CITY OF HOUSTON
Public Works and Engineering Department

Storm Water Maintenance Branch Infrastructure Asset Management Plan (IAMP) FY-2017-2022

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OUR VISION

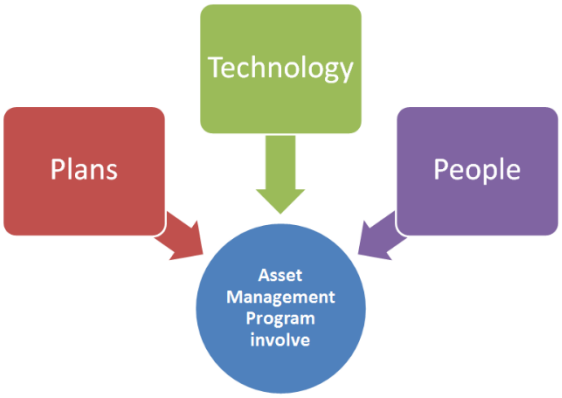
This document is the first Storm Water Maintenance Branch (SWMB) multiple - year plan for the strategic operation and management of the City of Houston's (COH) storm water infrastructure. It focuses on the SWMB's asset management program for the City's **closed and open drainage systems**, setting out clear objectives for the improvement of the current management system, defining desired service levels for each asset type, and providing future year action plans aimed at maintaining and improving the storm water infrastructure at or above the defined service levels.

Our vision is this document will evolve to enable executive managers and City Council to organize and integrate infrastructure strategic objectives across City Departments leading to decisions that guide the City of Houston in future improvements and funding which better service the citizens.

SWMB is committed to strive making the most cost-effective renewal and replacement investments and provide the highest-quality customer service possible.

1.0 SWMB INFRASTRUCTURE ASSET MANAGEMENT PLAN OVERVIEW

The SWMB Infrastructure Asset Management Plan (IAMP) is a comprehensive management approach for assuring the optimum operability of the *existing storm water system* and sub-systems; with minimum asset life-cycle total costs, while providing the expected level of service to users/customers. It will provide guidance for managing capital assets to minimize the total cost of owning and operating them, while delivering the full operability Service Levels of the assets as they are currently configured.



SWMB, as the drainage system owner and operator, is responsible for making sure that its storm water system stays in operable condition—regardless of the age of components or the availability of funds.

In order to meet this responsibility challenge, SWMB is developing and implementing a systematic approach of asset management program that will provide an effective long-term planning, life-cycle costing, proactive operations & maintenance, and capital replacement plans based on cost-benefit analyses.

The use of an effective asset management system will help protect the City's storm water infrastructure and extend financial resources by:

- Making sure asset components are protected from premature failure (optimizing asset life) through proper operations and maintenance;
- Reducing the cost of new or planned investments in infrastructure assets through economic and technical evaluation of options using life-cycle costing and value engineering;
- Facilitating proactive capital improvement planning and implementation over longer cycles to reduce annual operating costs and overall (operating and capital replacement) costs;
- Focusing on results by clearly defining **responsibility**, **accountability**, and **reporting** requirements within the organization.

SWMB IAMP is a **continuous improvement process** that will guide the acquisition, use, and disposal of storm water infrastructure assets to optimize service delivery and minimize costs over the asset's entire functional life. Some of the core components in order to develop a strategic asset management plan are:

1. Inventory - What do we own and where is it?
2. Condition and Operability Assessment
3. Current Asset Performance (Levels of Service)
4. Maintenance Activities & Strategies
5. Selection of Performance Measurements (Key Performance Indicators)
6. Action Items for Continuous Improvement
7. Data Management Tools

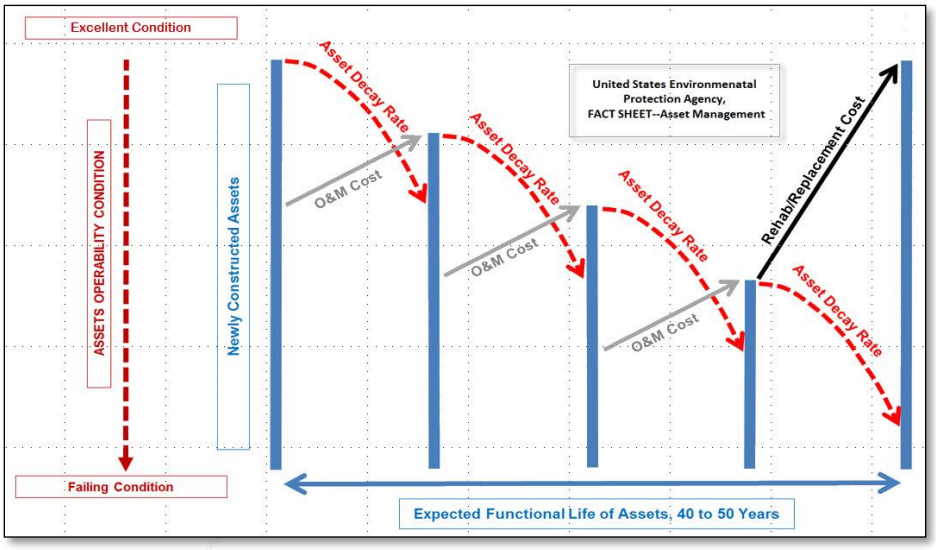


Figure 1: Asset Life Cycle Decay, Maintenance, and Replacement

1.1 Inventory - What do we own and where is it?

The City of Houston storm water system provides rainfall event runoff conveyance for the 650+ square miles of the contiguous City area. The storm water system infrastructure is comprised of the following categories of asset (approximately, as of 01-02-2017):

CLOSED DRAINAGE SYSTEM & ASSETS	3,900 Miles of Storm Gravity Mains 116,504 Storm Drainage Inlets 81,301 Storm Water Manholes/Junction Boxes 6,400 Outfalls 30 Roadway Underpasses with Storm Ponding Level Warning Devices (15 with Pump Stations)
OPEN DRAINAGE SYSTEM & ASSETS	2,800 Total Miles of Roadside Ditch (both sides of street) 90 Total Miles of Off-Road/Major Drainage Ditch 35 Storm Water Detention Basins (~140 acres)

Table 1: Current Total Drainage System Assets Inventory

In order to best serve the citizens of Houston, it is critical for SWMB to have the most up-to-date count of its infrastructure as possible. The ability of SWMB and other Divisions to support all planning and maintenance activities to its fullest is hindered by not having an accurate inventory of all the assets.

1.2 Condition and Operability Assessment

The Government Accounting Standards Board Statement 34 (GASB 34) modified accounting option requires that condition assessment be **based on an up-to-date inventory of assets**, and that the methods used be documented in such a way that the same results could be obtained by someone else performing the same assessment. A condition level measurement scale should be used, and a minimum acceptable condition should be established.

SWMB is tasked on an annual basis to perform condition assessment of its storm water infrastructure in order to identify assets that are underperforming, determine the reasons for the deficiency, predict when failure is likely to occur, and determine what corrective action (preventive, repair, rehabilitation, or reconstruction) is needed and when. Every asset type investigated will follow our prioritization process as described in the following sections.

1.2.1 Storm Sewer Condition Rating System

SWMB will Inspect, Plan, & Prioritize Maintenance of approximately 10% of its **Storm Sewer inventory per fiscal year** (FY). The following **Storm Sewer Condition Rating System** will be used to determine the priority list for our maintenance crews regarding cleaning and infrastructure repairs.

- **GOOD:** Acceptable structural condition. Low Priority; no action needed.
- **FAIR:** Defects that will become POOR within the foreseeable future. No action is needed at this time; however, will nominate as Medium Priority and monitor for future maintenance.
- **POOR:** Defect requires maintenance. Will schedule maintenance as High Priority; Should be completed within 30 days.
- **TBD:** Condition To be Determined. The asset could not be located or inspected using routine methods. Exploratory inspection will be scheduled.

1.2.2 Roadside Ditch Condition Rating System

SWMB will Inspect, Plan, & Prioritize Maintenance of approximately 20% of its **Roadside Ditch inventory per fiscal year** (FY). The following **Roadside Ditch Condition Rating System** will be used to determine the priority list for our maintenance crews.

- **ADEQUATE:** Ditch is functioning as designed; no safety hazard found. No action needed.
- **INADEQUATE:** Ditch requires maintenance. Will schedule maintenance as High Priority; should be completed within 30 days. Inadequate condition can include deficiencies such as blocked or collapsed stub in, roadway, outfall, culvert or crossover; ditch or culvert with significant sediment accumulation; potential public hazard; affecting critical facilities i.e. schools or hospitals.

Some assets may be referred to our Preventive Maintenance Plan, this plan is intended to restore drainage capacity in larger areas that are most in need, effectively maximizing results for the entire neighborhood. The assets referred to our Preventive Maintenance Plan will be ranked and placed on a priority list for planned maintenance and repair work. The planned work prioritization will be based on the volume of incidents reported on the neighborhood, the need and level of maintenance/repairs required, and the CIP projects completed in the area.

1.2.3 Off-Road Ditch Condition Rating System

SWMB will inspect and assess **Off-Road Ditches inventory** at a minimum of **twice per fiscal year** (FY). In addition, the **Off-Road Ditches** will be inspected after extreme rain events to ensure the system is draining appropriately and to identify any damages and/or blockages that may have occurred as a result of the increased runoff.

The following **Off-Road Ditch Condition Rating System** will be used to determine the maintenance priority list for re-grading, cleaning, and infrastructure repairs.

- **GOOD:** Ditch is functioning as designed. Low Priority; no action needed.
- **FAIR:** Needs Minimal to Moderate maintenance repairs to restore optimal operational capacity. Will schedule maintenance as Medium Priority; should be completed within 30 days.
- **POOR:** Needs Major maintenance repairs to restore optimal operational capacity. Will schedule maintenance as High Priority; should be completed within 30 days. Note: If beyond O&M Capabilities, will be referred to the CIP/LDP for further action.

1.2.4 Detention Basin Condition Rating System

SWMB will inspect and assess all Detention Basin Facilities at a minimum of **once per fiscal year** (FY). In addition, the Detention Basin Facilities will be inspected after extreme rain events to ensure the system is draining appropriately and to identify any damages and/or blockages that may have occurred as a result of the increased runoff.

Upon completion of each inspection, the asset will be ranked and placed on a priority list based on the rating system to identify the need and level of maintenance/repairs required. The rating system will be assessed for each asset as needed.

The following Detention Basin Facilities **Condition Rating System** will be used to determine the priority list for our maintenance crews regarding maintenance and repairs.

- **GOOD:** Detention basin is functioning as designed. Low Priority; no action needed.
- **FAIR:** Needs Minimal to Moderate maintenance repairs to restore optimal operational capacity. Will schedule maintenance as Medium Priority; should be completed within 30 days. Routine maintenance can include items such as vegetation, debris/trash removal, minor erosion, concrete cracks, or minor sediment accumulation.
- **POOR**: Immediate Repair Necessary. Needs maintenance repairs to restore optimal operational capacity. Will schedule maintenance as High Priority; should be completed within 30 days. Failure is imminent or has already occurred. This

can include items such as structural failure of a feature, significant erosion, or significant sediment accumulation.

1.3 Current Asset Performance (Levels of Service) & Expected Life

The SWMB, as the designated owner and operator of the City's drainage system, is committed to deliver **the Optimum Service Level** of the storm water infrastructure as it is currently configured, to maintain the flow of the storm water free of debris and foreign objects that would obstruct the flow of storm water drainage, and delivering results in a timely and cost effective manner.

In order to know whether assets are performing satisfactorily, the service levels those assets are expected to provide must be defined. Asset management decisions and the resulting asset performance must be consistent and acceptable to its customers. When asset management decisions are made, only those options that would satisfy service level requirements should be further considered. Because resources are limited, it may sometimes be necessary to adjust service level goals to be compatible with resource availability.

The basic level of service definition for the City's storm water systems will be to deliver reliable conveyance of the normal/day-to-day rainfall (2-year design storm) events at a minimum cost. Existing level of service will be drainage system-specific, particularly in areas where improvements are most needed and will yield the greatest benefits.

Examples of activities to maintain designed level of service include:

- Ensuring adequate system capacity for all service areas
- Eliminating system bottlenecks due to pipe blockages
- Minimizing cost and maximizing effectiveness of programs
- Prioritizing maintenance and repairs to meet Level of Service goals.

TYPE	Expected Functional Life	Inventory (as of 01/02/2017)	Condition Assessment Status
CLOSED DRAINAGE SYSTEM	**50 years** (Gravity mains, manholes, inlets, etc.)	**3,900 Miles of Storm Gravity Mains**	**Good Fair Poor TBD**
OPEN DRAINAGE SYSTEM	**40 years**	**2,800 Total Miles of Roadside Ditch (both sides of street)**	**Adequate Inadequate**
		90 Total Miles of Off-Road/Major Drainage Ditch	**Good Fair Poor TBD**
		35 Storm Water Detention Basins (~140 acres)	**Good Fair Poor**

Table 2: Drainage System Expected Life, Current Inventory, and Condition Ratings

A side-by-side comparison between identified information needs and existing systems to reveal gaps. A prioritized, phased plan is then developed to fill in the gaps. An engineering and economic evaluation of management options for "Bridging the Gap" between **expected** and **actual** asset Service Level will determine the most cost-effective maintenance, repair, and replacement actions to improve the existing asset operability.

1.4 Maintenance Activities & Strategies

The primary categories of asset life cycle management tasks include: a) Inspection; b) Maintenance, and c) Obsolescence renewal

An effective maintenance program keeps the drainage system running smoothly and helps prevent premature deterioration of components. Planning should be performed annually and updated throughout the year as needed to address changing conditions. Maintenance activities are either planned (i.e., inspecting all storm gravity lines in the system every 10 years) or unplanned (i.e., defect repair, emergency blockage removal).

The asset management goal is to **maximize** planned maintenance and **minimize** unplanned maintenance improving system performance and preserve asset condition as long as possible. Planned maintenance is more cost-effective because it is performed on a nonemergency basis, is coordinated with other system operation activities, and provides more opportunity to value engineer activities during the planning process. In general, chronic unplanned maintenance conditions indicate that:

- Planned maintenance is too infrequent
- Planned maintenance is inadequate (activities are ineffective at preventing defects, or needed activities are not being performed)
- The failing component may be too deteriorated to preserve through maintenance, or it is improperly designed, and should be rehabilitated or replaced

TYPE	Estimated Assets' Functional Life (yr)	Approx. Total Assets in SWMB System (GIS)	Unit of Assets in SWMB System	INSPECTION Annual Inspection Best Practices Targets [inspect at least once every 10 years]	MAINTENANCE Annual Maintenance Best Practices Targets [maintain at least 2 times during its expected functional life]	OBSOLESCENCE RENEWAL Annual Obsolescence Renewal Targets
OPEN DRAINAGE SYSTEM	40	**2,800**	Miles	Inspect each ditch portion a minimum of 4 times in its expected operational life; **inspect at least 1 time each 10 years**	Perform routine maintenance on each ditch at least 2 times in its expected operational life; **maintain at least 1 time each 20 years**	Complete replacement at end of its expected operational life: **2.5% of the complete system replaced/renewed annually**
CLOSED DRAINAGE SYSTEM	50	**3,900**	Miles	Inspect each underground pipe portion a minimum of 5 times in its expected operational life; **inspect at least 1 time each 10 years**	Perform routine maintenance on each underground pipe portion at least 2 times in its expected operational life; **maintain at least 1 time each 25 years**	Complete replacement at end of its expected operational life: **2.0% of the complete system replaced/renewed annually**

Table 3: Drainage System Best Practice Targets

Maintenance planning is improved by evaluating the patterns of failures leading to unplanned maintenance to see if they were related to timing (the line failed before the next cleaning was

scheduled); ineffective maintenance methods; or to advanced deterioration or improper design. It is important to document the assumptions, methods, and information used to support maintenance planning analysis.

Reactive maintenance (fail-and-fix) will always be required to some extent since all pending asset failures cannot be identified a priori. However, if only reactive maintenance (repair at failure) is used, the costs of maintenance repairs are higher due to emergency response costs. Asset management is intended to maintain storm water system components over long planning horizons, and finally replaced when deterioration outweighs the benefit of further maintenance—full costs are distributed over the life of the asset.

Utilities can save 20-40% in operations and maintenance costs by prioritizing activities on and investing in the most critical assets.

In the past, due to the high demands of 311, SWMB have been prevented to focus on preventive maintenance (condition based maintenance), which leads us into a reactive mode, with most of the operational resources allocated to emergency response and point repair of failed components. However, SWMB has slowly transitioned maintenance activities from being reactive to being proactive aiming to preserve and restore drainage capacity and lessen the likelihood of asset failure before it actually occurs.

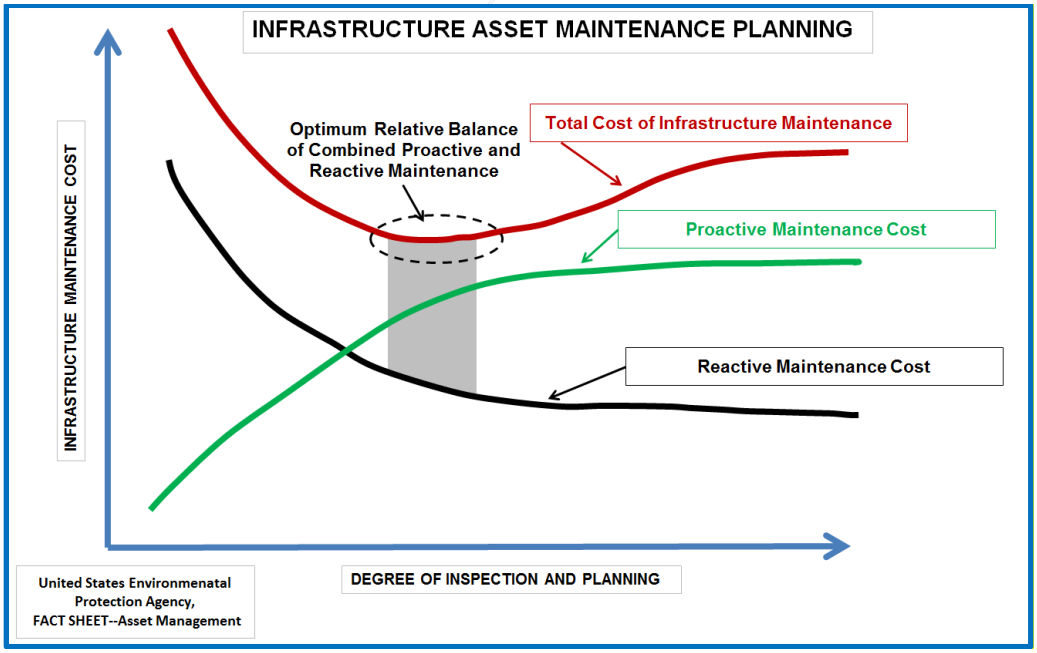


Figure 2: Proactive Maintenance Optimized with Reactive Maintenance

1.5 Selection of Performance Measurements (Key Performance Indicators)

Performances measurements are specific metrics designed to assess whether level of service objectives are being met. Some of the SWMB performance measurements are as follows:

Process Measures	FY-17 Proposed Process Metrics Goals	FY-18 Proposed Process Metrics Goals
Inspect 311 Complaints within 10 days	**90%**	**90%**
Inspect Storm Lines/Leads (this includes gravity mains, manholes, junction boxes, and inlets)	**300 miles**	**300 miles**
Clean Storm Lines/leads cleaning (this includes gravity mains, manholes, junction boxes, and inlets)	**50 miles**	**65 miles**
Inspect Roadside ditches	**250 miles**	**500 miles**
Roadside ditches de-silted	**170 miles**	**300 miles**
Inspect Off-Road Ditches [1]	**140 miles [2]**	**180 miles**
Off-Road Ditches re-established	**30 acres**	**30 acres**
Storm water quality inspections completed (each):	**700**	**700**
Improve employee core competence	**Training minimum of 15 hours per employee per year**	**Training minimum of 15 hours per employee per year**

[1] These ditches are 90 miles of off-road major ditches—each ditch section is inspected 2 times a year.

[2] These ditches FY-17 known asset inventory was 70 miles of off-road major ditches – each ditch section inspected 2 times a year.

Table 4: Process Measures and Goals per Fiscal Year

1.6 Action Items for Continuous Improvement

Continuous improvement processes are based on periodic review of systems against performance measures to identify any shortfalls. Performance measures can be related to level of service goals, condition maintenance goals, or asset management system goals. The continuous improvement plan should include elements to improve the collection, management and use of data, including:

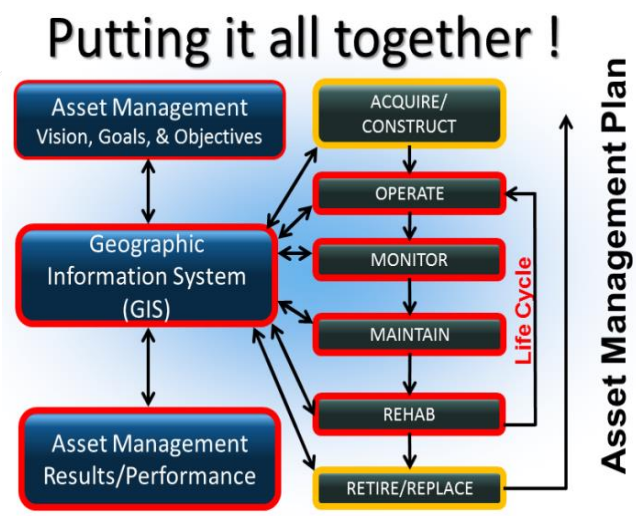
- More aerial coverage of asset inspection and condition assessment.
- Identification, inspection, and condition assessment of additional asset classes.
- More sophisticated information management tools.
- Better data quality assurance.
- More data correlating types of defects and time-to-failure to improve predictive planning capability.
- More integration between operational, financial, and planning systems.
- Improved organizational efficiency through better systematization of asset management programs.

1.7 Data Management Tools

The SWMB has a complex geographical need. It is critical to have the most up-to-date count and the geospatial location of all the infrastructure assets, which SWMB operate and maintains, in order to best serve the citizens of Houston. Also, not having all the assets accounted for hinders the ability of SWMB and other Divisions to support all planning and maintenance activities to its fullest. Geographic Information Systems (GIS) plays a critical role in ensuring PWE assets are accurately located and maintained. GIS is a foundational technology linking every activity of a utility; including design and construction, asset management, workforce management and increasingly real-time network operations.

The SWMB IAMP approach calls for information to be managed in a way that facilitates timely decision-making for planning, prioritization, and emergency response. It also establishes basic requirements for information system elements, including:

- Accurate system maps identifying pertinent storm water system component assets
- Data related to system assets capacity and system condition inspections
- Inventory of system assets and condition
- Records of preventive and reactive operation and maintenance activities
- Schedules and budgets with long planning horizons for routine operations and maintenance activities, planned rehabilitation, and replacement
- Decision support systems linked to the system Geographic Information System (GIS) graphic and asset attribute data



2.0 STRATEGIC GOALS, OBJECTIVES, AND TASKS

The objective of SWMB is to maintain all assets at a level that is safe and acceptable to the public. The intent of the IAMP is to maximize the life-cycle of assets throughout the City. ***Preventative maintenance must become a priority***. Understanding the life-cycle of all assets will assist SWMB in determining the funding required to address the need. Until the needed funding is attained, the IAMP will help identify the best allocation of current funding to maintain the infrastructure to the best of SWMB's abilities.

2.1 Strategic Goals

Future SWMB Infrastructure Status Reports will begin to align with three strategic goals to address the storm drainage infrastructure maintenance:

- Continuously improve the method of aligning service priorities with infrastructure investment decision-making.
- Continuously improve the facilitators (skilled people, processes, and data), monitoring methods, and reporting tools that support the performance of infrastructure to deliver services.
- Continuously update SWMB infrastructure funding strategy (reallocations to optimize network).

2.2 Strategic Objectives

To provide an action plan for continuous improvement of the IAMP over the next 5-years, the following SWMB Maintenance Plan Strategic Objectives are recommended:

- Reach a sustainable level of preventive maintenance that meets or exceeds Best Management Practices.
- Determine asset service level operability by identifying, analyzing, and prioritizing operation and maintenance activities.
- Carryout operability improvements; clearing, cleaning, and/or repairing portions of the storm water system with deficiencies.
- Schedule preventive maintenance for the complete storm drainage system (set maintenance cycles based on Best Management Practices for each asset).
- Obsolescence Renewal - each year replace a minimum estimated portion of the complete storm drainage system which has exceeds its operational life (approximately a percentage of the complete system which represents the ratio of one year divided by the expected operable life of the assets).
- Finalize Operability Assessments for all areas which have reports of structural flooding.
- Finalize prioritized schedule of maintenance activities for each high concern areas and implement the required maintenance tasks.

- Implement a program to address local drainage issues which are less urgent than scheduled maintenance; are not directly impacting drainage service levels, but are critical based on other criteria.
- Prioritize improvements by incorporating impacts of urban deification on the streets and drainage system.
- In addition to scheduled preventive maintenance, 3-1-1 driven maintenance activities are always considered first priority and the data obtained from these activities are continuously updated and used in planning of scheduled system-wide preventive maintenance.
- Establish a predictable source of funds that will allow the City to prioritize, budget, and schedule the complex task of repairing, replacing, and upgrading the streets and drainage systems.

2.3 Strategic Tasks

The strategic tasks of the Infrastructure Asset Management Plan (IAMP) are:

- Implementation and continuous execution of the infrastructure asset management system comprised of decision support systems linking:
  - The City Geographic Information System (GIS) databases.
  - Rebuild Houston analyses, data, and project prioritizations.
  - Analyses and data from the Comprehensive Drainage Plan (CDP).
  - Current and planned projects involving storm drainage in the Capital Improvement Program (CIP).
  - The Harris County Flood Control District (HCFCD) Flood Warning System (FWS) - hydrological data used in Service Level performance evaluations for sub-systems of the storm drainage system.
- Inventory of all the assets and sub-systems of the storm drainage system.
- Operability assessment of the complete storm drainage system and sub-systems.
- Condition assessment of the assets comprising the storm drainage system and sub-systems.
- Necessary Maintenance actions identified and executed including:
  - Condition and operability inspections and evaluations.
  - Preventive maintenance.
  - Re-active response maintenance.
  - Point repairs.
  - Sub-system rehabilitation/re-configuration.
  - Analyses and evaluation of applicability of Local Drainage Projects (LDPs).