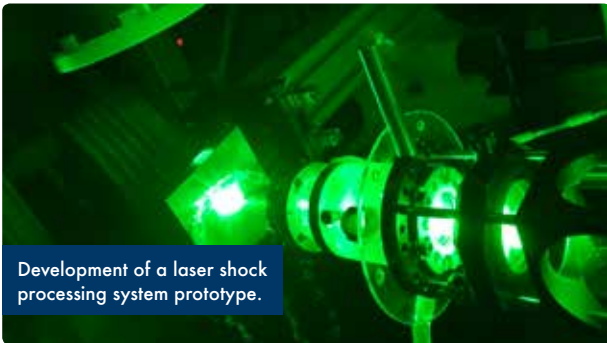
The collaboration between the CSIR and APBIO resulted from the Industrial Biocatalysis Hub's mission to develop

and localise technologies using biocatalysis. The hub is funded by the Technology Innovation Agency and the Department of Science and Innovation.

Since the inception of the work with APBIO, the CSIR has succeeded in optimising a technology that had been developed on a small scale. This process includes optimisation of parameters that are critical for increased bioconversion of precursor molecules in citrus oil to more valuable compounds with insect repellent activities. The scale-up of the technology resulted in the production of a market sample that exceeded agreed specifications, which led to APBIO signing a licence agreement with the CSIR. A complete dossier of the technology has been transferred to APBIO to enable the company to commercialise the technology and produce the two products of interest.

CSIR AND ESKOM COLLABORATE TO IMPROVE DURABILITY OF COMPONENTS USED IN POWER GENERATION

The CSIR and Eskom are collaborating to jointly develop laser shock processes for the local power-generation sector.



Development of a laser shock processing system prototype.

In a first outcome of the partnership, engineers at the two organisations developed a prototype laser shock processing platform. Using this platform, they applied laser shock process technology to the attachment region of a turbine blade, known as a fir-tree root. Low-pressure steam turbine blades are approximately 1 m long, and rotate at approximately 3 000 revolutions per minute in a wet steam environment at around

42°C. The highly stressed blade attachment region can become susceptible to failure mechanisms such as fatigue and stress corrosion cracking. Conventionally, beneficial compressive residual stresses are introduced by mechanical shot peening. Laser shock peening has emerged as an attractive technology for cases where shock peening may be inadequate.

The lifetime of the metal components can be extended and the resilience to failure improved through laser shock peening. Extending the lifetime of components means that costly components require less frequent replacement. The process is superior when compared to the current mechanical shot peening process.

The breakthroughs in laser shock processes enable significant advancements in critical turbine infrastructure operations, ultimately leading to improved energy generation and reduced operational costs.

CONDITION MONITORING FOR LOCOMOTIVES ON TRACK

The CSIR and Transnet Engineering have been working together since 2015 to develop a condition monitoring system to track the performance and health of locomotives. In March 2023, the research team delivered 30 production units to Transnet Freight Rail.



A locomotive condition monitoring system.

As part of the collaboration, the CSIR provided Transnet Engineering with data packs, equipping the state-owned company to manufacture its own locomotive condition monitoring units. The data accumulated

by the locomotive monitoring systems help to predict when the locomotive and its equipment will require maintenance and to identify any potential issues before they become critical. Transnet intends to become an original equipment manufacturer of the products used in the locomotive condition monitoring system, and lead innovation in the railway industry.

The collaboration is guided by a memorandum of agreement between the CSIR and Transnet. Under this agreement, future upgrades to the system are planned, ensuring that the technology remains cutting-edge and adaptable to evolving industry needs. The partnership extends its focus beyond the current systems to the joint development of other groundbreaking systems.

STRENGTHENING LOCAL AEROSPACE AND MANUFACTURING INDUSTRIES THROUGH TECHNOLOGY DEVELOPMENT AND ACCREDITATION SUPPORT



A Trewfit Controls employee assembles a valve position indicator.

A number of local companies in the aerospace, defence, marine and sector-wide manufacturing industries benefitted from support from the Aerospace Industry Support Initiative (AISI). The AISI is an initiative of the Department of Trade, Industry and Competition, hosted and managed by the CSIR.

The AISI assisted a local valve and automation specialist to attain certification for equipment used in explosive atmospheres. The small, medium and micro enterprise (SMME), TrewFit Controls, specialises in designing and manufacturing valve automation products and hydraulic components. These products are used to monitor and control valves in marine, mining and manufacturing environments.

IECEX, ATEX and SANAS certifications facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required safety standards. IECEX is the International Electrotechnical Commission for Certification to Standards Relating to Equipment for Use in Explosive Atmosphere; ATEX is the European Regulatory Framework for Manufacture, Installation and Use of Equipment in Explosive Atmospheres; and SANAS is the South African National Accreditation System. The certifications achieved enabled the company to expand into national and international markets, including Europe, thereby creating more jobs.

The AISI also assisted Centurion-based SMME Petrawell to improve its technology readiness and

manufacturing processes to develop composite winding filament vessels. Filament winding is a technique that is primarily used to manufacture hollow, circular or prismatic parts such as pipes and tanks. As part of the project, Petrawell designed, manufactured and tested composite filament winding high-pressure – as well as cryogenic (very low temperature) – vessels for the storage and transportation needs of the aerospace and hydrogen market. The project helped the local company enter into partnerships with other industry players and enhance its capabilities and offerings.

Working with CSIR robotics experts, the AISI supported a woman-owned SMME that custom designs and manufactures automotive floor mats for commercial vehicles. Pretoria-based Premier Mats and Accessories is working towards a digital and fully integrated production process with reduced waste and high levels of quality. The intervention included the generation of computer-aided design models for all product templates in a format that can be used by the computer numerical control machine to cut mat profiles. The SMME supplies its products to major motor truck companies such as UD SA Trucks and Daimler Chrysler (Mercedes-Benz SA), as well as Motus, Barloworld, McCarthy and Lereko Motors.

DEVICE FOR BETTER ROCK HAZARD IDENTIFICATION IN MINES NAMED RUNNER-UP IN INTERNATIONAL COMPETITION

A CSIR-patented device that helps mineworkers identify rock hazards or looming fall-of-ground incidents was named the runner-up in an international competition for rock hazard identification, the International Rock Hazard Identification and Safe Removal Innovation Challenge.

The conventional method of mining in hard-rock mines, such as gold and platinum mines, follows a drill, blast and clean process. After blasting, skilled human re-entry inspectors assess the stope in underground mines for loose rock. Fall-of-ground incidents pose a significant risk, resulting in fatalities and a negative economic impact.

The CSIR-developed thermal acoustic device was developed by a team of rock engineers, human factor specialists, internet of things experts and artificial intelligence engineers. It provides a more reliable identification of loose rock in underground mines, reducing reliance on human sensory abilities such as hearing and vision, which often deteriorate in field conditions.

Based on the results of field trials, areas of improvement and enhancement have been identified and are being implemented in preparation for commercial uptake by local and international mining industries.



DIGITAL TWIN TECHNOLOGY FOR TRACKLESS MOBILE MACHINERY PILOTED AT AN OPEN-CAST MINE

The CSIR has developed a near real-time digital risk prediction tool to help prevent collisions of trackless mobile machinery in the mining industry.



The tool has been developed with industry inputs to reduce and ultimately eliminate vehicle accidents, which have been the second largest contributor to fatalities in the South African mining industry for over a decade. The tool uses fourth industrial revolution technologies such as big data analysis, artificial intelligence, machine learning and digital twin

technology to evaluate the risk associated with vehicle interaction. The tool provides data-driven insights into driver behaviour and existing control measures to enable the continuous improvement of trackless mobile machinery safety and productivity to predict possible scenarios for optimised mining operations.

The CSIR made significant progress during a pilot study of the technology at a South African open-cast mine. The study contributed to safety improvements through optimised mining traffic management plans and operational efficiencies by generating insights into vehicle performance data.

The organisation is collaborating with the mining industry to determine a commercialisation approach for the successful uptake of the tool in the mining industry.

PROVIDING MINING TRAINEES WITH NEAR-REAL EMERGENCY EXPERIENCES USING VIRTUAL REALITY TECHNOLOGY

The CSIR has developed a competency-based training framework that incorporates the use of advanced technologies, such as virtual reality, to improve the safety of mineworkers through training on hazardous mining operational incidents.



The training framework uses virtual reality to provide mining trainees with immersive and experiential training for adequately responding to emergency situations such as underground fires and explosions. The use of virtual reality increases workers' ability to retain and recall information. Personal responses in a simulated high-consequence scenario are evaluated to assess whether workers react appropriately when faced with a real emergency. This approach increases workers' ability to retain and recall information and execute the correct emergency response procedures swiftly and accurately.

Traditional learning methods, such as classroom-based learning, typically involve the trainees listening to a lecture

and reading training content, followed by an assessment as a means of evaluating competency. Research has shown that these methods result in poor retention and recollection of the knowledge. This necessitated the team to investigate more effective methods to assist with the retention and recall of information by mineworkers when faced with an emergency, in support of industry's zero-harm mining initiative.

The CSIR has completed the development of the e-learning and virtual reality modules. The newly developed tool puts the worker in near-real emergency situations, such as underground fires and explosions. Personal responses are evaluated to assess each trainee's competence, informing further training steps for a time-optimised training approach. The competency-based approach is especially well-suited to training for high-consequence, low-frequency scenarios.

The approach is set to contribute to the safety of South Africa's mineworkers as it improves their understanding of hazardous underground incidents and prepares them to respond in such a scenario.

ELECTRONIC MINE SAFETY LOGBOOK TECHNOLOGY FOR MINES

A tablet-based electronic mine safety logbook is being trialled at two South African gold mines in Gauteng. The CSIR developed the high-level functional and interface requirements.

Compliance with mine safety legislation and operational standards is an imperative in the South African mining industry. The Mine Health and Safety Act, 1996 (Act 29 of 1996) governs the safety standards at mines and the Department of Mineral Resources oversees compliance with the law by means of regular inspections at mine operational sites.

The recording of legally required safety data is currently captured manually in a paper-based logbook. These logbooks are used by shift supervisors to capture data, as they are responsible for the legal

compliance of the daily, weekly and monthly recorded safety data. Limitations of this method include incorrect recording and loss of data. The new software allows shift supervisors to complete the safety logbook more accurately and in accordance with safety legislation requirements.

The technology has been developed under a South African Mining Extraction Research, Development and Innovation-hosted programme in collaboration with the Mandela Mining Precinct, mine safety managers and original equipment manufacturer technology suppliers.

COLLECTING WAVE DATA FOR WAVE BREACH FORECASTING SYSTEM FOR NAMIBIAN COASTAL MINING

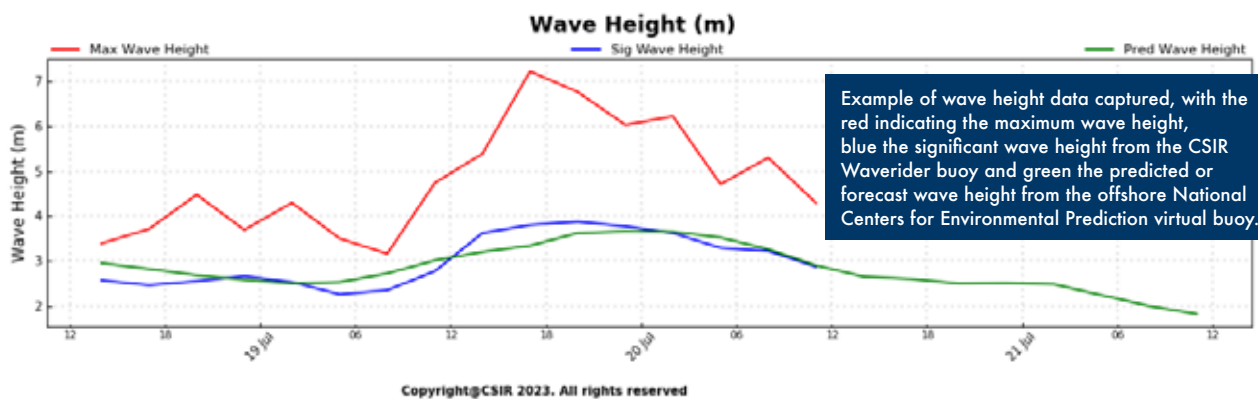
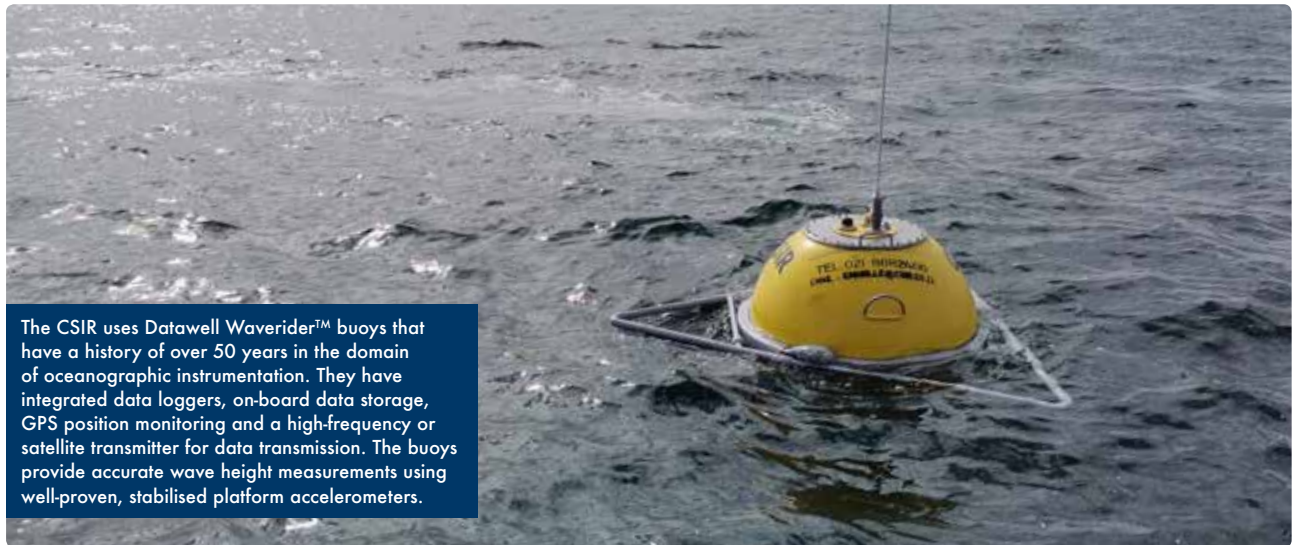
The CSIR, in collaboration with WSP Africa (Pty) Ltd, is providing wave data for the development of an early warning system for possible breaches to the seawall caused by high ocean waves in support of coastal mining operations in southern Namibia.

Mining activities extend into the coastal area where artificial seawalls or sand berms have been created to protect operations from the sea. However, these berms have been breached in the past, leading to equipment damage and production disruptions.

Researchers and engineers are using wave data to develop a solution that can alert the mine of potential breaches to the sand berms. By providing advance notice of rough sea conditions approaching the seawall, the mines can take proactive measures to strengthen their defenses using earth-moving machinery.

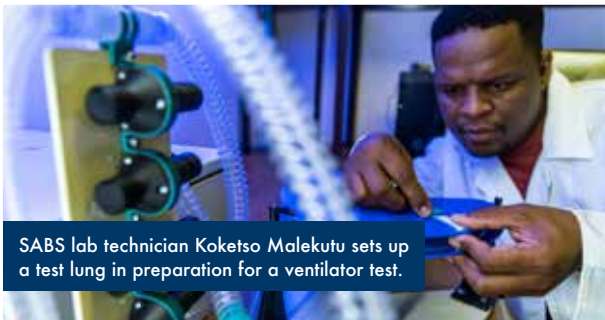
In a significant milestone, the project now has 100% data coverage in two locations over a period of 12 months. The wave information gathered is being used to assess the potential for breaches and develop the forecasting model.

By implementing the wave data collection and forecasting system, coastal mining operations in southern Namibia will be better equipped to protect their infrastructure and mitigate the risks associated with high ocean waves and increasing storm surge intensity due to climate change.



CSIR AND SABS PARTNER TO EMPOWER LOCAL VENTILATOR MANUFACTURERS

The CSIR and the South African Bureau of Standards (SABS) have joined forces to establish a ventilator test facility. The facility will provide certification assistance to local ventilator manufacturers.



SABS lab technician Koketso Malekutu sets up a test lung in preparation for a ventilator test.

As a certification hub, the facility will help instill confidence in the quality of locally produced ventilators and strengthen South Africa's capacity to respond effectively during times of health crises. It contributes

to self-sufficiency, reducing dependence on imports, and enables the country to meet its own healthcare demands.

The CSIR led the development of cutting-edge test equipment and an advanced instrumentation package. The SABS, in turn, focused on the regulatory requirements in South Africa, aligning its efforts with the new SABS standard for ventilators.

The collaboration and resulting facility will bolster the local industry's ability to manufacture ventilators that meet international quality standards, ensuring that patients receive the best possible care.

SUPPORTING AN SMME IN MEDICAL DEVICE MANUFACTURING TO DEVELOP INFECTION-CONTROL CURTAINS

The CSIR has played a vital role in supporting 3G Medical, a local South African small, medium and micro enterprise (SMME) that specialises in the manufacturing of medical devices.



A coated infection-control hospital curtain.

The organisation's support has helped 3G Medical meet regulatory requirements, develop products and access markets.

Regulatory support provided by the CSIR has ensured that 3G Medical complies with healthcare standards, both locally and internationally, specifically in terms of ISO 13485. ISO, the International Organization for Standardization, is a worldwide federation of

national standards bodies, and ISO 13485 specifies requirements for a quality management system relating to the provision of medical devices and related services. One of 3G Medical's products is a coated single-use hospital curtain that mitigates the spread of hospital-acquired infections, thereby safeguarding the wellbeing of patients, healthcare workers and visitors. The coating allows the curtain to stay active for up to 24 months, reducing the pressure on hospital laundries.

Continued CSIR support will enable critical testing, polymer formulations and validation of product performance and efficacy.

With the help of the CSIR, 3G Medical has expanded its export opportunities exponentially. In addition to the broad-spectrum disposable curtain, the collaboration between the CSIR and 3G Medical has assisted with new infection-control products that have been approved for the United Kingdom health market.

IMPLEMENTING TELEVISION WHITE SPACES TO PROVIDE CONNECTIVITY TO RURAL AREAS

The CSIR has made great strides in deploying its novel television white spaces (TVWS) technology, which makes it possible to provide affordable broadband wireless internet connectivity to underserved rural and township communities by using TV bands for broadband access.

The CSIR, in collaboration with the United Nations Development Programme (UNDP), has facilitated the deployment of the technology to support 13 youth and women-owned small, medium and micro enterprise (SMME) network operators. These operators have implemented affordable broadband network infrastructure in underserved communities in the Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and the Western Cape.

In one project, as part of a partnership between the CSIR, the UNDP, AL Baraka Bank and AdNotes, a high-tech computer laboratory has been set up at Olwandle High School in Gamalakhe, located outside of Port Shepstone in KwaZulu-Natal. The initiative benefits learners in a resource-limited context, enabling them to gain exposure to the digital age for the first time.

To further support ICT-based SMMEs owned by youth and women, the CSIR has signed a memorandum of understanding with SEACOM South Africa Ltd, a prominent global internet service provider. The collaboration will offer direct internet access, national private lines, colocation services and cloud solutions to these beneficiaries.



FINGERPRINT BIOMETRIC TECHNOLOGY LICENSED TO COMMERCIAL PARTNERS

The CSIR has licensed its software fingerprint technology to two commercial partners, iPulse and Wongeta. The technology enables digital devices with cameras, such as smartphones and webcams, to function as fingerprint scanners – without needing embedded fingerprint scanners.



Businesses are facing an increasing need to find reliable ways of authenticating users of their systems to avoid fraud and decrease attacks on their infrastructure. South Africans continue to be vulnerable to identity theft due to data breaches.

The CSIR innovation comprises a contactless acquisition module that accepts a colour photograph of a finger and extracts the fingerprint pattern to create a fingerprint image, with interoperability to different devices and the ability to integrate into existing databases.

iPulse, a technology company in access control systems, and Wongeta, a company in the financial industry,

will use the technology to enhance their services and authentication mechanisms.

The technology has many potential use cases. These include user authentication during delivery services, patient identification during accidents and identification of criminals in the field during arrests. Use cases are being explored to improve the logistics, finance, health, security and education sectors.

The technology has the potential to assist both government and industry in strengthening their systems and processes.

A WINNING RECIPE FOR THE EXTRACTION OF A HIGH-VALUE PRODUCT FROM SAWDUST BIOMASS

The CSIR Biorefinery Industry Development Facility is developing a protocol for the optimal extraction of the high-value product xylitol from xylose, a sugar isolated from wood or sawdust biomass.



CSIR chemical engineering technologist Londani Mbambo processes woodchips into pulp and sugar-rich hydrolysate.

The protocol contains in-depth processes on how to evaluate and process parameters for converting xylose into an important platform for sustainable bioproducts for the xylitol market. Xylitol is widely used as a food and beverage sweetener and its market is expanding.

Related ongoing research and development includes the study of the effect of the process parameters on yield, as



A rapid displacement heating digester at the CSIR Biorefinery Industry Development Facility.

well as determining the optimum process conditions that will serve as the baseline for subsequent studies.

Once demonstrated, the technology will be licensed to small, medium and micro enterprises that are interested in manufacturing xylitol locally. The product will serve as a direct import replacement to xylitol, which is currently being sold in South Africa.

INNOVATION IN PRODUCTION OF KAOLIN-CONTAINING POLYPROPYLENE COMPOUNDS FOR THE AUTOMOTIVE SECTOR

The CSIR has developed a formulation and method to produce kaolin-containing polypropylene compounds.



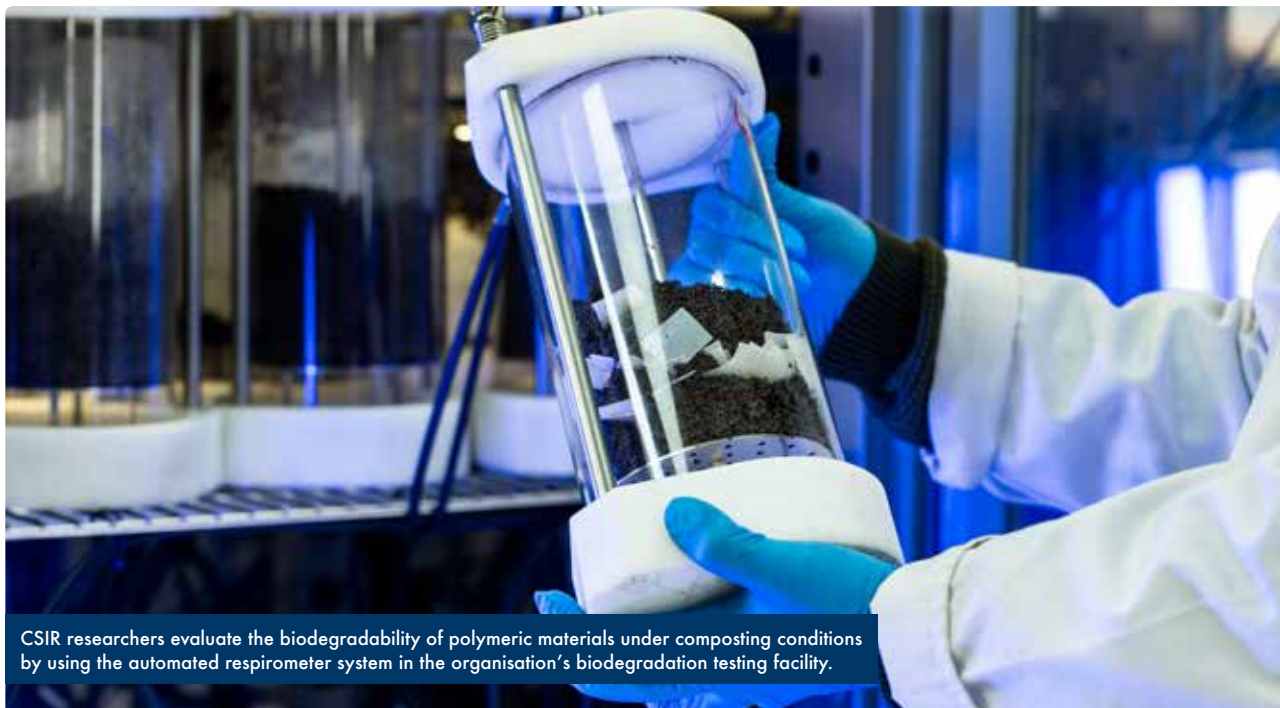
Kaolin-containing polypropylene pellets.

Polypropylene compounds are widely used in a variety of applications, including in the automotive sector, where they are used in dashboards, bumpers and

interior trim. The CSIR formulation looks at replacing expensive and imported calcium carbonate in the polypropylene compound to provide an equivalent or superior product to the local market.

While there is some literature on the creation of kaolin-containing polypropylene compounds, the CSIR-developed process for these applications is novel. Researchers worked with industry partners, Kaolin Group Polymer Compounds (Pty) Ltd, who signed a licence agreement with the CSIR to undertake industry testing of the product. The test results were encouraging, resulting in equally successful trials at an auto maker.

CSIR PIONEERS NATIONAL STANDARDS FOR HOME COMPOSTABLE MATERIALS AND PRODUCTS



The CSIR completed the development of standards for home compostability of materials and products. The standards were approved by the South African Bureau of Standards.

The main aspects that are addressed by the new standards are carbon dioxide biodegradation (mineralisation), disintegration during composting, negative effects of the composting process, ecotoxicity effects on the quality of the resulting compost – including the presence of high levels of regulated metals – and other harmful effects.

These standards specify in-depth procedures and requirements for material and products that are

suitable for home composting, in line with International Organization for Standardization (ISO 17088).

The work followed the establishment of the CSIR's biodegradation testing laboratory, Africa's only laboratory equipped to test and verify the biodegradability of materials. These include imported and locally produced products that are promoted as biodegradable and compostable.

ADDRESSING SERVICE DELIVERY ISSUES IN MUNICIPAL AREAS AFFECTED BY TRANSITIONS IN MINING

The CSIR is helping to improve service delivery and find solutions for challenges experienced in eight local municipalities that are affected by transition in mining.

The organisation is an implementing partner of the Municipal Capability and Partnership Programme (MCPPE), a joint effort involving Anglo American, the Department of Cooperative Governance, Anglo American Platinum, Kumba Iron Ore, De Beers, participating mines, and the participating municipalities. The programme focuses on strengthening capability and partnering in support of improved water quality and quantity management, infrastructure development and management and strategic development planning.

Technical experts worked with the Gamagara and Tsantsabane Local Municipalities in the Northern Cape and Mogalakwena Local Municipality in Limpopo to improve access to water, water quality, water balance reporting and infrastructure maintenance. In these three municipalities, as well as in the North-West municipality of Moses Kotane, the programme partners are also responding to groundwater and borehole management challenges, in collaboration with local teams.

In Limpopo, the MCPPE helped build the capability of the Bloubaerg Municipality to manage infrastructure projects,



Municipal, industry and civil society partners in discussion during the Mogalakwena area-based strategic planning.

specifically on engineering service delivery requirements, associated costing and contract management. For the Musina Municipality, with its growing population, collaboration focused on accurately quantifying this growth and the associated service delivery needs, and on asset management and immovable assets.

In the Moses Kotane, Fetakgomo Tubatse and Mogalakwena Local Municipalities, the municipal and programme teams have made substantial inroads in strengthening area-based strategic planning and partnering processes in support of sustainable development and infrastructure investment in mining regions.

GUIDING THE GOVERNANCE OF GROUNDWATER IN A CHANGING CLIMATE

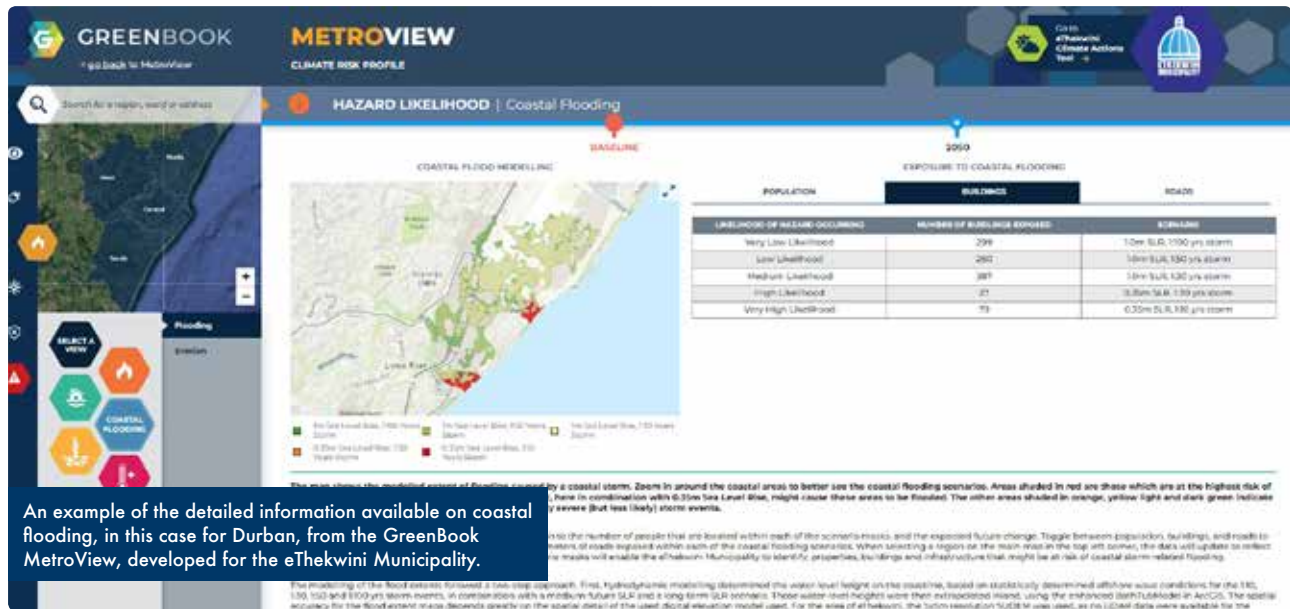
A multi-institutional and multidisciplinary research team worked alongside two rural communities in the Eastern Cape and KwaZulu-Natal to co-produce a framework to guide the governance of groundwater in the two areas.

South Africa has committed to ensuring access to water and sanitation for all, as outlined in Sustainable Development Goal 6. Additionally, Chapter 2 of the Constitution of South Africa, 1996 recognises the right of access to sufficient water of adequate quality as being essential to a good quality of life. To give effect to this right, the Water Services Act, 1997 (Act 108 of 1997) mandates municipalities to provide water to communities within their respective jurisdictions. Despite this, many rural municipalities have difficulty supplying water services to all their residents, resulting in many rural households relying on natural springs.

However, groundwater is increasingly becoming vulnerable to the impacts of climate change.

The research team investigated innovative solutions to address water insecurity in the Thukela and uMzimvubu River Catchments in KwaZulu-Natal and the Eastern Cape, respectively, which are located in two of South Africa's strategic water source areas. The study focused on understanding how holistic catchment management can improve the adaptive capacity of the communities to the impacts of climate change on spring water supply.

DECISION-SUPPORT TOOLS AND TRAINING TO HELP MITIGATE COASTAL FLOODING



CSIR researchers have held training sessions at all 16 South African coastal district municipalities on the use of layers and maps that enable them to manage the potential risks of the country's coastal areas.

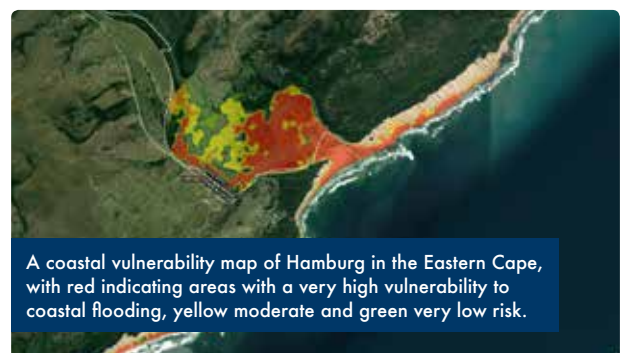
The training courses were attended by officials of relevant municipal offices, such as spatial planning, disaster management, environmental management and waste management.

The sessions followed the earlier National Coastal Climate Change Vulnerability Assessment that the CSIR conducted for the Department of Forestry, Fisheries and the Environment. This assessment delineated areas that are potentially at risk of coastal flooding for five storm and two sea-level rise scenarios for the whole of the South African coast. German-based GIZ was instrumental in funding the work and subsequent training.

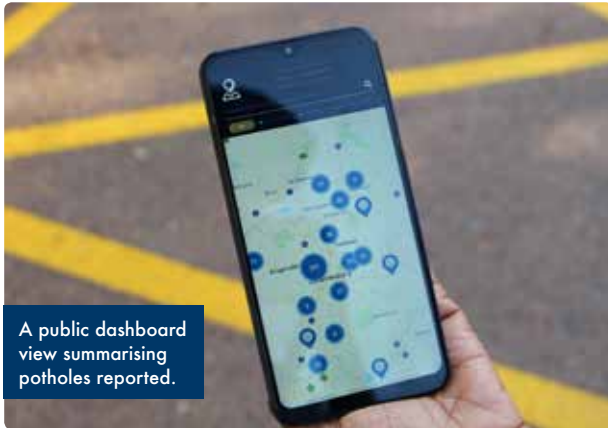
The GreenBook MetroView is another tool developed by the CSIR specifically to support local government to adapt to climate change by providing evidence around climate change, population growth, risk and vulnerability for metropolitan municipalities. The CSIR, together with National Treasury and ABSA, co-funded the development of GreenBook MetroView tools for two coastal metros, the eThekweni Municipality and

the Buffalo City Metro. In partnership with Santam and the Climate and Disaster Resilience Fund, the CSIR is developing an online training course on the GreenBook and supporting its rollout and uptake in district municipalities.

In March 2023, the CSIR was approached by the Eastern Cape provincial government to deploy technical expertise in support of disaster response efforts, following severe flooding in the Port St Johns area. Discussions about future data-driven decision support continue.



AN APP TO REPORT AND MONITOR ROAD MAINTENANCE ISSUES



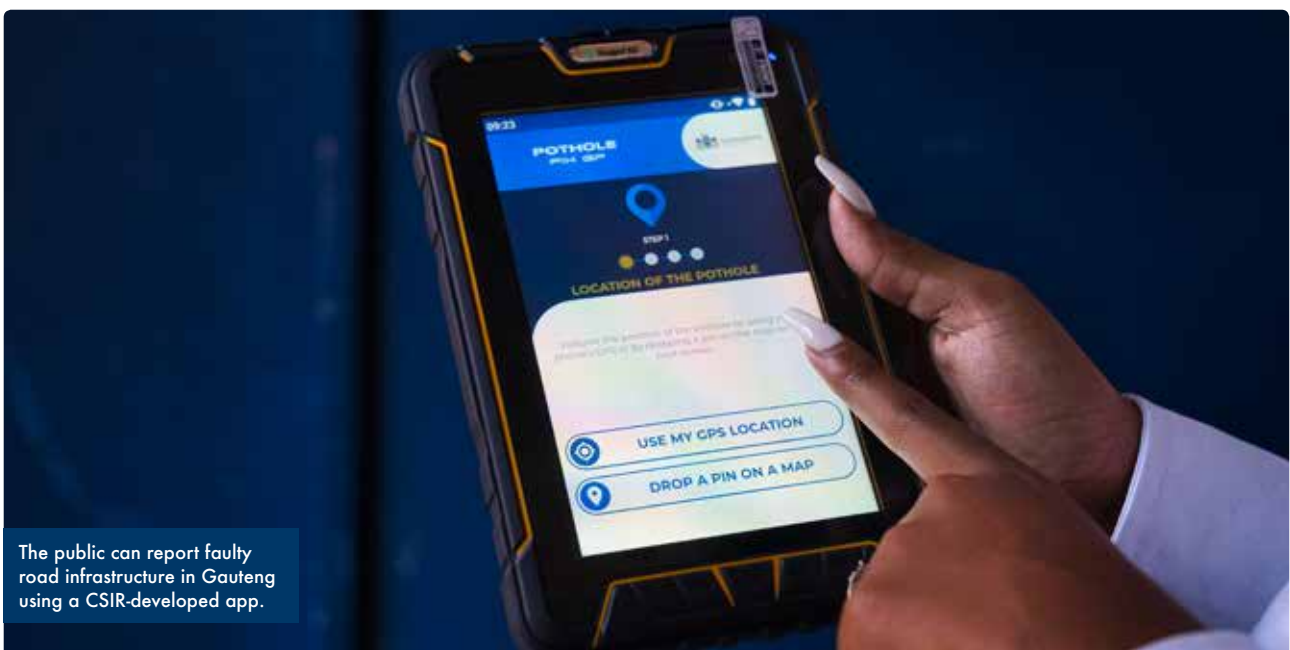
The CSIR has developed a mobile application (app) to streamline and digitise the reporting of road infrastructure maintenance issues such as potholes and traffic signal failures in Gauteng. Road infrastructure failures pose a significant problem for motorists nationwide, leading to vehicle damage and safety concerns.

The CSIR was commissioned by the Gauteng Department of Roads and Transport (GDRT) to develop the mobile app, which initially served as a platform for the public to report potholes on roads in Gauteng but has been expanded to also allow the public to report

non-functioning traffic signals, while enabling the GDRT to track and monitor the progress on addressing the reported issues. The app uses geographic information system technology, allowing it to pinpoint the exact location of reported maintenance issues and allocate the issue to the correct road authority for repair and maintenance.

The app consists of two interfaces: a mobile app available for iOS and Android devices that allows the public to report potholes and non-functioning traffic signals, and a web application dashboard for the GDRT. When users report a road maintenance issue through the mobile app, real-time data is transmitted to the GDRT, enabling it to efficiently allocate resources, monitor reported cases and initiate repairs. Since its launch, over 9 000 public users have submitted reports, resulting in approximately 7 200 reported maintenance issues being assigned to the different road authorities in Gauteng.

The CSIR drew on its expertise in road asset management and road maintenance activities to develop the app and continues to support the GDRT with services such as the generation of weekly reports to aid decision-making and resource allocation.



DEVELOPING A NATIONAL PUBLIC TRANSPORT SUBSIDY POLICY FOR EQUITABLE AND SUSTAINABLE PUBLIC TRANSPORT

The CSIR provided technical guidance to the Department of Transport in the development of a proposed new national public transport subsidy policy.

A key outcome of the collaboration was the finalisation of a subsidy policy supported by a public transport funding model that acknowledges all modes of transport within the public transport value chain.

Public transport plays a crucial role in South African society, contributing to socioeconomic development. However, the sector faces challenges relating to critical under-resourcing, especially in rural areas. Recognising the need for a comprehensive approach to the subsidisation of public transport, the 2021 White Paper on Transport Policy emphasised the need for a national public transport subsidy policy to establish objectives, implementation models and costing methodologies.

The policy is a product of extensive stakeholder consultation. The resulting framework embraces the



The CSIR contributed to the development of a new national public transport subsidy policy.

principles of user-targeting, equity and long-term sustainability.

Following Cabinet approval for much broader public consultation, the adoption of the policy will provide the first post-apartheid guide on how to resource public transport for sustainable outcomes.

A VALUABLE TOOL FOR INFLUENCING INFRASTRUCTURE INVESTMENT DECISIONS FOR MPUMALANGA

The CSIR has helped develop an interactive geospatial dashboard to guide infrastructure investment decisions in Mpumalanga by providing crucial real-time information to policymakers and stakeholders.



The Mpumalanga Infrastructure Master Plan web application.

The geospatial web application is an additional outcome of the Mpumalanga Infrastructure Master Plan 2060 that the CSIR developed. It helps users identify locations, industrial zones and key infrastructure across various sectors.

The multisectoral project was undertaken in collaboration with the Mpumalanga Department of Public Works, Roads and Transport as a follow up to the infrastructure planning and development framework, first developed in 2012. The plan will address the comprehensive planning and implementation of all types of infrastructures.

The plan is being reviewed and inputs are being incorporated from stakeholders in sectors such as roads and transport, logistics, energy, information and communications technology, water and sanitation, asset management, waste management and spatial planning. Based on these consultations, the CSIR has identified priority areas for implementation between 2022 and 2060.

ELECTRONIC MONITORING SYSTEM TO HELP THE DEPARTMENT OF CORRECTIONAL SERVICES MANAGE THOSE ON PAROLE

The Department of Correctional Services has commissioned the CSIR to develop an electronic monitoring system to monitor citizens who have been placed on parole or other specific conditions.

The system is intended to help reduce the incarceration of prisoners in overcrowded correctional facilities, facilitate re-integration into society and lower the associated cost.

To ensure that the system is robust and tailored to the specific requirements of the department, the project is multiphased, with the solution, adjunct devices and supporting applications being developed in phases, with iterative improvements.

In the first phase, the CSIR developed a prototype of a monitoring bracelet for prisoners in the low-risk category who are placed on parole. It features wireless charging and was designed to seamlessly integrate with the department's Offender Management Systems. It will be developed to manufacturing readiness in subsequent phases.

The system incorporates a mobile application specifically designed for community corrections officials, allowing

them to interact with the system and maintain situational awareness of individuals on their case load, facilitating effective community-based corrections.



CONTRIBUTING TO INTERNATIONAL REPORT ON GOVERNANCE OF INTERNET OF THINGS TECHNOLOGIES AND LOCAL ADOPTION BY SMMEs

The Centre for the Fourth Industrial Revolution South Africa (C4IR South Africa) played a part in developing the State of the Connected World Insights 2023 Edition.

The report was launched by the World Economic Forum at its annual meeting in Davos, Switzerland, in January 2023. The report examined governance gaps related to internet of things and associated technologies, establishing priorities for businesses and government leaders to put into action.

In a South African-focused pilot project, C4IR South Africa looked at ways to accelerate the adoption of the industrial internet of things (IIoT) by South African small, medium and micro enterprises (SMMEs). C4IR South Africa adopted the IIoT policy protocol to

explore skills development options that will best serve the needs of the SMMEs, create an ecosystem to support continuous learning and remove barriers to the adoption of such technologies, demonstrate inclusive digital transformation by providing support and advice to SMMEs, and create a collaborative platform for its business partners to work with government and academia to co-design, prototype, test and refine various enablers for 4IR technology adoption.

The second phase of the project is to secure partners and formulate a scaling-up approach.

EXPLORING CIRCULAR ECONOMY OPPORTUNITIES IN MINING, AGRICULTURE AND MANUFACTURING

The circular economy has been recognised by the South African government as a new growth opportunity for the country.



The CSIR has published a series of short briefing notes on what the circular economy means across seven resource-intensive sectors of the economy, and three technical reports on circular economy opportunities in the South African mining, agriculture and manufacturing sectors. The reports explored the appropriateness of circular economy interventions, their current level of implementation, and the sectors' readiness to adopt these interventions.

The study on mining found that South Africa has 18 critical or strategic minerals, five of which have less than 50 years of economically viable mining remaining, assuming no new major reserves are found. In addition, these minerals are mostly exported, suggesting that South Africa may have little control over their downstream circularity, which raises concerns regarding future mineral scarcity and its impact on the economy. The study found that while resource scarcity is a driver for South Africa to transition to a more circular economy, other factors such as job creation, socioeconomic development, climate commitments and business objectives are also powerful drivers.

Adopting more circular practices in the agricultural sector has the potential to improve food security, while also reducing the resource intensity of this sector. The

main findings of the study were that stakeholders are aware of most of the circular economy interventions applicable to the agriculture sector. However, a few stakeholders were uncertain with regard to the less familiar interventions, such as chemical leasing, zero tillage, equipment sharing, vertical farming and precision agriculture. The South African agriculture sector is ready, and has already implemented, some circular economy interventions, although not yet at the scale for meaningful impact.

The South African economy is heavily dependent on the export of un-beneficiated minerals and unwrought base metals linked strongly to resource extraction from the mining sector. An evaluation of circular economy practices in the manufacturing sector highlighted the potential to build the resilience, competitiveness and sustainability of South Africa's manufacturing economy, with the added benefit of economic growth and job creation in line with global trends.

The CSIR publications provide a baseline for government and the private sector to unlock new opportunities, whether it be through supportive policy that will enable a circular economy transition, or unlocking new businesses and new business models.

NEW UNIFORMS AND BOOTS FOR SA ARMY

The CSIR has developed a new camouflage uniform and improved combat boots for the SA Army.



The new uniform features a gendered garment design, an updated pattern and colours, as well as a new fabric that suits diverse operational environments. The uniform is lightweight and more colour-fast than previous versions. The new boots were also designed to cater for males and females and feature a new sole technology for relative comfort in wet and dry conditions.

CSIR researchers worked closely with the army to determine its requirements and learn about the challenges of the current soldier kit. The project team collaborated with local manufacturers to assist with the development and is in the process of localising the production of the fabric.

The Military Command Council, Army Command Council and other members of the South African National Defence Force (SANDF) participated in a fitting range process to ensure that correct sizes are allocated during the cut-make-trim process of the uniform.

The development of patterns and colours follows an extensive research, development and innovation process carried out over years and involved comprehensive sampling of the operational environments across South Africa's border areas. The effectiveness of the pattern, colours and fabric will be determined during the wearer trials scheduled for different operational environments. The new boots are being evaluated by soldiers along the border.

Initially intended for the SA Army, it is envisaged that the new clothing will be adopted by the rest of the SANDF.

The CSIR-developed uniform is durable, lightweight and designed for both males and females. The pattern and colours are protected and the uniform will be serialised when issued to soldiers.

BUILDING CAPACITY IN CODING FOR HIGH-PERFORMANCE COMPUTING

Participants from 26 different research institutions in South Africa attended the Coding Summer School of the Centre for High Performance Computing (CHPC).

This marked the first-ever collaborative effort among multiple institutes to organise and participate in a coding training event within the country. Institutes from outside of South Africa were given the opportunity to participate virtually, fostering international collaboration in coding education.

The Coding Summer School was held over two weeks from the end of January 2023. Participants from various locations across the country came together to acquire essential coding knowledge tailored for high-performance computing and computational sciences.

The school started with a basic programming course, followed by topics such as data visualisation, data analysis, modelling and simulation, machine learning and software management. Learning took part through interactive sessions, practical exercises and hands-on workshops, enabling participants to enhance their



One of the 26 research institutions that hosted a total of 556 individuals during the Coding Summer School.

understanding of coding principles and their practical application in high-performance computing environments.

The CHPC organised the Coding Summer School in collaboration with the National Institute for Theoretical Computational Science. The CHPC is one of three primary pillars of the national cyberinfrastructure intervention that are supported by the Department of Science and Innovation and is hosted by the CSIR.

NURTURING TALENT FOR INTERNATIONAL CYBERSECURITY COMPETITIONS

The South African National Research Network (SANReN) hosted its sixth Cyber Security Challenge Competition during the Centre for High Performance Computing National Meeting that was held in December 2022.

Ten teams from universities across South Africa, as well as Lesotho and Malawi, qualified to compete in the final round, showcasing their expertise in network and information security.

The primary objective of the competition is to foster interest in the field of network/information security among Southern African tertiary education institutions. Additionally, it serves as a platform for students to gain exposure to international cybersecurity competitions, since the competition's organising committee also forms part of the steering committee for the African Region to The International Cybersecurity Challenge (AFRICC).

Ten previous participants of the SANReN Cyber Security Challenge Competition have been selected to join the

Southern African team of AFRICC and will participate in the 2023 International Cybersecurity Championship and Conference in the United States of America.



In one challenge, students participated in a hackathon where they had to attack each others' networks, while defending their own.

Reaching the top of the career ladder

The CSIR welcomed three new chief researchers and 15 principal researchers during the year under review. This faculty of researchers is an important indicator of the organisation's capacity to fulfil its mandate and retain its status as a distinguished research organisation on the continent. Attaining these positions requires local and international recognition of a sustained track record and significant outputs in a specialised research field, with proven impact on society and within the research community.

CHIEF RESEARCHERS



Dr Santosh Ramchuran

Focuses on developing, implementing and commercialising innovative bio-based technologies, products and processes.



Dr Sandy Thomalla

Focuses on unpacking the links between carbon and climate change in the Southern Ocean.



Dr Jabu Mtsweni

Focuses on cybersecurity, cyberwarfare, data science and socially relevant computing.

PRINCIPAL RESEARCHERS



Dr Daniel Glaser

Focuses on the industrialisation of the power generation, aerospace, automotive and mining sectors.



Dr Ntombi Mathe

Focuses on the additive manufacturing of aluminium, titanium alloys and high entropy for applications in rail, energy and the aerospace industries.



Dr Dithoto Modungwa

Focuses on research and development in vehicle mobility and unmanned systems with applications in the defence space.



Dr Janine Scholefield

Focuses on developing models of disease in a dish, using advanced imaging, genome engineering and stem cell technology.

PRINCIPAL RESEARCHERS



Dr Jayita Bandyopadhyay (Sinha Roy)

Focuses on developing polymeric blends and nanocomposite materials for high-end industrial applications.



Johnny Botha

Focuses on open-source intelligence and cryptocurrency crime investigations.



Dr Maretha O'Kennedy

Focuses on developing new-generation, safe, highly efficacious vaccines for the latest circulating disease strains in search of optimal protection.



Dr Maya Mathew

Focuses on the development of bio-based and compostable materials from renewable and sustainable resources.



Dr Nicholas Musyoka

Focuses on hydrogen technology, with expertise in the carbon capture, utilisation and storage space.



Dr Sudhakar Muniyasamy

Focuses on developing sustainable bio-based biodegradable plastics.



Dr Thanyani Pandelani

Focuses on the biomechanics of traumatic injury, particularly to the lower extremities and pelvis.



Dr Vincent Ojijo

Focuses on polymer processing, with expertise in polymer composites, biodegradable polymers and the circular economy.



Jonas K Johakimu

Focuses on biorefinery, industrial pulp and paper, waste economy, and water and energy efficiency.



Dr Jenny-Lee Panayides

Focuses on supporting the self-sufficiency of African pharmaceutical manufacturing through the localisation of modern manufacturing technologies.

Absent: Bhavya Vallabh

Nurturing our talent

COMMITMENT TO A WORLD-CLASS WORK ENVIRONMENT



The CSIR was awarded Top Employer in South Africa certification, an accolade that it received for the sixth time. Being certified as a Top Employer by the Top Employers Institute shows an organisation's dedication to a better working environment, which it exhibits through excellent human capital policies and people practices. Dr Thulani Dlamini, CSIR Chief Executive Officer, with the 2023 trophy and the CSIR collection of Top Employer trophies (below).



BUILDING OUR TALENT ECOSYSTEM

A total of 100 CSIR employees were awarded staff bursaries to upgrade their qualifications through the Skills Development Levy. Of the 100, 20 employees are enrolled for their Masters' degrees and 12 are pursuing their doctoral qualifications.

BEATING YOUTH UNEMPLOYMENT

The CSIR first partnered with the Youth Employment Service (YES) programme in 2020. The programme provides South African youth with job opportunities and job readiness skills. To date, the CSIR has supported 175 young South Africans through the YES programme. Three of the eight candidates who were absorbed into roles at the CSIR in 2023, are below, from left: Ndumiso Zungu, who holds an Advanced Diploma (Administrative Information Management) and assists with the CSIR's planning, reporting, monitoring and evaluation; Khodani Musandiwa, who holds a BSc Hons (Environmental Management) and provides administrative support on projects in mining; and Tumelo Ramoshebi, who holds a Diploma (Information Technology), and assists with business matters.



EXCELLENT UPTAKE OF E-LEARNING

The CSIR scooped the prestigious LinkedIn Talent Award in the category 'Learning Champion' for rolling out the LinkedIn Learning platform to assist staff with continued learning and development that complements classroom-type learning interventions. Receiving the award on behalf of the CSIR were (left) Andile Mabindisa, Group Executive: Human Capital and Communication and Lebogang Sekgwele, Manager: Behavioural Learning and Development.



GROWING THROUGH STAFF EXCHANGES



Staff exchange programmes between the CSIR and its industry partners facilitate the sharing of best practices, developing human capital and advancing business growth. In one such collaboration, the CSIR and its Namibian counterpart, the National Commission on Research, Science and Technology (NCRST), entered into an agreement in 2022 to build skills in pilot-scale production and technical skills for the fourth industrial revolution. Year one of the programme focused on human capacity development to support skills development for industry. With its focus on creating internship opportunities for university students, the first intake of the programme was four Namibian university students, two of whom were trained in agroprocessing and two in bioprocessing. From left, Wennyth Farmer, Angela Muyenga and Mbili-Yetu Shetunyenga became employees of the NCRST after completing the programme at the CSIR.

DEVELOPING LEADERSHIP AND MANAGEMENT SKILLS

In June 2022, 82 employees entered the inaugural Leadership and Management Development Programme, designed for specific occupational levels. The CSIR partnered with Wits Business School and Maccaulei to implement the programme. The programme is designed to increase the CSIR's leadership capacity – equipping employees with skills to manage their teams for better performance results.

BELGIUM-SOUTH AFRICA COLLABORATION HELPS PAVE THE WAY FOR RENEWABLE ENERGY TRANSITION

The CSIR has taken into use a new indoor energy storage testbed that strengthens South Africa's ability to support local players in the battery value chain, thereby boosting the country's capabilities in renewable energy storage.



From left, Dr Thulani Dlamini, CSIR Chief Executive Officer; Bruno Reynjens, VITO Commercial Director; HE Matthias Diependaele, Minister for Finance, Budget, Housing and Immovable Heritage, Government of Flanders; His Majesty the King of the Belgians; Dr Phil Mjwara, Director-General of the DSI and Prof. Arnold van Zyl, Interim Chairperson of the CSIR Board.



From left, Dr Sandile Malinga, Group Executive: CSIR Smart Society, Renesh Thakoordeen, CSIR Project Leader and VITO Energy Technology Project Manager Carlo Mol.



A high-precision system for battery module and pack tests.

The indoor energy storage testbed resulted from an ongoing collaboration agreement between the CSIR and VITO, the Flemish Institute for Technological Research.

The testbed was established within the framework of the World Bank Energy Storage Partnership. The partnership recognises that energy transitions – with increased wind and solar power use – are underway in many countries and that, to integrate renewable resources into grids, energy storage is key. The World Bank Group, therefore, established a partnership to help foster international cooperation on technology research and development in this field.

This, in turn, opened the way for the CSIR-VITO collaboration on an energy storage testbed to primarily performance-test lithium-ion batteries and emerging

energy storage technologies for a South African and sub-Saharan market.

The facility equips the CSIR to test the performance and reliability of batteries, as expressed by their storage capacity, lifecycle and depth of discharge. It will help build capacity in the South African battery industry, as lower-capacity clients will have access to indoor testbed facilities, and overall market knowledge can be improved.

The facility is equipped with a high-precision system for battery module and pack tests. It has many channels to test numerous batteries in parallel under dissimilar test cycles. It also has a new-generation temperature chamber to provide data on the operating behaviour of batteries used in harsh climates – which will impact optimal performance.

SOUTH AFRICAN-FINNISH PARTNERSHIP RESULTS IN NEW SORGHUM-BASED NUTRITIONAL DRINK

A new ready-to-drink sorghum product was developed by Nutrigo SA – a Tshwane University of Technology spin-off company – with the support of the Southern Africa Network for Biosciences (SANBio).

SANBio led a Finnish-Southern African Partnership Programme, a BioFISA II continuation programme, that supported six projects from South Africa, Lesotho and Zimbabwe in addressing some of the economic challenges exacerbated by the Covid-19 pandemic in the Southern African Development Community region. The programme is funded through the government of Finland and South Africa, through the Department of Science and Innovation.

Through the support from SANBio, Nutrigo SA created 10 jobs. Eight people were trained, and one farmer was trained to produce finger millet to follow on the production.

The project helped to ensure that the sorghum drink, called Niselo, was introduced to the market through fruit-stop shops, convenience stores, pharmacies and Pretoria-based gymnasiums. A partnership with a non-government organisation, Bethany House, and Tshwane Metro formed part of the project's corporate social investment during which a feeding programme for jobseekers and the homeless in the streets of Pretoria was undertaken. Nutrigo SA is now a majority shareholder in a United Kingdom start-up, called BiaGO Limited.

Numerous other projects were undertaken, including a project in Lesotho to develop and commercialise affordable and nutritious snacks using indigenous foods and a project based in Zimbabwe for supplementary vitamins and minerals for grazing animals.

SANBio is an African Union Development Agency–New Partnership for Africa's Development Southern African Network initiative hosted by the CSIR.



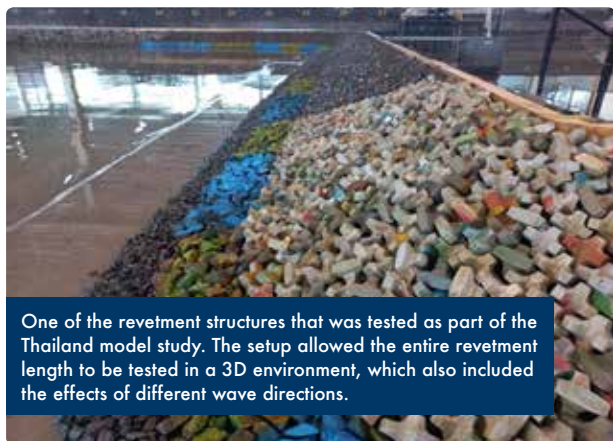
In a Lesotho-based project, researchers developed and commercialised snacks using indigenous foods such as sorghum.



A newly developed sorghum-based drink.

CSIR COMPLETES MODEL STUDY FOR PORT EXPANSION IN THAILAND

Port and coastal engineers at the CSIR have completed a two and three-dimensional physical model study to support terminal expansion plans at a port in Thailand.



One of the revetment structures that was tested as part of the Thailand model study. The setup allowed the entire revetment length to be tested in a 3D environment, which also included the effects of different wave directions.

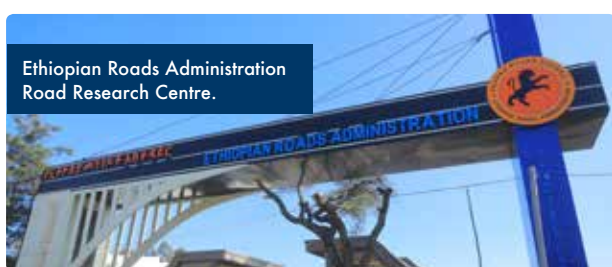
The Industrial Estate Authority of Thailand plans to enhance the capacity of Thailand's petrochemical facility for the shipment of natural gas and liquid cargo.

The aim of the port expansion project was to assess and verify the stability of key elements within various marine infrastructures, ensuring the successful implementation of the expansion plans. Key aspects included the stability of the armour layer, toe design, measurement of wave overtopping and confirming the impact of wave forces on the capping wall.

The physical model study comprised a total of five test series, making it one of the most extensive projects of its kind undertaken by the CSIR in the last decade. Spanning seven months, the study examined various aspects of the port expansion plans, offering valuable insight into the project's feasibility, as well as issues of structural stability and operational efficiency.

PARTNERING FOR ROADS RESEARCH AND ENHANCED ROAD INFRASTRUCTURE IN ETHIOPIA

The CSIR is providing technical assistance to the Ethiopian Roads Administration Road Research Centre.



Ethiopian Roads Administration Road Research Centre.

The assistance is being undertaken in association with I.T Transport Ltd, a United Kingdom-based transport and infrastructure consulting company, and focuses on enhancing the capacity of the researchers to provide quality research outputs to improve road infrastructure in Ethiopia.

One of the CSIR's key contributions is the development of short and long-term training programmes for the researchers, as well as guidelines on research management and road industry operations, including

road design, construction, maintenance, management and safety. The CSIR will also play a key role in compiling technical assessment reports that identify gaps in research initiatives related to road materials, design analysis and evaluation of road structures.

These short-term outputs will be followed by long-term action plans to support the future demands of construction and road asset management, highway design, transport, road safety and environment, landslides and geotechnical investigations and materials research.

The partnership between the CSIR, I.T Transport Ltd and Ethiopia underlines the importance of collaboration in strengthening institutions and promoting research, innovation and information-sharing within the roads and transport sector.

GUIDING UGANDA'S COMMITMENT TO ESTABLISH A CENTRE FOR TRANSPORT RESEARCH AND INNOVATION

The CSIR has partnered with the Uganda National Roads Authority (UNRA) to establish a research, development and innovation (RD&I) centre that focuses on the roads and transport sector.

The CSIR conducted a feasibility study to assess UNRA's capacity to strengthen Uganda's road network planning and implementation. Based on the findings, the CSIR proceeded with the development of a strategic and operational framework, as well as a five-year business plan.

The framework was developed through consultative engagements with UNRA internal stakeholders, ensuring ownership and addressing technical and institutional challenges. The business plan outlines the vision, mission and goals of the RD&I centre, addressing governance, funding sources, key performance indicators and potential research areas. It also focuses on capacity-building through human

resources, knowledge management and skills transfer. The proposed new centre will drive RD&I efforts in the road sector in Uganda.



BILL & MELINDA GATES FOUNDATION INVESTMENT TO BOOST AFRICAN HEALTH INNOVATION

Africa's plans to build capacity to respond to future pandemics received a major boost when, in 2022, the CSIR received an investment worth approximately R80 million from the Bill & Melinda Gates Foundation to drive skills and health innovation.

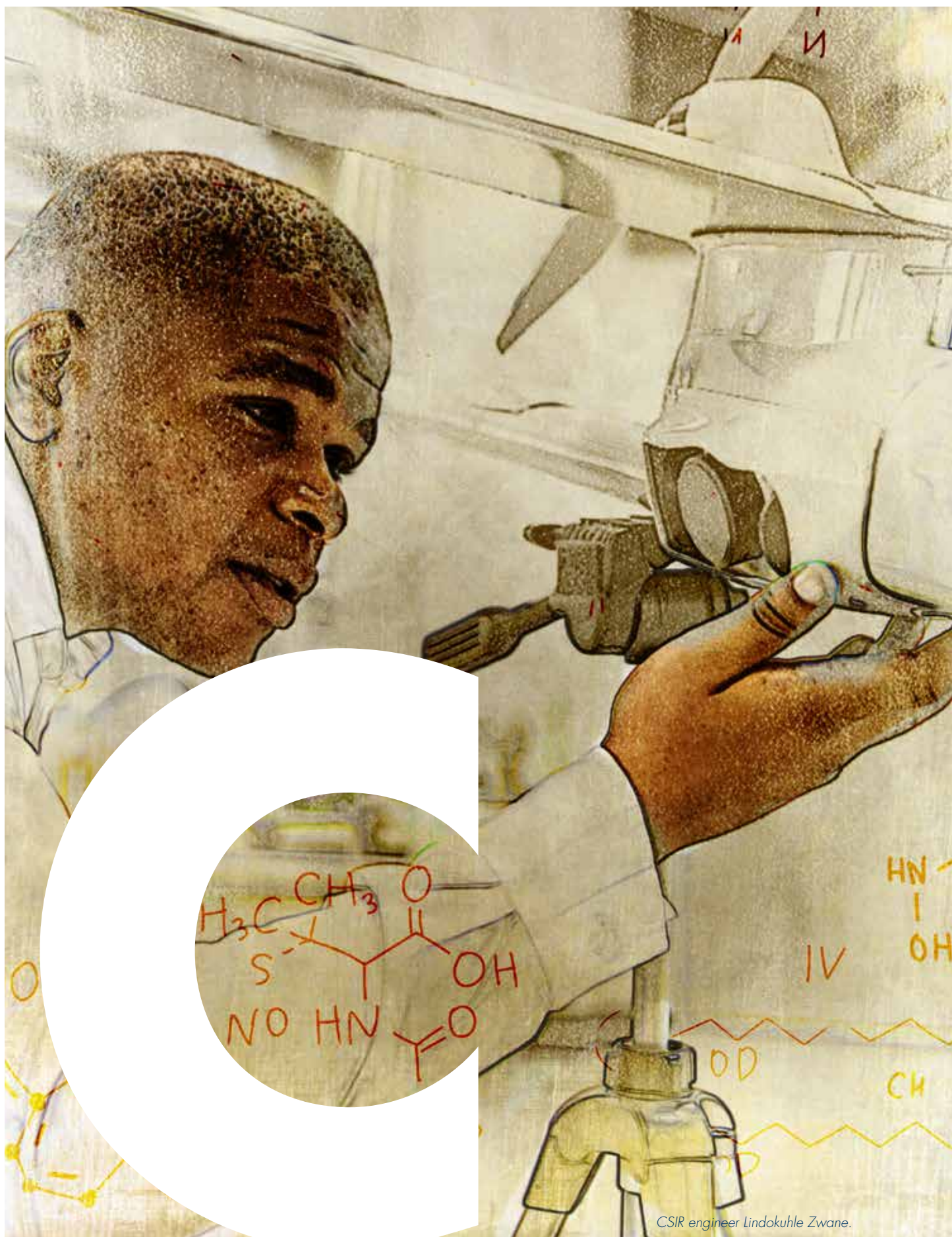


The investment, which seeks to strengthen Africa's biomanufacturing capability through a workforce training

and skills development programme, is set to help reduce the continent's dependence on imported critical health products. It will strengthen the continent's capability to manufacture health products, which, in turn, will help reduce cost and improve access to such products.

The CSIR is leading training on the manufacture of active pharmaceutical ingredients, biopharmaceuticals and vaccines on the African continent.

The investment will contribute to the modernisation of infrastructure and equipment that are key to building a robust local biomanufacturing capability. Additionally, it will allow for the expansion of the existing CSIR microbial production facility and the establishment of bench-scale production using mammalian cell culture systems – a key focus area to ensure that biopharmaceuticals that are developed in Africa do not remain in the research and development phase but are successfully commercialised.



CSIR engineer Lindokuhle Zwane.

PERFORMANCE INFORMATION

This section provides an overview of the organisation's performance against the set objectives and targets for the 2022/23 financial year. The overview provides a description of any significant developments that may have impacted the organisation's ability to deliver on its Strategic Plan and Annual Performance Plan.

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AUDITOR'S REPORT: PREDETERMINED OBJECTIVES

The Auditor-General South Africa (AGSA) currently performs the necessary audit procedures on the performance information to report on material findings. The audit conclusion on the performance against predetermined objectives is included in the report to management, under the Report on the annual performance report section of the Auditor's Report.

For the Auditor's Report, refer to page 138 in Part F.

OVERVIEW OF PERFORMANCE

Service Delivery Environment

There are many examples where the CSIR has deployed capabilities in support of service delivery (for more details please see Part B above). These include providing support to various organs of state, including the Department of Health, Department of Correctional Services, Department of Defence, Department of Police (the South African Police Service), National and Gauteng Departments of Transport and Home Affairs, Eskom, Transnet, the South African Weather Service, and many others. There is increasing demand for CSIR support of government due to the need for scientific and evidence-based policy advice and decision support, novel solutions, niche national facilities, deep SET capabilities, as well as strategic independence. In 2022/23, there was a 51% increase in projects implemented in support of government compared to the previous financial year.

As an example, in the third week of March 2023, the CSIR was approached by the Eastern Cape provincial government to deploy technical expertise in support of disaster response efforts, following severe flooding in the Port St Johns area. The CSIR, South African National Space Agency (SANSA) and the DSI deployed experts to advise on remote sensing and decision support efforts. The CSIR engaged with the provincial government and the municipality on the establishment of a strategic capability for data-driven decision support and a command centre to capacitate the municipality in the event of future natural disasters. The CSIR, SANSA and DSI provided similar assistance during last year's equally devastating floods in KwaZulu-Natal.

Another example of service delivery support is the development of the PotholeFixGP mobile app, which can provide the exact location of a pothole by using the phone's Global Positioning System functionality or dropping a geo-location pin on a map. In addition to providing the location of the pothole, the user can also provide information on the estimated size of the pothole and a corresponding photograph of the pothole. The app has a public dashboard where users can view reported potholes and their repair status. A user can track a reported pothole using the reference number they received when they initially reported the pothole on the app. PotholeFixGP provides a status update of the pothole, from "to assigned" and eventually "to completed" for the department and the user who reported the issue. This collaboration between the GDRT and the CSIR signals a commitment to the digitalisation of the transport sector as it facilitates enhanced accountability by the GDRT and other roads authorities in the province.

This work happened against the backdrop of a weak economy. South Africa's gross domestic expenditure on research and development has been declining year-on-year, since 2017/18. In the last three years, there has been negligible, nominal Parliamentary Grant growth to sustain and grow national strategic capabilities. With high inflation on input costs and above inflation increases on utilities, the CSIR is under pressure to grow contract R&D income to remain financially sustainable. CSIR's response in addressing funding constraints and achieving growth is to increase private sector and international income by aligning our offerings with market needs, as well as accelerating the pace and scale of commercialisation.

In nominal terms, private sector contract R&D income grew by 14%, while international income increased by 21%. The CSIR also, once again, increased performance in joint technology development activities with industry sectors. However, the weak economy will impact the CSIR's prospects for significant and sustained local income growth in the future. Seven of the 10 industry sectors tracked by Statistics South Africa shrank between October and December 2022, with agricultural output falling 3.3% quarter on quarter, mining 3.2%, finance 2.3%, trade 2.1% and manufacturing 0.9%. Three of the industry sectors (agriculture, mining and manufacturing) that the CSIR supports had been impacted negatively.

Internationally, the post-Covid-19 economic recovery, supply chain constraints, the war in Ukraine and Chinese Covid-19 restrictions have resulted in soaring

global inflation. The rand remained weak against major currencies and the CSIR increased its international contract R&D income as a percentage of total revenue by 1%. The CSIR will continue to pursue niche opportunities in the global market.

Organisational Environment

The organisation drove several noteworthy initiatives in the last year because of challenges experienced and strategic intent.

Enhancing organisational agility and efficiency

Various initiatives were introduced to enhance organisational agility and efficiency. These are a work in progress and include the development of Business Development and Commercialisation (BD&C) processes, streamlining of administrative processes, monitoring of cost efficiency and Office 365, among others.

Organisational climate initiatives

The CSIR embarked on an extensive programme to create a positive organisational climate to enhance employee wellbeing and satisfaction, and overall organisational performance. Action plans in response to the climate survey were implemented across the organisation at corporate, division/portfolio and cluster levels. These include:

- **Employee Wellness:** The CSIR Wellness Programme involved the facilitation of mental health and wellbeing initiatives in partnership with Bestmed. An increase in attendance has been observed in comparison to the previous financial year. Some of the topics covered in the online webinars included burnout, anxiety, work-life integration, resilience, physical wellness and mental health.
- **Leadership Development:** The Leadership and Management Development Programme (LMPD) was rolled out in partnership with Wits Business School and Maccauley Learning Academy. A total of 82 employees attended the various LMPDs.
- **Values-based Leadership:** The Values-based Leadership Development Programme for the Executive team has progressed well and will continue into the first quarter of 2023/24.
- **Skills Development:** A total of 100 CSIR employees were supported to upgrade their qualifications through the Skills Development Levy during the 2022 academic year, and 138 are supported for the 2023 academic year, of which 102 are newly funded and 36 are continuing from last year.

Some areas have had challenges that necessitated the review of the value propositions or reorganisation.

Reorganisation of certain areas

The CSIR reorganised its Water Research Centre, ELs, Advanced Agriculture and Food cluster and ICT portfolio to improve operational efficiencies.

Reviewing capabilities at risk

The CSIR is in the process of reviewing and re-positioning several capabilities at risk to optimise their value propositions. These are:

- **Health Innovation:** Limited funding to support CSIR health innovation capabilities and initiatives in support of South Africa's drive to localise vaccines and critical biological therapies.
- **Defence and Security:** Optronic Sensor System capabilities currently under review to re-position for financial sustainability.
- **Energy:** Offerings, capabilities and business model of the Energy Research Centre under review to enhance value proposition to drive relevance, impact and future sustainability.

Attraction, retention and development of scarce and critical skills

Competition for high-end scarce and critical SET skills in the market is high and threatens our ability to deliver on the CSIR SOs, as well as respond to stakeholder and market needs. The CSIR continues to experience challenges in attracting and retaining skills in ICT, cyber, sensor systems, systems engineering 4IR, as well as transport and logistics, in response to high market demand and limited capacity in these high-growth areas. The CSIR has several initiatives in progress to address this issue. These include, but are not limited to:

- Attraction and retention of chief and principal researchers;
- Attraction and retention of SET females;
- The Accelerated Principal Researcher Programme; and
- The Capability Development Investment Programme to attract chief researchers from the external market.

Security of energy supply at remote sites

Increased load shedding by Eskom has impacted operations at CSIR sites across the country. In large facilities like the Centre for High Performance Computing, this has warranted the installation of large generators and a shift in operating hours. The CSIR is developing an energy resiliency plan in an attempt to minimise disruption to operational revenue-generating activities.

Increasing the pace and scale of commercialisation

The CSIR has rigorously explored the possibility of creating a standalone special purpose technology commercialisation enterprise. This enterprise will have dedicated capacity to drive the commercialisation of CSIR intellectual property by creating an environment that will attract entrepreneurs and investors. It will provide facilities for the incubation and acceleration of start-up enterprises. The enterprise will work with other role players in the NSI to create an ecosystem of IP creators, entrepreneurs and providers of capital. The CSIR has earmarked R100 million as an initial investment into the vehicle and hopes to leverage a significant amount from the business and development finance institutions. The establishment of the enterprise has been approved by the CSIR Board.

Key Policy Developments and Legislative Changes

The CSIR strategy is aligned with the STI Policy. The 2019 White Paper on STI is geared towards harnessing the power of science to deal with South Africa's socioeconomic challenges. The Decadal Plan is the implementation guide for the STI Policy. The intended long-term outcomes of the implementation initiatives proposed in the Decadal Plan are well aligned with the CSIR Strategy and are:

- A productive National System of Innovation (NSI) contributing to economic growth and inclusivity, social development and environmental sustainability;
- Strong institutions; and
- A capable state.

Strategies to secure financial resources for the implementation of the Decadal Plan recognise that the public component of the NSI is far wider than just the DSI and that funding from other STI-intensive government departments will be leveraged to implement the Decadal Plan initiatives. Furthermore, the public budget for STI will be coordinated through the involvement of the DSI via high-level governance structures (i.e., a Presidential STI Plenary, and an Inter-ministerial STI Committee). The STI budget allocation will be supported by analysis and evidence provided by a strengthened National Advisory Council on Innovation. Initiatives aimed at increasing investment by the private sector in South African STI are detailed in the Decadal Plan, also acknowledging that policy certainty is critical for private sector participation.

There have been some changes to relevant regulations or legislation and some have affected the CSIR's operations during the period. National Treasury Regulations in certain instances still make it difficult for public entities to contract directly with government and state-owned enterprises for mandated work. Regulations still require the CSIR to compete for R&D activities in open pre-selection tenders and market analysis, which, as a public entity mandated to perform this type of work, should not be the case.

While there is a strong drive to ensure that procurement by government departments, constitutional institutions and public entities guarantees value for money, as well as open and effective competition and fairness, there are several instances in which direct contracting of the CSIR's strategic capabilities, albeit that it serves the national interest, has not been without challenges.

The CSIR, in pursuit of balancing regulatory requirements, its mandate and Shareholder's Compact obligations, has had limited success in its attempts to be designated as the preferred supplier for its core mandate services in support of national efforts. This has inadvertently led to significant constraints in the organisation's ability to execute its core mandate in the national interest.

Progress towards predetermined objectives

Overall, the CSIR has achieved 90% of its key performance indicators for 2022/23. Over the past four years, there have been several achievements against the CSIR Strategy to exploit knowledge generated, support industry and enable a capable state, namely:

- Significant increase (68%) in the number of technology development activities;
- Double the number of priority patent activities and licensing activities;
- More than double the effort to localise technology solutions;
- Significant increase in (61%) joint technology development activities with industry partners;
- An increase (94%) in the number of projects implemented by the CSIR on behalf of the government; and
- A 40% increase in the number of standards delivered on behalf of the state, which is a testament to the organisation's position as a trusted science partner to government.

Over the past four years, there has been an overall reduction in publication outputs (-9%) due to the Parliamentary Grant that has not increased in par with inflation over the years and a reduction in the CSIR's contribution to national policy development (-40%) due to the reduced demand for policy development support in a constrained fiscal environment.

The CSIR's Strategy supports several of the government priorities; the CSIR SOs are aligned to the seven Medium-term Strategic Framework apex priorities:

- The CSIR supports 'economic transformation and job creation' through conducting RD&I that is geared towards the localisation of technology and import replacements, support of SMMEs with technology solutions and conducting joint technology development activities with industry partners.
- The CSIR supports the 'building of a capable, ethical and developmental state' through conducting RD&I that informs policy development, development of standards and the implementation of various strategic projects on behalf of government.
- In support of 'education, skills and health', one of the pillars of the CSIR's Strategy implementation involves human capital development. The CSIR ensures continued capacity development and transformation of its SET base. Often, that SET base is absorbed elsewhere in the South African NSI. A demonstration the CSIR's continued RD&I activities in the health space, is the local development of ventilators during the Covid-19 pandemic.
- In support of 'spatial integration, human settlements and local government', the CSIR continues to conduct research in the area of 'smart places' and examples that demonstrate the contribution include the development of the 'Investmap', which is a tool for regional economic development planning that supports all spheres of government with a regional approach to planning.
- In support of 'a better Africa and world', the CSIR continues to forge partnerships with the rest of the African continent and the world.

INSTITUTIONAL PROGRAMME PERFORMANCE INFORMATION

The strategic intent of the new CSIR Strategy can be summarised as growth, sustainability, impact and relevance. These four pillars bring alignment between responding to our mandate and addressing internal organisational imperatives.

The CSIR's intention is to use its capabilities, such as skilled human resources, infrastructure and intellectual property, to support the inclusive growth of the South African economy, contributing to the alleviation of poverty, and addressing unemployment and inequality. The CSIR also intends to grow as an organisation, strengthening its HC base and other competencies required to remain a world-class organisation, while strengthening its financial position.

Our intentions regarding sustainability refer to the CSIR developing technologies to improve the competitiveness of South African enterprises and ensuring that they are financially and environmentally sustainable. This intent also speaks to the financial sustainability and good governance of the CSIR in a resource-constrained environment.

The CSIR will strive to make a greater impact on the economy and society through the commercialisation of technologies and innovations, leading to the creation of new enterprises that contribute to industrial and socioeconomic development, as well as technology and knowledge transfer that enable a capable state.

The fourth pillar – relevance – relates to the appreciation of the relevance of innovation in industrialisation by private sector decision-makers and public sector policymakers. The intention is to also ensure that the organisation is relevant by addressing market needs and socioeconomic challenges, as well as being able to deliver on its mandate of improving the quality of life of the people of South Africa.

The CSIR Strategy hangs on its clearly defined SOs, which are derived from the prevailing strategic drivers in our operating environment.

SO1**Conduct RD&I of Transformative Technologies and Accelerate their Diffusion.**

This SO seeks to ensure that the CSIR undertakes cutting-edge R&D in areas that will bring transformative change in the South African economy and society.

SO2**Improve the Competitiveness of High-Impact Industries to Support South Africa's Re-Industrialisation by Collaboratively Developing, Localising and Implementing Technology.**

This SO seeks to improve the competitiveness of South Africa's high-impact industries through research, development, technology localisation and industrialisation in a collaborative manner with partners, thereby contributing to the reindustrialisation of the country.

SO3**Drive Socioeconomic Transformation Through RD&I that Supports the Development of a Capable State.**

This SO emphasises the CSIR's role in supporting the development of a capable state and enabling the government to drive the socioeconomic transformation of South Africa through RD&I.

SO4**Build and Transform HC and Infrastructure.**

This SO seeks to build and transform the required HC and invest in infrastructure to drive industrialisation and the advancement of society.

SO5**Diversify Income and Maintain Financial Sustainability and Good Governance.**

This SO seeks to improve the CSIR's financial sustainability by diversifying revenue sources and optimising the business model to achieve competitiveness supported by good (efficient and sound) governance.

SO1: Conduct RD&I of transformative technologies and accelerate their diffusion.

In this SO, the CSIR has put in place key performance indicators (KPIs) that measure the organisation's ambitions to translate knowledge generated into innovations.

Exceptional performance was realised for the 2022/23 financial year in the number of publication equivalents, the number of new patents granted and the number of new technology demonstrators (see Table 1).

The number of licence agreements signed is an area that needs attention in the 2023/24 financial year. The CSIR realised 56% of its target for new licence agreements signed. This was due to delays in the execution of licence agreements, as well as loss of key resources, which caused capacity constraints (see Table 1).

Table 1: Planned targets and actual achievements for SO1 KPIs

SO1: Conduct RD&I of transformative technologies and accelerate their diffusion.						
Performance Indicator	Actual Achievement 2021/22	Planned Target 2022/23	Actual Achievement 2022/23	Deviation from Planned Target to Actual Achievement for 2022/23	Comment on Deviations	Threshold/ Number
KPI 01: Publication equivalents	422.5	304.5	398	31%	Target exceeded	≥95%/≥289.3
KPI 02: New priority patent applications filed	7	7	8	14%	Target exceeded	≥75%/≥5
KPI 03: New patents granted	16	6	19	217%	Target exceeded	≥80%/≥5
KPI 04: New technology demonstrators	55	54	62	15%	Target exceeded	≥85%/≥46
KPI 05: Number of technology licence agreements signed	12	18	10	-44%	Target not met due to delays in execution of licence agreements and loss of key resources, causing capacity restraints	≥75%/≥14

Tables 2, 3 and 4 represent the activities that speak to the utilisation of CSIR knowledge in the commercialisation value chain. The road that the CSIR needs to take to realise more impact of its knowledge-generation activities will require intensified efforts in ensuring that these activities are strategically implemented, including co-creation with potential end users of the technologies.

Table 2: List of new priority patents filed in 2022/23

No.	Patent title	Application number	Filing Date	Country
1	African horse sickness viral protein 2 as vaccine and to serve in serotype specific diagnostics	2213002.5	6/9/2022	United Kingdom (UK)
2	Multi-layered biodegradable polymer nanocomposite-based film	2022/11707	27/10/2022	South Africa
3	Active compound encapsulation system and method of formulating the same	PCT/IB2022/062274	15/12/2022	Patent Cooperation Treaty
4	Cannabidiol (CBD) e-liquid delivery vehicles for therapeutic/nutraceutical administration by vaporisation	2023/03797	24/3/2023	South Africa
5	A method and system for contactless fingerprint acquisition	N2034473	30/3/2023	Netherlands
6	A method and system for hashing a fingerprint minutia template	N2034475	30/3/2023	Netherlands
7	A biometric hash matching method and system, particularly a fingerprint hash matching method and system	N2034476	30/3/2023	Netherlands
8	Molecular modeling method for a functional material	2023/04033	31/3/2023	South Africa

Table 3: New patents granted in 2022/23

No	Patent Title	Patent Number	Issue Date	Country
1	Preheating of material in an additive manufacturing apparatus	7035076	3/4/2022	Japan
2	Preheating of material in an additive manufacturing apparatus	EP3554794	27/4/2022	European Patent Office
3	Production of a spinel material	394112	1/4/2022	India
4	Production of a layered lithium-manganese-nickel-cobalt oxide material	10-2385307	6/4/2022	Korea
5	Recycling or processing of layered packaging materials	EP3877130	4/5/2022	European Patent Office
6	A process and method for producing titanium and titanium alloy billets and spherical powder	GB2575005	15/6/2022	UK
7	Threat detection method and system	ZL 201780026212.9	12/7/2022	China
8	Preheating of material in an additive manufacturing apparatus	ZL 2017800780541	23/8/2022	China
9	Build platform guiding arrangement for an additive manufacturing apparatus	11,420,388	23/8/2022	USA
10	A method and system for analysing a biological sample of label-free cells for presence of an infective agent	ZL 201880020729.1	20/9/2022	China
11	A coupling device, a drive assembly for a coupling device and a method of supplying a substance	10-2447921	22/9/2022	Korea
12	Build platform guiding arrangement for an additive manufacturing apparatus	ZL201880067733.3	18/11/2022	China
13	Preheating of material in an additive manufacturing apparatus	11,485,083	1/11/2022	United States of America (USA)
14	Electroless titanium process	GB2567007	23/11/2022	UK
15	System for monitoring the conditions of structural elements and a method of developing such a system	417871	12/1/2023	India
16	The pasteurisation of unshelled eggs	7211958	16/1/2023	Japan
17	A gas detection system and method	2790013	14/2/2023	Russia
18	Threat detection method and system	GC0012118	18/1/2023	Gulf Cooperation Council
19	Gas detection system and method	11,585,751	21/2/2023	USA

Table 4: Technology licence agreements signed

No.	Licensee	Technology	Date signed
1	Kaolin Group Polymer Compounds	Formulation and method to produce kaolin containing polypropylene compounds	31/5/2022
2	Adnotes Digital (Pty) Ltd	S-GLSD (Spectrum Switch)	13/6/2022
3	Proton Chem cc	Biocontrol products (various): T. asperellum	30/8/2022
4	Idwala Industrial Holdings Pty Ltd	Killicombo - Bitumen fillers	15/9/2022
5	DMT Agricultural Service Primary Cooperative	Developing new cosmetic product lines from rose geranium using new technologies	11/11/2022
6	Afrivet Business Management (Pty) Ltd	Blue-tick cattle vaccine	7/12/2022
7	Applied Protein Biotechnologies (Pty) Ltd	Noot-a-bug	30/1/2023
8	IPulse Systems (Pty) Ltd	VeristicPrint - Contactless fingerprint acquisition	6/2/2023
9	UVIRCO Technologies (Pty) Ltd	GASCAM camera	30/3/2023
10	Wongeta (Pty) Ltd	VeristicPrint - Contactless fingerprint biometric authentication	30/3/2023

SO2: Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology.

In this SO, the CSIR has identified high-impact sectors in which South Africa could carve out a competitive advantage to the specific sectors of the economy, stimulating overall socioeconomic growth. Exceptional performance was realised for the 2022/23 financial year in the three KPIs under this SO (see Table 5).

The CSIR realised a 145% achievement (45% above set target) in the number of new localised technologies, 137% achievement (37% above set target) in the number of joint technology agreements being implemented for industry and 161% achievement (61% above set target) in the number of SMMEs supported. This performance demonstrates the CSIR's commitment to supporting re-industrialisation in the country through technological support. In this SO, there is a strong focus on serving the needs and requirements of high-impact sectors and generating knowledge for public good.

Table 5: Planned targets and actual achievements for SO2 KPIs

SO2: Improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively developing, localising and implementing technology.						
Performance Indicator	Actual Achievement 2021/22	Planned Target 2022/23	Actual Achievement 2022/23	Deviation from Planned Target to Actual Achievement for 2022/23	Comment on Deviations	Threshold/ Number
KPI 06: Number of localised technologies	14	11	16	45%	Target exceeded	≥75%/≥8
KPI 07: Number of joint technology development agreements being implemented for industry	25	27	37	37%	Target exceeded	≥75%/≥20
KPI 08: Number of SMMEs supported	99	72	116	61%	Target exceeded	≥75%/≥54

SO3: Drive socioeconomic transformation through RD&I that supports the development of a capable state.

Exceptional performance was realised for the 2022/23 financial year in the three KPIs under this SO (see Table 6).

The CSIR realised a 108% achievement (8% above set target) in the number of reports contributing to national policy development, 156% (56% above set target) in the number of standards delivered or contributed to support the state and 289% (189% above set target) in the number of projects implemented to increase the capability of the state. This exceptional performance in supporting a capable state resonates very well with the mandate of the CSIR as the organisation acts in the national interest.

Table 6: Planned targets and actual achievements for SO3 KPIs

Performance Indicator	Actual Achievement 2021/22	Planned Target 2022/23	Actual Achievement 2022/23	Deviation from Planned Target to Actual Achievement for 2022/23	Comment on Deviations	Threshold/ Number
KPI 09: Number of reports contributing to national policy development	22	13	14	8%	Target exceeded	≥75%/≥10
KPI 10: Number of standards delivered or contributed in support of the state	8	9	14	56%	Target exceeded	≥75%/≥7
KPI 11: Number of projects implemented to increase the capability of the state	86	45	130	189%	Target exceeded	≥75%/≥34

SO4: Build and transform HC and infrastructure.

This SO is concerned with building a transformed SET base and research infrastructure that will deliver high-quality scientific and industrial research capabilities that support the economy and a capable state. The CSIR realised achievement greater than 100% in eight KPIs under this SO (see Table 7).

Table 7: Planned targets and actual achievements for SO4 KPIs

SO4: Build and transform HC and infrastructure						
Performance Indicator	Actual Achievement 2021/22	Planned Target 2022/23	Actual Achievement 2022/23	Deviation from Planned Target to Actual Achievement for 2022/23	Comment on Deviations	Threshold/ Number
KPI 12: Total SET staff	1 497	1 598	1 555	-3%	Target achieved	≥95%/≥1 518
KPI 13: Percentage of SET staff who are black	67.8%	67%	70%	+3%	Target exceeded	<>2%pts/ ≥65%
KPI 14: Percentage of SET staff who are female	39.1%	38%	39%	+1%	Target exceeded	<>2%pts/ ≥36%
KPI 15: Percentage of SET staff with PhDs	20.5%	21%	20%	-1%	Target achieved	<>1%pt ≥20%
KPI 16: Total chief researchers	15	16	15	-6%	Target achieved	≥90%/≥14
KPI 17: Percentage of chief researchers who are black	13.3%	19%	27%	+8%	Target exceeded	5%pts/ ≥14%
KPI 18: Percentage of chief researchers who are female	13.3%	13%	20%	+7%	Target exceeded	5%pts/ ≥8%
KPI 19: Total principal researchers	188	189	195	+3%	Target exceeded	≥95%/≥180
KPI 20: Percentage of principal researchers who are black	34%	34%	38%	+4%	Target exceeded	<>3%pts ≥31%
KPI 21: Percentage of principal researchers who are female	19%	20%	21%	+1%	Target exceeded	<>3%pts ≥17%
KPI 22: Number of staff involved in exchange programmes with industry	31	26	42	+62%	Target exceeded	≥75%/≥20
KPI 23: PPE investment (Rm)	104	259.8	161.30	-38%	Target not met due to delays in the acquisition of equipment, as well as installation delays	≥95%/≥246.8

The CSIR exceeded the set target in the percentage of SET staff who are black by 3%, exceeded the set target for the percentage of SET staff who are female by 1%, exceeded the set target for the percentage of black chief researchers by 8%, exceeded the set target for the percentage of female chief researchers by 7%, is 3% above the set target for the total number of principal researchers, 4% above the set target for the percentage of black principal researchers, 1% above the set target for the percentage of female principal researchers and 62% above the set target for the number of staff involved in exchange programmes with industry.

In three KPIs, the organisation realised satisfactory achievement (within the thresholds set in the 2022/23 Shareholder's Compact). The CSIR missed the set target for the number of total SET staff by 3%, missed the set target for the percentage of SET staff with PhDs by 1%, and missed the set target for the number of total chief researchers by 6%. The CSIR increased its investment in PPE by 55% in comparison with the previous financial year but missed the set target for 2022/23 by 38%.

SO5: Diversify income, maintain financial sustainability and good governance.

Income diversification remains a key objective for the CSIR. The aim is to reduce the financial risk associated with significant reliance on public sector income. Income diversification is also expected to improve the CSIR's profitability. As part of its business model, the CSIR aims to increase private sector R&D income, as well as rigorously pursue international opportunities,

especially on the African continent. Commercialisation and technology transfer will be intensified as part of achieving impact, in line with our strategic intent, but also to grow our royalty and licensing income.

Good governance is the bedrock of the CSIR's performance goals, and the organisation aims to maintain an unqualified audit outcome, keep a good safety record and maintain its B-BBEE credentials. The CSIR exceeded performance in three of the KPIs under this SO – the net profit, percentage contract R&D income from international sources, and the RIR (see Table 8).

The CSIR exceeded the set target for the net profit by R48.97 million, exceeded the target for the percentage contract R&D income from international sources as a percentage of total revenue by 1% and achieved an RIR of 0 against a target of <1 (see Table 8).

Four KPIs were achieved – total income received, contract R&D income from public sector sources as a percentage of total revenue, B-BBEE rating, and the audit outcome from the review of the CSIR Annual Financial Statements and Annual Performance Report. The CSIR realised a 99% achievement (1% below the set target) in the total income for the 2022/23 financial year. The CSIR maintained a B-BBEE rating of 1 and holds an unqualified audit record for the 2022/23 financial year (see Table 8).

Even though the CSIR grew its local private sector contract R&D income by 14% in nominal terms, it realised a 9% local private sector income as a percentage of total revenue, 3% short of the set target of 12% for 2022/23 (see Table 8).

Table 8: Planned targets and actual achievements for SO5 KPIs

SO5: Diversify income, maintain financial sustainability and good governance.						
Performance Indicator	Actual Achievement 2021/22	Planned Target 2022/23	Actual Achievement 2022/23	Deviation from Planned Target to Actual Achievement for 2022/23	Comment on Deviations	Threshold/ Number
KPI 24: Total income (Rm)	2 654	2 903	2 861	-1%	Target Achieved	≥95%/≥2 758
KPI 25: Net profit (Rm)	137	-5.4	43.57	+48.97	Target Exceeded	≥95%/≥-5.13
KPI 26: SA public sector income (% total income)	56%	55%	56%	+1%	Target Achieved	≥95%/≥52%
KPI 27: SA private sector income (% total income)	9%	12%	9%	-3%	Target not achieved due to significant reduction in the Covid-19 diagnostic testing offering and lower than anticipated events at the International Convention Centre impacted the ability to realise private sector income	≥95%/≥11%
KPI 28: International contract income (% total income)	8%	8%	9%	+1%	Target Exceeded	≥95%/≥7.6%
KPI 29: B-BBEE rating	1	1	1	None	Target Achieved	N/A
KPI 30: RIR	0.14	<1	0	Increased	Target Exceeded	N/A
KPI 31: Audit opinion	Unqualified audit opinion	Unqualified audit opinion	Unqualified audit opinion	Unqualified audit opinion	Target Achieved	N/A

Strategy to overcome areas of underperformance

The CSIR did not meet its target for the number of licence agreements signed. Strategies to improve performance include:

- Enhancing the BD&C capacity within divisions.
- Driving the establishment of a commercialisation enterprise as indicated above, which aims to accelerate the pace and scale at which IP assets are commercialised through the further creation of dedicated specialist capacity; attracting adequate financial resources along the technology de-risking process through to commercialisation; and collaboration with suitable entrepreneurs and investment partners to transform CSIR technologies into marketable products, services, spinouts and startups.

The performance on PPE investment was 38% below the set target. This was driven by cautious financial management and delays in the acquisition of equipment funded by the public sector. These include delays in the delivery of Hot Isostatic Press equipment for the Future Production: Manufacturing cluster, as well as delays in the acquisition and installation of equipment for the Centre for High Performance Computing and Data Intensive Research Infrastructure of South Africa.

Reporting on the Institutional Response to the Covid-19 Pandemic

Covid-19 and ways of working

There have been 550 suspected cases reported by CSIR staff and, of these, 225 cases have been confirmed positive. The number of confirmed staff fatalities due to Covid-19 stands at three from March 2020 to date. There remains only one confirmed onsite transmission recorded for the period.

The CSIR Incident Response Team continually reviews the legislation and necessary recommendations are made considering risks identified. The health risk assessment, as well as the Return-to-Work Guidelines, have been implemented in the organisation and other concerned parties. The current Return-to-Work Guidelines and protocols have been reviewed and shared with the organisation. Several precautionary measures have been relaxed at CSIR sites; however, the Code of Practice on SARS COV-2 and the updates to the Hazardous Biological Agents regulations require that workplaces continue with some of the Covid-19 risk identification and mitigation measures. Further advice has been sought from internal CSIR scientific advisory groups and the recommendations have been incorporated into the precautionary protocols.

Covid-19 Vaccination Drive

The onsite Covid-19 vaccination facility for staff and family members, where 408 vaccines were administered, has been closed since September 2022. The CSIR Health Office will continue to offer booster shots and vaccinations through the onsite Medical Centre. Should there be a need to re-introduce the vaccination drive for staff, tenants, contractors and visitors, this will be arranged.

REVENUE COLLECTION

The CSIR has received the full Parliamentary Grant estimated for the 2022/23 financial year. The R3.1 million that has not yet been declared as income, as reflected in Table 9, relates to projects that commenced during the 2022/2023 financial year but will only be completed in the 2023/2024 financial year.

The contract income target has not been achieved as reflected in Table 9. Factors that affected total revenue generation include:

- Key contracts with customers in the public sector not being secured as planned;
- Reduction in Covid-19 diagnostic testing for both the private and public sectors;
- Large value rental agreements with proposed tenants not secured due to the trend in hybrid work arrangements post the Covid-19 pandemic;
- Delays in the acquisition of equipment funded by public sector funding; and
- The electricity crisis impacting wind tunnel testing and the ability to earn revenue from contracts in this area.

The royalty income target has not been achieved due to licensees not being able to generate sufficient revenue that would yield the royalties that were budgeted for.

The collection of long-outstanding debt is one of the key focus areas of the entity and is being closely monitored. This has proven successful, despite the economic strain experienced globally and customers delaying payments. Throughout the financial year, the outstanding debt greater than 90 days has been consistently reducing from the highest point in June 2022 of R112.9 million (55.1%) to R47.21 million (14%).

Bad debt provision was reduced by R10.50 million from March 2022 (R38.57 million) to March 2023 (R28.07 million). The decrease in the provision relates closely to the decrease in debt greater than 90 days. Debt greater than 90 days that has not been provided has been carefully considered in accordance with IFRS9 and the organisation has a firm written commitment from customers to pay outstanding balances.

Debt older than 365 days was reduced by R5.06 million to R16.27 million from March 2022 (R21.33 million) and R7.80 million of this debt has been handed over to external/legal debt collectors.

Table 9: Sources of revenue generation for the CSIR

	2022/2023			2021/2022		
Sources of revenue	Estimate	Actual Amount Collected	(Over)/Under Collection	Estimate	Actual Amount Collected	(Over)/Under Collection
	R'000	R'000	R'000	R'000	R'000	R'000
Parliamentary Grant	741 615	738 476	3 139	725 537	730 274	(4 737)
Contract income	2 157 023	2 079 076	77 947	2 140 288	1 916 674	223 614
Royalty income	4 500	1 645	2 855	2 000	7 395	(5 395)
Total	2 903 138	2 819 197	83 941	2 867 825	2 654 343	213 482

CAPITAL INVESTMENT

The CSIR has committed to R78 million worth of new infrastructure maintenance projects and concluded R64 million worth of maintenance projects that were in progress. Concluded maintenance projects that were undertaken during the period under review include:

- Upgrades to segments of the main water reticulation network;
- Replacement of the Power Factor correction system at the main substation on the Pretoria campus;
- Opening of new borehole systems;
- Corrective maintenance of the CCTV system;
- Upgrade of entrances to the Scientia campus;
- Waterproofing of buildings; and
- Upgrades to Building 10 on the Scientia campus.

Infrastructure projects that are still ongoing are listed below with their expected completion dates (see Table 10).

Table 10: List of infrastructure projects that are currently in progress and their expected completion dates

Infrastructure Project	Expected completion
Upgrade of HVAC for basement labs in Building 2 (Scientia)	2024
Replacement of 132kV Surge Arrestors (Scientia)	2023
Replacement of Stables Roof Trusses (Rosebank, Western Cape)	2023
Asbestos Replacement Project	2030
Scientia Waste Yard Upgrade	2024
Establishment of pilot manufacturing facility in Building 14C (Scientia)	2025
Installation of crawl beam in Building 13	2023
Establishment of a Mockmine project (Carlow Road)	2025
Upgrade of Demo in Building 43	2023
Establishment of a new security control phased approach	2026
Building Condition Assessments	2023

The CSIR is currently developing an energy resilience plan in the light of energy restrictions. This includes a combination of diesel generators and solar energy solutions for critical facilities and operations.



CSIR researcher Shelley Haupt.

GOVERNANCE

The CSIR Board, along with its various committees, is responsible for the oversight of the application of the CSIR mandate through delivering on the annual plan and the performance of the organisation. This section provides an overview of the governance systems, processes and controls in place to hold the organisation to account.

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INTRODUCTION

Corporate governance embodies processes and systems that direct, control and hold public entities to account. In addition to legislative requirements based on a public entity's enabling legislation and the Companies Act, 2008 (Act 71 of 2008), when it comes to public entities, corporate governance is applied through the precepts of the Public Finance Management Act (PFMA), 1999 (Act 1 of 1999) and associated regulations and run in tandem with the principles contained in the King IV Report on Corporate Governance. While the King IV Report on Corporate Governance is not legally binding, it serves as a benchmark against which the conduct and performance of the CSIR's governance structures are measured, allowing the CSIR to act with independence

and within the best interest of the organisation, and in support of its mandate to accelerate socioeconomic prosperity through leading innovation.

Parliament, the Accounting Authority (CSIR Board of Directors) and the Accounting Officer (CSIR CEO) and delegated executives) of the public entity are responsible for corporate governance.

PORTFOLIO COMMITTEES

The Chairperson of the Board and Exco hold bilateral meetings with the Executive Authority to ensure that performance is in line with the Shareholder's Compact.

The Board and Exco are also mandated to account to Parliament.

Table 1: CSIR/Parliament engagements

Date	Activity	Details	Responsible Person/Party
30 September 2022	Tabling of the 2021/22 CSIR Annual Report in the Announcements, Tablings and Committee Reports (ATC) 150 of 2022.	Minister of Higher Education, Science and Innovation	Board & Exco
21 October 2022	Presentation on the 2021/22 CSIR Annual Report.	Portfolio Committee on Higher Education, Science and Innovation	Board & Exco
20 March 2023	Tabling of the CSIR 2023/24 Shareholder's Compact in ATC 38 of 2023.	Minister of Higher Education, Science and Innovation	Board & Exco

Areas of risk and what implementation plans/actions the public entity undertook

The graph below presents the top risks mapped for the organisation during the last year and reflects the risk profile with which the CSIR closed the year.

For each of these risks, the organisation has a defined risk mitigation strategy and risk owner from the executive to monitor mitigation progress and risk movement. It is presented to Exco monthly and to the Board Audit and Risk Committee quarterly.

Inherent risk rating

25	25	50	75	125
20	20	40	60	100
16	16	32	48	80
15	15	30	45	75
12	12	24	36	60
10	10	20	30	50
9	9	18	27	45
8	8	16	24	40
6	6	12	18	30
5	5	10	15	25
4	4	8	12	20
3	3	6	9	15
2	2	4	6	10
1	1	2	3	5

Control assessment rating

Systemic risk
Strategic risk
Operational risk

1. Regulatory environment Intergovernmental constraints.
2. Financial unsustainability.
3. National SET scares and critical skills shortage.
4. BCM 1 - Unstable security of electricity supply.
5. Inadequate scale and pace of IP commercialisation.
6. Instability of attract and retain new and experienced SET skills.
7. BMC 2 - Aging and failing infrastructure.
8. Negative health, safety and environmental incidents.
9. Ineffective and inefficient business systems and processes.
10. Cybersecurity attacks.
11. Inadequate physical security measures.

EXECUTIVE AUTHORITY

The Executive Authority of the CSIR is the Minister of Higher Education, Science and Innovation. The Accounting Authority of the CSIR is the CSIR Board, duly appointed by the Minister. The Practice Note issued by National Treasury dealing with the Submission of Corporate Plans requires the inclusion of the following in the Corporate Plan:

- a. Five-year Strategic Plan
- b. Annual Performance Plan
- c. Governance Structures
- d. Risk Plan
- e. Fraud Plan
- f. Financial Plan
- g. Materiality/Significance Framework

The Executive Authority requires quarterly reporting from the CSIR on prescribed dates. For the 2022/23 financial year the following reports were submitted.

- h. Quarter 1 Report – 20 July 2022
 - i. Quarter 2 Report – 20 October 2022
 - j. Quarter 3 Report – 20 January 2023
 - k. Quarter 4 Report – 20 April 2023
- No issues were raised by the Executive Authority on reports submitted.

ACCOUNTING AUTHORITY/BOARD

Introduction

The governance infrastructure of the CSIR is the collection of governance operating models – the people, processes and systems – that have been put in place to govern daily organisational activities.

This infrastructure also includes the processes used to gather and report information to the Board, external stakeholders and management.

The Board is responsible for oversight across the organisation, in areas such as business and risk strategy, organisational structure, financial soundness and regulatory compliance.

The CSIR governance operating model assists the Board to engage management in providing the information that the Board requires to exercise governance and risk oversight. It ensures the requisite oversight and gives input on policies that ultimately influence the way governance is conducted. It further actively engages management on understanding governance activities

that occur at various levels within the organisation, as well supports management in its efforts to enhance programme efficiency and effectiveness.

The Board Committees are governed by committee charters that define the committees' responsibilities and address linkages between the committee, the broader executive team, and the Board of Directors.

The CSIR organisational design and reporting structure provides a clear, comprehensive organisational structure that defines reporting lines for decision-making, risk management, financial and regulatory reporting, public disclosures, and crisis preparedness and response.

The Board of Directors, which constitutes the Accounting Authority, is responsible for the preparation and fair presentation of the consolidated and separate financial statements in accordance with International Financial Reporting Standards and the requirements of the PFMA, and for such internal control as the Accounting Authority determines is necessary to enable the preparation of consolidated and separate financial statements that are free from material misstatement, whether due to fraud or error. In preparing the consolidated and separate financial statements, the Accounting Authority is responsible for assessing the group's ability to continue as a going concern, disclosing, as applicable, matters relating to going concern and using the going concern basis of accounting.

The role of the Board

The responsibilities of the Board are governed by the Scientific Research Council Act, 1988 (Act 46 of 1988) and the PFMA. The Board approves the strategy, goals, operating policies and priorities of the organisation and monitors compliance with policies, applicable legislation and achievement against objectives. All members of the Board, except the CEO, are non-executive. Board members are actively involved in and bring independent judgement to bear on the Board's deliberations and decisions. The Board, whose current number of members adheres to the statutory minimum requirements, meets quarterly.

For the year under review, the Board met seven times. The meetings were held on 26 May 2022, 28 July 2022, 19 September 2022 (special), 27 October 2022, 5 December 2022 (special), 9 March 2023 and 20 March 2023 (special). A three-day Board induction

session was held from 22 to 24 February 2023. A Board strategic session was held on 25 August 2022. The annual financial statements for the 2021/22 financial year were approved on 28 July 2022.

The Board further engaged in various ad hoc meetings to be advised and provide specific input on matters of strategic importance.

The Board comprises three sub-committees, namely, the Audit and Risk Committee (ARC); the Human Resources, Social and Ethics Committee (HRSEC); and the Research, Development and Innovation Committee (RDIC) (see page 92). These committees are selected according to the skills sets required for the committees to fulfil their functions. The Board has adopted formal Terms of Reference, reflected in the Board Charter, whereas the Board Committees are governed by their respective charters, which define the roles and responsibilities in their respective advisory capacities to the Board of Directors.

Board Charter

The CSIR Board Charter sets out the functions and responsibilities of the Board, along with certain matters relevant to the operations of the Board. These responsibilities are aligned with and encompass the provisions of the Scientific Research Council Act, the PFMA and the King IV Report on Corporate Governance.

The CSIR Board of Directors has decided to apply the corporate governance principles of the Protocol on Corporate Governance in the Public Sector, and the King IV Codes on Corporate Governance to its activities to regularise and improve the corporate governance of the CSIR. This Board Charter sets out the corporate governance policies of the CSIR, as adopted by the Board, and must be read with the Shareholder's Compact between the CSIR and the Minister of Higher Education, Science and Innovation.

While this Charter includes references to minimum acceptable standards of governance, in pursuit of its underlying ideals, it is critical that substance prevails over form. The Charter reaffirms the Board's intention to exceed these corporate governance standards wherever reasonable, having due consideration for the following:

- Recognised standards of governance;
- Best practice locally and internationally;

- The recommendations of the King IV Code on Governance;
- The Protocol on Governance of State-owned Entities; and
- The objectives set out in section 3 of the Scientific Research Council Act.

The Board Charter aims to regulate the parameters within which the Board will operate and ensure the application of the principles of good corporate governance in all dealings by, in respect and on behalf of the organisation.

The Board has made significant progress in complying with the Charter in that it:

- Has guided the continued integration of the CSIR's values and standards of conduct, ensuring that these are adhered to through its input and oversight of the review and re-alignment of all CSIR policies.
- Provides leadership to the CSIR within a framework of prudent and effective controls that enable assessment and management of risk.
- Reviews the CSIR's directions, strategies and financial objectives, annually, and ensures that the necessary resources are in place for the CSIR to meet its objectives, while assessing the progress made, quarterly.
- Oversees and ensures that the performance of the CSIR executive management and the Board itself (and committees) is assessed and monitored regularly.
- Oversees information technology governance through quarterly engagements on business development, commercialisation and technology innovation through the Research, Development and Industrialisation Committee and annual interaction with and reporting by the Research Ethics Committee.

Composition of the Board

April to December 2022

Prof. Thokozani Majozi

Chairperson of the CSIR Board; Dean: Faculty of Engineering and the Built Environment at the University of Witwatersrand

Dr Thulani Dlamini

CEO, CSIR

Prof. Amber-Robyn Childs

Senior Lecturer at Rhodes University

Dr Ramatsemela Masango

Executive Director, Mzansi Energy Solutions and Innovations (Pty) Ltd

Stafford Masie

Non-Executive Director and Shareholder, Thumbzup (South Africa, Australia/AsiaPac, London and USA)

Tiny Mokhabuki

Chief Financial Officer, MICT SETA

Dr Vuyo Mthethwa

Deputy Vice-Chancellor: People and Operations, Durban University of Technology

Joel Netshitenzhe

Executive Director, Mapungubwe Institute for Strategic Reflection Board Vice-Chairperson

Dr Christine Render

Independent Consultant

Cassim Shariff

Executive Director at SDB GAS and Lirazest

Composition of the Board (continued)

April to December 2022

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Prof. Thokozani Majozi (Chairperson of the CSIR Board)	2015	Non - Active Term ended 31 December 2022	University of Manchester Institute of Science and Technology PhD (Process Integration) University of Natal MSc (Engineering) BSc (Chemical Engineering)		Director – A1 Consulting Engineers CC		5
Dr Thulani Dlamini (CSIR CEO)	2017	Active	University of the Witwatersrand PhD Chemistry, Catalysis BSc (Hons) Chemistry BSc Chemistry University of South Africa Master's in business leadership		Council Member National Advisory Council on Innovation Director Vumelana Trade 120 Kusile Invest 125 Mavela Consulting Services		7
Prof. Amber-Robyn Childs	2019	Non – Active Term ended 31 December 2022	Rhodes University PhD (Ichthyology) MSc (Cum Laude) (Ichthyology)		None	RDI Committee	5

Composition of the Board (continued)

April to December 2022

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Dr Ramatsemela Masango	2015	Non - Active Term ended 31 December 2022	Pennsylvania State University PhD (Nuclear Engineering) MSc (Nuclear Engineering) Lyceum College Diploma in Project Management Cape Peninsula University of Technology BTech Degree (Chemical Engineering)		Executive Director Mzansi Energy Solutions and Innovations (Pty) Ltd (Mzesi) Mzesi Energy Mzesi Academy Mzesi Holdings Non-Executive Director ArioGenix Face to Face Foundation Redhorn Holdings Mzesi Water & Construction Yonga Energy Tingo Technologies Amanzi Technologies Africa Energy Wise Solutions Zondibex Miyenzi Investments Vito	RDI Committee HRSEC Committee	4

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Dr Christine Render	2019	Active	Leeds University PhD (Chemical Engineering) BSc Hons. (Chemical Engineering)	Industrial Development / Research New sources of growth broadly (Digital capabilities, Block Chain, Internet of things) Intellectual Property Management, Technology transfer and Commercialisation Scientific Development for directed research	Partner/Shareholder Owner – Team Consultation Pty (Ltd):	ARC RDI Committee	5
Dr Vuyo Mthethwa	2019	Active	University of KwaZulu-Natal PhD (Higher Education Governance)	Human Resources	Employee; Deputy Vice Chancellor: People and Operations Durban University of Technology	ARC HRSEC	6
Cassim Shariff	2019	Non- Active Term ended 31 December 2022	Leicester Business School, DeMontfort University Master's in business administration		Executive Director Aquaworx Remediator & Infrastructure Solutions Southern Cross Diamonds Director Lirazest Greenstone Energy Non-Executive Director Silver Crown Trading	HRSEC RDI	5

Composition of the Board (continued)

April to December 2022

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Stafford Masie	2019	Non - Active Term ended 31 December 2022			Non-Executive Director & Shareholder Thumbzup South Africa Thumbzup Australia/ AsiaPac Thumbzup International (London) Thumbzup USA Executive Director & Shareholder/Funder Green Moon Transact GATTACA SnapTutor LRXYM Fitness Non-Executive Director & Board Member Advtech – Sauronai Holdings LLC (USA): (South Africa) Discovery Bank	ARC RDI	4
Tiny Mokhabuki	2019	Non -Active Term ended 31 December 2022	University of KwaZulu-Natal PGDA (with CTA) University of the Witwatersrand Bachelor of Commerce Global Institute of Business Sciences Aspen Management Programme CA(SA)		Director Business Entrepreneur Community - (Dormant, deregistration process) Equota Mokhabuki Building and Construction Sphimokha Digiten Employee MICT SETA	ARC	4

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Joel Netshitenzhe	2015	Non - Active Term ended 31 December 2022	University of London MSc (Financial Economics) Postgraduate Diploma (Economic Principles) Institute of Social Sciences, Moscow Diploma (Political Science)		Executive Director Mapungubwe Institute of Strategic Reflection Director Life Healthcare Group Lushote Trading (Fledgling) Topaz Sky Trading 316 (Fledgling) Betascape (Dormant) Member Camel Rock Trading 434 (Dormant) NEC Member African National Congress Patron Oliver & Adelaide Tambo Foundation Visiting Professor Wits School of Governance	RDI	4

Composition of the Board

January to March 2023



Prof. Arnold van Zyl
Retired President,
Baden-Wuerttemberg
Cooperative State University



Dr Thulani Dlamini
CEO,
CSIR



Maleke Matolong
Chairperson of Finance
Committee,
Northwest Cricket Board



Mahesh Fakir
Independent Consultant



Jules Newton
Executive Director, Innovation
Green Business Value Chain
Portfolio



Dr Vuyo Mthethwa
Senior Human Resources Director,
Durban University of Technology



Vuyani Jarana
CEO,
Ilitha Telecommunications



Dr Christine Render
Independent Consultant



Michelle Govender
Cyber Risk Emerging
Technologies Leader,
Deloitte



Prof. Yunus Ballim
Retired Emeritus Professor,
University of the
Witwatersrand

Composition of the Board (continued)

January to March 2023

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Prof. Arnold van Zyl (Interim Chairperson of the CSIR Board)	2023	Active	University of Cape Town PhD (Engineering) MSc (Engineering) BSc (Engineering)	Industrial Development /Research New sources of growth broadly (Digital capabilities, Block Chain, Internet of things) Intellectual Property Management, Technology transfer and Commercialisation Scientific Development for directed research	None	ARC RDIC (Chair) HRSEC	2
Dr Thulani Dlamini (CSIR CEO)	2017	Active	University of Witwatersrand PhD Chemistry, Catalysis BSc (Hons) Chemistry BSc Chemistry University of South Africa Master's in business leadership		Council Member National Advisory Council on Innovation Director Vumelana Trade 120 Kusile Invest 125 Mavela Consulting Services		7

Composition of the Board (continued)

January to March 2023

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Dr Christine Render	2019	Active	Leeds University PhD (Chemical Engineering) BSc Hons. (Chemical Engineering)	Industrial Development / Research New sources of growth broadly (Digital capabilities, Block Chain, Internet of things) Intellectual Property Management, Technology transfer and Commercialisation Scientific Development for directed research	Partner/ Shareholder Owner – Team Consultation Pty (Ltd):	ARC RDI Committee	5
Dr Vuyo Mthethwa	2019	Active	University of KwaZulu-Natal PhD (Higher Education Governance)	Human Resources	Employee; Deputy Vice Chancellor: People and Operations Durban University of Technology	ARC HRSEC	6
Prof. Yunus Ballim	2023	Active	University of the Witwatersrand BSc Chemistry BSc (Hons) Chemistry PhD Chemistry, Catalysis University of South Africa Master of Business Leadership	Academic Representative	Trustee Chair ABB Education Trust Trustee Gallagher Foundation Trust	ARC RDI Committee	1

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Mahesh Fakir	2023	Active	University of London MSc (Development Finance) University of Durban – Westville Master of Business Administration MSc University of Natal Post Graduate Diploma in Civil Engineering BSc (Civil Engineering) ML Sultan Technikon National Diploma	Legal and Governance	None	RDI ARC	2
Jules Newton	2023	Active	University of the Witwatersrand BA (Education)	Social and Entrepreneurial Skills	Non-Executive Director Inhlabathi Pty (Ltd) Trustee Jeppe Trust- Executive Director, Shareholder Newton van Rensburg Properties	HRSEC RDI Committee	2

Composition of the Board (continued)

January to March 2023

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Maleke Matolong	2023	Active	Southern African Institute of Business Accountant (SAIBA) BAP (SA) The Chartered Institute of Government Finance, Audit and Risk Officers (CIGFARO) Associate member University of North-West Master of Business Administration Bcom Accounting	Finance	Board Member North-West Cricket	ARC	1
Michelle Govender	2023	Active	University of KwaZulu Natal BSc (Electrical Engineering) Engineering Council of SA Professional Engineer University of South Africa Post Graduate Diploma: Applied Risk Management	New sources of growth broadly (Digital capabilities, Block Chain, Internet of things)	Non Executive Director Circle of Global Business Women (Pro Bono)	ARC RDI Committee	2

Name	Date Appointed	Date Resigned	Qualifications	Area of Expertise	Board Directorships	Other Committees or Task Teams (e.g.: Audit and Risk committee/ Ministerial task team)	No. of Meetings attended
Vuyani Jarana	2023	Active	University of Stellenbosch master's in business administration Hons in Business Administration University of Transkei (Walter Sisulu University) Bcom Economics Business Commercial Law	New sources of growth broadly (Digital capabilities, Block Chain, Internet of things)	Non Executive Director Enx Pty Ltd: ECDC Teconica Telecommunications: Executive Director Ilitha Telecommunications Ilitha infrastructure Pty Ltd Jarana Investment Holdings Council Member Walter Sisulu University Related party company (Spouse) JBV Consulting Agency	ARC HRSEC	2

Committees

Table 3: List of Board Committees

Committee	No. of meetings held	No. of members	Names of members
ARC Audit and Risk Committee	Four meetings were held: 23 May 2022 24 May 2022 (Special) 19 July 2022 19 October 2022	4	Tiny Mokhabuki – Chairperson Stafford Masie Dr Christine Render Dr Vuyo Mthethwa
	One meeting was held: 28 February 2023	5	Vuyani Jarana – Chairperson Prof. Arnold van Zyl Maleke Matolong Michelle Govender Mahesh Fakir
HRSEC Human Resources, Social and Ethics Committee	Three meetings were held: 17 May 2022 18 July 2022 17 October 2022	3	Dr Vuyo Mthethwa – Chairperson Cassim Shariff Dr Ramatsemela Masango
	One meeting was held: 27 February 2023	5	Dr Vuyo Mthethwa – Chairperson Jules Newton Prof. Arnold van Zyl Vuyani Jarana Prof. Yunus Ballim
RDIC Research, Development and Industrialisation Committee	Three meetings were held: 19 May 2022 21 July 2022 20 October 2022	5	Dr Christine Render – Chairperson Dr Ramatsemela Masango Dr Amber-Robyn Potts (Childs) Cassim Shariff Joel Netshitenzhe
	One meeting was held: 3 March 2023	6	Prof. Arnold van Zyl – Chairperson Prof. Yunus Ballim Dr Christine Render Jules Newton Mahesh Fakir Michelle Govender

Remuneration of Board members

Name	Remuneration per meeting	Other allowance	Other re-imbursements - Travel	Total
Prof. Thokozani Majozi	R15 696	None	None	R251 136.00
Dr Amber-Robyn Potts (Childs)	R11 664	None	R4 586.96	R81 648.00
Dr Ramatsemela Masango	R11 664	None	None	R93 312.00
Stafford Masie	R11 664	None	R668.40	R117 126.00
Dr Vuyo Mthethwa	R11 664	None	R1 488.92	R123 175.00
Dr Christine Render	R11 664	None	R3 060.22	R134 151.00
Cassim Ebrahim Shariff	R11 664	None	R1 131.28	R116 640.00
Tiny Mokhabuki	R11 664	None	R474.28	R474.28
Joel Netshitendzhe	R11 664	None	None	R70 998.27
Prof. Arnold van Zyl	R673 per hour	None	R10 608.73	R35 980.00
Mahesh Fakir	R501 per hour	None	R449.96	R20 031.00
Vuyani Jarana	R501 per hour	None	R2 324.58	R16 573.04
Joel Matolong	R501 per hour	None	None	R18 027.00
Prof. Yunus Ballim	R501 per hour	None	R940.00	R19 717.00
Michelle Govender	R501 per hour	None	R733.20	R18 027.00
Jules Newton	R501 per hour	None	R5 691.84	R19 029.00

RISK MANAGEMENT

The Board is responsible for ensuring that there is a comprehensive and effective risk management system in place, including accountability for risk governance. Enterprise risk management in the CSIR is an ongoing process that focuses on identifying, assessing, managing and monitoring all known forms of risks across all operations. A structured process of enterprise risk management ensures that the goals and objectives of the CSIR are attained. This takes cognisance of the fact that the risks identified are often inter-linked and cannot be managed in isolation. The management of risk is assigned at appropriate levels throughout responsibility areas of activity across the entire organisation to ensure adequate responses.

The CSIR has a Board-approved Risk Management Policy and a supporting framework. The policy and framework are operationalised through the implementation of the supporting structures, standards, processes, technologies and system/tool.

The CSIR has an annual risk management plan that is approved by the Board and published as part of the CSIR Shareholder's Compact. An annual enterprise risk management plan is also approved and monitored by

Exco to ensure the adequacy and effectiveness of the risk management system.

The CSIR has repositioned the Enterprise Risk Management Services portfolio to ensure that it is fit for purpose and aligned to the business needs. The new structure was implemented during the 2020/21 financial year, in line with the re-organisation process.

Quarterly strategic and operational risk assessments are conducted to ensure effective management of the existing business risks, as well as the identification and mitigation of emerging risks. The risk assessments are conducted by line management in the clusters, portfolios, strategic projects and key collaboration partnerships/initiatives. The outcomes of the various risk assessments are collated to formulate a CSIR risk register (commonly referred to as the CSIR top risks).

The risk assessment process is structured to analyse and evaluate the following three key categories:

Systemic risks:

These are risks that originate from macro-economic and national challenges affecting the NSI and the National Government Business Enterprise space in which the CSIR operates.

Strategic risks:

These are risks that have a direct impact on the ability of the CSIR to deliver on its mandate.

Operational risks:

These risks include financial, legal and compliance risks, and are those risks that affect the systems, people and processes through which the CSIR operates.

As part of re-positioning its support services to align with the CSIR Strategy, the CSIR is establishing an operational risk management committee that will be the key role-player in maturing the combined assurance model of the organisation.

Based on the internal audit reports, the organisational results achieved, the audit report on the annual financial statements and the management report of the Auditor-General, the Board is satisfied that the risk management system has been effective during the year under review.

INTERNAL AUDIT AND AUDIT COMMITTEES

The group has an internal audit function that is responsible for reviewing the design and operating effectiveness of the organisation's governance, risk and internal control processes. The CSIR Internal Audit function reports to the Audit and Risk Committee, which is responsible for approving the Internal Audit Charter, the annual audit plan and budget to maintain its independence.

The annual audit plan is based on the key risks to the organisation, the outcome of the enterprise risk assessment conducted by management, as well as specific areas highlighted by Internal Audit and the Audit and Risk Committee. In addition, areas highlighted by the external auditors in the internal control reviews are incorporated into the internal audit plan for follow up.

In line with the PFMA requirements, the internal audit activity assured the Audit and Risk Committee and management that the internal controls were appropriate and effective. This was achieved by means of objective appraisal and evaluation of the risk management processes, internal control and governance processes, as well as identifying corrective action and suggested enhancements to the controls and processes. A

comprehensive report on the status of implementing the annual audit plan, the key findings identified and the status of resolving the previously reported internal and external audit findings are presented to the Audit and Risk Committee, quarterly.

The Internal Audit function is fully supported by management, the Board and the Audit and Risk Committee and has full, unrestricted access to all organisational activities, records, property and personnel.

For the period under review, Internal Audit performed an evaluation of the adequacy and effectiveness of controls in the following areas:

- Governance and risk management;
- Performance reporting;
- Human capital management and development;
- Contract income and project management;
- Financial management;
- Property plant and equipment;
- Supply chain management and accounts payable;
- Billing and accounts receivable;
- Facilities maintenance;
- Capital project management
- Physical security services;
- Privacy;
- Customer contract management;
- Information, Communication and Technology;
- Records management;
- Board of Directors and Executives remuneration and expenses; and
- Follow-up of previous audit findings.

Key activities and objectives of the Audit and Risk Committee

The Audit and Risk Committee enhances the independence of the Internal Audit function and provides oversight over risk management, governance and control processes. The Audit and Risk Committee assists the Board in the effective execution of its responsibilities with the aim of achieving the CSIR's objectives. It continues to function and has met four times during the period under review. It is responsible for improving the operations of the organisation by overseeing the audit functions, internal controls and financial reporting process.

The Audit and Risk Committee assists the CSIR to:

- Create and maintain an effective internal control environment – financial controls, accounting systems and reporting;
- Deal with all matters prescribed by the regulations issued in terms of the PFMA and the Scientific Research Council Act;
- Identify material risks and management thereof;
- Agree on the scope and review the annual external audit plan and the work of its internal auditors;
- Review and approve the Internal Audit Charter and the risk based on a three-year strategic internal audit plan and annual audit plan;
- Act in an unfettered way to understand the dynamics and performance of the organisation without restrictions;
- Ensure that it can prevent, detect and respond to fraud and allegations of fraud; and
- Discharge its responsibility relating to:
 - the safeguarding of assets,
 - operation of adequate procedures and controls,
 - reviewing of financial information and the preparation of the financial statements, and
 - attendance of Audit and Risk Committee meetings by Audit and Risk Committee members (tabular form).

The following table discloses relevant information about the Audit and Risk Committee members.

Table 4: Relevant information about the Audit and Risk Committee members

Name	Internal or external	If internal, position in the public entity	Date appointed	Date Resigned	No. of Meetings Attended
Tiny Mokhabuki	External		2019	Term ended 31 December 2022	3
Dr Thulani Dlamini	Internal	CEO	2015	Active	5
Dr Christine Render	External		2019	Term ended 31 December 2022	4
Stafford Massie	External		2019	Term ended 31 December 2022	4
Dr Vuyo Mthethwa	External		2019	Active	4
Vuyani Jarana	External		2023	Active	1
Prof. Arnold van Zyl	External		2023	Active	1
Michelle Govender	External		2023	Active	1
Maleke Matolong	External		2023	Active	1
Mahesh Fakir	External		2023	Active	1

COMPLIANCE WITH LAWS AND REGULATIONS

Regulatory compliance requires the CSIR to continuously analyse its unique requirements and any mandates specific to the organisation and then develop processes to meet these requirements.

Typical steps to achieve regulatory compliance include:

- Identifying applicable regulations – determine which laws and compliance regulations apply to the CSIR's industries and operations.
- Determining requirements – identify the requirements in each regulation that are relevant to the organisation and consider plans on how to implement these mandates.
- Documenting compliance processes – clearly document compliance processes, with specific instructions for each role involved in maintaining compliance.

- Monitoring changes and determining whether they apply – compliance requirements are updated constantly, and changes are continuously monitored to determine if they are relevant to the CSIR and how best they should be integrated.
- Conducting in-house compliance audits to review the CSIR's adherence to regulatory guidelines.
- Preparing in-house audits, which help to prepare for externally conducted, formal compliance audits carried out by independent third parties.

The focus and mandate of the Compliance function are to develop a well-defined regulatory/compliance universe for the CSIR and ensure that the policies and processes align to facilitate continued and effective compliance. Specific focus areas include privacy law, ethics management, trade compliance and corporate governance. The repositioning of the Compliance function previously reported on led to dedicated, focused, visible and impactful management of compliance risks for the business.

IRREGULAR EXPENDITURE

	2022/23 R'000	2021/22 R'000
Reconciliation of Irregular Expenditure		
Description		
Opening Balance	11 799	8 187
Add: Irregular expenditure confirmed	841	3 741
		-
Less: Irregular expenditure condoned	-	129
Less: Irregular expenditure not condoned and removed	-	-
Less: Irregular expenditure recoverable	-	-
Less: Irregular expenditure not recovered and written off	-	-
Closing Balance	12 530	11 799

Reconciliation notes to the Annual Financial Statement Disclosure

Description		
Irregular expenditure that was under assessment in 2021/22	-	-
Irregular expenditure that relates to the 2021/22 and identified in the 2022/23		68
Irregular expenditure for the current year	841	3 673
Total	841	3 741

During the year ended March 2023, an amount of R68 000 was identified as irregular expenditure incurred in the 2021/22 financial year by the internal auditors during the review of irregular expenditure transactions.

b) Details of current and previous year irregular expenditure (Under assessment, determination and Investigation)

Description		
Irregular expenditure under assessment	212	-
Irregular expenditure under determination	-	-
Irregular expenditure under investigation	-	-
Total	212	-

c) Details of current and previous year irregular expenditure condoned

Description		
Irregular expenditure condoned	-	129
Total	-	129

Included in the balance of R12,5 million above is a total of R6,2 million's worth of transgressions that the CSIR Board has requested National Treasury to condone. At the time of preparation of these financial statements the CSIR was waiting for confirmation of condonation.

d) Details of current year and previous year irregular expenditure removed - (Not condoned)

Description		
Irregular expenditure not condoned and removed	-	-
Total	-	-

	2022/23 R'000	2021/22 R'000
e) Details of current and previous year irregular expenditure recovered		
Description		
Irregular expenditure recovered	-	-
Total	-	-
f) Details of current and previous year irregular expenditure written off (Irrecoverable)		
Description		
Irregular expenditure written off	-	-
Total	-	-
g) Details of non-compliance cases where an institution is involved in an inter-institutional arrangement institution is not responsible for the non-compliance		
Description		
None		
Total		
h) Details of non-compliance cases where an institution is involved in an inter-institutional arrangement (where the institution is responsible for the non-compliance)		
Description		
None		
Total		
i) Details of current and previous year disciplinary or criminal steps as a result of irregular expenditure		
Description		
Consequence management in progress	588	1 060
Consequence management implemented	253	2 681
Total	841	3 741

FRUITLESS AND WASTEFUL EXPENDITURE

	2022/23 R'000	2021/2022 R'000
Reconciliation of fruitless and wasteful expenditure		
Opening Balance	191	174
Add: Fruitless and wasteful expenditure confirmed	-	17
Less: Transferred to receivables for recovery	-	-
Less: Fruitless and wasteful expenditure written off	-	-
Total	191	191

PROCUREMENT BY OTHER MEANS

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
The supply of a DTEG equipment for the Smart Mobility	IntoAfrika Resources (Pty) Ltd	Sole Source	SSP3050	170
Lease of duct space and provision of maintenance and support services for the Tshwane Metropolitan area for CSIR owned Dark Fibre	Dark Fibre Africa (Pty) Ltd	Sole Source	SSP3157a	73 438
Lease of duct space and provision of maintenance and support services for the Cape Town Metropolitan area for CSIR owned Dark Fibre	Dark Fibre Africa (Pty) Ltd	Sole Source	SSP3199b	77 651
Renewal of CoJ licence	Drive Control Corporation (Pty) Ltd	Sole Source	SSP3327	4 379
Altium Design software renewal	EDA Technologies	Sole Source	SSP3362	88
A liquid-liquid and gas-liquid separator in ETFE	Zaiput Flow Technologies, LLC	Sole Source	SSP3372	85
Annual renewal of Altium software licence	EDA Technologies	Sole Source	SSP3374	119
Annual Servicing of ASAP Instrument	Poretech cc	Sole Source	SSP3387	57
CSIR Advanced Material Testing Laboratories accreditation for Conformity Assessment in line with calibration and good laboratory practice Act (Act 19 of 2006).	SANAS	Sole Source	SSP3399	56
Procurement of a 1000ton press upgrade	Moog GmbH SA	Sole Source	SSP3405	1 202
Altium Designer Commercial Subscription Renewal: Altium Designer Standalone Commercial Single Site SN-06118693 Standard	EDA Technologies	Sole Source	SSP3408	51
The provision of e SigmaPlot software license	Inpixon India Limited	Sole Source	SSP3411	35
The provision of a Web Based Supply Chain Benchmarking Tool	Winning Moves Limited	Sole Source	SSP3416	500
Electronic Warfare Market by Capability	Markets & Markets Research	Sole Source	SSP3426	76
SABINET subscription renewal	SABINET Online Ltd	Sole Source	SSP3431	777
SCOPUS subscription renewal	Elsevier B. V	Sole Source	SSP3432	497
SABINET CMS Parliamentary office renewal	SABINET Online Ltd	Sole Source	SSP3434	228
Oracle Agreement 1815616 renewal	Oracle Corporation South Africa (PTY) Ltd	Sole Source	SSP3441	76
Refurbished HP 9000 C100 workstations	Cypress Technology Inc	Sole Source	SSP3442	92
Industrial converters	Eagle Technology	Sole Source	SSP3443	109

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
The provision of Maintenance, Service including evaluation, minor repairs, firmware updates, board modifications, calibration, and testing of the CSIR wave rider Instrument	Sea-Bird Scientific	Sole Source	SSP3446	37
Licence Renewal	John Wiley & Sons Ltd	Sole Source	SSP3448	540
Exhibition	Prometheus GMBH	Sole Source	SSP3449	59
2 X Thermal Anemometers and Calibration	Young Calibration Limited	Sole Source	SSP3450	115
Licence renewal: NuQ Payroll System Software system solution, support and maintenance	Pay Squad CC	Sole Source	SSP3457	1 944
Vincent horizontal screw press Model CP-4	Vincent Corporation	Sole Source	SSP3458	401
Composite Repair Type	American Bureau of Shipping	Sole Source	SSP3462	312
REMchannel Subscription Renewal	Remchannel (Pty) Ltd	Sole Source	SSP3469	68
BCC Renewal	BCC Research LLC	Sole Source	SSP3474	616
Repair: PARR Reactor Heater Assy * Heater assembly needs major repair	Labotec Pty Ltd	Sole Source	SSP3475	56
Purchase of Discovery DSC2500 differential scanning calorimeter (with trade-in discount)	ADI Scientific (PTY) Ltd	Sole Source	SSP3481	2 124
Return Shipping of the Leak Detector from JEOL UK	Angstrom Scientific (Pty) Ltd	Sole Source	SSP3482	125
The provision of Anylogic Modeling Training, Anylogic V8.8 Professional software and Wolfram Mathematica V13.1 Perpetual Network License	Blue Stallion Technologies cc	Sole Source	SSP3485	764
Oracle 2718401 Software Renewal	Oracle Corporation South Africa (PTY) Ltd	Sole Source	SSP3489	2 311
The supply of wind monitor equipment for CSIR Coastal Engineering and Port Infrastructure Group	Inteltronics	Sole Source	SSP3491	119
Dynamic pencil probes and signal conditioners maintenance.	TANDM Technologies (Pty) Ltd	Sole Source	SSP3492	35
Renewal of Oracle Agreement 6626768	Oracle Corporation South Africa (PTY) Ltd	Sole Source	SSP3499	620
ANSYS Licence and Tecs Renewal	Qfinsoft (Pty) Ltd	Sole Source	SSP3501	347
3D printing of components and parts	Metal Heart (Pty) Ltd	Sole Source	SSP3506	53
Proficiency Testing (PT)	Industrial Analytical (Pty) Ltd	Sole Source	SSP3509	33
ECOFLEX	AMT Composites (Pty) Ltd	Sole Source	SSP3510	100
Bentley AssetWise ALIM Renewal Subscription for 2023	Bentley systems international Ltd	Sole Source	SSP3515	1 201

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
EDAQ Data acquisition	TANDM Technologies (Pty) Ltd	Sole Source	SSP3516	124
FLD HPLC detector, Installation and Training (Replacement of broken detector)	Chemetrix Export (Pty) Ltd	Sole Source	SSP3523	496
Standard Sponsor PLUS Panelist: Water Webinar	Creamer Media South Africa (PTY) LTD	Sole Source	SSP3524	36
TGA Q500 & 5500 Parts	Advanced Laboratory Solutions t/a ADI Scientific Pty Ltd	Sole Source	SSP3535	103
DFA Annual SLA for Tshwane Metro	Dark Fibre Africa (PTY) LTD	Sole Source	SSP 2371	2 701
Analysis of Hexavalent Chromium 1854	SGS Galson	Single Source	SIN 225	111
Bringing the Lengau Cluster back online	Eclipse Holdings (Pty) Ltd	Emergency Source	EMP 54	48
Dick Wittington combat boot	Dick Whittington Shoes (PTY) LTD	Sole Source	SSP3363	4 037
Package 'Talkwalker Research' for Talkwalker Project 'Council for Scientific and Industrial Research- Analytics'	Talkwalker Sarl	Sole Source	SSP3371	819
Detego Suite Ultimate - Annual Renewal Includes: Field, MA, Covert, Fusion, Ballisc Imager, Detego	TRINEXIA (PTY) LTD	Sole Source	SSP3415	161
Procurement of Laser arc lamps	Horiba Jobin Yvon GmbH	Sole Source	SSP3418	52
Microsoft Enterprise Support Services	Microsoft (S A) (Pty) Limited	Sole Source	SSP3429	1 506
Customised MSC Simulation Product Training	SIMTEQ Engineering (PTY) LTD	Sole Source	SSP3436	60
The supply of Waverider buoys spares and parts for CSIR Smart Mobility	Datawell BV	Sole Source	SSP3445	1 614
Microsoft Enterprise Agreement Renewal	Microsoft Ireland Corporation LTD	Sole Source	SSP3454	14 549
Science Direct Subscription Renewal	Elsevier B. V	Sole Source	SSP3460	2 890
IMAGINE Software Maintenance Renewal	Geo Data Design PTY LTD	Sole Source	SSP3464	186
Tourmaline ICP Underwater Blast Sensor	TANDM Technologies (Pty) Ltd	Sole Source	SSP3478	240
Market Report	Market Research.com Profound ACQ	Sole Source	SSP3479	113
Ramlog Licence renewal	R&M Technologies CC	Sole Source	SSP3495	124
Renewal Of Oracle Agreement 18819200	Oracle Corporation South Africa PTY LTD	Sole Source	SSP3500	68
The supply of TZM muffle box	Shanghai Gehang Vacuum Technology	Sole Source	SSP3505	406

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Annual ChemDraw Prime (ChemDraw Maintenance License renewal) and Signals Notebook	Perkin Elmer Informatics Inc	Sole Source	SSP3508	56
Repair of the Titan Tensile Strength Tester	Dutest Agencies CC	Sole Source	SSP3519	60
KZN Exhibition	Specialised Exhibition PTY LTD	Sole Source	SSP3521	34
Procurement Laser spare component for maintenance	HORIBA Jobin Yvon GmbH	Sole Source	SSP3522	40
Micro Focus Assurance and SUSE Products Renewal	AXIZ (Pty)Ltd	Sole Source	SSP3528	4 861
New Kuka Robot Acquisition on LSP Accelerator Project	Jendemark Automation (PTY) LTD	Sole Source	SSP3538	702
TeamViewer Tensor Renewal	Team Viewer GMBH	Sole Source	SSP3542	1 011
Enhance Training project a breathing apparatus is required to simulate breathing under emergency conditions.	Hannover Engineering (PTY) LTD	Sole Source	SSP3543	163
Global Investment Casting Market Research Report—Forecast till 2025	Absolute Reports PVT LTD	Sole Source	SSP3544	32
1. Measuring Plate Pp25/Di/Ti 1 Pcs D: 25 Mm; For Dielectrical Meas. Cell. 2. Ceramic Isolator Di-Option for Ctd	Anton Paar Southern Africa (PTY)	Sole Source	SSP3550	42
3x C-Plus Bioreactors	Sartorius South Africa (Pty) Ltd	Sole Source	SSP3571	14 473
Requirements for the upgrading of the fire tunnel:	Donald James Bryden	Single Source	SIN 189	48
Renewal of subscription service for Solidworks Research Network	Mecad Systems PTY LTD	Single Source	SIN 215	89
Toyota Hilux bakkie parts for repairs	McCarthy Toyota PTY LTD	Single Source	SIN 230	32
AS9100 Aerospace Quality Management System - 1st Surveillance Audit 2022	NOVO STAR management system solutions India Private	Single Source	SIN184	32
Mobile trailer lights generator upgrades	Aztec Components	Single Source	SIN 217	633
KnowBe4 Security Awareness Subscription Renewal and support for a period of 12 months	FULLSTREAM BUSINESS SERVICES (PTY) LTD	Single Source	SIN 222	866
Liquid Helium	AFROX	Single Source	SIN 227	322
Emergency replacement of Airconditioning Unit at the CSIR ICC Amethys Room.	Optimal Air cc	Emergency procurement	EMP 52	381
Substation 12 has had a transformer failure which resulted in loss of supply and production to the High-Speed Wind Tunnel.	Uni-Test	Emergency procurement	EMP 53	251
Trailer mounted light mast generator sets	Aztec Components	Emergency procurement	EMP 50	7 237

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Rerouting of existing Fiber at WVSU Butterworth Campus	Telkom SA SOC Limited ("Telkom")	Single Source	SIN 178	109
THE Development of a Micro-Heater Platform	Incomar Aerospace and Defence Systems (Pty) Ltd	Single Source	SIN 181	198
SPK Heat Exchanger	Retecon Services (Pty) Ltd	Sole Source	SSP3020	130
Smart Mobility need to procure Plan G SBD service for two Datawell buoys.	MetOcean Telematics	Sole Source	SSP3004	68
Resonator replacement	Retecon Services (Pty) Ltd	Sole Source	SSP3060	3 269
Annual renewal of the Power Factory for Research (PF4R) – License with unlimited nodes for 7 users	Digsilent Buyisa (Pty) Ltd.	Sole Source	SSP3068	159
Membrane Vacuum pump	Busch Vacuum Solutions	Sole Source	SSP3063	50
Qualica License renewal	Qualica GmbH	Sole Source	SSP3062	32
Optinum software license renewal	Opti-num Solutions (Pty) Ltd	Sole Source	SSP3074	381
Bentley Select AssetWise ALIM Software Subscription for 2022	BENTLEY SYSTEMS INTERNATIONAL LTD	Sole Source	SSP3080	1 284
Request to advertise on Business Day Earth Magazine	HighBury Media	Sole Source	SSP3075	72
SABS subscription renewal	SABS	Sole Source	SSP3078	231
Edwards High Vacuum pump model RV12	United Scientific (Pty) Ltd	Sole Source	SSP3071	153
The provision of service and maintenance of Wave Gliders for the CSIR Ocean Systems & Climate	Liquid Robotics Inc.	Sole Source	SSP3033	471
Supply and Delivery of Material for Water Leak repairs to the Mogalakwena Local Municipality	GeoWater Systems (PTY) Ltd	Sole Source	SSP2914	86
Kimmon Laser tube	A and J Scientific	Sole Source	SSP3083	258
The provision of Arctic Hub Software License for SANReN Computer Security Incident Response Team	Arctic Security Ltd	Sole Source	SSP3021	648
SYNCOR, Inc	Conical Technologies	Sole Source	SSP3084	92
NPort S8455I - (4 RS-232/422/485 ports, 5 10/100M Ethernet ports, 2KV Isolation Protection, 12-48 VDC, 0 to 60°C)	RJ connect	Sole Source	SSP3069	94
Quotation for renewal of mentor support contract	ASIC Design Services	Sole Source	SSP3079	175
Para Boot testing	SABS	Sole Source	SSP3072	85
Pearl Scanner and JAWS fr the blind	Sensory Solutions	Sole Source	SSP3082	46

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
IR Viewer	Wirsam Scientific & Precision	Sole Source	SSP3088	61
Accessories hardware for Instron Instrument	ADI Scientific Pty Ltd	Sole Source	SSP3065	2 525
Gascam FPGA tool annual license renewal	Arrow Altech Distributors	Sole Source	SSP3110	102
The supply of exhibition material for the International Supercomputing Conference in Hamburg, Germany.	Cubiworx	Sole Source	SSP3095	52
DFA connectivity link between Centre for High Performance Computing (CHPC) and Shawco House; and from Shawco House site and University of Cape Town (UCT)	DARK FIBRE AFRICA (PTY) LTD	Sole Source	SSP3107	66
DFA connectivity link between Marine and Coastal Management (MCM) and South African Environmental Observation Network (SAEON) ulwazi node	DARK FIBRE AFRICA (PTY) LTD	Sole Source	SSP3108	41
Request for connectors	Marine Solutions	Sole Source	SSP3090	216
Entrust Annual Renewal (2022)	Law Trusted Third Party Services (Pty) Ltd	Sole Source	SSP3101	162
Casting SA Full Page Full Colour August 2022, October 2022, December 2022, February 2023, April 2023, June 2023 and Csting SA Website Logo Twelve month from August 2022 to July 2023	BA Crawford Publishing	Sole Source	SSP3097	121
Eco-logic Publishing (Eco-logic Awards)	Eco-Logic Publishing	Sole Source	SSP3096	119
Request for exhibiting at the Manufacturing Indaba - 9th edition	Manufacturing Indaba	Sole Source	SSP3093	156
Boxcryptor software license renewal	Secomba Gmbh	Sole Source	SSP3117	137
National Event: 21 - 22 June 2022, Sandton Convention Centre	Manufacturing Indaba	Sole Source	SSP3087	544
Upgrade (Perpetual License): CORE Spectrum – Floating license	Letter 27 Imagine it Pty Ltd	Sole Source	SSP3114	112
The acquisition of economic forecasting and impact assessment models software for Smart Mobility	Conningarth Economists	Sole Source	SSP3056	462
The supply of 1 x Digital Mass Flow Controller BRONKHORST	Mecosa Pty Ltd	Sole Source	SSP3105	150
REMchannel remuneration survey subscription services	PWC RESEARCH SERVICES (PTY) LTD t/a REMCHANNEL PTY LTD	Sole Source	SSP3089	63
Supply of 120-degree wide angle submarine camera	Marine Solutions	Sole Source	SSP3116	122
Initial Audit – BV service provider for UWS	Bureau Veritas	Sole Source	SSP3122	66
Exhibition space Aero south africa 2022	Messe Frankfurt South Africa (Pty) Ltd	Sole Source	SSP3115	52

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Supply of 3 x Compressors.	Service First Cape (Pty) Ltd	Sole Source	SSP3135	167
Laboratory accreditation	SANAS	Sole Source	SSP3109	78
Oracle re-instatement (Agreement 18819200)	Oracle Corporation (South Africa) (Pty) Ltd	Sole Source	SSP3120	83
Renewal of subscription services for One year	Dassault Systèmes SA (Pty) Ltd	Sole Source	SSP3099	42
BIOVIA Materials Studio Academic Research Suite – National software license	Dassault Systèmes SA (Pty) Ltd	Sole Source	SSP3094b	1 299
Equipment of laser material processing	Fraunhofer ILT	Sole Source	SSP3102	144
Technical Components	Harmonic Drive	Sole Source	SSP3132	631
One key license and support	Pragma	Sole Source	SSP3136b	294
MindView Software Licence Renewal for 1 Year	MatchWare Inc	Sole Source	SSP3138	56
Mathworks Software Products	Opti-num Solutions (Pty) Ltd	Sole Source	SSP3144	766
COJ _ Certificate Management System Renewal - 3 Year Licence	Law Trusted Third Party Services (Pty) Ltd	Sole Source	SSP3148	758
Udemy for Business Licenses	Udemy Business	Sole Source	SSP3152	474
Siemens software: Plant Simulation Consultation and Support	Siemens	Sole Source	SSP3160a	228
The supply of SG Spares for SG573 Case 4755 and total sensor repair for the CSIR Ocean Systems & Climate	Hill Unmanned Systems, Inc.	Sole Source	SSP3157b	57
Spatial Light modulator	Holoeye Photonics	Sole Source	SSP3158b	148
The provision of laboratory analyses on water/ wastewater and sediment for the CSIR Durban Outfalls Monitoring project 2022/23	Eurofins Analytico BV	Sole Source	SSP3160b	257
Materials for Manufacturing: ARMOX500T	SSAB	Sole Source	SSP3162	94
Technical Components	Humanetics	Sole Source	SSP3165	51
Repairs of Peak Scientific AB-3G Nitrogen generator which provides high-purity nitrogen gas to one of the mass spectrometry systems	Peak Scientific Africa (Pty) Ltd	Sole Source	SSP3169	57
Annual accreditation fee 2022/2023	SANAS	Sole Source	SSP3172	45
SMSPRIME and EMI	Custom Made Investigation Technology Solutions	Sole Source	SSP3173	65
8 cancer cell lines for the cell culturing and to establish protocol for cancer precision medicine	PromoLab (Pty) Ltd T/A Separations	Sole Source	SSP3174	138

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
The supply of Booth Space at HPC2022 Conference in Cetraro, Italy.	Prof. Lucio Grandinetti	Sole Source	SSP3175	34
Annual license renewal of SuperPro Designer	INTELLIGEN, INC.	Sole Source	SSP3176	108
The supply of 2 x batteries and spare parts for a Web Teledyne Slocum glider	Teledyne Webb Research	Sole Source	SSP3177	755
Siemens software maintenance renewal	Siemens	Sole Source	SSP3178	1 522
Annual service of the Synapt UPLC-MS equipment used for high end analysis of small molecules	Microsep (Pty) Ltd	Sole Source	SSP3180	263
The provision of Flownex license and training for Smart Places	M-Tech Industrial (Pty) Ltd	Sole Source	SSP3182	333
Computer, Camera, and camera analysis software for Olympus BX40 microscope.	Wirsam Scientific and Precision Equipment (Pty) Ltd	Sole Source	SSP3183	69
Global Africa Network - South Africa Business publication	Global Africa Network Media (Pty) Ltd	Sole Source	SSP3184	40
Edgcam Maintenance Contract	Stillam Services CC	Sole Source	SSP3186	45
Famelab Competition	Jive Media	Sole Source	SSP3187	49
EBSCO Academic eBooks Collection Annual Subscription Renewal (01 August 2022 – 31 July 2023)	EBSCO International Inc	Sole Source	SSP3190	135
Lab Accreditation and Certification	SANAS	Sole Source	SSP3192	90
Servicing of the Milli-Q water purification system in Lab C34 in Building 18C	Merck Life Science (Pty) Ltd	Sole Source	SSP3194	42
Repair and Maintenance of 3D printer	3D Manufacturing Technology	Sole Source	SSP3196	88
Microcep process sensors and cables	Microsep (Pty) Ltd	Sole Source	SSP3197	274
Sartorius inlet, exhaust and venting filter for Bioprocess fermenters	SARTORIUS SOUTH AFRICA (PTY) LTD	Sole Source	SSP3198	64
Hamilton process sensors and cables	PromoLab (Pty) Ltd T/A Separations	Sole Source	SSP3199	199
ThermoFisher QuantStudio5 Equipment Service and ThermoFisher Kingfisher Flex Equipment Service	LTC Tech South Africa (Pty) Ltd	Sole Source	SSP3200	549
The provision of specialised software adds on for MS power point. Think Cell - 1 Year Subscription Renewal	TITUS Corporation	Sole Source	SSP3203	100
The provision of sustainability Handbook and Panel session at the sustainability summit.	Kagala Media (Pty) Limited	Sole Source	SSP3204	192
Services: Laboratory analysis of water samples for protozoan parasites, enteric viruses, and tissue culture maintenance	Aquadoc Analytics	Sole Source	SSP3205	224

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
AI Media Expo Africa 2022	AI Media Organizers Pty Ltd	Sole Source	SSP3206	115
Hepa filters	Devos Laboratory	Sole Source	SSP3208	34
The supply of Broadband IOT equipment for Supporting SMMEs to Bridge the Digital Divide	Whizpace	Sole Source	SSP3214	242
Southern African Energy Efficiency Confederation Conference (SAEEC) 28 – 30 September 2022	Southern African Energy Efficiency Confederation (SAEEC)	Sole Source	SSP3179	58
Renewal of Software License from carmenta	Carmenta Geospatial Technologies AB	Sole Source	SSP3185	78
Repair and replacement of parts for chiller	Compact Cooling	Sole Source	SSP3193	108
Raptor/ Custom Payload Integration	Alti UAS (PTY) LTD	Sole Source	SSP3201	744
Technical Components	Logicalis SA	Sole Source	SSP3211	675
Covert System SCW0186AMX	SCW Turnkey Projects	Sole Source	SSP3216	455
Provincial Government Handbook 2022 and National Government Handbook 2023	Yes Media	Sole Source	SSP3219	58
Resource Magazine February 2023, August and November 2022 edition 2 – 3 inserts	Novus Print	Sole Source	SSP3220	64
Yearly service of the Physica Smartpave plus Modular Compact Rheometers used in the specification testing of bituminous binder.	Anton Paar Southern Africa	Sole Source	SSP3222	34
1 x RMA-CRE-SRVXM License Replacement VXmodel – MOD, 1 x RMA-CRE-SRVXMI License Replacement VXinspect Full – INS	High Tech Machine Tools	Sole Source	SSP3223	36
Who Owns Whom (WOWEB) Annual Subscription Renewal (01 September 2022 – 31 August 2023)	Who Owns Whom (Pty) Ltd	Sole Source	SSP3227	124
Quantec EasyData Annual Subscription Renewal (01 September 2022 – 31 August 2023)	Quantec Enterprises (Pty) Ltd	Sole Source	SSP3228	442
Supply of PS-410 Schenck power supply	DURR Africa (Pty) Ltd	Sole Source	SSP3229	116
Bio Africa Conference	Bio Africa	Sole Source	SSP3233	179
Capacitating Blouberg municipality on the use of a land decision-making framework	i@consulting	Single Source	SIN 180	99
Cyber professional license renewal.	CGCIS Ltd.	Sole Source	SSP3073	765
Technical Components	Siemens (Pty) Ltd	Sole Source	SSP3188	52
Technical Components	Timbre Broadcast Solutions	Sole Source	SSP3191	199
Watson Marlow pumps used on Bioprocess reactors	Watson-Marlow Bredel SA (Pty) Ltd	Sole Source	SSP3195	122

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
The repair and upgrade VINDTA 3C	Marine Analytics and Data	Sole Source	SSP3202	141
Ethniks scala software renewal 2022	Ethniks Scala	Sole Source	SSP3215	87
Annual accreditation fee 2022/2023	SANAS	Sole Source	SSP3217	34
Technical Components	Gisma Steckverbinder GMBH	Sole Source	SSP3218	48
Hyhenated TGA-FTIR Pump Module Replacement	PerkinElmer SA	Sole Source	SSP3224	97
Turbo Pump Replacement	Carl Zeiss	Sole Source	SSP3225	219
The upgrading of cetis PV-Module test 3 system - Sun Simulator in the PV module lab	H.A.L.M Elektronik GMBH	Sole Source	SSP3230	2 364
Billboard Advertising	Kwaito Trading Company (Pty) Ltd	Sole Source	SSP3231	45
Specialised Mining Electrical engineering	Donald Bryden	Sole Source	SSP3238	80
Accreditation fee for the South African National Accreditation System (SANAS) 2022/2023	SANAS	Sole Source	SSP3239	34
Request for 1 x TVWS Base Station, 2 x CPE devices and 1 x Cloud SW (NMS)	WiFrost Inc.	Sole Source	SSP3241	72
Writefull Annual Subscription Renewal (24 August 2022 – 23 August 2023)	WorldWide Information Services (Pty) Ltd	Sole Source	SSP3242	101
Scanlab scanner components	Scanlab GmbH	Sole Source	SSP3243	111
MATLAB Annual Liscence	Opti Num Solutions	Sole Source	SSP3245	81
3.5" SCSI 68-pin Wide Single Ended (SE) SSD, 2.14GB capacity, SLC NAND Flash, 0°C to +70°C operating temp	Red Rock Technologies inc	Sole Source	SSP3246	44
Request to participate in National Event: International Aluminium Federation of South Africa Conference 26 – 27 October 2022 to be held in Cape Town.	Aluminium Federation of South Africa	Sole Source	SSP3248	200
Hamilton EasyFerm Plus Arc 425mm	United Scientific (PTY) LTD	Sole Source	SSP3249	81
Replacement Lens Control PCB for the Waters Synapt HDMS	Microsep	Sole Source	SSP3250	156
Construction of an exhibition stand at the BioAfrica Conference in Durban	Brand Sprout	Sole Source	SSP3255	120
License renewal for casewise	Wasewise	Sole Source	SSP3258	333
Ground vibration test (GVT) system hardware equipment	TANDM Technologies	Sole Source	SSP3259	132
Highly specialized underwater military grade PU cables with connectors	Hiconnex	Sole Source	SSP3262	229

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Custom explosive detonators for PUDU system	Loulen Manufacturing	Sole Source	SSP3263	194
SPIE subscription renewal (01 September 2022 to 31 August 2023)	SPIE	Sole Source	SSP3267	88
Modules, Technical Components	Siemens	Sole Source	SSP3268	88
Annual licence renewal (Solid Works)	Siemens Industry Software SA (Pty) Ltd	Sole Source	SSP3270	45
Market Research Report	BCC Research LLC	Sole Source	SSP3271	71
Replacement of Y axis Motor for a 3 D printer	3D Solids Additive Manufacturing Technology CC	Sole Source	SSP3276	110
Supply and Delivery of Liquid Helium Baseline 5.0 0.3KG	African Oxygen (Pty) Ltd	Urgent Source	URG001	52
The provision of Iridium Communications Service to the CSIR.	CLS South Africa	Sole Source	SSP3235	300
RAPDASA Conference exhibition	RAPDASA	Sole Source	SSP3237	230
Sciformer Systems Used for KPI Submissions, Contract Data Management and Partnership Management Models	Management Planning Systems	Sole Source	SSP3247	54
Kuka Repairs	Jendamark	Sole Source	SSP3256	37
Provisioning dark fibre link to connect ASSAf new building to SANReN network	Dark Fibre SA	Sole Source	SSP3265	153
The supply of parts and spares for the CSIR GO PCO2 system	General Oceanics Inc	Sole Source	SSP3272	121
The enhancement of the FGD Supplier Database Portal for Eskom Medupi Power Station	Cambridge Industrial Systems	Sole Source	SSP3273	576
The supply three scroll compressors of which two will be installed in chiller 1 circuit 2	Service First Cape (Pty) Ltd	Sole Source	SSP3275	180
DR-2477-P/M250 Analog torque transducer with feather key. Lorenz part No. 109467 Capacity: 5Nm. Accuracy class: 0.25%	Elexsys Precision Physical Measurement	Sole Source	SSP3285	33
Product certification-ANS 62-1:2013 - Pipes suitable for threading and of nominal size not exceeding 150 mm. Class: Medium - 8NB (Screw/Plain), 10NB (plain), 15NB (plain) and 20NB (plain)	SABS	Sole Source	SSP3287	210
Servicing and repairs of the MilliQ in building 18 used to generate deionised water	Merck Life Science Pty	Sole Source	SSP3292	71
NCPC-SA Profile in BBQ Magazine for 20 Years Celebration	Cape Media t/a Kaqala Media	Sole Source	SSP3293	34
Annual renewal of Business licences (SimaPro Compact, Analyst, Developer)	The Green House	Sole Source	SSP3298	74
The supply of Dynamic Shear Rheometer spindles and plate sets	Anton Paar Southern Africa, Pty Ltd	Sole Source	SSP3300	79

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Request for Investment in the 4th upgrade of capacity on the West Africa Cable System (WACS)	Broadband Infraco SOC Ltd (BBI)	Sole Source	SSP3301	20 476
Gaussian and Linda Software Maintenance renewal	Gaussian Inc.	Sole Source	SSP3305	262
Advertising space in Highbury Sasfika Media - African Decisions	Highbury Sasfika Media	Sole Source	SSP3308	29
Media buying	African Science Stars (Pty) Ltd	Sole Source	SSP3312	65
Request for Piezo ceramics for Umbiflow project	APC International Ltd	Sole Supplier	SSP3153	131
Oracle Licence Renewal 2022	Oracle Corporation South Africa (Pty) Ltd	Sole Supplier	SSP3252	735
Genesys Licence	Letter 27 Imagine IT (Pty) Ltd	Sole Supplier	SSP3264	182
Annual licence renewal	Aerotherm Computational Dynamics CC	Sole Supplier	SSP3269	1 394
Tunable laser diode	Toptica Photonics AG	Sole Supplier	SSP3274	438
JA-14 Rotor Centrifuge	Beckman Coulter South Africa (Pty) Ltd	Sole Supplier	SSP3278	84
Annual accreditation fee 2022/2023	SANAS	Sole Supplier	SSP3284	34
769.89-1 OD7 Ultra Narrow Bandpass and 757.9-1 OD4 Ultra Narrow Bandpass	Alluxa INC	Sole Supplier	SSP3286	50
Cooled Scientific USB3.1 sCMOS BSI camera (Gpixel 2020BSI,	Ximea GMBH	Sole Supplier	SSP3288	188
ARCHIBUS Annual Support and Maintenance (01 October 2022 to 30 September 2025)	Archibus Solution Centre South Africa (Pty) Ltd	Sole Supplier	SSP3290	1 006
Lab Safety and enhancement oif material development Processes	Labotec (Pty) Ltd	Sole Supplier	SSP3291	175
Request for ESI software license renewal	ESI Group	Sole Supplier	SSP3302	516
CSIR Energy Centre participation at the WINDABA Exhibition for the Wind Energy Industry	Messe Frankfurt South Africa (Pty) Ltd	Sole Supplier	SSP3306	55
The supply of a diagnostic kit (for the detection of protozoan parasites in water)	Idexx Laboratories (Pty) Ltd	Sole Supplier	SSP3307	78
The procurement of cross-connects	Tertiary Education and Research Network of South Africa (TENET)	Sole Supplier	SSP3309	879
The Procurement of Vehicle access ladder systems	Castor & Ladder (Pty) Ltd	Sole Supplier	SSP3313	181
Procurement of Power supply modules	Conical Technologies (Pty) Ltd	Sole Supplier	SSP3315	187
InMagic suite: Presto Annual Software Subscription Renewal and Telephone Support (01 November 2022 - 31 October 2023)	Mindex Stelsels CC	Sole Supplier	SSP3317	188

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Solidworks data import	Siemens (Pty) Ltd	Sole Supplier	SSP3318	163
EMME Maintenance	Bentley Systems International Limited	Sole Supplier	SSP3319	40
CSIR participation on 15th Green Building Convention 2022, 2 - 4 Nov 2022	Green Building Council of South Africa	Sole Supplier	SSP3322	71
Request to participate in National Event: Southern African Energy Efficiency Confederation Conference (SAEEEC)	Southern African Energy Efficiency Confederation (SAEEEC)	Sole Supplier	SSP3323	37
The supply of laboratory consumables for Particulate Sampling	Merck Life Science (Pty) Ltd	Sole Supplier	SSP3324	104
Outside Broadcast on Ukhozi FM and SAFM to advertise the CSIR 2022 Conference	SABC	Sole Supplier	SSP3328	575
SOW -Solution architect	Siemens (Pty) Ltd	Sole Supplier	SSP3330	66
EGC 500 KOH Eluent generator cartridge for HPIC	Anatech Instrumenets (Pty) Ltd	Sole Supplier	SSP3333	43
The supply of a Glass Tank and enclosed stand for the Ndlambe green village in Ekhuphumleni Township	Wilbro Trading (Pty) Ltd	Sole Supplier	SSP3337	39
The supply of wireless road surface deflectometer - (RSD)	Westplex (Pty) Ltd	Sole Supplier	SSP3181	123
Renewal of SAS Licences	SAS Institute Pty Ltd	Sole Supplier	SSP3240	110
Mekateko Medi -Sawubona	Mikateko Media	Sole Supplier	SSP3257	40
The provision of HR DAQ Data Acquisition and Analysis Package for the CSIR in Stellenbosch, South Africa	HR Wallingford Limited	Sole Supplier	SSP3266	121
Oracle Annual Technical Support Services Renewal (30 November 2022 to 29 November 2023)	Oracle Corporate (South Africa) (Pty) Ltd	Sole Supplier	SSP3289	2 587
Arena Holdings Business Live space procurement	Arena Holding (Pty) Ltd	Sole Supplier	SSP3294	42
Kweda Media & Communications Municipal Focus space procurement	Kweda Media & Communications Municipal Focus	Sole Supplier	SSP3295	52
Kaqala Media Leadership Magazine space procurement	Kaqala Media Leadership Magazine	Sole Supplier	SSP3297	51
The replacement of the buoyancy glider - a G3 Teledyne Webb Research Slocum glider	Teledyne Instruments, Inc	Sole Supplier	SSP3303	4 639
LTC SA Tech MVP II Kit	LTC Tech South Africa	Sole Supplier	SSP3304	114
Service and repair of CSIR Coulter Counter	AMS Laboratory Technologies Pty Ltd	Sole Supplier	SSP3310	74
Request for approval to be featured in Arena Holdings ST Women September 2023	Arena Holding (Pty) Ltd	Sole Supplier	SSP3310b	37

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
IEEE Electronic Library (IEL) Annual Subscription Renewal (30 November 2022 - 29 November 2023)	EBSCO International Inc	Sole Supplier	SSP3314	1 645
Repair the load cell on the Cannon Bending-Beam Rheometer - BBR	Zutek Services cc	Sole Supplier	SSP3325	57
Renewal of Micro Focus Assurance Renewal	Micro Focus South Africa	Sole Supplier	SSP3326	1 295
MedeA Universal Cluster Expansion Software	Material Design	Sole Supplier	SSP3334	175
Core is a system engineering software that accurately integrates management of customer requirements	Letter 27-Imagine IT (Pty) Ltd	Sole Supplier	SSP3335	117
Magics Renewals	Rapid 3D JV	Sole Supplier	SSP3336	68
MSC Software renewal	Simteq Engineering (Pty) Ltd	Sole Supplier	SSP3338	433
Exhibition stand building in Accra, Ghana	Africa Open Data & Internet Research Foundation	Sole Supplier	SSP3339	173
The provision of 1 year license for the PBS Pro Resource Manager Software and Support, for the HPC system	Eclipse Holdings (Pty) Ltd	Sole Supplier	SSP3341	8 625
Replacement of cavity and crista	Toptica Photonics AG	Sole Supplier	SSP3342	507
iThenticate Annual Subscription Renewal (08 November 2022 - 07 November 2023)	Eiffel Corp (Pty) Ltd	Sole Supplier	SSP3343	148
SEGMENT CIRCLE WITH 3 MOA RED DOT including AC3211.5 FJORD/ TRJJICON MGRS M2 HMG MOUNT	ECM Technologies	Sole Supplier	SSP3345	91
The supply of wind monitors for CSIR Coastal Engineering and Port Infrastructure Group	Inteltronics	Sole Supplier	SSP3346	85
LENS, 35MM, F1.8, 1, VIS-SWIR	Navitar Inc	Sole Supplier	SSP3347	56
Korn Ferry Architect annual subscription and migration from JEM (Job evaluation manager)	Korn Ferry Pty Ltd	Sole Supplier	SSP3349	454
Procurement of hydraulic cylinders	Hytec South Africa (RF) (Pty) Ltd	Sole Supplier	SSP3350	172
The provision of sample analysis for TerrAttesT in water for the CSIR	Eurofins Analytico	Sole Supplier	SSP3352	33
Repairs and maintenance services for the 2 SBE 911 plus CTD systems for the CSIR	Sea Technology Services (Pty) Ltd	Sole Supplier	SSP3353	110
HiPace 80 Work Exchange	Shimadzu	Sole Supplier	SSP3354	88
OPNsense Business Support Renewal	Deciso Sales BV	Sole Supplier	SSP3355	122
The supply of rechargeable batteries for the CSIR Slocum G3 glider	Teledyne Instruments, Inc	Sole Supplier	SSP3358	638

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
The supply of supply two compressors and replace two faulty compressors	Service First Cape (Pty) Ltd	Sole Supplier	SSP3359	167
Highbury Sasfika Business Day Earth August 2023	Highbury Media	Sole Supplier	SSP3360	72
Small tunnels hire and weapon usage	Denel Soc Ltd	Sole Supplier	SSP3367	47
MSC Software renewal	Simteq Engineering (Pty) Ltd	Sole Supplier	SSP3368	114
Honeycomb HIVE Scout single cell RNA sequencing kit for the generation of single cell RNA transcriptome libraries from cultured cells.	Perkin Elmer	Sole Supplier	SSP3369	90
Vapourtec E-Series Photochem module and accessories	Vapourtec Ltd	Sole Supplier	SSP3370	676
DNA and consumables Kit	Promolab Pty Ltd t/a Separations	Sole Supplier	SSP3373	50
Archibus Annual Subscription Renewal (14 January 2023 - 13 January 2024)	ARCHIBUS Solution Centres South Africa (Pty) Ltd	Sole Supplier	SSP3375	517
EBSCO Custom Database Annual Subscription Renewal (01 January 2023 - 31 December 2023)	EBSCO International Inc	Sole Supplier	SSP3376	904
Branding and Hosting of the Aeronautical Society of South Africa Annual Conference 2022	Aeronautical Society of South Africa (AeSSA)	Sole Supplier	SSP3378	403
Procurement of equipment from foreign sole supplier.	Green Teg	Sole Supplier	SSP3379	144
SBV Formula PUDU Chemical Foam	REAC Polyurethane	Sole Supplier	SSP3383	523
Mobile hopper	GTV Verschleibschultz GmbH	Sole Supplier	SSP3385	92
Oxyboks Training Units	Drager South Africa	Sole Supplier	SSP3386	105
Repairs to the Gel Permeation Chromatography (GPC).	Malvern Panalytical	Sole Supplier	SSP3388	102
Oracle Annual Technical Support Services Renewal Agreement 1772234	Oracle Corporate (South Africa) (Pty) Ltd	Sole Supplier	SSP3390	463
Microorganisms - American Type Culture Collection (ATCC)	Industrial Analytical (Pty) Ltd	Sole Supplier	SSP3395	79
Perceptive Content Subscription Licensing Renewal (ImageNow)	OrangeNow (Pty) Ltd	Sole Supplier	SSP3396	2 393
Renewal of Clarivate Annual Subscription for 2023	WorldWide Information Services (Pty) Ltd	Sole Supplier	SSP3400	484
The manufacturing of the TSS prototype for the new Heavy Vehicle Simulator, the Traffic Stream Simulator (TSS).	Hytec South Africa (RF) (Pty) Ltd	Sole Supplier	SSP3401	326

Project description	Name of supplier	Type of procurement by other means	Contract number	Value of contract R'000
Enterprise-wide Matlab licenses (Framework agreement of consolidated license for various clusters)	Optinum Solutions Pty Ltd	Sole Supplier	SSP3402	3 399
Procurement of precision rails	Tectra Automation (RF) Pty Ltd	Sole Supplier	SSP3406	177
The provision of iridium data services for satellite communications on the CSIR buoys out at sea	MetOcean Telematics Limited	Sole Supplier	SSP3412	77
Birns MCOM21M Connector	Marine Solutions Underwater Systems	Sole Supplier	SSP3414	41
Science Online Journal – 2023 Subscription Renewal	WorldWide Information Services (Pty) Ltd	Sole Supplier	SSP3420	123
SolarWinds Software Europe DAC	SolarWinds Software Europe DAC	Sole Supplier	SSP3424	490

CONTRACT VARIATIONS AND EXPANSIONS

Project description	Name of supplier	Contract modification type (Expansion or Variation)	Contract number	Original contract value	Value of previous contract expansion/s or variation/s (if applicable)	Value of current contract expansion or variation
				R'000	R'000	R'000
Quantity surveying services for building refurbishment at the CSIR Pretoria site	Qsource CC	Variation	NT 75	299	N/A	135
Refurbishment of the future Pharma Facility	LTS Health Africa (Pty) Ltd	Variation	NT 76	1 903	N/A	2 276
Structural engineering services for the Upgrade of Uninterrupted power supply in Rosebank Project	BVi Consulting Engineers (Pty) Ltd	Variation	NT 77	82	85	47

FRAUD AND CORRUPTION

The CSIR Fraud Prevention and Management Policy and Fraud Prevention Plan (FPP) have been developed in compliance with section 3.2.1 of the Treasury Regulations of the PFMA. The CSIR subscribes to the principles of good corporate governance, which require business to be conducted in an honest, ethical and transparent manner. Consequently, the CSIR is committed to eradicating fraudulent and corrupt behaviour at all levels within the organisation.

This FPP is premised on the CSIR's core ethical values driving its business; the development of its systems, policies and procedures; and interactions with upstream and downstream stakeholders in its value chain and overall value proposition, including public and private sector customers, members of the public, suppliers and service providers, employees and its shareholder.

In alignment with the CSIR's core organisational EPIC values, this FPP is the cornerstone of promoting ethical conduct and determining how incidents or suspected incidents of fraud and corruption will be prevented, detected and investigated.

The FPP is a dynamic plan, and it will continuously evolve as the CSIR strives to further promote ethics and prevent fraud.

The main principles upon which the FPP of the CSIR is based are:

- Creating a corporate culture that is ethical, fair and intolerant to fraud and, thereby, aligned with the CSIR's core organisational EPIC values;
- Deterring fraud and corruption;
- Reporting suspicious fraudulent activity without fear of reprisals or recriminations;
- Detecting fraud;
- Investigating any detected fraud;
- Taking appropriate action in the event of fraud, e.g., disciplinary action, recovery of losses and prosecution; and
- Applying sanctions, such as blacklisting of suppliers/service providers who have been found guilty of corrupt practices.

This plan applies to all allegations, attempts and incidents of fraud that have an impact or the potential to have an impact on the CSIR.

The CSIR's FPP encompasses controls that have the following four strategic objectives:

- Identify possible fraud and corruption risks to which the CSIR may be exposed and areas of its business in which these are likely to occur;
- Prevent instances of fraud and corruption from occurring;
- Detect instances of fraud and corruption when they do occur; and
- Respond appropriately and take corrective action when fraud and corruption occur.

The policy of the CSIR is one of zero tolerance to fraud and corruption as captured in the CSIR Ethics Statement and Code of Conduct. All alleged cases of fraud and corruption will be investigated and followed up by the application of all remedies available, within the full extent of the law, and the implementation of appropriate prevention and detection measures. These measures include existing financial and related controls and verification mechanisms as prescribed in the systems, policies and procedures of the CSIR.

The CSIR wishes to facilitate a culture of disclosure of information relating to suspected fraud and related misconduct by employees in a responsible manner. Employees and stakeholders are encouraged to report suspicions of fraudulent activity without fear of reprisals or recriminations.

All CSIR employees and management must comply with the spirit and content of the plan.

A person who holds a position of authority as stipulated in section 34 of the Prevention and Combating of Corrupt Activities Act, 2004 (Act 12 of 2004) should report any suspected corrupt activity and/or an offence of theft/fraud to the police.

The CSIR's Audit and Risk Committee significantly influences the fraud control environment, particularly by setting the tone at the top of the organisation. This is achieved through the discharge for its duties in terms of the PFMA and Treasury Regulations.

The Audit and Risk Committee systematically oversees and periodically reviews the internal controls established by the management of CSIR.

MINIMISING CONFLICT OF INTEREST

Board members and CSIR employees (internal stakeholders) may not place themselves in a position in which their personal interests conflict, or may possibly conflict, with their duty to act in the best interests of the CSIR. This gives rise to the following duties:

- To act bona fide in the interests of the CSIR;
- Not to compete improperly with the CSIR; and
- For Board members to disclose direct or indirect personal or private interests, as envisaged in the provisions of section 50(3)(a) of the PFMA, which shall be duly recorded in the minutes at a meeting. For CSIR employees to also disclose direct or indirect personal or private interests in fulfilment of their common law duty to act in good faith and in the best interest of employer.

Board members are required to inform the Board, through the Board Secretary, in advance, of any conflicts or potential conflicts of interest they may have in relation to items of business to be transacted at a meeting. Equally, CSIR employees are required to disclose any interests they may hold in any organisation, whether it does business with the CSIR or not. This requirement and duty to disclose are enforced when internal stakeholders join the CSIR and at any stage thereafter as necessitated by changed circumstances or position that may pose a potential conflict of interest.

For the CSIR Board, the declarations are managed by the Company Secretariat function and for CSIR employees, by the HC Development function.

Board members may not vote and must not be counted in the quorum of a meeting to pass a resolution in respect of any business where they have a direct or indirect interest.

If any Board member wilfully or negligently fails to disclose an interest as required above or if he/she participates in the proceedings of the Board notwithstanding any conflict of interest, the relevant proceedings of the Board may, at the discretion of the other Board members, be declared null and void.

In exceptional circumstances, the Board may decide that, in the light of interests disclosed by a Board member, such Board member shall not be entitled to receive any

further information on any matter before the Board and shall instruct the Board Secretary accordingly. A Board member who is aggrieved by the Board's decision in this regard shall be entitled to make representations to the Board, which will refer the matter to an independent governance expert whose decision shall be final and binding on the parties.

CODE OF CONDUCT

The Board and the CSIR Exco approved and adopted the Ethics Statement and Code of Conduct that reflects their commitment to a policy of fair dealing and integrity in conducting their operations. The Code has been significantly restated to ensure that it closely aligns to the CSIR set of values, compliance to laws and regulations, and requires all employees to maintain the highest ethical standards, ensuring that business practices are conducted in a manner that is beyond reproach. An Ethics Hotline has been established to facilitate anonymous reporting of ethical transgressions.

The CSIR consistently promotes the application of the Code every year through various awareness activities.

HEALTH, SAFETY AND ENVIRONMENTAL ISSUES

The CSIR's commitment to sustainable development as a strategic priority encompasses the organisation's commitment towards Safety Health Environment and Quality (SHEQ). In delivering on its mandate, the CSIR ensures that its greatest consideration and priority are for the health and safety of colleagues, contractors, suppliers, customers, tenants and local communities, and the protection of the environment. The CSIR is committed to excellence in managing these areas through the SHEQ function.

The CSIR Audit and Risk and Safety Health Environment Leadership Committee assists the Board in monitoring the effectiveness of SHEQ management systems within the CSIR and guiding the Board in decision-making from a SHEQ perspective.

A dedicated SHEQ department works with the business to ensure that the company has deliverable policies, is proactive in its risk assessment and professional in

its remediation. In line with the CSIR's re-positioning of its support services, the SHEQ structure has also now been adapted to include a significant enhancement of operational oversight, advice and support.

In the year under review, the CSIR achieved its target to secure a Recordable Incident Rate (RIR) of less than 1, by achieving an RIR of 0. Despite this achievement, the CSIR is continuously monitoring its SHE risks and implementing appropriate response measures to address undesirable trends as and when identified. This includes numerous management safety walkabouts, a NeuroSafety programme aimed at improving our SHE culture, SHE articles published on the intranet and safety tips communicated in SHE committees in the clusters, centres, portfolios and regional sites. This is done to raise awareness about the number of incidents and environmental issues that occurred during the year, including sharing the lessons learned from such incidents and near misses.

CSI AND OUTREACH ACTIVITIES

The Mandela Day Initiative was celebrated through various activities in regions in which the CSIR is located. The initiative focused on providing learner and teacher support to science, technology, engineering and mathematics schools in previously disadvantaged areas.

During this initiative, a total of 154 CSIR staff members participated across the CSIR regions. Seven high schools

(Chesterville, Fundukaliphe, Kayamandi, Manyano, Phumanyova, Sikhululekile, and Ukuphumula) were supported and 1 767 grade 12 learners were reached. The support included the painting of classrooms; donation of laboratory equipment, donation of office furniture and mathematical instruments.

BOARD SECRETARY

The Board Secretary's responsibilities include the following:

- Providing the Board and individual Board members with guidance as to the nature and extent of their duties and responsibilities, and how such duties and responsibilities must be properly discharged in the best interest of the CSIR and the shareholder;
- Ensuring the induction of new and inexperienced Board members and, together with the Chairperson of the Board, developing mechanisms for providing continuous education and training for all Board members to improve and maintain the effectiveness of the Board;
- Assisting the Chairperson in determining the Annual Calendar and Annual Board Plan and other issues of an administrative nature; and
- Providing a central source of guidance and advice to the Board on matters of business ethics and good governance – the Board Secretary's appointment is subject to the same 'fit and proper test' to which a new Board member's appointment is subject.

AUDIT COMMITTEE REPORT

We are pleased to present our report for the financial year ended 31 March 2023.

Audit and Risk Committee Responsibility

The Audit and Risk Committee has complied with its responsibilities arising from section 77 of the PFMA and Treasury Regulation 3.1.13. The committee has adopted formal Terms of Reference as its charter, approved by the Board. Accordingly, the committee has conducted its affairs in compliance with this charter and has discharged its responsibilities as contained therein.

Committee members and attendance

The Audit and Risk Committee consists of members as stated on page 92 of this report. In terms of its Terms of Reference, the committee convened at least four meetings for the period under review. The meetings and schedule of attendance are shown on page 95 of this report.

The CEO, the executive management, and representatives of internal and external auditors attended committee meetings by invitation. The committee also periodically meets separately with internal and external auditors. The internal and external auditors have unrestricted access to the committee.

The effectiveness of internal control

The system of internal control that the CSIR applies over financial risk management is effective, efficient and transparent. In line with the PFMA and King IV report, the Internal Audit function provides the committee and management with assurance that the internal controls are appropriate and effective. This is achieved by means of the risk management process, as well as the identification of mitigating measures and an ongoing assessment thereof.

From the quarterly reports of Internal Audit, the audit report on the annual financial statements and the management report of the Auditor-General of South Africa, it was noted

that no matters that include any material deficiencies in the system of internal control or any deviations therefrom were reported. Accordingly, the committee can report that the system of risk management and internal control over financial reporting for the period under review was efficient and effective.

In-year management and quarterly reports

The committee has noted and is satisfied with the content and quality of the quarterly reports prepared and issued by the CSIR during the year under review.

Evaluation of financial statements

We have reviewed the annual financial statements prepared by the CSIR for the year ended 31 March 2023. Based on the information provided, the committee considers that it complies, in all material respects, with the requirements of the various Acts governing disclosure and reporting on the annual financial statements.

Auditor's Report

We have reviewed the public entity's implementation plan for audit issues raised in the prior year and we are satisfied that the matters have been adequately resolved.

The Audit and Risk Committee concurs with and accepts the conclusions of the external auditor on the annual financial statements and is of the opinion that the audited annual financial statements should be accepted and read together with the report of the auditor.



Vuyani Jarana

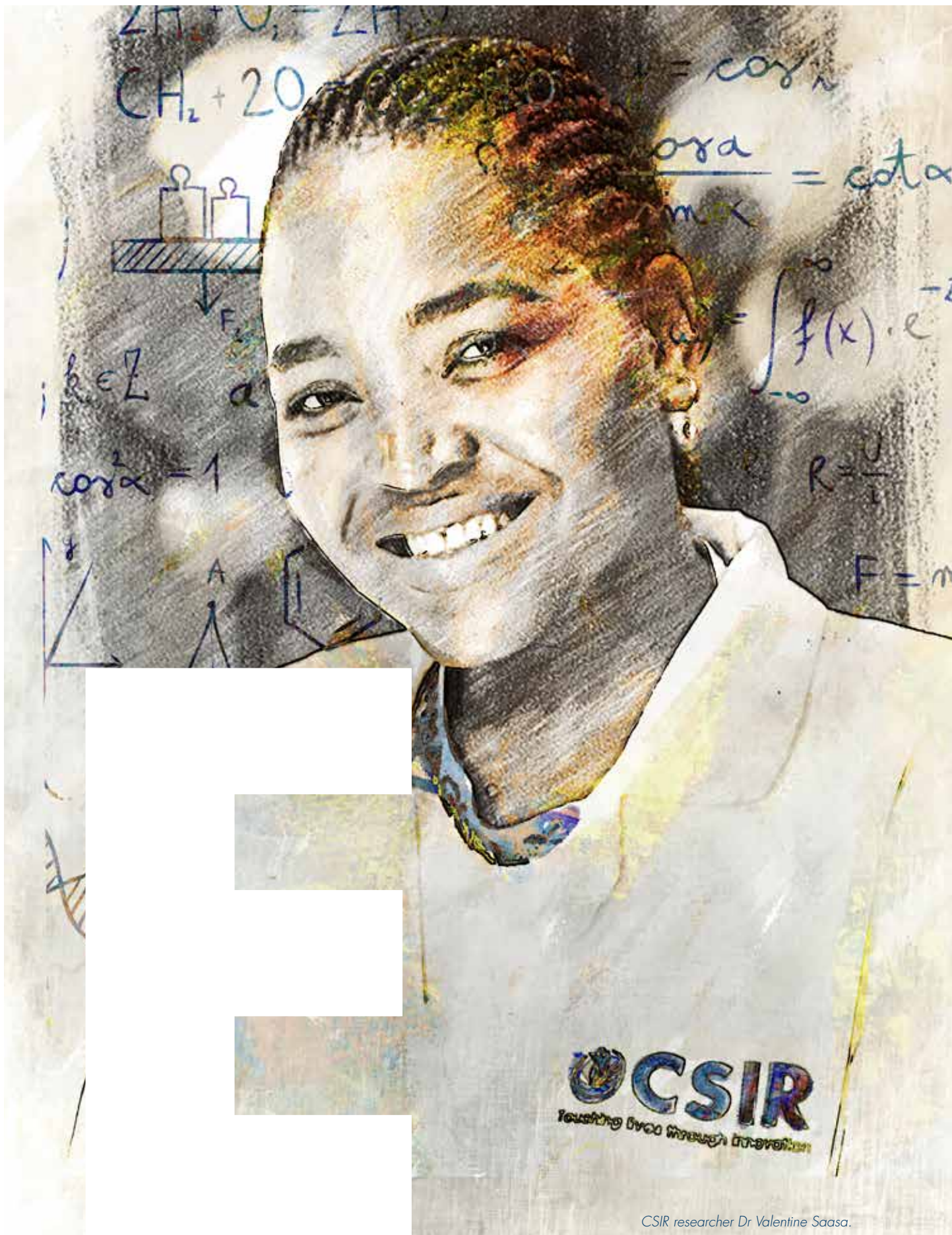
Chairperson of the Audit and Risk Committee
CSIR

27 July 2023

B-BBEE COMPLIANCE PERFORMANCE INFORMATION

The following table has been completed in accordance with compliance to the Broad-based Black Economic Empowerment (B-BBEE) requirements of the B-BBEE Act, 2003 (Act 53 of 2013) and as determined by the Department of Trade, Industry and Competition.

Has the department/public entity applied any relevant Code of Good Practice (B-BBEE Certificate Levels 1 – 8) with regard to the following:		
Criteria	Response Yes/No	Discussion
Determining qualification criteria for the issuing of licences, concessions or other authorisations in respect of economic activity in terms of any law?	No	The CSIR does not issue any licences/concessions or authorisations to allow economic activity in terms of any law. This would likely only apply to entities that are responsible for issuing trade licences or mining/exploration licences and the like.
Developing and implementing a preferential procurement policy?	Yes	The CSIR developed and implemented a Procurement Policy that incorporates preferential procurement, together with various templates, evaluation criteria, frameworks, etc. to ensure same is achieved. This is monitored monthly.
Determining qualification criteria for the sale of state-owned enterprises?	No	The CSIR do not generally engage in such sales, but when we do, certain criteria would be developed on a case-by-case basis to align with the nature of the asset/technology on sale and the CSIR mandate, and to secure sustainable offerings in the interest of South Africa. A case in point is the sale of laboratories where we set criteria to secure a buyer that would allow for the service offering to remain sustainable and available in the South African context.
Developing criteria for entering into partnerships with the private sector?	No	Certain criteria would be developed on a case-by-case basis to align with the objective of the collaboration to align with the CSIR mandate and secure sustainable offerings and commercialisation of technology in the interest of South Africa. In these instances, where the opportunity allows for feasible and sustainable commercialisation through SMMEs, criteria such as B-BBEE levels/status or black/female ownership could be included. There is no firm policy on this as the nature of the technology and available markets would determine the feasibility of such criteria.
Determining criteria for the awarding of incentives, grants and investment schemes in support of B-BBEE?	No	The awarding of grants, incentives and investments is not a core activity in the CSIR, and we do not make material investments in this context, save for the context of the Youth Employment Service Programme application, bursary awards and corporate social investment initiatives that would target previously disadvantaged categories of individuals or institutions (such as schools, higher education institutions, etc.).



CSIR researcher Dr Valentine Saasa.

HUMAN CAPITAL

This section provides a detailed account of the strategies, programmes and interventions implemented in the year under review and the outcomes of these in the HC portfolio.

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INTRODUCTION

The contribution of the CSIR towards challenges of the country requires a highly skilled, diverse, developed and capable workforce that can deliver on the CSIR's mandate and national strategic objectives. As such, the CSIR plays an instrumental role in supporting national strategic objectives through investment in and the development of skilled HC that can contribute towards the achievement of the national imperatives through the scientific research, innovation and technology development. The continuous development of HC is imperative in building a sustainable supply of SET staff who ultimately provide solutions that address the socioeconomic challenges of the country.

Transformation of CSIR staff, particularly the SET base, remains a priority and progress has been made in the last few years in terms of demographic diversity and strengthening the SET base. The senior management and middle management occupational levels have also seen an increase in transformed staff, as well as female staff representation.

The implementation of the talent reviews and succession planning process was successful for the 2022/23 Financial Year (FY). This is a positive step towards building a pool of suitably qualified employees to meet the current and future needs for critical and scarce skills. The CSIR has started to realise the benefits of talent reviews and succession planning across the board. As the business cascades the process to lower levels, the value will be much more evident.

HC development remains a priority to ensure that the organisation is adequately equipped with the right skills for it to meet its strategic objectives. There are several pipeline development programmes that aim to improve the attraction and retention of critical skills. The pipeline programmes provide the organisation with access to PhD graduates to address the percentage of staff qualified with doctoral qualifications.

Following the approval of leadership and management programmes, the CSIR successfully rolled out the LMPD and the first cohort of candidates is due to graduate. The Executive Development Programme has also been curated and will be rolled out to executives in the next FY. Other programmes initiated in the FY, and to be rolled in the next FY, include the Executive Coaching and Mentorship Train-the-Trainer programmes.

Provision of reliable people data to the organisation to assist with decision-making and protection of such data is critical. The importance of HC systems as enablers cannot be overemphasised. Through efficient systems, management responsibilities such as recruitment, performance reviews and similar administrative responsibilities are made easier for managers to spare more time for other equally important operational matters. HC systems must also be efficient in tracking important organisational metrics and simplifying reporting in a continuously reliable manner, as well as supporting faster decision-making.

As part of the retention strategy and ensuring that the CSIR is still regarded as the employer of choice, the organisation was once again awarded with the Top Employer accolade for 2023 by the Top Employer Institute. The organisation was also awarded with the LinkedIn Africa Champion Award by LinkedIn, making it the first state-owned enterprise to receive the LinkedIn award in South Africa.

Through strategic partnerships with relevant external stakeholders in the NSI, the organisation has managed to leverage support towards skills development, innovation, youth unemployment and corporate social investment. Approximately 200 internships, through various programmes, have been provided to unemployed youth in South Africa, with the support of strategic partners. The CSIR's self-funded flagship YES programme continues to offer unemployed graduates opportunities to work in the organisation and its partnering SMMEs, in particular, female candidates and people living with disabilities.

STAFF AND TRANSFORMATION PROFILE

Total Staff Profile

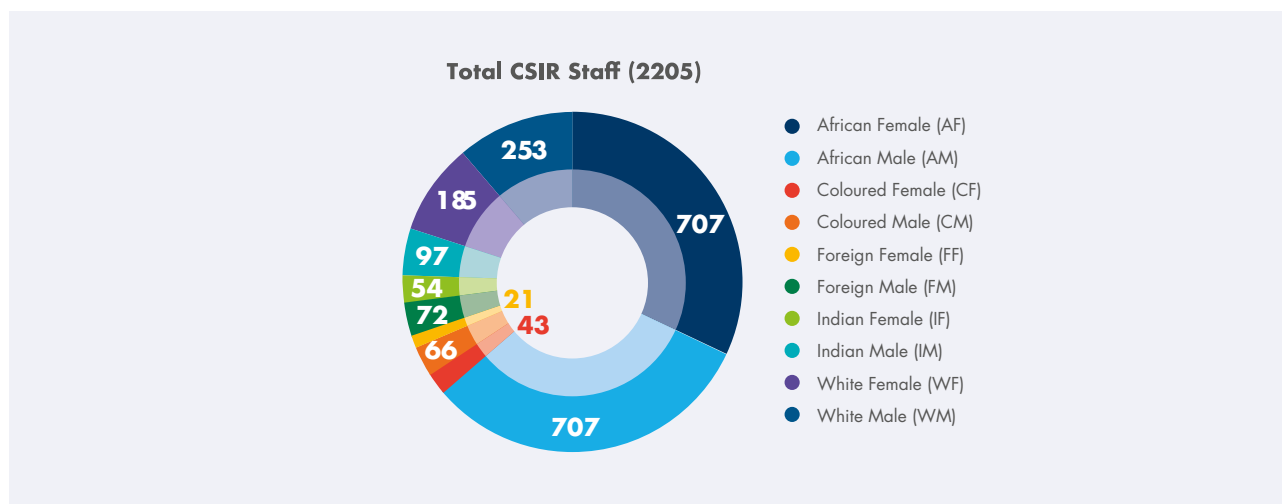


Figure 1: Staff profile

The total CSIR staff headcount at the end of 2022/23 was 2 205, compared to 2 209 as at 31 March 2022, a decrease by four for this FY. The CSIR headcount at the end of quarter 4 (Q4) includes 1 555 (71%) SET staff and 650 (29%) support staff. The headcount also includes 1 674 (76%) black South Africans, as well as 989 (45%) female South Africans.

Table 1: CSIR staff profile as at 31 March 2022/23

Staff category	SET staff	%	Support staff	%	Total	%
Permanent	1 335	60.5%	550	24.9%	1 885	85.5%
Fixed-term Contracts*	76	3.4%	18	0.8%	94	4.3%
Studentships	19	0.9%	0	0.0%	19	0.9%
Graduates-in-Training (GITs)	30	1.4%	0	0.0%	30	1.4%
Internships	59	2.7%	38	1.7%	97	4.4%
Post Doctorate	3	0.1%	0	0.0%	3	0.1%
YES Programme	33	1.5%	41	1.9%	74	3.4%
WIL Students	0	0.0%	3	0.1%	3	0.1%
Grand Total	1 555	70.5%	650	29.5%	2 205	100.0%

* Staff contracts less than 12 months.

SET and Support Staff Profile

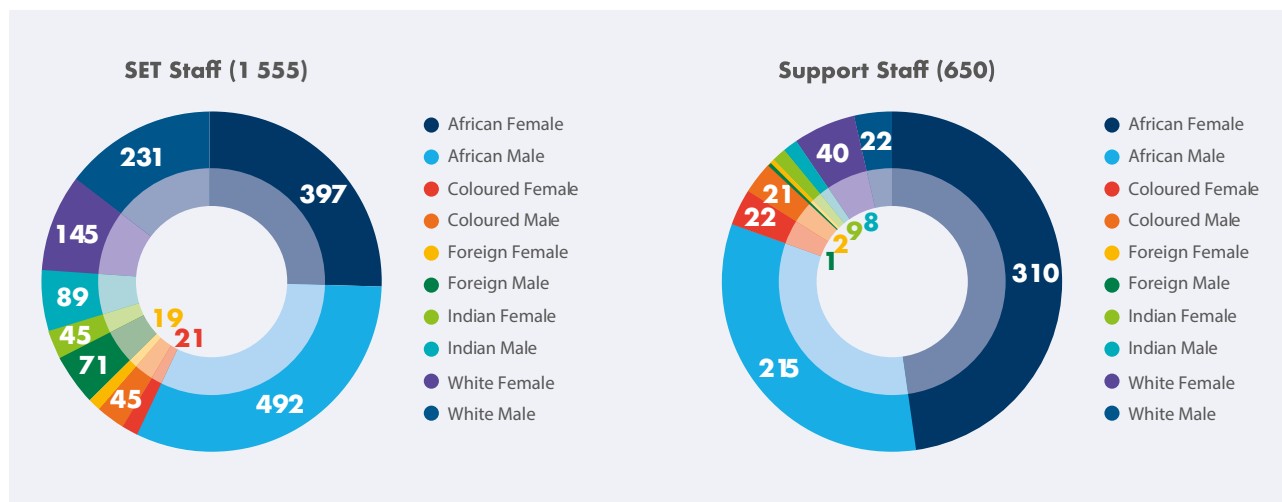


Figure 2: SET and support staff profile

CSIR Employment Equity Performance against NEAP Targets

The table below reflects the transformation profile against National Economically Active Population (NEAP) targets as at 31 March 2023. The table shows a 7.3% increase of black South Africans when compared to FY 2019/20.

Table 2: Performance against NEAP Targets

Performance	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total Foreign	Grand Total
Target %	42.7	35.8	5.2	4.4	1.7	1.1	5.1	4	100	0	0	0	100
FY19/20 Average %	27.6	28.5	2.7	2.6	4.6	2.8	15.8	10.4	95	3.9	1.1	5	100
FY20/21 Average %	29	28.7	2.9	2.4	4.5	2.9	14.5	10.2	95.1	3.9	1	4.9	100
FY21/22 Average %	30.7	31.6	3	2.2	4.3	2.7	12.5	8.7	95.7	3.4	0.9	4.3	100
FY22/23 Average %	32.1	32.1	3	2	4.4	2.5	11.5	8.4	96	3	1	4	100.0
GAP % (FY22/23 Ave Vs Target %)	-10.6	-3.7	-2.2	-2.4	2.7	1.4	6.4	4.4	-4	3	1	4	0.0

Number of Staff with Disabilities

Table 3: Staff with disability by occupational level

Occupational Category	AM	CM	IM	WM	AF	CF	IF	WF	FM	Total	Total Staff	%
Top Management	0	0	0	0	0	0	0	0	0	0	20	0.0%
Senior Management	0	0	0	0	0	0	1	0	0	1	91	1.1%
Middle Management	2	0	0	0	0	1	6	1	1	11	858	1.3%
Skilled	2	0	0	0	0	1	3	1	0	7	929	0.8%
Semi-skilled	0	0	0	0	0	0	0	0	0	0	208	0.0%
Unskilled	13	20	0	0	0	0	0	0	0	33	99	33.3%
Total	17	20	0	0	0	2	10	2	1	52	2 205	2.4%

STAFF MOVEMENTS

Appointments by Occupational Level

A total of 390 employees (including 226 temporary employees), comprising 354 (91%) black South Africans and 164 (42%) female South Africans were appointed from 1 April 2022 to 31 March 2023, as seen in the following table. This total number of appointments includes 164 permanent staff, of which 143 (87%) are black South Africans and 46 (28%) are female South Africans. There were 130 (79%) and 34 (21%) permanent SET staff and support staff, respectively, for the FY 2022/23.

Table 4: Appointments by occupational level

Category	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
Top Management	1	0	0	0	0	0	0	0	1	0	0	0	1
Senior Management	0	0	1	0	0	0	0	0	1	0	0	0	1
Middle Management	30	20	3	2	7	0	9	1	72	3	2	5	77
Skilled	45	16	2	1	2	0	3	2	71	0	1	1	72
Semi-skilled	5	4	4	0	0	0	0	0	13	0	0	0	13
Total Permanent	81	40	10	3	9	0	12	3	158	3	3	6	164
Fixed-term Contracts*	16	14	1	0	3	0	6	2	42	1	1	2	44
Studentship	6	5	0	0	0	0	0	0	11	1	0	1	12
GITs	7	2	0	0	0	0	1	0	10	0	0	0	10
Internships	34	40	1	0	1	3	2	0	81	1	0	1	82
Post Doctorate	1	1	0	0	0	0	0	0	2	0	0	0	2
YES Programme	26	46	0	0	0	0	0	0	72	0	0	0	72
WIL Students	1	3	0	0	0	0	0	0	4	0	0	0	4
Grand Total	172	151	12	3	13	3	21	5	380	6	4	10	390

* Staff contracts less than 12 months.

CSIR Staff Exits

The total number of employees, including temporary employees of 187, who exited the CSIR in the 2022/23 FY is 382, which includes 311 (81%) black South Africans and 152 (40%) female South Africans. There were 261 (68%) SET staff who exited, while support staff who exited accounted for 121 (32%) of the total staff for the year.

Table 5: Total staff exits

Occupational Category	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
Permanent	61	42	11	7	12	4	37	10	184	10	1	11	195
Fixed-term Contracts*	72	95	2	1	1	3	5	5	184	1	2	3	187
Grand Total	133	137	13	8	13	7	42	15	368	11	3	14	382

* Staff contracts less than 12 months.

A total of 195 permanent staff have exited the CSIR since the beginning of the FY to end March 2023. The permanent staff exits for the year include 137 (70%) black South Africans and 63 (32%) female South Africans. SET permanent employees accounted for 152 (78%) out of the 195 permanent employees, while permanent support staff accounted for 43 (22%) for the year.

Table 6: Permanent staff exits by occupational category

Occupational Category	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
Top /Management	0	1	0	0	0	0	0	0	1	0	0	0	1
Senior Management	2	3	1	1	2	0	2	0	11	1	0	1	12
Middle Management	24	16	4	2	7	2	32	5	92	9	1	10	102
Skilled	22	19	2	2	3	2	3	4	57	0	0	0	57
Semi-skilled	12	2	4	2	0	0	0	1	21	0	0	0	21
Unskilled	1	1	0	0	0	0	0	0	2	0	0	0	2
Grand Total	61	42	11	7	12	4	37	10	184	10	1	11	195

Table 7: Permanent staff exits by category

Permanent Staff Exits	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
Deceased	0	0	0	0	0	0	0	0	0	0	0	0	0
Dismissal	1	2	0	0	0	0	0	0	3	0	0	0	3
No-fault Dismissal: Incapacity	4	0	1	1	0	0	0	0	6	0	0	0	6
No-fault Dismissal: Retrenchment	11	10	0	2	1	0	1	1	26	0	0	0	26
Resignation	43	29	9	4	11	4	31	9	140	8	1	9	149
Retirement	3	0	1	0	0	0	5	0	9	2	0	2	11
Grand Total	62	41	11	7	12	4	37	10	184	10	1	11	195

Table 8: Exits of staff on fixed-term contracts

Staff on Fixed-Term Contracts Exits*	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
No-fault Dismissal: Retrenchment	1	0	0	0	0	0	0	0	1	0	0	0	1
End of Contract	60	60	1	1	1	3	7	4	137	1	2	3	140
Deceased	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	61	60	1	1	1	3	7	4	138	1	2	3	141

*Staff contracts less than 12 months.

HC DEVELOPMENT

Student Pipeline Development

The number of students in the student pipeline programmes as at 31 March 2023 is illustrated in the following table, showing the demographics for the pipeline.

Table 9: Student Pipeline Programmes

Programme	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total Foreign	Grand Total
CSIR Bursary Programme	31	36	1	1	3	0	2	4	78	1	0	1	79
IBS Bursary Programme	70	147	1	4	5	8	11	15	261	7	3	10	271
merSETA Bursaries	17	11	0	0	0	0	1	1	30	0	0	0	30
Studentships	9	8	0	0	0	0	1	0	18	1	0	1	19
GITs	13	11	1	0	1	2	1	1	30	0	0	0	30
Total	140	213	3	5	9	10	16	21	417	9	3	12	429
Percentage	33%	50%	1%	1%	2%	2%	4%	5%	97%	2%	1%	3%	100%

CSIR Bursary Programme

The CSIR Bursary Programme awarded bursaries to 22 students in 2023. This increases the number of bursary students currently funded to 79.

Inter-Bursary Support (IBS) Bursary Programme

The DSI allocated a total of R43 million, as such, a total of 185 new bursars have been awarded the IBS bursary for the 2023 academic year, bringing the total number of students to 288. The current spread is 124 Doctoral, 94 Masters' and 70 Honours students.

merSETA Bursary Programme

There are currently 18 students funded under this programme (13 undergraduate, two Masters' and three Doctoral students). merSETA has paid over R13 million for both undergraduate and postgraduate bursaries.

Studentships

The number of studentships has been decreasing, in line with the plan to initiate a postgraduate bursary programme at Masters' and PhD levels. In Q4 of 2021/22, the total number of studentships was 33. The number of studentships decreased to 19 as at 31 March 2023.

GIT Programme

The number of beneficiaries for GIT programme has increased by 30 new beneficiaries in FY 2022/23 and this brings the total number of graduates supported in the programme since its inception in 2019/20 to 107. An additional four GITs have been absorbed into permanent positions and this brings the total number of graduates appointed permanently in various clusters to 38.

Unemployed Youth Development Programmes

Table 10: Unemployed Youth Development Programmes

Programme	AM	AF	CM	CF	IM	IF	WM	WF	Total SA	FM	FF	Total Foreign	Grand Total
YES	28	46	0	0	0	0	0	0	74	0	0	0	74
Internship	40	51	1	0	1	2	0	1	96	1	0	1	97
WIL	2	1	0	0	0	0	0	0	3	0	0	0	3
Total	70	98	1	0	1	2	0	1	173	1	0	1	174
Percentage	40.2%	56.3%	0.6%	0.0%	0.6%	1.1%	0.0%	0.6%	99.4%	0.6%	0.0%	0.6%	100.0%

YES Programme

A new cohort of 66 YES (61% female and 47% people with disabilities) youth was appointed in FY 2022/23, bringing the total to 74 currently supported YES candidates. Of the new cohort, 33 were placed within the CSIR and 33 with partner SMMEs and external partners.

WIL Programme

There are currently 18 students funded under the WIL programme through the merSETA funding (13 undergraduates, two masters' and three doctoral students). The merSETA has provided over R13 million in funding for both undergraduates and postgraduate bursaries.

CSIR STAFF TRAINING

Technical Training

The total annual investment in training staff during 2022/2023 FY is R8 268 078 and the total number of employees enrolled for training is 1 402. With the introduction of the e-Learning platform in FY 2022/23, the organisation has been able to complement classroom-type training to develop the capabilities of CSIR employees through behavioural, business, technical, and leadership online short courses in support of organisational performance. A total of 2 810 courses

and 73 874 videos have been completed online as at 31 March 2023.

Leadership and Management Development Programmes

The LMDP for the 2022/23 FY intake was 82 employees across the different occupational levels. This number included 76 (93%) black South Africans and 39 (48%) female staff. A graduation ceremony for the employees is planned for 24 July 2023.

Three new development programmes will be introduced in the organisation.

- **Executive Development Programme** – this will commence in mid-July 2023 and will be delivered by the University of Cape Town Graduate School of Business (UCT GSB). The UCT GSB Executive Development Programme is a high-impact programme designed to equip senior leaders with the strategic thinking, innovative mindset and values-based leadership needed to ensure a long-term competitive advantage for the organisation.
- **Executive Coaching** – three service providers have signed contracts with the CSIR and, as a panel of suppliers, will assist with the implementation of executive coaching. The onboarding of the three service providers took place on 20 February 2023 and the total number of coaches is 26.

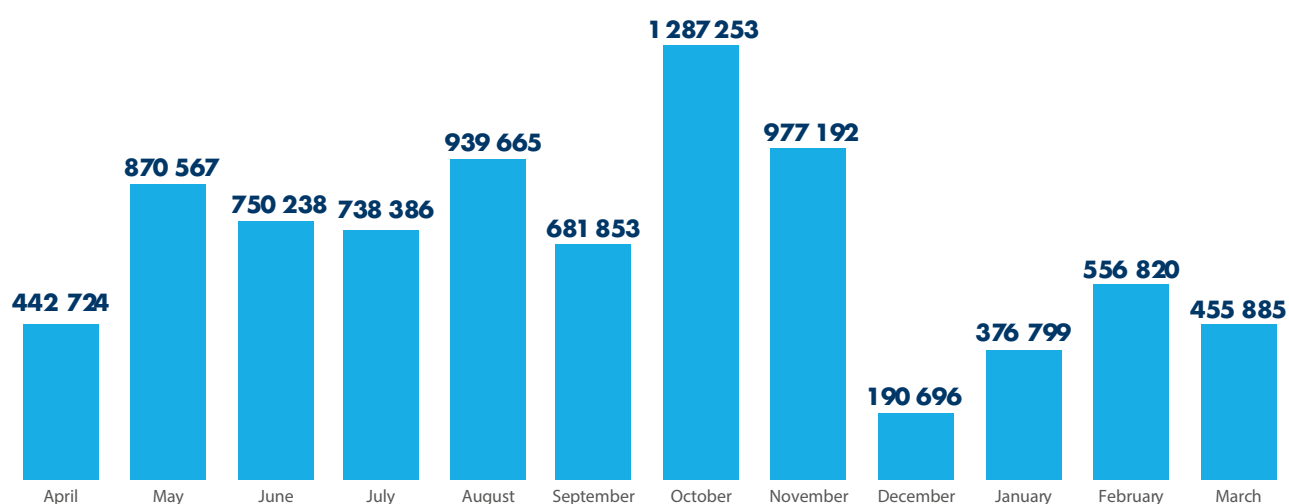


Figure 3: Summary of training costs by month

Table 11: Training costs by occupational category

Category	Number of Staff	Rand	% of Total Training Cost
Top Management	18	132 298	1.47%
Senior Management	62	507 301	5.64%
Middle Management	586	4 534 162	50.44%
Skilled	619	3 390 215	37.71%
Semi-skilled	104	398 658	4.43%
Unskilled	13	27 197	0.30%
Grand Total	1 402	8 989 831	100.00%

Table 12: Training costs by event type

Training Event	Number of Staff	Amount
Computer-based Training	216	2 269 781
Conferences	457	3 291 922
Seminars	729	3 428 128
Total	1 402	8 989 831

Table 13: Training provided by occupational categories, race and gender

Occupational Category	AM	AF	CM	CF	IM	IF	WM	WF	Total (SA)	FM	FF	Total (Foreign)	Grand Total
Top Management	7	3	0	0	3	0	3	2	18	0	0	0	18
Senior Management	17	4	6	0	11	0	15	9	62	0	0	0	62
Middle Management	160	139	10	9	31	32	97	93	571	15	0	15	586
Skilled	227	235	15	8	22	32	32	48	619	0	0	0	619
Semi-skilled	55	36	6	4	0	1	1	1	104	0	0	0	104
Unskilled	11	2	0	0	0	0	0	0	13	0	0	0	13
Grand Total	477	419	37	21	67	65	148	153	1387	15	0	15	1402

External stakeholder engagements on skills development

The continued engagements with Sector Education and Training Authorities (SETAs) throughout the FY to enhance the CSIR's skills development imperatives have resulted in signed memorandums of understanding and the support of several of the CSIR's skills development programmes, such as the leadership programme, bursary programme, internship programme, candidacy programme, as well as SMME development. The CSIR has received funding from the Chemicals Industry Education and Training Authority, Finance and Accounting Services, Media Information and communication Technologies SETA, merSETA, as well as the Energy and Water SETA to the total amount of R39.8 million to ensure capacity development in these programmes. In addition, with regard to the apprenticeship programme, merSETA has also approved the Stellenbosch Technology for Special Operation site as a training provider for the Fitter and Turner Apprenticeship and will be evaluating the Pretoria site in April 2023.

Further, the CSIR hosted the Boards and executive committees of the National Skills Authority (NSA) and Mining Qualification Authority. The CSIR has also been appointed as a member of the Ministerial Task Team on the Fourth Industrial Revolution for the post-school education and training system.

Learning Factories

The CSIR, in partnership with the DSI and Department of Higher Education and Training, co-hosted a workshop on future skills and they have started reviewing the draft framework on Learning Factory (LF) for Technical Vocational Education and Training (TVET) colleges. The NSA committed to working with the CSIR on the establishment of LFs for TVET colleges.

TALENT MANAGEMENT

Talent Review

The talent management framework was successfully implemented. The succession plans for the CEO and the CEO's direct reports were presented to the Board in October 2022. The talent reviews and succession plans for executive cluster managers and group managers were also finalised.

The career paths project for support staff progressed well in the FY 2022/23, with the aim being to allow staff to understand the required experience, qualifications and competence levels to further their careers in the portfolios.

Attraction and Retention Initiatives

The implementation of the approved frameworks commenced with the drive to attract and retain SET staff at the following identified levels:

- Attraction and retention of chief and principal researchers;
- Attraction and retention of SET females;
- The Accelerated Principal Researcher Programme; and
- The Capability Development Investment Programme to attract chief researchers from the external market.

Career Ladders

Through the SET career ladders, the CSIR saw the promotion of 15 principal researchers and three chief researchers. One black South African candidate in the ARDP was one of the chief researchers who was promoted in the cycle. A recognition event was held for the promoted chief and principal researchers on 6 March 2023.

Performance Management

The performance management system has been enhanced with functionality that is aligned with the business requirements. Furthermore, to augment the performance management process, training was provided to staff members. The training included training videos explain the system processes to be followed – links to the videos were included in the automated systems emails to new employees. LinkedIn learning training videos on conducting successful performance reviews were communicated to the organisation as part of the performance management communication to the organisation.

REWARDS AND RECOGNITION

Employee Value Proposition

The Employee Value Proposition (EVP) was approved by the Exco and communication interventions are being developed to launch the EVP and create awareness. The EVP will be promoted internally and externally.

Top Employer Certification

The CSIR participated in the Top Employer Survey for the 2023 certification and the results showed a significant improvement from the previous years. The CSIR has been certified as a Top Employer once again for the year 2023.

Excellence Awards

The Excellence Awards event was hosted on 3 November 2022 at the International Convention Centre. A total of 94 winners were announced.

Alumni Programme

During the 8th Biennial Conference that took place in November 2022, the CSIR Alumni and Emeritus

Programme was launched and an impressive number of at least 70 alumni joined the programme just after the launch. The programme currently has 1 085 members.

CSIR Staff Bank Preferential Rates

Webinars were presented by the three major banks (Absa, First National Bank and Standard Bank), where they presented their exclusive preferential rates for CSIR employees.

LinkedIn Talent Award

With the CSIR's drive to improve the skills of its employees and complementing classroom-type training, the CSIR introduced the online LinkedIn Learning platform in the 2022/23 FY. As a result of the successful utilisation of the online courses by employees, the CSIR was the first state-owned entity to receive the prestigious LinkedIn Talent Award at the LinkedIn Talent Awards Africa awards ceremony held on 2 March 2023. The LinkedIn Talent Awards Africa is a celebration of teams around the world that are innovating and leading the future of work.

EMPLOYEE RELATIONS AND TRANSFORMATION

Internal and External Employee Relations Matters

Table 14: Summary of internal and external employee relations matters

Matters	Investigations	Disciplinary	Grievances	Incapacity	CCMA	Total
Open	1	1	4	4*	1	11
Closed	15	8	15	11	4	53

* All four active incapacity cases are incapacity due to ill health or injury.

The CSIR continues to see a sharp decline in several pending employee relations cases due to the capacity-building of line managers and HC professionals in the organisation. The speed of attending to and closing matters without compromising rigour and quality has also contributed to the decline. Further capacity training, aimed at identifying and training selected line managers as initiators and chairpersons of employee relations processes, was introduced in the FY.

Reorganisation

The Employee Relation and Transformation function supported the implementation of the reorganisation process, which commenced in June 2022, involving four business areas, namely, Information and Communication Technology (ICT) Services, Enterprise Creation for Development (ECD), Water Research Centre (WRC) and Environmental Laboratories (EL). The process in respect

of three business areas (ECD-WRC-EL) concluded on 30 September 2022, and no employment contract was forcibly terminated. The process in respect of ICT was concluded on 30 January 2023, with the placement of all employees in the new structure.

A comprehensive close-out report was submitted to the Commission for Conciliation, Mediation and Arbitration in February 2023. The table below shows the summary of the close-out report.

Table 15: Reorganisation Close-out Report

	Affected Universe	VSPs ¹	Placed employees ²	Lapsed contracts ³	Resignations ⁴
ECD	14	11	3	0	0
WRC	7	3	4	0	0
EL	18	11	1	5	1
ICT	69	0	65	0	4
Total	108	25	73	5	5

¹ Employees who applied for voluntary severance packages, following which their services were terminated on 30 September 2022.

² ECD and EL employees appointed into alternative positions elsewhere in the organisation, while ICT and WRC employees were appointed into the new ICT and WRC structures.

³ Internship contracts that expired during the reorganisation process, following which the interns were released by the organisation.

⁴ Employees who resigned during the reorganisation process, following which their services were terminated before the process could be finalised.

Employment Equity Report

The Employment Equity Report for 2022 was submitted to the Department of Employment and Labour on 15 December 2022.

EMPLOYEE WELLNESS

Psychosocial Intervention

The CSIR Wellness Office continued with the Mental Health and Wellbeing Campaign in partnership with Bestmed. A series of webinars was, with sessions held twice a month (every other Friday) and an increase in attendance has been observed in comparison with the previous FY. Some of the topics that were covered in the online webinars included burnout, anxiety, work-life integration, resilience, sports/recreation and mental health.

Climate Survey

With the completion of the climate survey that was conducted in the FY 2021/22, the focus shifted to the development of divisional/portfolio response plans in FY 2022/23. The response plans were consolidated at the CSIR level and were rolled out and tracked quarterly.

CSIR Sports Club

In promoting a healthy lifestyle for employees, a successful re-launch of the CSIR Sports Club took place in December 2022 and hosted more than 1 000 attendees from the CSIR, as well as external stakeholders. The CSIR has the following sub-clubs: running, squash, table tennis, tennis and volleyball. Three new sub-clubs were established, namely, cycling, hiking and golf.

HC SYSTEM IMPROVEMENTS

PeopleSoft Human Capital Management (HCM) Upgrade

The PeopleSoft HCM upgrade to version 9.2 is in the final stages of development and testing before it is transferred to production for the organisation to use.

SharePoint Implementation

The Microsoft 365 SharePoint structure for HC was designed and implemented for use by the HC community. HC staff were trained on the SharePoint platform and the system's collaboration features introduced improved efficiency in staff output.

HC OVERSIGHT STATISTICS

Table 16: Personnel cost by programme/activity/objective

Programme/activity/objective	Total expenditure for the entity (R'000)	Personnel expenditure (R'000)	Personnel expenditure as a % of total exp. (R'000)	No. of employees	Average personnel cost per employee (R'000)
CSIR Advanced Chemistry and Life Sciences Division	329 990	170 894	52%	221	773,28
CSIR Advanced Production and Security Division	900 705	485 992	54%	618	786,40
CSIR Smart Society Division	1 012 679	528 427	52%	694	761,42
Business Excellence and Integration Portfolio	181 311	60 635	33%	81	748,58
Chief Financial Officer Portfolio	32 734	117 273	358%	192	610,80
Human Capital and Communications Portfolio	131 383	82 075	62%	129	636,24
Legal Compliance and Business Enablement Portfolio	132 502	120 734	91%	240	503,06
CSIR Leadership and Governance	50 974	44 581	87%	30	1486,03
Sub Total	2 772 279	1 610 611	58%	2 205	730,44
Provision for performance bonus	98 722	98 722			
Post retirement benefits interest cost	1 020	1 020			
TOTAL	2 872 021	1 710 353			

Table 17: Personnel cost by salary band

Level	Personnel expenditure (R'000)	Percentage of personnel expenditure to total personnel cost (R'000)	No. of employees	Average personnel cost per employee (R'000)
Top management	59 227	3,68%	20	2 961
Senior management	167 870	10,42%	91	1 845
Professional qualified	878 942	54,57%	858	1 024
Skilled	438 312	27,21%	929	472
Semi-skilled	56 679	3,52%	208	272
Unskilled	9 582	0,59%	99	97
Total	1 610 611	100,00%	2205	730
Provision for performance bonus	98 722			
Post retirement benefits interest cost	1 020			
TOTAL	1 710 353			

Table 18: Performance rewards

Programme/activity/objective	Performance rewards	Personnel expenditure (R'000)	Percentage of performance rewards to total personnel cost (R'000)
Top management	7 349	59 227	12%
Senior management	14 437	167 870	9%
Professional qualified	45 992	878 942	5%
Skilled	18 165	438 312	4%
Semi-skilled	2 367	56 679	4%
Unskilled	26	9 582	0%
Total	88 336	1 610 611	5%
Provision for performance bonus		98 722	
Post retirement benefits interest cost		1 020	
TOTAL		1 710 353	

Table 19: Employment and vacancies as at 31 March

Programme/activity/objective	2021/2022 No. of employees	2022/2023 Approved posts	2022/2023 No. of employees	2022/2023 Vacancies	Percentage of vacancies
CSIR Advanced Chemistry and Life Sciences	230	233	221	12	5.43%
CSIR Advanced Production and Security	619	680	618	62	10.03%
CSIR Smart Society	732	764	694	70	10.09%
Business Excellence and Integration	80	89	81	8	9.88%
Office of the Chief Financial Officer	164	196	192	4	2.08%
HC and Communication	126	144	129	15	11.63%
Legal Compliance and Business Enablement	233	252	240	12	5.00%
CSIR Leadership and Governance	25	34	30	4	13.33%
Total	2 209	2 392	2 205	187	8.48%

Table 20: Overview of staff complement, including vacancies

Programme/activity/objective	2021/2022 No. of employees	2022/2023 Approved posts	2022/2023 No. of employees	2022/2023 Vacancies	Percentage of vacancies
Top Management	17	21	20	1	5.00%
Senior Management	92	109	91	18	19.78%
Professional Qualified	854	930	858	72	8.39%
Skilled	869	975	929	46	4.95%
Semi-skilled	250	215	208	7	3.37%
Unskilled	127	142	99	43	43.43%
Total	2 209	2 392	2 205	187	8.48%

Table 21: Reasons for staff leaving

Reason	Number	% of total no. of staff leaving
Death	0	0%
Resignation	149	39%
Dismissal	3	1%
Retirement	11	3%
Ill health	6	2%
End of contract/Termination by agreement	187	49%
Retrenchments	26	7%
Total	382	100%

Table 22: Employee relations matters statistics

Matters	Investigations	Disciplinary	Grievances	Incapacity	CCMA	Total
Open	1	1	4	4*	1	11
Closed	15	8	15	11	4	53

Table 23: Equity target and employment equity status

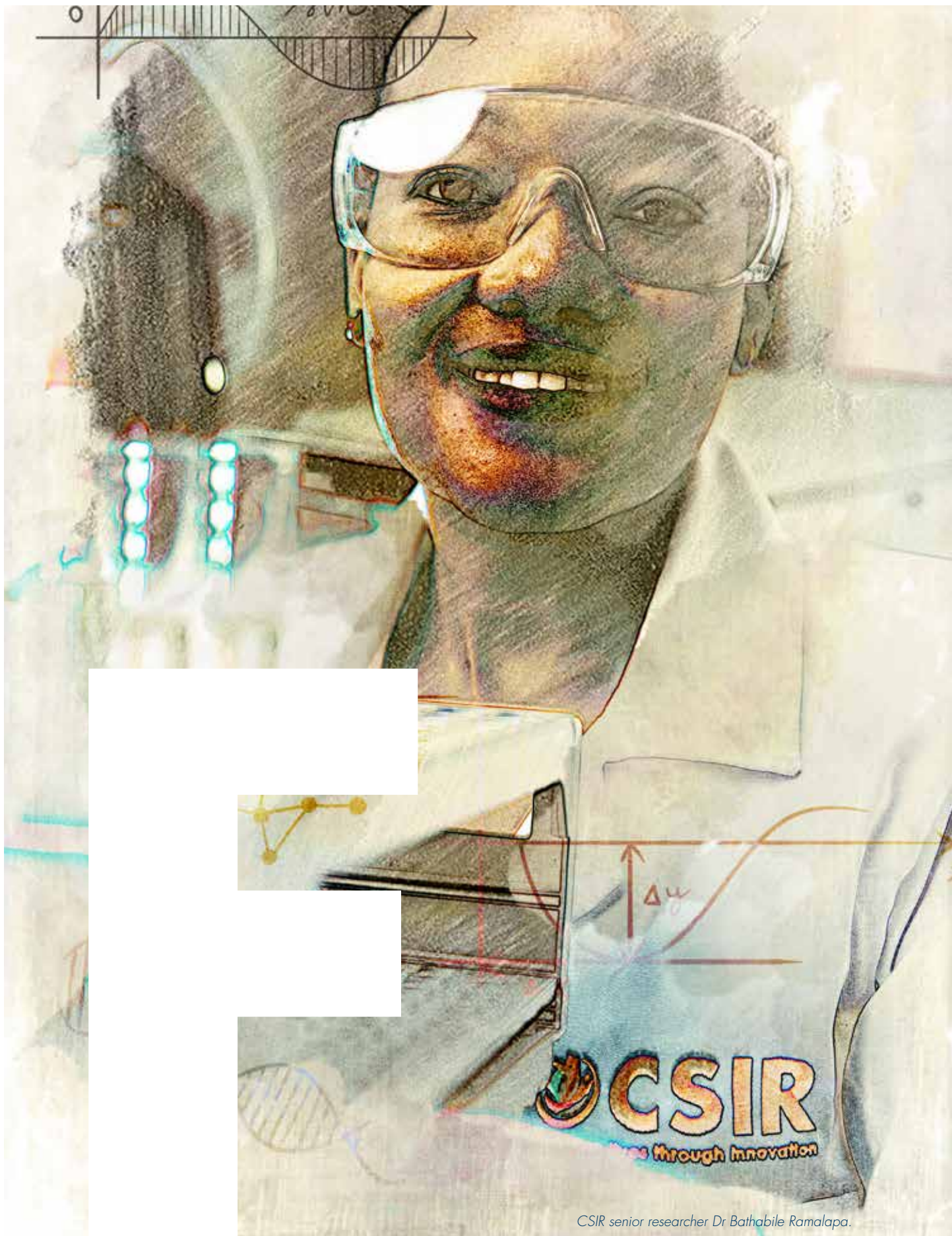
Occupational Levels	Male							
	African		Coloured		Indian		White	
	Current	Target	Current	Target	Current	Target	Current	Target
Top Management	9	7	0	0	4	2	2	2
Senior Management	25	30	5	3	9	8	21	18
Professional Qualified	209	180	23	27	56	52	183	199
Skilled	332	311	26	24	27	30	47	50
Semi-skilled	93	98	12	15	1	1	0	1
Unskilled	39	39	0	0	0	0	0	0
Total	707	665	66	69	97	93	253	270

Table 24: Female employees across occupational levels

Occupational Levels	Female							
	African		Coloured		Indian		White	
	Current	Target	Current	Target	Current	Target	Current	Target
Top Management	2	4	0	0	0	0	1	1
Senior Management	8	20	0	3	0	1	10	9
Professional Qualified	173	131	11	17	26	27	108	108
Skilled	378	371	22	26	27	26	61	73
Semi-skilled	86	88	10	11	1	1	5	6
Unskilled	60	70	0	0	0	0	0	0
Total	707	684	43	57	54	55	185	197

Table 25: Disabled employees across occupational levels

Occupational Levels	Disabled Staff			
	Male		Female	
	Current	Target	Current	Target
Top Management	0	0	0	0
Senior Management	1	1	0	0
Professional Qualified	9	5	2	4
Skilled	6	7	2	8
Semi-skilled	0	2	0	2
Unskilled	13	1	20	1
Total	29	17	24	16



CSIR senior researcher Dr Bathabile Ramalapa.

CONSOLIDATED FINANCIAL STATEMENTS

The consolidated financial statements set out on pages 144 to 192, have been prepared on the going concern basis and were approved by CSIR Board on 27 July 2023.

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REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

REPORT OF THE AUDITOR-GENERAL TO PARLIAMENT ON THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Report on the audit of the consolidated and separate financial statements

Opinion

1. I have audited the consolidated and separate financial statements of the Council for Scientific and Industrial Research (CSIR) and its subsidiaries (the group) set out on pages 144 to 192, which comprise the consolidated and separate statement of financial position as at 31 March 2023, consolidated and separate statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, as well as notes to the consolidated and separate financial statements, including a summary of significant accounting policies.
2. In my opinion, the consolidated and separate financial statements present fairly, in all material respects, the financial position of the group as at 31 March 2023 and their financial performance and cash flows for the year then ended in accordance with the International Financial Reporting Standards (IFRS) and the requirements of the Public Finance Management Act 1 of 1999 (PFMA).

Basis for opinion

3. I conducted my audit in accordance with the International Standards on Auditing (ISAs). My responsibilities under those standards are further described in the responsibilities of the auditor-general for the audit of the consolidated and separate financial statements section of my report.
4. I am independent of the group in accordance with the International Ethics Standards Board for Accountants' International code of ethics for

professional accountants (including International Independence Standards) (IESBA code) as well as other ethical requirements that are relevant to my audit in South Africa. I have fulfilled my other ethical responsibilities in accordance with these requirements and the IESBA code.

5. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my opinion.

Emphasis of matter

6. I draw attention to the matter below. My opinion is not modified in respect of this matter.

Restatement of corresponding figures

7. As disclosed in note 29 to the financial statements, the corresponding figures for 31 March 2022 were restated as a result of an error in the financial statements of the entity at, and for the year ended 31 March 2023.

Other matter

8. I draw attention to the matter below. My opinion is not modified in respect of this matter.

National Treasury Instruction No. 4 of 2022-23: PFMA Compliance and Reporting Framework

9. On 23 December 2022, the National Treasury issued Instruction 4 of 2022-23, which came into effect on 3 January 2023, in terms of section 76(1) (b), (e) and (f), 2(e) and 4(a) and (c) of the PFMA. The instruction note deals with the PFMA compliance and reporting framework and addresses, among

REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

others, the disclosure of unauthorised expenditure, irregular expenditure and fruitless and wasteful expenditure. Irregular expenditure and fruitless and wasteful expenditure incurred in prior financial years and not yet addressed no longer need to be disclosed in the disclosure notes to the annual financial statements. Only the current year and prior year figures are disclosed in note 18 to the financial statements of CSIR. Movements in respect of irregular expenditure and fruitless and wasteful expenditure also no longer need to be disclosed in the notes to the annual financial statements. The disclosure of these movements (e.g. condoned, recoverable, removed, written off, under assessment, under determination and under investigation) is now included as part of the other information in the annual report of the CSIR.

10. I do not express an opinion on the disclosure of irregular expenditure and fruitless and wasteful expenditure in the annual report

Responsibilities of the accounting authority for the consolidated and separate financial statements

11. The accounting authority is responsible for the preparation and fair presentation of the consolidated and separate financial statements in accordance with the IFRS and the requirements of the PFMA and for such internal control as the accounting authority determines is necessary to enable the preparation of consolidated and separate financial statements that are free from material misstatement, whether due to fraud or error.
12. In preparing the consolidated and separate financial statements, the accounting authority is responsible for assessing the group's ability to continue as a going concern; disclosing, as applicable, matters relating to going concern; and using the going concern basis of accounting unless the appropriate governance structure either intends to liquidate the group or to cease operations, or has no realistic alternative but to do so.

Responsibilities of the auditor-general for the audit of the consolidated and separate financial statements

13. My objectives are to obtain reasonable assurance about whether the consolidated and separate financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes my opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with the ISAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these consolidated and separate financial statements.
14. A further description of my responsibilities for the audit of the consolidated and separate financial statements is included in the annexure to this auditor's report.

Report on the annual performance report

15. In accordance with the Public Audit Act 25 of 2004 (PAA) and the general notice issued in terms thereof, I must audit and report on the usefulness and reliability of the reported performance information against predetermined objectives for the selected material performance indicators presented in the annual performance report. The accounting authority is responsible for the preparation of the annual performance report.
16. I selected the following material performance indicators related to strategic objectives (SO)1: conduct RD&I of transformative technologies and accelerate their diffusion, SO2: improve the competitiveness of high-impact industries to support South Africa's re-industrialisation by collaboratively

REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

developing, localising, and implementing technology and SO3: drive socioeconomic transformation through research, development and innovation (RD&I) that supports the development of a capable state presented in the annual performance report for the year ended 31 March 2023. I selected those indicators that measure the entity's performance on its primary mandated functions and that are of significant national, community or public interest.

- Publication equivalents
- New priority patent applications filed
- New patents granted
- New technology demonstrators
- Number of technology license agreements signed
- Number of localised technologies
- Number of joint technology development agreements being implemented for industry
- Number of SMMEs supported
- Number of reports contributing to national policy development
- Number of standards delivered or contributed in support of the state
- Number of projects implemented to increase the capability of the state

17. I evaluated the reported performance information for the selected material performance indicators against the criteria developed from the performance management and reporting framework, as defined in the general notice. When an annual performance report is prepared using these criteria, it provides useful and reliable information and insights to users on the entity's planning and delivery on its mandate and objectives.

18. I performed procedures to test whether:

- the indicators used for planning and reporting on performance can be linked directly to the entity's mandate and the achievement of its planned objectives
- the indicators are well defined and verifiable to ensure that they are easy to understand

and apply consistently and that I can confirm the methods and processes to be used for measuring achievements

- the targets linked directly to the achievement of the indicators and are specific, time bound and measurable to ensure that it is easy to understand what should be delivered and by when, the required level of performance as well as how performance will be evaluated
- the indicators and targets reported on in the annual performance report are the same as what was committed to in the approved initial or revised planning documents
- there is adequate supporting evidence for the achievements reported.

19. I performed the procedures for the purpose of reporting material findings only.

20. I did not identify any material findings on the reported performance information for the selected material performance indicators.

Other matter

21. I draw attention to the matter below.

Achievement of planned targets

22. The annual performance report includes information on reported achievements against planned targets.

Report on compliance with legislation

23. In accordance with the PAA and the general notice issued in terms thereof, I must audit and report on compliance with applicable legislation relating to financial matters, financial management and other related matters. The accounting authority is responsible for the entity's compliance with legislation.

REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

24. I performed procedures to test compliance with selected requirements in key legislation in accordance with the findings engagement methodology of the Auditor-General of South Africa (AGSA). This engagement is not an assurance engagement. Accordingly, I do not express an assurance opinion or conclusion.

25. Through an established AGSA process, I selected requirements in key legislation for compliance testing that are relevant to the financial and performance management of the entity, clear to allow consistent measurement and evaluation, while also sufficiently detailed and readily available to report in an understandable manner. The selected legislative requirements are included in the annexure to this auditor's report.

26. I did not identify any material non-compliance with the selected legislative requirements.

Other information in the annual report

27. The accounting authority is responsible for the other information included in the annual report. The other information referred to does not include the consolidated and separate financial statements, the auditor's report and those selected material indicators in the scoped-in strategic objectives presented in the annual performance report that have been specifically reported on in this auditor's report.

28. My opinion on the consolidated and separate financial statements, the report on the audit of the annual performance report and the report on compliance with legislation do not cover the other information included in the annual report and I do not express an audit opinion or any form of assurance conclusion on it.

29. My responsibility is to read this other information and, in doing so, consider whether it is materially

inconsistent with the consolidated and separate financial statements and the selected material indicators in the scoped-in strategic objectives presented in the annual performance report, or my knowledge obtained in the audit, or otherwise appears to be materially misstated.

30. I did not receive the other information prior to the date of this auditor's report. When I do receive and read this information, if I conclude that there is a material misstatement therein, I am required to communicate the matter to those charged with governance and request that the other information be corrected. If the other information is not corrected, I may have to retract this auditor's report and re-issue an amended report as appropriate. However, if it is corrected this will not be necessary.

Internal control deficiencies

31. I considered internal control relevant to my audit of the consolidated and separate financial statements, annual performance report and compliance with applicable legislation; however, my objective was not to express any form of assurance on it.

32. I did not identify any significant deficiencies in internal control.

Auditor - General

Pretoria
31 July 2023



AUDITOR-GENERAL
SOUTH AFRICA

Auditing to build public confidence

REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

Annexure to the auditor's report

The annexure includes the following:

- the auditor-general's responsibility for the audit
- the selected legislative requirements for compliance testing.

Auditor-general's responsibility for the audit

Professional judgement and professional scepticism

As part of an audit in accordance with the ISAs, I exercise professional judgement and maintain professional scepticism throughout my audit of the consolidated and separate financial statements and the procedures performed on reported performance information for selected material performance indicators and on the entity's compliance with selected requirements in key legislation.

Financial statements

In addition to my responsibility for the audit of the consolidated and separate financial statements as described in this auditor's report, I also:

- identify and assess the risks of material misstatement of the consolidated and separate financial statements, whether due to fraud or error; design and perform audit procedures responsive to those risks; and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations or the override of internal control
- obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control
- evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made.

- conclude on the appropriateness of the use of the going concern basis of accounting in the preparation of the consolidated and separate financial statements. I also conclude, based on the audit evidence obtained, whether a material uncertainty exists relating to events or conditions that may cast significant doubt on the ability of the entity and its subsidiaries to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the consolidated and separate financial statements about the material uncertainty or, if such disclosures are inadequate, to modify my opinion on the consolidated and separate financial statements. My conclusions are based on the information available to me at the date of this auditor's report. However, future events or conditions may cause an entity to cease operating as a going concern
- evaluate the overall presentation, structure and content of the consolidated and separate financial statements, including the disclosures, and determine whether the consolidated and separate financial statements represent the underlying transactions and events in a manner that achieves fair presentation
- obtain sufficient appropriate audit evidence regarding the financial information of the entities or business activities within the group to express an opinion on the consolidated financial statements. I am responsible for the direction, supervision and performance of the group audit. I remain solely responsible for my audit opinion.

Communication with those charged with governance

I communicate with the accounting authority regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that I identify during my audit.

I also provide the accounting authority with a statement that I have complied with relevant ethical requirements regarding independence and to communicate with them all relationships and other matters that may reasonably be thought to bear on my independence and, where applicable, actions taken to eliminate threats or safeguards applied.

REPORT OF THE AUDITOR-GENERAL

for the year ended 31 March 2023

Compliance with legislation – selected legislative requirements

The selected legislative requirements are as follows:

Legislation	Sections or regulations
Public Finance Management Act 1 of 1999	Section 50(3) Section 51(1)(a)(iii); 51(1)(a)(iv); 51(1)(b)(i); 51(1)(b)(ii); 51(1)(e)(iii) Section 52(b) Section 53(4) Section 54(2)(c); 54(2)(d) Section 55(1)(a); 55(1)(b); 55(1)(c)(i) Section 56 Section 57(b) Section 57(d)
Regulations to the Public Finance Management Act 1 of 1999	Treasury Regulation 29.1.1; 29.1.1(a); 29.1.1(c); 29.2.1; 29.2.2; 29.3.1 Treasury Regulation 31.1.2(c) Treasury Regulation 33.1.1; 33.1.3
Prevention and Combating of Corrupt Activities Act 12 of 2004	Section 34(1)
Construction Industry Development Board Act 38 of 2000	Section 18(1) Section 22(3)
CIDB Regulations	CIDB regulation 17 & 25(7A)
PPPFA	Section 2.1(a); 2.1(b); 2.1(f)
PPR 2017	Paragraph 4.1; 4.2 Paragraph 5.1; 5.3; 5.6; 5.7 Paragraph 8.2; 8.5 Paragraph 9.1; 9.2 Paragraph 11.1; 11.2 Paragraph 12.1 and 12.2
PPR 2022	Paragraph 4.1; 4.2; 4.3; 4.4 Paragraph 5.1; 5.2; 5.3; 5.4
NT SCM Instruction Note 03 2021/22	Paragraph 4.3; 4.4; 4.4(c); 4.4(d)
NT SCM Instruction Note 11 2020/21	Paragraph 3.1; 3.4(b); 3.9
NT instruction note 4 of 2015/16	Paragraph 3.4
Second amendment of NTI 05 of 2020/21	Paragraph 4.8; 4.9 ; 5.1 ; 5.3
Erratum NTI 5 of 202/21	Paragraph 1
Erratum NTI 5 of 202/21	Paragraph 2
NT instruction note 5 of 2020/21	Paragraph 5.1 and 5.3

STATEMENT OF PROFIT OR LOSS AND OTHER COMPREHENSIVE INCOME

for the year ended 31 March 2023

	Note	GROUP		CSIR	
		2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Revenue	2	2 819 197	2 654 343	2 819 197	2 654 343
Other income	26	41 776	2 907	41 776	2 895
Total operating income		2 860 973	2 657 250	2 860 973	2 657 238
Expenses					
Employees' remuneration		(1 710 353)	(1 563 959)	(1 710 353)	(1 563 959)
Depreciation		(42 459)	(49 763)	(42 459)	(49 763)
Operating expenses		(1 119 103)	(1 046 057)	(1 119 209)	(1 043 940)
Operating (loss) profit		(10 942)	(2 529)	(11 048)	(424)
Finance income	3	55 367	53 178	55 037	52 966
Finance expense	4	(422)	(1 069)	(422)	(1 069)
Share of loss of joint ventures and associates		(151)	2 138	-	-
Profit for the year		43 852	51 718	43 567	51 473
Other comprehensive income:					
Items that will not be reclassified to profit or loss:					
Remeasurement of post-retirement medical benefit obligation		1 246	1 595	1 246	1 595
Items that may be reclassified to profit or loss:					
Gains on valuation of investments in debt instruments		16 111	-	16 111	-
Other comprehensive income for the year net of taxation		17 357	1 595	17 357	1 595
Total comprehensive income for the year		61 209	53 313	60 924	53 068

STATEMENT OF FINANCIAL POSITION AS AT 31 MARCH 2023

for the year ended 31 March 2023

	Note	GROUP		CSIR	
		2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
ASSETS					
Non-current assets		794 654	747 674	799 304	752 324
PPE	5	786 623	737 633	786 623	737 633
Right-of-use assets	6	8 031	7 598	8 031	7 598
Investments in subsidiaries	8	-	-	4 650	4 650
Investments in joint ventures	7	-	2 443	-	2 443
Current Assets		2 028 313	1 926 745	2 019 658	1 918 407
Inventories	20	639	605	639	605
Other receivables from contracts with customers	21	203 503	181 803	203 503	181 803
Trade and other receivables	9	446 832	307 945	446 802	307 912
Contract assets	22	2 871	4 315	2 871	4 315
Investments at fair value	23	134 487	-	134 487	-
Cash and cash equivalents	16	1 239 981	1 432 077	1 231 356	1 423 772
TOTAL ASSETS		2 822 967	2 674 419	2 818 962	2 670 731
EQUITY AND LIABILITIES					
EQUITY		1 282 131	1 220 921	1 278 100	1 217 176
Reserves		149 682	133 571	149 682	133 571
Retained income		1 132 449	1 087 350	1 128 418	1 083 605
LIABILITIES					
Non-current liabilities		15 748	17 963	15 748	17 963
Lease liabilities	6	5 720	7 561	5 720	7 561
Retirement benefit obligation	11	10 028	10 402	10 028	10 402
Current Liabilities		1 525 088	1 435 535	1 525 114	1 435 592
Trade and other payables	10	357 316	373 676	357 342	373 733
Lease liabilities	6	2 244	3 765	2 244	3 765
Retirement benefit obligation	11	1 950	1 802	1 950	1 802
Advances from customers	25	1 064 856	968 302	1 064 856	968 302
Provisions	24	98 722	87 990	98 722	87 990
TOTAL LIABILITIES		1 540 836	1 453 498	1 540 862	1 453 555
TOTAL EQUITY AND LIABILITIES		2 822 967	2 674 419	2 818 962	2 670 731

STATEMENT OF CHANGES IN EQUITY

for the year ended 31 March 2023

	Revaluation reserve	Reserve for valuation of investments	Total reserves	Retained income	Total equity
	R '000	R '000	R '000	R '000	R '000
GROUP					
Restated Balance at 1 April 2021	133 571	-	133 571	1 034 037	1 167 608
Profit for the year	-	-	-	51 718	51 718
Other comprehensive income	-	-	-	1 595	1 595
Total comprehensive income for the year	-	-	-	53 313	53 313
Opening balance as previously reported	133 571	-	133 571	1 175 341	1 308 912
Adjustments					
Prior period error	-	-	-	(87 990)	(87 990)
Balance at 1 April 2022 as restated	133 571	-	133 571	1 087 351	1 220 922
Profit for the year	-	-	-	43 852	43 852
Other comprehensive income	-	16 111	16 111	1 246	17 357
Total comprehensive income for the year	-	16 111	16 111	45 098	61 209
Balance at 31 March 2023	133 571	16 111	149 682	1 132 449	1 282 131
CSIR					
Restated Balance at 1 April 2021	133 571	-	133 571	1 030 537	1 164 108
Profit for the year	-	-	-	51 473	51 473
Other comprehensive income	-	-	-	1 595	1 595
Total comprehensive income for the year	-	-	-	53 068	53 068
Opening balance as previously reported	133 571	-	133 571	1 171 595	1 305 166
Adjustments					
Prior period error	-	-	-	(87 990)	(87 990)
Balance at 1 April 2022 as restated	133 571	-	133 571	1 083 605	1 217 176
Profit for the year	-	-	-	43 567	43 567
Other comprehensive income	-	16 111	16 111	1 246	17 357
Total comprehensive income for the year	-	16 111	16 111	44 813	60 924
Balance at 31 March 2023	133 571	16 111	149 682	1 128 418	1 278 100

STATEMENT OF CASH FLOWS

for the year ended 31 March 2023

	Note	GROUP		CSIR	
		2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Cash flows from operating activities					
Cash receipts from external customers		2 024 093	1 930 649	2 024 111	1 930 638
Parliamentary Grant received		741 615	725 537	741 615	725 537
Cash paid to suppliers and employees		(2 798 142)	(2 659 231)	(2 798 150)	(2 659 199)
Cash generated from operations	15	(32 434)	(3 045)	(32 424)	(3 024)
Finance income received		33 243	54 510	32 913	54 298
Finance expense		(284)	(803)	(284)	(803)
Net cash inflow from operating activities		525	50 662	205	50 471
Cash flows from investing activities					
Purchase of PPE	5	(88 256)	(50 972)	(88 256)	(50 972)
Sale of PPE	5	4 698	1 436	4 698	1 436
Purchase of investments at fair value		(125 000)	-	(125 000)	-
Remeasurement of debt investments at fair value through other comprehensive income		16 111	-	16 111	-
Loan repayment from Sera (Pty) Ltd		1 950	-	1 950	-
Net cash outflow from investing activities		(190 497)	(49 536)	(190 497)	(49 536)
Cash flows from financing activities					
Payment on lease liabilities		(1 854)	(1 626)	(1 854)	(1 626)
Net cash outflow from financing activities		(1 854)	(1 626)	(1 854)	(1 626)
Unrealised exchange losses on foreign cash balances		(270)	(2 556)	(270)	(2 556)
Total cash movement for the year		(192 096)	(3 056)	(192 416)	(3 247)
Cash at the beginning of the year		1 432 077	1 435 133	1 423 772	1 427 019
Total cash at end of the year	16	1 239 981	1 432 077	1 231 356	1 423 772

ACCOUNTING POLICIES

for the year ended 31 March 2023

Entity information

The CSIR is a national government business enterprise (enacted by The Scientific Research Council Act, 1988 (Act 46 of 1988) as amended by Act 71 of 1990, domiciled in the Republic of South Africa. The address of the CSIR's principal place of business is Meiring Naudé Road, Brummeria, Pretoria. The CSIR undertakes directed and particularly multidisciplinary research and technological innovation to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic.

The consolidated annual financial statements of the Group, as at and for the year ended 31 March 2023, comprise the entity and its subsidiaries (together referred to as the Group) and the Group's interest in associates and jointly controlled entities.

1. Significant accounting policies

The principal accounting policies applied in the preparation of these consolidated and separate financial statements are set out below.

1.1 Basis of preparation

The consolidated and separate financial statements have been prepared on the going concern basis in accordance with, and in compliance with, International Financial Reporting Standards ("IFRS") and International Financial Reporting Interpretations Committee ("IFRIC") interpretations issued and effective at the time of preparing these consolidated financial statements and the Public Finance Management Act, 1999 (Act 1 of 1999) as amended by Act 29 of 1999.

These consolidated financial statements comply with the requirements of the South African Institute of Chartered Accountants Financial Reporting Guides as issued by the Accounting Practices Committee and the Financial Reporting Pronouncements as issued by the Financial Reporting Standards Council.

The consolidated financial statements have been prepared on the historic cost convention, unless otherwise stated in the accounting policies, which follow and incorporate the principal accounting policies set out below. They are presented in rand, which is the Group and entity's functional currency.

These accounting policies are consistent with the previous period.

1.2 Consolidation

Basis of consolidation

The consolidated financial statements incorporate the separate financial statements of the CSIR and all subsidiaries.

Subsidiaries are entities (including structured entities), which are controlled by the Group.

The Group has control of an entity when it is exposed to or has rights to variable returns from involvement with the entity and it has the ability to affect those returns through the use of its power over the entity.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.2 Consolidation (continued)

The results of subsidiaries are included in the consolidated financial statements from the effective date of acquisition to the effective date of disposal.

All inter-company transactions, balances, and unrealised gains on transactions between Group companies are eliminated in full on consolidation. Unrealised losses are also eliminated unless the transaction provides evidence of an impairment of the asset transferred.

Investments in subsidiaries in the separate financial statements

In the CSIR's separate financial statements, investments in subsidiaries are carried at cost less any accumulated impairment losses.

1.3 Joint arrangements

A joint arrangement is an arrangement where two or more parties have joint control. Joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities require the unanimous consent of the parties sharing control. A joint arrangement is either a joint operation or a joint venture.

A joint operation is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the assets, and obligations for the liabilities, relating to the arrangement. A joint venture is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the net assets of the arrangement. The Group has assessed the nature of its joint arrangements and determined them to be joint ventures.

Joint ventures

An interest in a joint venture is accounted for using the equity method. Under the equity method, interests in joint ventures are carried in the statement of financial position at cost, adjusted for post acquisition changes in the CSIR's share of net assets of the joint venture, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment.

Losses in a joint venture in excess of the Group's interest in that joint venture, including any other unsecured losses, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the joint venture.

Profits or losses on transactions between the Group and a joint venture are eliminated to the extent of the Group's interest therein. Unrealised losses are eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of joint ventures have been changed where necessary to ensure consistency with the policies adopted by the Group.

Investments in joint ventures in the separate financial statements

In the company's separate financial statements, investments in joint ventures are carried at cost less any accumulated impairment losses.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.4 Investments in associates

An associate is an entity over which the Group has significant influence and which is neither a subsidiary nor a joint arrangement. Significant influence is the power to participate in the financial and operating policy decisions of the investee but has no control or joint control over those policies. It generally accompanies a shareholding of between 20% and 50% of the voting rights.

Investments in associates are accounted for using the equity method. Under the equity method, investments in associates are carried in the Statement of Financial Position at cost adjusted for post-acquisition changes in the Group's share of net assets of the associate, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment. Losses in an associate in excess of the Group's interest in that associate, including any other unsecured losses, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the associate.

Profits or losses on transactions between the Group and an associate are eliminated to the extent of the Group's interest therein. Unrealised losses are eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of associates have been changed where necessary to ensure consistency with the policies adopted by the Group.

1.5 Significant judgements and sources of estimation uncertainty

The preparation of consolidated financial statements in conformity with IFRS requires management, from time to time, to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets, liabilities, income and expenses. These estimates and associated assumptions are based on experience and various other factors that are believed to be reasonable under the circumstances. Actual results may differ from these estimates. The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised and in any future periods affected.

Critical judgements in applying accounting policies

The critical judgements made by management in applying accounting policies, apart from those involving estimations, that have the most significant effect on the amounts recognised in the financial statements, are outlined as follows:

Revenue recognition

The nature of the CSIR's business is varied in that there are contracts with customers, which give rise to single performance obligations, and others which give rise to multiple performance obligations. Judgement is applied in the determination of distinct performance obligations, as well as to when transfer of control of the identified performance obligations is satisfied.

In identifying distinct performance obligations, judgement was applied in assessing whether certain deliverables are separately identifiable from other items to be transferred to the customer in terms of the contract.

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for the year ended 31 March 2023

1.5 Significant judgements and sources of estimation uncertainty (continued)

Key sources of estimation uncertainty

Impairment of financial assets

As at 31 March 2023, the Group had R32 million (2022: R38 million) in allowance for doubtful accounts for trade and other receivables. The allowance for doubtful accounts is based on assumptions about risk of default and expected loss rates. The Group uses judgement in making these assumptions and selecting the inputs to the calculation of the allowance for doubtful accounts, based on the expected credit loss model (used in IFRS 9).

Impairment testing

Impairment of property, plant and equipment

At each reporting date, property, plant and equipment in use are assessed for impairment. To assess whether any impairment exists, estimates of expected future cash flows are used. Actual outcomes could vary significantly from such estimates. Factors such as changes in discount rates, the planned use of buildings, machinery or equipment or closure of facilities and technical obsolescence could lead to shorter useful lives or impairment.

Useful lives of property, plant and equipment

Management assess the appropriateness of the useful lives of property, plant and equipment at the end of each reporting period. The useful lives of motor vehicles, furniture and computer equipment are determined based on Group replacement policies for the various assets.

When the estimated useful life of an asset differs from previous estimates, the change is applied prospectively in the determination of the depreciation charge.

Provisions

Provisions are inherently based on assumptions and estimates using the best information available. Additional disclosure of these estimates of provisions are included in note 24.

Estimates of employee benefit liabilities

An updated actuarial valuation is carried out at the end of each financial year for the post-employment liabilities of the Group. Key assumptions used to determine the net assets and liabilities of these obligations and their sensitivities are set out in note 11.

1.6 Property, plant and equipment

Property, plant and equipment are tangible assets that the Group holds for its own use or for rental to others and which are expected to be used for more than one year.

An item of property, plant and equipment is recognised as an asset when it is probable that future economic benefits associated with the item will flow to the Group, and the cost of the item can be measured reliably.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.6 Property, plant and equipment (continued)

Property, plant and equipment is initially measured at cost. Cost includes all of the expenditure that is directly attributable to the acquisition or construction of the asset.

Expenditure incurred subsequently for major services, additions to or replacements of parts of property, plant and equipment are capitalised if it is probable that future economic benefits associated with the expenditure will flow to the Group and the cost can be measured reliably. Day-to-day servicing costs are included in profit or loss in the year in which they are incurred.

Major inspection costs that are a condition of continuing use of an item of property, plant and equipment and that meet the recognition criteria are included as a replacement in the cost of the item of property, plant and equipment. Any remaining inspection costs from the previous inspection are derecognised.

Major spare parts and stand by equipment that are expected to be used for more than one year are included in property, plant and equipment.

Property, plant and equipment is subsequently stated at cost less accumulated depreciation and any accumulated impairment losses, except for land which is stated at revalued amount less any accumulated impairment losses.

Depreciation of an asset commences when the asset is available for use as intended by management. Depreciation is charged to write off the asset's carrying amount over its estimated useful life to its estimated residual value, using a method that best reflects the pattern in which the asset's economic benefits are consumed by the Group. Leased assets are depreciated in a consistent manner over the shorter of their expected useful lives and the lease term. Depreciation is not charged to an asset if its estimated residual value exceeds or is equal to its carrying amount. Depreciation of an asset ceases at the earlier of the date that the asset is classified as held for sale, or derecognised.

The useful lives of items of property, plant and equipment have been assessed as follows:

Item	Depreciation method	Average useful life
Buildings	Straight line	90 years
Furniture and fixtures	Straight line	3 to 20 years
Motor vehicles	Straight line	10 years
Office equipment	Straight line	3 to 20 years
IT equipment	Straight line	3 to 5 years
Land	Straight line	Indefinite

The residual value, useful life and depreciation method of each asset are reviewed at the end of each reporting year. If the expectations differ from previous estimates, the change is accounted for prospectively as a change in accounting estimate.

Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item is depreciated separately.

The depreciation charge for each year is recognised in profit or loss unless it is included in the carrying amount of another asset.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.6 Property, plant and equipment (continued)

Impairment tests are performed on property, plant and equipment when there is an indicator that they may be impaired. When the carrying amount of an item of property, plant and equipment is assessed to be higher than the estimated recoverable amount, an impairment loss is recognised immediately in profit or loss to bring the carrying amount in line with the recoverable amount.

An item of property, plant and equipment is derecognised upon disposal or when no future economic benefits are expected from its continued use or disposal. Any gain or loss arising from the derecognition of an item of property, plant and equipment, determined as the difference between the net disposal proceeds, if any, and the carrying amount of the item, is included in profit or loss when the item is derecognised.

1.7 Financial instruments

Financial instruments held by the Group are classified in accordance with the provisions of IFRS 9 Financial Instruments. Broadly, the applicable classification possibilities, which are adopted by the Group, are as follows:

Financial assets that are debt instruments:

- Amortised cost. (This category applies only when the contractual terms of the instrument give rise, on specified dates, to cash flows that are solely payments of principal and interest on principal, and where the instrument is held under a business model whose objective is met by holding the instrument to collect contractual cash flows).
- Mandatorily at fair value through profit or loss. (This classification automatically applies to all debt instruments that do not qualify as at amortised cost or at fair value through other comprehensive income); or

Financial liabilities:

- Amortised cost

Note 14 of the financial instruments and risk management presents the financial instruments held by the Group based on their specific classifications.

All regular way purchases or sales of financial assets are recognised and derecognised on a trade date basis. Regular way purchases or sales are purchases or sales of financial assets that require the delivery of assets within the timeframe established by regulation or convention in the marketplace.

The specific accounting policies for the classification, recognition and measurement of each type of financial instrument held by the Group are presented below:

Trade and other receivables

Classification

Trade and other receivables, excluding, when applicable, VAT and prepayments, are classified as financial assets subsequently measured at amortised cost (note 9).

They have been classified in this manner because their contractual terms give rise, on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding.

The Group's business model is to collect the contractual cash flows on trade and other receivables.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.7 Financial instruments (continued)

Trade and other receivables (continued)

Recognition and measurement

Trade and other receivables are recognised when the Group becomes a party to the contractual provisions of the receivables. They are measured, at initial recognition, at transaction price.

They are subsequently measured at amortised cost.

The amortised cost is the amount recognised on the receivable initially, minus principal repayments, plus cumulative amortisation (interest) using the effective interest method of any difference between the initial amount and the maturity amount, adjusted for any loss allowance.

Impairment

The Group recognises a loss allowance for expected credit losses on trade and other receivables, excluding VAT and prepayments. The amount of expected credit losses is updated at each reporting date.

The Group measures the loss allowance for trade and other receivables at an amount equal to lifetime expected credit losses (lifetime ECL), which represents the expected credit losses that will result from all possible default events over the expected life of the receivable.

Measurement and recognition of expected credit losses

The Group applies the simplified approach to trade receivables, contract assets and lease receivables of measuring the loss allowance at an amount equal to lifetime expected credit losses in terms of IFRS 9. The Group applies the ECL valuation model as follows:

- It rebuts the more than 30 days past due presumption, instead the CSIR presumes that there is a significant increase in credit risk when payments are more than 90 days outstanding from dates of invoices. Based on historical experience for most of the CSIR's debtors if contractual payments become more than 30 days past due, this does not represent a significant increase in the credit risk of a financial instrument. It is rather due to their extensive administrative systems for local debtors, or timing differences in moving money outside of the borders of their countries for international customers instead of financial difficulty of the debtors.
- When a receivable (i.e., an invoice) is more than 90 days outstanding, an allowance for loss is raised, for 100% of the outstanding amount, excluding Value Added Tax (thus a 100% loss probability is assumed). However, no allowance is raised when there is a firm commitment by the debtor that they will settle the amount due even if the receivable is more than 90 days outstanding.
- An allowance for loss is raised even if a receivable (invoice) is less than 90 days outstanding when there is evidence indicating a significant increase in credit risk of a debtor.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.7 Financial instruments (continued)

Trade and other receivables (continued)

Write-off policy

The Group writes off a receivable when there is information indicating that the counterparty is in severe financial difficulty and there is no realistic prospect of recovery, e.g., when the counterparty has been placed under liquidation or has entered into bankruptcy proceedings. Receivables written off may still be subject to enforcement activities under the Group recovery procedures, taking into account legal advice where appropriate. Any recoveries made are recognised in profit or loss.

Credit risk

Details of credit risk are included in the trade and other receivables note (note 9) and the financial instruments and risk management note (note 14).

Derecognition

Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

Investments in debt instruments at fair value through profit or loss

Classification

Certain investments in debt instruments are classified as mandatorily at fair value through profit or loss. These investments do not qualify for classification at amortised cost or at fair value through other comprehensive income because either the contractual terms of these instruments do not give rise, on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding, or the objectives of the group business model are met by selling the instruments rather than holding them to collect the contractual cash flows. The Group holds investments in Index Linked Notes (note 23), which are at fair value through profit or loss.

Recognition and measurement

Investments in debt instruments at fair value through profit or loss are recognised when the group becomes a party to the contractual provisions of the instrument. The investments are measured at initial recognition and, subsequently, at fair value based on observable market rates. Transaction costs are recognised in profit or loss.

Fair value gains or losses are included in other income (note 26)

Impairment

Investments in debt instruments at fair value through profit or loss are not subject to impairment provisions.

Derecognition

Refers to the derecognition section of the accounting policy for the policies and processes related to derecognition.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.7 Financial instruments (continued)

Trade and other payables

Classification

Trade and other payables (note 10), excluding VAT and amounts received in advance, are classified as financial liabilities subsequently measured at amortised cost.

Recognition and measurement

They are recognised when the Group becomes a party to the contractual provisions, and are measured, at initial recognition, at fair value plus transaction costs, if any.

Trade and other payables expose the Group to liquidity risk and, possibly, to interest rate risk. Refer to note 14 for details of risk exposure and management thereof.

Trade and other payables denominated in foreign currencies

When trade payables are denominated in a foreign currency, the carrying amount of the payables are determined in the foreign currency. The carrying amount is then translated to the Rand equivalent using the spot rate at the end of each reporting period. Any resulting foreign exchange gains or losses are recognised in profit or loss.

Details of foreign currency risk exposure and the management thereof are provided in the financial instruments and risk management note (note 14).

Derecognition

Refer to the "derecognition" section of the accounting policy for the policies and processes related to derecognition.

Financial guarantee contracts

A financial guarantee contract is a contract that requires the issuer to make specified payments to reimburse the holder for a loss it incurs because a specified debtor fails to make payments when due in accordance with the terms of a debt instrument.

Financial guarantee contracts issued by the Group are initially measured at their fair values and, if not designated as at Fair Value Through Profit or Loss and do not arise from a transfer of a financial asset, are subsequently measured at the higher of:

- The amount of the loss allowance determined in accordance with IFRS 9; and
- The amount initially recognised less, where appropriate, cumulative amount of income recognised in accordance with the revenue recognition policies.

Refer to note 28 for details of financial guarantee contracts.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.7 Financial instruments (continued)

Cash and cash equivalents

Cash and cash equivalents are stated at carrying amount, which is deemed to be fair value.
Financial instruments (continued) Derecognition

Financial assets

The Group derecognises a financial asset only when the contractual rights to the cash flows from the asset expire, or when it transfers the financial asset and substantially all the risks and rewards of ownership of the asset to another party. If the Group neither transfers nor retains substantially all the risks and rewards of ownership and continues to control the transferred asset, the Group recognises its retained interest in the asset and an associated liability for amounts it may have to pay. If the Group retains substantially all the risks and rewards of ownership of a transferred financial asset, the Group continues to recognise the financial asset and also recognises a collateralised borrowing for the proceeds received.

Financial liabilities

The Group derecognises financial liabilities when, and only when, the Group's obligations are discharged, cancelled or they expire. The difference between the carrying amount of the financial liability derecognised and the consideration paid and payable, including any non-cash assets transferred or liabilities assumed, is recognised in profit or loss.

1.8 Tax

Income tax

The CSIR is exempt from South African income tax in terms of section 10 (1) (t) (i) of the Income Tax Act, 1962 (Act 58 of 1962).

1.9 Leases

The Group assesses whether a contract is or contains a lease at the inception of the contract.

A contract is or contains a lease if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration.

In order to assess whether a contract is or contains a lease, management determines whether the asset under consideration is "identified", which means that the asset is either explicitly or implicitly specified in the contract and that the supplier does not have a substantial right of substitution throughout the period of use. Once management has concluded that the contract deals with an identified asset, the right to control the use thereof is considered. To this end, control over the use of an identified asset only exists when the group has the right to substantially all of the economic

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.9 Leases (continued)

benefits from the use of the asset, as well as the right to direct the use of the asset.

In circumstances where the determination of whether the contract is or contains a lease requires significant judgement, the relevant disclosures are provided in the significant judgments and sources of estimation uncertainty section of these accounting policies.

A lease liability and corresponding right-of-use asset are recognised at the lease commencement date, for all lease agreements for which the Group is a lessee, except for short-term leases of 12 months or less, or leases of low value assets. For these leases, the Group recognises the lease payments as an operating expense (note 6) on a straight-line basis over the term of the lease unless another systematic basis is more representative of the time pattern in which economic benefits from the leased asset are consumed.

The various lease and non-lease components of contracts containing leases are accounted for separately, with consideration being allocated to each lease component on the basis of the relative stand-alone prices of the lease components and the aggregate stand-alone price of the non-lease components (where non-lease components exist).

However as an exception to the preceding paragraph, the Group has elected not to separate the non-lease components for leases of land and buildings.

Details of leasing arrangements where the Group is a lessee are presented in note 6: Leases (Group as lessee).

Lease liability

The lease liability is initially measured at the present value of the lease payments that are not paid at the commencement date, discounted by using the rate implicit in the lease.

If this rate cannot be readily determined, the Group uses its incremental borrowing rate.

Lease payments included in the measurement of the lease liability comprise the following:

- Fixed lease payments, including in-substance fixed payments, less any lease incentives;
- Variable lease payments that depend on an index or rate, initially measured using the index or rate at the commencement date;
- The amount expected to be payable by the Group under residual value guarantees;
- The exercise price of purchase options, if the Group is reasonably certain to exercise the option;
- Lease payments in an optional renewal period if the Group is reasonably certain to exercise an extension option; and
- Penalties for early termination of a lease, if the lease term reflects the exercise of an option to terminate the lease.

Variable rents that do not depend on an index or rate are not included in the measurement of the lease liability (or right-of-use asset). The related payments are recognised as an expense in the period incurred and are included in operating expenses (note 6).

The lease liability is presented as a separate line item on the Statement of Financial Position.

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1.9 Leases (continued)

The lease liability is subsequently measured by increasing the carrying amount to reflect interest on the lease liability (using the effective interest method) and by reducing the carrying amount to reflect lease payments made. Interest charged on the lease liability is included in finance expense (note 4).

The group remeasures the lease liability (and makes a corresponding adjustment to the related right-of-use asset) when:

- There has been a change to the lease term, in which case the lease liability is remeasured by discounting the revised lease payments using a revised discount rate;
- There has been a change in the assessment of whether the group will exercise a purchase, termination or extension option, in which case the lease liability is remeasured by discounting the revised lease payments using a revised discount rate;
- There has been a change to the lease payments due to a change in an index or a rate, in which case the lease liability is remeasured by discounting the revised lease payments using the initial discount rate (unless the lease payments change is due to a change in a floating interest rate, in which case a revised discount rate is used);
- There has been a change in expected payment under a residual value guarantee, in which case the lease liability is remeasured by discounting the revised lease payments using the initial discount rate;
- A lease contract has been modified and the lease modification is not accounted for as a separate lease, in which case the lease liability is remeasured by discounting the revised payments using a revised discount rate.

When the lease liability is remeasured in this way, a corresponding adjustment is made to the carrying amount of the right-of-use asset, or is recognised in profit or loss if the carrying amount of the right-of-use asset has been reduced to zero.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.9 Leases (continued)

Right-of-use assets

Right-of-use assets are presented as a separate line item on the Statement of Financial Position. Lease payments included in the measurement of the lease liability comprise the following:

- The initial amount of the corresponding lease liability;
- Any lease payments made at or before the commencement date;
- Any initial direct costs incurred;
- Any estimated costs to dismantle and remove the underlying asset or to restore the underlying asset or the site on which it is located, when the group incurs an obligation to do so, unless these costs are incurred to produce inventories; and
- Less any lease incentives received.

Right-of-use assets are subsequently measured at cost, less accumulated depreciation and impairment losses.

Right-of-use assets are depreciated over the shorter period of lease term and useful life of the underlying asset. However, if a lease transfers ownership of the underlying asset or the cost of the right-of-use asset reflects that the group expects to exercise a purchase option, the related right-of-use asset is depreciated over the useful life of the underlying asset. Depreciation starts at the commencement date of a lease.

For right-of-use assets that are depreciated over their useful lives, the useful lives are determined consistently with items of the same class of property, plant and equipment. Refer to the accounting policy for property, plant and equipment for details of useful lives.

The residual value, useful life and depreciation method of each asset are reviewed at the end of each reporting year. If the expectations differ from previous estimates, the change is accounted for prospectively as a change in accounting estimate. Each part of a right-of-use asset with a cost that is significant in relation to the total cost of the asset is depreciated separately.

The depreciation charge for each year is recognised in profit or loss unless it is included in the carrying amount of another asset.

Group as lessor

Leases for which the Group is a lessor are classified as finance or operating leases. Whenever the terms of the lease transfer substantially all the risks and rewards of ownership to the lessee, the contract is classified as a finance lease. All other leases are classified as operating leases. Lease classification is made at inception and is only reassessed if there is a lease modification.

When the Group is an intermediate lessor, it accounts for the head lease and the sublease as two separate contracts. The sublease is classified as a finance or operating lease by reference to the right-of-use asset arising from the head lease. If the head lease is a short-term lease to which the Group applies the exemption described previously, then it classifies the sub-lease as an operating lease.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.9 Leases (continued)

The various lease and non-lease components of contracts containing leases are accounted for separately, with consideration being allocated by applying IFRS 15.

1.10 Inventories

Inventories are measured at the lower of cost and net realisable value on the weighted average method.

Net realisable value is the estimated selling price in the ordinary course of business less the estimated costs of completion and the estimated costs necessary to make the sale.

The cost of inventories comprises of all costs of purchase, costs of conversion and other costs incurred in bringing the inventories to their present location and condition.

Inventories includes a "right to returned goods asset", which represents the Group's right to recover products from customers where customers exercise their right of return under the Group returns policy. The Group uses its accumulated historical experience to estimate the number of returns on a portfolio level using the expected value method. A corresponding adjustment is recognised against cost of sales.

1.11 Other receivables from contracts with customers

This accounting policy needs to be read in conjunction with the accounting policies for revenue from contracts with customers, contract assets and advances on contracts with customers. The Group presents as an asset the gross amount due from customers for contract work for all contracts in progress for which costs incurred plus recognised profits (less recognised losses) exceed progress billings. These are included in other receivables from contracts with customers under current assets. Progress billings that are invoiced but not yet paid by customers are included in trade and other receivables.

1.12 Impairment of assets

The Group assesses at each end of the reporting period whether there is any indication that an asset may be impaired. If any such indication exists, the Group estimates the recoverable amount of the asset.

Irrespective of whether there is any indication of impairment, the Group also:

- Tests intangible assets with an indefinite useful life or intangible assets not yet available for use for impairment annually by comparing its carrying amount with its recoverable amount. This impairment test is performed during the annual period and at the same time every period.
- Tests goodwill acquired in a business combination for impairment annually.

If there is any indication that an asset may be impaired, the recoverable amount is estimated for the individual asset. If it is not possible to estimate the recoverable amount of the individual asset, the recoverable amount of the cash-generating unit to which the asset belongs is determined.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.12 Impairment of assets (continued)

The recoverable amount of an asset or a cash-generating unit is the higher of its fair value less costs to sell and its value in use.

If the recoverable amount of an asset is less than its carrying amount, the carrying amount of the asset is reduced to its recoverable amount. That reduction is an impairment loss.

An impairment loss of assets carried at cost less any accumulated depreciation or amortisation is recognised immediately in profit or loss.

An entity assesses at each reporting date whether there is any indication that an impairment loss recognised in prior periods for assets other than goodwill may no longer exist or may have decreased. If any such indication exists, the recoverable amounts of those assets are estimated.

The increased carrying amount of an asset other than goodwill attributable to a reversal of an impairment loss does not exceed the carrying amount that would have been determined had no impairment loss been recognised for the asset in prior periods.

A reversal of an impairment loss of assets carried at cost less accumulated depreciation or amortisation other than goodwill is recognised immediately in profit or loss. Any reversal of an impairment loss of a revalued asset is treated as a revaluation increase.

1.13 Employee benefits

Short-term employee benefits

The cost of short-term employee benefits (those payable within 12 months after the service is rendered, such as paid vacation leave and sick leave, bonuses, and non-monetary benefits such as medical care), is recognised in the period in which the service is rendered and not discounted.

The expected cost of compensated absences is recognised as an expense as the employees render services that increase their entitlement or, in the case of non-accumulating absences, when the absence occurs.

Defined contribution plans

Payments to defined contribution retirement benefit plans are charged as an expense as they fall due.

Pension fund

The Group operates a defined contribution plan, the assets of which are held in a separate trustee-administered fund. The benefits payable by the fund in the future, due to retirements and withdrawals from the fund, are contributions to the fund together with fund interest at a rate determined by the valuator with the consent of the trustees. The rate is so determined that the value of the total of the fund shall not exceed the value of the total assets of the fund.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.13 Employee benefits (continued)

Defined contribution plans (continued)

Post-retirement benefits other than pensions

The Group provides post-retirement medical benefits to qualifying employees, which is deemed to be a defined benefit plan. The expected costs of these benefits are determined using the projected unit credit method, with actuarial valuations being carried out at each reporting date. Contributions are made to the relevant funds over the expected service lives of the employees entitled to those funds. The estimated cost of providing such benefits is charged to profit or loss on a systematic basis over the employees' working lives within the Group.

Actuarial gains and losses are recognised in other comprehensive income in the year when actuarially determined. The amount recognised in the statement of financial position represents the present value of the post-retirement medical fund benefit obligation. Any asset resulting from this calculation is limited to actuarial losses and the present value of available refunds and reductions in future contributions to the plan.

Defined benefit plans

For defined benefit plans the cost of providing the benefits is determined using the projected unit credit method. Actuarial valuations are conducted on an annual basis by independent actuaries separately for each plan.

Consideration is given to any event that could impact the funds up to the end of the reporting period where the interim valuation is performed at an earlier date.

Past service costs are recognised immediately to the extent that the benefits are already vested, and are otherwise amortised on a straight line basis over the average period until the amended benefits become vested.

To the extent that, at the beginning of the financial year, any cumulative unrecognised actuarial gain or loss exceeds ten percent of the greater of the present value of the projected benefit obligation and the fair value of the plan assets (the corridor), that portion is recognised in profit or loss over the expected average remaining service lives of participating employees.

Actuarial gains or losses within the corridor are not recognised.

Actuarial gains and losses are recognised in the year in which they arise, in other comprehensive income.

Gains or losses on the curtailment or settlement of a defined benefit plan is recognised when the group is demonstrably committed to curtailment or settlement.

When it is virtually certain that another party will reimburse some or all of the expenditure required to settle a defined benefit obligation, the right to reimbursement is recognised as a separate asset. The asset is measured at fair value. In all other respects, the asset is treated in the same way as plan assets. In profit or loss, the expense relating to a defined benefit plan is presented as the net of the amount recognised for a reimbursement.

The amount recognised in the statement of financial position represents the present value of the defined benefit obligation as adjusted for unrecognised actuarial gains and losses and unrecognised past service costs, and reduces by the fair value of plan assets.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.13 Employee benefits (continued)

Defined benefit plans (continued)

Any asset is limited to unrecognised actuarial losses and past service costs, plus the present value of available refunds and reduction in future contributions to the plan.

1.14 Provisions and contingencies

Provisions are recognised when:

- The Group has a present obligation as a result of a past event;
- It is probable that an outflow of resources embodying economic benefits will be required to settle the obligation; and
- A reliable estimate can be made of the obligation.

The amount of a provision is the present value of the expenditure expected to be required to settle the obligation. A constructive obligation to restructure arises only when an entity:

- Has a detailed formal plan for the restructuring, identifying at least:
 - The business or part of a business concerned,
 - The principal locations affected,
 - The location, function, and approximate number of employees who will be compensated for terminating their services,
 - The expenditures that will be undertaken,
 - When the plan will be implemented; and
- Has raised a valid expectation with those affected that it will carry out the restructuring by starting to implement that plan or announcing its main features to those affected by it.

Contingent assets and contingent liabilities are not recognised. Contingencies are disclosed in Note 13.

1.15 Government grants

Government grants are recognised when there is reasonable assurance that:

- The Group will comply with the conditions attached to them; and
- The grants will be received.

Government grants are recognised as income over the periods necessary to match them with the related costs that they are intended to compensate.

A government grant that becomes receivable as compensation for expenses or losses already incurred or for the purpose of giving immediate financial support to the entity with no future related costs is recognised as income for the period in which it becomes receivable.

Government grants related to assets, including non-monetary grants at fair value, are presented in the Statement of Financial Position by deducting the grant to arrive at the carrying amount of the asset.

Grants related to income are presented as a credit in the profit or loss and other comprehensive income (separately).

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.16 Revenue from contracts with customers

The Group derives revenue from contracts with customers for the following:

- Contract income, including CSIR International Convention Centre revenue;
- Operating leases; and
- Royalty income.

The Group measures and accounts for revenue based on the specifications of each individual contract with a customer, excluding any amounts received on behalf of third parties, and based on the contractual obligations either accounts for the revenue at a specific point in time or over time as control of the goods or services are transferred to the customer.

The Group recognises revenue over time if a customer simultaneously receives and consumes all of the benefits provided by the Group. The Group recognises revenue at a point in time if the over time criteria is not met. Revenue is recognised when control is transferred to the customer which is usually when legal title passes to the customer and the business has the right to payment. Refer below for further explanation of the different products and services and when control is transferred to the customer and when the Group has right to payment.

Contract income (including CSIR International Convention Centre revenue)

Contract income comprises the consideration received or receivable on contracts entered into with customers in the ordinary course of the CSIR's activities. Revenue is shown net of amounts collected on behalf of third parties (e.g., VAT). Revenue is recognised at the amount of the transaction price that is allocated to each performance obligation, determined at an amount that depicts the consideration to which CSIR expects to be entitled in exchange for transferring the goods and services promised to the customer. Where a contract contains multiple performance obligations, the transaction price is allocated to each performance obligation based on their relative stand-alone selling prices.

Contract income is recognised when the transfer of control of the identified performance obligation(s) has been satisfied. In term contracts, where milestones and invoicing dates are not aligned, revenue is recognised according to the stage of completion. Stage of completion is measured based on costs incurred as a percentage of total estimated costs required to satisfy the performance obligation.

Operating leases

Contract income from operating leases is recognised on a straight-line basis over the lease term.

Royalty income

Royalty income is recognised when the underlying transactions triggering their payment occurs. Royalty income is measured at the rate per customer contract.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.17 Contract assets and advances on contracts with customers

The accounting policy for contract assets needs to be read in conjunction with the accounting policy for revenue from contract with customers. Contract assets arise on the basis that costs are incurred to satisfy performance obligations, the related payment timing is determined based on each individual contract. These costs include costs to fulfil a contract and includes costs such as direct labour, materials, professional/consulting services and allocation of overhead cost which relate directly to satisfy performance obligations of the contract.

Contract assets are recovered from the customer when the relevant performance obligations are completed and payment can be obtained from the customer. If costs are incurred on a contract without a corresponding payment received it is shown as contract asset at the reporting period.

If the customer has paid in advance for performance obligations to satisfied it is shown as an advance on contract with customers within current liabilities. The Group presents as a liability the gross amount due to customers for contract work for all contracts in progress for which progress billings exceed costs incurred plus recognised profits (less recognised losses).

1.18 Related parties

A related party is a person or an entity with the ability to control or jointly control the other party, or exercise significant influence over the other party, or vice versa, or an entity that is subject to common control, or joint control.

Control is the power to govern the financial and operating policies of an entity so as to obtain benefits from its activities.

A related party transaction is a transfer of resources, services or obligations between the reporting entity and a related party, regardless of whether a price is charged.

Significant influence is the power to participate in the financial and operating policy decisions of an entity but is not control over those policies.

Key management are those persons responsible for planning, directing and controlling the activities of the entity, including those charged with the governance of the entity in accordance with legislation, in instances where they are required to perform such functions. All individuals from the level of Corporate Executive up to the Board of Directors are regarded as key management.

Close members of the family of a person are those family members who may be expected to influence or be influenced by that person in their dealings with the entity.

The entity is exempt from disclosure requirements in relation to related party transactions if that transaction occurs within normal supplier and/or client/recipient relationships on terms and conditions no more or less favourable than those which it is reasonable to expect the entity to have adopted if dealing with that individual entity or person in the same circumstances and terms and conditions are within the normal operating parameters established by that reporting entity's legal mandate.

ACCOUNTING POLICIES

for the year ended 31 March 2023

1.18 Related parties (continued)

Where the entity is exempt from the disclosures in accordance with the above, the entity discloses narrative information about the nature of the transactions and the related outstanding balances, to enable users of the entity's financial statements to understand the effect of related party transactions on its annual financial statements.

The entity operates in an economic sector currently dominated by entities directly or indirectly owned by the South African government. As a consequence of the constitutional independence of the three spheres of government in South Africa, only entities within the national sphere of government are considered to be related parties.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

	GROUP		CSIR	
	2023	2022	2023	2022
	R '000	Restated R '000	R '000	Restated R '000
2. Revenue				
Revenue				
Parliamentary Grant	738 476	730 274	738 476	730 274
Contract income	1 765 536	1 596 368	1 765 536	1 596 368
Royalty income	1 645	7 395	1 645	7 395
Other government grants	313 540	320 306	313 540	320 306
	2 819 197	2 654 343	2 819 197	2 654 343
The group disaggregates revenue from customers as follows:				
Parliamentary Grant				
Parliamentary Grant received	741 615	725 537	741 615	725 537
Less:				
Grant received for projects started before year-end but not completed	(56 644)	(53 505)	(56 644)	(53 505)
Add:				
Grant received in prior year for projects completed in this year	53 505	58 242	53 505	58 242
	738 476	730 274	738 476	730 274
Contract income				
Local private sector	263 216	232 116	263 216	232 116
Local public sector	1 259 619	1 163 501	1 259 619	1 163 501
International sector (including Africa)	242 701	200 751	242 701	200 751
	1 765 536	1 596 368	1 765 536	1 596 368
Royalty income				
Royalty income	1 645	7 395	1 645	7 395
Other government grants				
Other government grants	313 540	320 306	313 540	320 306
Total revenue	2 819 197	2 654 343	2 819 197	2 654 343

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

2. Revenue (continued)

	GROUP		CSIR	
	2023 %	2022 Restated %	2023 %	2022 Restated %
Parliamentary Grant				
Parliamentary Grant received	26	28	26	28
Contract income				
Local private sector	9	9	9	9
Local public sector	45	44	45	44
International sector (including Africa)	9	7	9	7
Other government grants				
Other government grants	11	12	11	12
	100	100	100	100

Included in other government grants is R110 million (2022: R128 million) ring-fenced allocation from the DSI for specific initiatives managed through memorandums of agreement.

Included in contract income is rental income amounting to R59,9 million (2022: R57,8 million) and revenue of R29 million (2022: R6 million) earned by the CSIR International Convention Centre.

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

Other government grants relate to income from contracts with government that impose specified performance conditions on the CSIR.

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
3. Finance income				
Interest income				
Investments in financial assets:				
Finance income	55 367	53 178	55 037	52 966
Finance income				
Interest on bank balances	11 094	53 178	10 764	52 966
Other investment income	44 273	-	44 273	-
Total	55 367	53 178	55 037	52 966

4. Finance expense

Finance leases	422	1 069	422	1 069
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NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

5. Property, plant and equipment

GROUP	2023			2022		
	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000
Land	138 400	-	138 400	138 400	-	138 400
Buildings	583 784	(103 088)	480 696	537 691	(97 094)	440 597
Furniture and fixtures	15 306	(13 531)	1 775	15 569	(13 409)	2 160
Motor vehicles	7 197	(6 023)	1 174	8 177	(6 795)	1 382
Office equipment	544 569	(429 408)	115 161	531 105	(419 873)	111 232
IT equipment	222 549	(173 132)	49 417	210 610	(166 748)	43 862
Total	1 511 805	(725 182)	786 623	1 441 552	(703 919)	737 633

CSIR	2023			2022		
	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000	Cost or revaluation R '000	Accumulated depreciation R '000	Carrying value R '000
Land	138 400	-	138 400	138 400	-	138 400
Buildings	583 784	(103 088)	480 696	537 691	(97 094)	440 597
Furniture and fixtures	15 306	(13 531)	1 775	15 569	(13 409)	2 160
Motor vehicles	7 197	(6 023)	1 174	8 177	(6 795)	1 382
Office equipment	544 569	(429 408)	115 161	531 105	(419 873)	111 232
IT equipment	222 549	(173 132)	49 417	210 610	(166 748)	43 862
Total	1 511 805	(725 182)	786 623	1 441 552	(703 919)	737 633

Reconciliation of property, plant and equipment – Group – 2023					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Total R '000
Land	138 400	-	-	-	138 400
Buildings	440 597	46 433	(340)	(5 994)	480 696
Furniture and fixtures	2 160	301	(93)	(593)	1 775
Motor vehicles	1 382	-	-	(208)	1 174
Office equipment	111 232	19 703	2 697	(18 471)	115 161
IT equipment	43 862	21 819	(471)	(15 793)	49 417
	737 633	88 256	1 793	(41 059)	786 623

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

5. Property, plant and equipment (continued)

Reconciliation of property, plant and equipment – Group – 2022					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Total R '000
Land	138 400	-	-	-	138 400
Buildings	437 463	8 965	7	(5 838)	440 597
Furniture and fixtures	2 755	148	(47)	(696)	2 160
Motor vehicles	1 620	-	-	(238)	1 382
Office equipment	119 857	20 539	(4 731)	(24 433)	111 232
IT equipment	44 022	21 320	(5 550)	(15 930)	43 862
	744 117	50 972	(10 321)	(47 135)	737 633

Reconciliation of property, plant and equipment – CSIR – 2023					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Total R '000
Land	138 400	-	-	-	138 400
Buildings	440 597	46 433	(340)	(5 994)	480 696
Furniture and fixtures	2 160	301	(93)	(593)	1 775
Motor vehicles	1 382	-	-	(208)	1 174
Office equipment	111 232	19 703	2 697	(18 471)	115 161
IT equipment	43 862	21 819	(471)	(15 793)	49 417
	737 633	88 256	1 793	(41 059)	786 623

Reconciliation of property, plant and equipment – CSIR – 2022					
	Opening balance R '000	Additions R '000	Other changes, movements R '000	Depreciation R '000	Total R '000
Land	138 400	-	-	-	138 400
Buildings	437 463	8 965	7	(5 838)	440 597
Furniture and fixtures	2 755	148	(47)	(696)	2 160
Motor vehicles	1 620	-	-	(238)	1 382
Office equipment	119 857	20 539	(4 731)	(24 433)	111 232
IT equipment	44 022	21 320	(5 550)	(15 930)	43 862
	744 117	50 972	(10 321)	(47 135)	737 633

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

5. Property, plant and equipment (continued)

Revaluations

The Group's land is stated at revalued amounts, being the fair value at the date of revaluation, less any subsequent accumulated impairment losses. Revaluations are performed every five years and in intervening years if the carrying amount of the land differs materially from their fair value.

The fair value measurements as of Tuesday, 31 March 2020 were performed by Mr Potela Peter Mabelane, an independent valuer not related to the Group. Mr Mabelane is member of the South African Council for the Property Valuers Profession and has the appropriate qualifications and recent experience in the fair value measurement of properties in the relevant locations.

The carrying value of the revalued assets under the cost model would have been:

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Land	4 829	4 829	4 829	4 829

Details of properties

Land and buildings are unencumbered and full details of the titles are available at the registered office of the CSIR.

A change in the depreciation estimate due to a change in the useful lives of equipment, ICT equipment, furniture and fittings and vehicles resulted in a R4,4 million (2022: R3,7 million) decrease in the depreciation amount for the current financial year.

During the current financial year, assets to the value of R78,7 million (2022: R66,5 million) were purchased with government grant funds. At year-end, the cumulative value of assets purchased with government grant funds and shown at a nil cost is R927,8 million (2022: R865,2 million).

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

6. Leases (group as lessee)

The Group leases several assets, including buildings, motor vehicles and office equipment. The average lease term is four years.

Details pertaining to leasing arrangements, where the Group is lessee are presented below:

Net carrying amounts of right-of-use assets

The carrying amounts of right-of-use assets are included in the following line items:

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Buildings	4 870	7 287	4 870	7 287
Motor vehicles	3 161	274	3 161	274
Office equipment	-	37	-	37
	8 031	7 598	8 031	7 598
Additions to right-of-use assets				
Buildings	5 043	-	5 043	-
Motor vehicles	3 061	360	3 061	360
	8 104	360	8 104	360

Depreciation recognised on right-of-use assets

Depreciation recognised on each class of right-of-use assets, is presented below.

Buildings	921	2 261	921	2 261
Motor vehicles	442	275	442	275
Office equipment	37	92	37	92
	1 400	2 628	1 400	2 628

Other disclosures

Interest expense on lease liabilities

Lease liabilities

The maturity analysis of lease liabilities is as follows:

Within one year	2 664	4 062	2 664	4 062
Two to five years	5 517	7 391	5 517	7 391
More than five years	527	-	527	-
	8 708	11 453	8 708	11 453
Non-current liabilities	5 720	7 561	5 720	7 561
Current liabilities	2 244	3 765	2 244	3 765
	7 964	11 326	7 964	11 326

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

7. Interests in joint venture and associate

GROUP				
Name of company	% ownership interest 2023	% ownership interest 2022	Carrying amount 2023 R '000	Carrying amount 2022 R '000
Joint venture				
Sera (Pty) Ltd - South Africa	50.00%	50.00%	-	3 226
Associate				
Persomics AB - Sweden	35.03%	35.03%	21 454	21 454
			21 454	24 680
Impairment	-		(21 454)	(22 237)
			-	2 443

CSIR				
Name of company	% ownership interest 2023	% ownership interest 2022	Carrying amount 2023 R '000	Carrying amount 2022 R '000
Joint venture				
Sera (Pty) Ltd - South Africa	50.00%	50.00%	16 166	18 116
Associate				
Persomics AB - Sweden	35.03%	35.03%		
			16 166	18 116
Impairment of investment in joint ventures	-		(16 166)	(15 673)
			-	2 443

Sera (Pty) Ltd is in the process of deregistration.

The following are details of the significant joint ventures' and associates' assets, liabilities, income and expenses:

	JOINT VENTURES GROUP		ASSOCIATES GROUP	
	2023 R '000	2022 R '000	2023 R '000	2022 R '000
Current assets	465	4 808	68	62
Non-current assets	-	-	8 630	7 784
Current liabilities	11	35	1 464	1 321
Non-current liabilities	-	36 232	-	-
Income	37	90	-	6 272
Expenses	339	74	467	239

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

8. Interests in subsidiaries, including consolidated structured entities

	GROUP		CSIR	
	2023	2022	2023	2022
	R '000	Restated R '000	R '000	Restated R '000
Shares at cost less impairment losses	-	-	4 650	4 650
- by subsidiaries	-	-	-	-
- impairment of loans	-	-	-	-

The following table provides details of the entity, which is controlled directly by the CSIR, and the carrying amount of the investment in the CSIR's separate financial statements.

CSIR						
Name of company	% voting power 2023	% voting power 2022	% holding 2023	% holding 2022	Carrying amount 2023 R '000	Carrying amount 2022 R '000
Technology Finance Corporation SOC	100	100	100	100	4 650	4 650

9. Trade and other receivables

	GROUP		CSIR	
	2023	2022	2023	2022
	R '000	Restated R '000	R '000	Restated R '000
Financial instruments:				
Trade receivables	354 886	271 775	354 872	271 743
Accrued income	16	1	-	-
Loss allowance	(32 113)	(38 565)	(32 113)	(38 565)
Trade receivables at amortised cost	322 789	233 211	322 759	233 178
Deposits	60	-	60	-
Other receivables	6 196	2 487	6 196	2 487
Non-financial instruments:				
Prepayments	117 787	72 247	117 787	72 247
Total trade and other receivables	446 832	307 945	446 802	307 912

10. Trade and other payables

Financial instruments:				
Trade payables	248 596	247 404	248 622	247 460
Salary related payables	86 540	79 430	86 540	79 430
Non-financial instruments:				
VAT	22 180	46 841	22 180	46 841
Trade and other payables	357 316	373 675	357 342	373 731

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

11. Retirement benefits of employees

CSIR Pension Fund

The fund is registered in terms of the Pension Funds Act, 1956 (Act 24 of 1956), and is a defined contribution plan. The CSIR's liability to the fund was limited to paying the employer contributions up until 29 February 2016. The impact of the tax reform, effective from 1 March 2016, is that the CSIR package structure was changed to reflect all retirement fund contributions as employee contributions. All permanent CSIR employees are members of the fund.

Employee contributions of R194 million (2022: R181 million) were expensed during the year.

Post-retirement medical benefits

The CSIR has a postretirement medical benefit obligation to certain qualifying retired CSIR employees (pensioners) who joined the CSIR prior to 30 September 1996. An offer was made to qualifying pensioners in December 2005 to accept an annuity, payable from an independent source, equivalent to the value of their medical subsidy. The pensioners who accepted the offer are no longer entitled to a subsidy from the CSIR.

The accumulated benefit obligation and the annual cost of accrual of benefits are assessed by independent, qualified actuaries using the projected unit credit method. The estimated present value of the anticipated expenditure for the remaining 18 continuation members (2022: 18 continuation members) was recalculated by the actuaries as at 31 March 2023 and will be funded through cash and cash equivalents. These cash and cash equivalents have not been set aside specifically for this benefit.

The amount included in the statement of financial position arising from the CSIR's obligation in respect of post-retirement medical benefits is as follows:

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Carrying value				
Present value of the defined benefit obligation-wholly unfunded	(11 978)	(12 204)	(11 978)	(12 204)
Non-current liabilities	(10 028)	(10 402)	(10 028)	(10 402)
Current liabilities	(1 950)	(1 802)	(1 950)	(1 802)
	(11 978)	(12 204)	(11 978)	(12 204)

Amounts recognised in the statement of profit or loss and other comprehensive income in respect of the scheme are as follows:

Net amount recognised

Interest cost	1 020	918	1 020	918
Actuarial loss	(1 246)	(1 595)	(1 246)	(1 595)
	(226)	(677)	(226)	(677)
Movements for the year				
Opening balance	12 204	12 881	12 204	12 881
Net expense recognised in profit or loss	(226)	(677)	(226)	(677)
Net liability at the end of the year	11 978	12 204	11 978	12 204

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

11. Retirement benefits of employees (continued)

Key assumptions used

Principal actuarial assumptions at the reporting date

Discount rates used

Expected rate of return on assets

The above results are sensitive to changes in the assumed future rate of medical inflation

GROUP		CSIR	
2023	2022 Restated	2023	2022 Restated
%	%	%	%

9.33 %

9.01 %

9.33 %

9.01 %

4.73 %

5.60 %

4.73 %

5.60 %

GROUP		CSIR	
2023	2022 Restated	2023	2022 Restated
R '000	R '000	R '000	R '000

Defined contribution plan

The effect of a one percent increase in the assumed future rate of medical inflation would have the following effects:

The total group contribution to such schemes

600

664

600

664

The effect of a one percent decrease in the assumed future rate of medical inflation would have the following effects:

Effect on defined benefit obligation

(553)

(609)

(553)

(609)

The above sensitivity analyses are based on a change in an assumption while all other assumptions are assumed to remain unchanged. This may not always be realistic as some of the assumptions tend to be correlated. When calculating the sensitivity of the defined benefit obligation to significant actuarial assumptions, the same method (present value of the defined benefit obligation calculated with the projected unit credit method at the end of the reporting period) has been applied as when calculating the liability recognised within the statement of financial position.

Historical information:	2023 R '000	2022 R '000	2021 R '000	2020 R '000	2019 R '000
Present value of the defined benefit obligation	11 798	12 204	12 881	11 800	10 906

The average term (undiscounted) of the defined benefit obligation is 8.4 years (2022: 8.6 years) and the average duration (discounted) of the defined benefit obligation is 5.25 years (2022: 5.7 years).

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

12. Board members, directors and executive management's remuneration

2023			
	Emoluments R '000	Directors' fees R '000	Total R '000
Board members and Executive Directors			
Dr TH Dlamini	7 191	-	7 191
Non-executive Board members			
Prof. T Majazi	-	251	251
Prof. A van Zyl	-	36	36
M Govender	-	18	18
Dr AR Childs	-	82	82
Dr C Render	-	134	134
S Masie	-	117	117
Prof. Y Ballim	-	20	20
M Matolong	-	18	18
Dr R Masango	-	93	93
J Netshitenzhe	-	71	71
Dr V Mthethwa	-	123	123
C Shariff	-	117	117
V Jarana	-	17	17
M Fakir	-	20	20
J Newton	-	19	19
Executive Management			
MA Dindar	4 408	-	4 408
E Opperman (Acting CFO since 17 January 2023)	474	-	474
Dr K Naidoo	3 078	-	3 078
Dr RK Chikwamba	4 302	-	4 302
Dr MS Maserumule	4 614	-	4 614
MC Mabindisa	3 270	-	3 270
Adv. E Kennedy	3 616	-	3 616
Dr S Malinga (from 1 August 2022)	2 496	-	2 496
	33 449	1 136	34 585

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

12. Board members, directors and executive management's remuneration (continued)

2022			
	Emoluments R '000	Directors' fees R '000	Total R '000
Board members and Executive Directors			
Dr TH Dlamini	6 265	-	6 265
Non-executive Board members			
Prof. T Majazi	-	363	363
Dr AR Childs	-	118	118
Dr R Masango	-	153	153
S Masie	-	167	167
Dr V Mthethwa	-	167	167
J Netshitenzhe	-	102	102
Dr C Render	-	167	167
C Shariff	-	165	165
Executive Management			
MA Dindar	4 104	-	4 104
Dr K Naidoo (Acting executive since 1 January 2022)	664	-	664
Dr RK Chikwamba	4 252	-	4 252
Dr MS Maserumule	4 243	-	4 243
K Njobe (until 31 December 2021)	2 291	-	2 291
MC Mabindisa	3 064	-	3 064
Adv. E Kennedy	3 199	-	3 199
	28 082	1 402	29 484

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

13. Contingencies

In the nature of the CSIR's business, agreements with complex deliverables may be entered into. All necessary steps are taken to manage the risks inherent to these transactions. If and when it is evident that there is a reasonable probability that a dispute on a transaction could lead to costs against the CSIR, such costs will be disclosed. Refer to note 28 for financial guarantees issued by the CSIR.

14. Financial instruments and risk management

Financial risk management

Overview

The Group is exposed to the following risks from its use of financial instruments:

- Credit risk;
- Liquidity risk; and
- Market risk (currency risk, interest rate risk and price risk).

This note presents information about the Group's exposure to each of the above risks and the Group's objectives, policies and processes for measuring and managing risk. Further quantitative disclosures are included throughout these consolidated financial statements.

The Board has overall responsibility for the establishment and oversight of the Group's risk management framework. The Group's risk management policies are established to identify and analyse the risks faced by the Group, to set appropriate risk limits and controls, and to monitor risks and adherence to limits. Risk management policies and systems are reviewed regularly to reflect changes in market conditions and the Group's activities. The Group, through its training and management standards and procedures, aims to develop a disciplined and constructive control environment in which all employees understand their roles and obligations.

The Audit and Risk Committee oversees how management monitors compliance with the Group's risk management policies and procedures and reviews the adequacy of the risk management framework in relation to the risks faced by the Group. The Group Audit and Risk Committee is assisted in its oversight role by Internal Audit. Internal Audit undertakes both regular and ad hoc reviews of risk management controls and procedures, the results of which are reported to the Audit and Risk Committee.

The estimated net fair values, as at the reporting date, have been determined using available market information and appropriate valuation methodologies as outlined below. This value is not necessarily indicative of the amounts that the Group could realise in the normal course of business. The fair values of the financial assets and financial liabilities are sensitive to exchange rate movements. A sensitivity analysis of a 10% increase/decrease in exchange rate fluctuation on the bank balances held in foreign currency bank accounts as at 31 March 2023 is performed. The fair value of receivables, bank balances, repurchase agreements and other liquid funds, payables and accruals, approximate their carrying amount due to the short-term maturities of these instruments.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

14. Financial instruments and risk management (continued)

14.1 Market risk

Foreign currency risk

The Group is exposed to currency risk on sales and purchases that are denominated in a currency other than the respective functional currency of the Group entities.

The Group enters into forward exchange contracts to buy specified amounts of foreign currencies in the future at a predetermined exchange rate.

Forward exchange contracts are entered into mainly to cover import orders. The Group has no policy to enter into forward exchange contracts for anticipated foreign receipts. The Group does not use derivative financial instruments for speculative purposes.

The Group's exposure to foreign currency risk was as follows:

31 March 2023	ZAR '000	EURO '000	USD '000	GBP '000	OTHER '000	Total R'000
Trade receivables	339 359	-	7 909	7 543	577	355 388
Bank accounts	47 806	5 422	37 811	6 351	54	97 444
Trade and other payables	(333 770)	(1 224)	-	(17)	(125)	(335 136)
Gross statement of financial position exposure	53 395	4 198	45 720	13 877	506	117 696
Net exposure	53 395	4 198	45 720	13 877	506	117 696

31 March 2022	ZAR '000	EURO '000	USD '000	GBP '000	OTHER '000	Total R'000
Trade receivables	251 011	3 089	12 075	271	146	266 592
Bank accounts	31 476	4 237	33 169	2 506	222	71 610
Trade and other payables	(325 667)	(160)	(965)	-	(42)	(326 834)
Gross statement of financial position exposure	(43 180)	7 166	44 279	2 777	326	11 368
Net exposure	(43 180)	7 166	44 279	2 777	326	11 368

The following closing exchange rates were applied at reporting date:

Rand per unit of foreign currency:

USD

Euro

GBP

GROUP	
2023	2022 Restated
17.895	14.567
19.554	16.309
22.210	19.309

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

14. Financial instruments and risk management (continued)

Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have decreased profit or loss by the amounts shown below. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2022.

	GROUP	
	2023 R '000	2022 Restated R '000
Euro	(665)	(749)
USD	(4 572)	(4 621)
GBP	(1 391)	(278)
Other	(76)	(41)

Interest rate risk

Interest rate exposure and investment strategies are evaluated by management on a regular basis. Interest-bearing investments are held with several reputable banks in order to minimise exposure.

At the reporting date the interest rate profile of the Group's interest-bearing financial instruments was as follows:

Fixed rate instruments: Carrying amount

	GROUP	
	2023 R '000	2022 Restated R '000
Financial assets: Fixed deposits and Index-Linked Notes	140 273	5 362

The Group does not designate derivatives as hedging instruments under a fair value hedge accounting model. Therefore, a change in interest rates at the reporting date would not affect profit or loss.

Variable rate instruments: Carrying amount

	GROUP	
	2023 R '000	2022 Restated R '000
Financial assets: Call deposits	1 136 656	1 354 804
Financial assets: Bank balances	97 444	71 610
	1 234 100	1 426 414

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

14. Financial instruments and risk management (continued)

Sensitivity analysis

An increase of 100 basis points in interest rates at the reporting date would have increased equity and profit and loss by the amounts shown below. This analysis assumes that all other variables, in particular foreign currency rates, remain constant. The analysis is performed on the same basis for 2022.

14.2 Credit risk

Credit risk is the risk of financial loss to the Group if a customer or counterparty to a financial instrument fails to meet its contractual obligations, and arises principally from the Group's bank balances and deposits, trade and other receivables and loans to joint ventures, associates and subsidiaries.

Trade and other receivables and loans to joint ventures, associates and subsidiaries

Trade and other receivables and loans to joint ventures, associates and subsidiaries are presented net of impairment losses. Credit risk with respect to trade receivables is limited due to the large number of customers comprising the Group's customer base and their dispersion across different industries and geographical areas.

Bank balances and deposits

The Group's bank balances and cash are placed with high credit, quality financial institutions with no significant exposure to any one financial institution.

Guarantees

Refer to note 28 for details on bank guarantees issued with respect to facilities.

Exposure to credit risk

The carrying amount of financial assets represents the maximum credit exposure.

The maximum exposure to credit risk at the reporting date was:

	GROUP	
	2023 R '000	2022 Restated R '000
Current fixed deposits	140 273	5 362
Call deposits	1 136 656	1 354 804
Bank balances	97 444	71 610
Cash on hand and cash deposits	97	112
Trade and other receivables	446 772	307 945
Contracts in progress less provision for losses	203 503	181 803
	2 024 745	1 921 636

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

14. Financial instruments and risk management (continued)

The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:

	GROUP	
	2023 R '000	2022 Restated R '000
Local public sector	235 267	157 851
Local private sector	73 743	51 225
International sector	18 311	18 950
	327 321	228 026

The Group's most significant customers are various local public sector customers.

The aging of the Group's trade receivables at the reporting date was:

	2023 Gross R'000	2023 Impairment R'000	2022 Gross R'000	2022 Impairment R'000
Not past due	259 400	-	168 320	3 810
Past due 0 – 30 days	40 495	1 682	32 490	1 122
Past due 31 – 120 days	23 762	2 666	18 546	5 104
Past due more than 120 days	31 734	23 722	47 236	28 530
	355 391	28 070	266 592	38 566

The movement in the allowance for impairment in respect of trade receivables during the year was as follows:

	GROUP	
	2023 R'000	2022 R'000
Balance at 1 April	38 566	38 180
Movement for the year		
Recoveries	-	(377)
Reversals and write-off	(12 363)	(34 327)
New impairment allowances	1 867	35 090
Balance at 31 March	28 070	38 566

The allowance account in respect of trade receivables is used to record impairment losses unless the Group is satisfied that no recovery of the amount owing is possible; at that point the amount considered irrecoverable is written off against the financial asset directly.

The fully performing trade receivables are considered to be of high credit quality.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

14. Financial instruments and risk management (continued)

14.3 Liquidity risk

Liquidity risk is the risk that the Group will not be able to meet its financial obligations as these fall due. The Group's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Group's reputation.

The Group monitors its cash flow on a daily basis. Typically, the Group ensures that it has sufficient cash on demand to meet expected operational expenses for a period of 60 days, including the servicing of financial obligations; this excludes the potential impact of extreme circumstances that cannot be predicted reasonably, such as natural disasters.

The following are the contractual maturities of financial liabilities, including interest payments but excluding the impact of netting agreements for the Group:

	2023			2022		
	Contractual cash flows			Contractual cash flows		
Non-derivative financial liabilities	Carrying amount R'000	6 months or less R'000	6 - 12 months R'000	Carrying amount R'000	6 months or less R'000	6 - 12 months R'000
Trade and other payables	(330 136)	(330 136)	-	(326 834)	(326 834)	-

14.4 Fair values

As at 31 March 2023, the carrying amount of bank balances and cash, deposits, trade and other receivables, contracts in progress and trade and other payables approximated their fair values due to the short-term maturities of these assets and liabilities.

Basis for determining fair values

Trade and other receivables and trade and other payables

The fair value of trade and other receivables and trade and other payables is calculated based on the present value of future cash flows, discounted at the average return on investment rate at the reporting date.

Forward exchange contracts

The fair value of forward exchange contracts is determined using forward exchange rates at the Statement of Financial Position date, with the resulting value discounted back to present value.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

15. Reconciliation of operating profit to cash generated from operating activities

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Profit before taxation	43 852	51 718	43 567	51 473
Adjustments for:				
Depreciation and amortisation	42 459	49 763	42 459	49 763
Profit on disposal and write-off of PPE and remeasurement of fair value investments	(14 831)	(563)	(14 831)	(563)
(Gains)/losses on foreign exchange	(19 751)	174	(19 751)	174
Bad debt written off	13 139	15 846	13 139	15 846
Interest income	(55 367)	(53 178)	(55 037)	(52 966)
Finance expense	422	1 069	422	1 069
Impairments	6 945	2 463	6 945	386
Movements in retirement benefit assets and liabilities	1 020	918	1 020	918
Movements in provisions	10 732	87 990	10 732	87 990
Leave and bonus accrual	19 133	11 922	19 133	11 922
Share of losses/(profits) from joint venture and associate	151	(2 138)	-	-
Other non-cash items	(81)	12 844	86	12 800
Changes in working capital:				
Inventories	(34)	351	(34)	351
Trade and other receivables	(120 575)	(29 972)	(120 578)	(29 972)
Contract assets	1 444	3 616	1 444	3 616
Other receivables from contracts with customers	(31 392)	(49 872)	(31 392)	(49 872)
Trade and other payables	(31 418)	(78 425)	(31 466)	(78 388)
Advances from customers	101 718	(27 571)	101 718	(27 571)
Cash generated from operations	(32 434)	(3 045)	(32 424)	(3 024)

16. Cash and cash equivalents

Cash and cash equivalents consist of:

Cash on hand	97	112	97	112
Bank balances	97 442	71 609	96 695	70 856
Short-term deposits	1 142 442	1 360 356	1 134 564	1 352 804
	1 239 981	1 432 077	1 231 356	1 423 772

Cash on hand comprises of petty cash.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

17. Related parties

Relationships

Minister	Dr Blade Nzimande
Holding Entity	DSI
Subsidiaries	Technifin (100%) Refer to Note 8
Joint ventures	Sera (50%) Refer to Note 7
Associates	Persomics (35.03%) Refer to Note 7
Entities in Ministerial Portfolio	Department of Higher Education and Training and other related entities under the holding entity
National government	All national government departments and their related entities
Directors and key management	Board of Directors and key management (refer to Note 12)

The CSIR is a schedule 3B National Government Business Enterprise in terms of the PFMA as amended by Act 29 of 1999 and, therefore, falls within the national sphere of government. As a consequence, the CSIR has a significant number of related parties, being entities that fall within the national sphere of government. Amounts due from/to these entities are subject to the same terms and conditions as normal trade receivables and trade payables.

In addition, the CSIR has a related party relationship with its subsidiaries and joint ventures and associates (see Note 7). Unless specifically disclosed, these transactions are concluded at arm's length and the Group is able to transact with any entity.

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Transactions with related parties				
Constitutional institutions				
Services rendered	1 668	2 117	1 668	2 117
Services received	3	17	3	17
Amount due (to) from	1 533	348	1 533	348
Major public entities				
Services rendered	187 887	230 500	187 887	230 500
Services received	64 147	37 021	64 147	37 021
Amount due (to) from	15 928	49 707	15 928	49 707
National public entities				
Services rendered	94 079	103 612	94 079	103 612
Services received	25 313	16 946	25 313	16 946
Amount due (to) from	17 405	26 800	17 405	26 800
National government business enterprises				
Services rendered	7 662	4 983	7 662	4 983
Services received	570	427	570	427
Amount due (to)	5 254	1 673	5 254	1 673
Government departments				
Services rendered	1 916 513	1 795 124	1 916 513	1 795 124
Services received	8 388	54 504	8 388	54 504
Amounts due (to) from	149 613	66 391	149 613	66 391
Subsidiaries				
Amount due (to) from	-	-	(13)	(13)

The above is a summary of transactions with related parties during the year and balances due at year-end.

Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 12 for Executive Management's remuneration).

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

18. Irregular and fruitless and wasteful expenditure

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Irregular expenditure and fruitless and wasteful expenditure				
Irregular expenditure	841	3 741	841	3 741
Fruitless and wasteful expenditure	-	17	-	17
	841	3 758	841	3 758

During the financial ended 31 March 2023, the PFMA Compliance and Reporting Framework introduced compliance reporting requirements effective 3 January 2023 and requires that the amounts disclosed for irregular and fruitless and wasteful expenditure must be inclusive of VAT. As the reporting requirements only became effective 3 January 2023, it must be noted that the amounts disclosed for irregular and fruitless and wasteful expenditure in prior years are VAT exclusive, and that only the current year amounts disclosed are inclusive of VAT.

19. New Standards and Interpretations

19.1 Standards and interpretations not yet effective

The Group has considered and decided against the early adoption of the following standards and interpretations, which have been published and are mandatory for the Group's accounting periods beginning on or after 1 April 2023 or later periods:

- Disclosure of Accounting Policies – Amendments to IAS 1 and IFRS Practice Statement 2: Effective for annual periods beginning on or after 1 January 2023. Entities are encouraged to revisit their accounting policy information disclosures to ensure consistency with the amended standard. Entities should carefully consider whether 'standardised information, or information that only duplicates or summarises the requirements of the IFRSs' is material information and, if not, whether it should be removed from the accounting policy disclosures to enhance the usefulness of the financial statements. The amendment is not expected to have material impact on the CSIR.
- Definition of Accounting Estimates - Amendments to IAS 8: Effective for annual periods beginning on or after 1 January 2023. The amendments are intended to provide preparers of financial statements with greater clarity as to the definition of accounting estimates, particularly in terms of the difference between accounting estimates and accounting policies. Although the amendments are not expected to have a material impact on entities' financial statements, they should provide helpful guidance for entities in determining whether changes are to be treated as changes in estimates, changes in policies, or errors.

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
20. Inventories				
Finished goods	639	605	639	605

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

21. Other receivables from contracts with customers

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Contracts in progress at the end of the reporting period				
Other receivables from contracts with customers	203 503	181 803	203 503	181 803

Other receivables from contracts with customers arise as a result of the time lag between customer billing and revenue recognition. Contract assets (refer to note 22) constitute capitalised costs on point in time contracts with customers. Advances received in excess of work completed are included in advances on contracts with customers under current liabilities.

22. Contract assets

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Summary of contract assets				
Contract assets	2 871	4 315	2 871	4 315
Reconciliation of contract assets				
Opening balance	4 315	7 931	4 315	7 931
Transfers of contract assets to receivables	(1 444)	(3 616)	(1 444)	(3 616)
	2 871	4 315	2 871	4 315

23. Investments at fair value

Investments held by the group, which are measured at fair value, excluding debt instruments measured at fair value through other comprehensive income are as follows:

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Designated at fair value through profit or loss:				
Index-Linked Notes	134 487	-	134 487	-

This is an investment that is a structured financial instrument issued by FirstRand Bank Limited. It is in the form of listed registered notes with a maturity date of 22 December 2023.

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

24. Provisions

Reconciliation of provisions - Group - 2023

	Opening balance R '000	Additions R '000	Utilised during the year R '000	Total R '000
Other provisions	87 990	98 722	(87 990)	98 722

Reconciliation of provisions - Group - 2022

	Opening balance R '000	Additions R '000	Utilised during the year R '000	Total R '000
Restructuring	12 464	-	(12 464)	-
Other provisions	-	87 990	-	87 990
	12 464	87 990	(12 464)	87 990

Reconciliation of provisions - CSIR - 2023

	Opening balance R '000	Additions R '000	Utilised during the year R '000	Total R '000
Other provisions	87 990	98 722	(87 990)	98 722

Reconciliation of provisions - CSIR - 2022

	Opening balance R '000	Additions R '000	Utilised during the year R '000	Total R '000
Restructuring	12 464	-	(12 464)	-
Other provisions	-	87 990	-	87 990
	12 464	87 990	(12 464)	87 990

The restructuring provision relates to redundancy costs incurred as result of the reorganisation that took place at the CSIR. On 13 April 2018, the Board approved a targeted intervention that focused on the aspects of the CSIR operations that were not sustainable. Other provisions comprise provision for employees' performance incentive.

Other provisions comprise provision for short-term performance incentives. The provision was based on the approved Short-term Incentive guideline and was estimated based on past established practice. The opening balance was restated. For more detail refer to note 29 (prior period error).

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

25. Advances from customers

Advances from customers constitute income received from customers in advance.

26. Other income

	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Administration and management fees received	-	12	-	-
Bad debts recovered	53	4	53	4
Compensation from insurance claims	28 855	1 436	28 855	1 436
Other recoveries	3 440	2 329	3 440	2 329
Gains on fair value adjustment of shortterm investments	9 487	-	9 487	-
Loss on disposal of PPE	(59)	(874)	(59)	(874)
	41 776	2 907	41 776	2 895

27. Capital commitments

Property, plant and equipment	118 359	105 684	118 359	105 684
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28. Financial guarantees

Local and foreign payments and performance guarantees issued as at 31 March	39 088	38 176	39 088	38 176
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NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

for the year ended 31 March 2023

29. Prior period error

CSIR pays short-term incentives under the Short-term Incentive guideline as approved by the Board. During the 2022/23 financial year it was discovered that a provision relating to this was not recognised in accordance with our accounting policy, which states that "the cost of short-term employee benefits, (those payable within 12 months after the service is rendered, such as paid vacation leave and sick leave, bonuses, and non-monetary benefits such as medical care), are recognised in the period in which the service is rendered and are not discounted, as well as the established past practice of the organisation to make provision for such incentives where underlying criteria have been met. Based on the policy and the established practice we concluded that a provision should have been raised in the 2021/22 financial year in accordance with IAS37, which requires a prior period adjustment of R87.9 million to the 2021/22 results.

The prior period adjustments resulted in restating the retained earnings at 31 March 2022 from R1,171 billion to R1,083 billion for CSIR and R1,175 billion to R1,087 billion for the Group.

The above result in adjustments as follows:

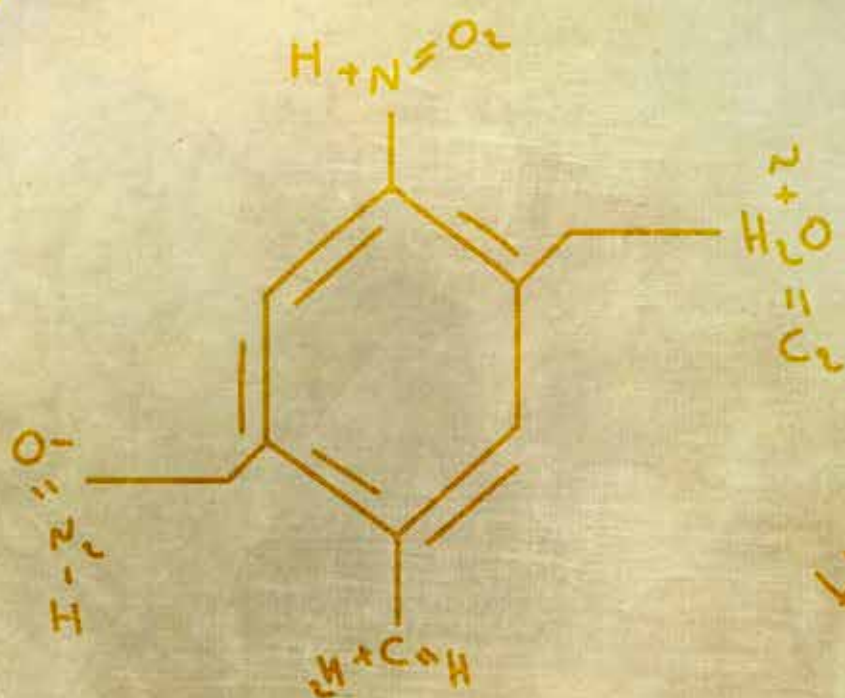
	GROUP		CSIR	
	2023 R '000	2022 Restated R '000	2023 R '000	2022 Restated R '000
Statement of Financial Position				
Provisions	-	87 990	-	87 990
Opening retained earnings	-	(87 990)	-	(87 990)
Statement of Profit of Loss and Other Comprehensive Income				
Employees' remuneration	-	(87 990)	-	(87 990)

$$b + b^2$$

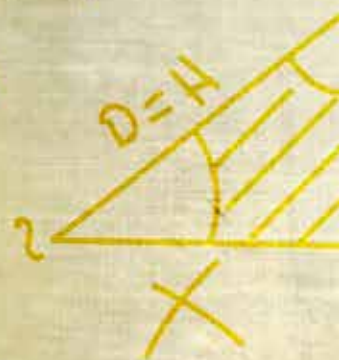
$$b^3$$



α



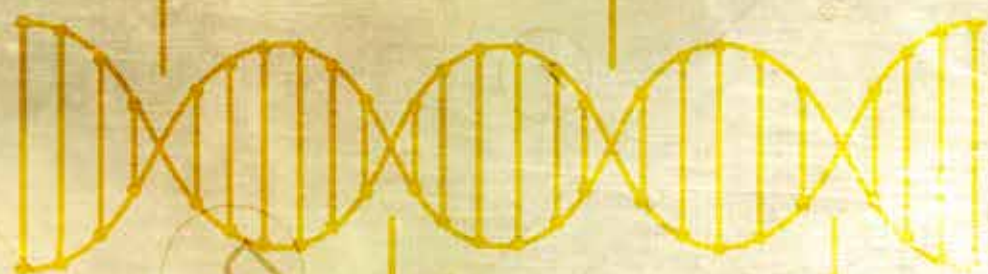
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$$\omega \sim \sqrt{\frac{m}{R}}$$

CH₂

2O₂



β

20



CSIR principal researcher Dr Sandy Thomalla.

CSIR PUBLICATIONS

This section provides a detailed account of the CSIR's publication equivalents. These include accredited journal articles, conference papers, books and book chapters.

Journal articles	196
Conference papers	216
Books and book chapters	225

Journal Articles (285)

- Abolnik, C, Smith, Tanja, Wandrag, DBR, Murphy, M, Rautenbach, M, Olibile, O, O’Kennedy, Martha M. 2022. Dose immunogenicity study of a plant-produced influenza virus-like particle vaccine in layer hens. *Heliyon*, 8(6), p.7pp.
- Adedeji, KB, Ponnle, AA, Abu-Mahfouz, Adnan MI, Kurien, AM. 2022. Towards digitalization of water supply systems for sustainable smart city development—Water 4.0. *Applied Sciences*, 12(18), p.25pp.
- Adekoya, Gbolahan J, Adekoya, OC, Sadiku, ER, Hamam, Y, Ray, Suprakash S. 2022. Effect of Borophene and Graphene on the Elastic Modulus of PEDOT: PSS Film—A Finite Element Study. *Condensed Matter*, 7(1), p.8pp.
- Adekoya, Gbolahan J, Adekoya, OC, Sadiku, RE, Hamam, Y, Ray, Suprakash S. 2022. Numerical investigation and response surface optimization of the effective modulus and electrical and thermal conductivities of the borophene nanoplatelet-reinforced PEDOT: PSS nanocomposite for energy storage application. *ACS Omega*, 7(51), p.48447-48466.
- Adekoya, OC, Adekoya, Gbolahan J, Rotimi, ES, Hamam, Y, Ray, Suprakash S. 2022. Density functional theory interaction study of a polyethylene glycol-based nanocomposite with cephalexin drug for the elimination of wound infection. *ACS Omega*, 7(38), p.33808-33820.
- Adeola, Omolola M, Ramoelo, Abel, Mantlana, Khanyisa B, Mokotedi, Mompe EO, Silwana, W, Tsele, Philemon. 2022. Review of publications on the water-energy-food nexus and climate change adaptation using bibliometric analysis: A case study of Africa. *Sustainability*, 14(20), p.16pp.
- Adetunji, KE, Hofsajer, IW, Abu-Mahfouz, Adnan MI, Cheng, L. 2022. An optimization planning framework for allocating multiple distributed energy resources and electric vehicle charging stations in distribution networks. *Applied Energy*, 322, p.15pp.
- Adetunji, KE, Hofsajer, IW, Abu-Mahfouz, Adnan MI, Cheng, L. 2022. A novel dynamic planning mechanism for allocating electric vehicle charging stations considering distributed generation and electronic units. *Energy Reports*, 8, p.14658-14672.
- Adigun, RA, Malan, FP, Balogun, Mohammed O, October, N. 2022. Rational optimization of dihydropyrimidinone-quinoline hybrids as plasmodium falciparum glutathione reductase inhibitors. *ChemMedChem*, 17, p.15pp.
- Agbakoba, Victor C, Hlangothi, P, Andrew, Jerome E, Mathew, Maya J. 2022. Mechanical and shape memory properties of 3D-Printed Cellulose Nanocrystal (CNC)-reinforced polylactic acid bionanocomposites for Potential 4D applications. *Sustainability*, 14(19), p.19pp.
- Ahmed, MEO, Senabe, Jeremiah V, Yahaya, ES, Fouche, G, Steenkamp, P, Steenkamp, V. 2022. Isolation and antioxidant activity of 5-methyldihydroflavasperone from ethanol leaf extract of *Guiera senegalensis* JF Gmel. *Journal of Medicinal Plants for Economic Development*, 6(1), p.7pp.
- Akintemi, EO, Govender, Krishna K, Singh, T. 2022. A DFT study of the chemical reactivity properties, spectroscopy and bioactivity scores of bioactive flavonols. *Computational and Theoretical Chemistry*, 1210, p.12pp.
- Akpakwu, GA, Hancke, GP, Abu-Mahfouz, Adnan MI. 2022. An optimization-based congestion control for constrained application protocol. *International Journal of Network Management*, 32(1), p.20pp.

- Alenoghena, CO, Onumanyi, Adeiza J, Ohize, HO, Adejo, AO, Oligbi, M, Ali, SI, Okoh, SA. 2022. eHealth: A survey of architectures, developments in mHealth, security concerns and solutions. *International Journal of Environmental Research and Public Health*, 19(20), p.54pp.
- Alimi, KOA, Ouahada, K, Abu Mahfouz, Adnan MI, Rimer, S, Alimi, OA. 2022. Refined LSTM based intrusion detection for denial-of-service attack in Internet of Things. *Journal of Sensor and Actuator Networks*, 11(3), p.14pp.
- Alwer, AO, Rasheed, J, Abu-Mahfouz, Adnan MI, Shams, P. 2022. Study and evaluation of quality of services in mobile internet protocol v6 using IEEE802.11e. *Wireless Communications and Mobile Computing*, p.11pp.
- Amiri-Rigi, A, Kesavan Pillai, Sreejarani, Emmambux, Mohammad N. 2022. Development of hemp seed oil nanoemulsions loaded with ascorbyl palmitate: Effect of operational parameters, emulsifiers, and wall materials. *Food Chemistry*, p.8pp.
- Arabi, Sumaiya, Taljaard, Susan, Weerts, Steven P. 2022. Adapting environmental management systems for African ports. *WMU Journal of Maritime Affairs*, p.18pp.
- Aramide, B, Jamiru, T, Pityana, Sisa L, Sadiku, R, Popoola, P. 2022. Scanning speed effect on the microstructure, hardness, wear, and corrosion performance of VC-Cr3C2 reinforced laser claddings on steel baseplate for tillage application. *Transactions of the Indian Institute of Metals*, 75(8), p.2149–2157.
- Aramide, B, Sadiku, R, Popoola, P, Pityana, Sisa L, Jamiru, T. 2022. The microstructure and anti-wear property of FeCrV15 and FeCrV15+Cr deposits fabricated via laser deposition on steel base-plate for soil-working tools. *Applied Physics A*, 128(490), p.10pp.
- Badenhorst, Jacob AC, De Wet, Febe. 2022. NCHLT Auxiliary speech data for ASR technology development in South Africa. *Data in Brief*, 41, p.8pp.
- Bala, S, Van Biljon, J, Herselman, Martha E. 2022. Open data accessibility mechanisms for tourism development in South Africa. *Communications in Computer and Information Science*, p.15pp.
- Balkissoon, Simiksha, Andrew, Jerome E, Sithole, Bishop B. 2022. Dissolving wood pulp production: A review. *Biomass Conversion and Biorefinery*, p.36pp.
- Banda, L, Mzyece, M, Mekuria, Fisseha. 2022. 5G business models for mobile network operators—A survey. *IEEE Access*, 10, p.94851-94886.
- Bellagarda, J, Abu-Mahfouz, Adnan MI. 2022. Connect2NFT: A web-based, blockchain enabled NFT Application with the Aim of Reducing Fraud and ensuring authenticated social, non-human verified digital identity. *Mathematics*, 10(21), p.25pp.
- Bellagarda, JS, Abu-Mahfouz, Adnan MI. 2022. An updated survey on the convergence of distributed ledger technology and artificial intelligence: Current state, major challenges and future direction. *IEEE Access*, 10(5), p.50774-50793.
- Bessinger, M, Lück-Vogel, Melanie, Skowno, A, Conrad, F. 2022. Landsat-8 based coastal ecosystem mapping in South Africa using random forest classification in Google Earth Engine. *South African Journal of Botany*, p. 928-939.
- Bhaumik, M, Maity, Arjun, Brink, HG. 2022. Metallic nickel nanoparticles supported polyaniline nanotubes as heterogeneous Fenton-like catalyst for the degradation of brilliant green dye in aqueous solution. *Journal of Colloid and Interface Science*, 611, p.408-420.

Bieri, M, Du Toit, J, Feig, G, Maluta, NE, Mantlana, Khanyisa B, Mateyisi, Mohau J, Midgley, GF, Mutanga, Shingirirai S, Von Maltitz, G, Brümmer, C. 2022. Integrating project-based infrastructures with long-term greenhouse gas observations in Africa. *Clean Air Journal*, 32(1), p.9pp.

Blaauw, SA, Maina, JW, Mturi, George AJ, Visser, AT. 2022. Flexible pavement performance and life cycle assessment incorporating climate change impacts. *Transportation Research Part D*, 104, p.15pp.

Blaauw, SA, Maina, JW, O'Connell, Johannes S. 2022. Exposure of construction workers to hazardous emissions in highway rehabilitation projects measured with low-cost sensors. *Environmental Pollution*, 313, p.10pp.

Blomerus, Nicholas D, Cilliers, Jacques E, Nel, Willem AJ, Blasch, E, De Villiers, Pieter. 2022. Feedback-assisted automatic target and convolutional neural network for improved explainability in sar applications clutter discrimination using a bayesian. *Remote sensing*, 14(23), p.25pp.

Bora, D, Jayaramudu, J, Saikia, P, Bohra, RC, Phukan, L, Periyar Selvam, S, Ray, Suprakash S, Sadiku, ER. 2022. Effect of boehmite alumina nanoparticles on the physical and chemical characteristics of eco-friendly sodium alginate/polyvinyl alcohol bio-nanocomposite film. *International Journal of Polymer Analysis and Characterization*, 27(4), p.236-251.

Bredenkamp, IE, Kritzinger, E, Herselman, Martha E. 2022. Evaluating a consumer data protection framework for IS compliance awareness in South Africa: An expert review. In: Guarda, T Portela, F Augusto, M (eds.). *Communications in Computer and Information Science*, p.353-367.

Cebekhulu, Eric, Onumanyi, Adeiza J, Isaac, Sherrin J. 2022. Performance analysis of machine learning algorithms for energy demand–supply prediction in smart grids. *Sustainability*, 14(5), p.26pp.

Chandrasekar, M, Subash, M, Perumal, V, Panimalar, S, Aravindan, S, Uthrakumar, R, Inmozhi, C, Isaev, AB, Muniyasamy, Sudhakar, Raja, A, Kaviyarasu, K. 2022. Specific charge separation of Sn doped MgO nanoparticles for photocatalytic activity under UV light irradiation. *Separation and Purification Technology*, 294, p.11pp.

Chemura, A, Nangombe, Shingirai S, Gleixner, S, Chinyoka, S, Gornott, C. 2022. Changes in climate extremes and their effect on maize (*Zea mays* L.) suitability over Southern Africa. *Frontiers in Climate*, 4, p.14pp.

Cronin, MF, Swart, S, Marandino, CA, Anderson, C, Browne, P, Chen, S, Joubert, WR, Schuster, U, Venkatesan, R, Nicholson, Sarah-Anne. 2022. Developing an Observing Air-Sea Interactions Strategy (OASIS) for the global ocean. *ICES Journal of Marine Science*, 80(2), p.367-373.

Dada, M, Popoola, P, Mathe, Ntombizodwa R, Pityana, Sisa, Adeosun, S. 2022. Electrical resistivity and oxidation behavior of Cu and Ti doped laser deposited high entropy alloys. *World Journal of Engineering*, p.9pp.

Dawood, Zubeida C, Van 't Wout, C. 2022. An ontology towards predicting terrorism events. *International Journal of Cyber Warfare and Terrorism (IJCWT)*, 12(1), p.13pp.

De Jager, Peta, Wall, K. 2022. A pragmatic derivative method to assess the condition of a public health-built infrastructure portfolio. *Journal of the South African Institution of Civil Engineering*, 64(3), p.42-49.

Devi, Nishu, Ray, Suprakash S. 2022. Electromagnetic interference cognizance and potential of advanced polymer composites toward electromagnetic interference shielding: A review. *Polymer Engineering and Science*, p.31pp.

Dheda, D, Cheng, L, Abu-Mahfouz, Adnan MI. 2022. Long short-term memory water quality predictive model discrepancy mitigation through genetic algorithm optimisation and ensemble modeling. *IEEE Access*, 10, p.24638 - 24658.

Dima, Ratshilumela S, Maleka, Prettier M, Maluta, NE, Maphanga, Rapela R. 2022. Structural, electronic, mechanical, and thermodynamic properties of Na deintercalation from olivine NaMnPO₄: First-principles study. *Materials*, 15(15), p.14pp.

Dima, Ratshilumela S, Tshwane, David M, Shingange, Katekani, Modiba, Rosinah, Maluta, NE, Maphanga, Rapela R. 2022. Adsorption of NH₃ and NO₂ molecules on sn-doped and undoped ZnO (101) surfaces using density functional theory. *Processes*, 10(10), p.12pp.

Djeutchouang, Laique M, Chang, Nicolette, Gregor, L, Vichi, M, Scheel Monteiro, Pedro M. 2022. The sensitivity of pCO₂ reconstructions to sampling scales across a Southern Ocean sub-domain: A semi-idealized ocean sampling simulation approach. *Biogeosciences*, 19(17), p.26pp.

Dos Santos, M, John, Juanette, Garland, R, Palakatsela, R, Banos, A, Martens, P, Nemukula, B, Ramathuba, M, Nkholo, F, Lenyibi, K. 2022. Climate change and health within the South African context: A thematic content analysis study of climate change and health expert interviews. *African Journal of Primary Health Care & Family Medicine*, 14(1), p.12pp.

Du Plessis, MD, Swart, S, Biddle, LC, Giddy, IS, Monteiro, Pedro M, Reason, CJC, Thompson, AF, Nicholson, Sarah-Anne. 2022. The daily-resolved Southern Ocean mixed layer: Regional contrasts assessed using glider observations. *Journal of Geophysical Research: Oceans*, 127(4), p.21pp.

Du Toit, J, Napier, Mark, Marais, L, Cloete, J, Crankshaw, Beth. 2022. A typology of designs for housing research: Improving methodological coherence of paradigm, approach and design. *Quality & Quantity*, p.17pp.

Duma, Zama G, Dyosiba, Xoliswa L, Moma, John, Langmi, Henrietta W, Louis, Benoit, Parkhomenko, Ksenia, Musyoka, Nicholas M. 2022. Thermocatalytic hydrogenation of CO₂ to methanol Using Cu-ZnO bimetallic catalysts supported on metal-organic frameworks. *Catalysts*, 12(4), p.15pp.

Duncanson, L, Kellner, JR, Armston, J, Dubayah, R, Minor, DM, Hancock, S, Healey, SP, Patterson, PL, Main, Russell S, Naidoo, Laven. 2022. Aboveground biomass density models for NASA's Global Ecosystem Dynamics Investigation (GEDI) lidar mission. *Remote Sensing of Environment*, 270, p.20pp.

Dzikiti, S, Ntuli, NR, Nkosi, NN, Ntshidi, Zanele, Ncapai, L, Gush, MB, Mostert, THC, Du Preez, R, Mobebe, NT, Mpandeli, S, Pienaar, Harrison H. 2022. Contrasting water use patterns of two drought adapted native fruit tree species growing on nutrient poor sandy soils in northern KwaZulu-Natal. *South African Journal of Botany*, 147, p.197-207.

Dzikiti, Sebinasi, Lotter, Johanna M, Mpandeli, C, Nhamo, L. 2022. Assessing the energy and water balance dynamics of rain-fed rooibos tea crops (*Aspalathus linearis*) under changing Mediterranean climatic conditions. *Agricultural Water Management*, 274, p.12pp.

Edholm, JM, Swart, S, Plessis, Marcel D, Nicholson, Sarah-Anne. 2022. Atmospheric rivers contribute to summer surface buoyancy forcing in the Atlantic sector of the Southern Ocean. *Geophysical Research Letters*, 49(17), p.10pp.

Effossou, KA, Cho, Moses A, Ramoelo, A, Cho, MA. 2022. Mechanisms and consequences of benefit sharing from oil palm agribusiness plantations establishment in South Comoé Region, Côte d'Ivoire. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 123(1), p.63-73.

Effossou, KA, Cho, Moses A, Ramoelo, A. 2022. Impacts of conflicting land tenure systems on land acquisition by agribusiness developers in Côte d'Ivoire. *Journal of Agribusiness and Rural Development*, 63(1), p.25-39.

Elias, N, Thambiran, Tirusha. 2022. The future is a zero-carbon building sector: Perspectives from Durban, South Africa. *South African Journal of Science*, 118(9-10), p.8pp.

Ellard, John J, Mathabathe, Maria N, Siyasiya, CW, Bolokang, Amogelang S. 2022. Powder characteristics blending and microstructural analysis of a hot-pack rolled vacuum arc-melted yttrium-based sheet. *South African Journal of Industrial Engineering*, 33(3), p.274-283.

Fabris-Rotelli, I, Wannenburger, A, Maribe, G, Thiede, R, Vogel, M, Coetzee, M, Sethaelo, K, Selahle, E, Debba, Pravesh, Rautenbach, V. 2022. An informal road detection neural network for societal impact in developing countries. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 4, p.267-274.

Folorunso, Oladipo, Kumar, Neeraj, Hamam, Y, Sadiku, R, Ray, Suprakas S. 2022. Facile solvent/drying fabrication of PVA/PPy/rGO: A novel nanocomposite for energy storage applications. *Results in Materials*, 15, p.10pp.

Fox, T, Furnival-Adams, J, Chaplin, M, Napier, Mark, Olanga, EA. 2022. House modifications for preventing malaria (Review): 2022. *Cochrane Database of Systematic Reviews*, 10, p.72pp.

French, H, Segabinazzi, L, Middlebrooks, B, Peterson, E, Schulman, M, Roth, Robyn L, Crampton, Michael, Conan, A, Marchi, S, Gilbert, T. 2022. Efficacy and safety of native and recombinant zona pellucida immunocontraceptive vaccines formulated with non-freund's adjuvants in donkeys. *Vaccines*, 10(12), p.16pp.

Friedlingstein, P, Jones, MW, O'Sullivan, M, Andrew, RM, Bakker, DCE, Hauck, J, Le Quéré, C, Peters, GP, Peters, W, Djetchouang, Laique M. 2022. Global Carbon Budget 2021. *Earth System Science Data*, 14(4), p.1917-2005.

Funke, Nikki, Huitema, D, Petersen, A. 2022. Impending doom or unnecessary panic? The struggle for discursive hegemony in South Africa's acid mine drainage policy problem. *Critical Policy Studies*, p.21pp.

Gasparatos, A, Mudombi, S, Balde, BS, Von Maltitz, Graham P, Johnson, FX, Romeu-Dalmau, C, Jumbe, C, Ochieng, C, Luhanga, D, Nyambane, A. 2022. Local food security impacts of biofuel crop production in southern Africa. *Renewable and Sustainable Energy Reviews*, 154, p.15pp.

Gbadamosi, SA, Hancke, GP, Abu-Mahfouz, Adnan MI. 2022. Interference avoidance resource allocation for D2D-enabled 5G narrowband Internet of Things. *IEEE Internet of Things Journal*, 9(22), p.22752-22764.

Gbadeyan, Oluwatoyin J, Fagbemi, Olajumoke D, Jerome, Andrew E, Adali, S, Glen, B, Sithole, Bishop B. 2022. Cellulose nanocrystals and snail shell-reinforced polyvinyl alcohol bioplastic films: Additive concentration optimization and mechanical properties assessment. *Journal of Applied Polymer Science*, 139(36), p.12pp.

Gebrekrstos, Amanuel, Orasugh, Jonathan T, Muzata, TS, Ray, Suprakas S. 2022. Cellulose-based sustainable composites: A review of systems for applications in EMI shielding and sensors. *Macromolecular Materials and Engineering*, p.22pp.

Geldasa, FT, Kebede, Mesfin A, Shura, MW, Hone, FG. 2022. Identifying surface degradation, mechanical failure, and thermal instability phenomena of high energy density Ni-rich NCM cathode materials for lithium-ion batteries: A review. *RSC Advances*, 10(12), p.5891-5909.

Giliberto, M, Thimiri Govindaraj, Deepak B, Cremaschi, A, Skånland, SS, Gade, A, Tjønnfjord, GE, Schjesvold, F, Munthe, LA, Taskén, K. 2022. Ex vivo drug sensitivity screening in multiple myeloma identifies drug combinations that act synergistically. *Molecular Oncology*, 16(6), p.1241-1258.

Glaser, Daniel, Polese, C, Venter, AM, Marais, D, Plaisier, JR. 2022. Evaluation of laser shock peening process parameters incorporating Almen strip deflections. *Surface and Coatings Technology*, 434, p.13pp.

Goga, T, Harding, Kevin, Russo, Valentino, Von Blotnitz, H. 2022. What material flow analysis and life cycle assessment reveal about plastic polymer production and recycling in South Africa. *South African Journal of Science*, 118, p.5pp.

Gondwe, MFK, Chirwa, PWC, Cho, Moses A, Geldenhuys, CJ, Tshidzumba, RP. 2022. Key drivers of LULCC in co-managed and government managed forest reserves in Malawi (1999–2018). *International Forestry Review*, 24(1), p.1-14.

Guenat, S, Purnell, P, Davies, ZG, Nawrath, M, Stringer, LC, Rathnaiah Babu, GR, Balasubramanian, M, Ballantyne, EE, Bylappa, BK, De Jager, Peta. 2022. Meeting sustainable development goals via robotics and autonomous systems. *Nature Communications*, 13(3559), p.10pp.

Gumbo, AD, Kapangaziwiri, Evison, Mathivha, FI. 2022. A systematic study site selection protocol to determine environmental flows in the headwater catchments of the vhembe biosphere reserve. *International Journal of Environmental Research and Public Health*, 19(10), p.12pp.

Habib, MH, Katzis, K, Mfupe, Luzango P, Ephrem, TB. 2022. Performance optimization of high-altitude platform wireless communication network exploiting TVWS spectrums based on modified PSO. *IEEE Open Journal of Vehicular Technology*, 1, p.11pp.

Harris, LR, Skowno, AL, Sink, KJ, Van Niekerk, Lara, Holness, SD, Monyeki, M, Majiedt, P. 2022. An indicator-based approach for cross-realm coastal biodiversity assessments. *African Journal of Marine Science*, 44(3), p.239-253.

Hassouna, A, Ait-Kaddour, A, Abu-Mahfouz, Adnan MI, Rathod, NB, Bader, F, Barba, FJ, Biancolillo, A, Cropotova, J, Galanakisk, CM, Jambrak, AR. 2022. The fourth industrial revolution in the food industry - Part I: Industry 4.0 technologies. *Critical Reviews in Food Science and Nutrition*, p.18pp.

Henrico, S, Coetzee, S, Cooper, Antony K. 2022. Qualitative insights into the acceptance of QGIS in South Africa. *Transactions in GIS*, p.20pp.

Horak, E, Komba, Julius J, Maina, J, Sebaaly, H, Muller, J. 2022. Contiguous aggregate packing as common principle for benchmarking asphalt density, stiffness and permeability control. *Construction and Building Materials*, 328, p.10pp.

Hurrell, Tracey, Naidoo, Jerolen, Scholefield, Janine. 2022. Hepatic models in precision medicine: An African perspective on pharmacovigilance. *Frontiers in Genetics*, 13, p.8pp.

Hussien, HM, Katzis, K, Mfupe, Luzango P, Bekele, ET. 2022. Capacity, coverage and power profile performance evaluation of a novel rural broadband services exploiting TVWS from high altitude platform. *IEEE Open Journal of the Computer Society*, 3, p.86-95.

Iroegbu, Augustine O, Ray, Suprakash S. 2022. Lignin and keratin-based materials in transient devices and disposables: Recent advances toward materials and environmental sustainability. *ACS Omega*, 7(13), p.10854-10863.

Iroegbu, Austine O, Ray, Suprakash S. 2022. Nanocellulosics in transient technology. *ACS Omega*, 7(51), p.47547-47566.

Jassat, W, Karim, SSA, Ozougwu, L, Welch, R, Mudara, C, Masha, M, Rousseau, P, Wolmarans, M, Selikow, Anthony, Govender, N. 2022. Trends in cases, hospitalizations, and mortality related to the Omicron BA.4/BA.5 subvariants in South Africa. *Clinical Infectious Diseases*, p.8pp.

- Jele, TB, Sithole, Bishop B, Lekha, Prabashni, Andrew, Jerome E. 2022. Characterisation of pulp and paper mill sludge for beneficiation. *Cellulose*, 29, p.4629-4643.
- John, Maya J, Lefatle, MC, Sithole, Bishop B. 2022. Lignin fractionation and conversion to bio-based functional products. *Sustainable Chemistry and Pharmacy*, 25, p.14pp.
- Jordaan, Johannes P. 2022. A simplified test method to estimate the relative rib area of rebar. *Concrete Beton Technical Journal*, 171, p.8pp.
- Jurado-Lasso, FF, Marchegiani, L, Jurado, JF, Abu Mahfouz, Adnan MI, Fafoutis, X. 2022. A survey on machine learning software-defined wireless sensor networks (ml-SDWSNS): Current status and major challenges. *IEEE Access*, 10, p.23560-23592.
- Kanyane, LR, Popoola, API, Pityana, Sisa L, Tlotleng, Monnamme. 2022. Synthesis of Ti-Al-xNb ternary alloys via laser-engineered net shaping for biomedical application: Densification, electrochemical and mechanical properties studies. *Materials*, 15(2), p.13pp.
- Kaudia, A, Sokona, YY, Mantlana, Khanyisa B, Mbandi, A, Osano, P, Kehbila, AG, Nzuve, L, Tagwireyi, C, Heaps, C, Hicks, K. 2022. The launch of the first-ever integrated assessment of air pollution and climate change for sustainable development in Africa. *Clean Air Journal*, 32(2), p.2pp.
- Kemp, Lana, Steyn, W, Roux, Michael P. 2022. Enhanced methodology for visual bridge inspections in South Africa. *Journal of the South African Institution of Civil Engineering*, 64(3), p.50-57.
- Kenmogne, Vanelle L, Nweke, EE, Takundwa, Mutsa M, Fru, PN, Thimiri Govinda Raj, Deepak B. 2022. Application of drug repurposing-based precision medicine platform for leukaemia patient treatment. *Advances in Experimental Medicine and Biology*, p.12pp.
- Kgomo, Mosima B, Shingange, Katekani, Nemufulwi, Muredeni I, Swart, HC, Mhlongo, Gugu H. 2022. Belt-like In₂O₃ based sensor for methane detection: Influence of morphological, surface defects and textural behavior. *Materials Research Bulletin*, 158, p.16pp.
- Khanyile, AT, Andrew, Jerome E, Paul, V, Sithole, Bishop B. 2022. A comparative study of supercritical fluid extraction and accelerated solvent extraction of lipophilic compounds from lignocellulosic biomass. *Sustainable Chemistry and Pharmacy*, 26, p.14pp.
- Khoele, Khotso, Ama, Monday O, Ray, Suprakas S, Popoola, AP, Desai, D, Delport, DJ. 2022. Tribocorrosion behavior of bare and nanocoated foils used on high-speed air-foil bearings. *The International Journal of Advanced Manufacturing Technology*, 120, p.3225–3235.
- Kiarii, EM, Govender, Krishna K, Mamo, MA, Govender, PP. 2022. A DFT study of two-dimensional CdS/TiS₂ on isotropic chalcogenide AgSbTe₂ thermoelectric material: Electronic charge transfer and optical properties. *Current Applied Physics*, 40, p.50-61.
- Kinsey, GS, Riedel-Lyngskær, NC, Miguel, A, Boyd, M, Braga, M, Shou, C, Cordero, RR, Duck, BC, Maweza, Elijah L, Pratt, Lawrence E. 2022. Impact of measured spectrum variation on solar photovoltaic efficiencies worldwide. *Renewable Energy*, 196, p.995-1016.
- Kufakunesu, R, Hancke, G, Abu-Mahfouz, Adnan MI. 2022. A fuzzy-logic based adaptive data rate scheme for energy-efficient LoRaWAN communication. *Journal of Sensor and Actuator Networks*, 11(4), p.18pp.

- Kukuni, TG, Markus, E, Kotze, B, Abu-Mahfouz, Adnan MI. 2022. Development of IoT-based machine learning application for data anomaly detection with in a smart manufacturing plant. *NeuroQuantology*, 20(10), p.3637-3648.
- Kumar, Neeraj, Gusain, Rashi, Pandey, S, Ray, Suprakas S. 2022. Hydrogel nanocomposite adsorbents and photocatalysts for sustainable water purification. *Advanced Materials Interfaces*, p.50pp.
- Kumari, V, Mphahlele-Makgwane, MM, Makgwane, Peter R, Sharma, A, Parmar, D, Kumari, K, Kumar, N. 2022. Ultrasonically Pd functionalized, surface plasmon enhanced ZnO/CeO₂ heterostructure for degradation of organic pollutants in water. *The European Physical Journal Plus*, 137(565), p.16pp.
- Kunert, KJ, Pillay, Priyen. 2022. Loop replacement design: A new way to improve potency of plant cystatins: A new way to improve potency of plant cystatins. *The FEBS Journal*, 289(7), p.1823-1826.
- Kupfer, S, Santamaria-Aguilar, S, Van Niekerk, Lara, Lück-Vogel, Melanie. 2022. Investigating the interaction of waves and river discharge during compound flooding at Breede Estuary, South Africa. *Natural Hazards and Earth System Science*, 22(1), p.187–205.
- Kuruma, Malkappa, Bandyopadhyay, Jayita, Ojijo, Vincent O, Ray, Suprakas S. 2022. Superior flame retardancy, antidripping, and thermomechanical properties of polyamide nanocomposites with graphene-based hybrid flame retardant. *Journal of Applied Polymer Science*, 139(37), p.17pp.
- Lambrechts, IA, Thiipe, VC, Katti, KV, Mandiwana, Vusani, Kalombo, Lonji, Ray, Suprakas S, Rikhotso, Rirhandzu S, Janse van Vuuren, A, Esmear, T, Lall, N. 2022. Targeting acne bacteria and wound healing in vitro using *Plectranthus aliciae*, Rosmarinic Acid, and Tetracycline Gold Nanoparticles. *Pharmaceuticals*, 15(8), p.18pp.
- Lemley, D, Lekane, CP, Taljaard, Susan, Adams, JB. 2022. Inorganic nutrient removal efficiency of a constructed wetland before discharging into an urban eutrophic estuary. *Marine Pollution Bulletin*, 179, p.6pp.
- Lesufi, M, Akinwamide, SO, Makoana, Nkutowane W, Tshabalala, Lerato C, Olubambi, PA. 2022. Nanoindentation and corrosion behaviour of 410 stainless steel fabricated via additive manufacturing. *Transactions of the Indian Institute of Metals*, 380, p.8pp.
- Loveday, PW, Long, Craig S. 2022. Numerical analysis of guided wave transmission through a long defect in a rail rack. *Journal of Nondestructive Evaluation, Diagnostics and Prognostics of Engineering Systems*, 5(4), p.8pp.
- Ludick, Chantel J, Van Heerden, Quintin. 2022. A multi-objective optimization approach for disaggregating employment data. *Geographical Analysis*, p.25pp.
- Lulane, EB, Dzikiti, Sebinasi, Volschenk, T, Lötze, E, Midgley, SJ. 2022. Quantifying water saving benefits of fixed white protective netting in irrigated apple orchards under Mediterranean-type climate conditions in South Africa. *Scientia Horticulturae*, 305, p.10pp.
- Mahlangu, Thembisile, Arunachellan, I, Ray, Suprakas S, Onyango, M, Maity, Arjun. 2022. Preparation of copper-decorated activated carbon derived from platamus occidentalis tree fiber for antimicrobial applications. *Materials*, 15(17), p.15pp.
- Mahlathi, Christopher D, Wilms, J, Brink, I. 2022. Investigation of scarce input data augmentation for modelling nitrogenous compounds in South African rivers. *Water Practice and Technology*, p.17pp.
- Makama, NR, Van Staden, CJ, Botha, Adele. 2022. User experience framework for teachers using mobile technologies in resource-constrained environments. *Lecture Notes in Networks and Systems*, 235, p.239-252.

Makhetha, MJ, Markus, ED, Abu-Mahfouz, Adnan MI. 2022. Efficient wireless power transfer via self-resonant Conformal Strongly Coupled Magnetic Resonance for wireless sensor networks. *Energy Reports*, 8(13), p.1358-1367.

Makwakwa, Dimakatso M, Motloung, Mpho P, Ojijo, Vincent O, Bandyopadhyay, Jayita, Ray, Suprakash S. 2022. Influencing the shape recovery and thermomechanical properties of 3DP PLA using smart textile and boehmite alumina and thermochromic dye modifiers. *Macromol*, 2(3), p.485-499.

Mantlana, Khanyisa B, Jegede, AO. 2022. Understanding the multilateral negotiations on climate change ahead of COP27: Priorities for the African region. *South African Journal of International Affairs*, 29(3), p.255-270.

Mantlana, Khanyisa B, Rumble, O, Gilder, A. 2022. UNFCCC COP27. Coalitions in the UNFCCC: A case study of Egypt as host of UNFCCC COP27. *Carbon & Climate Law Review*, 16(3), p.205-215.

Manyatshe, A, Cele, Zamani E, Balogun, Mohammed O, Nkambule, Thabo T, Msagati, Titus A. 2022. Chitosan modified sugarcane bagasse biochar for the adsorption of inorganic phosphate ions from aqueous solution. *Journal of Environmental Chemical Engineering*, 10(5), p.13pp.

Manyatshe, A, Cele, Zamani E, Balogun, Mohammed O, Nkambule, TTI, Msagati, TAM. 2022. Lignocellulosic derivative-chitosan biocomposite adsorbents for the removal of soluble contaminants in aqueous solutions – Preparation, characterization and applications. *Journal of Water Process Engineering*, 47, p.19pp.

Mapengo, CR, Ray, Suprakash S, Emmambux, MN. 2022. Granular morphology, molecular structure and thermal stability of infrared heat-moisture treated maize starch with added lipids. *Food Chemistry*, 382, p.8pp.

Maphanga, Charles P, Manoto, Sello L, Mabena, Chemist M, Ombinda-Lemboumba, Saturnin, Maaza, Malik, Mthunzi-Kufa, Patience. 2022. Laser-enabled delivery of antiretroviral drugs into HIV-1 infected TZM-bl cells. *Journal of Biophotonics*, 15(10), p.11pp.

Maphanga, Charles P, Manoto, Sello, Ombinda-Lemboumba, Saturnin, Ismail, Y, Mthunzi-Kufa, Patience. 2022. Localized surface plasmon resonance biosensing of Mycobacterium tuberculosis biomarker for TB diagnosis. *Sensing and Bio-Sensing Research*, 39, p.12pp.

Marais, JM, Abu-Mahfouz, Adnan MI, Hancke, GP. 2022. Improving the sustainability of confirmed traffic in LoRaWANs through an adaptive congestion scheme. *IEEE Sensors Journal*, p.10pp.

Mashamaite, CV, Manyevere, A, Chakauya, Ereck. 2022. Cleome gynandra: A wonder climate-smart plant for nutritional security for millions in semi-arid areas. *Frontiers in Plant Science*, p.15pp.

Mashifane, Thulwaneng B, Bourbonnais, A, Fawcett, SE. 2022. Nitrous oxide dynamics in the southern Benguela upwelling system. *Journal of Geophysical Research: Oceans*, 127(11), p.17pp.

Masselot, P, Sera, F, Schneider, R, Kan, H, Lavigne, E, Stafoggia, M, Tobias, A, Chen, H, Burnett, RT, Garland, Rebecca M. 2022. Differential mortality risks associated with PM2.5 components: A multi-country, multi-city study. *Epidemiology*, 33(2), p.167-175.

Maswanganye, SE, Dube, T, Jovanovic, N, Kapangaziwiri, Evison, Mazvimavi, D. 2022. Using the water balance approach to understand pool dynamics along non-perennial rivers in the semi-arid areas of South Africa. *Journal of Hydrology: Regional Studies*, 44, p.17pp.

Mathekg, B, Nxumalo, Precius Z, Thimiri Govindaraj, Deepak B. 2022. Micro and nanofluidics for high throughput drug screening. *Progress in Molecular Biology and Translational Science*, 187(1), p.93-120.

Matsabisa, MG, Alexandre, Kabamba B, Ibeji, CU, Tripathy, S, Erukainure, OL, Malatji, Kanyane, Chauke, Siphon H, Okole, Blessed N, Chabalal, HB. 2022. In vitro study on efficacy of PHELA, an African traditional drug against SARS-CoV-2. *Scientific Reports*, 12, p.12pp.

Matseke, Mphoma S, Luo, Hongze, Wen, L, Zheng, Haito. 2022. The upgraded performance of the $\text{NiFe}_2\text{O}_4/\text{C}$ electrocatalyst using Co substitution for the oxygen reduction reaction in an alkaline solution. *Journal of Physics and Chemistry of Solids*, 165, p.7pp.

Mavuso, MA, Makgwane, Peter R, Ray, Suprakas S. 2022. Construction of heterojunctions CeO_2 interfaced Nb, Sn, Ti, Mo and Zn metal oxide catalysts for photocatalytic oxidation of α -pinene inert C-H. *Inorganic Chemistry Communications*, 137, p.8pp.

McDonald, Andre M, Van Wyk, MA, Chen, G. 2022. A direct solution to the stochastic inverse Eigenvalue problem for complex-valued eigenspectra. *Linear Algebra and its Applications*, 658, p.262-282.

McDonald, André M, Van Wyk, MA. 2022. Identification of nonlinear discrete systems from probability density sequences. *IEEE Transactions on Circuits and Systems I: Regular Papers*, p.14pp.

Mdlalose, Lindani M, Chimuka, L. 2022. Mitigation approaches to prevent microplastics effects in the aquatic environment: Exploration of microbeads from personal care and cosmetic products. *International Journal of Environmental Research*, 16, p.9pp.

Meissner, R, Gonçalves, Duarte PD. 2022. Considering the 'other' in wildlife crime mitigation: A South African strategy case study. *Acta Criminologica: African Journal of Criminology & Victimology*, p.20pp.

Mkhohlakali, A, Fuku, X, Seo, MH, Modibedi, Remegia M, Khotseng, L, Mathe, M. 2022. Electro-design of bimetallic PdTe electrocatalyst for ethanol oxidation: Combined experimental approach and ab initio Density Functional Theory (DFT)-Based Study. *Nanomaterials*, 12(20), p.17pp.

Mkhohlakali, Andile, Fuku, Xolle, Modibedi, Remegia M, Khotseng, L, Mathe, Mkhulu. 2022. Electrodeposition of ternary BiTePd nanofilm electrocatalyst using surface-limited reaction for direct ethanol fuel cell. *Journal of the Electrochemical Society*, 169(4), p.12pp.

Mlotshwa, TM, Maluta, NE, Kirui, JK, Maphanga, Rapela R. 2022. Electronic and optical properties of copper zinc tin sulphide ($\text{Cu}_2\text{ZnSnS}_4$) doped with calcium and barium. *Materials Express*, 12(1), p.114-122.

Mochane, MJ, Motloung, MT, Mokheba, TC, Mofokeng, Tladi G. 2022. Morphology and photocatalytic activity of zinc oxide reinforced polymer composites: A mini review. *Catalysts*, 12(11), p.19pp.

Modimola, MS, Green, E, Njobeh, P, Senabe, Jeremiah V, Fouche, G, McGaw, L, Nkadimeng, SM, Mathiba, Kgama, Mthombeni, J. 2022. Investigating the toxicity of compounds yielded by staphylococci on Vero cells. *Toxins*, 14(10), p.25pp.

Mofokeng, Lethula E, Hlekelele, Lerato, Moma, J, Tetana, ZN, Chauke, Vongani P. 2022. Energy-efficient $\text{CuO}/\text{TiO}_2@\text{GCN}$ cellulose acetate-based membrane for concurrent filtration and photodegradation of ketoprofen in drinking and groundwater. *Applied Sciences*, 12(3), p.19pp.

Mofokeng, Lethula E, Hlekelele, Lerato, Tetana, ZN, Moma, J, Chauke, Vongani P. 2022. CuO-doped TiO_2 supported on graphitic carbon nitride for the photodegradation of ketoprofen in drinking and groundwater: Process optimization and energy consumption evaluation. *ChemistrySelect*, 7(10), p.15pp.

- Mokgalapa, N, Akinola, SA, Shoko, T, Kesavan Pillai, Sreejarani, Sivakumar, D. 2022. Chitosan molecular weights affect anthracnose incidence and elicitation of defence-related enzymes in avocado (*Persea americana*) cultivar 'Fuerte.' *International Journal of Food Microbiology*, 366, p.9pp.
- Mokhena, TC, Matabola, KP, Mohothu, TH, Mtibe, Asanda, Mochane, MJ, Ndlovu, G, Andrew, Jerome E. 2022. Electrospun carbon nanofibres: Preparation, characterization and application for adsorption of pollutants from water and air. *Separation and Purification Technology*, 288, p.26pp.
- Mokhena, TC, Sadiku, ER, Ray, Suprakas S, Mochane, MJ, Matabola, KP, Motloung, Mpho P. 2022. Flame retardancy efficacy of phytic acid: An overview. *Journal of Applied Polymer Science*, 139(7), p.36pp.
- Mokoena, Refiloe, Mturi, George AJ, Maritz, Johan, Mateyisi, Mohau J, Klein, Pieter. 2022. African case studies: Developing pavement temperature maps for performance-graded asphalt bitumen selection. *Sustainability*, 14(3), p.24pp.
- Molemans, M, Van Leth, F, Mc Kelly, David H, Wood, Robin, Hermans, S. 2022. Neighbourhood risk factors of recurrent tuberculosis in Cape Town: A cohort study using geocoded notification data. *Journal of Epidemiology and Community Health*, p.7pp.
- Molobi, E, Sacks, N, Theron, Maritha. 2022. Crack mitigation in laser engineered net shaping of WC-10wt%FeCr cemented carbides. *Additive Manufacturing Letters*, 2, p.8pp.
- Molokomme, DN, Onumanyi, Adeiza J, Abu-Mahfouz, Adnan MI. 2022. Edge intelligence in Smart Grids: A survey on architectures, offloading models, cyber security measures, and challenges. *Journal of Sensor and Actuator Networks*, 11(3), p.50pp.
- Monga, Ilunga, Paul, V, Muniyasamy, Sudhakar, Zinyemba, O. 2022. Green synthesis of sodium cyanide using hydrogen cyanide extracted under vacuum from cassava (*Manihot esculenta* Crantz) leaves. *Sustainable Chemistry*, 3(3), p.312-333.
- Moodley, R, Mashaba, C, Rakodi, GH, Ncube, NB, Maphoru, MV, Balogun, Mohammed O, Jordan, A, Warner, DF, Khan, R, Tukulula, M. 2022. New quinoline-urea-benzothiazole hybrids as promising antitubercular agents: Synthesis, in vitro antitubercular activity, cytotoxicity studies, and in silico ADME profiling. *Pharmaceuticals*, 15(5), p.19pp.
- Motlatle, Abesach M, Ray, Suprakash S, Ojijo, Vincent O, Scriba, Manfred R. 2022. Polyester-based coatings for corrosion protection. *Polymers*, 14(16), p.23pp.
- Motloung, Mpho P, Mofokeng, Tladi G, Mokhena, Teboho C, Sinha Ray, Suprakas S. 2022. Recent advances on melt-spun fibers from biodegradable polymers and their composites. *International Polymer Processing*, 37(5), p.523-540.
- Motloung, Mpho P, Mofokeng, Tladi G, Ray, Suprakas S. 2022. Effects of urea loading on soil biodegradation properties of melt-processed polycaprolactone-based composites for potential application in agriculture. *Journal of Applied Polymer Science*, 140(8), p.12pp.
- Mphahlele, Nonhlanhla E, Ipadeola, AK, Haruna, AB, Mwonga, PV, Modibedi, Remegia M, Palaniyandy, Nithyadharseni, Billing, C, Ozoemena, KI. 2022. Microwave-induced defective PdFe/C nano-electrocatalyst for highly efficient alkaline glycerol oxidation reactions. *Electrochimica Acta*, 409, p.9pp.
- Mphuthi, N, Sikhwivhilu, L, Ray, Suprakash S. 2022. Functionalization of 2D MoS₂ nanosheets with various metal and metal oxide Nanostructures: Their properties and application in electrochemical sensors. *Biosensors*, 12(6), p.45pp.

- Mtsetwa, NS, Tarwireyi, P, Sibeko, CN, Abu-Mahfouz, Adnan MI, Adigun, M. 2022. Blockchain-based security model for LoRaWAN firmware updates. *Journal of Sensor and Actuator Networks*, 11(1), p.39pp.
- Mthimkhulu, N, Mosiane, KS, Nweke, EE, Balogun, Mohammed O, Fru, PN. 2022. Prospects of delivering natural compounds by polymer-drug conjugates in cancer therapeutics. *Anti-Cancer Agents in Medicinal Chemistry*, 22(9), p.1699-1713.
- Mtibe, Asanda, Hlekelele, Lerato, Kleyi, Phumelele E, Muniyasamy, Sudhakar, Nomadolo, Elizabeth N, Ofosu, Osei, Ojijo, Vincent O, Mathew, Maya J. 2022. Fabrication of a Polybutylene Succinate (PBS)/Polybutylene Adipate-Co-Terephthalate (PBAT)-based hybrid system reinforced with lignin and zinc nanoparticles for potential biomedical applications. *Polymers*, 14(23), p.14pp.
- Mtsweni, Jabu S, Thaba, James M. 2022. Building an integrated cyber defence capability for african missions. *Journal of Information Warfare*, 21(1), p.17-34.
- Muchavi, Noluntu S, Raganya, Mampai L, Machaka, R, Motsi, Glenda T, Makhatha, E. 2022. Influence of SN on the microstructure and mechanical properties of Ti-MO-NB alloys for orthopaedic applications. *South African Journal of Industrial Engineering*, 33(3), p.318-325.
- Mutemwa, Muyowa, Mtsweni, Jabu S. 2022. A cybersecurity architecture that supports effective incident response. *Journal of Information Warfare*, 21(1), p.139-155.
- Mvelase, Gculisile M, Anochie-Boateng, J, Gräbe, PJ. 2022. Application of a modern laser technique to evaluate the performance of recycled railway ballast. *Journal of the South African Institution of Civil Engineering*, 64(4), p.16-28.
- Mwim, EM, Mtsweni, Jabu, Mwim, OS. 2022. Review of cyber security and policy implementation within South African health institutions. *Journal of Information Warfare*, 21(1), p.35-70.
- Mwim, EN, Mtsweni, Jabu S. 2022. Systematic review of factors that influence the cybersecurity culture. In: Rannenber, K (eds.). *IFIP Advances in Information and Communication Technology*, p.147-172.
- Naidoo, Jerolen, Hurrell, Tracey, Scholefield, Janine. 2022. IPSC-derived models in Africa: An HIV perspective. *Biochimie*, 196, p.153-160.
- Naidoo, Laven, Main, Russell S, Cho, Moses A, Madonsela, Sabelo, Majazi, Nobuhle P. 2022. Machine learning modelling of crop structure within the Maize Triangle of South Africa. *International Journal of Remote Sensing*, 43(1), p.27-51.
- Naidoo, Sasha. 2022. Commentary on the contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. *South African Journal of Science*, p.4pp.
- Naki, T, Matshe, William MR, Ubanako, P, Adeyemi, Samson A, Balogun, Mohammed O, Ray, Suprakas S, Choonara, YE, Aderibigbe, BA. 2022. Dopamine-loaded polymer-drug conjugates for potential synergistic anti-cancer treatment. *Polymer-Plastics Technology and Materials*, p.19pp.
- Naqvi, KH, Markus, ED, Muthoni, M, Abu Mahfouz, Adnan MI. 2022. A critical review of IoT-connected healthcare and information security in South Africa. In: Zhang, YD Senjyu, T So-In, C Joshi, A (eds.). *Lecture Notes in Networks and Systems*, 286, p.739-746.
- Ncube, EN, Steenkamp, PA, Van der Westhuyzen, Christiaan W, Steenkamp, Lucia H, Dubery, IA. 2022. Metabolomics-guided analysis of the biocatalytic conversion of sclareol to ambradiol by *hyphozyma roseoniger*. *Catalysts*, 55 (12(1)), p.16pp.

Ndlovu, Z, Desai, D, Pandelani, Thanyani A, Ngwangwa, H, Nemavhola, F. 2022. Biaxial estimation of biomechanical constitutive parameters of passive porcine sclera soft tissue. *Applied Bionics and Biomechanics*, p.11pp.

Nemavhola, F, Pandelani, Tanyani A, Ngwangwa, H. 2022. Fitting of hyperelastic constitutive models in different sheep heart regions based on biaxial mechanical tests. *Russian Journal of Biomechanics*, 26(2), p.14-24.

Nemufulwi, Murendeni I, Swart, HC, Mhlongo, Gugu H. 2022. Highly selective acetone detection displayed by a surface engineered fiber-like ZnFe₂O₄ based-sensor following heat-treatment ramping rate variation. *Materials Letters*, 330, p.5pp.

Neyt, Nicole C, Van der Westhuizen, Johan C, Panayides, Jenny-Lee, Riley, DL. 2022. Design and testing of an ozonolysis reactor module with on-the-fly ozone degassing under flow conditions. *Reaction Chemistry & Engineering*, 7, p.1718-1727.

Ngwangwa, H, Nemavhola, F, Pandelani, Thanyani A, Msibi, M, Mabuda, I, Davies, N, Franz, T. 2022. Determination of cross-directional and cross-wall variations of passive biaxial mechanical properties of rat myocardia. *Processes*, 10(4), p.17pp.

Ngwangwa, H, Pandelani, Thanyani A, Msibi, M, Mabuda, I, Semakane, L, Nemavhola, F. 2022. Biomechanical analysis of sheep oesophagus subjected to biaxial testing including hyperelastic constitutive model fitting. *Heliyon*, 8(5), p.6pp.

Ngwem, MCN, Kemmegne-Mbougouen, JC, Langmi, HW, Musyoka, Nicholas M, Mokaya, Robert. 2022. Electrochemical sensor for ascorbic acid, acetaminophen and nitrite based on Organoclay/Zr-MOF film modified glassy carbon electrode. *ChemistrySelect*, 7(40), p.12pp.

Nicholson, Sarah-Anne, Whitt, DB, Fer, I, Du Plessis, Marcel, Lebéhot, Alice D, Swart, S, Sutton, AJ, Monteiro, Pedro MS. 2022. Storms drive outgassing of CO₂ in the subpolar Southern Ocean. *Nature Communications*, 13(158), p.12pp.

Nkabyo, HA, Oyenih, AB, Joseph, CM, Olaoye, OO, Lopis, Anton S, Luckay, RC. 2022. Platinum(II) complexes bearing asymmetrically substituted pivaloylthioureas: Synthesis, crystal structures, DFT and antioxidant studies. *Polyhedron*, 226(1), p.8pp.

Nkera-Gutabara, Claudine K, Kerr, R, Scholefield, Janine, Hazelhurst, S, Naidoo, Jerolen. 2022. Microbiomics: The next pillar of precision medicine and its role in African healthcare. *Frontier in Genetics*, 13, p.8pp.

Nkomzwayo, Thulisile N, Mguni, L, Hildebrandt, D, Yao, Y. 2022. Adsorptive desulfurization using period 4 transition metals oxide: A study of Lewis acid strength derived from the adsorbent ionic-covalent parameter. *Chemical Engineering Journal*, 444, p.18pp.

Nkosi, Nomqhele Z, Manzi, MSD, Westgate, M, Roberts, Dave, Durrheim, RJ, Ogasawara, H, Ziegler, M, Rickenbacher, M, Liebenberg, B, Onstott, TC. 2022. Physical property studies to elucidate the source of seismic reflectivity within the ICDP DSeis seismogenic zone: Klerksdorp goldfield, South Africa. *International Journal of Rock Mechanics and Mining Sciences*, 155, p.17pp.

Nomadolo, Elizabeth N, Dada, OE, Swanepoel, Andri, Mokhena, Teboho, Muniyasamy, Sudhakar. 2022. A comparative study on the aerobic biodegradation of the biopolymer blends of poly(butylene succinate), poly(butylene adipate terephthalate) and poly(lactic acid). *Polymers*, 14(9), p.14pp.

Nsikani, MN, Anderson, P, Bouragaoui, Z, Geerts, S, Gornish, ES, Kairo, JG, Khan, N, Madikizela, B, Mganga, KZ, Ntshotsho, Phumza. 2022. UN decade on ecosystem restoration: Key considerations for Africa. *Restoration Ecology*, p.8pp.

Ntshabele, K, Isong, B, Gasela, N, Abu-Mahfouz, Adnan MI. 2022. A trusted security key management server in LoRaWAN: Modelling and analysis. *Journal of Sensor and Actuator Networks*, 11(3), p.23pp.

Ntshabele, K, Isong, B, Gasela, N, Abu-Mahfouz, Adnan MI. 2022. A comprehensive analysis of LoRaWAN key security models and possible attack solutions. *Mathematics*, 10(19), p.19pp.

Ntuli, IM, Mulopo, J, Diale, Palesa P. 2022. Coupled GO-MWCNT composite ink for enhanced dispersibility and synthesis of screen-printing electrodes. *Chemistry Africa*, p.12pp.

Numan, N, Jeyaram, S, Kaviyarasu, K, Neethling, P, Sackey, J, Kotsedi, CL, Akbari, M, Morad, R, Mthunzi-Kufa, Patience, Sahraoui, B, Maaza, M. 2022. On the remarkable nonlinear optical properties of natural tomato lycopene. *Scientific Reports*, 12(9078), p.13pp.

Nyadongo, ST, Olakanmi, EO, Pityana, Sisa L. 2022. Analysis of dry sliding wear performance of tribaloy T-800/Tungsten carbide coating deposited via laser cladding assisted with preheating. *Journal of Materials Engineering and Performance*, p.15pp.

Oberholzer, MM, Oberholster, PJ, Ndlela, Luyanda L, Botha-Oberholtster, AM, Truter, CJ. 2022. Assessing alternative supporting organic materials for the enhancement of water reuse in subsurface constructed wetlands receiving acid mine drainage. *Recycling*, 7(3), p.25pp.

Ogbodo, EU, Abu-Mahfouz, Adnan MI, Kurien, AM. 2022. A survey on 5G and LPWAN-IoT for improved smart cities and remote area applications: From the aspect of architecture and security. *Sensors*, 22(16), p.31pp.

Ogbodo, EU, Abu-Mahfouz, Adnan MI, Kurien, AM. 2022. Enabling LPWANs for coexistence and diverse IoT applications in smart cities using lightweight heterogeneous multihomed network model. *Journal of Sensor and Actuator Networks*, 11(4), p.19pp.

Ojuria, OO, Ramdas, Veshara, Aderibigbe, EA, Williams, GC, Ramchuran, Santosh O, Al-Nageim, H. 2022. Improving strength and hydraulic characteristics of regional clayey soils using biopolymers. *Case Studies in Construction Materials*, 17, p.11pp.

O'Kennedy, Martha M, Coetzee, P, Koekemoer, O, Du Plessis, L, Lourens, CW, Kwezi, Lusingizwe, Du Preez, Ilse, Mamputha, Sipho, Rutkowska, Daria A, Lemmer, Yolandy. 2022. Protective immunity of plant-produced African horse sickness virus serotype 5 chimeric virus-like particles (VLPs) and viral protein 2 (VP2) vaccines in IFNAR-/- mice. *Vaccine*, 40(35), p.5160-5169.

Olatinwo, DD, Abu-Mahfouz, Adnan MI, Hancke, GP. 2022. Energy-aware hybrid MAC protocol for IoT enabled WBAN systems. *IEEE Sensors Journal*, 22(3), p.2685-2699.

Oloyede, MO, Onumanyi, Adeiza J, Bello-Salau, H, Djouani, K, Kurien, A. 2022. Exploratory analysis of different metaheuristic optimization methods for medical image enhancement. *IEEE Access*, 10, p.28014 - 28036.

Omoniyi, PO, Mahamood, RM, Arthur, Nana KK, Pityana, Sisa L, Skhosane, Besabakhe S, Okamoto, Y, Shinonaga, T, Maina, MR, Jen, TC, Akinlabi, ET. 2022. Joint integrity evaluation of laser beam welded additive manufactured Ti6Al4V sheets. *Scientific Reports*, 12(4062), p.9pp.

- Onumanyi, Adeiza J, Molokomme, Daisy N, Isaac, Sherrin J, Abu-Mahfouz, Adnan MI. 2022. AutoElbow: An automatic elbow detection method for estimating the number of clusters in a dataset. *Applied Sciences-Basel*, 12(15), p.17pp.
- Orasugh, Jonathan T, Ray, Suprakas S. 2022. Graphene-based electrospun fibrous materials with enhanced EMI shielding: Recent developments and future perspectives. *ACS Omega*, 7(38), p.33699–33718.
- Orasugh, Jonathan T, Ray, Suprakas S. 2022. Prospect of DFT utilization in polymer-graphene composites for electromagnetic interference shielding application: A review. *Polymers*, 14(4), p.29pp.
- Oyesola, M, Mpofu, K, Daniyan, I, Mathe, Ntombizodwa R. 2022. Design and simulation of a bearing housing aerospace component from titanium alloy (Ti6Al4V) for additive manufacturing. *Acta Polytechnica*, 62(6), p.15pp.
- Palaniyandy, N, Reddy, MV, Zaghbi, K, Kebede, Mesfin A, Raju, Kumar, Modibedi, Remegia M, Mathe, Mahlanyane K, Abhilash, KP, Balamuralikrishnan, S. 2022. High rate and stable capacity performance of 2D LiMn_{1.5}Ni_{0.5}O₄ nanoplates cathode with ultra-long cycle stability. *Journal of Alloys and Compounds*, 903, p.11pp.
- Pandelani, Thanyani A, Modungwa, Dithoto M. 2022. The response of military lower extremity and Hybrid III leg using the Hybrid III and EuroSID-2 ATD in vertical loading impacts. *Traffic Injury Prevention*, p.5pp.
- Petersen, CR, Van Deventer, Heidi, Smith-Adao, Lindie, Nel, JL. 2022. Incorporating free-flowing rivers into global biodiversity targets: Prioritization and targeted interventions to maintain ecological integrity. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 33(1), p.4pp.
- Pfaff, MC, Hart-Davis, M, Smith, Marie E, Veitch, J. 2022. A new model-based coastal retention index (CORE) identifies bays as hotspots of retention, biological production and cumulative anthropogenic pressures. *Estuarine, Coastal and Shelf Science*, 273, p.13pp.
- Phahlamohlaka, Letlibe J, Theron, J, Aschmann, MJ. 2022. National cybersecurity implementation in South Africa: The conundrum question. *Journal of Information Warfare*, 21(1), p.16pp.
- Phasha, Vivey M, Senabe, Jeremiah V, Ndzotoyi, Phatheka T, Okole, Blessed N, Fouche, G, Chuturgoon, A. 2022. Review on the use of kojic acid-a skin-lightening agent. *Cosmetics*, 9(3), 64, p.11pp.
- Phuthu, L, Dima, Ratshilumela S, Maluta, NE, Kirui, JK, Maphanga, Rapela R. 2022. DFT study of TiO₂ brookite (210) surface doped with silver and molybdenum. *Materials Research Express*, 9(9), p.10pp.
- Radingoana, Precious M, Guillemet-Fritsch, S, Noudem, J, Olubambi, PA, Chevallier, G, Estourn, C. 2022. Microstructure and thermoelectric properties of Al-doped ZnO ceramic prepared by spark plasma sintering. *Journal of the European Ceramic Society*, p.8pp.
- Raji, ID, Bello-Salau, H, Umoh, IJ, Onumanyi, Adeiza J, Adegboye, MA, Salawudeen, AT. 2022. Simple deterministic selection-based genetic algorithm for hyperparameter tuning of machine learning models. *Applied Sciences*, 12(3), p.19pp.
- Raji, SA, Popoola, API, Pityana, Sisa L, Popoola, OM, Raji, NK, Tlotleng, Monnamme. 2022. In-situ LENS fabricated Ti–Al–Si alloy phase transformation and microstructural evolution after isothermal annealing heat treatments. *Minerals, Metals and Materials Series*, p.313-324.
- Ramadhan, RS, Glaser, Daniel, Soyama, H, Kockelmann, W, Shinohara, T, Pirling, T, Fitzpatrick, ME, Tremsin, AS. 2022. Mechanical surface treatment studies by Bragg edge neutron imaging. *Acta Materialia*, 239, p.12pp.

- Ramatlo, DA, Long, Craig S, Loveday, PW, Wilke, DN. 2022. Physics-based modelling and simulation of reverberating reflections in ultrasonic guided wave inspections applied to welded rail tracks. *Journal of Sound and Vibration*, 530, p.20pp.
- Rambau, KM, Tarimo, DJ, Fasakin, O, Musyoka, Nicholas M, Manyala, N. 2022. Asymmetric supercapacitor based on novel coal fly ash derived metal-organic frameworks as positive electrode and its derived carbon as negative electrode. *Journal of Applied Electrochemistry*, 52, p.821-834.
- Ramdas, Veshara, Laloo, Rajesh, Mandree, Prisha, Mgangira, Martin B, Mukaratirwa, Samson, Ramchuran, Santosh O. 2022. Performance evaluation of bio-based fractions derived from *Bacillus* spp. for potential in situ soil stabilisation. *Applied Sciences*, 12(4), p.21pp.
- Ramson, SRJ, Vishnu, S, Kirubaraj, AA, Anagnostopoulos, T, Abu-Mahfouz, Adnan MI. 2022. A LoRaWAN IoT-enabled trash bin level monitoring system. *IEEE Transactions on Industrial Informatics*, 18(2), p.786-795.
- Ramulifho, RD, Gupta, K, Glaser, Daniel. 2022. Evaluation of a high-temperature pre-heating system design for a large-scale additive manufacturing system. *Micromachines*, 13(9), p.20pp.
- Rants'o, TA, Van Greunen, DG, Van der Westhuizen, Cornelius J, Riley, DL, Panayides, Jenny-Lee, Koekemoer, Lizette L, Van Zyl, RL. 2022. The in silico and in vitro analysis of donepezil derivatives for *Anopheles* acetylcholinesterase inhibition. *Plos One*, p.21pp.
- Rants'o, TA, Koekemoer, LL, Panayides, Jenny-Lee, Van Zyl, RL. 2022. Potential of essential oil-based anticholinesterase insecticides against *anopheles* vectors: A review. *Molecules*, 27(20), p.22pp.
- Rants'o, TA, Van der Westhuizen, Johan C, Van Zyl, RL. 2022. Optimization of covalent docking for organophosphates interaction with *Anopheles* acetylcholinesterase. *Journal of Molecular Graphics and Modelling*, 110, p.11pp.
- Rapetsoa, MK, Manzi, MSD, Westgate, M, Sihoyiya, M, James, I, Onyebueke, E, Kubeka, P, Durrheim, RJ, Kgarume, Thabang E. 2022. Cost-effective in-mine seismic experiments to image platinum deposits and associated geological structures at Maseve platinum mine, South Africa. *Near Surface Geophysics*, p.1-18.
- Rasheed, J, Wardak, AB, Abu-Mahfouz, Adnan MI, Umer, T, Yesiltepe, M, Waziry, S. 2022. An efficient machine learning-based model to effectively classify the type of noises in QR code: A hybrid approach. *Symmetry*, 14(10), p.21pp.
- Rasheed, J, Waziry, S, Alsubai, S, Abu-Mahfouz, Adnan MI. 2022. An intelligent gender classification system in the era of pandemic chaos with veiled faces. *Processes*, 10(7), p.15pp.
- Ratshidi, L, Grobbelaar, S, Botha, Adele. 2022. Conceptualising the factors influencing community health workers' preparedness for ICT implementation: A systematised scoping review. *Sustainability*, 14(14), p.25pp.
- Raw, JL, Van der Stocken, T, Carroll, D, Harris, LR, Rajkaran, A, Van Niekerk, Lara, Adams, JB. 2022. Dispersal and coastal geomorphology limit potential for mangrove range expansion under climate change. *Journal of Ecology*, 111(1), p.139-155.
- Reader, J, Opperman, DFL, Van der Watt, ME, Theron, Anjo, Leshabane, M, Da Rocha, S, Turner, J, Garrabrant, K, Piña, I, Mills, C. 2022. New transmission-selective antimalarial agents through hit-to-lead optimization of 2-[[1,1'-Biphenyl]-4-carboxamido]benzoic acid derivatives. *ChemBioChem*, p.9pp.
- Roets-Dlamini, Yrielle, Laloo, Rajesh, Moonsamy, Ghaneshree, Kumari, S, Nasr, M, Ramchuran, Santosh O, Bux, F. 2022. Development of *Bacillus* spp. consortium for one-step "Aerobic Nitrification-Denitrification" in a fluidized-bed reactor. *Bioresource Technology Reports*, 17, p.9pp.

Roets-Dlamini, Yrielle, Moonsamy, Ghaneshre, Laloo, Rajesh, Ramchuran, Santosh O. 2022. Use of *Bacillus* spp in the bioremediation of fats, oils and greases (FOG's), and other waste substrates in food processing effluents. *Biocatalysis and Agricultural Biotechnology*, 42, p.8pp.

Russo, C, Veitch, J, Carr, M, Fearon, G, Whittle, Christo P. 2022. An intercomparison of global reanalysis products for Southern Africa's major oceanographic features. *Frontiers in Marine Science*, 9, p.27pp.

Ruyobeza, B, Grobbelaar, SS, Botha, Adele. 2022. Hurdles to developing and scaling remote patients' health management tools and systems: A scoping review. *Systematic Reviews*, 11, p.23pp.

Ruyobeza, B, Grobbelaar, SS, Botha, Adele. 2022. Integrated remote primary care infrastructure: A framework for adoption and scaling of remote patient management tools and systems. *Lecture Notes in Networks and Systems*, 447, p.797-817.

Samanta, AP, Ali, MS, Orasugh, Jonathan T, Ghosh, SK, Chattopadhyay, DC. 2022. Crosslinked nanocollagen-cellulose nanofibrils reinforced electrospun polyvinyl alcohol/methylcellulose/polyethylene glycol bionanocomposites: Study of material properties and sustained release of ketorolac tromethamine. *Carbohydrate Polymer Technologies and Applications*, 3, p.12pp.

Sari-Ak, D, Alomari, O, Shomali, RA, Lim, J, Thimiri Govindaraj, Deepak B. 2022. Advances in CRISPR-Cas9 for the Baculovirus Vector System: A systematic review. *Viruses-Basel*, p.17pp.

Sariket, D, Maity, Arjun, Kundu, S, Bhattacharya, C. 2022. In situ chemical synthesis of g-C₃N₄/In₂O₃ semiconductor composites for photoelectrochemical water oxidation. *Journal of Solid State Chemistry*, 315, p.8pp.

Seile, BP, Bareetseng, Andries S, Koitsiwe, MT, Aremu, AO. 2022. Indigenous knowledge on the uses, sustainability and conservation of African ginger (*Siphonochilus aethiopicus*) among two communities in Mpumalanga province, South Africa. *Diversity*, 14(3), p.14pp.

Sekoai, Patrick T, Chuniilall, Viren, Sithole, Bishop B, Habimana, O, Ndlovu, S, Ezeokoli, OT, Sharma, P, Yoro, KO. 2022. Elucidating the role of biofilm-forming microbial communities in fermentative biohydrogen process: An overview. *Microorganisms*, 10(10), p.19pp.

Selikane, DG-A, Gumede, TP, Shingange, Katekani, Malevu, TD. 2022. A brief overview on the extraction of cellulose from medicinal plants for advanced applications. *Materials Science Forum*, 1059, p.81-85.

Senekane, MF, Makhene, A, Oelofse, Suzanna HH. 2022. A critical analysis of indigenous systems and practices of solid waste management in rural communities: The case of Maseru in Lesotho. *International Journal of Environmental Research and Public Health*, 19(18), p.24pp.

Serwale, MR, Coetsee, T, Sole, KC, Fazluddin, Shahed. 2022. Purification of titanium sponge produced by lithiothermic reduction of titanium tetrachloride: Effect of leaching conditions. *Journal of the Southern African Institute of Mining and Metallurgy*, 122(12), p.733-740.

Siebritz, L-A, Desai, A, Cooper, Antony K, Coetzee, S. 2022. The South African Spatial Data Infrastructure – Where are the Municipalities?. *International Journal of Spatial Data Infrastructures Research*, 15, p.143-170.

Singels, A, Jones, MR, Lumsden, Trevor G. 2022. Potential for sugarcane production under current and future climates in South Africa: Sugar and ethanol yields, and crop water use. *Sugar Tech*, p.9pp.

Singh, Advaita A, Pillay, Priyen, Naicker, Previn, Alexandre, Kabamba B, Malatji, Kanyane, Mach, L, Steinkellner, H, Vorster, J, Chikwamba, Rachel K, Tsekoo, Tsepo L. 2022. Transient proteolysis reduction of *Nicotiana benthamiana*-produced CAP256 broadly neutralizing antibodies using CRISPR/Cas9. *Frontiers in Plant Science*, 13, p.24pp.

Singh, T, Duba, T, Muleba, L, Matuka, OD, Glaser, Daniel, Ratshikhopho, E, Kirstena, Z, Van Reenen, Tobias H, Masuku, Z, Singo, D. 2022. Effectiveness of a low-cost UVGI chamber for decontaminating filtering facepiece respirators to extend reuse. *Journal of Occupational and Environmental Hygiene*, 20, p.40-53.

Sinha Roy, Jayita, Kesavan Pillai, Sreejarani, Ray, Suprakash S. 2022. Layered double hydroxides for sustainable agriculture and environment: An overview. *ACS Omega*, 7(24), p.20428-20440.

Smit, KP, Van Niekerk, Lara, Harris, LR, McQuatters-Gollop, A, Shannon, LJ, Sink, KJ. 2022. A roadmap to advance marine and coastal monitoring, biodiversity assessment, and international reporting: A developing nation perspective. *Frontiers in Marine Science*, p.9pp.

Smith-Adao, Lindie B, Blanchard, R, Kotzee, Ilse M, Le Maitre, D, Ntshotsho, Phumza, Audouin, Michelle A, Forsyth, G, Walters, M. 2022. Flood hazards in a changing world: Challenges and opportunities in the Garden Route. *The Water Wheel*, 21(4), p.38-44.

Stafford, William H, Russo, Valentina, Nahman, Nagman. 2022. A comparative cradle-to-grave life cycle assessment of single-use plastic shopping bags and various alternatives available in South Africa. *The International Journal of Life Cycle Assessment*, 27, p.1213–1227.

Stark, RT, Pye, DR, Chen, W, Newton, OJ, Deadman, BJ, Miller, PW, Panayides, Jenny-Lee, Riley, DL, Helldardt, K, Hii, KK. 2022. Assessing a sustainable manufacturing route to lapatinib. *Reaction Chemistry & Engineering*, 7, p.2420-2426.

Suliman, Ridhwaan, Mtsweni, Jabu S. 2022. Adding up the numbers: COVID-19 in South Africa. *South African Journal of Science*, 118(5/6), p.5pp.

Swartbooi, Ashton, Kapanji-Kakoma, KK, Musyoka, Nicholas M. 2022. From biogas to hydrogen: A techno-economic study on the production of turquoise hydrogen and solid carbons. *Sustainability*, 14(17), p.14pp.

Taljaard, Susan, Lemley, DA, Van Niekerk, Lara. 2022. A method to quantify water quality change in data-limited estuaries. *Estuarine, Coastal and Shelf Science*, 272, p.11pp.

Tanui, HK, Nkabyo, HA, Pearce, BH, Hussein, AA, Lopis, Anton S, Luckay, RC. 2022. Iron(III) and copper(II) complexes derived from the flavonoids morin and quercetin: Chelation, crystal structure and DFT studies. *Journal of Molecular Structure*, 1257, p.6pp.

Thobakgale, Setumo L, Ombinda-Lemboumba, Saturnin, Mthunzi-Kufa, Patience. 2022. A molecular study of aspirin and tenofovir using gold/dextran nanocomposites and surface-enhanced raman spectroscopy. *Molecules*, 27(8), p.13pp.

Thobakgale, Setumo L, Ombinda-Lemboumba, Saturnin, Mthunzi-Kufa, Patience. 2022. Chemical sensor nanotechnology in pharmaceutical drug research. *Nanomaterials*, 12(15), p.17pp.

Thulaganyo, D, Njengele-Tetyana, Z, Mhlanga, N, Tetyana, P, Skepu, Amanda, Ngila, JC, Sikhivhilu, LM. 2022. Development of a versatile half-strip lateral flow assay toward the detection of rift valley fever virus antibodies. *Diagnostics (Basel)*, 12(11), p.11pp.

Tshililo, FP, Mutanga, Shingirirai S, Sikhwivhilu, K, Siame, J, Hongoro, C, Managa, LR, Mbohwa, C, Madyira, DM. 2022. Analysis of the determinants of household's water access and payments among the urban poor. A case study of Diepsloot Township. *Physics and Chemistry of the Earth, Part A/B/C*, 127, p.8pp.

Tsoeunyane, GM, Mathe, Ntombizodwa R, Tshabalala, Lerato C, Makhatha, ME. 2022. Electropolishing of additively manufactured Ti-6Al-4V surfaces in nontoxic electrolyte solution. *Advances in Materials Science and Engineering*, p.12pp.

Tumba, NL, Naicker, Previn, Stoychev, Stoyan H, Killick, MA, Owen, GR, Papathanasopoulos, MA. 2022. Covalent binding of human two-domain CD4 to an HIV-1 subtype C SOSIP.664 trimer modulates its structural dynamics. *Biochemical and Biophysical Research Communications*, 612, p.181-187.

Umba, SMW, Abu-Mahfouz, Adnan MI, Ramotsoela, D. 2022. Artificial intelligence-driven intrusion detection in software-defined wireless sensor networks: Towards secure IoT-enabled healthcare systems. *International Journal of Environmental Research and Public Health*, 19(9), p.21pp.

Van der Westhuizen, Johan, Du Toit, Jurie H, Neyt, Nicole C, Riley, DL, Panayides, Jenny-Lee. 2022. Use of open-source software platform to develop dashboards for control and automation of flow chemistry equipment. *Digital Discovery*, 1(5), p.596-604.

Van Deventer, Heidi, Linström L, Durand, JF, Naidoo, L, Cho, Moses A. 2022. Deriving the maximum extent and hydroperiod of open water from Sentinel-2 imagery for global sustainability and biodiversity reporting for wetlands. *Water SA*, 48(1), p.75-89.

Van Deventer, Heidi, Linström, A, Naidoo, L, Jobe, N, Sieben, EJJ, Cho, Moses A. 2022. Comparison between Sentinel-2 and WorldView-3 sensors in mapping wetland vegetation communities of the Grassland Biome of South Africa, for monitoring under climate change. *Remote Sensing Applications: Society and Environment*, 28, p.16pp.

Van Deventer, Heidi, Nortje, Karen, Naidoo, L, Apleni, P, Tsele, P, Bester, J, Grundling, PL, Janse van Rensburg, S, Aucamp, I. 2022. Wetlands and society: Bringing Science, Policy and Society closer Together for The Maputaland Coastal Plain's Wetlands. *Water Wheel*, p.30-32.

Van Heerden, Quintin, Karsten, Carike, Holloway, Jennifer P, Petzer, Engela, Burger, Paul AD, Mans, Gerbrand G. 2022. Accessibility, affordability, and equity in long-term spatial planning: Perspectives from a developing country. *Transport Policy*, p.104-119.

Van Heerden, Quintin, Van Vuuren, J. 2022. Evidence-based decision-making in supporting integrated local-level urban and climate change adaptation planning simultaneously: A simulation-optimisation approach. *Town and Regional Planning*, 81, p.7-23.

Van Niekerk, Lara, Lamberth, SJ, James, NC, Taljaard, Susan, Adams, JB, Theron, AK, Krug, M. 2022. The vulnerability of South African estuaries to climate change: A review and synthesis. *Diversity*, 14(9), p.35pp.

Van Niekerk, Lara, Taljaard, Susan, Lamberth, SJ, Adams, JB, Weerts, Steven P, MacKay, CF. 2022. Disaggregation and assessment of estuarine pressures at the country-level to better inform management and resource protection – the South African experience. *African Journal of Aquatic Science*, p.22pp.

Van Schalkwyk, A, Grobbelaar, SS, Vermeulen, E, Herselman, Martha E. 2022. A scoping review of the use of log data for evaluating mobile Apps: Exploring implications for mHealth Apps. *IEEE Access*, 10, p.124805-124820.

- Van van der Westhuizen, Johan C, Stander, A, Riley, DL, Panayides, Jenny-Lee. 2022. Discovery of novel Acetylcholinesterase inhibitors by virtual screening, in vitro screening, and molecular dynamics simulations. *Journal of Chemical Information and Modeling*, 62(6), p.1550-1572.
- Van Wyk, JC, Sewell, BT, Danson, MJ, Tsekoa, Tsepo L, Sayed, MF, Cowan, DA. 2022. Engineering enhanced thermostability into the *Geobacillus pallidus* nitrile hydratase. *Current Research in Structural Biology*, 4, p.256-270.
- Veerasamy, Namosha. 2022. The evolution of cyber threats in the South African context. *Journal of Information Warfare*, 21(1), p.91-104.
- Vishnu, S, Jino Ramson, SR, Rukmini, MSS, Abu-Mahfouz, Adnan MI. 2022. Sensor-based solid waste handling systems: A survey. *Sensors*, 22(6), p.19pp.
- Wahab, OO, Olasunkanmi, LO, Govender, Krishna, Govender, PP. 2022. Computational study of the mechanistic pathway of hydroxyl radical-initiated degradation of disperse red 73 dye. *Chemistry Africa*, 5(1), p.135-148.
- Walubita, LF, Ling, M, Fuentes, L, Komba, Julius J, Mabrouk, GM. 2022. Correlating the asphalt-binder MSCR test results to the HMA HWTT and field rutting performance. *Journal of Transportation Engineering, Part B: Pavements*, 148(3), p.63pp.
- Waseem, KH, Mushtaq, H, Abid, F, Abu-Mahfouz, Adnan MI, Shaikh, A, Turan, M, Rasheed, J. 2022. Forecasting of air quality using an optimized recurrent neural network. *Processes*, 10(10), p.21pp.
- Wessels, K, Li, X, Bouvet, A, Mathieu, R, Main, Russell S, Naidoo, L, Erasmus, B, Asner, GP. 2022. Quantifying the sensitivity of L-Band SAR to a decade of vegetation structure changes in savannas. *Remote Sensing of Environment*, 284, p.21pp.
- Williams, LL, Lück-Vogel, Melanie. 2022. Geographic information system data considerations in the context of the enhanced bathtub model for coastal inundation. *Transactions in GIS*, p.16pp.
- Woldekidan, Haregewoin B, Woldesemayat, AA, Adam, G, Tafesse, Mesfin, Thimiri Govindaraj, Deepak B. 2022. Aptamer-based tumor-targeted diagnosis and drug delivery. *Advances in Experimental Medicine and Biology*, p.20pp.
- Zhu, H, Ouahada, K, Abu-Mahfouz, Adnan MI. 2022. Peer-to-peer energy trading in smart energy communities: A Lyapunov-based energy control and trading system. *IEEE Access*, 10, p.17pp.
- Zhu, H, Ouahada, K, Abu-Mahfouz, Adnan MI. 2022. Transmission loss-aware peer-to-peer energy trading in networked microgrids. *IEEE Access*, 10, p.126352-126369.
- Zlobinsky, N, Johnson, DL, Mishra, AK, Lysko, Albert A. 2022. Comparison of metaheuristic algorithms for interface-constrained channel assignment in a hybrid Dynamic Spectrum Access – Wi-Fi infrastructure WMN. *IEEE Access*, 10, p.26654-26680.
- Zodwa Dlamini, Z, Skepu, Amanda, Kim, N, Mkhabele, M, Khanyile, R, Molefi, T, Mbatha, S, Setlai, B, Mulaudzi, T, Mabongo, M. 2022. AI and precision oncology in clinical cancer genomics: From prevention to targeted cancer therapies-an outcomes-based patient care. *Informatics in Medicine Unlocked*, 31, p.12pp.
- Zuma, IK, Gasa, NL, Mazibuko, X, Simelane, BC, Pillay, Priyen, Kwezi, Lusiizwe, Tsekoa, Tsepo L, Poee, OJ. 2022. Recombinant expression, purification and PEGylation of DNA Ligases. *Protein and Peptide Letters*, p.9pp.

Conference Papers (110)

Adetunji, O, Adeniyi, O, Botha, Adele, Herselman, Martha E. 2022. Medication nonadherence in TB patients: Innovative technology use and related legal framework. The 2022 International Conference on Computational Science and Computational Intelligence, CSCI'22, Las Vegas, USA, 14-16 December 2022, p.8pp.

Afachao, K, Abu-Mahfouz, Adnan MI. 2022. A review of Intelligent IoT devices at the edge. Institute of Electrical and Electronics Engineers (IEEE) Second International Conference on Artificial Intelligence of Things (ICAIoT 2022), Istanbul, Turkey, 29-30 December 2022, p.6pp.

Alimi, OA, Ouahada, K, Abu Mahfouz, Adnan MI, Rimer, S, Alimi, KOA. 2022. Supervised learning-based intrusion detection for SCADA systems. Institute of Electrical and Electronics Engineers (IEEE) Nigeria 4th International Conference on Disruptive Technologies for Sustainable Development (NIGERCON), Lagos, Nigeria, 5-7 April 2022, p.5pp.

Blaauw, Ciara, Nel, Willem AJ, Pieterse, Chane, Mosito, Katlego E, Tema, Thabo H. 2022. South African airborne SAR facility towards application and technology R&D. Institute of Electrical and Electronics Engineers (IEEE) Radar Conference, New York, 21-25 March 2022, p.6pp.

Bosscha, Peter A, De Ronde, Willis. 2022. The journey of the CSIR L.I.F.E. CPAP ventilator. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.15pp.

Chauke, Mapoo D, Mphadza, Fhumulani R. 2022. Framework for critical infrastructure security rating. 1228th International Academic Conference on Engineering, Technology and Innovations, Cape Town, 24-25 February 2022, p.5pp.

Chirwa, L, Erasmus, Louwrence D. 2022. Technology readiness and maturity in narrow reef mining in the context of systems engineering. 16th Annual Systems Engineering Conference: Systems Engineering - New Normal, CSIR ICC, Pretoria, 14-16 November 2022, p.114-130.

Cilliers, Jacques E, Du Plessis, WP. 2022. Mutual information-based analysis of recognition of MANPADS missiles. Radar 2022, International Conference on Radar Systems, Murrayfield Stadium, Edinburgh, UK, 24 - 27 October 2022, p.6pp.

Crafford, Gerhardus J, Rosman, B. 2022. Improving reinforcement learning with ensembles of different learners. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.13pp.

Dawood, Zubeida C, Mkuzangwe, Nenekazi NP. 2022. Advancing cybersecurity capabilities for South African organisations through R&D. Proceedings of the 17th International Conference on Cyber Warfare and Security, New York, USA, 17-18 March 2022, 17(1), p.102-110.

Dlamini, Sifiso B, Turpin, M, Herselman, Martha E. 2022. Technology and pedagogical factors to be considered when building a resilience framework for integrating and using mobile technologies in South African rural schools. In: Cunningham, M Cunningham, P (eds.). ISTAfrica 2022 Conference Proceedings, Virtual, 16-20 May 2022, p.7pp.

Dludla, Angeline G, Vilakazi, Mlamuli C, Burger, Christiaan R, Lysko, Albert A, Ngcamu, Lwando, Mboweni, Lawrence, Masonta, Moshe, Kobo, Hlabishi I, Mamushiane, Lusani. 2022. Testing performance for several use cases with an indoor OpenAirInterface USRP-Based base station. 5th International Conference on Multimedia, Signal Processing and Communication Technologies, Online, 26-27 November 2022, p.5pp.

Ebrahim, Rozeena, Mthethwa, Nosipho B, Lysko, Albert A. 2022. Analysis of uniformity in steering capability of an ESPAR antenna. 5th International Conference on Multimedia, Signal Processing and Communication Technologies (IMPACT-2022), Online, 26-27 November 2022, p.5pp.

Emeruem, C, Keet, CM, Dawood, Zubeida C, Wang, S. 2022. BFO Classifier: Aligning domain ontologies to BFO. In: Sales, TP Hedblom, M Tan, H (eds.). CEUR Workshop Proceedings, Jönköping University, Sweden, 15-19 August 2022, 3249, p.13pp.

Erasmus, Louwrence D, Auret, Marius, Venter, Jacobus P. 2022. Integrative engineering framework for a research and development enterprise. In: Hattingh, T (eds.). 33rd Annual Conference of the Southern African Institute for Industrial Engineering, Zimbali, Durban, South Africa, 3-5 October 2022, p.376-385.

Faniso, Zimbini, Magimisha, E, Malatji, T. 2022. Remote Sensing of Aerosol Optical Depth (AOD) over Pretoria, South Africa. In: Prinsloo, A (eds.). South African Institute of Physics Virtual conference (SAIP), North-West University, 22-30 July 2021, p.398-404.

Faniso-Mnyaka, Zimbini, Skosana, Vusi J, Nana, Muhammad A, Magidimisha, Edwin. 2022. Image quality assessment methods for near-infrared wildfire imagery. Proceedings of the 8th International Conference on Engineering and Emerging Technologies (ICEET), Kuala Lumpur, Malaysia, 27-28 October 2022, p.6pp.

Ferreira, A, De Saxe, C, Steenkamp, Anton J, Nordengen, P. 2022. Developing a truck rollover risk calculator for South Africa. South African Transport Conference 2022 (SATC), Pretoria, South Africa, 4-7 July 2022, p.13pp.

Fon, RC, Igboamalu, F, Ndjiongue, AR, Ouahada, K, Leke, C, Abu Mahfouz, Adnan MI. 2022. Energy harvesting in GPON fiber optic receivers with SLIPT for the Internet of Things. International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 4-5 August, 2022, p.6pp.

Fon, RC, Igboamalu, F, Ndjiongue, AR, Ouahada, K, Leke, C, Abu-Mahfouz, Adnan MI. 2022. Outage probability of an underwater wireless system based on the CSK transmission. Institute of Electrical and Electronics Engineers (IEEE) International Symposium on Networks, Computers and Communications, Shenzhen, China, 19-22 July 2022, p.6pp.

Gibberd, Jeremy T. 2022. Integrating the sustainable development goals into green and sustainable building rating tools. CIB World Building Congress 2022: Building Our Future, RMIT University, Melbourne, Australia, 27 - 30 June 2022, p.9pp.

Gibberd, Jeremy T. 2022. Integrating the sustainable development goals into green and sustainable neighborhood building rating tools. CIB World Building Congress 2022: Building Our Future, RMIT University, Melbourne, Australia, 27 - 30 June 2022, p.10pp.

Gibberd, Jeremy T. 2022. Rainwater harvesting design approaches. Water Efficiency Conference, Trinidad & Tobago, 14-16 December 2022, p.125-133.

Gibberd, Jeremy T. 2022. School water and rainwater use modeller. Water Efficiency Conference, Trinidad & Tobago, 14-16 December 2022, p.134-144.

Gonçalves, Duarte P, Serfontein, Christian J. 2022. Systemic approaches to critical infrastructure risk and security capabilities. 16th INCOSE South Africa Systems Engineering Conference (Virtual), 14-16 November 2022, p.16pp.

Govender, Avashna. 2022. Multi-MelGAN voice conversion for the creation of under-resourced child speech synthesis. IST-Africa 2022 Conference Proceedings, Virtual, South Africa, 16-20 May 2022, p.7pp.

Grobler, Inus. 2022. Performance and applications of lithium titanite oxide cells. Interdisciplinary Conference on Mechanics, Computers and Electrics (ICMECE 2022), Barcelona, Spain, 6-7 October 2022, p.6pp.

Holloway, Mark, Camisani-Calzolari, Fernando R, Theron, Hendrik J. 2022. Field deployable additive manufactured housing for an electro-optical system: A case study. Interdisciplinary Conference on Mechanics, Computers and Electrics (ICMECE 2022), Barcelona, Spain, 6-7 October 2022, p.7pp.

Kemp, Lana, Roux, Michael P, Steyn, WJvdM. 2022. Bridge CNN defect prediction models using existing image data. 11th Austroads Bridge Conference, Adelaide Convention Centre, 15-18 November 2022, p.14pp.

Khoza, Nokuthula G, Khosa, Marshal V, Mahlangu, Thabo V, Ndlovu, Nkosinathi. 2022. Plant seedling classification using machine learning. 2022 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 4-5 August 2022, p.6pp.

Koen, Hildegard S, Cornelius, Justin C, Oosthuizen, R. 2022. Using topic modelling to analyse bus route data. 40th Annual Southern African Transport Conference and Exhibition (SATC), CSIR Convention Centre, Pretoria, 4-7 July 2022, p.13pp.

Kufakunesu, Rachel, Hancke, Gerhard P, Abu-Mahfouz, Adnan MI. 2022. The impact of gateway node density on the performance of LoRaWAN. The Southern Africa Telecommunication Networks and Applications Conference (SATNAC), Western Cape, South Africa, 28 - 30 August 2022, p.214-218.

Ledwaba, Lehlogonolo PI, Hancke, GP, Isaac, Sherrin J. 2022. Investigating distance bounding for delegated proof-of-proximity consensus within IIoT. 2022 IEEE International Symposium on Industrial Electronics (ISIE 2022), Anchorage, Alaska, USA, 1-3 June 2022, p.4pp.

Lekoadi, Paul M, Tlotleng, Monnamme, Annan, K, Maledi, N, Masina, Bathusile N. 2022. Effect of heat treatment on microstructure, hardness and tensile properties of high-speed selective laser melted Ti6Al4V. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.14pp.

Lysko, Albert A, Mfupe, Luzango P. 2022. Estimating the number of people affected by switching off analogue TV. 3rd International Conference on Communication, Computing & Industry 4.0-2022 (C2I4-2022), 15-16 December 2022, p.5pp.

Lysko, Albert A, Ngcamu, Lwando, Shingwenyana, Rhulani K, Ramotsoela, D. 2022. Considering the connectivity options for a smart water management system deployment. 3rd International Conference on Communication, Computing and Industry 4.0-2022 (C2I4-2022), Virtual, 15-16 December 2022, p.5pp.

Mabunda, HD, Ramotsoela, DT, Abu-Mahfouz, Adnan MI. 2022. Intrusion detection in water distribution systems using machine learning techniques: A survey. Institute of Electrical and Electronic Engineers (IEEE) 31st International Symposium on Industrial Electronics (ISIE), Anchorage, Alaska, USA, 1-3 June 2022, p.418-423.

Mabunda, N, Ramotsoela, DT, Abu Mahfouz, Adnan MI. 2022. Intrusion detection in water distribution systems using machine learning techniques. Institute of Electrical and Electronic Engineers (IEEE) 2nd International Conference on Artificial Intelligence of Things, Istanbul, Turkey, 29-30 December 2022, p.418-423.

Madigoe, Mandy N, Modiba, Rosinah, Lesley Cornish, L. 2022. Fabrication of a β -based titanium alloy for biomedical applications. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.8pp.

Magogodi, Steven M, Mathabathe, Maria N, Bolokang, Amogelang S, Siyasiya, C. 2022. The electrochemical corrosion behaviour of Ti48Al-2Nb-0.7Cr-0.3Si alloy in 3.5%NaCl. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.9pp.

Makgatho, M, Marivate, V, Sefara, Tshephisho J, Wagner, V. 2022. Training cross-lingual embeddings for Setswana and Sepedi. Proceedings of the International Conference of the Digital Humanities Association of Southern Africa (DHASA), Virtual Conference, 29 November - 3 December 2021, 3(3), p.9pp.

Makgoba, MW, Mosuang, TE, Mahladi, MA, Matshaba, MG, Maphanga, Rapela R, Mhlana, N, Mokhele, T. 2022. Structural stability of some gold (Au) and silver (Ag) nanoparticles. 66th Annual Conference of the South African Institute of Physics, Virtual Conference, Gqeberha, 4-8 July 2022, p.31-35.

Makoana, Nkutuane W, Yadroitsava, I, Tshabalala, Lerato C, Yadroitsev, I, Mathoho, Ipfi, Pityana, Sisa L. 2022. Post processing of Ti6Al4V manufactured using high power laser powder bed fusion. Additive Manufacturing Meets Medicine - AMMM 2022, Fraunhofer Research institute IMTE, Lubeck, Germany, 13-15 September 2022, 4(1), p.4pp.

Malinga, Andries L, Strauss, A, Letaba, P, Pretorius, MW. 2022. Technology roadmapping and 4IR in defence: Case of command-and-control systems. 28th International Conference on Engineering, Technology and Innovation & 31st International Association for Management of Technology (Joint Conference), Nancy, France, 19-23 June 2022, p.8pp.

Mamushiane, Lusani, Mwangama, J, Lysko, Albert A, Kobo, Hlabishi I. 2022. 5G network slice resource overbooking: An opportunity for telcos to boost their revenue. Southern Africa Telecommunication Networks and Applications Conference (SATNAC) 2022, Fancourt, George, Western Cape, South Africa, 28-30 August 2022, p.14-19.

Mangole, Tshogofatso, Helberg, ASJ, Nair, Kishor K. 2022. Resource usage evaluation of the PHOTON hash function. 2022 Conference on Information Communications Technology and Society (ICTAS), Durban, South Africa, 9-10 March 2022, p.6pp.

Maraais, Mario A, Lotriet, H, Matthee, M, De Moor, A. 2022. The role of social capital in sustainable ICT4D. In: Stillman, L Anwar, M (eds.). 20th Annual Community Informatics Research Network (CIRN) Conference, Prato, Italy, 9-11 November 2022, p.128-147.

Maremi, Keneilwe J, Thulare, Tumiso, Herselman, Martha E. 2022. The benefits of digital transformation addressing the hindrances and challenges of e-government services in South Africa: A scoping review. IST-Africa Conference, Virtual, 16-20 May 2022, p.8pp.

Matinise, Sihle N, Oelofse, Suzanna HH. 2022. Revision of the integrated waste management plan guideline and integrated waste management plan portal. WasteCon 2022, Emperor's Palace, Johannesburg, South Africa, 18-20 October 2022, p.12pp.

May, Siyasanga I, Bokoro, P, Pratt, Lawrence E, Roro, Kittessa T. 2022. Modelling photovoltaic power output using machine Learning techniques. IEEE PES/IAS PowerAfrica, Kigali, Rwanda, 22-26 August 2022, p.5pp.

Mbele, CM, Malik, Humma H, Pretorius, JHC. 2022. Managing structural integrity of pipelines utilising inline inspection data. Institute for Electric and Electronic Engineers (IEEE) 28th ICE/ITMC & 31st IAMOT Joint Conference, Nancy, France, 19-23 June 2022, p.7pp.

Mbiada, AK, Isong, B, Lugayizi, F, Abu Mahfouz, Adnan MI. 2022. Introductory computer programming teaching and learning approaches: Review. International Conference on Electrical, Computer and Energy Technologies (ICECET), Prague, Czech Republic, 20-22 July 2022, p.8pp.

Mdakane, Lizwe W. 2022. SENTINEL-1 SAR for operational monitoring of Southern Africa Oceans. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Nice, France, 6-11 June 2022, p.301-306.

Meyers, Bronwyn C, Grobler, Jan-Hendrik, Snedden, GC. 2022. The numerical aerodynamic investigation of swirling inlet flow in a vaporizer tube micro-gas turbine combustor. 25th ISABE Conference, Ottawa, Canada, 25-30 September 2022, p.28pp.

Mfusi, Busisiwe J, Mathe, Ntombizodwa R, Makoana, Nkutowane W, Popoola, P. 2022. Optimization of surface modification for additively manufactured AlSi10Mg using a vibratory polishing surface finisher. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.12pp.

Mlongeni, M, Abu-Mahfouz, Adnan MI, Hancke, GP. 2022. Towards building a secure NB-IoT environment on 5G Networks: A user and device access control system review. 48th Annual Conference of the IEEE Industrial Electronics Society, Brussels, Belgium, 17-20 October 2022, p.6pp.

Modikwe, T, Maledi, N, Mathe, Ntombizodwa R, Pityana, Sisa L, Dada, M, Makoana, Nkutowane W. 2022. Post-processing of direct metal deposited AlCrCoCuFeNi HEA using centrifugal barrel finishing. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.12pp.

Mokuwe, Mamuku W, Goorun, Yurisha, Crafford, Gerhardus J. 2022. Assembly line quality assurance through hand tracking and object detection. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.8pp.

Molose, R, Isong, B, Dladlu, N, Abu-Mahfouz, Adnan MI. 2022. Data aggregation schemes for maximal network lifetime: Review. 2022 International Conference on Electrical, Computer and Energy Technologies (ICECET), Prague, Czech Republic, 20-22 July 2022, p.8pp.

Monareng, KM, Maphanga, Rapela R, Ntoahae, PS. 2022. Development of machine learning models for predicting energies of sodium-ion battery materials. South African Institute of Physics Annual Conference, Virtual Conference, Nelson Mandela University, 4-8 July 2022, p.49-54.

Moshokoa, Nthabiseng A, Raganya, Mampai L, Machaka, Ronald, Obadele, BA, Mamookho, ME. 2022. Microstructure and bending properties of solution-treated Ti-Mo binary alloys for biomedical applications. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.12pp.

Mosito, Katlego E, Nel, Willem AJ, Blaauw, Ciara, Gaffar, YA, De Witt, Jasias J. 2022. Detection, tracking and geo-location of moving targets in airborne radar data using a DPCA GMTI technique. 2022 Institute for Electrical and Electronic Engineers (IEEE) Radar Conference (RadarConf22), New York City, NY, USA, 21-25 March 2022, p.6pp.

Motsai, Tebogo M, Makhatha, ME, Camagu, Siggibo T, Machio, Christopher N, Daswa, Pfarelo, Radingoana, Precious M, Motsi, Glenda T. 2022. Microstructures and thermal behaviour of Ti_{31.75}V_{18.25}Pt₅₀ and Ti₂₅V₂₅Pt₅₀ potential shape memory alloys. 8th International PGM SAIMM 2022, Sun City, Rustenburg, South Africa, 2-4 November 2022, p.13pp.

Motsai, Tebogo, Makhatha, E, Camagu, Siggibo, Machio, Chris, Daswa, Pfarelo, Radingoana, Precious, Motsi, Glenda. 2022. The effect of vanadium and nickel on the microstructure and transformation temperatures of Ti50Pt50 alloy. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.13pp.

Mphahlele, M, Mokonyama, Mathetha T. 2022. Transferrable capacity development lessons in support of municipal transport service delivery: Case study of Bojanala Platinum District Municipality. 40th International Southern African Transport Conference, CSIR ICC, Pretoria, South Africa, 4-8 July 2022, p.13pp.

Mthethwa, Nozipho BP, Masonta, Moshe T, Dlamini, Sifiso B, Ngcamu, Lwando. 2022. Towards developing a broadband infrastructure dashboard framework. IST-Africa 2022 Conference, Virtual, 16-20 May 2022, p.9pp.

Mthethwa, Sthembile, Pretorius, Morne. 2022. Academic and skills credentialing using distributed ledger technology (DLT) and W3C Standards: Technology assessment. International Conference on Intelligent and Innovative Computing Applications, The Ravenala Attitude Hotel Balaclava, Mauritius, 8-9 December 2022, p.170-182.

Mtshali, Mxolisi S, Mboweni, Lawrence S, Kobo, Hlabishi I. 2022. Resource and service orchestration for deploying openstack cloud using MAAS and Juju. In: Smuts, M Moorcroft, R (eds.). Southern Africa Telecommunication Networks and Applications Conference (SATNAC) 2022, George, Western Cape, South Africa, 28-30 August 2022, p.114-119.

Muswema, Aubrey P, Oelofse, Suzanna HH. 2022. "A can of worms": Aerosol waste within the context of EPR, some insight from South Africa. WasteCon 2022, Emperor's Palace, Johannesburg, South Africa, 18-20 October 2022, p.7pp.

Nahman, Anton, Oelofse, Suzanna HH, Palfreman, J. 2022. Recommendations for advancing the circular plastics economy in South Africa. WasteCon 2022, Emperors Palace, Johannesburg, South Africa, 18-20 October 2022, p.15pp.

Naidoo, Thegaran, Verster, Jacobus J, Marais, Stephen T. 2022. A cloud-based road infrastructure analysis system using machine learning. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.10pp.

Nel, Willem AJ, Mostert, S. 2022. MicroSTAR: A bistatic space to ground SAR and its potential for civilian and security applications. 2022 IEEE Radar Conference (RadarConf22), New York City, NY, USA, 21-25 March 2022, p.6pp.

Nemukongwe, MT, Kirui, JK, Maluta, NE, Maphanga, Rapela R. 2022. Synthesis, characterization and simulation of graphene oxide nanomaterial for application in hybrid supercapacitors. In: Prinsloo, A (eds.). South African Institute of Physics Annual Conference 2022, Virtual Conference, Nelson Mandela University, 4-8 July 2022, p.118-122.

Nkosi, N, Manzi, M, Roberts, David P, Durrheim, R, Ogasawara, H, Ziegler, M, Liebenberg, B, Onstott, T. 2022. Experimental and in-situ physical properties measurements from a seismogenic zone in a deep South African mine. 4th Conference on Geophysics for Mineral Exploration and Mining of NSG, Belgrade, Serbia, 18-22 September 2022, p.5pp.

Nomqonde, BH, Mashinini, PM, Lekoadi, Paul M, Masina, Bathusile N. 2022. Investigation of the microstructure evolution of TiC/Ti-6Al-4V composite manufactured by laser melting deposition. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.13pp.

Nwachukwu, SE, Chepkoech, M, Lysko, Albert A, Awodele, K, Mwangama, J, Burger, Christiaan R. 2022. Integration of massive MIMO and machine learning in the present and future of power consumption in wireless networks: A review. 2022 IEEE 7th Forum on Research and Technologies for Society and Industry Innovation (RTSI), Paris, France, 24-26 August 2022, p.7pp.

Oelofse, Suzanna HH, Nahman, Anton, Russo, Valentina, Stafford, William H, Muswema, Aubrey P, Mathew, Maya J, Muniyasamy, Sudhakar. 2022. Transitioning from conventional plastic to more sustainable alternative materials: Evidence from South Africa. WasteCon 2022, Emperor's Palace, Johannesburg, South Africa, 18-20 October 2022, p.10pp.

Oladele, DA, Markus, ED, Abu-Mahfouz, Adnan MI. 2022. Towards an adaptable framework for mobility assistive technologies. 12th International Conference on Emerging Ubiquitous Systems and Pervasive Networks / 11th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare, Leuven, Belgium, 1-4 November 2021, 198, p.301-306.

Osifeko, MO, Hancke, GP, Abu Mahfouz, Adnan MI. 2022. Impact of mobility speed and network density on the performance of vehicular ad hoc network routing protocols. International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 4-5 August 2022, p.5pp.

Pandelani, Thanyani A, Carpanen, D, Masouros, D. 2022. Evaluating pelvis response during simulated underbody blast loading. International Mechanical Engineering Congress and Exposition (IMECE2022), Columbus, Ohio, 30 October - 3 November 2022, p.6pp.

Pandelani, Thanyani A, Reinecke, John D, Hamilton, Silumko L. 2022. Experimental verification of TNT equivalence to PE4 charges using a Blast Test Device. In: Manning, TG Rickert II, FC (eds.). 32nd International Symposium, Reno, Nevada Jointly organized by the Association & Society Management International, Inc. (ASMI) and the International Ballistics Society (IBS), 9-13 May 2022, p.13pp.

Pandelani, Thanyani, Blumenthal, R, Nixon, K, West, N, Reinecke, John D, Gomes, C. 2022. Lightning barotrauma and lightning dysbarism: A laboratory study. 36th International Conference on Lightning Protection, Cape Town, South Africa, 2-7 October 2022, p.899-902.

Perumal, Sarisha, Thambiran, Tirusha, Garland, R, Klimont, Z, Gomez-Sanabria, A, Burger, R, Annegarn, H, John, Juanette, Kwatala, Ngwako, Naidoo, Mogesh. 2022. A critical assessment of current policies that will drive future emissions in Johannesburg, Ekurhuleni, and Tshwane. Proceedings of the 2022 Conference of the National Association for Clean Air, 5-7 October 2022, p.119-124.

Pieterse, Frans-Paul, Smit, Johan C, Cilliers, Jacques E. 2022. On the importance of the accuracy of the estimate of the radar position for fully coherent jamming of a Stripmap SAR sensor. International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET), Bandung, Indonesia, 6-7 December 2022, p.183-188.

Polasi, Letlotlo T, Oelofse, Suzanna HH. 2022. Lessons learned from separation at source implementation in Newcastle. WasteCon 2022, Emperor's Palace, Johannesburg, South Africa, 18-20 October 2022, p.8pp.

Potgieter, Monique, Nel, Willem AJ. 2022. Three-dimensional scatterer extraction for ISAR resynthesis. 2022 IEEE Radar Conference (RadarConf22), New York City, NY, USA, 21-25 March 2022, p.6pp.

Raganya, Mampai L, Moshokoa, Thabiseng, Machaka, Ronald, Obadele, B, Makhatha, M. 2022. Microstructure and tensile properties of heat-treated Ti-Mo alloys. In: Du Preez, WB (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.8pp.

Ramasobane, P, Mashinini, MP, Masina, Bathusile N. 2022. Effects of energy density on the microstructure evolution of TiC/Ti6Al4V-ELI metal composite fabricated with laser metal deposition. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.8pp.

Ramazhamba, Pardon T, Venter, HS. 2022. A distributed model for sharing tendering project information in the South African local government. Cyberworlds (CW2022) Kanazawa, Japan, 27-29 September 2022, p.8pp.

Sampson, L, Rust, FC, Smit, Michelle A. 2022. What does the future hold for low volume rural roads in developing countries such as South Africa?. SARF, IRF, PIARC 7th Regional Conference for Africa, Cape Town International Convention Centre, Cape Town, South Africa, 18-20 October 2022, p.11pp.

Sebe, ID, Sithole, ME, Modiba, Rosinah. 2022. Investigating the effects of Carbon and Boron atoms on the ϵ -MnAl alloy properties employing the first principle approach. In: Prinsloo, A (eds.). 66th Annual Conference of the South African Institute of Physics, Virtual Conference, Gqeberha, 4-8 July 2022, p.123-126.

Sefara, Tshephisho J, Mbooi, Mahlatse S, Mashile, Katlego J, Rambuda, Thompho, Rangata, Mapitsi R. 2022. A toolkit for text extraction and analysis for natural language processing tasks. 2022 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), Durban, South Africa, 4-5 August 2022, p.6pp.

Setati, Tiro, Botha, Natasha, Roux, Jeanne M. 2022. Experimental approach to calculate the moments of inertia of a hexacopter unmanned aerial vehicle. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.11pp.

Setati, Tiro, Perold, WJ, Fourie, PR, Withey, Daniel J. 2022. Comparing closed-loop control of drug infusion using MPC and PID. In: Roque, A Fred, A Gamboa, H (eds.). Proceedings of the 15th International Joint Conference on Biomedical Engineering Systems and Technologies - Volume 1: BIODEVICES, 9-11 February 2022, 1, p.126-133.

Shibambu, Ncedisa AM, Moganedi, S. 2022. How working from home has affected the SA Industries: A cybersecurity culture perspective. Proceedings of the 2022 International Conference on Intelligent and Innovative Computing Applications, The Ravenala Attitude Hotel Balaclava, Mauritius, 8-9 December 2022, p.137-143.

Skhosane, Besabakhe S, Masina, Bathusile N, Lekoadi, Paul M, Pityane, Sisa L. 2022. In-situ production of WC-Ni using a laser cladding technique. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.10pp.

Smit, Michelle A, Akhalwaya, Imraan, Rust, FC, Ramdas, Veshara. 2022. Microbial Induced Calcium Carbonate Precipitation (MICCP) for road construction. 40th Annual Southern African Transport Conference, CSIR ICC, Pretoria, 4-7 July 2022, p.14pp.

Smith, Andrew C. 2022. An architecture to negotiate and monitor energy exchanges in the smart microgrid. 3rd International Conference on Clean and Green Energy Engineering (CGEE), Istanbul, Turkey, 28-30 August 2022, p.4pp.

Snyman-van der Walt, Luanita, Schreiner, Gregory O, Lochner, Paul A. 2022. Systems thinking in impact assessment: Where we are and where we're going. Proceedings of the 10th South African System Dynamics Conference: "Transforming our World of Systems," Online, 16-18 November 2022, p.5-15.

Steenkamp, Anton J, Steenkamp, Andries L. 2022. Using Gaussian process machine learning to predict dynamic road wear of a rigid heavy vehicle. 40th Annual Southern African Transport Conference, CSIR ICC, Pretoria, 4-7 July 2022, p.12pp.

Stewart-Burger, CD, Ludick, Danie J, Potgieter, M. 2022. Open-set classification of small complex targets with ISAR imaging [Paper]. IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting (AP-S/URSI), Denver, CO, USA, 10-15 July 2022, p.1188-1169.

Steynberg, L, Erasmus, Louwrence D, Pretorius, L. 2022. Blockchain technology adoption in outbound logistics for the fourth industrial revolution. Portland International Conference on Management of Engineering and Technology (PICMET), Portland, OR, USA, 7-11 August 2022, p.11pp.

Tshwane, David M, Modiba, Rosinah. 2022. Structural stability of Cubic Ti₂AlV and Tetragonal TiAl₂V using first principle calculations. 66th Annual Conference of the South African Institute of Physics, Virtual Conference, Gqeberha, 4-8 July 2022, p.68-72.

Tshwane, David M, Modiba, Rosinah. 2022. Surface properties of Ti₂AlV (100) and (110) surfaces using first-principle calculations. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, p.5pp.

Van Schalkwyk, A, Grobbelaar, S, Vermeulen, E, Herselman, Martha E. 2022. Contributing to monitoring and evaluation practices by conceptualizing a Valuable Insights from Log Analysis (VILA) Framework. Institute for Electrical and Electronic Engineers (IEEE) 28th ICE/ITMC & 31st IAMOT Joint Conference in Nancy, France, 19-23 June 2022, p.51-59.

Van Zyl, AC, Wiehahn, EA, Cilliers, Jacques E, Niesler, TR. 2022. Optimised multi-parameter NLFM pulse compression waveform for low time-bandwidth radar. Radar 2022, International Conference on Radar Systems, Murrayfield Stadium, Edinburgh, United Kingdom, 24-27 October 2022, p.289-294.

Veerasamy, Namosha, Pieterse, Heloise. 2022. Rising above misinformation and deepfakes. International Conference on International Conference on Cyber Warfare and Security, Albany, New York, USA, 17-18 March 2022, p.340-348.

Veerasamy, Namosha, Yoolla, Yaseen, Dawood, Zubeida C. 2022. Application of geospatial data in cyber security. European Conference on Cyber Warfare and Security, University of Chester, United Kingdom, 16-17 June 2022, p.305-313.

Wessels, Gert J, Botha, Natasha, Koen, Hildegard S, Van Eden, Beatrice. 2022. Towards better flood risk management using a Bayesian network approach. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.15pp.

Zandamela, Frank, Ratshidaho, Terence, Nicolls, F, Stoltz, George G. 2022. Cross-dataset performance evaluation of deep learning distracted driver detection algorithms. In: Du Preez, W (eds.). 23rd Annual International RAPDASA Conference joined by RobMech, PRASA and CoSAAMI, Somerset-West, Cape Town, 9-11 November 2022, 370, p.19pp.

Books (4) and Book Chapters (25)

Adeniran, A, Motsatsi, Lorato L, Mbanga, S, Ayesu-Koranteng, E, Shakantu, W. 2022. An investigation of waste management practice in a South African township: A case study of Ekuphumleni township, Ndlambe municipality. In: Raimi, MO Sunday, OA Sawyerr, HO Adias, CT (eds.). *Emerging Issues in Environmental Epidemiology and Its Reflection*, p.22pp.

Adetunji, RO, Strydom, MA, Herselman, Martha E, Botha, Adele. 2022. Augmented reality technology: A systematic review on gaming strategy for medication adherence. In: Al-Emran, M Shaalan, K (eds.). *Recent Innovations in Artificial Intelligence and Smart Applications*, p.47-66.

Ama, OM, Khoele, K, Govender, PP, Ray, Suprakas S. 2022. Application of surface-modified electrode materials in wastewater treatment. In: Ama, OM Ray, Suprakas S Ogbemudia Osifo, P (eds.). *Modified Nanomaterials for Environmental Applications: Electrochemical Synthesis, Characterization, and Properties*, p.107-119.

Babawarun, T, Ngwangwa, HM, Netshivhulana, AG, Pandelani, Thanyani A, Ho, WH. 2022. Evaluating static and modal responses of a small scale conventional and bio-inspired wind turbine blade. In: Zingoni, A (eds.). *Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems*, p.144-149.

Baburam, C, Mitema, A, Tsekoa, Tsepo L, Feto, NA. 2022. Bacillus species and their invaluable roles in petroleum hydrocarbon bioremediation. In: Islam, MT Rahman, M Pandey, P (eds.). *Bacilli in Agrobiotechnology*, p.101-126.

Breil, P, Pons, MN, Armani, G, Amer, R, Pienaar, Harrison H, Paul Oberholster, P, Namour, P. 2022. Natural-based solutions for bioremediation in water environment. In: El-Gendy, NS (eds.). *Sustainable Solutions for Environmental Pollution, Volume 2: Air, Water, and Soil Reclamation*, p.93pp.

Dubash, NK, Mitchell, C, Boasson, EL, Borbor-Córdova, MJ, Fifita, S, Haites, E, Jaccard, M, Jotzo, F, Naidoo, Sasha, Romero-Lankao, P. 2022. National and sub-national policies and institution. *Climate Change 2022: Mitigation of Climate Change. IPCC Sixth Assessment Report*, p.1355-1450.

Gibberd, Jeremy T. 2022. Social and economic sustainability targets in construction. In: De Jager, P (eds.). *The Sustainability Handbook. Volume 4*, 4, p.32-43.

Godfrey, Linda K, Sithole, Bishop B, Mathew, Maya J, Mturi, George AJ, Muniyasamy, Sudhakar. 2022. Transitioning to a Circular Economy in South Africa: The role of innovation in driving greater waste valorisation. In: Ren, J Zhang, L (eds.). *Circular Economy and Waste Valorisation*, p.153-176.

Hobbs, PJ, Pienaar, Harrison H, Van Wyk, E, Xu, Y. 2022. Anatomy of a South African Karst Hydrosystem: The hydrology and hydrogeology of the Cradle of Humankind World Heritage Site. In: Hobbs, PJ Pienaar, Harrison H van Wyk, E Xu, Y (eds.). p.356pp.

Matamanda, AR, Chirisa, I, Rammile, S, Marais, Mario A. 2022. Housing and Technology: Special Focus on Zimbabwe. In: Brauch, HG (eds.). p.114pp.

Mathabathe, Maria N, Bolokang, Amogelang S. 2022. Challenges in machining of advanced materials. In: Gajrani, KK Prasad, A Kumar, A (eds.). *Advances in Sustainable Machining and Manufacturing Processes*, p.3-16.

Mathibe, MJ, Muchenje, T, Masonta, Moshe T. 2022. Smart township digital framework: Growing the township economy post-COVID-19 pandemic. In: Eniola, AA Iwu, CG Opute, AP (eds.). *The Future of Entrepreneurship in Africa*, p.17pp.

Mofokeng, Tladi G, Motloung, Mpho P, Ama, OM, Ray, Suprakash S. 2022. Electrochemical characterization of nanomaterials. Modified nanomaterials for environmental applications: Electrochemical synthesis, characterization, and properties, p.11-24.

Napier, Mark, Cooper, Antony K, Holloway, Jennifer P, Thanjekwayo, L, Graham, N, Le Roux, A. 2022. A tale of two pathways: How the low-end Gauteng residential property market may be shaped either by state-driven supply or by a more enabled private sector. In: Aly, K François, V Catherine, K Victor, A (eds.). Understanding African Real Estate Markets, p.135-157.

Ngwangwa, HM, Lebea, L, Nemavhola, F, Pandelani, Thanyani A, Modungwa, Ditholo. 2022. Investigation of the performance of different constitutive models on omasum uniaxial tensile behaviour. In: Zingoni, Aphose (eds.). Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems, p.5pp.

Ngwangwa, HM, Msibi, M, Maduba, I, Nemavhola, F, Pandelani, Thanyani A. 2022. Evaluating the tensile behaviour of rat myocardium across its three walls from biaxial tensile test data. Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems, p.344-348.

Ngwangwa, HM, Semakane, L, Nemavhola, F, Pandelani, Thanyani A, Modungwa, Ditholo M. 2022. Modelling of biaxial tensile behaviour of the tracheal tissue using three exponential-based hyperelastic constitutive. Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems, p.5pp.

Okole, Blessed N, Kesavan Pillai, Sreejarani, Ndzotoyi, Phatheka, T, Phasha, Vivey M. 2022. Use of herbal extract-based nanoemulsions for hair care application. In: Setapar, SM Ahmad, A Jawaid, M (eds.). Nanotechnology for the preparation of cosmetics using plant-based extracts, p.203-233.

Pandarum, Aradhna, Tlokolo, Nthabeleng B, Marema, Abram, Rakaibe, Tshwanelo K, Simiyu, Donah S. 2022. Repurposing of coal-fired power stations and coal mines for a JUST transition in South Africa. In: Alive2Green (eds.). The Sustainability Handbook: Volume 5, p.66-85.

Pandelani, Thanyani A, Masouros, SD, Calvo-Gallego, JL. 2022. Application of quasi-linear viscoelasticity for the characterisation of human buttocks adipose tissue. In: Zingoni, A (eds.). Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems, p.315-319.

Pandelani, Thanyani A, Modungwa, Dithoto M, Hamilton, Silumko L, Reinecke, John D. 2022. Comparison of TNT to PE4 charge using a simplified rigid torso. In: Zingoni, A (eds.). Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems, p.6pp.

Peter, LS, Kobo, Hlabishi I, Srivastava, VM. 2022. A comparative review analysis of OpenFlow and P4 protocols based on software defined networks. In: Jacob, IJ Shanmugam, SK Izonin, I (eds.). Data Intelligence and Cognitive Informatics, p.699-711.

Phuthu, L, Maluta, NE, Maphanga, Rapela R. 2022. Structural, electronic, and optical properties of mono- and co-doped graphene with Ti and Ru. In: Ikram, M Maqsood, A Bashir, A (eds.). Graphene - Recent Advances, Future Perspective and Applied Applications, p.16pp.

Rathogwa, Mashudu, Mokonyama, Mathetha T. 2022. Using systems dynamics modelling to facilitate sustainable decision making and improved planning and implementation of integrated public transport networks (IPTN) as effective spatial transformation instruments in South African cities. In: De Jager, Peta (eds.). Sustainability Handbook. Volume 5, p.126-137.

Ray, Suprakas S. 2022. Nanocomposites: Processing and mechanical properties. In: Auras, RA Lim, L-T Selke, SEM Tsuji, H (eds.). Poly(Lactic Acid): Synthesis, Structures, Properties, Processing, Applications, and End of Life. Second Edition, p.411-424.

Ray, Suprakash S, Banerjee, R. 2022. Sustainable Polylactide-Based Blends. p.437pp.

Van Schoor, Abraham M, Nkosi, Nomqhele Z, Magweregwe, Fleckson, Kgarume, Thabang E. 2022. Deep-level Gold and Platinum Mining - The Application of Geophysics in South Africa. p.76pp.

Walters, Chavon R, Steyn, Maronel. 2022. From waste to resource: Opportunities and challenges to combat water scarcity. In: De Jager, P (eds.). The Sustainability Handbook. Volume 4, 4, p.100-114.



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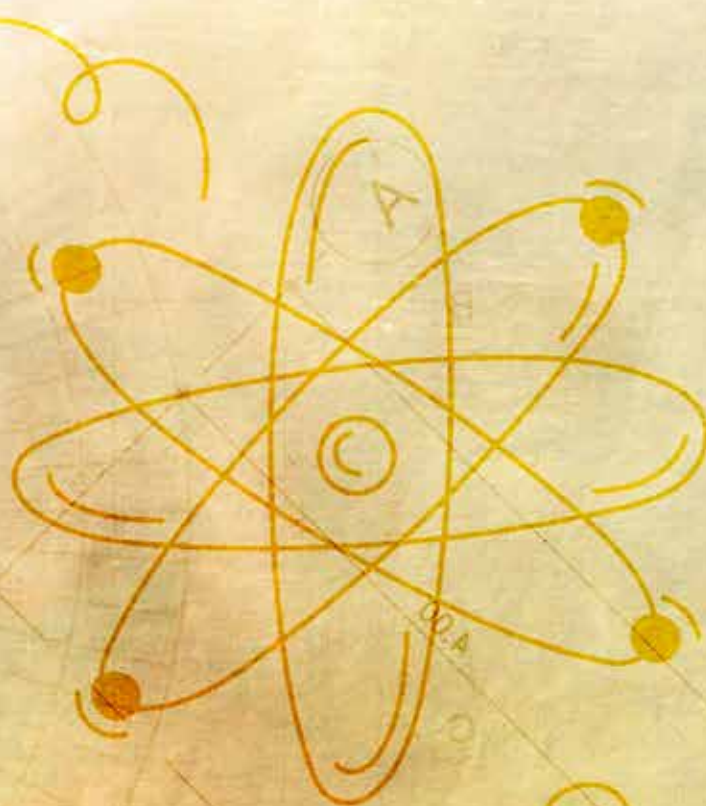
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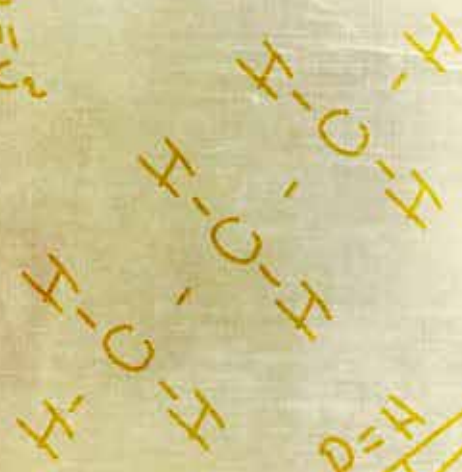
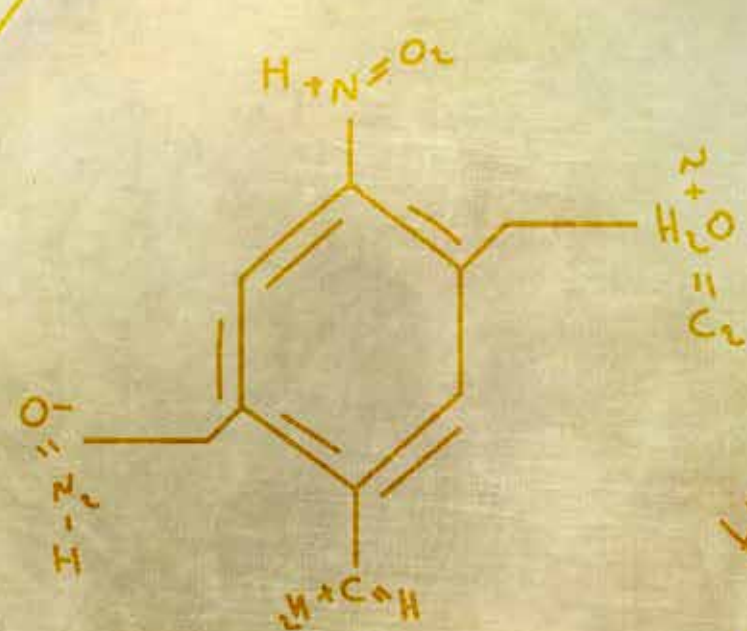


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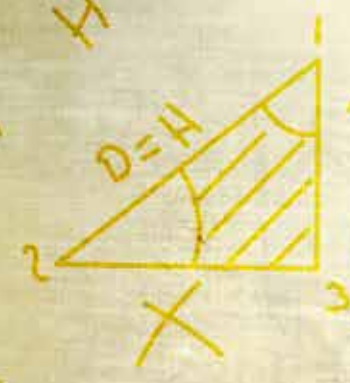
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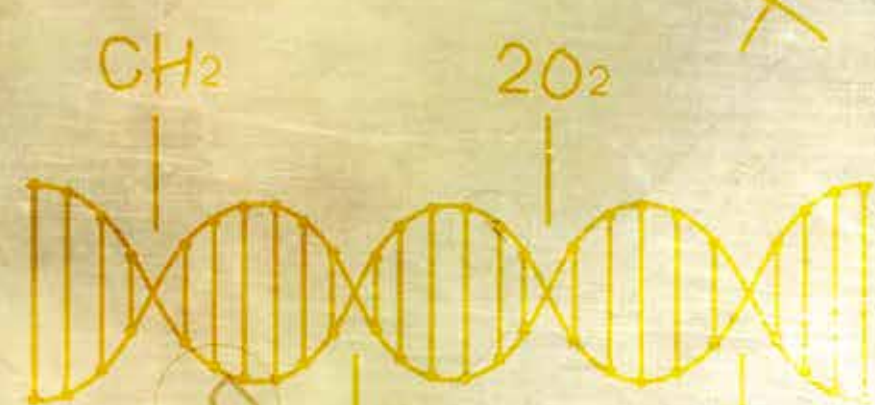


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Published by: CSIR Communication
Enquiries: Tel +27 12 841 2911
Email: Enquiries@csir.co.za

ISBN 10: 0-7988-5668-8
ISBN 13: 978-0-7988-5668-3



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