Annex A

Awarded Projects under L2 NIC Second Call for Proposals

S/N	Title	Principal Investigator (PI), Co-PIs and Collaborators
1.	Cool Singapore	PI: Asst Prof Wan Man Pun/ NTU Co-PIs: A*STAR ICES, NIPSEA Technologies Collaborators: NTU, BCA, HDB
2.	Technology for cement-treatment of ground in areas obstructed by obstacles	PI: Assoc Prof Lee Fook Hou / NUS Co-PI and Collaborator: LTA
3.	Hybrid reflective, catalytic and pyroelectric nanocomposite for holistic solar heat gain, air quality and energy sustainability solution	PI: Assoc Prof Ho Ghim Wei/ NUS Co-PI: NUS Collaborators: BCA, iGAP Pte Ltd, Exxel Technology Pte Ltd
4.	Web-based 3D GeoData Modelling and Management System (GeM2S)	PI: Prof Chu Jian / NTU Co-PI: BCA Collaborators: LTA, URA, University of Hong Kong, British Geological Survey
5.	Augmenting Urban Soundscapes: Design Tools, Noise Mitigation System, and Evaluation of the Urban Sound Environment – Phase 1	PI: Assoc Prof Gan Woon Seng / NTU Co-PI: HDB Collaborators: NTU, BCA, HDB, University of Southampton, University of Sheffield, New York University

1. Cool Singapore

Urban fabric materials in buildings, pavements and other impervious surfaces absorb heat due to solar irradiation. These heated urban fabric materials subsequently heat up the surrounding air causing the urban heat island (UHI) effect phenomenon. UHI effect is found to adversely affect comfort and well-being of people in urban areas. This heating effect is often exacerbated by insufficient natural cooling mechanisms (e.g., wind ventilation, vegetation, water bodies, etc.) in urban areas due to highly dense urban developments. As a major metropolis in the tropical region subjected to year-round hot and humid climate, an effective solution to the UHI effect plays an important role to Singapore's continuous urbanisation, sustainability, comfort and well-being as well as energy efficiency.

This project aims to develop a mitigation solution for UHI effect based on the Cool Surface technology. Cool Surfaces are materials that reduce the solar radiation absorption when they are applied on urban surfaces, leading to reduction of urban ambient temperature. A comprehensive modelling and field measurement study will be conducted to formulate the strategy for Cool Surface deployment in Singapore and to provide the scientific foundation for such a strategy. A suite of high-performance Cool Surface materials featuring high solar reflectance, high durability and self-cleaning properties will also be developed to cater for the needs of deployment on different urban surfaces. Real-world performances of the new Cool Surface materials will be examined through field test beddings.

2. Technology for cement-treatment of ground in areas obstructed by obstacles

In many large cities, usable space is a premium resource and underground development is often more a matter of necessity rather than choice. Singapore, for instance, has already embarked on underground development in a big way. However, in Singapore and many other large cities, such as Jakarta, Bangkok and Shanghai, soft clayey soil is commonly encountered. In such cases, underground construction often cannot proceed unless the soil is appropriately hardened. A common method is to mix cement into the soft soil to harden it. Current technology does not permit locations which underlie existing infrastructure, utilities, services or obstacles to be improved in a safe and cost-effective manner; this is becoming an increasingly common occurrence as the underground becomes more congested.

The objective of this project is to develop an equipment which will allow cement treatment to be conducted around corners and obstacles, based on a concept developed in a current NRF-funded project. The heart of this development is a computer-controlled mechanism which will allow the shaft of the mixing equipment to bend and thereby skirt around the obstacles in question, while simultaneously rotating and delivering cement into the ground. Preliminary trials to date have indicated that the concept is viable in-principle. The aim of this project is to produce a working prototype of such an equipment. The project will cover the hardware, software, monitoring and quality control aspects of the new technology. If successful, this development will potentially enable cement-treatment to be used in areas currently inaccessible. This enables previously obstructed and inaccessible regions

of the ground to be treated by cement. This technology is likely to find application not just in Singapore but also in other congested large cities with areas underlain by soft soils.

3. Hybrid reflective, catalytic and pyroelectric nanocomposite for holistic solar heat gain, air quality and energy sustainability solution

The urban heat island (UHI) effect in built-up populated areas has adversely increased the annual mean air temperature by a few degrees Celsius. One of the major factors that contribute to the UHI effect in Singapore is the geometric effect of tall and densely-packed buildings. These buildings unfavorably provide multiple surfaces for sunlight absorption and reflection. Other implication includes blocking of wind that leads to reduced convection cooling and air pollutants dissipation. Elevated ambient temperature can affect the community's environment and quality of life, resulting in 1) *Increased energy consumption*: Higher ambient temperature increases energy demand for cooling especially during peak periods. 2) *Increased air pollutant and greenhouse gases emission*: Increased energy demand consequently results in higher air pollutant and greenhouse gas emission. 3) *Compromised human* well-being: Warmer ambient along with higher air pollution levels can lead to general discomfort and other heat/pollution related sickness.

In view of the UHI effect, this proposal aims to develop hybrid nanocomposite for integrated cooling and waste heat-to-energy conversion technology. The nanocomposite consists of heat reflective nanostructures and polymer composites that capture and utilize reflected heat for electricity generation. Additionally, the nanocomposite also functions as photocatalytic material capable of degrading volatile organic compound pollutants for improved indoor air quality.

The proposed technology offers multiple benefits, including improved human health and comfort, reduced energy usage, and lower greenhouse gas emissions. In this project, NUS will be working in close collaboration with the Building and Construction Authority (BCA) to develop an integrated functional material that seamlessly coordinates building efficiency and performance for sustainable urban solutions.

4. Web-based 3D GeoData Modelling and Management System (GeM2S)

The main objective of this project is to establish a Web-based three-dimensional (3D) Geological and Geotechnical Data Modelling and Management System (GeM2S) to reduce construction cost and increase productivity for future underground construction projects in Singapore. A huge amount of geological and geotechnical data has been collected in the past. This project is to develop a system to use these data for future underground construction. A 3D model and database for both geological and geotechnical data will be established using the existing borehole data as well as validated in-situ and laboratory data. This model can be updated with new geological and geotechnical data available in the future.

By using this system, virtual borehole and cross-section can be created online as part of the BCA’s Geoscience Information Sharing Portal; the geological conditions

at a site can be evaluated together with the geological or geotechnical model established. In this way, the uncertainties involved in the design parameters can be reduced, the design can thus be reliable without being too conservative. A method will also be provided to allow the data to be transferred to a platform compatible with Building Information Modelling, so that the data can be easily used for construction projects. This will help further in reducing construction cost and increasing productivity. The proposed 3D GeM2S system will be used by both government agencies and industries for either underground space planning or infrastructure developments such as for construction of buildings, roads, MRTs, or underground caverns.

5. Augmenting Urban Soundscapes (AUS) : Design Tools, Noise Mitigation System, and Evaluation of the Urban Sound Environment

The key objective of this project is to develop a demonstrator of a software system for simulation and creation of the sound environment that allows designer to generate sound objects (of noise sources and natural sound sources), which can be placed in a 3D space.

Soundscape is a new concept that explores and evaluates sound/noise in the environment in a holistic manner. The proposed soundscape approach utilises active noise mitigation techniques that maintain natural ventilation in residential areas. Ambient noise reduction can be achieved based on psychoacoustic masking approaches that are perceptually more soothing and relaxing to the residents, and also trigger positive physiological responses.

User can perceive the soundscape through a pair of augmented reality (AR) headsets to listen and see how different sound objects will interact with each other, and preference of the sound attributes can be evaluated by human subjects. Arising from these findings, we can develop soundscape masking techniques to improve the aural comfort of residents in public areas.