MANUAL FOR MAINTENANCE AND REPAIR OF ROADS

ENERGY MANAGEMENT AND OPERATION & MAINTENANCE OF 16 SELECTED MCS SERVICES INFRASTRUCTURE ASSETS PROJECT

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PITCO (PRIVATE) LIMITED

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1. INTRODUCTION

1.1 The Objective of Road Maintenance and Repair

The main purpose of municipal road maintenance and repair is to provide a safe, efficient, and reliable transportation network for its users. These users encompass motorists, cyclists, and pedestrians alike, making it paramount to maintain the infrastructure's integrity and safety. This is achieved through various activities, such as repairing potholes, updating signage, managing road markings, and maintaining streetlights. Any potential hazards are addressed promptly, ensuring the safety of all who utilize these public roads.

Additionally, the functionality of roads is a key aspect that requires regular attention. Effective maintenance of road surfaces, sidewalks, bicycle lanes, and drainage systems help ensure a smooth traffic flow and prevent potential issues like flooding. This functionality is not just about the present but also aims to guarantee the longevity of the roadways. Routine maintenance plays a vital role in mitigating minor issues before they escalate into major problems, thus saving money in the long term by reducing the need for large-scale repairs or complete road replacements.

Comfort is another vital aspect addressed by municipal road maintenance. Regular upkeep helps to rectify surface irregularities that could potentially lead to discomfort for passengers or damage to vehicles. The journey's comfort and safety reflect directly on the municipality's responsibility towards its residents.

Road maintenance also significantly contributes to the economic efficiency of a municipality. Well-maintained roads reduce vehicle operating costs by causing less wear and tear on the vehicles, minimizing traffic delays, and facilitating better connectivity for economic activities. This economic efficiency also ties in with the environmental responsibility of the municipality. Smooth and well-designed roads can potentially lead to reduced vehicle emissions by ensuring a more efficient traffic flow, thus contributing to environmental sustainability.

Lastly, the aesthetics of well-maintained roads can foster a sense of community pride. The overall appearance of a city or town reflects the administration's dedication to its residents. Therefore, road maintenance and repair is not just about functionality, safety, and economy—it also contributes to the community's pride and the city's overall aesthetic appeal.

1.2 Scope of the Manual

The Manual for Repair and Maintenance of Municipal Roads serves as a comprehensive guide to ensure the effective management and upkeep of urban road networks. This manual typically outlines the procedures, methods, and practices required for preserving municipal roads in an optimum state of usability, ensuring safety, functionality, and longevity.

The manual provides detailed procedures for routine, preventive and corrective maintenance activities. Another crucial part of the manual is dedicated to the principles and practices for road repair works, including both minor and major repairs. It covers the best practices for conducting road repairs, with guidelines on managing traffic during repairs, ensuring worker and public safety, and minimizing environmental impact.

Finally, the manual provides guidance on planning, scheduling, implementing and documenting maintenance activities and their reporting.

2. UNDERSTANDING MUNICIPAL ROADS

2.1 Definition and Types of Municipal Roads

Municipal roads, which form an integral part of an urban transportation network, are of various types depending on the materials used in their construction, the kind of traffic they handle, and their location. A detailed description of the various types of municipal roads is given below

2.1.1 Macadam Road

Named after the Scottish engineer John McAdam, Macadam roads are built using broken stone layers. The base layer consists of large stones, while the upper layers use progressively smaller stones, creating a hard surface. McAdam also suggested that the stones should be covered with a layer of stone dust to bind the pieces together. Modern versions of these roads, often called "tar macadam" or "tarmac," include a layer of tar or bitumen to bind the stones together, providing a smoother surface and better water resistance.

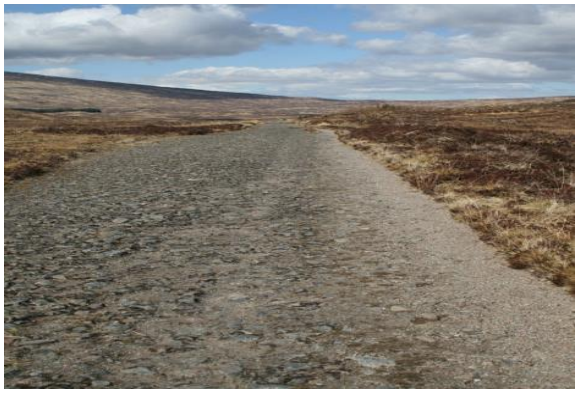

Figure 1: Macadam Road

2.1.2 Murram Road

Murram roads are usually found in regions like East Africa and the Indian Subcontinent. These roads are made using murram, a type of laterite soil that becomes hard upon wetting and drying, making it a suitable, cost-effective option for road construction in regions where it's abundantly available. Murram roads need regular maintenance as they can get muddy and slippery in the rainy season and dusty during the dry season.

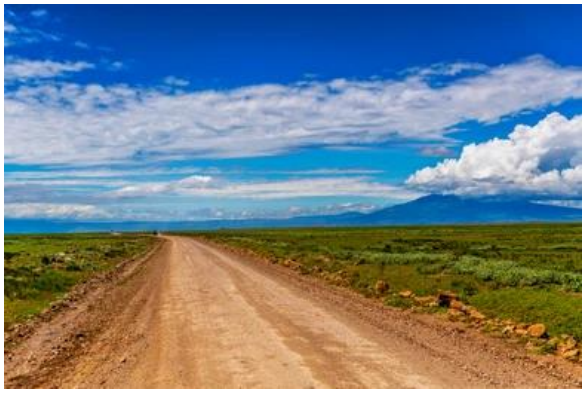

Figure 2: Murram Road

2.1.3 Metaled Road

Metaled roads are those where the carriage way is made using broken stone or gravel in a simple sense. They are also known as "water-bound macadam" roads. These types of roads are suitable for both motor and non-motor traffic. After the stones are laid, they are compacted with a roller and bound together with fine gravel and clay, creating a hard and durable surface.

Figure 3: Water-Bound Macadam Road

2.1.4 Unmetalled Road

Unmetalled roads, also known as "dirt roads," "gravel roads," or "unpaved roads," have a surface made from native material, such as gravel, murram, sand, or clay, depending on the location. These roads are cheaper to build but require frequent maintenance due to their susceptibility to wash boarding, potholes, dust, and mud. They are often found in rural or undeveloped areas.

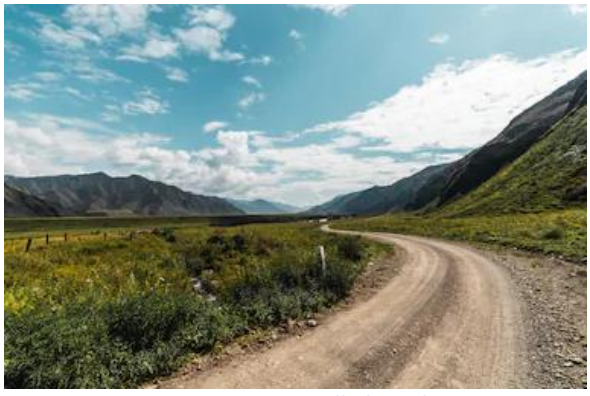

Figure 4: Unmetalled Road

2.1.5 Brick Paved Roads

Brick paving is a method of road construction that dates back to ancient times, and it has seen a resurgence in recent years due to its aesthetic appeal and durability. Brick paved roads are composed of bricks, typically made from clay or concrete, that are laid on a prepared subsurface.

The construction process usually starts with the preparation of a solid foundation, often a bed of sand or a layer of compacted aggregate, over which the bricks are laid. The bricks can be placed in a variety

of patterns, such as herringbone, basketweave, or running bond, depending on aesthetic preference and the need for durability. Once the bricks are laid, the gaps between them are filled with sand or another filler, which is then compacted and sealed. This process locks the bricks into place and provides additional stability.

Figure 5: Brick Paved Road

2.2 Role of Municipal Roads in Urban Development

Municipal roads play a central role in fostering economic development and ensuring accessibility and mobility within a city. They act as the veins of a city's economy, connecting different regions and facilitating commerce by enabling easy transportation of goods and services. Businesses rely on these roads to reach their customers and suppliers, thereby fostering economic growth and job creation. Moreover, these roads are essential for providing access to vital facilities like schools, hospitals, and recreational centers. A well-structured and maintained road network enhances mobility, making it easier for residents to navigate around the city and significantly improving their quality of life.

The importance of municipal roads extends to urban planning, public health and safety, and promoting social equity. The design and layout of roads shape the urban landscape and dictate land use patterns, influencing the positioning of residential, commercial, and industrial zones. By contributing to sustainable urban development, road planning can promote efficient land use and help combat urban sprawl. Moreover, safe and well-kept roads contribute significantly to public health by minimizing the risk of traffic accidents. They can also support public health initiatives by incorporating features like bike lanes or pedestrian paths, thereby encouraging physical activity. Furthermore, municipal roads can bolster social equity by providing access to all parts of the city, ensuring that residents, irrespective of their dwelling place, have equal access to public services and economic opportunities.

Lastly, municipal roads contribute to environmental sustainability when designed and maintained correctly. Efficient traffic flow on well-designed roads can mitigate vehicle emissions, thus reducing the city's overall carbon footprint. Additionally, adopting sustainable materials and practices in road construction and maintenance can further minimize environmental impact. Therefore, the role of municipal roads in urban development is multifaceted, influencing the city's economy, public health, social equity, and environmental sustainability.

3. ROAD MAINTENANCE

3.1 The Need for Regular Maintenance

Regular maintenance of roads is of paramount importance for multiple reasons. Firstly, it ensures the safety of all road users. Poorly maintained roads can lead to numerous safety hazards, such as accidents caused by potholes, malfunctioning streetlights, or faded road markings. Regular maintenance helps to promptly identify and address such issues, thereby ensuring a safer environment for pedestrians, cyclists, and motorists.

Another crucial aspect of regular maintenance is that it contributes to the longevity of the road infrastructure. Roads are subjected to constant wear and tear due to weather conditions, heavy traffic, and natural aging of materials. Regular maintenance helps to minimize this deterioration by addressing minor issues before they escalate into significant problems. This not only extends the life of the roadways but also proves to be cost-effective in the long run, as the cost of large-scale repairs or road replacement is substantially higher than that of regular upkeep.

Additionally, regular maintenance enhances the functionality and comfort of the road for users. It ensures smooth traffic flow, minimizes disruptions due to road defects, and provides a comfortable journey for drivers and passengers. From an environmental perspective, well-maintained roads can reduce vehicle emissions by improving traffic flow and minimizing the need for frequent stops and starts. Lastly, the aesthetic aspect should not be overlooked - a well-maintained road network contributes to the overall appearance of the city and fosters a sense of community pride.

3.2 Preventative Maintenance Techniques

Preventive maintenance refers to proactive measures taken to preserve the condition of the road and prevent premature deterioration. One common technique is crack sealing, where cracks are cleaned and filled with a sealant to prevent water infiltration, which can cause damage to the underlying pavement structure.

Another technique is surface treatments such as chip sealing or micro-surfacing. These treatments involve applying a thin layer of asphalt and aggregate to the road surface. This not only provides a new wearing surface but also seals the existing pavement, protecting it from water damage and oxidation.

Preventive maintenance also includes the management of drainage systems. Ensuring that water drains properly off the road surface is crucial to prevent damage caused by water infiltration and freezing. This involves maintaining ditches, culverts, and storm drains, as well as ensuring that the road surface is properly graded to direct water away.

3.3 Routine Maintenance Practices

Routine maintenance involves regular, often daily, or weekly, activities aimed at preserving the functionality of the road. This includes tasks such as street sweeping to remove debris that could cause damage or pose a safety hazard, and grass cutting along roadside verges to maintain visibility.

Another routine maintenance practice is pothole repair. Potholes are not only a safety hazard, but they can also cause damage to vehicles. Repairing them promptly can prevent accidents and reduce maintenance costs for road users.

Routine maintenance also includes the upkeep of street furniture such as benches, trash bins, and signage, as well as the maintenance of streetlights to ensure visibility and safety at night.

3.4 Periodic Maintenance

Periodic maintenance refers to major activities carried out at longer intervals, typically every few years, to restore the road's structural integrity and surface characteristics. This might involve resurfacing or overlaying the road when the pavement has deteriorated to a point where simple surface treatments are no longer effective.

Rehabilitation works also come under periodic maintenance, which may include full-depth repairs where portions of the pavement structure are completely reconstructed. In some cases, periodic maintenance might involve road widening to accommodate increased traffic volume or changes in traffic patterns.

Periodic maintenance also includes major repairs or replacement of road-related structures such as bridges, culverts, and large signs. These activities are planned based on regular inspections that assess the condition of these structures.

4. ROAD REPAIR

4.1 Identifying Road Damage

Municipal road damage comes in many forms, from simple potholes to more serious structural failures. To properly identify and document these issues, one needs to follow a systematic process that involves several steps:

4.1.1 Preliminary Planning

- **Develop a checklist:** MC should develop a detailed checklist of possible types of damage, including potholes, cracks, rutting, depression, raveling, shoving, bleeding, stripping, and block cracking.
- **Get appropriate tools:** MC will need a variety of tools to measure damage and record its findings. These could include a measuring tape, a camera, a notepad, or mobile device for making notes, and safety gear (like a reflective vest).
- **Define the survey area:** Identify the stretch of road to be inspected. This could be all the roads in a particular area of the city, or it could be specific roads known to have issues.
- **Hierarchy Map:** For identifying provincial, District and MC roads we need to prepare a hierarchy map of these roads showing clearly provincial roads, NHA roads, District roads and MC roads in different colors. This map will used by each Engineer, and other officers and officials of MC. The information can be compiled in the proforma as under:

Table 1: Sample Hierarchy Form

S. #	Road Hierarchy	Approx. length (km)	
		Kacha	Metaled
1.			
2.			
3.			
4.			

- **MC Road Map:** Create a proper road map for each MC. For creating a permanent reference of each road in MC records, each road should be numbered. The following designation may be used for different kinds of roads.
    - Primary or main roads - **P**
    - Secondary or approach/Access roads - **S**
    - Tertiary or distribution roads/lanes - **T**

Each designation will have separate Serial Numbers. These numbers should be written with their designation on the detailed map of MC preferably on 1:500 or 1" = 400ft. If possible, a map of 1" = 200' may be prepared in part and fixed on wall of Committee/Conference room to show the detailed streets as well. This will help to assess the current position of roads and streets in the town and will also help in planning process. Undermentioned symbols may be used in preparation of this map.

Table 2: Road Map Samples

Sr. #	Description of road/structure		Symbol	Colour
1.	NHA Roads			Pink bold line
2.	Provincial Roads			Black bold line
3.	District roads			Red bold line
4.	MC Roads: Metaled			Green bold line
	Brick Paved			Green thin line
	Unmetalled			Green dotted line
5.	Culvert / Bridge			Black
6.	Road Designation & number	ROW (ft)	S-15 18	Black
		Metaled width (ft)		
7.	Chowks (crossroads)		3	Orange colour fill with chowk number inside in black
	Flyovers		1	Thick loop of the same colour as that of flying road with flyover No. in circle
9.	Underpass		1	Thick arrow on under passing road in its colour with underpass No. in circle.
10.	Traffic Signal			Black line with colour fill green on right red on left

4.1.2 Inspection

- **Visual inspection:** The relevant MC staff should walk or drive slowly along the road, looking carefully for any signs of damage. The staff should use its checklist to ensure they do not overlook anything.
- **Measurement:** When the staff finds a problem, it should measure the extent of damage. For a pothole or crack, the staff will need to record its length, width, and depth. For other types of damage, the staff may need to use different measurement techniques.
- **Photographic evidence:** The MC staff should take clear, well-lit photos of the damage from multiple angles. This will help others understand the extent of the problem and assist in planning repairs.
- **Notation:** The staff should make notes about the location and extent of the damage. They might find it helpful to sketch a quick map or could use a GPS-enabled device to record precise locations.

4.1.3 Data Analysis

- **Identify Patterns:** The staff needs to look for certain areas where damage is more prevalent, or certain types of damage that may occur together. This could point to underlying issues that need to be addressed.

- **Prioritize Issues:** Not all damage is equal. Some issues might be cosmetic, while others could be safety hazards. The MC staff should rank the issues it finds in terms of urgency.

4.1.4 Reporting

- **Compile your findings:** The staff should bring together all the notes, measurements, and photographs taken into a single report.
- **Include recommendations:** Based on the observations and the severity of the issues found, the staff should make recommendations as to which problems should be addressed first and suggest possible solutions or further investigations if needed.
- **Present the report to the relevant authority:** The final step is to present the findings to the municipal authorities or other relevant bodies. They can then use the report to plan repairs and allocate resources.

4.2 Techniques for Road Repair

Repairing municipal roads is a complex process that requires a deep understanding of the different types of damage and the appropriate repair techniques for each one. The appropriate technique depends on the severity and type of road damage, the volume and type of traffic on the road, the local climate, and the available budget. The repair process usually also includes quality assurance procedures to ensure that the work was done properly.

Here's a review of several common repair techniques for various types of road damage:

4.2.1 Pothole Repair

- **Throw-and-go:** As an expedient and cost-effective solution, the throw-and-go method is often deployed for immediate fixes, particularly in adverse weather conditions or in high-traffic areas where more extensive repairs might cause unnecessary delays. In this method, workers shovel a cold patch asphalt mixture directly into the pothole. This mixture typically includes a solvent that stays pliable even in colder temperatures, making it a go-to option for emergency winter repairs. While it's the fastest method, the downside is its lack of longevity; the fill material often dislodges due to traffic or weather conditions, necessitating repeated applications.
- **Throw-and-roll:** The throw-and-roll method is a slight upgrade from the throw-and-go process. It involves the same filling of the pothole with a cold patch asphalt mixture. However, in this method, the patch is further compacted using a roller or even the repair vehicle's tire. Compaction helps to create a flush surface with the existing pavement and allows for better bonding of the new material, increasing the repair's durability. Although still a temporary fix, this approach is preferable when there's a need for an immediate, yet slightly more long-lasting, solution.
- **Semi-permanent:** This method offers a more enduring solution for pothole repair. It begins with removing any water and debris from the hole, a step that is often skipped in quicker methods but is critical to ensure a strong bond between the existing road surface and the new material. The edges of the pothole are squared off using a pavement saw or jackhammer, facilitating a better connection and reducing the chances of the repair material becoming dislodged. The hole is then filled with a hot or cold patch material and compacted with a roller or vibratory plate. Due to its thorough process, this method provides a longer-lasting repair compared to the previous two methods.
- **Spray-injection:** As the most sophisticated method, spray-injection requires specialized machinery and trained operators. In this method, the pothole doesn't need to be cut or

squared off, nor does it need to be manually cleared of water or debris. Instead, a truck-mounted system uses high-pressure air to remove debris and moisture from the pothole. It then applies a tack coat of binder to the cleaned hole to help the repair material adhere properly. The system injects a mixture of asphalt and aggregate into the pothole, and the material is then left to compact under traffic. Given its mechanized process and the durability of the repair, this method is an ideal choice for larger potholes or for use in regions with substantial budgets for road maintenance.

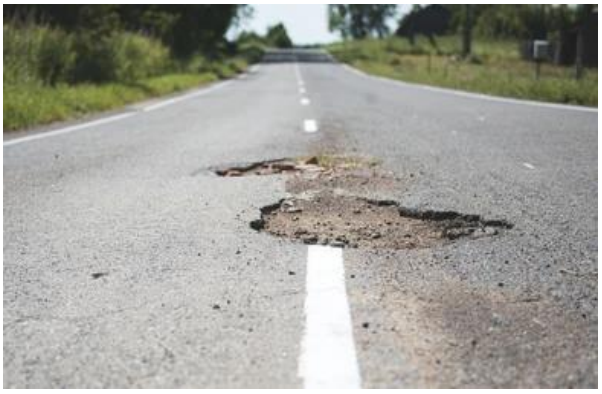

Figure 6: Potholes on the road

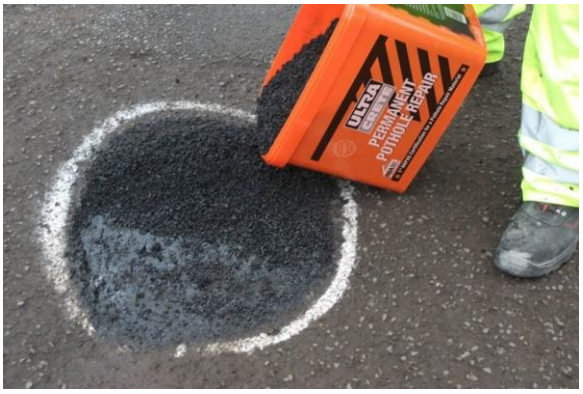

Figure 7: Repair of pothole

4.2.2 Crack Sealing and Filling

- **Clean and seal:** The clean and seal method is typically utilized for active or "working" cracks, which show movement of more than approximately 2.5mm due to temperature changes and pavement movement. The first step in this method involves thorough cleaning of the crack to remove any debris, dust, or vegetation. High-pressure air or heat lances are commonly used to ensure the crack is free of moisture and other contaminants, providing a clean surface for the sealant to adhere to. Once cleaned, a high-quality sealant material is applied into the crack. Sealants usually consist of rubberized asphalt or silicone that can move with the crack while providing a waterproof seal. The primary purpose of the clean and seal method is to prevent water intrusion into the pavement subbase, which can cause significant damage and reduce the overall lifespan of the pavement.
- **Saw and seal:** The saw and seal method is a preventive maintenance technique primarily used in new pavements or as a part of a rehabilitation project. In this technique, a pavement saw is used to induce a clean, well-defined crack in the pavement, which is expected to be the point of least resistance for future crack formation. The induced crack is then filled with a sealant, creating a 'controlled' crack that helps manage pavement cracking and can prevent the formation of random, uncontrolled cracks. By preemptively establishing where the crack will form and ensuring it is properly sealed, this method mitigates potential damage to the pavement structure caused by water infiltration and subsequent freeze-thaw cycles. Although the upfront costs for the saw and seal method can be higher due to the need for specialized equipment and labor, the long-term benefits in extending pavement life can make it a cost-effective option.

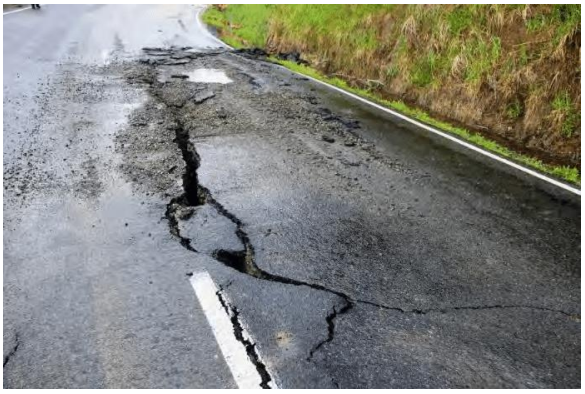

Figure 8: Cracks on the Road

Figure 9: Repair of Cracks using Saw and Seal Method

4.2.3 Surface Treatments

- **Chip seal (or Tar-and-Chip):** This is a cost-effective method that involves the application of a layer of asphalt emulsion or hot liquid asphalt on the road surface, followed by a layer of crushed stone or gravel. These materials are then rolled to embed the stones into the asphalt. This technique provides a rugged and durable driving surface, improves traction, and seals small cracks, preventing water intrusion. Chip sealing is particularly effective for low-traffic roads and rural areas.
- **Micro surfacing or slurry seal:** Both these techniques involve the application of a thin layer of asphalt emulsion mixed with finely crushed stone to the road surface. In micro-surfacing, a polymer-modified asphalt emulsion is used, and it can be applied in thicker layers, allowing it to correct minor road imperfections or ruts. Slurry sealing, on the other hand, uses a non-modified asphalt emulsion and is typically applied in a thinner layer. Both methods seal the road surface from water intrusion, restore friction, and improve road appearance. These treatments are fast-drying, allowing roads to be reopened to traffic soon after application.
- **Fog seal:** Fog sealing is a light application of diluted, slow-setting asphalt emulsion over the existing road surface. The emulsion fills small voids and cracks and seals the pavement surface from water infiltration. It also helps to reduce surface raveling by gluing together loose stones on the asphalt surface. This method is cost-effective and can prolong the lifespan of the pavement, but it's primarily used on low-traffic roads as it doesn't significantly enhance the road's structural capacity.

4.2.4 Overlays

- **Thin overlays:** Thin overlays typically consist of layers of asphalt mix that are 1 to 2 inches thick. These overlays are commonly composed of high-quality, durable aggregates mixed with modified asphalt binder, ensuring a combination of strength, durability, and flexibility. Thin overlays serve a dual purpose - they enhance ride quality by providing a smooth, even surface and reduce pavement distress by sealing the existing pavement from water intrusion and oxidative damage from sunlight. Additionally, they can improve surface friction, leading to safer driving conditions. Thin overlays are a cost-effective solution for maintaining roadways, as they require less material and time to apply compared to thicker overlays. They can be used on various types of roadways, from residential streets to high-speed highways.

Figure 10: Thin Overlay on existing Road

- **Thick overlays:** Thick overlays, often more than 2 inches thick, are used when the pavement requires a significant structural boost or when major improvements in ride quality are desired. They are designed to bear heavier traffic loads and to correct structural deficiencies in the existing pavement, such as rutting or fatigue cracking. Like thin overlays, they're composed of an asphalt mix, but the aggregate size and mixture proportions may vary depending on the intended use. Applying a thick overlay can also help to restore proper drainage and cross-slope, or the side-to-side tilt of the roadway. While thick overlays demand a higher upfront cost due to the increased amount of material and labor needed for application, they offer long-term benefits by significantly extending the roadway's service life.

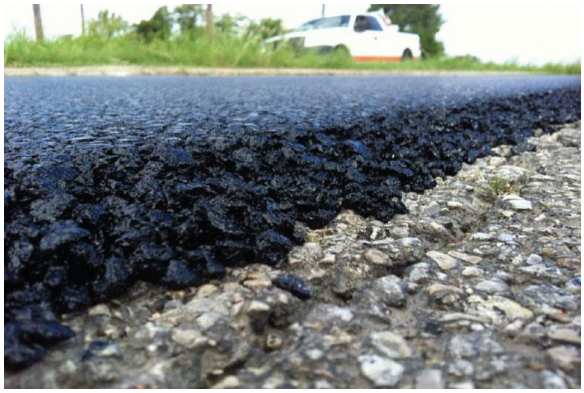

Figure 11: Thick Overlay on existing Road

4.2.5 Reconstruction

- This is required when the pavement has completely failed. It involves the complete removal and replacement of the existing pavement. This is the most expensive solution but is sometimes the only viable option for severely damaged roads.

4.2.6 Application of Road Markings

Road markings play a crucial role in maintaining orderly traffic and promoting safety on our roads. Here's a detailed explanation of how these markings are typically applied:

- **Preparation:** Before any new marking is applied, the road surface must be properly prepared. This can involve cleaning the surface to remove any dirt, oil, or existing loose material. In some cases, especially if the road surface is old or worn, it may be necessary to remove existing

markings using methods such as sandblasting or grinding. For new asphalt, it is essential to ensure that the surface is cured adequately before applying markings.

- **Layout:** The next step is to lay out the road markings. This typically involves measuring and marking where the lines will go using chalk or temporary marking paint. This layout will act as a guide when applying the permanent markings.
- **Application of Paint:** There are several methods to apply road markings, but the most common is the use of specialized vehicles equipped with marking machines. These machines can accurately dispense the marking material (paint, thermoplastic, tape, etc.) following the pre-marked guides. The paint is usually applied with a spray gun that is set at a specific pressure to ensure an even distribution.
- For straight lines, such as lane divisions and crosswalks, the marking machine can move continuously along the road. For more complex patterns, like arrows or words, a stencil is often used.
- Road marking paint usually contains reflective glass beads. These beads are sprinkled on the wet paint immediately after it is applied to increase visibility at night. The beads reflect light from vehicle headlights back to the driver, making the markings easier to see.
- **Curing:** Once applied, the marking material needs time to dry or cure. The exact time depends on the type of material used and the weather conditions. During this time, the road section is usually closed off to prevent vehicles from smearing the fresh paint.
- **Quality Control:** After the markings have dried, a final inspection is carried out to ensure the markings are clear, straight, and meet the required standards. Any necessary touch-ups are made at this stage.

Figure 12: Road marking by marking Machine

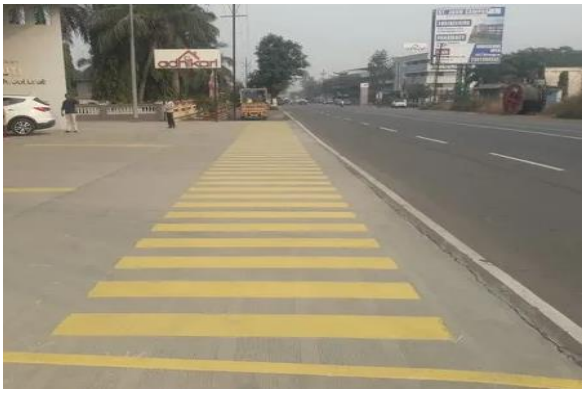

Figure 13: Proper Marked Road

The materials used for road markings, such as paint, thermoplastic, preformed tape, or epoxy, can vary depending on factors like the expected traffic volume, weather conditions, and the road surface material. Each material has its benefits and trade-offs in terms of cost, durability, application method, and drying time. The choice of material will greatly influence the application process. The MC should keep track of the road markings and allocate sufficient staff for replace/redo the markings when required (refer to Table 11&12 for details).

4.3 Special Considerations for Urban Roads

Urban road repair has its unique set of challenges due to various factors such as the volume of traffic, the presence of businesses and homes, and the underlying utilities. Here are some special considerations to keep in mind:

- Traffic Management: This is one of the most significant challenges for urban road repair. It's essential to minimize disruptions to traffic flow and ensure the safety of road users during repair work. This might involve working during off-peak hours, setting up detours, or maintaining at least one lane of traffic open at all times. Proper signage and safety measures should also be put in place.

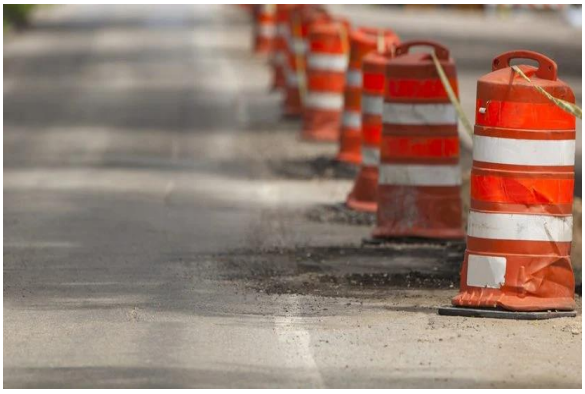

Figure 14: Traffic Diversion while road Repair

Figure 15: Road Works Sign

- Pedestrian and Cycling Infrastructure: Urban roads often include pedestrian walkways and cycling lanes. The maintenance and repair work should consider these elements to ensure safety and accessibility.
- Noise and Dust Control: Urban areas are dense with residents and businesses, so noise and dust from repair work can be a significant issue. Contractors may need to use noise-reduction equipment, dust suppression techniques, or schedule work during certain hours to minimize the impact on the surrounding community.
- Access to Businesses and Homes: Repair work shouldn't cut off access to homes or businesses. Temporary access routes may need to be set up, and stakeholders should be informed of the work schedule and how it will affect them.
- Public Transport: Buses, trams, or other public transport systems might use urban roads, and any repair work could disrupt their schedules. It's essential to work with the public transport agencies to mitigate the impact.
- Utilities: Urban roads often have various utilities running underneath them, including water, gas, electricity, and telecommunications services. Any road repair work needs to consider these and take steps to avoid damaging them. In some cases, repair work can be coordinated with utility maintenance or upgrade schedules.
- Parking: In many urban areas, street parking is a valuable resource. Road repair work could temporarily eliminate parking spots, so alternatives should be considered and communicated.
- Environmental Impact: The environmental impact of road repairs, including emissions from equipment and vehicles, disposal of old road materials, and runoff of materials into local waterways, should be minimized.
- Community Engagement: Communication with the local community is critical. Residents, businesses, and other stakeholders should be informed about the schedule, the expected disruptions, and the benefits the repairs will bring.
- Aesthetic and Cultural Considerations: In some urban areas, particularly historic districts, there might be aesthetic or cultural considerations to take into account. The materials and methods used for road repair might need to be compatible with the surrounding streetscape.

In summary, urban road repair requires careful planning and coordination with various stakeholders to minimize disruptions, ensure safety, and maximize the effectiveness of the repairs.

5. PLANNING AND PRIORITIZATION

The following aspects needs to be taken into account, for development of an effective road maintenance and repair plan

- **Developing improved information systems to promptly address issues**: Gain a comprehensive understanding of repair and maintenance requirements, and thus establish a robust basis for budgeting.
- **Taking measures to build support for improved operations and maintenance (O&M):** Specifically, the MC management should document the outcomes of recently conducted maintenance activities executed and share the results with the Chairperson, Vice Chairperson, and other municipal officials and elected representatives.
- **Alterations in the design of new roads to simplify maintenance:** Such alterations might include making additional arrangements for drainage (as roads and drains should be considered in tandem) and perhaps increasing the use of concrete roads in areas prone to regular flooding.
- **Creating a Year-Round Repair Schedule:** Once a comprehensive database of all the roads and their respective repair and maintenance costs per annum is developed, it will be possible to formulate an appropriate year-round repair schedule for roads. Roads of highest importance should be addressed first.

5.1 Development of Improved Information Base

To secure the necessary funds for road maintenance and repair in the Annual Budget, the MC must accurately determine the required financial resources. This task is impossible without having a comprehensive understanding of the infrastructure at hand. Therefore, the information that needs to be gathered includes:

- Surface area of the road that needs maintenance and repair.
- Kinds of surfaces involved.
- Expense associated with such repairs

5.1.1 Primary Information

To allocate funds in the upcoming budget, MC must make a swift preliminary estimation of the cost of repair and maintenance, particularly when there is not enough time to gather precise details. For this purpose, the following steps might be pursued:

- Determine the total length of roads under the MC's jurisdiction.
- Measure the surface area of primary/secondary and tertiary roads/lanes separately.
- Compute the maintenance cost for primary/secondary roads and tertiary roads/lanes independently.
- Assess the length of cross-drainage works and calculate the potential cost.
- Combine these costs to figure out the expense for repair and maintenance of primary/secondary roads and tertiary roads/lanes separately.
- Utilize the combined sum as an initial estimation of the funds that need to be allocated for road maintenance and repair. Current spending on maintenance and repair is likely to be lower than this figure, so the approximate figure should be used to advocate for increased funding for maintenance and repair. When making the case for increased maintenance and repair funds, emphasize that neglecting regular maintenance and repair could significantly increase the long-term cost of repair and rehabilitation.

5.1.2 Comprehensive Information Repository

5.1.2.1 The Infrastructure Database.

The MC should carry out detailed survey of roads and record relevant data for development of comprehensive database for roads. The templates for data collection are provided in **Annexure-A**. After the inspection and survey of each road, the data required in tables 6, 7, 8, and 9 should be compiled for a permanent record in the office. Prioritize the primary/secondary roads first, followed by tertiary roads/lanes.

This database will be instrumental in future planning, budgeting for maintenance and repairs, and accurate estimation of repairs. MO (I & S) can constitute a dedicated team comprising sub-engineers and a surveyor for surveying all the MC roads to compile this database. The data will be collected in relation to each type of road found within the MC. These may include

a) Bituminous roads such as
   - Asphalt concrete roads
   - Triple surface treatment roads
b) Concrete roads and walkways
c) Water-bound macadam (WBM) roads
d) Unpaved roads and pathways

Each of these roads will have a different anticipated lifespan and varying maintenance needs. Data must be gathered on the area and condition of road surface and the average maintenance cost. Local conditions may influence the latter. For example, maintenance costs for bituminous roads subjected to frequent flooding, or built on poor soils, will be significantly higher than in other areas.

5.1.2.2 Road Database register

A register should be established to store this data for future reference. All the information in these tables will be based on the physical characteristics and construction type of the roads. In addition to these features, emphasis must be placed on gathering the following information:

a) When was the road last repaired or resurfaced?
b) Factors impacting the maintenance level, such as heavy traffic, frequent flooding, high water table, higher axle loads, and similar issues.
c) The current condition of the road, which might include:
   - Smooth surface in a good state
   - Generally good condition but with water-induced deterioration
   - Generally good condition but with edge failure
   - Surface with potholes
   - Rough and damaged surface
   - Cracked surface
   - Surface with ruts and ravels
   - Any other condition
d) The action required, which would briefly indicate whether the road needs minor repairs, special repairs, pothole filling, edge remaking, or complete reconstruction with or without elevation.

5.1.2.3 Repair and Maintenance Cost Estimate

After determining the surface area of different types of roads, MC staff can estimate the total cost of repair and maintenance for each road separately. The preliminary unit cost of repair and/or maintenance of surface area can be calculated using the current rates of labor and materials. These

rates can later be adjusted based on the actual cost of repair and the difference between the estimated rates and the actual repair costs.

5.1.2.4 Management Information

The scope of management information should include:

- The availability of data such as plans, details of problematic areas, etc. (Table - 14).
- Details of repair/maintenance teams along with their responsibilities, with particular attention to the areas they manage (Table - 13).
- Records of standard maintenance routines, performed repair tasks, materials utilized, and costs incurred. This necessitates recording each repair task, along with the time and materials needed to complete it (Table - 10 & 13).
- Documentation of the locations of maintenance and repair activities (Table - 13). This will contribute to understanding where the maintenance needs seem to be more pronounced. Such understanding will allow further investigation to determine if the increased frequency of maintenance and/or repair is justified by local conditions or if there's a need to improve procedures to ensure tasks are carried out correctly.
- Information should be maintained at the municipal level. If some maintenance and repair responsibilities are devolved to the local level, supervisors overseeing those areas should be motivated to maintain their own records and to submit these records to the "central" body for inclusion in the municipality records.

This data can be consolidated into a database, which can be connected to system plans and eventually integrated into a Geographical Information System (GIS).

5.2 Enhancement of Management for Optimized Operation & Maintenance (O&M)

Establishing enhanced information systems, as discussed above, is a crucial first move in devising improved management strategies for O&M. Only when a registry of roads exists, comprising data on construction type, condition, history, and costs of repair and maintenance, can informed management decisions be made.

However, this is only the initial step. It will also be essential to ensure that the necessary repairs are executed promptly, competently, and to the required standard, necessitating improved management systems.

At the structural level, MC's management should contemplate two options:

- Decentralization of powers and responsibilities for various aspects of road maintenance, to lower echelons within the MC.
- Increased participation of private contractors in O&M.

5.3 Decentralized Approach to Road Inspection and Repair

a) It will be unfeasible for the MO (I & S) to regularly inspect every road within the MC. A more viable option would be to delegate responsibilities.

Municipal engineering staff should inspect all MC roads. As a rule, each road should undergo inspection for visible signs of wear tear every three months, especially after heavy rainfall.

Responsibility for inspecting roads should be delegated to lower levels such as Sub Engineers, with each officer assigned different areas of responsibility. Following each inspection, every team leader should establish a register of roads according to the provided template. All data should then be transferred to the main register with the MO (I&S).

b) Encourage community members to report any issues concerning road surfacing and drain performance.
c) Classify problems into those requiring immediate action and those that can be attended to later. Generally, a problem will necessitate immediate attention if one or more of the following conditions apply:
    - It occurs on a heavily trafficked road.
    - It occurs in a low-lying area prone to frequent flooding.
    - It has developed rapidly, posing a risk of further deterioration if left unaddressed.

5.3.1 Delegation of Powers and Responsibilities

There may be benefits in adopting a decentralized structure where maintenance and repair staff are segregated into teams, with each team being accountable for a specific area within the city. This would ensure that each team is familiar with its respective area and comprehends the potential issues that could arise there. The teams can be formed depending upon the size of the MC and the staff available within.

- **MCs led by a grade 17 officer as Municipal Officer (I&S)**

  Constitute teams with a sub-engineer as the lead and supervisors as team members.

- **MCs led by a grade 18 or 19 officer as Municipal Officer (I&S)**

  Constitute teams with Sub Engineers as the team members.

To guarantee effective operation, it will be necessary to:

- Precisely delineate the area to be managed by each maintenance team, as presented in Table 12 above.
- Establish detailed records of the roads within the maintenance area and ensure that these records are accessible to the leader of the delegated team.
- Guarantee that team leaders have straightforward access to the materials and equipment needed to execute repairs.
- Ensure the existence of clear procedures for documenting work as it is done and for keeping track of materials used.

5.4 Engaging Private Contractors

A key benefit of a decentralized approach to repair and maintenance management is the potential to engage private contractors for executing maintenance and repair tasks within specific zones. If this option is pursued, it's crucial to maintain comprehensive records and establish a system to oversee the maintenance and repair work. The oversight must consider:

- Work completion volume – is the contractor fulfilling the responsibilities they've been contracted for?
- Work quality – is the contractor meeting the necessary standards and specifications?

Efficient monitoring relies on clear and enforceable contracts, which in turn is dependent on the quality of contract documentation. Standard specifications and agreed payment rates should be established for common maintenance and repair tasks, and these should be included in the contract documentation. After the contract has been awarded, straightforward pro-forma record sheets can be maintained to note when and where maintenance and repair tasks have been performed, including the area serviced and costs incurred.

Don't take for granted that hiring a private contractor will inherently resolve all maintenance and repair issues of the MC. Keep in mind that contractors, regardless of their size, need to profit and might falter if they face substantial cash-flow issues. This implies the need to ensure that:

- Agreed rates are reasonable, and
- Payments are made regularly, without unnecessary delays.

On the other hand, contractors should be highly capable to perform tasks to the highest standard and must execute tasks effectively and efficiently. This indicates the need for:

- Robust procedures for selecting operation and maintenance contractors. Generally, MC's management should aim to develop a select list of contractors and only award contracts if a minimum of 3 responsive bids are received.
- One possible exception to the last point could be granting small contracts to community contracting groups to perform essential maintenance and repair within their own areas.
- Ensuring the contract documentation is unambiguous and equitable.
- Effectively monitoring the contractors' performance.

5.5 Establishment of Monitoring Systems for Operations & Maintenance (O&M)

Performance targets serve as a clear metric for the intended achievements in operations and maintenance. For them to be valuable, they need to be quantifiable and defined based on some sort of objectively verifiable indicator (OVI).

Here are some potential OVIs. The management of the MC should select the indicators that their respective MC can easily measure. Avoid selecting indicators that are impractical to measure:

- Percentage of roads rated as poor
- Number of potholes (with an area exceeding 1.0 sq ft) per kilometer
- Citizen satisfaction rate with the roads
- Number of road-related accidents in the MC
- Percentage of fully operational traffic lights in MC
- Number of registered complaints about the roads
- Citizen satisfaction rate with traffic and street signs
- Number of traffic and street signs with limited or no visibility

Maintenance and repair costs should be minimal for the first few years following a road's surfacing or resurfacing; however, they will likely increase over time. When compiling data on the cost of maintenance, it's advisable to initially focus on roads that have been surfaced or resurfaced. For each road, maintain an annual record of the required maintenance and repair actions and the associated costs (refer to Table 13). Although some variation is to be expected, these records will help the MC to develop an understanding of how much they should anticipate spending on maintenance and repair for roads of different ages. A delay in addressing issues may lead to road surface failure and subsequently high costs for replacing parts or the entire road.

5.6 Schedules of O&M Tasks

a) The next course of action should involve constructing detailed timetables for the execution of operations and maintenance tasks, as outlined below:
    - Identify system components in need of maintenance and repair. (Refer to the subsequent table for a list of components.) The management of the MC should review this in consideration of their unique local circumstances and make necessary additions or deletions.
    - For each system component, scrutinize existing O&M processes and identify available resources, current responsibilities, and ongoing issues and shortcomings.

- Drawing from this analysis, form a list of tasks to be performed for each system component. Document these tasks in a table, providing details on the task, the method and timing of execution, any necessary equipment and materials, and the process for tracking implementation. See **Annexure-B** for details.

b) The MO (I & S) and other senior municipal personnel should possess a copy of the comprehensive task list. Individuals responsible for specific system components should have copies of the portions of the list related to their areas of responsibility.

c) MC staff may feel they lack sufficient information to finalize the task list. In such cases, it's generally recommended to complete the list to the best of their ability using current knowledge and information, and subsequently update and refine it based on experience.

d) Pay close attention to new equipment, ensuring that it undergoes regular inspections in its initial weeks and months of operation so potential issues can be detected and rectified.

e) Make sure the procedures to follow in the event of problems and failures are clear. If suitable, provide a simple flow chart. This should illustrate the steps to be taken from the initial inspection report to the completion of the work necessary to address a problem, outlining the responsibilities at each stage and establishing a maximum allowable time for each phase of the process.

6. ENVIRONMENTAL AND SOCIAL IMPLICATIONS

6.1 Environmental Impact of Road Maintenance and Repair

Road maintenance and repair activities can have a significant impact on the environment so, the National Environmental Quality (Protection and Quality Regulations 1990, 1996 and 2000) identifies specific industrial sources to control and issue an Environmental Protection License is required to discharge wastes to the environment under controlled conditions. Where the project contractors require cement, concrete or granite-based products for improvement projects, the materials must be obtained from facilities having a relevant and current Environmental Protection License.

Some key environmental considerations include:

- **Emissions and Air Quality:** Road repair activities often involve the use of machinery that emits greenhouse gases. Moreover, dust generated during the work can degrade local air quality.
  In pursuance of the statutory requirement under clause (e) of sub-section (1) of section (6) of the Pakistan Environmental Protection Act, 1997(XXXIV of 1997), the Pakistan Environmental Protection Agency, with prior approval of the Pakistan Environmental Protection Council, revised the NEQS for Ambient Air in 2010.

Table 3: Ambient Air Quality Standards

Pollutants	Time-weighted average	Concentration in Ambient Air (Effective from 1st January 2012)	Method of Measurement
Sulphur Dioxide (So2)	Annual Average*	80 µg/m^3	Ultraviolet Fluorescence method
	24 hours**	120 µg/m^3	
Oxide of Nitrogen (NO)	Annual Average*	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	40 µg/m^3	
Oxide of Nitrogen as (NO2)	Annual Average*	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	80 µg/m^3	
Lead (PB)	Annual Average*	1 µg/m^3	ASS method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m^3	
Carbon Monoxide (CO)	Annual Average*	5 µg/m^3	Nom Dispersive Infra-Red (NDIR) method
		10 µg/m^3	
*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval			
** 24 hourly /8 hourly values should be met 98% of the year, 2% of the time, it may exceed but not in two consecutive days			

- **Noise Pollution:** Road repair works can cause considerable noise, affecting local wildlife and ecosystems.
  In pursuance of the statutory requirement under clause (c) of sub-section (1) of section (6) of the Pakistan Environmental Protection Act, 1997 (XXXIV of 1997), the Pakistan Environmental Protection Agency, with prior approval of the Pakistan Environmental Protection Council, revised the NEQS for Noise (2010). These standards are established for four different categories which include residential area, commercial area, industrial area and silent zone. These standards vary according to the day and night timing, daytime hours are 6:00 am to 10:00 pm and nighttime hours are 10:00 pm to 6:00 am. USEPA standards and World Bank guidelines along with National Environmental Quality Standards for noise effective from January 2012 are given below

Table 4: Noise Quality Standards

Sr. #	Category of Area	NEQS		WB guidelines		USEPA Standards	
		Day Time (dB)	Nighttime (dB)	Day Time (dB)	Nighttime (dB)	Indoor (dB)	Outdoor (dB)
1	Residential Area	55	45	55	45	45	55
2	Commercial Area	65	55	70	70	70	70

- **Water Quality:** Improper disposal of materials or run-off from the repair site can contaminate local water sources, affecting both wildlife and human populations. So, NEQs specifies some standard for discharges to reduce their impact.
  The parameters which are relevant to the contractor's activity and discharges to surface water or surface water courses and their limits during the proposed project are listed in table below

Table 5: National Environmental Quality Standards for Effluent Discharge

Sr. #	Parameter	Limit
1	Temperature	<40 C
2	pH	>6 and <10
3	Biological Oxygen Demand (BOD5)	<80 mg/l
4	Chemical Oxygen Demand (COD)	<150 mg/l
5	Total Suspended Solids (TSS)	<150 mg/l
6	Grease and Oil	<10 mg/l
7	An-ionic detergents (as MBAS)	<20 mg/l
8	Ammonia (NH_3)	<40 mg/l
9	Chlorine	<1.0 mg/l

- **Waste Management:** Waste materials, especially non-biodegradable ones like asphalt and concrete, need to be properly managed to prevent environmental harm.
- **Biodiversity:** Construction activities can disrupt local habitats, affecting local flora and fauna.

To mitigate these impacts, it's crucial to incorporate environmentally friendly practices, such as using low-emission machinery, recycling and reusing materials, implementing noise control measures, ensuring proper waste disposal, and minimizing disruption to local habitats.

6.2 Social Implications and Community Engagement

The social implications of road maintenance and repair include:

- **Mobility and Accessibility:** Road repair works can disrupt normal traffic flow and limit access to homes, businesses, and other facilities. This can affect people's daily lives, including their ability to commute to work or school, and access services.
- **Noise and Dust:** Construction activities can generate noise and dust that affect local residents, particularly those who are vulnerable, such as the elderly and those with respiratory issues.
- **Employment Opportunities:** On the positive side, road repair projects can generate local employment opportunities.

Effective community engagement is key to managing these social implications. This includes:

- **Communication:** Informing residents and businesses about the timing, scope, and impact of road repair works. This can be done through public meetings, newsletters, websites, and social media.
- **Consultation:** Consulting with the community before and during the project to understand their concerns and take them into account in the planning and implementation of the project.
- **Complaints Management:** Providing a mechanism for people to raise concerns or complaints and ensuring these are addressed in a timely and fair manner.
- **Benefits Sharing:** Where possible, benefits from the project (such as employment opportunities) should be shared with the local community.

By considering the environmental and social implications of road maintenance and repair, and by engaging effectively with the community, municipalities can minimize negative impacts and maximize the benefits of these projects.

6.3 Health and Safety Considerations

Health and safety are paramount in road maintenance and repair projects. Measures to ensure health and safety include:

- **Risk Assessment:** Identify and assess potential risks to workers and the public. This includes risks related to machinery, traffic, hazardous materials, noise, and dust.
- **Safety Training:** All workers should be properly trained in safety procedures. This includes the correct use of equipment, handling of materials, and response to emergencies.
- **Personal Protective Equipment (PPE):** Workers should be equipped with appropriate PPE, including hard hats, high-visibility clothing, safety footwear, and hearing protection.

- **Traffic Management:** Develop and implement a traffic management plan to ensure the safety of road users and workers. This includes appropriate signage, barriers, and diversions.
- **Emergency Preparedness:** Have a plan in place for dealing with emergencies. This includes first aid facilities, firefighting equipment, and procedures for evacuation or sheltering in place

ANNEXURE-A

Road Designation _____ Road Number _____

Name of Road _____

Table 6: Detail of MC Road

S. #	From	To	Length (ft)	ROW width (ft)	Metalled width (each side)		Shoulders			Foot Paths			Kind of surface asphalt / TST / concrete	Surface area of metalling (sft)	Surface area of other pavements (sft)	
					Single	Dual	One / both side	Width (ft)	Pavement Bricks / C. Pavers/ Kacha	One / both sides	Width (ft)	Pavement brick / c. pavers			Brick pavement.	Concrete pavements.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
	Total															

Table 7: Detail of MC roads (Main / Primary Roads)

S. #	Road designation and number	Name of road	Length (ft)	Width of ROW (ft)	Metaled width each side (ft)		Surface area of metaling (sft)			Surface area of footpaths and shoulders (sft)		Road drainage (longitudinal / cross)				When last repaired / resurfaced	Condition	Factors affecting level of maintenance *	Action required	Average cost of annual maintenance (Rs.)
												Drains		Sewers						
					Single	Dual	Asphalt	TST	Concrete	Brick Pav.	Concrete pavers	Type / size	Length (ft)	DIA (inches)	Length (ft)					
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	
	Total																			

*Factors affecting level of maintenance might be heavy traffic, frequent flooding, higher water table, higher axel loads and others

Table 8: Secondary Roads or Access Roads

S. #	Road designation and number	Name of road	Length (ft)	Width of ROW (ft)	Metaled width each side (ft)		Surface area of metaling (sft)			Surface area of footpaths and shoulders (sft)		Road drainage (longitudinal / cross)				When last repaired / resurfaced	Condition	Factors affecting level of maintenance *	Action required	Average cost of annual maintenance (Rs.)
												Drains		Sewers						
					Single	Dual	Asphalt	TST	Concrete	Brick Pav.	Concrete pavers	Type/ size	Length (ft)	DIA (inches)	Length (ft)					
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
	Total																			
*Factors affecting level of maintenance might be heavy traffic, frequent flooding, higher water table, higher axel loads and others																				

Table 9: Tertiary Road or Distributors (Streets and lanes)

S. #	Road designation and number	Name of road	Length (ft)	Width of ROW (ft)	Metaled width each side (ft)		Surface area of metaling (sft)			Surface area of footpaths and shoulders (sft)		Road drainage (longitudinal / cross)				When last repaired / resurfaced	Condition	Factors affecting level of maintenance *	Action required	Average cost of annual maintenance (Rs.)
												Drains		Sewers						
					Single	Dual	Asphalt	TST	Concrete	Brick Pav.	Concrete pavers	Type/ size	Length (ft)	DIA (inches)	Length (ft)					
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
	Total																			
*Factors affecting level of maintenance might be heavy traffic, frequent flooding, higher water table, higher axel loads and others																				

Table 10: Roads Repaired in Last Year and Targets for Current Year

S.#	Activity	Unit	Completed in last year (km)				Targets for current year (km)			
			By own labour	By contractor	Total	Cost (Rs.)	By own labour	By contractor	Total	Cost (Rs.)
1.	Patch work	Km								
2.	Road cuts	Nos								
3.	Road Resurfacing									
	TST	Km								
	Asphalt	Km								
	PCC	Km								
	Concrete pavers	Km								
	Total									

Table 11: Road Marking (Staff Deployed and Requirement)

S. #	Description of Post	Required strength			Actual Available			Short Fall		
		Regular	Contract	Total	Regular	Contract	Total	Regular	Contract	Total
1.	Supervisors									
2.	Painters									
3.	Beldaars									
4.	Others									

Table 12: Road Marking & Traffic Signals (Completed in Last Year and Targets for Current Year)

S. #	Activity	Unit	Completed in last year	Targets for current year
1.	Road marking	Road length (Km)		
2.	Zebra crossing	Nos.		
3.	Kerbs painting	Length (Km)		
4.	Sign boards for traffic	Nos.		
5.	Traffic Signals			
	(i) New installed	Nos.		
	(ii) Old repaired	Nos.		

Total cost of road marking

Completed in last year =Rs. _____Estimated cost of current year =Rs. _____**Repair**

Table 13: Repair and Maintenance Teams and cost / Target

Team. No.	Staff Deputed		Name of roads / areas repaired / maintained					
	Designation	Nos.	Name of roads	Length (km)	Time Period			Cost (Rs.)
					From	To	Days	
1.	Supervisor							
	Tar boiler operators							
	Road roller drivers							
	Dumper/tractor /trolley drivers							
	Beldars							
	others							
2.	As above		As above					
3.	As above		As above					

Table 14: Problem Spots

S. #	Name of road having problem	Road no. with designation	Length under problem	Description of problem	Cause of problem	Cost of repair	When last repaired
1							
2							
3							
4							

ANNEXURE-B

Table 15: M & R Schedule of Tasks - Roads and Paving

M & R Schedule of Tasks - Roads and Paving									
Ref. #	WHAT to do? (Define the O&M Task)	HOW to do? (Follow SOP Ref. #)	WHEN to do? (Frequency)	WHO to do? (Conducted by?)		Do WITH what?		Check DONE? (How to check?)	Who to CHECK? (To be checked by?)
				Class of Work	Worker	(Spares, Materials)	Special Tools, Equipment		
1	BITUMEN TOP – ROADS								
1.A	Pot holes and Ruts		M	R	Sub-Engineer			Visual/ driver observation	MO (I & S)
1.B	Waviness		M	R	Sanitary Inspector			Visual/ driver observation	Sub-Engineer
1.C	Cracking, Bleeding and Crazing		M	R	Road Mason			Visual observation	Sub-Engineer
1.D	Road shoulders		M	R	Sanitary Inspector			Visual/public observation	Sub-Engineer
1.E	Edge Failures		6M	R	Sub-Engineer			Visual/ driver observation	MO (I & S)
1.F	Kerb stones		M	M	Sanitary Inspector			Visual/public observation	Sub-Engineer
1.G	Side drain		W	M	Sanitary Inspector			Visual/public observation	Sub-Engineer
2	CEMENT CONCRETE (CC) ROADS								Sub-Engineer
2.A	Expansion joints sealing		3M	M	Sanitary Inspector			Visual observation	Sub-Engineer
2.B	Contraction joints cracks sealing		3M	M	Sanitary Inspector			Visual observation	Sub-Engineer
2.C	Edge protection		M	M	Sanitary Inspector			Visual observation	Sub-Engineer
2.D	Failed areas replacement		3M	R	Sub-Engineer			Visual/ driver observation	MO (I & S)
3	WATER BOUND MACADAM (WBM) ROADS								
3.A	Low spots filling		W	M	Road Mason			Visual/ driver observation	Sanitary Inspector
3.B	Gulley's erosion		M	M	Road Mason			Visual/ driver observation	Sanitary Inspector
3.C	Soft-spots		D	M	Sanitary Inspector			Visual/ driver observation	Sub-Engineer
3.D	Drain Crossing repair		W	R	Sanitary Inspector			Visual/public observation	Sub-Engineer
3.E	Lay-byes, passing places		M	M	Sub-Engineer			Visual/public observation	MO (I & S)
3.F	Road shoulders		W	M	Sanitary Inspector			Visual/public observation	Sub-Engineer
4	UNMADE / EARTHEN ROADS								
4.A	Regrading		6M	M	Sub-Engineer			Visual/ driver observation	MO (I & S)
4.B	Low spots		W	M	Sanitary Inspector			Visual/ driver observation	Sub-Engineer
4.C	Erosions		M	M	Sanitary Inspector			Visual/ driver observation	Sub-Engineer
4.D	Drain Crossing		M	M	Sanitary Inspector			Visual/public observation	Sub-Engineer
4.E	Lay-byes, passing places		M	M	Sanitary Inspector			Visual/public observation	Sub-Engineer
5	CROSS DRAINAGE WORKS								
5.A	Parapet walls		M	R	Sanitary Inspector			Visual/public observation	Sub-Engineer
5.B	Edge stones		M	R	Sanitary Inspector			Visual/ driver observation	Sub-Engineer
5.C	RCC slab		3M	R	Sub-Engineer			Visual observation	MO (I & S)
5.D	Revetment in slopes		M	R	Sanitary Inspector			Visual observation	Sub-Engineer
5.E	Protection works		M	R	Sub-Engineer			Visual/public observation	MO (I & S)
5.F	Erosion of Bed/ deck slab		M	R	Sub-Engineer			Visual/public observation	MO (I & S)
6	TRAFFIC ISLANDS AND DIVIDERS								
6.A	Civil works		M	R	Sanitary Inspector			Visual observation	Sub-Engineer
6.B	Signals & fabrication work		W	R	Sub-Engineer			Visual/ driver observation	MO (I & S)
7	INTERSECTIONS AND JUNCTIONS								
7.A	Markings & Painting		3M	M	Sanitary Inspector			Visual observation	Sub-Engineer
7.B	Dividers/ Demarcation		3M	M	Sub-Engineer			Visual/ driver observation	MO (I & S)
7.C	Road in embankment		M	M	Sanitary Inspector			Visual observation	Sub-Engineer

7.D	Road in Cutting		M	M	Sub-Engineer			Visual observation	MO (I & S)
8	COMMUNITY FACILITIES								
8.A	Bus Stops		M	M	Sub-Engineer			Visual/public observation	MO (I & S)
8.B	Service Parking		3M	M	Sub-Engineer			Visual/ driver observation	MO (I & S)
8.C	Pedestrian protection		M	M	Sub-Engineer			Visual/public observation	MO (I & S)
8.D	Road Marking		3M	M	Sanitary Inspector			Visual/public observation	MO (I & S)
8.E	Traffic Signals		3M	M	Sub-Engineer			Visual/public observation	MO (I & S)