

## 1.0 INTRODUCTION

Sustainable road design requires a good balance between environment, cost and social aspects. More sustainable road means less impact on the environment, lower life cycle costs and more positive societal outcomes. Hence, Jabatan Kerja Raya Malaysia has developed *Penarafan Hijau* (pH) JKR Road Sector as one of the initiatives to provide a sustainable road design rating scheme for the use of government road projects.

The content of this technical update will try to elaborate on the sustainable issues as describe in pH JKR Road Sector.

## 2.0 PENARAFAN HIJAU (pH) JKR ROAD SECTOR

pH JKR Road Sector is a tool that can be used to measure the sustainability of a development for government road projects.

- i. Objectives
  - a. To gauge sustainability level achieved by government projects;
  - b. To facilitate improvements to be made from time to time;
  - c. To encourage projects to be developed and operated sustainably
- ii. Benefits
  - a. Reduce raw material consumption
  - b. Reduce the use of fossil fuels
  - c. Reduce water consumption
  - d. Reduce greenhouse gas emissions
  - e. Reduce water pollution
  - f. Reduce solid waste
  - g. Conservation of habitats
  - h. Creating habitat
  - i. Reduce carbon footprint

iii. Rating Criteria

Projects subscribing to this scheme shall be rated based on the following seven criteria:

- a. Sustainable Site Planning & Management
- b. Pavement Technologies
- c. Environment & Water
- d. Access & Equity
- e. Construction Activities
- f. Material & Resources
- g. Innovation

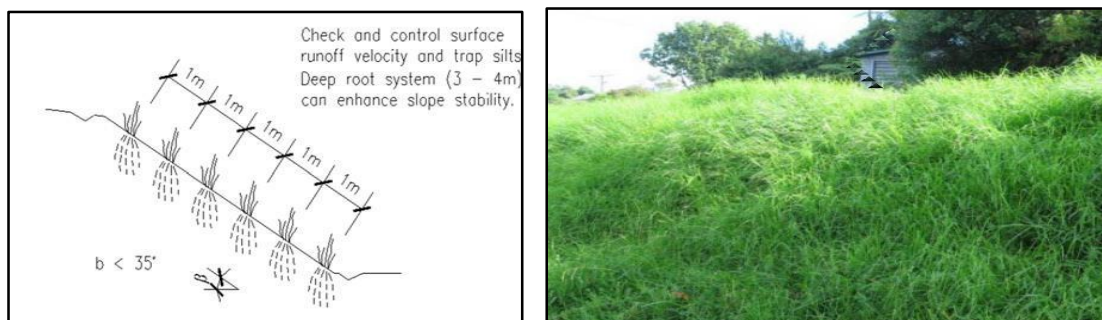
iv. Classification Rating

PERCENTAGE (%)	STAR	pH JKR RATINGS
40 - 49	★ ★	Potential Recognition
50 - 69	★ ★ ★	Best Management Practices
70 - 84	★ ★ ★ ★	National Excellence
85 - 100	★ ★ ★ ★ ★	Global Excellence

### 3.0 SUSTAINABLE SITE PLANNING AND MANAGEMENT

Sustainable site planning and management can be defined as a development that has the least environmental impact while meeting the client project goal. A proper sustainable road design must fit within JKR Standard or other local agency requirements (Department of Irrigation and Drainage and etc.) must also consider the environmental and social impacts.

Requirement for road works design, road alignment selection to minimize high cutting and embankment fill, site vegetation, noise mitigation plan, services for disabled users and noise control are the items in these criteria to be taken into consideration.



**Figure 1:** Vetiver Grass System as an Example of Site Vegetation



**Figure 2:** Example of Services for Disable Users: Ramp for Disabled Users at Zebra Crossing and Tactile on Pedestrian Walkway



**Figure 3:** Example of Noise Control: Noise Barrier in Sensitive Area

#### 4.0 PAVEMENT TECHNOLOGIES

The latest technology in design and construction of roads which can increase the sustainability of a road should be adopted. Permeable Pavement and Long Life Pavement are part of this criteria.

- i. Permeable Pavement can improve flow control and quality of stormwater runoff.



**Figure 4:** Porous Asphalt is Permeable Pavement Type.



- ii. Concrete pavement is one of the product that can minimize life cycle costs by promoting design of long – lasting pavement structures.



**Figure 5:** Photos taken from **PAKEJ 3: GUA MUSANG, KELANTAN KE KG. RELONG, PAHANG -SEKSYEN 3H: FELDA TELANG KE KG. KECHUR** whereby concrete pavement was adopted for this project.

## 5.0 ENVIRONMENT & WATER

Earthworks, erosion and sedimentation control and storm water management should be carried out sustainably. Restoration and preservation of the environment should also be taken into account.

### i. Sustainable Drainage

Sustainable drainage is a concept towards solving three major problems in Malaysia which are flash flood, water scarcity and water pollution. This is along term environment and social factor about drainage. Sustainable drainage using a component such as swale, bio-retention dry pond, dry retention basins, detention ponds and constructed wetlands. The system will minimize the amount of pollution entering the downstream waterways.

The design should have the capacity to convey the flow up to and including the minor system design ARI. Swales are designed to enhance water quality. Therefore, the design of swales channel with sufficient mild slope and cross-sectional is important to take into account to maintain non-erosive velocities. The important consideration to take into account is the design of swales should not be sited on unstable ground.

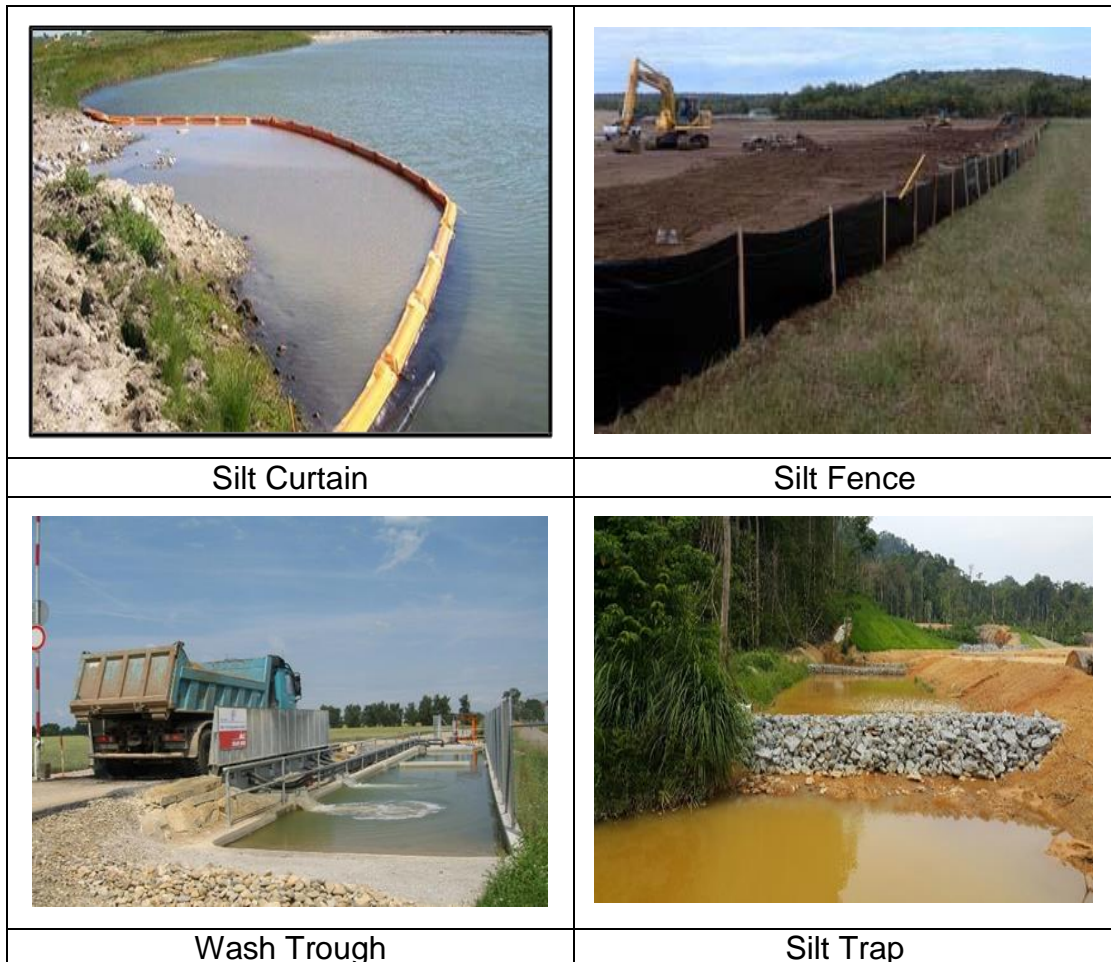


**Figure 6:** Photos of Swale & Detention Pond



ii. Environmental Protection Works (EPW)

Environmental Protection Works focus on solving problems arising from the interaction between humans and environmental systems and includes issues related to conservation, pollution, loss of biodiversity, land degradation or environmental policy. The key aim of environmental protection works is to protect and preserve natural ecosystems which is affected by construction activities due to implementation of road projects.



**Figure 7:** Example of Environmental Protection Works (EPW) devices

iii. Ecological Connectivity

Ecological connectivity refers to the structural and functional connectivity of landscapes that facilitates suitable habitats for flora and fauna. In Malaysia, initiative has been taken to implement ecological connectivity by providing viaduct at locations as shown below:



a. Sg. Deka, Terengganu (Completed 2009)



b. Sg. Yu, Pahang (Completed 2014)



c. Gerik, Perak (Completed 2015)





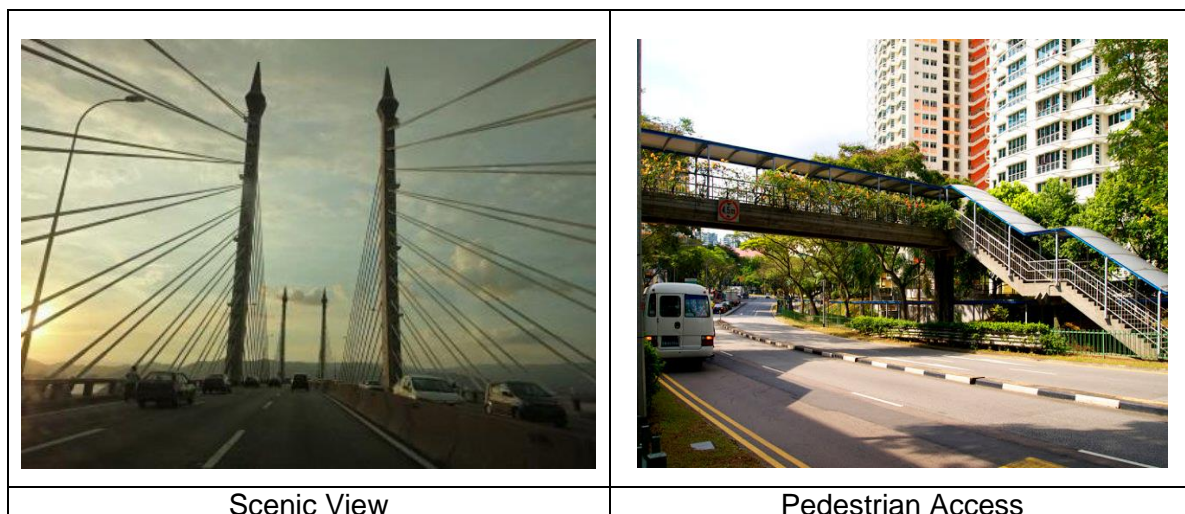
d. Rawang Bypass, Selangor (Completed 2017)

## 6.0 ACCESS AND EQUITY


Safety of road users can be escalated by conducting a safety audit at any stage of development. Road facilities such as pedestrian, bridges and bicycle lanes can also increase the level of road user safety. Rest & Recreation Area and Scenic View Area can enhance more facilities of the road users.

Definition of ACCESS is every road user should be able to safely and comfortably walk, bicycle, drive and/or ride transit from their home to work, school, parks, shopping and community facilities whereas definition of EQUITY is every road user should be able to enjoy the same quality of public facilities and services regardless of income, age, race, ability or geographic location.

Access and equity consist of six elements in pH JKR Road Sector which is road safety audit, scenic view, pedestrian access, motorcycle lane, rest area and bicycle access.





	
Motorcycle Lane	Rest Area
	
Bicycle Access	

**Figure 8:** Elements of Access and Equity

## 7.0 CONSTRUCTION ACTIVITIES

The impact of construction activities still greatly affect environment; therefore, a proper construction waste management plan is necessary with the aim to reduce the amount of waste produced on construction sites by setting out how building materials, and any resulting waste, will be managed during a project. The plan is then updated during the construction process to record and confirm how materials are reused, recycled or disposed of.

	
General Trash	Recycled Material (Wood)



**Figure 9:** Part of Waste Management Plan Devices

## 8.0 MATERIAL & RESOURCES

Material and Resources should focus on sustainability product such as application of green and renewable energy products.

### i. Green Products

One of the green product is Biodegradable Erosion Control Blanket are made with natural agricultural straw and fibers, and stitched together with degradable thread to a double layer photodegradable polypropylene netting. Biodegradable Erosion Control Blanket (ECB) immediately reduces soil erosion losses by 85% after installation. Subsequently, effective grass establishment is achieved by hydroseeding. The ECB also good in absorbing and dissipating energy released by heavy rainfall. In other word, soil, seed and fertilizer are protected from being washed away. Biodegradable Erosion Control Blanket also improves soil fertility as it biodegrades by improving the organic matter content and buffering capacity.



**Figure 10:** Application of Biodegradable Erosion Control Blanket Layer at Slope



ii. Renewable Energy Products

Renewable energy is defined as energy that is generated from natural processes that are continuously replenished. This includes sunlight, wind, geothermal heat, tides, water, and various forms of biomass. This energy cannot be exhausted and is constantly renewed. Alternative energy is a term used for an energy source that is an alternative to using fossil fuels. Generally, it indicates energies that are non-traditional and have low environmental impact. The term alternative is used to contrast with fossil fuels according to some sources. By most definitions alternative energy doesn't harm the environment, a distinction which separates it from renewable energy which may or may not have significant environmental impact.

a. Solar Road Stud



b. Solar Street Lighting



**Figure 11:** Part of Renewable Energy Products

## 9.0 INNOVATION

Initiatives and innovative designs that are in line with the government's mission is encourage.

### i. Ultra-High Performance Concrete (UHPC)

One of the innovation product is UHPC. It is an advanced construction material that affords new opportunities for the future of the highway infrastructure especially construction of bridge or elevated structure. Ultra-High Performance Concrete (UHPC) is cementitious-based composite materials with the benefits as follows:

- a. UHPC have 4 times material strength from conventional concrete and higher durability.
- b. Known as light weight component
- c. Standardized and control quality product (factory production).
- d. Easy and short duration for construction.



**Figure 12:** Photos taken from the project Sungai Rai Bridge, Perak whereby UHPC U-Beam was adopted for this project. Due to the characteristic of UHPC, longer span can be achieved (above 40m in length) and this provided the option to avoid the design of river pier. This will reduce the impact to the environment and also less obstruction to the river during the construction stage.



ii) Tongue and Groove Shaped Concrete Drain

This product was invented by **JKR Kemaman** and has been awarded Gold Medal at iCompEx 2019. The benefit of tongue and groove shaped concrete drain is economical, consumes minimal construction material due to fabrication at factory, easy installation, time saving and minimal maintenance.



**Figure 13:** Photos taken from project at Jalan Bongkok, Bera whereby Tongue and Groove Shaped Concrete Drain was adopted for this project.

## 10.0 CONCLUSION

Jabatan Kerja Malaysia, JKR as the country's core government technical agency has taken the challenge to lead the country in implementing sustainable development in government projects under Strategic Plan JKR 2016 – 2020. JKR Strategic plan 2016 – 2020 is based on Five Strategic Themes with Theme 4: Leading Sustainability which aim to sets out in detail, the direction, focus areas and action plans for the organization in realising the government intention to pursuing green growth and efforts to achieve a low-carbon, resource-efficient, resilient and sustainable economy in the Eleventh Malaysia Plan. However, several issues and challenges while implementing the strategic plan such as insufficient integrated planning, coordination and enforcement; limited indigenous green technology; low awareness on environmental issues; and unsustainable development required to be addressed. Despite the issues and challenges faced by JKR, JKR is committed to achieve the government goals as planned in the Eleventh Malaysia Plan.

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