A DRAINAGE IDENTIFICATION ANALYSIS AND MAPPING DATABASE

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Abstract

Drainage Identification, Analysis and Mapping System (DIAMS) is a computerized database that captures and stores relevant information associated with all on-ground and under-ground hydraulic structures belonging to the New Jersey Department of Transportation (NJDOT). DIAMS retrieves relevant performance and financial information so that NJDOT can remain compliant with Phase II of the Government Accounting Standards Board Statement 34, which is NJDOT's sole means of reporting all financial transactions, namely the value of infrastructure drainage assets on an accrual accounting basis. DIAMS also retrieves all relevant environmental information to comply with Clean Water Act and reports to NJDEP. The DIAMS capabilities include identifying drainage infrastructure, maintaining inspection history, mapping locations, predicting service life based on the current condition states, and assessing present asset value. The DIAMS also contains several different repair, rehabilitation and replacement options to remedy the drainage infrastructure. In addition, the DIAMS can analyze asset information and determine decisions to inspect, rehabilitate, replace or do nothing at the project and network levels. Furthermore, the financial analysis module will output data into categories including inspection, cleaning, repair, and condition states. The process will direct users and decision makers to evaluate work orders, which will be reported in summaries, allowing the best choice for asset performance implementation for each asset type, thus making DIAMS an indispensable asset management and environmental information management tool. Possible improvements to DIAMS includes the system wide design improvements to accommodate impacts of climate change.

Introduction

Adequate drainage is essential in the design of highways since it affects the serviceability and usable life of highways, including the pavement's structural strength. If ponding on the traveled way occurs, hydroplaning becomes an important safety concern. Drainage design involves providing facilities that collect, transport and remove storm-water from highways. The design must also consider the storm-water reaching the roadway embankment through natural stream flow or manmade ditches. The regulatory environment related to drainage design is ever changing and continues to grow in complexity. Engineers responsible for the planning and design of drainage facilities must be familiar with Federal, state, county and local regulations, laws, and ordinances that may impact the design of storm drain systems (DelDOT, 2008).

Various maintenance treatments are employed by highway agencies to slow deterioration and restore condition of drainage infrastructure. However, budget constraints and other factors have often led to delaying or eliminating the application of these treatments. Such actions are expected to adversely influence the condition and performance and lead to a reduced level of service, to early deterioration, and eventually to the need for costly rehabilitation or replacement. Analytical tools are currently available to quantify the consequences of delayed application of maintenance treatments for drainage infrastructure. However, processes for using these tools to demonstrate the potential savings and performance enhancement resulting from applying maintenance treatments at the right time are not readily available. This research is attempting to address such processes. This information will help highway agencies better assess the economic benefits of maintenance actions and their role in enhancing the level of service of the highway system. In addition, incorporating these processes in asset management systems would provide a means for optimizing the allocation of resources.

Drainage Information Analysis and Mapping System (DIAMS)

Drainage Identification, Analysis and Mapping System (DIAMS) is a computerized database that captures and stores relevant information associated with all on-ground and under-ground hydraulic structures belonging to the New Jersey Department of Transportation (NJDOT). DIAMS retrieves relevant performance and financial information so that NJDOT can remain compliant with Phase II of the Government Accounting Standards Board Statement 34, which is NJDOT's sole means of reporting all financial transactions, namely the value of infrastructure drainage assets on an accrual accounting basis. DIAMS also retrieves all relevant environmental information to comply with Clean Water Act and reports to NJDEP.

DIAMS has four main modules consisting of: asset identification, financial analysis, data uploading and system administration. The entry point for DIAMS is shown in Figure 1, indicating where the selection of one of these modules may be made. Operationally, DIAMS has a two-layer (front-end) database for information management. The first-layer (data review application) is an Access 2003 application with users-interfaces and queries as well as data manipulation procedures. The second-layer is the database that stores performance and financial data of drainage infrastructure, as well as related photo/movie files and report documents, with all of the above components integrated into an effective data management system. Please note that Access 2003 has data capacity limitations, and hence DIAMS consists of three separate databases. However, the three separate databases are linked and streamlined in such a way that the user is unable to notice the existence of three separate databases. Users can review, modify, save and delete database records in DIAMS to keep the system data up-to-date and display them conveniently by forms and reports as well as by photos and videos. The functionality of each of the main modules and their sub-modules are illustrated in Figure 2 and elaborated upon in the following sections.

Asset Data Module

The user's Asset Module interfaces consists of a main switchboard, and four sets of data review/edit forms: Structures, Pipes(Culverts), Outfalls, and Storm-water Devices(MTD/BMP), as shown in Figure 3. In addition to the main switchboard the user's Asset Module interfaces contain several functional sub-modules, each of which are discussed below.

Inlet/Outlet Structures Data Module

The state's inlet-outlet structures are inspected by contractors who are tasked to identify and report their conditions so that decisions can be made regarding options of cleaning and repair as necessary. This task involves handling and deciphering an enormous amount of inspection data on the part of both inspectors and the state in managing the drainage system. The Inlet/Outlet Structures Data Module in DIAMS lightens this burden by giving searchable information about the locations of culvert endpoints, the inlet/outlet structures, and their conditions. In this module, digital photos of the culvert inlet and outlet structures are displayed. The Inlet/Outlet Structure Data form displays structure IDs and their attributes, as shown in Figure 4, as well as their inspection results. There are three combination boxes: (1) location by road name, (2) location by milepost, and (3) the expected inlet/outlet identification number that can be used to narrow the scope of search for a particular structure record. The structural asset information of the selected record is displayed on the upper selected box and the lower portion of the form will display related inspection information of the structure. The user can edit data fields on this form and add a new inspection record for a current structure. Photos can also be embedded into the structure records too. However, in order to keep data integrity, critical key fields, such as 'Structure ID', 'SRI', 'Latitude' and 'Longitude' are to be downloaded from source database only, with no asset record addition and deletion. Please note that the Standard Route Identification (SRI) system was developed to identify all NJ highways.

Pipe or Culvert Module

This module includes the pipe material type, current condition, treatment cost, and relevant date information for users to make operational decisions such as if the pipe needs inspection or rehabilitation treatment. There are three combination boxes: (1) location (Road, City, State…), (2) the start-manhole, (3) the end-manhole to narrow down the selection range of a particular pipe record in order to access the details of pipe asset and also for record editing of data. This record includes all related inspection information of the selected pipe section record, including comments, photo file names, and movie file names, etc. However, in order to keep data integrity, critical key fields, such as Report ID and Video ID are not allowed to be modified. They are supposed to be downloaded from the source database only, with no asset record addition and deletion.

The process of the decision-making for pipe treatment starts from treatment cost estimation. According to the pipe age, condition state, segment length and diameter as well as pipe material type, DIAMS will automatically calculate the standardized pipe treatment costs for the current pipe segment under review (e.g., the Installation cost, the Inspection/Cleaning cost, the Rehabilitation cost and the Replacement cost). If the treatment costs are not set yet for the pipe, they will be replaced by these auto-calculated standard costs. On the other hand, the pipe treatment costs will remain existing values until they have been changed. The standardized costs are calculated based on a unit treatment cost table created based on common practice reported in literature. The unit cost table is in fact a unit price template only. Users can modify the table contents from DIAMS several Cost Estimation Forms, based on their working experiences. They can also add new items as data records into the table or delete those not usable. By entering the cost items and quantities related to the pipe's installation, DIAMS will automatically calculate the total estimated installation cost for the pipe construction job. This total installation cost will be transferred back to the installation cost field on the Cost Estimation form as well as on the Pipe Assessment form. Based on all the estimated treatment costs, users can make a decision if certain treatment action should be performed. DIAMS can help users to justify if the chosen decision is worth performing by analyzing all suitable treatment techniques that the user can select and compare their corresponding expenses against their improved values. Based on the comparison, DIAMS will recommend or deny the user chosen techniques and remind the user to check existing data sets for accuracy.

DIAMS will also automatically compare the treatment technique costs (Action Costs) to ‘Do Nothing’ cost (i.e., the User Failure Cost) and notify the user if the selected action is justified or not. The user can make a choice to either accept the system recommendation or not.

Storm-water Device / Detention Basin Data Module

Storm-water Detention basins and Manufactured Treatment Devices (MTDs) are constructed to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of time, in particular, MTDs act as storm-water treatment devices before discharged. Please note that the MTDs are approved as off-line water quality devices that are installed on urban setting to treat the storm-water before discharge. For Best Management Practices (BMP), it essential to collect and maintain relevant data to enhance their overall performance and for that matter the performance of the drainage system. The DIAMS system contains two storm-water data modules and one detention basin data module in the system. The modules are enumerated as: (1) Device Data Entry module is designed for entering major MTD data sets quickly; (2) MTD Data Review module is designed for registering/editing all related MTD information in details; and (3) BMP (Detention Basin) data entry module is for entering/reviewing detention basin information. These modules can be assessed from MTD/BMP Data Entry/Review Modules form which is a sub-switchboard form of the Devices (MTD/BMP) on Asset Identification Switchboard, as shown in Figure 3. The following sections will discuss each of the sub-modules.

Storm-water Device Data Entry

This contains searchable records of storm-water device asset data, inspection data and major maintenance records, which are contained in a sub-forms under the following tabs: Device General Information, Inspection Information, and Maintenance Information. In locating a device record, the user can make use of two search methods: (1) by either specifying Location (Route/Street) or Milepost or (2) by selecting the Device ID, Type and Model Number. Key fields to linking the device record to other related factual and dimensional data tables are Device ID, Type and the Model Number. For each device record, these three fields must be filled first in order to save the record into the system databases. In addition, there are five function control buttons on the bottom of the form for: adding of new records; deleting of error records; updating of modified records, and previewing of a maintenance report for current record.

MTD Device Asset Data

This contains storm-water device asset data, such as device IDs, Names, Types and Model numbers. Additional information is contained in a tabular format under the following tabs: location; project; attribute; watershed; and device-network spatial relationship information. There are three combination boxes, for users to search or specify the device ID, Type, and Model No. These three key fields will define the device category and attribute characters so as to link the device record to other related factual and dimensional data tables. For each device record, these three fields must be filled first in order to save the record into the system databases. The rest of the device asset information has been organized into groups and displayed by five tab-forms. The following sections discuss the details of these tab-forms.

- Location Information

This displays the geographic information of the current device asset. Users can edit data fields on this form. Optionally, a watershed picture should be provided to illustrate the watershed area of the device location with respect to its drainage network.

- Spatial Relationship Information

This device is specified as either ‘online’ or ‘offline’ with respect to its existing proximity to drainage network. The ‘Y/N’ textbox is use to alter the selections between ‘Yes’ (offline) and ‘No’ (online). Here one can record information of device related structures, pipes, and outfalls, and in addition, information on previously inspected and recorded the relevant structures, pipes, and outfalls can be retrieved from DIAMS database for use.

MTD Device Inspection Data Review

The Inspection Data Review form contains six tabs that display all the information of a single inspection record related to the device currently under consideration on device asset form. Users can go through the six inspection data tabs to review or edit an inspection record of the device as well as its embedded photos. Also, users can browse through all the device’s inspection records. The following sections will discuss each tab:

- Routine Inspection

This is use to record device routine inspection data in filling in standardized data item entries.

- Measurements

This defines the measurements of sediment/trash/debris/oil thickness deposited in device. The measured results will be compared with device trigger values to determine the cleanout action necessity automatically. There is also an allocation for recording a second chamber data if the device demands.

- Inspection Decision

This is a decision-making module based upon the field measurements and device manufacturers’ recommended trigger values, various cleanout action necessities are automatically calculated and represented as either ‘Yes’ or ‘No’.

- Inspection Observation

Device inspection observation data can be recorded on this form by altering the content of any ‘Yes/No’ textboxes.

- Structure Inspection

Device related structure inspection data can be recorded on this form by the use of use of the combination boxes to fill in standardized data item entries.

- Inspection Photos

Up to five inspection photos can be embedded into a single device inspection record.

MTD Device Maintenance Data

This contains maintenance data records relevant to the selected device asset and its inspection records. It has four tabs that display all the information of device maintenance records related to the device under consideration from device asset/inspection forms.

Users can go through all the four maintenance data forms to review or edit a single maintenance record of the device as well as its embedded photos. They can also browse through all the device's maintenance records. The functionalities of the tabs are listed below:

- General Info./Cleanout Planning

This tab displays general information about the device maintenance as well as planned cleanout activities.

- Cleanout Records, Repair/Replacement Records, Maintenance Photos

This tab record cleanout/repair/replacement action results as well as device photos taken before or after these activities.

BMP (Detention) Data Module

This form contains detention basin asset data and inspection records, contained under the following tabs: BMP General Information, Inspection Information (Part 1), and Inspection Information (Part 2) which are detailed below.

- BMP (Detention) General Information

This sub-form displays the detention basin asset data such as ID, location, shape (Type) as well as its latitude and longitude. New data record can be added into system, through system prompts and commands. The key fields found here define the asset category and attribute characters so as to link the BMP record to other related factual and dimensional data tables. For each BMP record, these key fields must be filled in order to save the record into system databases.

- Inspection Information

The detention basin inspection result information will be entered into its Part 1 and Part 2 sub-forms, respectively. Figure 5 shows a sample inspection result report which can be generated by the user. Also, the diagram allows the user to generate and print an empty inspection data form when needed.

Outfalls (Storm-water Discharge) Data Module

Since an outfall is the point of release of the collected storm-water into the environment, such facilities are regulated by the USEPA or the state Department of Environmental Protection (DEP), making their routine inspection, monitoring and maintenance not only vital for facility performance but also very crucial for regulatory compliance. The Outfalls Data Module contains information of Outfall records. There are three combination boxes for users to narrow down the searching scope for an outfall record. A location (Road) is selected at first, followed by a rounded Milepost (one mile per interval), and finally the expected outfall that is close to the selected round-up milepost value to display the outfall record. The data that are displayed will contain information on both outfall asset records and all related inspection information of the selected outfall. Users can edit data fields on this form. However, in order to keep data integrity, critical key fields such as 'Outfall ID', 'Route ID', "Route_Direction' and 'Milepost', GPS coordinates, etc. should not be edited, but rather be downloaded from a source database. Any entered GPS data in the corresponding text fields can be converted into decimal numbers through the GPS Latitude or GPS Longitude data field. The program also allows the user to browse through all existing outfall records, but presently can't add and delete asset record. However, users can add a new inspection record for the current outfall, in addition to embedding of photos into the records. Furthermore, the program allows the user to generate the current outfall inspection record report, shown in Figure 6, which summarizes the relevant storm water discharge information of the outfall. Please note the physical observations, which are essential reporting data for the NJDEP to comply with Clean Water Act.

Data Uploading Module

This is a unique feature of DIAMS, where data generated by the maintenance contractors are automatically uploaded to the system. The Data Uploading Module provides the functionality for users to upload various vendor data database (Access 2000 format) into DIAMS data database. The module contains a single uploading form that is used in a sequential order process that will allow the user to see which specific data have been uploaded, as shown in Figure 7.

Financial Analysis Module

The objectives of this financial analysis module are to (1) determine the optimum allocation of the current maintenance budget, by identifying the assets that are to be inspected, replace, or repaired, (2) to estimate the minimum annual total budget needed over a given planning horizon, and (3) to make project level decisions to replace, rehabilitate or do nothing for a given state of assets. After the treatment techniques for the drainage infrastructure assets have been determined, the user can define maintenance projects. Here, a project is defined as a group of treatment jobs for drainage infrastructure assets, which are to be considered for a given total budget. With DIAMS, the user can search the optimal or near optimal solutions for the budget allocation among these treatment jobs of drainage infrastructure assets. The drainage infrastructure assets assessment and optimization process are the core components of DIAMS pipe financial analysis module. The system evaluates the input data set and summarizes its major attributions, such as how many drainage infrastructure assets are in the project, what is the total capital required by their treatment jobs, and how many are pre-fixed jobs as well as the minimum required capitals for these pre-fixed jobs. Figure 8 shows the budget optimization form.

The system is setup to provide a solution for two algorithms, namely: (1) 0-1 Implicit Enumeration algorithm to find a real optimal solution or (2) A heuristic procedure, named as ‘Catch-the-big-fish’, to obtain near-optimal solution. The 0-1 Implicit Enumeration algorithm enumerates all possible combinations of the decision variables and compares their resulting objective function values to determine the real optimal solution. On the other hand, the heuristic procedure sorts the selected treatments of the drainage infrastructure assets by their capital requirements then tries to catch-up the most costly ones without breaking the budget limit. The reason for two algorithms is that the real-optimal solution for the integer program problem has 2^N computational complexity. When $N>15$, the enumeration will exceed 32768 combinations. Although, the objective function and budget constraint are both simple linear additions, it may take a long time to evaluate all possible combinations when N gets too big. Therefore, it is recommended to use the heuristic procedure when $N>25$. The heuristic covers the more costly segments first, then considers the less expensive ones until the available budget is consumed.

System Administration Module

The program's System Administration Module provides a place for users to edit, add, delete, and save keywords. These keywords, as depicted in Figure 9, are provided here as standard data entries for some fields in asset and inspection forms of system entities. This form holds all the list table records designed for the DIAMS application. Users can modify these records to meet their individual needs.

It should be noted that the Treatment User Cost Parameters should be updated on June 30th of each year. At that time the user will need to visit the Federal Reserve Bank of Minneapolis web site for the Consumer Price Index (CPI) calculator to compute the escalation factor for the current year, as well as, to modify other parameters when necessary.

Discussion and Future Recommendations

DIAMS addresses the problems of archiving, accessing, analyzing and optimizing drainage infrastructure asset data for a highly efficient reporting system. The Asset Identification module stores all the receiving storm water data such as the quality/quantity of water and discharge to watersheds, while also being able to develop general property reports. Analysis ratings are used for the asset locations relative to the NJ roadway centerlines. Users can locate assets needing immediate repair by road/milepost based upon their condition state. NJDOT's drainage infrastructure asset management is analyzed from historical records and condition states of all assets in the system. The DIAMS capabilities include identifying drainage infrastructure, maintaining inspection history, mapping locations, predicting service life based on the current condition states, and assessing present asset value. In addition, the DIAMS contains several different repair, rehabilitation and replacement options to remedy the drainage infrastructure. The DIAMS can analyze asset information and determine decisions to inspect, rehabilitate, replace or do nothing at the project and network levels. At the project level it compares costs with risks and failures. This is achieved by comparing inspection, cleaning or repair costs with risks and costs associated with failure. At the network level, the associated costs are optimized to meet annual maintenance budget allocations by prioritizing drainage infrastructure needing inspection, cleaning and repair. In addition, the financial analysis module will output data into categories including inspection, cleaning, repair, and condition states. The process will direct users and decision makers to calculated work orders, which will be reported in summaries, allowing the best choice for asset performance implementation for each asset type.

Changes in weather patterns and their associated climatic variability affect hydrologic conditions and the hydrologic responses of watersheds (Arisz and Burrell 2006). As corroborated by various studies, climatic changes have brought about increases in rainfall intensities, which is one of main dynamics responsible for the presently observed increased frequency of flooding in cities (Arnbjerg-Nielsen and Fleischer 2009, Kleidorfer et al. 2014). The cumulative effects of these changes in hydrology due to climatic change are expected to alter the magnitude and frequency of peak flows over the service life of drainage infrastructure. Potential future changes in rainfall intensity are expected to alter the level of service of drainage infrastructure, with likely increased rainfall intensity resulting in more frequent flooding of storm sewers and surcharging of culverts (Arisz and Burrell 2006). Consequently, higher runoffs have impacted sewer and drainage system performance in terms of higher risk of flooding and sudden failure of drainage infrastructure due to increased flow rate, increasing the vulnerability of the country's drainage infrastructure (USGAO 2013, Neumann et al. 2015) and subsequent decrease of storm water treatment performance. Hence city planners have to take into consideration all of these climatic changes and their effects in drainage system design, maintenance and replacement (Ashley et al. 2005). Hence once all NJDOT drainage infrastructure are identified and cataloged it is proposed to incorporate a module to mitigate the climate change. With known rainfall and duration as well as known impact area and carrying capacity of drainage infrastructure, it is proposed to simulate the impact of climate change to update or eliminate bottlenecks and improve pump capacities to handle increased flow rates and to eliminate flooding and sudden failures of drainage infrastructure. This could be accomplished by water balance and contour map of the region.

Summary and Conclusions

The DIAMS consists of three major computer software components: databases, user interfaces and functionality modules. Among the significant performance features of DIAMS is its proactive nature, which affords decision makers the means of conducting a comprehensive financial analysis to determine the optimal proactive schedule for the proper maintenance actions and to prioritize them accordingly. The DIAMS structure is laid out to simplify the process of using the system to allow efficient and productive sequential flow of the information performance system. It includes four separate modules: asset identification, vendor data upload, financial analysis and system administration. The vendor data upload module has various sub-nodes to ensure that the contractor-supplied field collection data uploaded to the database is unified and consistent. The asset identification module performs key attribution of the various physical components, and assigns functionality attributes of the huge inventory of drainage infrastructure. The system administration module supports low-level data reviews and editing. The final module is the financial analysis for maintenance and repair costs, in addition to design and extension of drainage network. The pipe condition state obtained from inspection records and the stored unit cost information are used for cost analysis. Financial analyses of assets are performed by comparing inspection and/or rehabilitation costs with associated risks of failure. Benefits of DIAMS include long-term savings that accrue by adopting optimized preventive maintenance strategies and facilitating compliance with governmental accounting standards bureau (GASB-34) and federal storm water regulations. Possible improvements to DIAMS includes the system wide design improvements to accommodate impacts of climate change. This could be accomplished by water balance and contour map of the region.

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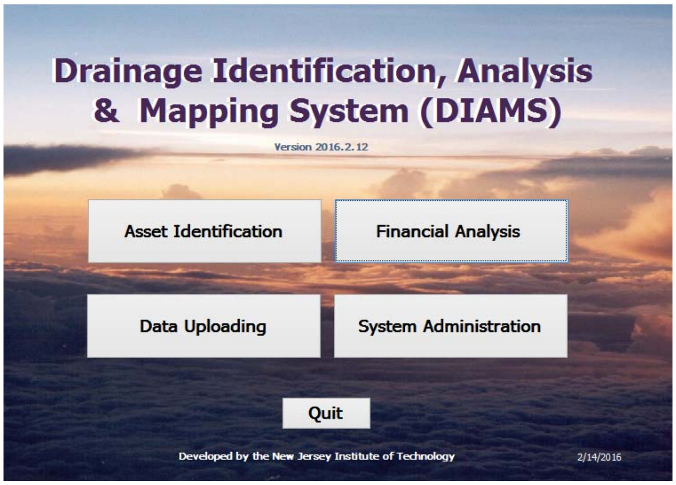


Figure 1 Main Form

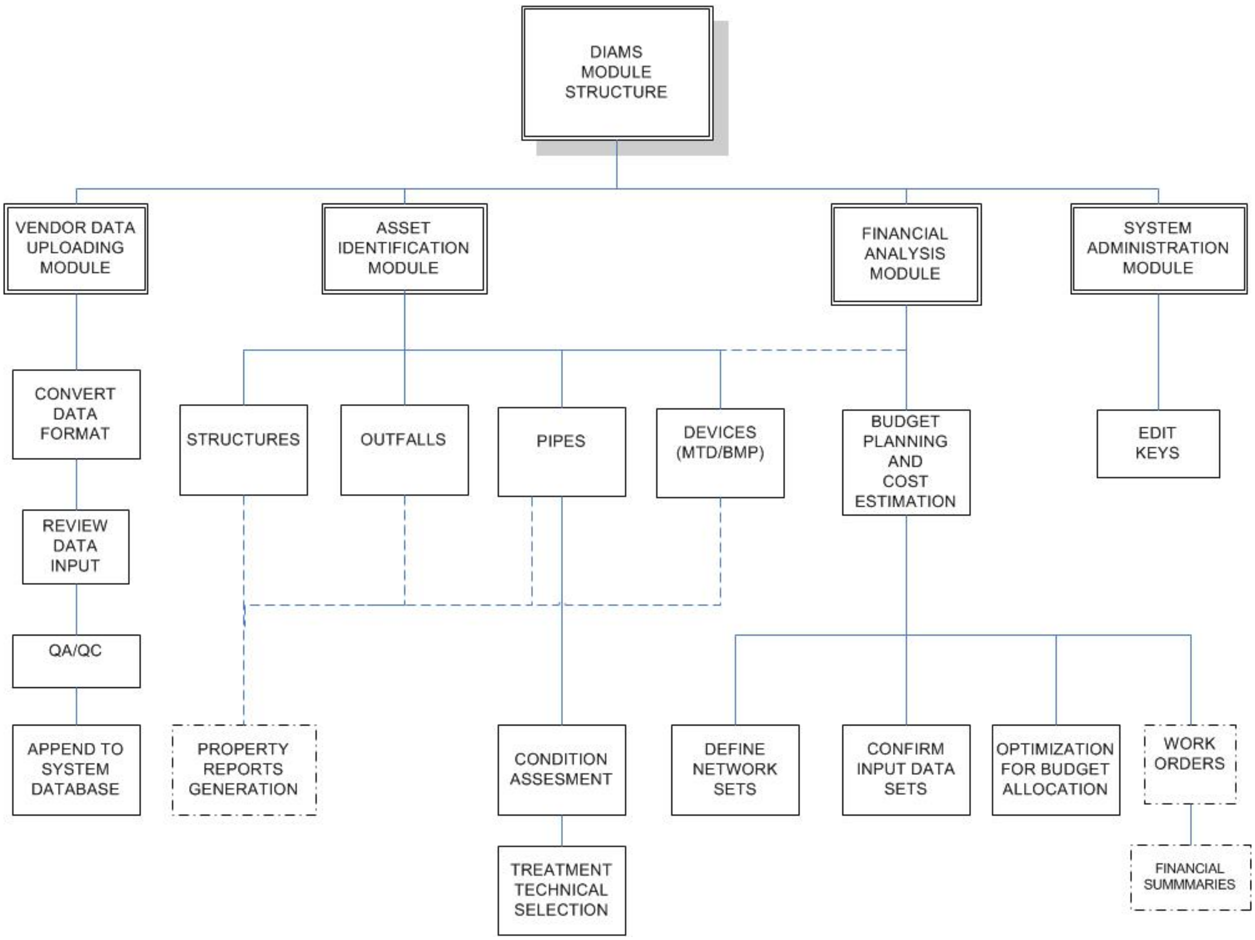


Figure 2 DIAMS Module Structure

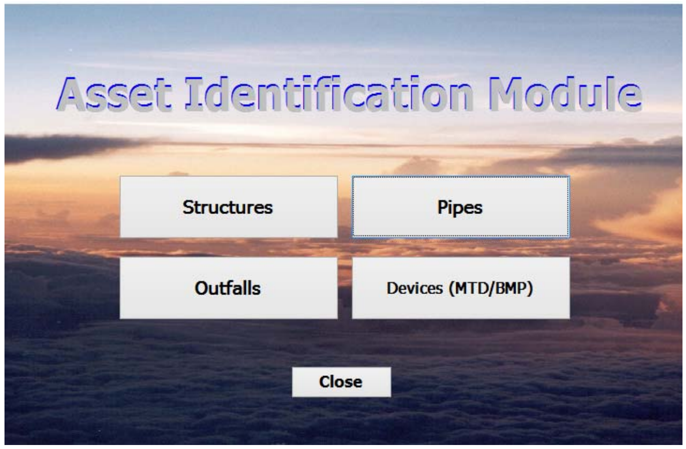


Figure 3 Asset Identification Switchboard Form

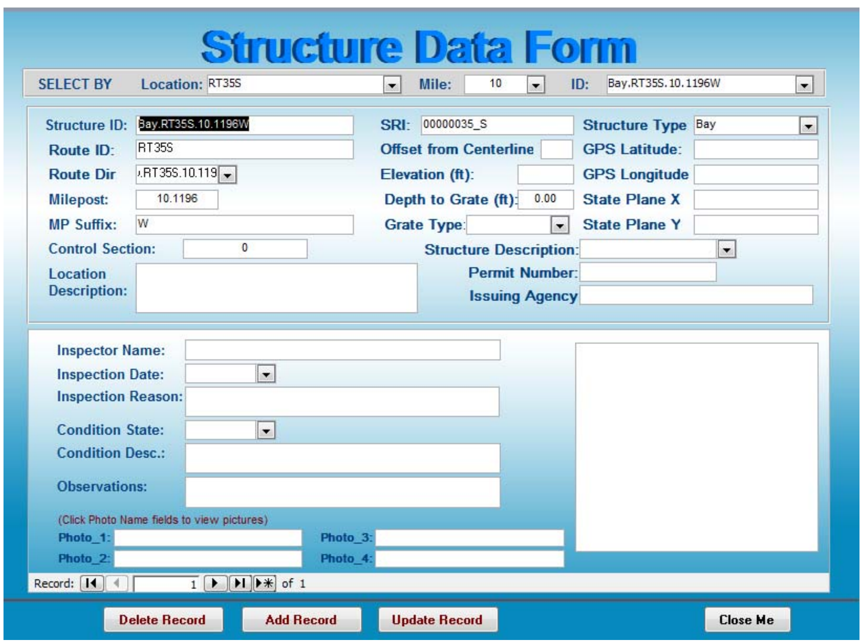
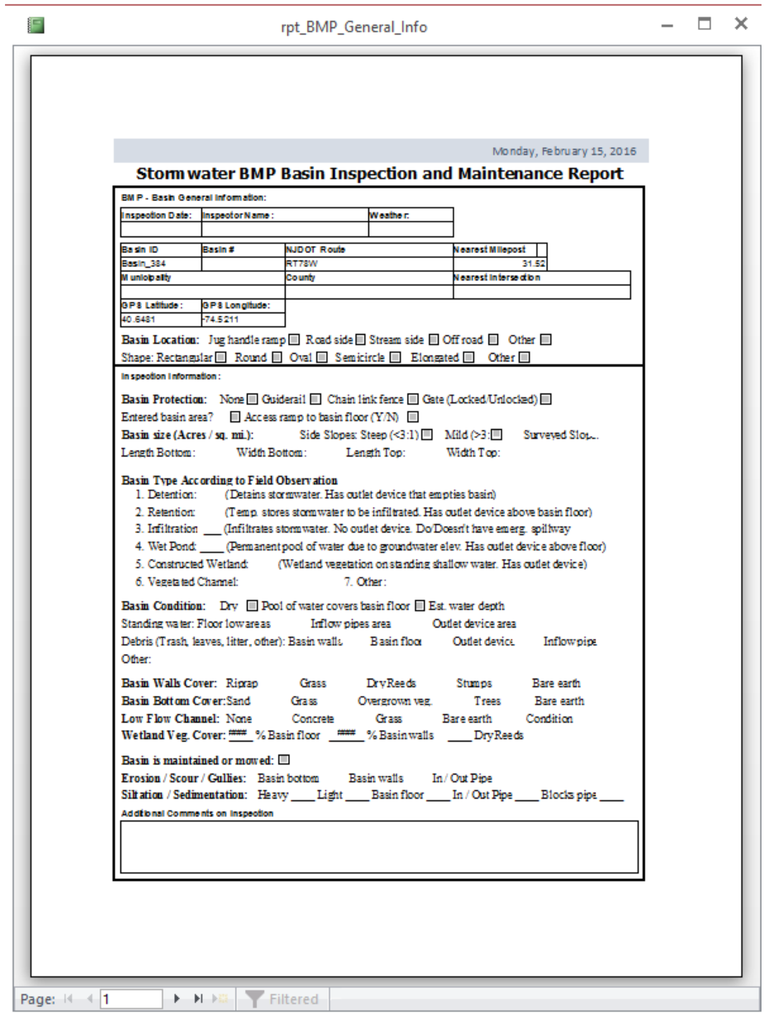


Figure 4 Inlet/Outlet Structure Data Form



rpt_BMP_General_Info

Monday, February 15, 2016

Storm water BMP Basin Inspection and Maintenance Report

BMP - Basin General Information:

Inspection Date:	Inspector Name:	Weather:

Basin ID	Basin #	NJDOT Route	Nearest Milepost
Basin_384		RT78W	31.52
Municipality		County	Nearest Intersection
GPS Latitude:	GPS Longitude:		
40.6481	-74.5211		

Basin Location: Jug handle ramp ☐ Road side ☐ Stream side ☐ Off road ☐ Other ☐

Shape: Rectangular ☐ Round ☐ Oval ☐ Semicircle ☐ Elongated ☐ Other ☐

Inspection Information:

Basin Protection: None ☐ Guiderail ☐ Chain link fence ☐ Gate (Locked/Unlocked) ☐

Entered basin area? ☐ Access ramp to basin floor (Y/N) ☐

Basin size (Acres / sq. mi.): Side Slopes: Steep (<3:1) ☐ Mild (>3: ☐ Surveyed Slo...

Length Bottom: Width Bottom: Length Top: Width Top:

Basin Type According to Field Observation

1. Detention: (Detains stormwater. Has outlet device that empties basin)
2. Retention: (Temp. stores stormwater to be infiltrated. Has outlet device above basin floor)
3. Infiltration ___ (Infiltrates stormwater. No outlet device. Do/Doesn't have emerg. spillway
4. Wet Pond: ____ (Permanent pool of water due to groundwater elev. Has outlet device above floor)
5. Constructed Wetland: (Wetland vegetation on standing shallow water. Has outlet device)
6. Vegetated Channel: 7. Other:

Basin Condition: Dry ☐ Pool of water covers basin floor ☐ Est. water depth

Standing water: Floor low areas Inflow pipes area Outlet device area

Debris (Trash, leaves, litter, other): Basin walls Basin floor Outlet device Inflow pipe

Other:

Basin Walls Cover: Riprap Grass Dry Reeds Stumps Bare earth

Basin Bottom Cover: Sand Grass Overgrown veg. Trees Bare earth

Low Flow Channel: None Concrete Grass Bare earth Condition

Wetland Veg. Cover: ####_ % Basin floor _####_ % Basin walls ____ Dry Reeds

Basin is maintained or mowed: ☐

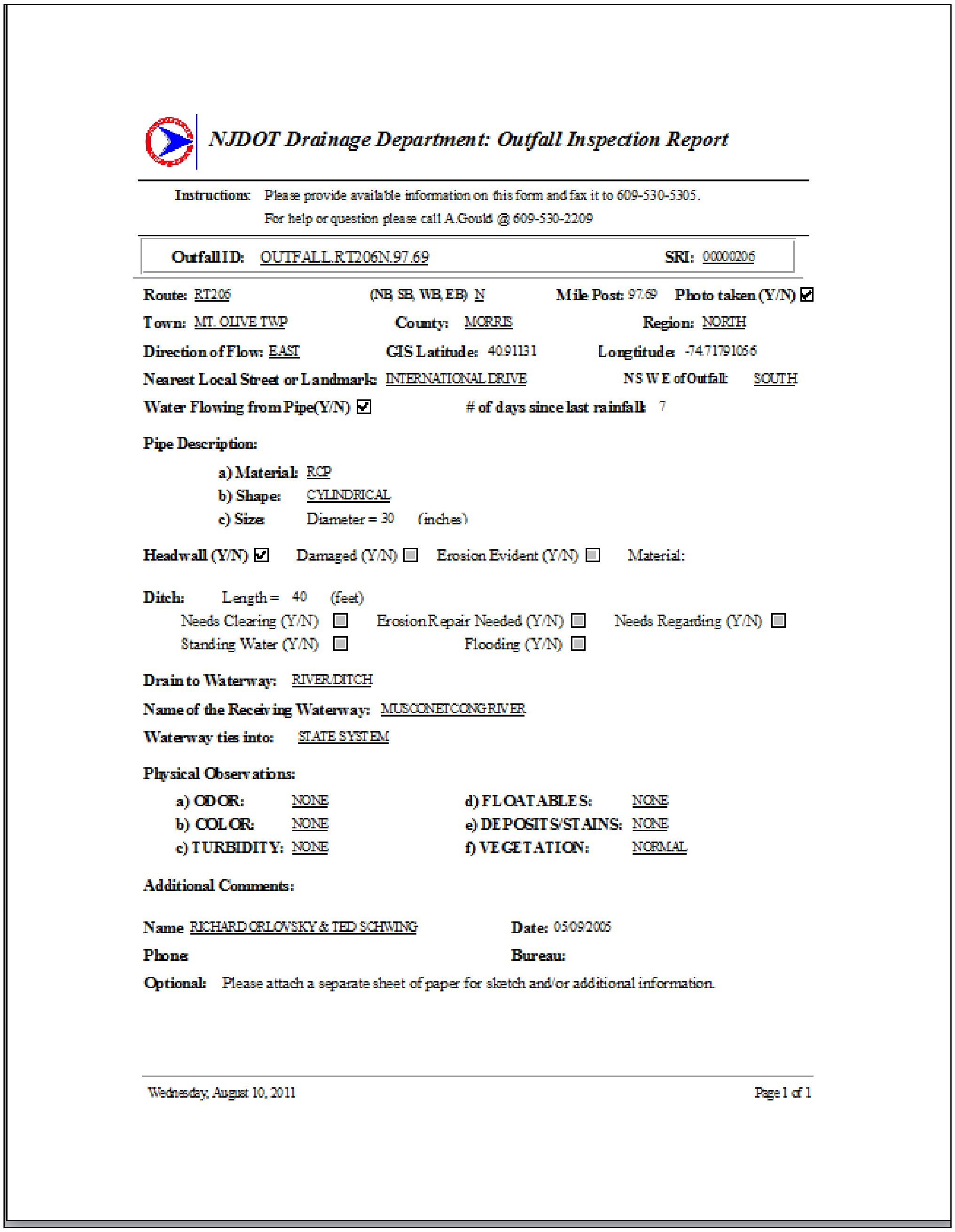
Erosion / Scour / Gullies: Basin bottom Basin walls In / Out Pipe

Siltation / Sedimentation: Heavy ____ Light ____ Basin floor ____ In / Out Pipe ____ Blocks pipe ____

Additional Comments on Inspection

Page: 1 Filtered

Figure 5 BMP (Detention Basin) Inspection Report



NJDOT Drainage Department: Outfall Inspection Report

Instructions: Please provide available information on this form and fax it to 609-530-5305.
For help or question please call A.Gould @ 609-530-2209

Outfall ID: OUTFALL.RT206N.97.69 **SRI:** 00000206

Route: RT206 (NB, SB, WB, EB) N **Mile Post:** 97.69 **Photo taken (Y/N)** ☑

Town: MT. OLIVE TWP **County:** MORRIS **Region:** NORTH

Direction of Flow: EAST **GIS Latitude:** 40.91131 **Longitude:** -74.71791056

Nearest Local Street or Landmark: INTERNATIONAL DRIVE **NSWE of Outfall:** SOUTH

Water Flowing from Pipe(Y/N) ☑ **# of days since last rainfall:** 7

Pipe Description:

a) Material: RCP
b) Shape: CYLINDRICAL
c) Size: Diameter = 30 (inches)

Headwall (Y/N) ☑ Damaged (Y/N) ☐ Erosion Evident (Y/N) ☐ Material:

Ditch: Length = 40 (feet)
Needs Clearing (Y/N) ☐ Erosion Repair Needed (Y/N) ☐ Needs Regarding (Y/N) ☐
Standing Water (Y/N) ☐ Flooding (Y/N) ☐

Drain to Waterway: RIVER DITCH

Name of the Receiving Waterway: MUSCONETCONG RIVER

Waterway ties into: STATE SYSTEM

Physical Observations:

a) ODOR: NONE **d) FLOATABLES:** NONE
b) COLOR: NONE **e) DEPOSITS/STAINS:** NONE
c) TURBIDITY: NONE **f) VEGETATION:** NORMAL

Additional Comments:

Name RICHARD ORLOVSKY & TED SCHWING **Date:** 05/09/2005

Phone: **Bureau:**

Optional: Please attach a separate sheet of paper for sketch and/or additional information.

Wednesday, August 10, 2011 Page 1 of 1

Figure 6 Outfall Inspection Record Report

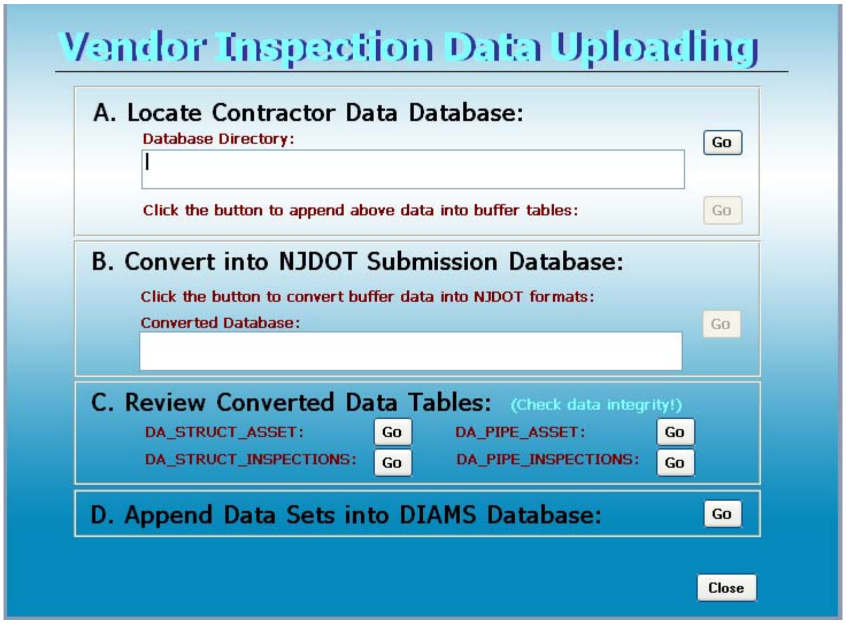


Figure 7 Vendor Inspection Data Uploading Form

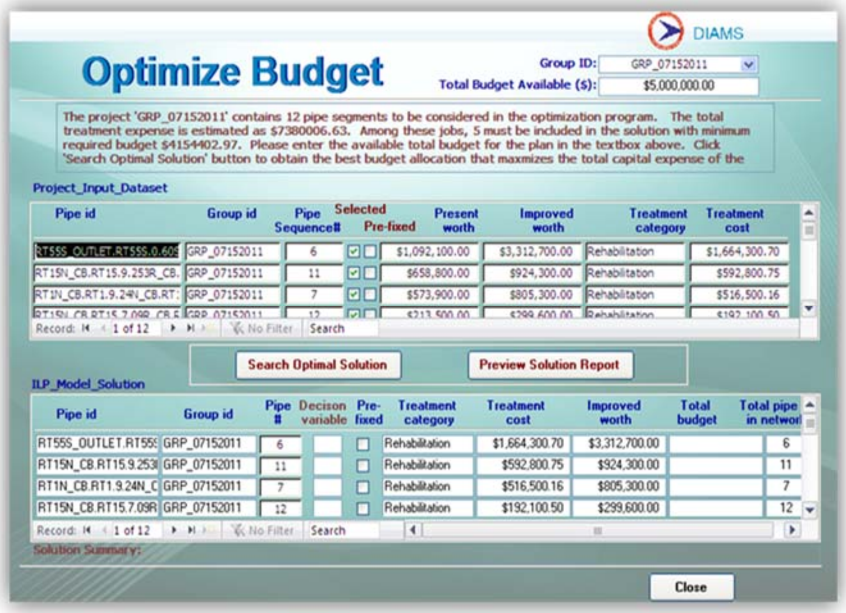


Figure 8 Optimize Budget Form.

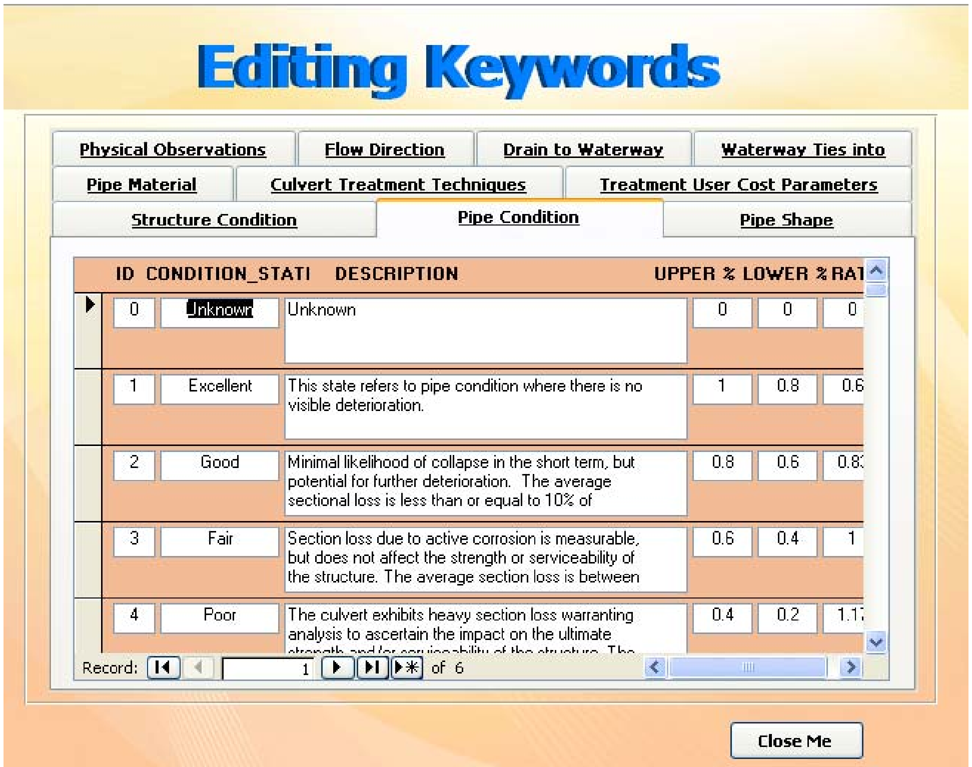


Figure 9 Standard Data Item Edition Forms