

Township infrastructural development must take sustainability and eco-efficiency into consideration.

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Eco-efficient township infrastructure

IN VIEW OF the inadequacy of tools to assess the environmental impacts of infrastructure design decisions, the aims of this paper are as follows:

- to emphasise the influence of climate on sustainability and the changing role of engineers
- to highlight the need for environmentally friendly, ecologically sensitive, innovative design, at the design stage of township infrastructure projects
- to establish sustainability criteria on civil engineering projects
- to define green infrastructure solutions among engineers by establishing a common language and standard of measurement
- to raise awareness of green engineering benefits and the environmental impact of consultants' design decision, in order to reduce the environmental impact of development
- to introduce environmentally conscious design decisions at inception stage, where they are influenced the most.

The changing role of engineers

Climate change is introducing many uncertainties into the management and planning of township infrastructure projects. In the area of sustainability, there is an urgent need to apply technologies and methods that deliver better and more sustainable performance in a way that is cost-effective.

With the potential for disasters increasing dramatically, engineers are expected to highlight the potential events, assist in the development of mitigation initiatives, and ensure appropriate design and construction. Measures adopted will have to explore shifts in paradigms to find innovative solutions that allow man to work with nature rather than against it.

Engineers will have to be at the forefront of developments, finding ways to maximise water capture, ensuring conservation of the resource from supply through to distribution, and the issues of innovation, technology and design.

TABLE 1 The Eco-efficient Infrastructure Performance Criteria

| Criteria | Measure |
|-------------------------------------|---|
| 1. Efficient layout planning | Placement of infrastructure in environmentally responsible, efficient ways, conserve land |
| 2. Resources | Encourages the efficient utilisation of materials/resources, selection of environmentally friendly materials |
| 3. Environmental quality | Design features that mitigate environmental impacts of infrastructure, by reducing effects of pollutants |
| 4. Functional efficiency | Design of infrastructure that maximises functional efficiency of infrastructure |
| 5. Future maintenance | Maximises the opportunities for integrating capital and operation of infrastructure, ensuring reliability of level of service |
| 6. Economy | Maximises the opportunities for integrated, cost-effective adoption of green infrastructure options |
| 7. Safety | Minimises the environmental impact of infrastructure by incorporating safety into the design |
| 8. Social | Ensuring social sustainability of infrastructure, promoting convenience, social resources and public participation |

It has been established that municipalities are not delivering infrastructure service in a sustainable manner. Most of the challenges are due to planning, implementation and monitoring systems failure. Further assessments revealed that municipalities do not comply with basic principles for sustainable service delivery.

Engineers urgently need to find innovative solutions that meet the required social and planning objectives while being energy efficient, sustainable, of high value in terms of quality and efficiency, and remaining cost-effective.

The lack of appropriate tools and skills for sustainable design was often quoted as a barrier to sustainable design.

Green technology

As the custodians of existing infrastructure and the developers of future infrastructure, consulting engineers recognise a responsibility to innovate and improve the products of their efforts and to understand the importance of instituting a dialogue with the rest of society on these subjects. Relatively few designers have, as yet, explored the transformative potential

of ecological design and have preferred to remain apolitical and unconcerned with the distributional impacts of design as they affect humans and ecosystems.

Infrastructure elements such as roads and water, sewerage and stormwater systems can result in the loss of critical ecosystems and biodiversity. There is a need to create an eco-sensitive infrastructure design that encourages and promotes the use of "softer" design solutions.

By utilising improved, environmentally friendlier design methods, this study aims to introduce environmentally friendly design decisions prior to the infrastructure design approval process. This increases overall competitiveness by bringing a whole new class of productive solutions to problems while adding a fresh perspective to the traditional infrastructure design process.

Declining influence of environmental interventions

It is essential that the environmental issues be integrated into achieving the most appropriate solutions. A sustainable project is managed



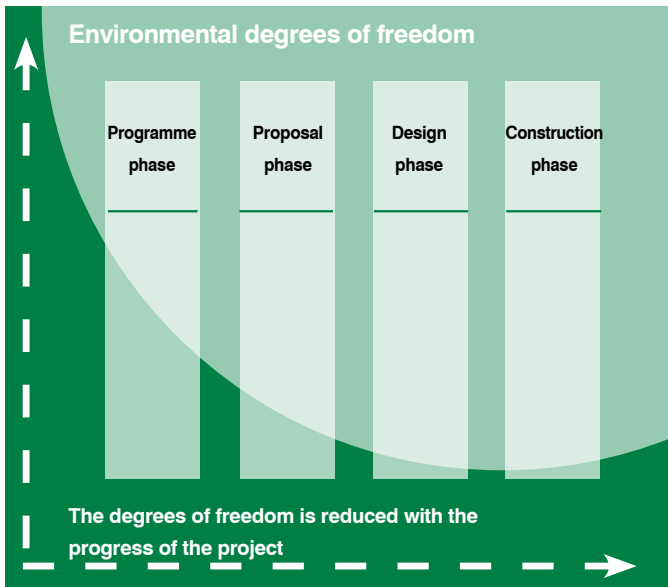


FIGURE 1 The declining influence of environmental interventions on a project

by taking control of the client's decision-making processes as early as possible, to provide the certainty of decision-making. This should be done by totally involving clients in the decision-making process. Diligent attention to greener infrastructure solutions from the very earliest phases of a project will help guarantee that quality design environmental solutions are "built-in" from the beginning. It is important to implement the environmental management from the early stages of the process, since the freedom to make decisions of importance for the environment decreases with the progress of the project.

Eco-efficient criteria

Criteria on infrastructure projects are tools that can be used in the conceptualisation, implementation and monitoring of progress in sustainable township infrastructure projects. The criteria define the essential components of the proposed green infrastructure toolkit, against which sustainability may be assessed. Through the measurement and monitoring of these indicators, the overall effects of the proposed green infrastructure toolkit can be assessed and evaluated, and action can be adjusted to meet stated aims and objectives more effectively.

Each criterion relates to a key element of sustainability. Collectively, the criteria provide an implicit definition for the concept of eco-efficient infrastructure solutions.

The client's vision, goals and objectives for eco-efficiency on a project can be translated into a core set of project criteria. While project goals set the direction, the project eco-efficiency categories provide the means to measure a project. They enable clients, engineers and stakeholders to gauge progress towards sustainable development by comparing the performance achieved on a project with the intended performance. Table 1 proposes eco-efficient infrastructure criteria. These were developed to:

- determine the means by which eco-environmental efficiency can be assessed, monitored, quantified and verified at any stage of the project, to ensure a value-added, quality-driven, green approach to infrastructure design
- provide a basis for the consultants and clients to work together on creating and evaluating sustainable infrastructure solutions, thereby ensuring comprehensive infrastructure planning with maximum stakeholder involvement
- achieve the required balance of sustainability, expenditure, value for money and quality, between the various elements of the project.

Greener design solutions

Engineers must be prepared not only to react to changes in climate and resource availability, but also to help manage that change through sustainable engineering solutions.

Civil infrastructure has various opportunities to undertake innovative, efficient and sustainable design instead of conventional design, but this rarely happens in practice. Incorporating this perspective into civil engineering infrastructure design, planning and building stages can have significant effects on the outcome.

Innovative approaches to planning and design can greatly mitigate the negative impacts of infrastructure services on the environment. Various green technology concepts were researched and modified to suit township infrastructure projects, with the aim of reducing the impacts of civil engineering infrastructure on residential developments.

Green technology that can be used on infrastructure projects may include the utilisation of natural or engineered systems that mimic natural landscapes, in order to capture, cleanse and reduce stormwater run-off. Greener stormwater infrastructure solutions can include rain gardens, rain barrels, green roofs, wetlands and permeable pavements.

Roads present many opportunities for green infrastructure applications that incorporate a wide variety of design elements, including street trees, permeable pavements, bioretention and swales. Greener water infrastructure opportunities include a reticulated recycled water supply, water-efficient fittings and intermediate storage.

Advantages of eco approach to infrastructure design

Green township infrastructure technologies will contribute to greenways and green corridors, and provide linkages between habitats, and wetlands. Green technologies have a number of environmental, economic and community benefits, including:

- conservation of natural resources
- reduces the ecological footprints of roads, sewer, stormwater and water, allowing ecosystems to function more naturally
- uses energy-efficiency systems and materials
- minimises impervious surfaces, reducing soil erosion
- enhances and protects ecosystems and biodiversity
- conserves and reuses water and treats stormwater run-off on-site
- recharged groundwater flow for streams, conserving water supplies.

Conclusions

By using this green approach, the sustainable design of township infrastructure services can be achieved by enforcing the consideration of resources, environmental impacts of design decisions, ecological sensitivity, innovation, maintenance and materials at the design stage of a project.

This paper highlights the numerous opportunities for improving eco-efficiency in infrastructure design. A new paradigm for infrastructure design is required to maintain environmental sustainability and mitigate flooding or drought.

Engineers need to look at greener technologies rather than just using traditional engineering solutions. Green techniques provide adaptation benefits for a wide array of circumstances, by conserving and reusing water, promoting groundwater recharge, and reducing surface water discharges that could reduce flooding.

Taking a greener approach to infrastructure development not only mitigates the potential environmental impacts of development, but makes economic sense as well. By softening the environmental footprint, avoiding waste and finding efficiencies, clients and local governments can increase their long-term sustainability. **35**

** For a full list of references, please contact liesl@3smedia.co.za.*