# Redevelopment of Singapore's Heritage Sites for A New Generation of Sustainable Industrial Parks

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## 1. Addressing Singapore's Land Scarcity amidst Dynamic Economic Growth (1965-Present)

Despite having limited natural resources, Singapore has managed to stay competitive in a fast changing environment largely through planning strategies that respond rapidly to the needs of the global economy. As a former colonial trading port, Singapore's economy was heavily reliant on international trade which necessitated her operating as a free port and free market[1]. As part of economic progress and the need to attract foreign investment to create more jobs, Singapore's industrialization diversified into 5 key sectors consisting of regional entreport trade; export-oriented manufacturing; petroleum refining and shipping; production of goods and services for the domestic economy; and the provision of specialized services for the international market, such as banking and finance, telecommunications and tourism. Within a span of 50 years since her independence in 1965, the city state's economy has drastically transformed from being labour-intensive to capital/technology-intensive and now to a knowledge/innovation-intensive economic structure which has contributed to the increase in GDP per capita from US$428 (1960) to US$50,123 (2011)[2] in only 50 years.

With the limited land supply in Singapore, this rapid industrial evolution has transformed Singapore's landscape tremendously, with an example being the changing of the coastal profile to create additional land to support the growth. Singapore's land mass has increased 25% from its original 58,150 ha and its population has grown from 1.89 million in 1965 to 5.1 million in 2012[3]. Being an island state, there is a limit to how much more land Singapore can reclaim from the sea. Alternative land creation methods such as going underground, potentially building airspace developments and recycling brownfield sites are being actively explored to increase the land supply in Singapore.

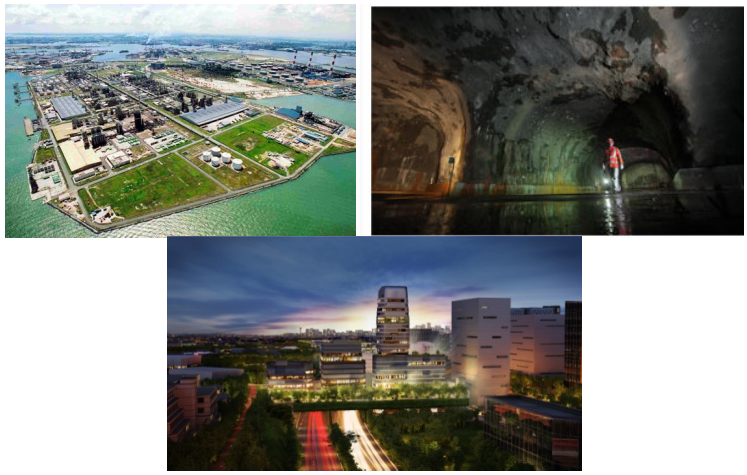

*Figure 1: (Left[4]) Jurong Island Chemical and Energy Hub was reclaimed from 7 islands. (Middle) Jurong Rock Cavern is an innovative solution to create more industrial space to store oil underground at Jurong Island. (Right) The conceptual air-right development decking over Ayer Rajah Expressway will create more land and synergize one-north's mixed-use development with Science Park which has been separated by the expressway.*
*Source: JTC Corporation*

With land scarcity as the key driver to achieve highly efficient land use, industrial developments have evolved and transformed over the years from sprawling low-rise development to highly intensified land use. However, we must not forget that new industrial products must still be able to support the needs of industries and must make economic sense to companies. In the 1960s, besides allocating land parcels for companies to build their own factories, Singapore also provided high-rise factory space for light industries and single-storey standard factories for general industries. Over the years, realizing that land is a very scarce resource, Singapore has stacked up most of its standard factories into 3-4 levels with a ramp to access to each factory unit. However, with many high-tech industries still requiring land-based factories in view of vibration concerns and use of very heavy equipment, there is a limit to how much we can push industries to go high-rise. Besides exploring underground space and air space to meet our future growth, there is also an increasing pressure to recycle old sites not only as part of urban redevelopment but also to serve as an alternate source of land supply to support new economic activities.

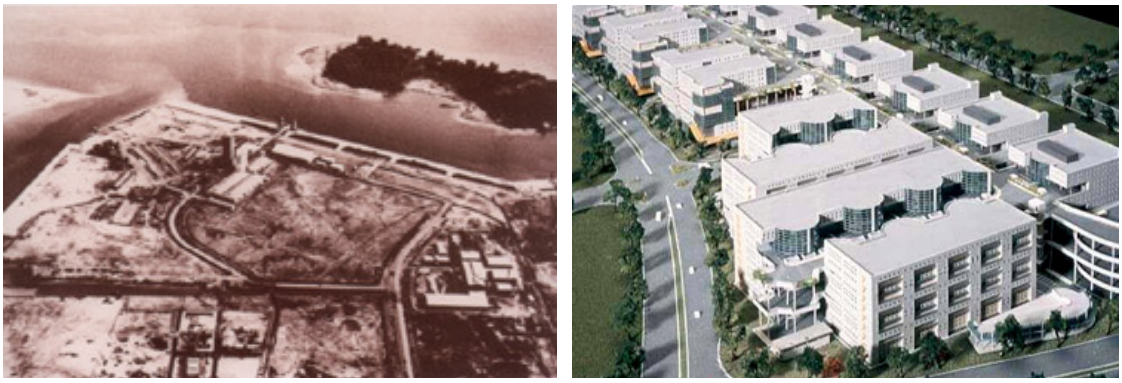

*Figure 2 :(Left) Singapore's Jurong industrial area in the 1960s and 1970s. (Right) An innovative idea of medium-rise ramp-up factories has been developed since the 1990s.*
*Source: JTC Corporation*

There are typically two sources of brown-field sites that are available for development. One source is existing industrial sites and the second source comes from the phasing out of land parcels that have housed various utilities such as sewage treatment plants or decommissioned military camps. For old industrial sites, the typical approach will be to activate an en-bloc redevelopment of the area which entails buying back outstanding leases from companies. For the second source of land supply, the national planning agency will designate such sites for redevelopment. One good example is the Seletar Aerospace Park (SAP).

The history of SAP begins with the Seletar Airport initially being built as a World War II Royal Air Force airbase (RAF) during colonial British rule. After the British withdrawal from Singapore, Seletar Airport became a civilian airport mainly serving flying schools and private charter companies[5]. In line with the Economic Development Board's (EDB) strategy to reinforce Singapore as the leading aerospace hub in Asia, the city-state came up with a new model of integrating an aerospace park with the airport. In 2006, JTC Corporation (JTC), a statutory board under the Ministry of Trade and Industry, was appointed the master planner and master developer to transform the 320 hectare of heritage brown-field land into the a new aerospace park which included the Seletar Airport.

*Figure 3: An aerial view of Seletar Airport, Singapore, with Royal Air Force Mosquito and Dakota aircraft parked in 1945[6].*
*Source: JTC Corporation*

## 2. Balancing Environmental Sustainability with Economic Growth

SAP's master planner, JTC Corporation, was given the challenge of conserving the heritage site and preserving the lush greenery landscape while efficiently creating ready-built infrastructure catering to the fast growing aerospace industry cluster.

### *2.1 Conservation of Historical Architecture*

In order to optimize valuable direct access to runways and taxiways, SAP is planned with two zones, runway access and non-runway access, in relation to their proximity to the airport runway. The runway access zone provides services for uses such as Maintenance, Repair and Overhaul (MRO), Fixed Based Operations (FBO) companies. Non-runway access companies such as manufacturers of engines, avionics components and maintenance of aircraft parts that are supporting runway access companies are located adjacent to them. Due to the operational requirements, the airport infrastructure is dominated by vast areas of asphalt and concrete runways and airport supporting facilities. For that reason, innovative and sensitive planning approaches have been carefully thought through to reduce the negative effects of the harsh environment on the site's natural heritage and ecological character.

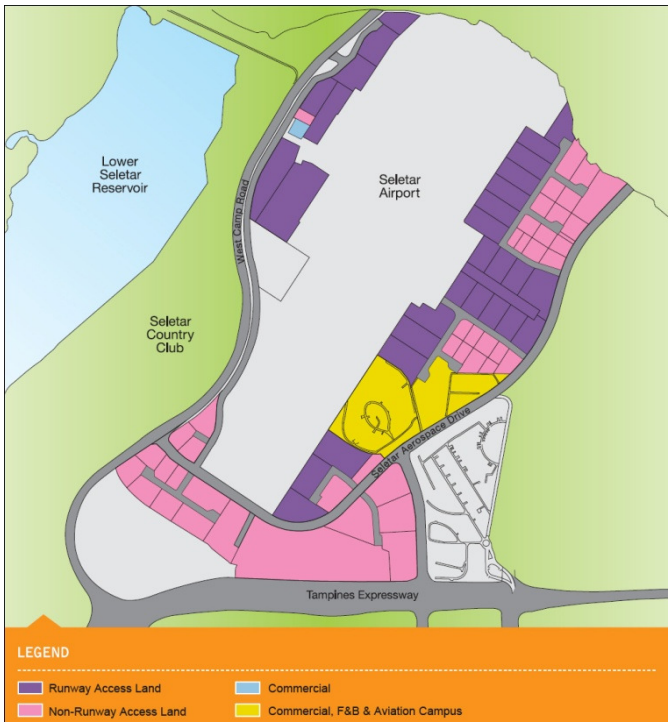


*Figure 4: SAP land use*
*Source: JTC Corporation*

Existing colonial buildings are a rare commodity in Singapore's architectural heritage. Based on typology and adaptive re-use studies with the Urban Redevelopment Authority (URA), clusters of colonial buildings were identified for conservation whilst taking into consideration the needs of sufficient land for future aerospace tenants.

Sensitive renovation work has also been implemented to fully conserve the historical buildings. JTC has taken every effort to ensure that irreplaceable heritage elements are carefully preserved and integrated. For instance, of the 378 black-and-white bungalows, 204 will be retained for various mixed-uses.

*Figure 5: (Left) Original lamp post is retained and (Right) Seletar Camp Guard House is kept as entry point for the estate*[7]
*Source: JTC Corporation*

In addition, infill developments have been planned to integrate with the existing conserved units to create a commercial, F&B and aviation institutional campus as a vibrant sub-cluster to industrial spaces. Urban design guidelines have been set out for infill developments to

harmonize with the existing colonial buildings' characteristics through various methods of control such as restrictions to changes in building heights, massing, setback, view corridors and etc. Figure 7 below shows an intimate black and white bungalow cluster in SAP being sensitively re-adapted to serve as a new social node.

*Figure 6: (above) Treatment of colonial buildings before (below) and after with infill.*
*Source: JTC Corporation*

*Figure 7: Artist's impression - Integrating the aerospace industry activities with existing landscaping and conserved bungalows.*
*Source: JTC Corporation*

### *2.1 Preservations of Natural Ambience*

The main priority for the preservation of greenery in SAP is to retain heritage landscape settings and create a similar rustic ambience for the new aerospace developments.

With help from National Parks Board, trees in the entire SAP were classified into Good-To-Keep, Should-Keep, Must-Keep and Heritage Trees categories based on the assessment of their species uniqueness. The road alignments, streetscape and land parcels are also carefully planned to include preserved trees within the roadside planting strips and many land parcels are also demarcated to avoid affecting the kept greenery.

*Figure 8: One of the preserved heritage trees and conserved colonial black and white units. Source: JTC Corporation*

To maintain the characteristics of rustic greenery inspired by the British 19th century picturesque landscape, JTC proposed similar concepts to the new streetscape throughout the estate. Various landscape typologies have been identified such as the woodlands area, rustic streetscape area, standard road area, grassland area, biodiversity mix area, coastal area, ornamental area and transitional area so that proper planting and landscape guidelines in later phases can be echoed with the original planting patterns.

*Figure 9: Due to the close proximity to the sea, the naturalistic planting selected were spaced randomly with coastal/seaside species of a range of varying heights and forms. Source: JTC Corporation*

*Figure 10: Species at bus stop locations were selected for flower / foliage colour and texture to create visual interest. Source: JTC Corporation*

In addition, other streetscape planting strategies were also implemented to enhance pedestrian-friendly experiences, a factor which is key to the new identity for SAP. Trees were introduced to the estate not only to provide shade against the tropical heat and glare but also to help alleviate the urban heat island effect and to remove excess carbon and air pollutants. For instance, large canopy trees will be planted along footpaths to provide shading while columnar trees will allow pedestrians to view the aeroplanes taking off at the end of the

runway. Non-standard road sections were also experimented with to allow wider planting strips along footpaths. Last but not least, openings within the tree planting layout were also intentionally created to frame view corridors to the airport, the reservoir, the golf course and other industrial parcels.

JTC's landscape design guidelines for individual parcels also takes care of the provision of planting within green buffers and planting strips through a formula devised to inform the tenants on the number and species of trees to be planted, depending on whether planting area is along pedestrian footpaths, west facing boundary edges or other areas.

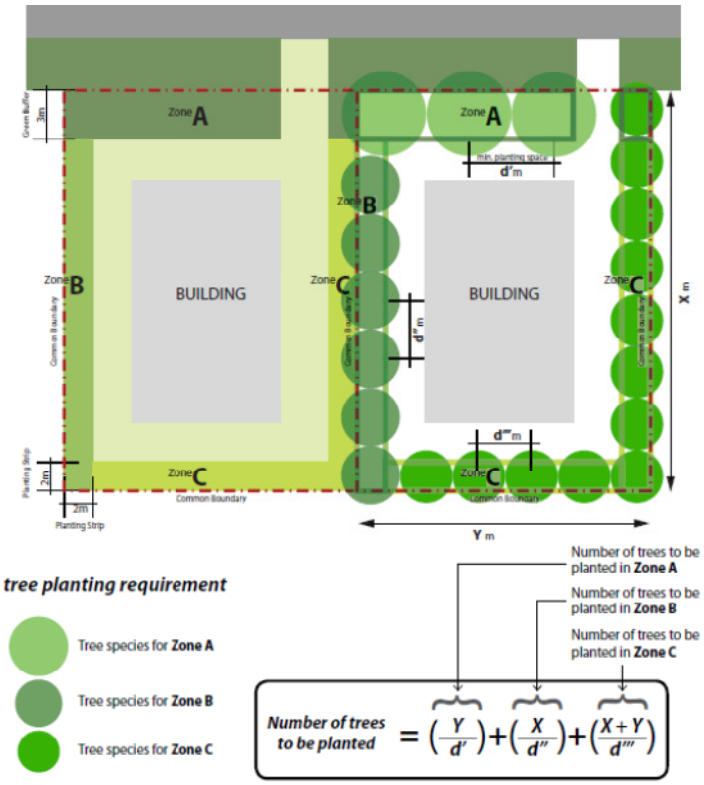


*Figure 11: The formula shows the total number of trees required within the individual development determined by the minimum tree planting spacing and the total length of perimeter of the planting zones.*
*Source: JTC Corporation*

### *2.2 People-oriented Urban Design*

The planning and design have also focused on addressing users' needs and comforts. Covered walkways have been provided throughout the estate, from the buildings to the nearest amenities and bus stops. That provides comfort and walkability for pedestrians under the tropical weather. With a pedestrian-friendly focus, bus stops are located within 400m, 5-minute walking distances to workplaces and strategically placed close to amenity nodes.

With a passive design approach, the roofs of covered walkways have taken the form of the wings of an aircraft which can be tilted for optimum shading depending on sun orientation. Similar to the covered walkways, the bus shelters were also designed to take on an aerodynamic form inspired by the Super Marine Spitfire aircrafts, a short range high performance interceptor aircraft that was based in RAF Seletar airbase..The dynamic architectural forms contribute to the overall architectural language of the aerospace park.

*Figure 12: (Left) Sheltered walkway referencing aircraft wing ailerons (Right).*
*Source: JTC Corporation*

*Figure 13: (Left) Bus stop sculpted as the wing of a Spitfire aircraft [8] (Right).*
*Source: JTC Corporation*

## 3. High Value-add Aerospace Industries in an Integrated Eco-system

After Singapore's independence, the government targeted the Aerospace Industry as one of the high-growth pillars in which a multi-pronged approach was adopted. The target has been to build up the full value chain clusters in MRO, FBO and pilot training. As a result, thousands of good jobs have been created for professionals and skilled workers. Over the past decades, the industry enjoyed such a rapid expansion that made Singapore the biggest MRO hub in Asia with a total contribution of US $4.8 billion (2008) to the Asian aerospace industry[9].

Indeed, SAP has anchored Singapore's aerospace sector as one of the fastest growing industries in the region. To stay sustainable, SAP is a model business eco-system covering large-scale high value-add activities of MRO, FBO, Pilot and Mechanics Training, Design-Manufacturing, R&D facilities and Business Aviation/General Aviation services. For instance, the Queen Bees of aerospace industries were enticed to set up their facilities such as Rolls-Royce Trent Engine Plant, Pratt & Whitney MRO Campus, ST Aerospace Campus. Benefitting from an integrated environment shaped by shared facilities and the potential of cross-knowledge exchanges, companies can be expected to synergize their resources to form an integrated aerospace business eco-system.

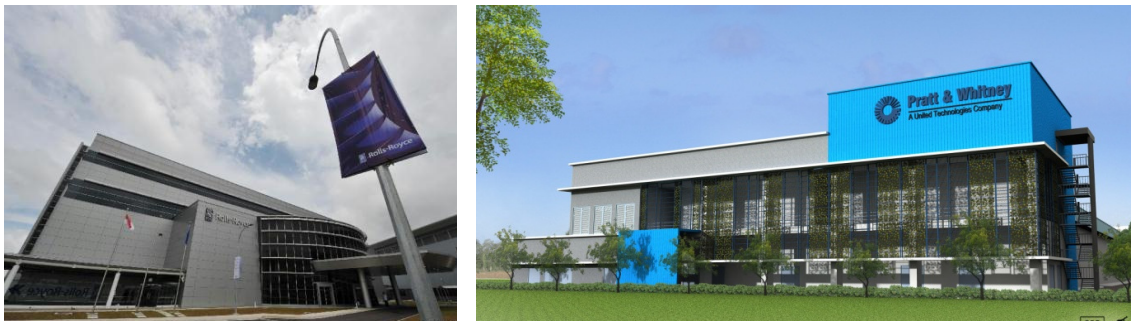


*Figure 14: Rolls Royce's Facility[10] (Left) and Artist Impression of Pratt and Whitney's Facility (Right)[11] Source: JTC Corporation*

### *3.1 Leading Industrial infrastructure*

The SAP industrial park is a classic example of why Singapore is known for providing reliable infrastructure as the unique competitive advantage as compared to other countries in the region. The site is strategically located in the Northeast of Singapore, easily accessible from the city centre and Changi International Airport where all the major aerospace enterprises are already located (such as SIA Engineering Company, ST Aviation Services, Goodrich Aerostructure, Pratt & Whitney, GE Aviation, Hamilton Sundstrand and Thales). With existing facilities and its strategic location, SAP will be fully expanded into a 320-hectare of purpose-built park in which 160 hectares of land will be dedicated for the use of the aerospace industry and the remaining will be occupied by the Seletar Airport.

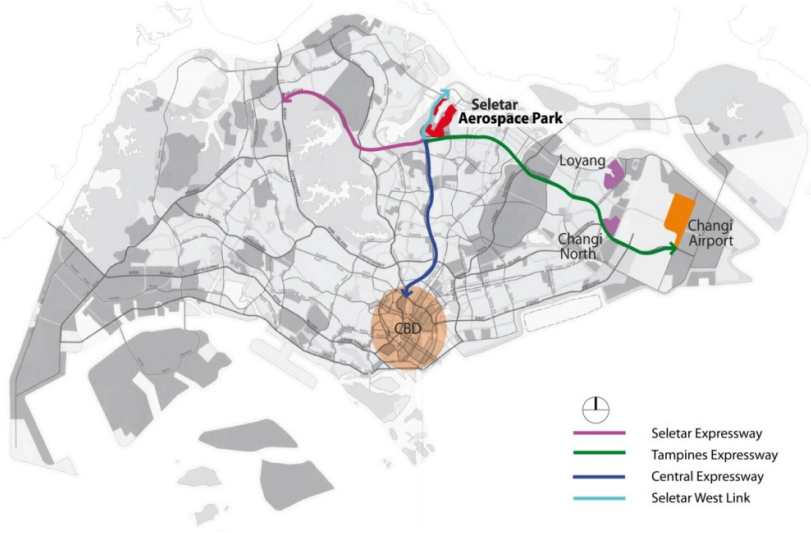


*Figure 15: The relationships between SAP, Changi Airport, CBD and nearby aerospace related industrial estates like Loyang and Changi North are strengthened by the Tampines Expressway. Source: JTC Corporation*

In 2007, SAP kick-started its transformation into a world-class integrated aerospace park. Within Phase 1 in the first two years, all infrastructure were speedily constructed including new roads, drainage and sewer networks. Upon the completion of a 66kV substation, 33 hectares of industrial land were immediately made available for leasing. Subsequently, the Phase 2 work were completed with further extensions of transportation systems such as arterial roads and internal roads for new anchor tenants. Moving forward, infrastructure work for Phase 3 of the SAP commenced in 2012 and is slated for completion by 2014. Today, SAP is host to 30 companies; creating thousands of jobs for skilled workers and

professionals; and is expecting to grow further in the future. The SAP is projected to be fully completed by 2018.

*Figure 16: Within 2 years, the 66kV Substation (Left), Business Aviation Complex (Centre) and Components Manufacturing and MRO Facility (Right) were ready to anchor tenants.*
*Source: JTC Corporation*


*Figure 17: SAP developing phases.*
*Source: JTC Corporation*

*Figure 18: Aerial view of Seletar Airport before development.*
*Source: JTC Corporation*

### *3.2 Innovative Infrastructural Solutions*

To complement the efforts in environmental sustainability, JTC is test-bedding an innovative storm water management system at the Business Aviation Complex. This gravel filtration system is an enhanced version of the bio-retention swales system with an on-site hydraulic engineering design. Environmental friendly aspects are introduced through a process of filtering and cleansing the first flush of rainwater before it flows into public drains and eventually discharges into the reservoir. As such, the downstream treatment of the reservoir water can be reduced. In future, the system will be implemented on a greater scale to achieve greater efficiency if the test-bedding is proven successful.

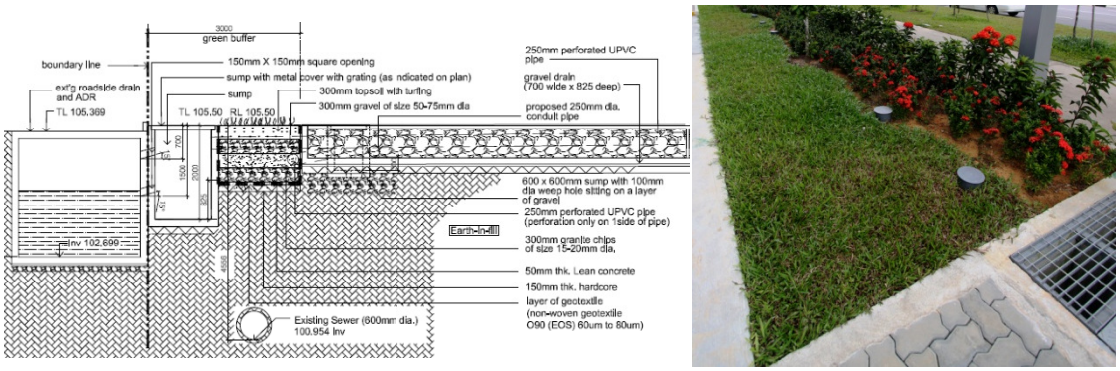


*Figure 19: (left) Detail Cross Section and (right) completed gravel filtration system[12].*
*Source: JTC Corporation*

## 3. Moving Forward

Within a short period of 6 years, JTC has completed the first two phases of the SAP development and is now carrying out the third phase. To date, the take-up rate for Seletar Aerospace Park has been encouraging, with 85 per cent of Phase One land taken up and over 60 per cent of Phase Two land parcels have been occupied. It has been crucial to actively speed up the preparation of facilities and infrastructure to catch up with the strong projected pipeline for aerospace industries coming into Singapore without forgetting the need to balance conservation and preservation for a heritage site like SAP.

Due to the limited land area of Singapore, the need to redevelop heritage sites is foreseeable and inevitable. As a pioneer in industrial park development in South East Asia, Singapore's SAP industrial park has gone one step further in the realm of sustainability. Therefore, the masterplan of SAP can certainly represent a successful case study for the best practices in developing a new generation of sustainable and viable industrial parks. The usage of brown-field sites not only recycles the limited land stock of Singapore, but also provides us with the opportunity to integrate and preserve the existing unique historical identity of Seletar with the newer, more urban landscape of the aerospace park. It is this unique value proposition that SAP presents to the region's aerospace industry that cannot easily be replicated elsewhere. Upon the completion of the full masterplan in 2018, we envisage that the charm of old heritage complemented by the the lush ecology of Seletar can come together to achieve an unmatched aviation culture within a world-class environment.

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