Water Resource Development

Highway Stormwater Management

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Content

Introduction

Stormwater runoff is created when rainwater or snowmelt flows across land without infiltrating into the ground. Infiltration is important because it provides moisture to plants, feeds streams and lakes, filters out pollutants, and recharges aquifers and groundwater. As stormwater runs across surfaces, it picks up pollutants which are then discharged into streams. Most stormwater is not treated before it is discharged, leading to polluted rivers, lakes, and oceans that are used for drinking water, recreation, food sources, and wildlife habitats. The two biggest concerns with stormwater runoff are polluted water quality and increased water quantity.

Polluted Water Quality

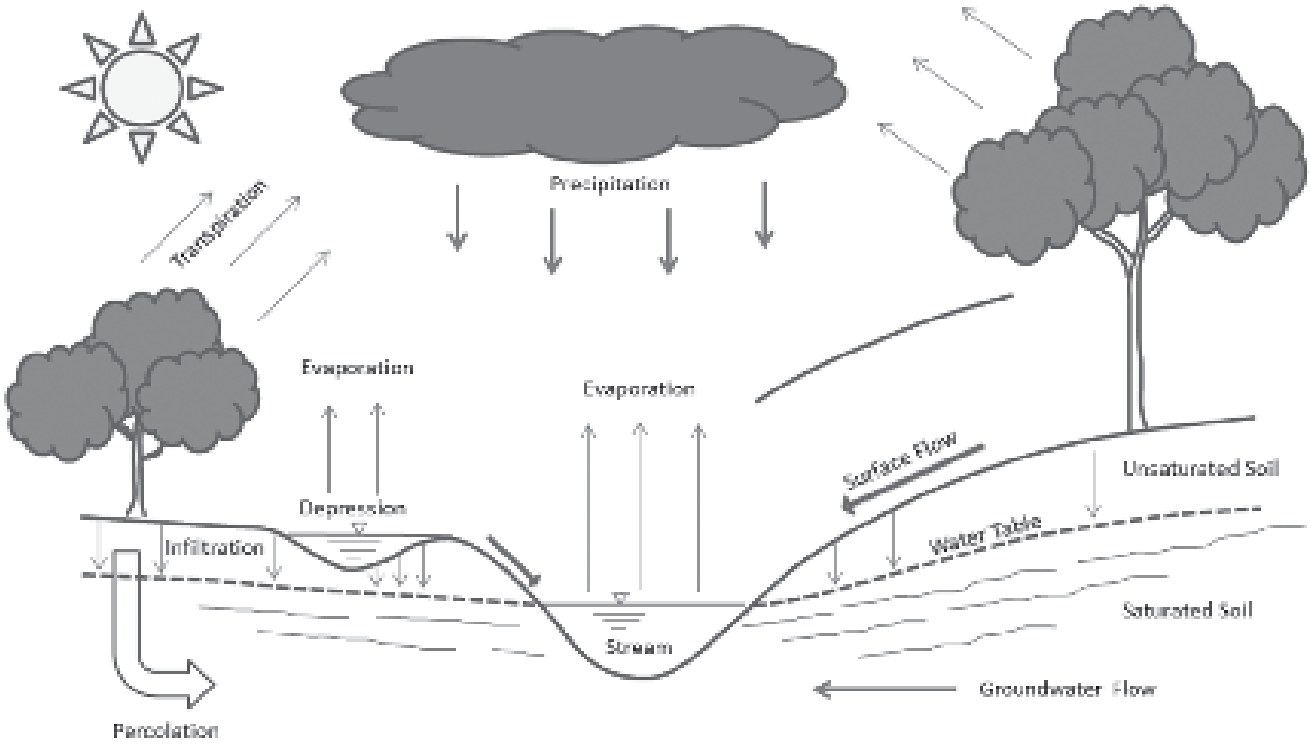
As stormwater flows across land, it picks up pollutants such as dirt, oil, fertilizer, and bacteria from animal waste. This stormwater often runs right into stormdrains that empty straight into our local waterways without being treated.

Increased Water Quantity

As illustrated in the diagram below, the amount of stormwater runoff increases as the amount of impervious surfaces increases. Natural ground cover allows for over half of precipitation to infiltrate into the ground, to provide moisture for plants and refill streams , and recharge aquifers. {1}

Abstract

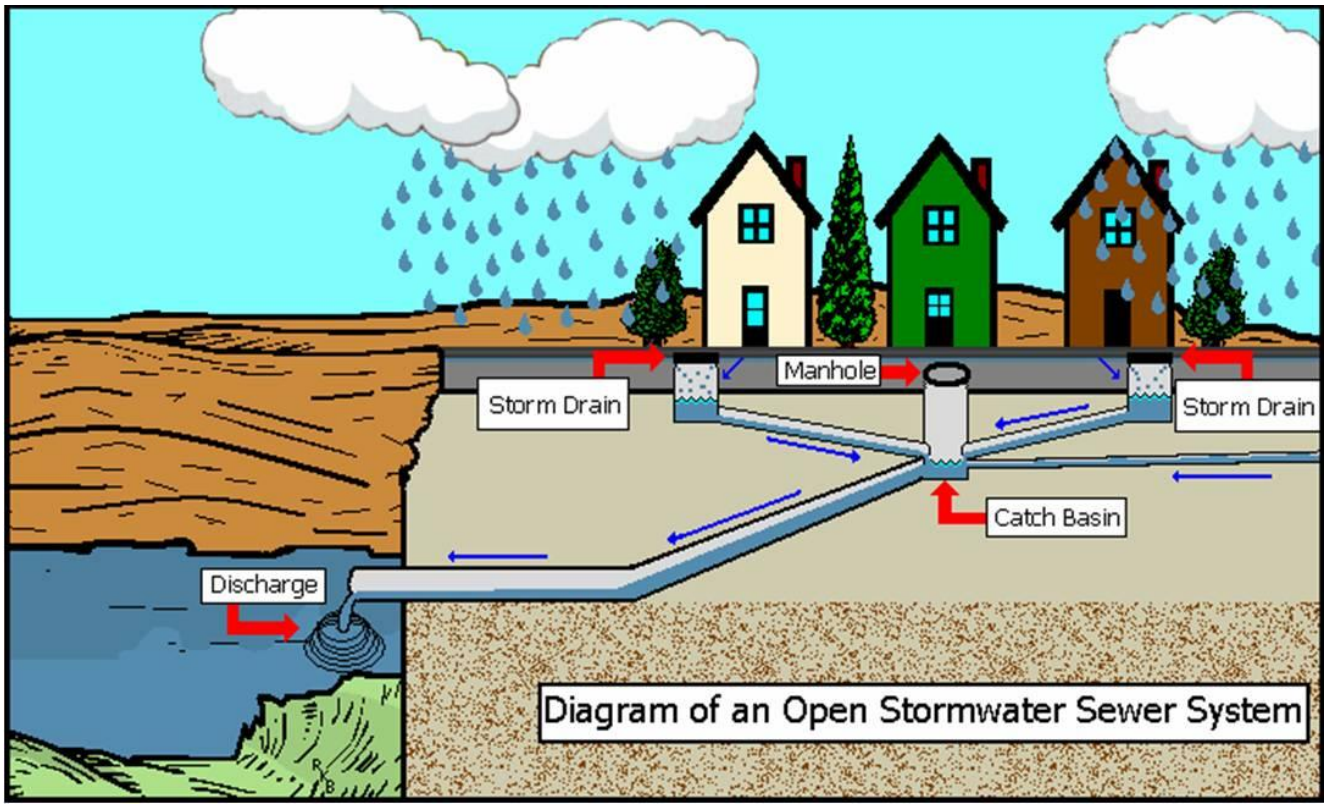
Highway stormwater management refers to the planning, design, and implementation of systems and practices to control and manage stormwater runoff from highways and roads. Stormwater runoff occurs when rainwater or melted snow flows over the surface of impervious areas, such as roads and highways, and can pick up pollutants such as oil, sediment, and chemicals along the way. If not properly managed, this runoff can lead to water pollution, erosion, and flooding.{1}



What is the process of harvesting rainwater?

It is the process of collecting water in areas that enjoy regular and frequent rainfall around the world, where this process is carried out by human intervention or naturally, and natural harvesting of water can be seen in the wake of severe storms as water flows to low-lying areas, forming water bodies in the form of natural lakes invested by farmers.

As for the harvesting of rainwater by humans, it occurs through the construction of the water facility, such as: artificial lakes, damscollected water can be used in various population activities, and for agricultural purposes. Roof collects rainwater and stores it from rooftops or large buildings and yards. Villages scattered in places lacking groundwater also need a successful way to provide drinking water requirements. {2}



What does the rainwater harvesting technology system consist of :

1- Welded roof of the house

Its specifications are to be smooth, not absorb dust in a high percentage, and to have a regular tendency to become free of small puddles, and the use of paints, especially tar, must be avoided, and the direction of the wind must be taken into account, as the efficiency of the surface work depends on the materials used in the construction of the surface, maintenance and periodic cleaning.

2- Water transmission system

It consists of side pipes installed along the edges of the roof that receive water falling on the ceiling, and direct it to vertical pipes, which in turn direct water to the tank. A sieve strainer should be placed at the entrance to the tank or pipes, and the materials from which the pipes are made do not react with water, such as: aluminum, plastic

3- Water storage method

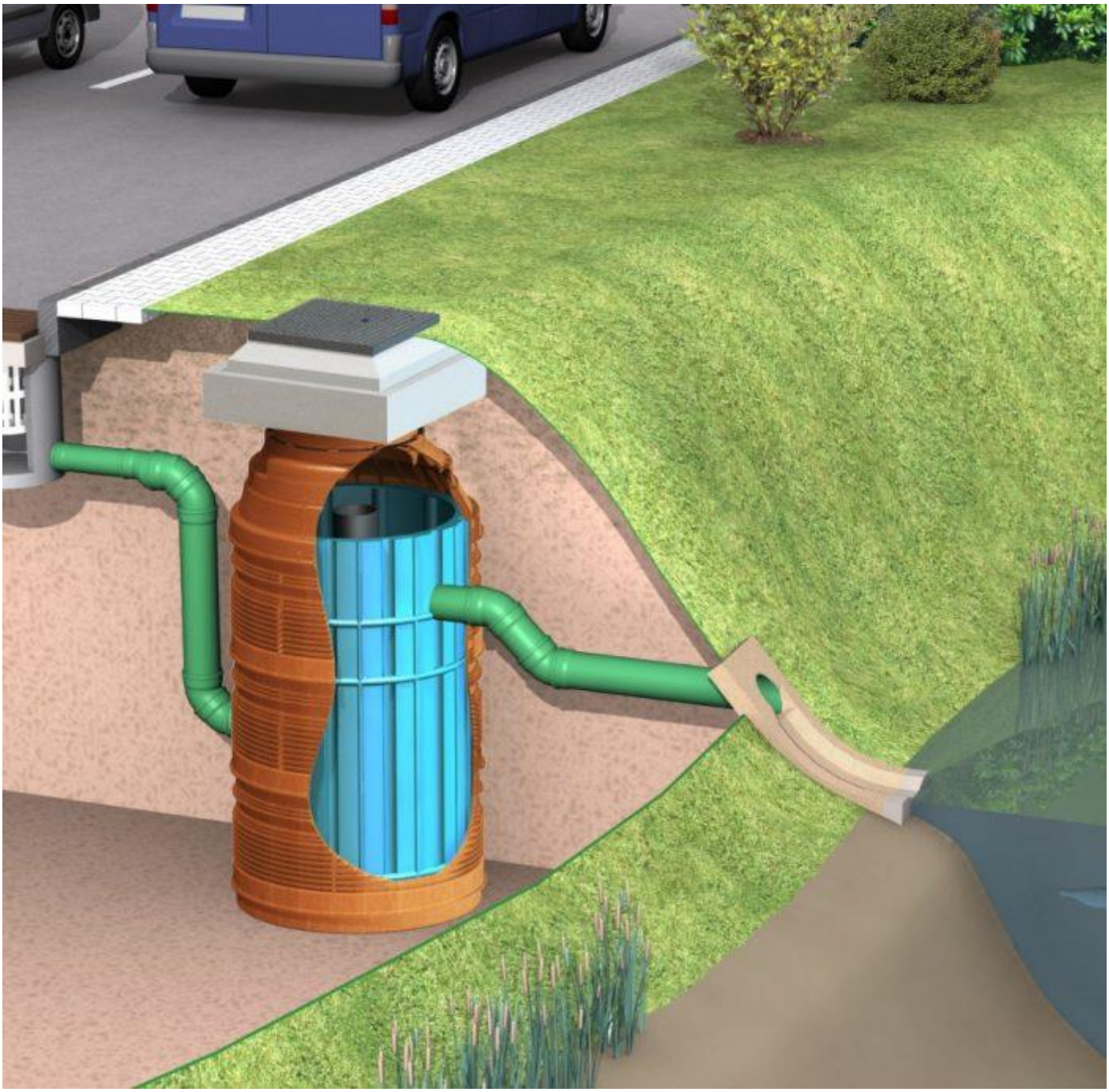
It is an artificial tank that is built of reinforced concrete with a capacity of (30, 60 or 100 m 3), and can reach 200 m 3, or berries, plastic, spindle glass, or stainless steel, and there are multiple forms of the tank, and its size depends on the amount of rain, and the area of the assembly surface, and these tanks can be dug inside or outside the ground, and the tank can be built as part of the house or as a facility attached to the house, and close to it. {2}

Here are some common strategies and practices used in highway stormwater management:

1. **Vegetated Swales:** Swales are shallow, vegetated channels designed to slow down and filter stormwater runoff. They help remove pollutants and promote infiltration into the soil.
2. **Retention and Detention Basins:** These are large ponds or basins designed to temporarily hold and slow down stormwater runoff. They allow sediments and pollutants to settle, and water to gradually release into the environment.
3. **Permeable Pavements:** These are surfaces that allow water to pass through, reducing runoff and promoting infiltration. Permeable pavements can include porous asphalt, concrete, or interlocking pavers.
4. **Green Infrastructure:** Incorporating natural elements, such as trees, grass, and other vegetation, into the design of highways can help absorb and filter stormwater runoff.
5. **Oil and Grit Separators:** These devices are installed in stormwater drainage systems to capture oil, grease, and other pollutants before they reach water bodies.
6. **Erosion Control Measures:** Implementing erosion control practices, such as silt fences, sediment basins, and erosion control blankets, helps prevent soil erosion and the transport of sediment into waterways.
7. **Stormwater Management Plans:** Developing comprehensive plans that outline strategies for managing stormwater on highways, including preventive measures, maintenance schedules, and monitoring protocols.
8. **Education and Outreach:** Public awareness and education programs can help inform the community about the importance of proper stormwater management and encourage responsible practices. {3}

Storm Drainage Planning and Design

- Analyses topography-
- Analyses other site conditions. -
- Analyses areas for probable location of drainage structures and facilities.



Consideration Factors During Stormwater Drainage Design:

❖ General Drainage Design Considerations

1. Stormwater systems should be planned and designed so as to generally conform to natural drainage patterns and discharge to natural drainage paths within a drainage basin. These natural drainage paths should be modified as necessary to contain and safely convey the peak flows generated by the development.
2. Runoff must be discharged in a manner that will not cause adverse impacts on downstream properties or stormwater systems. In general, runoff from development sites within a drainage basin should be discharged at the existing natural drainage outlet or outlets. If the developer wishes to change discharge points, he or she must demonstrate that the change will not have any adverse impacts on downstream properties or stormwater systems.
3. It is important to ensure that the combined minor and major system can handle blockages and flows in excess of the design capacity to minimize the likelihood of nuisance flooding or damage to private properties. If failure of minor systems and/or major structures occurs during these periods, the risk to life and property could be significantly increased.
4. In establishing the layout of stormwater networks, it is essential to ensure that flows will not discharge onto private property during flows up to the major system design capacity.

❖ Street and Roadway Gutters

1. Gutters are efficient flow conveyance structures. This is not always an advantage if removal of pollutants and reduction of runoff is an objective. Therefore, impervious surfaces should be disconnected hydrologically where possible and runoff should be allowed to flow across pervious surfaces or through grass channels. Gutters should be used only after other options have been investigated and only after runoff has had as much chance as possible to infiltrate and filter through vegetated areas.
2. It may be possible not to use gutters at all, or to modify them to channel runoff to off-road pervious areas or open channels. For example, curb opening type designs take roadway runoff to smaller feeder grass channels. Care should be taken not to create erosion problems in off-road areas. Protection during construction, establishment of strong stands of grass, and active maintenance may be necessary in some areas.
3. Use road cross sections that include grass channels or swales instead of gutters to provide for pollution reduction and reduce the impervious area required.
4. To protect the edge of pavement, ribbons of concrete can be used along the outer edges of asphalt roads.{5}

❖ Inlets and Drains

1. Inlets should be located to maximize overland flow path, take advantage of pervious areas, and seek to maximize vegetative filtering and infiltration. For example, it might be possible to design a parking lot so that water flows into vegetated areas prior to entering the nearest inlet.
2. Inlet location should not compromise safety or aesthetics. It should not allow for standing water in areas of vehicular or pedestrian traffic, but should take advantage of natural depression storage where possible.
3. Inlets should be located to serve as overflows for structural stormwater controls. For example, a bioretention device in a commercial area could be designed to overflow to a catch basin for larger storm events.
4. The choice of inlet type should match its intended use. A sumped inlet may be more effective supporting water quality objectives.

Use several smaller inlets instead of one large inlet in order

❖ Storm Drain Pipe Systems (Storm Sewers)

1. The use of better site design practices (and corresponding site design credits) should be considered to reduce the overall length of a piped stormwater conveyance system.
2. Shorter and smaller conveyances can be designed to carry runoff to nearby holding areas, natural conservation areas, or filter strips (with spreaders at the end of the pipe).

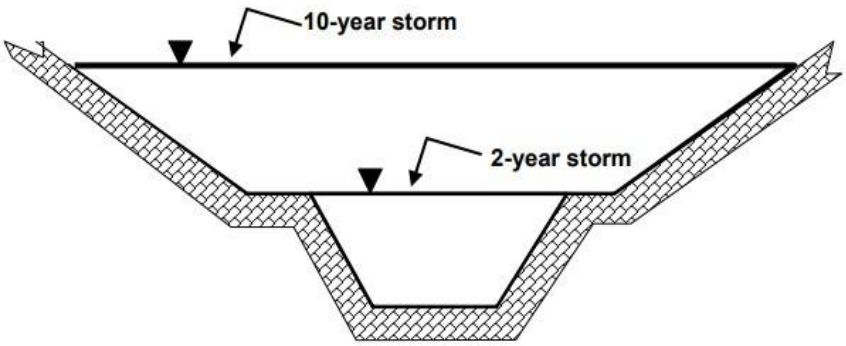
Ensure that storms in excess of pipe design flows can be safely conveyed through development without damaging structures or flooding major roadways. This is often done through design of both a major and minor drainage system. The minor (piped) system carries the mid-frequency design flows while larger runoff events may flow across lots and along streets as long as it will not cause property damage or impact public safety

Culverts

1. Culverts can serve double duty as flow retarding structures in grass channel design. Care should be taken to design them as storage control structures if depths exceed several feet, and to ensure safety during flows.
2. Improved inlet designs can absorb considerable slope and energy for steeper sloped designs, thus helping to protect channels.

❖ Open Channels

1. Open channels provide opportunities for reduction of flow peaks and pollution loads. They may be designed as wet or dry enhanced swales or grass channels.
2. Channels can be designed with natural meanders improving both aesthetics and pollution removal through increase of contact time.
3. Grass channels generally provide better habitat than hardened channel sections, though studies have shown that riprap interstices provide significant habitat as well. Velocities should be carefully checked at design flows and the outer banks at bends should be specifically designed for increased shear stress.
4. Compound sections can be developed that carry the annual flow in the lower section and higher flows above them. Below Figure illustrates a compound section that carries the 2-year and 10-year flows within banks. This reduces channel erosion at lower flows, and meandering, self-forming low flow channels that attack banks. The shelf in the compound section should have a minimum 1:12 slope to ensure drainage.
5. Flow control structures can be placed in the channels to increase residence time. Higher flows should be calculated using a channel slope that goes from the top of the cross piece to the next one if it is significantly different from the channel bottom for normal depth calculations. Channel slope stability can also be ensured through the use of grade control structures that can serve as pollution reduction enhancements if they are set above the channel bottom. Regular maintenance is necessary to remove sediment and keep the channels from aggrading and losing capacity for larger flows. {5}



Design Storm Recommendations

Listed below are the design storm recommendations for various stormwater drainage system components to be designed and constructed in accordance with the minimum stormwater management standards. It is recommended that the full build-out conditions be used to calculate flows for the design storm frequencies below.

✓ Storm Drainage Systems

1. 10- to 25-year design storm (for **pipe** and **culvert** design)
2. 10- to 25-year design storm (for **inlet design**)
3. 50-year design storm (**roadway Culvert Design**)

✓ Cross drainage facilities that transport storm runoff under roadways.{6}

25- to 100-year design storm, whichever is more stringent.

✓ Open Channel Design

Open channels include all channels, swales, etc.

25-year design storm Channels may be designed with multiple stages.

Conclusion

Water resource systems have benefited both people and their economies for many centuries. The services provided by such systems are multiple. Yet in many regions of the world, they are not able to meet even basic drinking water and sanitation needs. Nor can many of these water resource systems support and maintain resilient biodiverse ecosystems. Typical causes include inappropriate, inadequate and/or degraded infrastructure, excessive withdrawals of river flows, pollution from industrial and agricultural activities, eutrophication resulting from nutrient loadings, salinization from irrigation return flows, infestations of exotic plant and animals, excessive fish harvesting, flood plain and habitat alteration from development activities, and changes in water and sediment flow regimes

For this reason, we have to manage highway stormwater for decreasing its damages and benefit from it as a water resource,

For this reason, I suggested numbers of ways starting from increasing green areas and Permeable Pavements to decrease floods which is most used in counters like Chaina and gives a good result, because if the water sucked at all areas we decreases possibility of the flood ,

And for more benefits in some areas to reduce the possibility of flood, we have to use Retention and Detention Basins in which we collect and store the flood water when there is high amount of rain to using it when we needed it

Also, for decreasing the pollution of the water we have to separate Oil and Grit Separators from the water to be usable for using it

Finally we talked about the design storm recommendations for various stormwater drainage system components to be designed and constructed in accordance with the minimum stormwater management standards ,

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