
HOERIKWAGO
CRITICAL ZONE OBSERVATORY
City of Cape Town | Western Cape | South Africa
more information
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COVER PHOTOGRAPHY "FLAME THROW"
Simon Sephton

how...

scientists,
artists
&
diverse stakeholders
can collaborate with communities
to optimise water resources
and have a *transformative*
social impact

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introduction

South Africa's Mother City, Cape Town, is experiencing a profound challenge in meeting the demand for water from its growing population, as well as from agriculture, industry and business. Its response to climate change and how it optimises scarce resources will provide valuable lessons for other cities around the country, and beyond its borders.

One of the main weapons in the City's natural resource arsenal is the groundwater stored in aquifers: underground fractured rock or unconsolidated sediments, replenished when rain and river water seep through soil and fractures. Umvoto Africa, a water resource development and management consultancy, has over the past 25 years explored the potential of groundwater in the Western Cape and pioneered its exploration, development and management through a Monitor, Model and Adaptive Management approach.

While there are major aquifers in the area of the Western Cape Water Supply System which supplies the greater metropolitan area of the City of Cape Town and surrounding agriculture, this document focuses largely on the Cape Flats Aquifer underlying the Cape Flats area of Cape Town. This area extends over 400 km^2 between the iconic Table Mountain and the higher land to the east, Table Bay to the north and False Bay to the south. Formerly the area was relatively uninhabited. Water flowed through rivers and marshes (vleis) directly into False Bay or infiltrated through the sand dunes and out into the sea. Wetlands and sand being natural filters, the water which entered False Bay was clean.

The Cape Flats area and its surroundings are now characterised by dense human settlements (formal and informal), agricultural, industrial and mining activities. Formal settlements have encroached where there were sand dunes, while informal settlements have impacted on the natural seasonal pans, creating a man-made flood hazard during winter rains for shack dwellers and small-scale farmers.

Unlocking the potential of the Cape Flats Aquifer requires a holistic approach. It must address the underlying groundwater architecture, the above-ground surface water and transport infrastructure, demographic patterns and processes, and the natural and urban water cycles that draw in huge volumes of water and store and release this via the aquifer and rivers into False Bay. This requires collaboration between numerous stakeholders such as scientists, engineers, small-scale farmers, municipal officials and others. Support from the Cape Flats community is essential if this enormous natural resource is to be harnessed for the benefit of all. Furthermore, it can potentially help heal many of the historic societal wounds based on the apartheid system of segregation and discrimination.

This document is based on two years of debate and discussion. It shares current understandings and considerations within an area we refer to as the Hoerikwaggo Critical Zone Observatory: Cape Flats. We wish to inform and collaborate with individuals, institutions and organisations from numerous disciplines who are interested in environmental sustainability and partnering for transformative societal change.

Hoerikwaggo Critical Zone Observatory

The Critical Zone is the heterogenous (non-uniform), near surface environment of the Earth within which the natural habitat is regulated and nearly all terrestrial life is sustained. It incorporates the physical land surface, vegetation, rivers, lakes, and shallow seas that extend into the pedosphere (outermost layer of the earth), the unsaturated vadose zone and saturated groundwater zone, and all living organisms inhabiting these spaces, where ongoing and changing interactions occur between air, water, soil, rock and organisms, including humans.

In response to continuing and accelerating global change, Critical Zone Observatories (CZOs) have been established to monitor this changing and complex domain to better understand and sustain this space that is critical to life. The CZOs provide the common reference point and platform for bringing various groups of people together, such as scientists studying the physical and social environments, engineers and other practitioners altering the environments, the officials administering them, and – importantly – the communities living in and with these spaces. Aquifers being developed as additional sources to augment the Western Cape Water Supply System will comprise individual CZOs.

Our focus is on a zone at the southernmost tip of Africa, instantly recognisable by Table Mountain, which the indigenous people named Hoerikwaggo, or Mountain of the Sea. Table Mountain, and other local mountains such as the Hottentots Holland range, were once surrounded by water which lapped at their granite outcrops. As the water advanced and receded it laid the foundations for the low-lying, expansive Cape Flats. The area under discussion, which would bring multiple stakeholders together to unleash critical natural resources, has accordingly been named the Hoerikwaggo Critical Zone Observatory: Cape Flats.

SOURCES AND MORE INFORMATION:

https://en.wikipedia.org/wiki/Earth%27s_critical_zone
https://en.wikipedia.org/wiki/Critical_Zone_Observatories
https://pubs.geoscienceworld.org/vzj/article-abstract/10/5/781/315931/Interdisciplinary-sciences-in-a-global-network-of?redirectedFrom=fulltext

"WATERCATCHER" FOR UMVOTO, CAPE FLATS AQUIFER PROTECTION ZONE PROJECT, 2018
Anni Snyman, Eugenie Grobler and Kasty vandenberghe










Images: Endgame Media

City of Cape Town Resilience Strategy

The City of Cape Town (CoCT) municipal area experienced a severe drought from 2015-2017, a 1-in-590-year event. Its impact has highlighted the need to increase the assurance of water supply and build social resilience to drought and other climate-related events, including flooding and fast-changing patterns in urbanization.

The CoCT coined the phrase 'Day Zero' in 2017 to signify the day that taps would run dry. Images of snaking queues of people waiting to collect their daily ration of 25 litres of water became the topic of heated and anxious conversation. Cape Town collectively breathed a sigh of relief in March 2018 when it was announced that 'Day Zero' had been avoided because of early rains and, more importantly, the citizens of Cape Town reducing their water consumption by more than 40% [] a remarkable achievement. For the first time, many suburban families became aware of exactly how much water they use versus what they really need. Yet in many impoverished communities, such as those living in informal settlements on the Cape Flats, people continued walking to public standpipes to collect water – Day Zero being their everyday reality.

The CoCT draft Water Management Strategy (published for comment February 2019) confirms that securing a higher assurance of clean water supply is essential for achieving Cape Town's various development goals. This will include undoing the spatial legacy of apartheid, improving living conditions and enabling work opportunities. The long-term success of this strategy will however rely not only on engineers, planners, scientists and policymakers. Active and meaningful community participation that drives positive behaviour change, to become a societal way of life, is a key requirement for effective implementation of the vision.

The Strategy cites a commitment to "sufficient, reliable water from diverse sources". One of these sources is groundwater, stored naturally underground. The CoCT has three aquifer systems it can access: the Atlantis Aquifer north of the city; the Table Mountain Group Aquifers that form the high mountains and underlie the valleys in the mountain land surrounding greater Cape Town and environs; and the Cape Flats Aquifer. The dams which presently supply 98% of the water to Cape Town are all situated in the high mountain land.

SOURCES AND MORE INFORMATION:

Cities Support Programme. What the Cape Town Drought Taught US: 4 focus areas for local governments.
http://www.csag.uct.ac.za/wp-content/uploads/2018/12/CSP_climate_policy-brief_2018_11_26.pdf
Draft Cape Town water strategy: https://www.capetown.gov.za/City-Connect/Have-your-say/Issues-open-for-public-comments/draft-cape-town-water-strategy; http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/Water%20Outlook%202018_Rev%2030_31%20December%202018.pdf

The Cape Flats

The Cape Flats has a history of residential segregation, poverty and crime. During the apartheid era of residential segregation, particularly from the 1950s, the Cape Flats was earmarked as a relocation area for black communities moved from inner city and suburban areas. This had a devastating and long-term impact. Family cohesion and social networks were destroyed and there are now high levels of unemployment, crime and gangsterism. Despite this social and economic vulnerability there is also evidence of extraordinary resourcefulness and resilience.

The Cape Flats and surrounding areas are now overrun by dense human settlements (formal and informal), with localised agricultural, industrial and mining activities (Figure 3). Formal settlements and agriculture have followed where sand has been mined, flattening the terrain, while informal settlements encroach on the remaining natural dune lands and into the seasonal pan areas and the flood plains of the rivers and the canals. This poses a man-made flood hazard when the winter rains fall, and a pollution threat to open and underground water bodies, with health and other impacts on people, the environment and sustainable clean water supply.

The Cape Flats also include the Philippi Horticultural Area. These small farms, close to the main roads and industrial areas, produce most of Cape Town's vegetables. Flowers and livestock are also farmed and provide employment for semi-skilled workers. While this area helps ensure food security for the city, parts of it face the threat of development for housing and industry and some farming practices pose a risk to the groundwater quality.

The Cape Flats and surrounding areas house numerous informal settlements. (Endgame Media)

Community members are reliant on public standpipes for water. (Endgame Media)

The Cape Flats and surrounding areas house numerous informal settlements. (Endgame Media)

Despite living under stressful conditions, Cape Flats residents are often extremely resourceful, as seen with this food garden. (Endgame Media)

Steps towards self-sufficiency through the creation of a food garden (Endgame Media)

Developing the Cape Flats Aquifer as a water source for the City of Cape Town

The Cape Flats Aquifer (CFA) is a primary aquifer comprising layers of unconsolidated sand deposited by river, coastal and wind-driven processes. The CFA extends over 400 km2 between the Cape Peninsula and the eastern hinterland mountains bounded by False Bay in the south. (Figure 1).

A 2016 report on behalf of the South African Department of Water and Sanitation – the Cape Flats Aquifer Management Strategy (CFAMS) – provided recommendations to the CoCT to remediate the current state of the Cape Flats Aquifer; restore ecosystem functioning; maintain and expand small-scale community supply for non-potable gardening or urban-farming uses; and develop potentially potable bulk water supply through managed aquifer recharge.

The report also highlighted contamination of this aquifer in places and the urgent short-term need to identify and rectify the diffuse and point sources of contaminants. The potential short-term uses identified then included development of non-potable water for watering sports-fields, gardens, firefighting and local sanitation. Proposed medium- to long-term intervention involves the use of bioremediation and biomimicry principles to cleanse the surface water rivers and open bodies, implementing Managed Aquifer Recharge to prevent over-abstraction and restore balance. Using treated effluent from selected waste-water treatment works, the CFA could be developed as a storage sink for reclaimed water as well as a source to augment the CoCT supply.

Above ground, given the current and rapidly changing demographic complexity and built environment (Figure 3), the CFA involves a spectrum of water users regulated under local, provincial and national mandates. Integrating sustainable resource management (below and above ground) and equitable social development (above ground) underpins the direction of aquifer management of the CFA. Improved understanding of the aquifer itself (in terms of spatial extent; interaction with surface water; three-dimensional geometry; storage capacity; water quality) has been central to conceptualizing and designing Managed Aquifer Recharge and abstraction schemes, involving multiple sources of data covering a range of temporal and spatial scales (Figure 4). The development encompasses both short- and long-term strategies informed by two disaster risk reduction principles: No Regrets and Build Back Better.

SOURCES AND MORE INFORMATION:

https://www.imesa.org.za/wp-content/uploads/2015/11/Paper-16-Cape-flats-aquifer-and-false-bay-Opportunities-to-change-Rowena-Hay.pdf

FIGURE 1.
Historical map of the Cape Flats circa 1890, prior to construction of Steenbras Dam (started 1918), when the town was still wholly dependent on local Table Mountain stream and spring sources. As the linear dune symbols and "Drift sands" annotation shows, the greater part of the Cape Flats was an active dune-field, largely hostile to human settlement and difficult to cross by wagon transport. The superimposed black line indicates the extent of the Cape Flats Aquifer.

FIGURE 2.
Satellite image from 2016, covering same area as Figure 1, with Cape Flats Aquifer edge (black line) as common location reference. The present-day bulk supply pipelines (white lines) import water from reservoirs in the eastern hinterland mountains (white arrow). The sewage reticulation pipe network (yellow lines) demonstrates the street-level extent of formal urbanization. Water treatment works (light blue diamonds) ensure water quality of supplied water, whilst waste water treatment works (black pentagons) receive influxes from both sewerage and stormwater. Lakes and wetlands, both natural and artificial are indicated (blue areas), along with the main stream systems (blue lines).

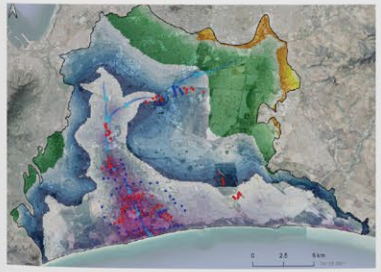

FIGURE 3.
Topographic map of area external to CFA edge (black line), merging with bedrock palaeo-topography (internal to CFA) and illustrating the shape of impermeable base of the CFA, which was shaped by pre-CFA river erosion around the main Rkhabkamma (Nyangamanzi) channel (blue arrows). Proposed groundwater abstraction wells (red dots) and managed aquifer recharge (MAR) wells (blue dots) are indicated, many within or marginal to the Philippi Horticultural Area (PHA, label and colour outline?).

Collaborative custodians of a shared resource

Society needs to move away from linear water use to a more circular, inclusive scenario providing more opportunities and flexibility. To achieve this, an adaptive management approach of Monitor, Model and Manage is required. This implies a 'learn by doing' approach: Iterative, collaborative, responsive, reflective, and incorporating holistic systems thinking. Above all, this approach requires a human layer that involves all participants, including the residential community, actively and continuously collaborating as custodians of this shared resource.

The Cape Flats Aquifer holds much promise for the future, despite significant challenges of water supply, flooding and pollution contributing to frequent and expensive public health and disaster management crises, further complicated by polarised communities. Regeneration of the CFA recharge zones and ecosystem services is an essential element of disaster risk reduction and improved assurance of water for the CoCT. The re-establishment of the natural water cycle, landscaping of healthy and safe public green spaces, and the generation of economic opportunities around ecosystem services will build community resilience and ensure social and water security.

Following the co-creation of the Snake Eagle Thinking Path in the small village of Matjiesfontein, an inaugural dawn walk further cemented community bonds and symbolically entrenched the contemplative path in the ecologically sensitive area. The path continues to raise environmental awareness and contributes to income for local people who are its custodians, via tourism. (Supplied Site_Specific Collective)

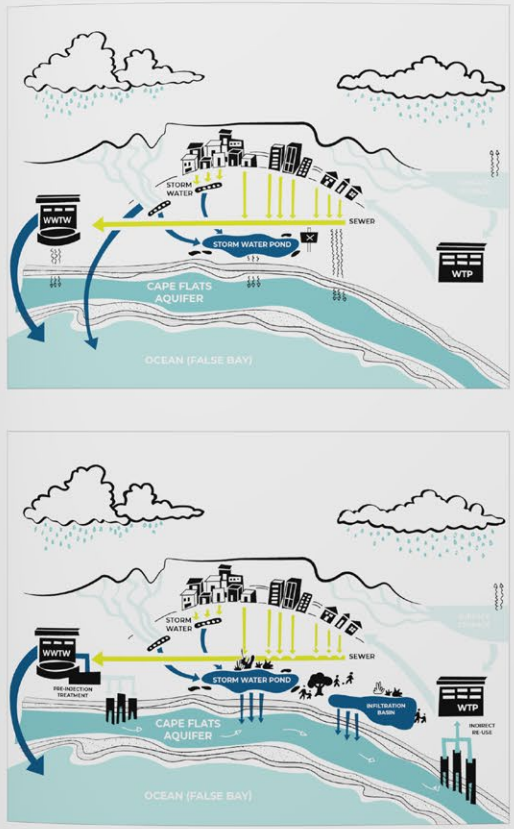

FIGURE 4.
Schematic of water flow through the CoCT. At the top is the current, linear use model where the bulk of the water moves from source, gets utilized once and then exits the system into the sea.

At the bottom is a conceptualization of a more circular water use where major portions of sourced water are redirected into the aquifer, reducing the amount reaching the sea after a single use.

Collaboration and Community Building through Transformative Arts

What is the vision for implementing CoCT's climate change adaptation and resilience strategy (and addressing water, food security and social challenges) on the Cape Flats sector of the Hoerikwaggo Critical Zone Observatory? Key elements are transformative art practice and water supply infrastructure platforms, encouraging collaborative community building, and citizen science networks.

Collaboration – even for a common goal and the common good – is difficult, especially in hierarchical and habitually competitive environments. However, collaboration is the mainstay of most creative arts processes, and Transformative Arts Practice has a long track record in South Africa, primarily dealing with individual and shared trauma and injustice.

'Transformative Arts' refers to the creative process by which practitioners engage participants in artistic activities to promote change in the lives of all who participate, as well as those who witness what is created. The activities facilitated encompass both expressive and contemplative practices, including story-telling, puppetry and poetry, dance, drama, music, painting and sculpting, nature and environmental art and photographic and video processes. Transformative Arts have played a significant role in providing a peaceful platform of protest and route to reconciliation in diverse conflict-ridden locations, including South Africa. Transformative Arts processes can release participants from the constraints of explanation and logic, revealing domains of possibility, imagery, metaphor and paradox, through which the deepest values and highest aspirations of humanity can be expressed.

On the Cape Flats our initial project concepts focus on land and environmental artworks, but any combination of these media can be used to deepen people's understanding of and commitment to the often-invisible water eco system that is vulnerable and impacted by human behaviour.

SOURCES AND MORE INFORMATION:

Drama for Life Arts Centre for Social Transformation and Healing
https://www.dramaforlife.co.za/

DETAIL OF CLOUD AND RAIN
Janet Ranson

Earth Science meets Transformative Arts

Umvoto has been collaborating with the Site Specific Land and Nature Art Collective to develop creative solutions to the complex scientific, social and administrative challenges linked to the precious aquifer water resources. The two have previously worked together on the Snake Eagle Thinking Path in the semi-desert Karoo – creating a meditative geoglyph in honour of a breeding pair of Snake-Eagles resident in the area. The geoglyph highlighted the beauty and fragility of the environment and its creation and maintenance was underpinned by strong community engagement. The launch highlighted local talent and created opportunities for under-resourced rural residents to earn incomes.

Under the leadership of Umvoto founder Rowena Hay and land and nature artist Anni Snyman, participants in the Cape Flats projects will partner with established non-profit organisations and civil society groups wherever possible. Diverse projects are envisaged for this natural science laboratory. These would not only attract the Cape Flats community to the aquifer but could educate and involve many more diverse stakeholders in caring for precious natural resources.

SOURCES AND MORE INFORMATION:
http://sitespecific.org.za/about/

SNAKE EAGLE THINKING PATH:
https://www.youtube.com/watch?v=nntSR5wtvM

AERIAL VIEW OF THE SNAKE EAGLE THINKING PATH.
Gustav Ludick

SECTION OF THE MEDITATIVE SNAKE EAGLE THINKING
Judy Bryant

'ANGEL' WORK BY LAND ARTIST
Strijdom van der Merwe, of the Site_Specific collective

Cape Flats Aquifer: Collaborative Zones

Umvoto Africa and Site_Specific have identified six Collaborative Zones on the location of the CFA. Here trusted and experienced arts and community facilitators will lead groups into creative processes that will build community spirit and provide safe platforms for collaboration. The first six Collaborative Zones that are envisaged (Figure 5), are based on areas of the CFA watershed that are crucial for the rehabilitation, protection, and development of this water source. Within these Collaborative Zones, multidisciplinary teams we call Intensive Collaborative Units (ICUs) will work together on projects focused on the water flowing through and under those areas.

The Collaborative Zones will provide the framework, platform, technology, and Transformative Art facilitators for any number of people and disciplines to collaborate, as well as coordinating ICUs across the CFA. ICUs will collaborate with local organisations, schools and community groups around environmental and nature art works, creative interventions and festivals, and any other processes that will ultimately benefit the CFA.

The delineation process initially focused on areas where the lightest surface infrastructure and human interaction overlap the deepest and most productive parts of the CFA. Open spaces used for agriculture or surface water systems and wetlands which overlay the trace of the aquifer inform the hard delineation of Collaborative Zones.

Secondly, it was necessary to consider the dominant processes on the land surface and their impact on the aquifer, the nature of the surface water and ecosystems, potential well field development and aquifer contamination. Underlying all the decisions is the imperative to upgrade water pathways, especially where sustainable management of the volumes in storage in the aquifer is supported and dependent on water-sensitive urban design strategies. For example, injection of treated water to potable standards (Managed Aquifer Recharge), inhibition of saline intrusion and management of storm water.

Intensive Collaborative Units: Engagement across disciplines and roles

Within each of the Collaborative Zones (CZ) priority areas are identified for intervention based on the environmental, human and water-related imperatives. The conversations and interventions to support social and economic improvements and behaviours that will realise a water-sensitive city are embarked on within the project imperative of implementing wellfield development and adapting existing surface water and storm water infrastructure using water-sensitive urban design (WSUD) principles.

Interventions can include art installations, literary programmes, theatre and music programmes, job creation programmes, education outreach with citizen science programmes started in schools, regarding the role of water and implementation of the CoCT vision for a Water Sensitive City by 2040. We see the process of realizing the final design and different stages of implementation within a Collaborative Zone as a series of Intensive Collaborative Units (ICU), each step involving different skills and persons, but at all stages involving the land owner, local community, various organisations within these communities, institutions with mandates in these communities and professionals associated with water-related infrastructure, the built environment, environmentalists, the humanities and the arts.

For example, Collaborative Zone 3 (Figure 5) is an area where sand mine rehabilitation will be required by law in due course. Zooming in, the team sees the opportunity to create a large land art work – the 'Face of the Aquifer' – that will be visible from the air. It will be achieved through the remediation of the open water bodies (dark areas) (Figure 5A), to demonstrate use of phytoremediation and other approaches to improve the water quality through creation of wetlands and, using the sand piles, to craft a three-dimensional Face of the Aquifer (see Figure 6B). This graphic makes visible the cooperation between the scientists working on the Cape Flats Aquifer Development project, the work of geoinformatic specialists and land artists.

We know the process of co-creating or installing an artwork to be community-building. It will combine knowledge exchange and skills transfer and connect one element within the CZ to other elements within the CZ and in due course one CZ to another. Such an art work is what we call an Intensive Care Unit (ICU) within one or more ward areas of the CoCT. It is envisaged that shaping the wetland basin is an integral visual component of building the Face of the Aquifer and these shapes are designed and built by the ICU with the community. It is possible that the water quality remediation processes would be another ICU.

Other design possibilities may emerge when engaging with mine owners and the communities of surrounding areas. Engaging with the relevant local provincial and national government departments and a broader team of technical specialists will inform and influence the final design, constrained by regulatory permissions required and resolving the practical details of implementation. A range of technologies, knowledge bases, facilitation and conflict resolution and local building skills can be incorporated.

The process, as we have experienced it, is transformational. Seeing the same space, understanding the same processes – biotic and water ecosystems, social and economic systems, land and social processes through the eyes and insight provided by other disciplines and practitioners for the common purpose of co-creating an art work that will be visible from the sky – transforms the space on the ground. It influences perceptions among the participants and impacts the time horizon for all involved in decision-making, from household to institutional level.

Therein lies the one element of change – our own role and contribution are informed by insights and we become a community through implementing common purpose.

FIGURE 6.
Eventual mine closure and rehabilitation, and water remediation, could be managed to create a 'Face of the Aquifer'.

Consol Glass sand mine (CGM) with potential CFA wellfield sites (red dots) to west of M7 motorway and Edith Stephens Nature Reserve south-east of CGM site.

Proposed future rehabilitation of CGM site to artificial wetland / lake system in land-art form representing the 'Face of the Aquifer'.

Creative answers to security challenges

The borehole sites in the Cape Flats are vandalised so regularly that cages are being erected around them - creating a negative and ugly impression. This is an excellent opportunity, however, for art to build on scientific implementation. The concept is to create cage sculptures that will become symbolic guardians of the aquifer. The launch of each guardian could be incorporated into the host community through a festival, with food grown in the Philippi area prepared by great local chefs. Educators, learners, musicians and performers could come together to show off local talent at the festival.

Security cages over boreholes and control equipment could support symbolic guardians of the aquifer. They could also be linked to popular cage fighting, a form of mixed martial arts which takes place in a cage or similar enclosed arena.

Drag racing – a race between two cars over a short distance, to test acceleration – is also extremely popular in the Cape Flats community. However, there are not enough facilities for racers to show off the power of their vehicles, so illegal racing on the flat, straight N1 highway has led to horrific crashes. Conventional drag racing takes place over a 400m stretch, although drivers are now asking for a 800m straight for more powerful cars. Legal drag racing facilities in the Cape CFA area could bring the community together while improving safety.

WASHING CRESCENT.
The Lotus Canal is a crucial part of the recharge system of the Cape Flats Aquifer. It is extremely polluted with plastic and human waste, making it a health and safety hazard, but it has considerable potential as a communal washing and relaxation area.
Iris Seyman

SECURITY FENCE.
Security fence could be transformed with artistic interventions. Proposal by land artist Strijdom van der Merwe for Paul Roos school, using small knotted fabric pieces to suggest a pixelated image on a security fence.
Strijdom van der Merwe

VISUALISATION OF ONE OF GORDON FROUD'S POLYHEDRON FORMS ALONG BADEN POWELL DRIVE
Gordon Froud