Oracle Business Intelligence Implementation Project

Final Report

Phase II - Task 1- Data Analysis for the Maintenance Management System

Submitted to
Nevada Department of Transportation

By

Alexander Paz, Ph.D., P.E.
Transportation Research Center
University of Nevada, Las Vegas

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UNLV | Howard R. Hughes College of ENGINEERING

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2-A MAINTENANCE MANAGEMENT SYSTEM

2-A-0 EXECUTIVE SUMMARY

This report provides detailed data analysis, identifies data anomalies, and provides corresponding recommendations for the Maintenance Management System (MMS) database of the Nevada Department of Transportation (NDOT). The MMS database dump file was provided by NDOT's Information Technology division and was imported into the Oracle environment of the University of Nevada, Las Vegas (UNLV). The data is related to the tracking and managing of maintenance tasks such as crack filling, culvert cleaning, chip seal, bridge maintenance, guardrail installation, snow removal, traffic incident cleanup, and flood damage repair. It includes such information as quantity and cost of materials, equipment, and labors required for various maintenance tasks as well as stockpile creation and handling process.

The MMS schema includes 75 tables. Of those 75 tables, nine tables are considered as important to provide significant data for the Business Intelligence (BI) project. The schema also includes 25 look up tables, which provide description of values or codes present in the main tables. In addition, five tables, that include information related to the reports generated by the current MMS Reporting System, are also considered as relevant tables for BI project. Other tables in the database are either empty or not significant for the BI project.

TBL_DATAMART_SUMMARY table is one of the main tables, which includes the most important attributes relevant to BI. TBL_TASK is another table that contains almost all attributes that are available in the TBL_DATAMART_SUMMARY. The TBL_TASK table along with other main tables and lookup tables can be used to generate the TBL_DATAMART_SUMMARY. There are 339 more records in the TBL_TASK table than in the TBL_DATAMART_SUMMARY. MMS_STOCKPILE_DETAIL table contains information related to stockpiles. The database also includes five additional lookup tables to provide description of codes used in the MMS_STOCKPILE_DETAIL table.

This report lists the potential data issues and the corresponding recommendations to address them. Data issues include inconsistency between main tables and lookup tables, incorrect county codes, incomplete data for some attributes, and absence of a lookup table(s) for foreign keys. Examples of such data anomalies and corresponding recommendations are provided in this document.

2-A-1 PURPOSE OF THE MAINTENANCE MANAGEMENT SYSTEM

The purpose of the Maintenance Management System (MMS) is to help maintain the entire statewide roadway system using available resources and budget, and consistent with work plan, policies, and program objectives. The MMS assists personnel of NDOT's Maintenance Management Division to achieve this objective by tracking and optimizing performance of pavements, bridges, routine maintenance strategies, equipment, and other highway infrastructures.

2-A-2 MAINTENANCE MANAGEMENT SYSTEM DATABASE

2-A-2-1 Definition and Description of Data

The MMS consists of a database, which stores most of the required information to track and manage such maintenance tasks as crack filling, culvert cleaning, chip seal, bridge maintenance, guardrail installation, snow removal, traffic incident cleanup, and flood damage repair. The information includes quantity and cost of materials, equipment, and labor required for various maintenance tasks performed by NDOT crews. It also includes stockpile related information such as type and quantity of materials stored as stockpiles, cost of stockpiles, and labor required for handling stockpiles.

2-A-2-2 Reference

Nevada Department of Transportation. Maintenance and Asset Management Division. https://www.nevadadot.com/About_NDOT/NDOT_Divisions/Operations/Maintenance/Maintenance_and_Asset_Management.aspx. Accessed July 2014.

2-A-3 DETAILED ANALYSIS

The MMS schema has 75 tables, which are listed in Table 2-A-1. Table 2-A-2 lists 39 tables that are relevant for the Business Intelligence (BI). The list includes nine main tables, 25 look up tables, and five tables related to the current MMS reporting system. The remaining tables either are empty, duplicates or contain information not relevant for the BI project.

Oracle Structured Query Language (SQL) developer was used to view, analyze, and query data. Various anomalies were found within the MMS database. Data anomalies are discussed and corresponding recommendations are provided.

TABLE 2-A-1 Tables Present in Maintenance Management System Database

TABLE NAME	DESCRIPTION
MMS_MAT_DIST_UCOST	MMS Standard material unit cost by district - (Non-Stockpile)
TBL_STOCKPILE_ CALCULATION	
MAINTCREWS_POLYS	
MMS_DIVI	MMS Divisions and Location table - (Crews)
MMS_INV_RD_CREW	MMS Maintenance Crew Road Segment responsibilities
MMS_SIG_DIVI	Linking table for MMS_SIG_USER and MMS_DIVI
MMS_SIG_USERS	List of employees that have a user profile
TBL_LABOR	TASK Labor used
LST_EMP	List of employees assigned to MMS Crews
LST_EMP_LOG	
LST_MATERIAL	
MDRT_1DF5D$	
MDRT_1DF68$	
MDRT_1DF73$	
MDRT_1DF7E$	
MICROSOFTDTPROPERTIES	
MMS_REPORT_LST	
TBL_MATERIAL	TASK Material used (non-stockpiled)
TEMP_TASK_ACTIVITY1	
LST_EQU_CAT	MMS Equipment List
TBL_EQUIPMENT	TASK Equipment used
TBL_NET_ELIGIBLE_EQU	
MMS_AADT_PARMS	
MMS_RI_COUNTY	County Table contains names for each county in Nevada
MMS_RI_ROAD	MMS Road List (one record per road)
MMS_RI_ROAD_RMID	
MMS_RI_SYS	MMS Road System List
MMS_DIST	MMS Maintenance Districts
MMS_2008_GEOM	
MMS_2009_GEOM	
MMS_2010_GEOM	
MMS_2011_GEOM	
TBL_DATAMART_SUMMARY	
TBL_TASK	TASK accomplished by maintenance crew per day
MMS_MATERIAL	MMS Materials list
TBL_MATERIAL_2003	TASK Material used (non-stockpiled)
VM_TEST_BY_MATERIAL	
PLAN_TABLE	
TBL_SP_TRANS_AUDIT_070	

TABLE NAME	DESCRIPTION
MMS_AIR_QLTY_RPT	
MMS_SP_TRANS_CODE	
MMS_FLOOD	Flood History, potential cause, and associated damage
MMS_MAIN_PAGES	
MMS_RPT_IMAGES	Name of images used in the MMS Reporting System
MMS_RPT_LST	List of reports that can be generated in the MMS Reporting System with description
MMS_RPT_PARAM_OBJ	List of attributes and associate tables to generate a report in the MMS Reporting System
MMS_RPT_PARAMETERS	List of parameters in the MMS Reporting System
MMS_RPT_SQL	SQL query implemented to create reports in the MMS Reporting System
MMS_RPT_TEMP_USERS	List of users of the MMS Reporting System
MMS_RPT_TSK_STANDARDS	Standard quantity of material and equipment required to perform maintenance tasks
MMS_MAT_STOCKPILE	MMS Stockpile Materials list
MMS_STOCKPILE_ALT_DIV	
MMS_STOCKPILE_DETAIL	
TBL_STOCK_DATAMART	
TBL_STOCK_PROD	TASK recipient stockpile on a stockpile build
TBL_STOCK_PROD_FROM	TASK donor stockpile material when building a stockpile
TBL_STOCK_USED	TASK stockpile material used
TSK_STOCKPILE_TRANS	
VM_TEST_BY_STOCKPILE	
MMS_ACCOUNT	MMS Task Account Table
MMS_BETTERMENT	Detailed information on MMS Betterment hat are performed as a part of maintenance management
MMS_BETTERMENTTASK	Description of the betterment tasks
MMS_CAUSE	MMS Task Causes of action
MMS_TASK	List of MMS Tasks
MMS_TSK_ACCU	Description of MMS Task accomplishment units
MMS_TSK_CAT	List of task categories.
MMS_TSK_EQU	Equipment used on a task
MMS_TSK_GRP	The group description for the tasks
MMS_TSK_MAT	Material type and quantity used on a task
MMS_TSK_PGM	List of the programs
TBL_LOCATION	TASK Location
MMS_PAYPERIOD	
MMS_YEAR	
MMS_SP_MAT_CONV	
MMS_MAT_UOM	MMS Unit-of-Measure descriptions

TABLE 2-A-2 Tables Relevant for BI Project

MAIN TABLES	LOOK UP TABLES
TBL_DATAMART_SUMMARY	MMS_CAUSE
TBL_TASK	MMS_DIVI
TBL_EQUIPMENT	MMS_TASK
TBL_LABOR	MMS_RI_ROAD_RMID
TBL_LOCATION	MMS_RI_ROAD
TBL_MATERIAL_2003	MMS_RI_COUNTY
MMS_STOCKPILE_DETAIL	LST_EMP
TSK_STOCKPILE_TRANS	LST_EQU_CAT
TBL_STOCKPILE_CALCULATION	MMS_MATERIAL
	MMS_MAT_UOM
TABLES RELATED TO MMS REPORTING	MMS_SP_MAT_CONV
MMS_RPT_LST	MMS_ACCOUNT
MMS_RPT_PARAM_OBJ	MMS_TSK_ACCU
MMS_RPT_PARAMETERS	MMS_TSK_EQU
MMS_RPT_SQL	MMS_TSK_GRP
MMS_RPT_TSK_STANDARDS	MMS_TSK_MAT
	MMS_TSK_PGM
	MMS_DIST
	TBL_NET_ELIGIBLE_EQU
	MMS_RI_SYS
	MMS_BETTERMENT TASK
	MMS_BETTERMENT
	MMS_TSK_CAT
	MMS_SP_TRANS_CODE
	MMS_FLOOD

2-A-4 TABLES THAT ARE RELEVANT TO BI PROJECT

2-A-4-1 TBL_DATAMART_SUMMARY Table

TBL_DATAMART_SUMMARY table is one of the primary tables in MMS database that summarizes all the information related to a maintenance task. This table is a de-normalized form of various tables such as TBL_TASK, TBL_LABOR, TBL_EQIPMENT, and TBL_LOCATION. It includes 1,714,582 records with 31 attributes. Table 2-A-3 illustrates the attributes present in the TBL_DATAMART_SUMMARY table. The primary key identifier for this table is C_Key, which is unique number assigned to each maintenance task.

TABLE 2-A-3 Attributes In TBL_DATAMART_SUMMARY Table

ATTRIBUTE_NAME	DATA_TYPE	NULLABLE
C_Betterment_Num	Varchar2(20 Byte)	Yes
C_Code	Varchar2(2 Byte)	Yes
C_County	Varchar2(20 Byte)	Yes
C_Desc_Accu	Varchar2(80 Byte)	Yes
C_Desc_Cause	Varchar2(80 Byte)	Yes
C_Div	Varchar2(4 Byte)	Yes
C_Initials	Varchar2(2 Byte)	Yes
C_Key	Char(23 Byte)	No
C_MMS_Better_WO_FK	Char(10 Byte)	Yes
C_MMS_Cause_FK	Char(2 Byte)	Yes
C_MMS_Divi_FK	Char(3 Byte)	Yes
C_MMS_RI_County_FK	Char(2 Byte)	Yes
C_MMS_RI_Road_FK	Char(3 Byte)	Yes
C_MMS_State_WO_FK	Char(10 Byte)	Yes
C_MMS_Task_FK	Char(10 Byte)	Yes
C_MMS_WO_FK	Char(10 Byte)	Yes
C_Road	Varchar2(5 Byte)	Yes
C_Task_DESC	Varchar2(80 Byte)	Yes
C_TSK_Comments	Varchar2(2000 Byte)	Yes
D_Task_Date	Date	Yes
N_Accu_Qty	Number(10,2)	Yes
N_Equ_Cost	Number	Yes
N_Hrs_Lab_OT	Number	Yes
N_Hrs_Lab_Reg	Number	Yes
N_Hrs_Task	Number	Yes
N_Lab_Cost	Number	Yes
N_Mat_Cost	Number	Yes
N_MP_From	Number(10,2)	Yes
N_MP_To	Number(10,2)	Yes
N_SP_Cost	Number	Yes
N_Travel_Cost	Number	Yes

The TBL_DATAMART_SUMMARY table has eight such attributes with suffix ‘FK’ as C_MMS_Better_WO_FK, C_MMS_Cause_FK, C_MMS_Divi_FK, C_MMS_RI_County_FK, C_MMS_RI_Road_FK, C_MMS_Task_FK, C_MMS_State_WO_FK, and C_MMS_WO_FK, which are used as foreign keys to lookup tables. A lookup table provides description about the codes used in the main table. These attributes establish relationships with other tables. For example, C_MMS_RI_County_FK attribute relates the TBL_DATAMART_SUMMARY table

with MMS_RI_COUNTY lookup table. Figure 2-A-1 shows the relation between the TBL_DATAMART_SUMMARY and six look up tables.

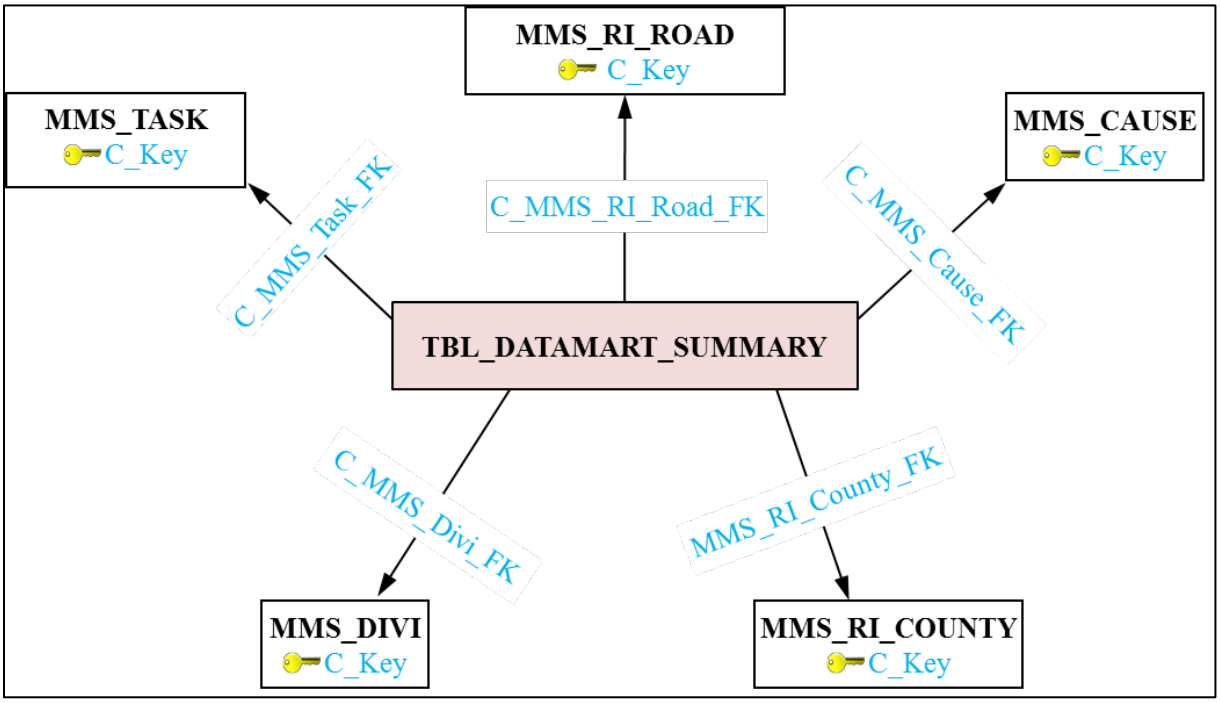

FIGURE 2-A-1 Relation between TBL_DATAMART_SUMMARY table and six other tables through respective foreign keys.

2-A-4-1-1 C_Key

C_Key is a unique primary key identifier for the TBL_DATAMART_SUMMARY that is assigned to each performed maintenance task.

2-A-4-1-2 C_MMS_Cause_FK

C_MMS_Cause_FK is a foreign key to connect the TBL_DATAMART_SUMMARY table with MMS_CAUSE lookup table. The MMS_CAUSE table provides 18 different possible causes that prompted the performance of maintenance tasks. For example, '01' is assigned for maintenance cause 'Special Event'. Table 2-A-4 illustrates the relationship between these two tables.

TABLE 2-A-4 Relationship Between TBL_DATAMART_SUMMARY and MMS_CAUSE

TBL_DATAMART_SUMMARY Table		MMS_CAUSE Table	
C_MMS_Cause_FK		C_Key	C_Desc
07		07	Road Closure
03		03	Act of Nature
11		11	Normal Maintenance
21		21	Graffiti

2-A-4-1-3 C_Desc_Cause

This attribute provide a potential cause that required the implementation of maintenance task on a site. This attribute is similar to C_Desc in the MMS_CAUSE table. It contains 26 distinct values, which are not consistent with the values provided in the C_Desc in the MMS_CAUSE table.

2-A-4-1-3-1 Anomalies

1. Description of cause such as 'Agreement Preparation/Inspection', 'Agreement Inspection', 'ance', 'Community Servive', and 'Remove Animal Waste', that are not available in the C_Desc attribute of the MMS_CAUSE lookup table, are present in the C_Desc_Cause of the TBL_DATAMART_SUMMARY table.
2. TBL_DATAMART_SUMMARY contains seven records with ‘GRAFFITI’ as description of cause with all letters in uppercase. However, the MMS_CAUSE table, which is a lookup table, contains ‘Graffiti’ with only first letter in uppercase.
3. There are few records with same C_Desc_Cause values but with different character lengths. For example, some records have ‘Accident’ in the C_Desc_Cause with a character length equal to eight while some records have ‘Accident’ value with character length equal to 80 including spaces. Table 2-A-5 illustrates the example of different character length for same description in the C_Desc_Cause.

TABLE 2-A-5 Description of cause with Different Character Length

C_DESC_CAUSE	CHARACTER LENGTH
Accident	8
Accident	80
Act of Nature	13
Act of Nature	80
Normal Maintenance	18
Normal Maintenance	80

4. In TBL_DATAMART_SUMMARY table, ‘Road Closure’ has codes ‘01’ and ‘07’ in C_Mms_Cause_Fk attribute. However, the lookup table MMS_CAUSE has code ‘07’ for ‘Road closure’ and ‘01’ for ‘Special Event’.

2-A-4-1-3-2 Recommendations

1. The description of cause can be corrected by including the values in the C_Desc attribute of the MMS_CAUSE lookup table.
2. The capitalization can be fixed by correcting ‘GRAFFITI’ value to ‘Graffiti’ in the C_Desc_Cause attribute of the TBL_DATAMART_SUMMARY table.
3. The incorrect character length of the values can be corrected and made consistent with the C_Desc attribute of the MMS_CAUSE lookup table.
4. The code switch can be fixed by correcting all the ‘Road Closure’ values to code ‘07’ in the C_Mms_Cause_Fk attribute of the TBL_DATAMART_SUMMARY table.

2-A-4-1-4 C_MMS_Divi_FK

This attribute is used as a foreign key to connect the TBL_DATAMART_SUMMARY table with MMS_DIVI lookup table. This foreign key is the C_Key of the MMS_DIVI table. The MMS_DIVI table contains detailed information related to a maintenance task division such as supervisor of a task, location description of each division, district ID, and crew size.

Table 2-A-6 illustrates the example of the relationship between the TBL_DATAMART_SUMMARY and the MMS_DIVI table.

TABLE 2-A-6 Relationship Between TBL_DATAMART_SUMMARY and MMS_DIVI

TBL_DATAMART_SUMMARY Table		MMS_DIVI Table				
C_MMS_Divi_FK		C_Key	C_Foreman	C_Location	C_MMS_Dist	M_Crew_Size
175		175	31191	Goldfield	2	0
355		355	14075	Bridge Maintenance	4	0
385		385	7558	Austin	6	0

2-A-4-1-5 C_Div

C_Div attribute provides a division number of the crews. It contains a prefix ‘C’ with a maintenance division number, which is assigned by the Integrated Financial System (IFS). This attribute is similar to the C_MMS_Divi_FK, which provides a division number without the IFS prefix.

2-A-4-1-5-1 Anomaly

The TBL_DATAMART_SUMMARY table has 111 distinct codes for different maintenance divisions. All these codes are available in C_Key attribute of the MMS_DIVI lookup table except for sixteen division codes: '128', '179', '228', '289', '298', '328', '333', '334', '345', '346', '354', '356', '359', '375', '379', and '389'. A total of 20,179 records associated with these 16 codes are provided in an Excel worksheet, *C_Div*, of an Excel document, *MMS*.

2-A-4-1-5-2 Recommendation

If the anomaly was introduced during data entry, it could be corrected by investigating the maintenance management system documents. Otherwise, description of maintenance division associated with these 16 codes could be included in the MMS_DIVI lookup table.

2-A-4-1-6 C_MMS_Task_FK

C_MMS_Task_FK is a foreign key that connects the TBL_DATAMART_SUMMARY table with MMS_TASK lookup table. The MMS_TASK table contains information related to the description of maintenance tasks, number of crew hours and labor hours, number of supervisors and workers involved in the maintenance task.

Table 2-A-7 illustrates the relation between the TBL_DATAMART_SUMMARY table and the MMS_TASK table. The TBL_DATAMART_SUMMARY table has 91 distinct codes in

the C_MMS_Task_Fk for various maintenance tasks. All these codes and descriptions are available in the C_Key of the MMS_TASK lookup table.

TABLE 2-A-7 Relationship Between TBL_DATAMART_SUMMARY and MMS_TASK

TBL_DATAMART_SUMMARY Table		MMS_TASK Table		
C_MMS_Task_FK		C_Key	C_MMS_Grp_FK	C_Task_Desc
134.01.01		134.01.01	134.01	Maintain Rest Areas and Welcome Centers
161.02.01		161.02.01	161.02	Inspect Structures

2-A-4-1-7 C_Task_Desc

C_Task_Desc attribute contains the description of tasks for codes provided in the C_MMS_Task_FK attribute of the TBL_DATAMART_SUMMARY table. This attribute is similar to the C_Task_Desc attribute of the MMS_TASK lookup table.

2-A-4-1-8 C_MMS_RI_Road_FK

C_MMS_RI_Road_FK is a foreign key that connects the TBL_DATAMART_SUMMARY table with MMS_RI_ROAD lookup table. The MMS_RI_ROAD table contains the descriptions of route in which the maintenance task was performed such as route number, alternate route, posted direction, and route name. Table 2-A-8 illustrates the relation between the TBL_DATAMART_SUMMARY and the MMS_RI_ROAD table.

TABLE 2-A-8 Relationship Between TBL_DATAMART_SUMMARY and MMS_RI_ROAD

TBL_DATAMART_SUMMARY		MMS_RI_ROAD			
C_MMS_RI_Road_FK		C_Key	C_Road	C_Name	C_County_FK
562		562	924	Old Glendale Yard	03
676		676	04	Van Sickle Bi-State Park	04

2-A-4-1-8-1 Anomaly

C_MMS_RI_Road_FK attribute contains 464 distinct codes for different routes. All these codes are available in C_Key of the MMS_RI_ROAD lookup table except ‘44’ and ‘427’. There are 8,352 records with this anomaly in the TBL_DATAMART_SUMMARY table. These records are provided in an Excel worksheet, *C_MMS_RI_Road_FK*, of an Excel document, *MMS*.

2-A-4-1-8-2 Recommendation

If descriptions for ‘44’ and ‘427’ are available in NDOT documents then this anomaly can be fixed by including the description in the MMS_RI_ROAD lookup table. If such record is not available then it should be investigated to find the correct route location.

2-A-4-1-9 C_Road

C_Road attribute contains three-digit numbers assigned to different routes. For example, ‘015’ is used for the route Interstate -15. The road number associated with a task is obtained from the MMS_RI_ROAD lookup table.

2-A-4-1-10 C_Code

This attribute refers to system designations of roadway network such as IR for Interstate Routes and SR for State Routes.

2-A-4-1-11 C_MMS_RI_County_FK

C_MMS_RI_County_FK is a foreign key to connect the TBL_DATAMART_SUMMARY table with the MMS_RI_COUNTY lookup table. The MMS_RI_COUNTY table provides name and code of a county. For example, ‘CC’ is assigned to Carson City. There are 19 distinct county codes present in the TBL_DATAMART_SUMMARY table including Mohave County of Arizona, and Mono County of California.

Table 2-A-9 illustrates the relationship between the TBL_DATAMART_SUMMARY table and the MMS_RI_COUNTY table. The codes in C_MMS_RI_County_FK are used to establish a relationship with the MMS_RI_COUNTY table through C_Key.

TABLE 2-A-9 Relationship Between TBL_DATAMART_SUMMARY and MMS_RI_COUNTY

TBL_DATAMART_SUMMARY		MMS_RI_COUNTY		
C_MMS_RI_County_FK		C_Key	C_Initials	C_Name
03		03	CL	Clark County
04		04	DO	Douglas County

2-A-4-1-12 C_County

C_County attribute provides the name of county, which is similar to the C_Name attribute of the MMS_RI_COUNTY lookup table. This attribute includes all 17 counties in Nevada, Mono County in California, and Mohave County in Arizona.

2-A-4-1-12-1 Anomaly

C_County has incorrect county names in 12 records. Table 2-A-10 illustrates the examples of inconsistency between county names in C_County and county codes in C_Initials.

TABLE 2-A-10 Inconsistency Between County Names in C_County and County Codes in C_Initials

C_Key	C_MMS_RI_County_FK	C_Initials	C_County
2452804:30124:140:16851	03	CL	Nye County
2451543:28938:340:10664	05	EL	Eureka County
2451551:39715:355:75323	05	EL	Eureka County
2451547:49495:355:17243	07	EU	Elko County
2452915:36687:350:32038	07	EU	Elko County
2452915:37374:350:25841	07	EU	Elko County
2452717:56162:240:43428	12	MI	Lyon county
2451554:29532:270:15786	16	WA	Carson County
2452821:45592:240:98735	16	WA	Churchill County
2452772:56370:225:65423	16	WA	Lyon County
2452671:27374:225:37579	16	WA	Lyon County
2452627:49648:384:27654	17	WP	Eureka County

2-A-4-1-12-2 Recommendation

The incorrect county names in C_County can be replaced by correct county names based on the county codes in C_Initials.

2-A-4-1-13 C_Initials

C_Initials attribute provides an abbreviation of a county. For example, 'CL' is assigned for 'Clark County' and 'DO' is assigned for 'Douglas County'.

2-A-4-1-14 N_Equ_Cost

N_Equ_Cost attribute provides a total rental cost of all equipment used for performing a maintenance task. Descriptions of equipment used for each task along with the associated rental cost are available in TBL_EQUIPMENT table. The values in the N_Equ_Cost attribute is a sum of the rental cost of equipment used for a particular task. The rental cost is provided in N_Rent_Cost attribute of the TBL_EQUIPMENT table. Table 2-A-11 illustrates an example of total equipment cost calculation in the N_Equ_Cost attribute of the TBL_DATAMART_SUMMARY using information available in the TBL_EQUIPMENT table.

TABLE 2-A-11 Example of Equipment Cost Calculation in TBL_DATAMART_SUMMARY from Rental Cost available in TBL_EQUIPMENT

TBL_DATAMART_SUMMARY				TBL_EQUIPMENT		
C_Key	C_Task_Desc	N_Equ_Cost		C_Tsk_Task_FK	C_Equipment_Desc	N_Rent_Cost
717762	Special Events Traffic Control	**356.58**		717762	Pickups ¾ Tons & 1 Ton	102.12
				717762	Pickup ½ Ton	76.98
				717762	Crew Cab	77.28
				717762	See Printed List	100.2
					Total	**356.58**

2-A-4-1-15 N_Mat_Cost

N_Mat_Cost attribute provides a total cost of all materials used for a task. TBL_MATERIAL_2003 table provides the detailed description of the materials including name, standard unit cost, and quantity used for each task. The values in the N_Mat_Cost attribute is calculated as a summation of the product of the standard unit cost and quantity of materials used for a maintenance task as provided in the TBL_MATERIAL_2003 table. Table 2-A-12 shows an example of calculation of total material cost in the N_Mat_Cost attribute using information available in the TBL_MATERIAL_2003 table.

TABLE 2-A-12 Example of Material Cost Calculation in TBL_DATAMART_SUMMARY Using TBL_EQUIPMENT

TBL_DATAMART_SUMMARY				TBL_MATERIAL_2003			
C_Key	**C_Task_ Desc**	**N_Mat_ Cost**		**C_Tsk_ Task_FK**	**C_Material_Name**	**N_Std_ Ucost**	**N_Qty_ Used**
717757	Remove/ Install Raised Pavement Markings	**793.86**		717757	Traffic Buttons Ceramic	0.43	400
				717757	Reflective Roadway Button	0.45	1100
				717757	Button Adhesive	34.62	3
				717757	Propane (Bulk) or (Cylinders)	1	23
					Total	**793.86**	

2-A-4-1-16 N_SP_Cost

N_SP_Cost attribute provides the total cost of stockpiles used or transferred out during a maintenance task. The values in this attribute are provided based on the calculation of stockpiles costs from TSK_STOCKPILE_TRANS and TBL_STOCKPILE_CALCULATION tables. The TSK_STOCKPILE_TRANS table provides the quantity of stockpiles used for a task and the TBL_STOCKPILE_CALCULATION table provides the unit cost of the stockpiles. The total stockpile cost is the sum of the product of the quantity and unit cost of stockpiles and is only provided for stockpiles used or transferred out.

Table 2-A-13 illustrates an example of calculation of stockpile costs provided in the N_SP_Cost in the TBL_DATAMART_SUMMARY table.

TABLE 2-A-13 Example of Calculation of Stockpile Cost in TBL_DATAMART_SUMMARY Using TBL_STOCKPILE_CALCULATION

TBL_DATAMART_ SUMMARY			TSK_STOCKPILE_TRANS				TBL_STOCKPILE_ CALCULATION		
C_Key	**C_Task_ Desc**	**N_SP _Cost**	**C_Key**	**C_Tsk_ Task_ FK**	**C_ Trans _ Code**	**N_ Trans _Qty**	**N_Key**	**C_Stock pile_ Trans_ FK**	**N_Unit _Cost**
100230	Paint Stripe and Solid Lines	**187.8**	67489	100230	100	**15**	31965	67489	**6.32**
			67490	100230	100	**10**	178182	67490	**5.55**
			67491	100230	100	**150**	208889	67491	**0.25**
			N_SP_Cost =15*6.32 + 10*5.55 + 150*0.25 =**187.8**						

2-A-4-1-17 N_Lab_Cost

This attribute provides the total costs of labors employed for a maintenance task. The values in this attribute are provided based on the calculation made using the following equation:

*N_Lab_Cost = Sum of [N_Rate *(N_Hrs_Reg +1.51*N_Hrs_OT)] …….. (Equation-1)*

Where N_Rate= Unit labor hour rate

N_Hrs_Reg= number of regular work hours, and

N_Hrs_OT= number of overtime work hours.

The N_Hrs_Reg, N_Hrs_OT and N_Rate attributes are provided in TBL_LABOR table. Table 2-A-14 illustrates an example of calculation of total labor cost in the N_Lab_Cost attribute from the TBL_LABOR table.

TABLE 2-A-14 Example of Calculation of Total Labor Cost in N_Lab_Cost Attribute

TBL_DATAMART_SUMMARY			TBL_LABOR				
C_Key	**C_Task_ Desc**	**N_Lab_ Cost**	**C_Tsk_ Task**	**C_Name_L**	**N_Hrs_ Reg**	**N_Hrs_ OT**	**N_Rate**
717762	Special Events Traffic Control	**1166.12**	717762	Youngberg	0	6	23.8
			717762	Dominguez	0	6	24.84
			717762	Weiss	0	6	13.36
			717762	Pollock	0	6	22.8
			717762	Merrell	0	6	11.92
			717762	Pietro	0	6	20.07
			717762	Hinkel	0	6	11.92
				Total	**1166.11**		

2-A-4-1-18 N_Hrs_Lab_Reg

N_Hrs_Lab_Reg attribute refers to a total regular work hours of labors for performing a maintenance task excluding overtime hours. The regular work hours are calculated as a summation of regular hours worked by all the labors to perform a maintenance task. The regular work hours worked by each worker is provided in the TBL_LABOR table. Table 2-A-15 illustrates an example of calculation of the total regular work hours in the N_Hrs_Lab_Reg using information available in the TBL_LABOR table.

TABLE 2-A-15 Example of Calculation of Total Regular Work Hours in N_Hrs_Lab_Reg Attribute

TBL_DATAMART_SUMMARY			TBL_LABOR		
C_Key	**C_Task_ Desc**	**N_Hrs_ Lab_Reg**	**C_Tsk_Task_FK**	**C_Name_L**	**N_Hrs _Reg**
2451507:428 47:308:29607	Repair / Replacement Of Traffic Signs	**16**	2451507:42847:308:29607	Mc Elroy	8
			2451507:42847:308:29607	Timko	8
				Total	**16**

2-A-4-1-19 N_Hrs_Lab_OT

N_Hrs_Lab_Reg attribute refers to a total overtime hours of labors required to perform a maintenance task. It is the sum of the overtime hours worked by crew members in a maintenance task. The overtime hours worked by crew members for a task is provided in the TBL_LABOR table. Table 2-A-16 illustrates an example of calculation of the total overtime work hours in the N_Hrs_Lab_OT using information available in the TBL_LABOR table.

TABLE 2-A-16 Example of Calculation of Total Overtime Hours in N_Hrs_Lab_OT Attribute

TBL_DATAMART_SUMMARY			TBL_LABOR		
C_Key	**C_Task_ Desc**	**N_Hrs_Lab_ OT**	**C_TSK_TASK_FK**	**C_Name_L**	**N_Hrs _OT**
2451507: 42847:30 8:29607	Repair/Replacement Of Traffic Signs	**2**	2451507:42847:308:29607	Mc Elroy	1
			2451507:42847:308:29607	Timko	1
				Total	**2**

2-A-4-1-20 N_Hrs_Task

N_Hrs_Task attribute refers to a total number of work hours required to perform a task. The total number of hours is the sum of regular work hours and overtime hours of all crew members involved in a task. The regular work hours and overtime hours are provided in the TBL_LABOR table. Table 2-A-17 illustrates an example of calculation of the total work hours in the N_Hrs_Task using information available in the TBL_LABOR table.

TABLE 2-A-17 Example of Calculation of Total Work Hours in N_Hrs_Task Attribute

TBL_DATAMART_SUMMARY			TBL_LABOR		
C_Key	**C_Task_Desc**	**N_Hrs_T ask**	**C_Tsk_Task_FK**	**C_Name_L**	**N_Hrs_ Task**
2451507: 42847:30 8:29607	Repair / Replacement Of Traffic Signs	**18**	2451507:42847:308:29607	Mc Elroy	9
			2451507:42847:308:29607	Timko	9
				Total	**18**

2-A-4-1-21 N_Travel_Cost

N_Travel_Cost attribute provides a total cost of travel made by crew members from and to a maintenance site during implementation of a maintenance task. The total travel cost is calculated based on regular hour, overtime hour, and travel time provided in the TBL_LABOR table. Figure 2-A-2 illustrates conditions to calculate the total travel cost associated with a maintenance task.

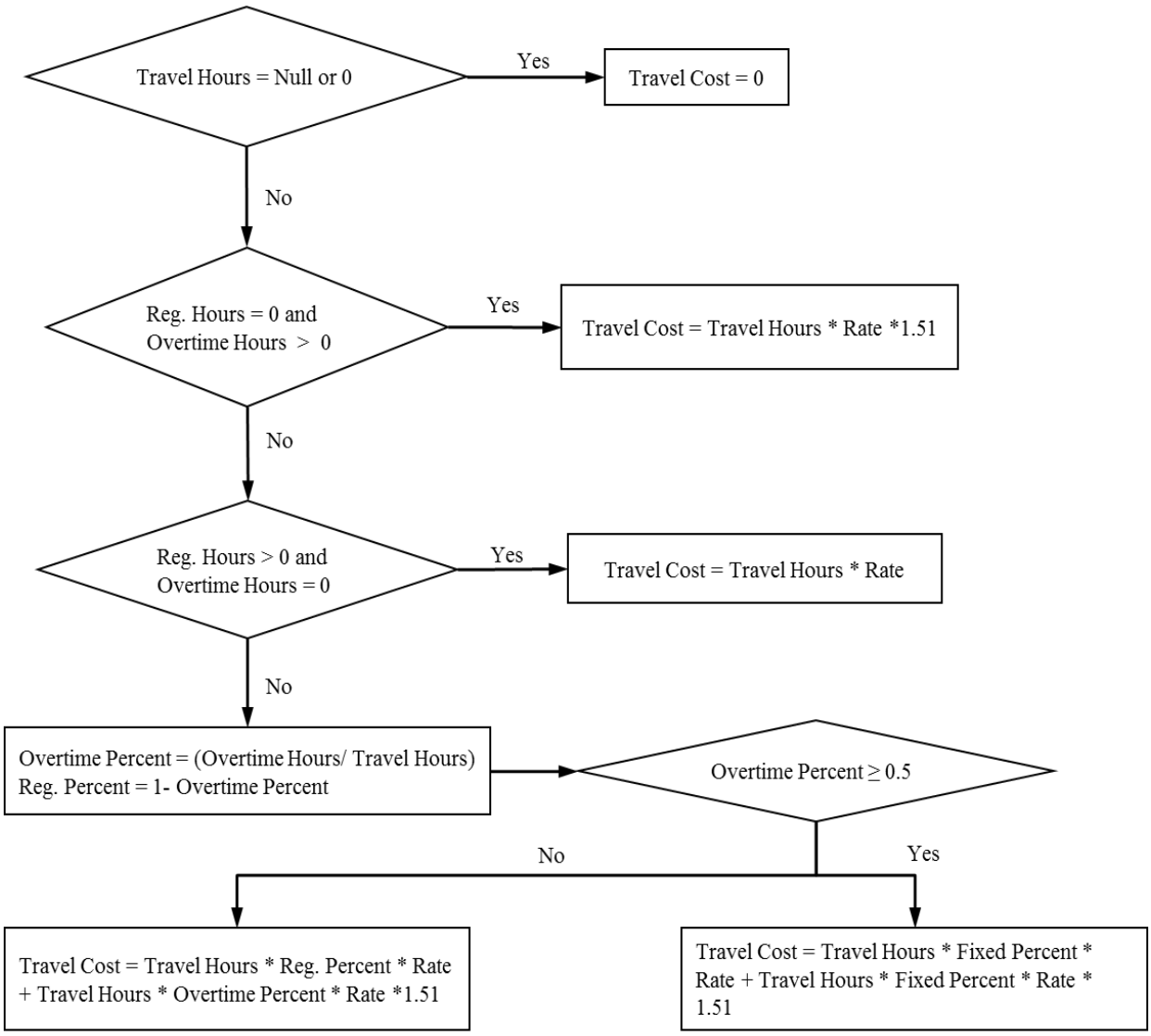

FIGURE 2-A-2 Flow chart to calculate the travel cost.

From the figure 2-A-2, the following conditions can be derived to calculate the total travel cost:

Condition 1: When Travel Time = 0 or null

When the travel time is not available or zero, the total travel cost is equal to zero i.e. N_Travel_Cost='0'. Table 2-A-18 shows an example calculation of travel cost when travel time is equal to zero.

TABLE 2-A-1 Example of Travel Cost Calculation when Travel Time = 0

TBL_DATAMART_ SUMMARY			**TBL_LABOR**					
C_Key	**C_Task _Desc**	**N_ Travel _Cost**	**C_Tsk _Task**	**C_ Name_L**	**N_ Hrs_Reg**	**N_Hrs _OT**	**N_ Time_ Travel**	**N_ Rate**
717748	Supervisory Duties	**0**	717748	Riggs	0	4	0	26.29
						Total	**0**	

Condition 2: When Travel Time ≠ 0 or null, Reg. Hours = 0, and Overtime Hours > 0
When the travel time is zero or not null, and the regular work hours equal to zero while overtime hours greater than zero, the total travel cost is the sum of the product of labor rate and 1.51 times the travel time for all crew members involved in a task. Thus, the travel cost is calculated under this condition using the equation given below:

*Travel Cost = Sum of (Rate * Travel Time *1.51)……(Equation-2)*

Table 2-A-19 shows an example calculation of travel cost for Condition-2.

TABLE 2-A-2 Example of Travel Cost Calculation when Travel Time ≠ 0 or Null, Reg. Hours = 0, and Overtime Hours > 0

TBL_DATAMART_SUMMARY			TBL_LABOR					
C_Key	**C_Task_Desc**	**N_Travel_Cost**	**C_Tsk_Task**	**C_Name_L**	**N_Hrs_Reg**	**N_Hrs_OT**	**N_Time_Travel**	**N_Rate**
717724	Special Events Traffic Control	92.78	717724	Nelson	0	4.5	0.5	29.67
			717724	Spendlove	0	4.5	0.5	18.45
			717724	Wise	0	4.5	0.5	17.68
			717724	Klocke	0	4.5	0.5	16.99
			717724	Brown	0	4.5	0.5	13.36
			717724	Ellerton	0	4.5	0.5	13.36
			717724	Houston	0	4.5	0.5	13.36
						Total	92.78	

Condition 3: When Travel Time ≠ 0 or Null, Reg. Hours > 0, and Overtime Hours = 0
When the travel time is not equal to zero or not null, and the regular work hours is greater than zero without overtime hour, the total travel cost a sum of the product of labor rate and the travel time for all crew members involved in a task.

*Travel Cost = Sum of (Labor rate *Travel hours)…… (Equation-3)*

Table 2-A-20 shows an example calculation of travel cost for Condition-3.

TABLE 2-A-3 Example of Travel Cost Calculation when Travel Time ≠ 0 or Null, Reg. Hours > 0, and Overtime Hours = 0

TBL_DATAMART_SUMMARY			TBL_LABOR					
C_Key	**C_Task_Desc**	**N_Travel_Cost**	**C_Tsk_Task**	**C_Name_L**	**N_Hrs_Reg**	**N_Hrs_OT**	**N_Time_Travel**	**N_Rate**
2451534:30955:340:2806	Repair/ Replacement Of Traffic Signs	115.83	2451534:30955:340:2806	Holm	4	0	3	11.88
			2451534:30955:340:2806	Brown	4	0	3	13.32
			2451534:30955:340:2806	Mcentire	4	0	3	13.41
						Total	115.83	

2-A-4-1-22 N_MP_From and N_MP_To

N_MP_From and N_MP_To attributes provide begin and end mileposts of a roadway segment, where a maintenance task was carried out. The TBL_DATAMART_SUMMARY table contains 181,006 records with null values in the N_MP_From and N_MP_To attributes.

2-A-4-1-22-1 Anomaly

The TBL_DATAMART_SUMMARY table has one record with negative milepost value in the N_MP_From and N_MP_To attributes. Table 2-A-21 provides the record with negative value as begin and end milepost.

TABLE 2-A-21 Negative Milepost Values in N_MP_From and N_MP_To Attributes

C_ Key	C_Desc_ Cause	D_Task _Date	C_ Code	C_ Road	C_ County	N_MP_ From	N_MP_ To
296600	Normal Maintenance	26-Sep-07	SR	359	Mineral County	-21.8	-21.8

2-A-4-1-22-2 Recommendation

If NDOT has the correct begin and end milepost values for the site, it can be appended in this table.

2-A-4-1-23 N_Accu_Qty

N_Accu_Qty attribute provides a quantity of task accomplished. This attribute is null for 139,547 records.

2-A-4-1-24 C_Desc_Accu

C_Desc_accu attribute provides a unit of measurement used to quantify a task accomplished. For example, cubic yards, gallons, and shoulder miles.

2-A-4-1-24-1 Anomaly

C_Desc_Accu attribute contains incorrect units of measurements in 13 records. Table 2-A-22 provides records with incorrect units of measurement included in the C_Desc_Accu.

TABLE 2-A-22 Incorrect Units of Measurement used for Quantity of Accomplished Task

C_Key	N_Accu_Qty	C_Desc_Accu
370363	1	0.33
392853	12	12 cubic yards
716655	2	2
716923	236	236
412164	24	4
173451	8	8
398843	0	Cubic Yards 10
242343	4	Cuic Yards 6
433041	120	Linear Feet 120
431234	3	M3an Hours
161694	2	Man Hours 2
707828	30	Man Hours 30
60684	1	Square Feet 20

2-A-4-1-24-2 Recommendation

The incorrect units of measurements can be corrected using information available in the MMS_TASK table and the MMS_TSK_ACCU table. The MMS_TASK table provides the foreign key to the MMS_TSK_ACCU table for each maintenance task. Thus, the correct unit of measurement for a quantity of task accomplished can be obtained from the MMS_TSK_ACCU table.

2-A-4-1-25 D_Task_Date

D_Task_Date attribute provides a date when a maintenance task was performed. The TBL_DATAMART_SUMMARY includes tasks performed between 12-April-1900 and 25-December-2014.

2-A-4-1-25-1 Anomaly

D_Task_Date attribute contains future dates in nine records. Table 2-A-23 provides these records with the future dates included in the D_Task_Date attributes of the TBL_DATAMART_SUMMARY table.

2-A-4-1-25-2 Recommendation

If the future dates are due to errors during data entry, it could be corrected by investigating the maintenance management system documents.

2-A-4-2 TBL_TASK Table

TBL_TASK is another main table, which includes important information related to maintenance tasks performed by NDOT crews. It has 1,714,911 records with 18 attributes. Table 2-A-24 illustrates the attributes present in the TBL_TASK table. The information available in this table can be de-normalized with information available in TBL_LABOR, TBL_MATERIAL_2003,

TSK_STOCKPILE_TRANS, TBL_STOCKPILE_CALCULATION, and TBL_EQUIPMENT tables to create the TBL_DATAMART_SUMMARY table. The TBL_TASK table has 339 more records than in the TBL_DATAMART_SUMMARY table. These 339 records can be included in the TBL_DATAMART_SUMMARY table such that the TBL_TASK can be ignored to eliminate the redundant information in the BI project.

TABLE 2-A-23 Records with Future Dates for Maintenance Task Performed

C_KEY	D_TASK_DATE	C_TSK_COMMENTS
729007	25-Dec-14	
718737	2-Dec-14	Replaced Lamps & ballasts Trop. & Las Vegas Blvd. Walk over bridges
718740	2-Dec-14	
718729	27-Nov-14	Repaired interior & exterior lights bldg. A, B, & C
718718	27-Nov-14	Support contractor, propane tank had wiring problem.
718712	26-Nov-14	Repaired roofs on office trailers
718705	26-Nov-14	Removed Drywall from ceiling in maintenance bay.
718706	26-Nov-14	
720765	14-Nov-14	Rock Patrol.

TABLE 2-A-24 Attributes Present in TBL_TASK Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Key	Char(23 Byte)	No
C_MMS_Cause_FK	Char(2 Byte)	Yes
C_MMS_Divi_FK	Char(3 Byte)	Yes
C_MMS_Task_FK	Char(10 Byte)	Yes
C_MMS_Wo_FK	Char(10 Byte)	Yes
C_MMS_Better_Wo_FK	Char(10 Byte)	Yes
C_MMS_State_Wo_FK	Char(10 Byte)	Yes
N_Accu_Qty	Number(10,2)	Yes
C_Div	Varchar2(4 Byte)	Yes
C_Task_Desc	Varchar2(80 Byte)	Yes
C_Desc_Accu	Varchar2(80 Byte)	Yes
C_Desc_Cause	Varchar2(80 Byte)	Yes
C_Betterment_Num	Varchar2(20 Byte)	Yes
D_Task_Date	Date	Yes
N_Daily_Order	Number(2,0)	Yes
C_Tsk_Comments	Varchar2(2000 Byte)	Yes
C_Created_By	Varchar2(10 Byte)	Yes
D_Created	Date	Yes

2-A-4-3 TBL_EQUIPMENT Table

TBL_EQUIPMENT table contains detailed information related to equipment used to perform a maintenance task. It includes description, rental hour, rental rate, and total cost of equipment used for a task. It has 2,834,927 records with 16 attributes. The attributes of this table are illustrated in Table 2-A-25.

TABLE 2-A-4 Attributes in TBL_EQUIPMENT Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Key	Char(28 Byte)	No
C_Tsk_Task_FK	Char(23 Byte)	No
C_Lst_Equ_Cat_FK	Char(3 Byte)	Yes
C_Meter_Type	Varchar2(1 Byte)	Yes
C_Desc_Equipment	Varchar2(1 Byte)	Yes
C_Equipment_Class	Varchar2(8 Byte)	Yes
C_Equipment_Desc	Varchar2(80 Byte)	Yes
L_Selected	Number(1,0)	Yes
N_Meter_Start	Number(9,1)	Yes
N_Meter_End	Number(9,1)	Yes
N_Rent_Hrs	Number(6,1)	Yes
N_Rent_Rate	Number(7,2)	Yes
N_Rent_Cost	Number(8,2)	Yes
N_Per_Usage_Charge	Number(8,2)	Yes
N_Tied_Up_Hrs	Number(6,1)	Yes
D_Tsk_Task_Date	Date	Yes

This table contains the following six attributes, which do not have any information:

1. C_Desc_Equipment
2. C_Meter_Type
3. N_Meter_End
4. N_Meter_Start
5. N_Per_Usage_Charge
6. N_Tied_Up_Hrs

2-A-4-3-1 C_Key

C_Key is a primary key of the TBL_EQUIPMENT table, which is a unique number assigned to equipment used in a maintenance task.

2-A-4-3-2 C_Tsk_Task_FK

C_Tsk_Task_FK is a foreign key that connects the TBL_EQUIPMENT table with TBL_TASK table. This attribute is equivalent to C_Key attribute of the TBL_TASK table.

2-A-4-3-3 C_Lst_Equ_Cat_FK

C_Lst_Equ_Cat_FK attribute is a foreign key to connect the TBL_EQUIPMENT table with LST_EQU_CAT lookup table. The LST_EQU_CAT table contains information related to categories of equipment, and their hourly rental rates. This table contains 78 distinct equipment categories.

2-A-4-3-3-1 Anomaly

The C_Lst_Equ_Cat_FK attribute contains values such as '00', '21', and '71' that are not included in the LST_EQU_CAT lookup table. A total of 850 records are found with this anomaly. These records are provided in an Excel worksheet, *Equipment_Lst_CAT_FK,* of an Excel document, *MMS.*

2-A-4-3-3-2 Recommendation

If the anomaly was introduced in the TBL_EQUIPMENT table during data entry, it can be corrected by investigating the MMS documents. If not, descriptions for these codes are required to append in the LST_EQU_CAT look up table,

2-A-4-3-4 C_Equipment_Class

C_Equipment_Class attribute contains description of equipment used in a maintenance task. It includes 151 distinct equipment descriptions.

2-A-4-3-5 N_Rent_Hrs

N_Rent_Hrs attribute provides number of hours associated with equipment rented to perform a maintenance task. The values range from '0' to '7511'.

2-A-4-3-6 N_Rent_Rate

N_Rent_Rate attribute provides rental rate of equipment used in a maintenance task. The rental rate ranges from '0' to '1064.77'. The rental rate of equipment can be zero for non-rented equipment used in a maintenance task.

2-A-4-3-7 N_Rent_Cost

N_Rent_Cost attribute provides a total rental cost of equipment used in a maintenance task. The rental cost is a product of the rental hours and rental rate of equipment. The total rental cost ranges from '0' to '111,202.14'.

2-A-4-3-8 D_Tsk_Task_Date

D_Tsk_Task_Date attribute provides a date when equipment was used to perform a maintenance task. This attribute has data from the year 1900 to 2014.

2-A-4-3-8-1 Anomaly

The D_Tsk_Task_Date attribute contains future dates in the five records in the TBL_EQUIPMENT table. Table 2-A-26 illustrates these records with future dates in the D_Tsk_Task_Date.

TABLE 2-A-26 Task with Future Dates in D_Tsk_Task_Date Attribute

C_Key	C_Tsk_Task_FK	N_Rent_Hrs	N_Rent_Rate	N_Rent_Cost	D_Tsk_Task_Date
1084539	720765	1	16.7	16.7	14-Nov-14
1081477	718705	3	16.7	50.1	26-Nov-14
1081490	718718	2	16.7	33.4	27-Nov-14
1081503	718737	2	16.7	33.4	2-Dec-14
1096310	729007	7	8.51	59.57	25-Dec-14

2-A-4-3-8-2 Recommendation

If the anomaly was introduced during data entry, it can be corrected by investigating the maintenance management system documents.

2-A-4-4 TBL_LABOR Table

TBL_LABOR table contains information related to labors or crewmembers involved in a maintenance task. It includes full names, task divisions, number of regular and overtime work hours, and travel time associated with each crew member involved in a maintenance task. It has 2,834,927 records with 16 attributes. The attributes present in this table are illustrated in Table 2-A-27.

TABLE 2-A-27 Attributes of TBL_LABOR Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Key	Char(28 Byte)	No
C_Tsk_Task_Fk	Char(23 Byte)	No
C_Lst_Emp_Fk	Char(9 Byte)	Yes
C_MMS_Divi_Fk	Char(3 Byte)	Yes
C_Div	Varchar2(4 Byte)	Yes
C_District	Varchar2(1 Byte)	Yes
C_Name_L	Varchar2(40 Byte)	Yes
C_Name_F	Varchar2(40 Byte)	Yes
C_Name_M	Varchar2(5 Byte)	Yes
L_Selected	Number(1,0)	Yes
N_Hrs_OT	Number(7,2)	Yes
N_Hrs_Reg	Number(7,2)	Yes
N_Time_Prod	Number(7,2)	Yes
N_Time_Traffic	Number(7,2)	Yes
N_Time_Travel	Number(7,2)	Yes
N_Hrs_Daily	Number(7,2)	Yes
N_Hrs_Task	Number(7,2)	Yes
N_Rate	Number(7,2)	Yes
D_Date	Date	Yes
D_Tsk_Task_Date	Date	Yes

2-A-4-4-1 C_Key

C_Key attribute is a primary key of the TBL_LABOR table, which is a unique number assigned to a crew-member involved in a maintenance task.

2-A-4-4-2 C_Tsk_Task_FK

C_Tsk_Task_FK is a foreign key that connects the TBL_LABOR table with TBL_TASK table. This attribute is equivalent to C_Key attribute of the TBL_TASK table.

2-A-4-4-3 C_Lst_Emp_FK

C_Lst_Emp_FK is a foreign key that connects the TBL_LABOR table with LST_EMP table. This attribute is equivalent to C_Key attribute of the LST_EMP table, which represents the nine-digit employee ID with leading five zeros. The IDs are usually available only for maintenance crewmembers. The TBL_LABOR table includes 2,567 distinct employee IDs. The LST_EMP lookup table provides full names of employees, their pay rates and work termination dates.

2-A-4-4-3-1 Anomaly

The TBL_LABOR table contains 17 distinct employee IDs in the C_Lst_Emp_FK that are not included in the LST_EMP lookup table. These records are provided in an Excel worksheet, *Labor_Lst_Emp_FK*, of an Excel document, *MMS.*

2-A-4-4-3-2 Recommendation

If NDOT has detailed information related to these seventeen missing employee IDs of the employees, they can be appended in the LST_EMP lookup table.

2-A-4-4-4 C_MMS_Divi_FK and C_Divi

C_MMS_Divi_FK is used as a foreign key to connect the TBL_LABOR table with MMS_DIVI lookup table. The code used as a foreign key is consistent with the value in C_Key of the MMS_DIVI table, which represents a maintenance division number of the crews. The MMS_DIVI table contains detailed information related to a maintenance division such as supervisor of a task, location description of a division, district ID, and crew size. The C_Divi attribute is similar to the C_MMS_Divi_FK. It contains a prefix ‘C’ to a division number as assigned by the IFS system.

2-A-4-4-4-1 Anomaly

The C_MMS_Divi_FK contains 16 division codes that are not available in the MMS_DIVI lookup table. These codes are '128', '179', '228', '289', '298', '328', '333', '334', '345', '346', '354', '356', '359', '375', '379', and '389'. The TBL_EQUIPMENT table contains 20,010 records with this anomaly. These records are provided in an Excel worksheet, *TBL_LABOR_C_DIVI*, of an Excel document, *MMS.*

2-A-4-4-4-2 Recommendation

If NDOT has correct information related to these 16 division codes, they can be appended in the MMS_DIVI look up table.

2-A-4-4-5 C_District

C_District provides a district number associated with a maintenance task. Description of district number is provided in MMS_DIST lookup table. The MMS_DIST table contains the district number, district headquarter location, and city name of district location. The C_District contains six sub-districts and Carson City. Table 2-A-28 shows the numbers, name, and location of all seven districts.

TABLE 2-A-28 Number, Name, and Location of Districts

C_District	C_Name	C_Location
1	L.V.	L. V. Admin
2	Reno	Reno Admin
3	Elko	Elko Admin
4	Ely	Ely Admin
5	Tono	Tono Admin
6	Winn	Winn Admin
9	H.Q.	Carson City (1263 S. Stewart St.)

2-A-4-4-5-1 Anomaly

The C_District attribute contains 1,267,388 records with null values.

2-A-4-4-5-2 Recommendation

The C_District attribute can have null values in the database. However, if the district information can be obtained using location information, it can be appended in the database.

2-A-4-4-6 N_Hrs_Task

N_Hrs_Task attribute provides a total number of hours worked by all crewmembers involved in a maintenance task. It is the sum of regular and overtime hours worked by the crewmembers. The values in this attribute range from ‘0’ to ‘1805’.

2-A-4-4-6-1 Anomaly

The N_Hrs_Task contains 14,621 records with the total work hours not equal to the sum of regular and overtime work hours. These records have the first name as ‘Worker’ in C_NAME_F attribute and the last name as ‘Maintenance’ in C_NAME_L attribute. These records are provided in an Excel worksheet, *Tbl_Labor_Hrs_Task*, of an Excel document, *MMS.*

2-A-4-4-6-2 Recommendation

If the anomaly was introduced during data entry, it could be corrected by investigating the Maintenance management system documents. If not, the correct work hour values for these records need to be verified.

2-A-4-4-7 N_Time_Prod

N_Time_Prod attribute provides a total productive time of employees or labors. It is calculated using the following equation:

N_Time_Prod= (N_Hrs_Reg+ N_Hrs_OT) - N_Travel_Time…….. (Equation-4)

The values in this attribute range from '-290' to '84'.

2-A-4-4-8 D_Date

D_Date attribute provides the date of labor usage to perform a maintenance task. It contains date from the year 1900 to 2014.

2-A-4-4-8-1 Anomaly

The D_Date contains future dates of labor usage in 24 records. Table 2-A-29 illustrates all these 24 records with future dates.

TABLE 2-A-29 D_Date Attribute with Future Dates in TBL_LABOR

C_Key	C_Tsk_Task_Fk	N_Hrs_OT	N_Hrs_Reg	N_Time_Period	N_Travel_Time	D_Date
1478137	719954	0	4	4	0	12-Nov-14
1478138	719954	4	4	8	0	12-Nov-14
1480020	720765	0	1	1	0	14-Nov-14
1475424	718705	0	5	5	0	26-Nov-14
1475425	718705	0	5	5	0	26-Nov-14
1475426	718706	0	3	3	0	26-Nov-14
1475427	718706	0	3	3	0	26-Nov-14
1475435	718712	0	8	8	0	26-Nov-14
1475436	718712	0	8	8	0	26-Nov-14
1484239	722595	0	1	1	0	27-Nov-14
1475456	718718	0	6	6	0	27-Nov-14
1475462	718729	0	8	8	0	27-Nov-14
1475463	718729	0	2	2	0	27-Nov-14
1475464	718729	0	8	8	0	27-Nov-14
1475465	718729	0	8	8	0	27-Nov-14
1475477	718740	0	10	10	0	2-Dec-14
1475478	718740	0	3	3	0	2-Dec-14
1475479	718740	0	3	3	0	2-Dec-14
1475480	718740	0	3	3	0	2-Dec-14
1475498	718746	0	8	8	0	3-Dec-14
1475499	718746	0	8	8	0	3-Dec-14
1475500	718746	0	8	8	0	3-Dec-14
1497956	729007	0	7	6	1	25-Dec-14
1497957	729007	0	7	6	1	25-Dec-14

2-A-4-4-8-2 Recommendation

If the anomaly was introduced during data entry, it could be corrected by investigating the Maintenance Management System documents.

2-A-4-5 TBL_MATERIAL_2003 Table

TBL_MATERIAL_2003 table contains information related to materials used in a maintenance task. It includes such information as material class, material name, quantity of material used in a task and materials used as stockpile.

The table has 887,619 records with 16 attributes. The attributes present in this table are illustrated in Table 2-A-30.

TABLE 2-A-30 Attributes of TBL_MATERIAL_2003 Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Charge_To_Stockpile_FK	Varchar2(6 Byte)	Yes
C_Desc_UOM	Varchar2(80 Byte)	Yes
C_Key	Char(28 Byte)	No
C_Material_Class	Varchar2(7 Byte)	Yes
C_Material_Name	Varchar2(80 Byte)	Yes
C_MMS_Material_FK	Char(4 Byte)	Yes
C_MMS_Stockpile_Detail_FK	Varchar2(6 Byte)	Yes
C_Tsk_Task_FK	Char(23 Byte)	No
D_Tsk_Task_Date	Date	Yes
L_Selected	Number(1,0)	Yes
L_Stockpiled	Number(1,0)	Yes
N_Labor_Ucost	Number(10,2)	Yes
N_Qty_Adjust	Number(10,2)	Yes
N_Qty_On_Hand	Number(10,2)	Yes
N_Qty_Used	Number(10,2)	Yes
N_Std_Ucost	Number(10,2)	Yes

2-A-4-5-1 C_Key

C_Key attribute is a primary key of the TBL_MATERIAL_2003 table, which is a unique number assigned to a type of material used in a maintenance task.

2-A-4-5-2 C_Tsk_Task_FK

C_Tsk_Task_FK is a foreign key that connects the TBL_MATERIAL_2003 table with the TBL_TASK table. This attribute is equivalent to C_Key attribute of the TBL_TASK table.

2-A-4-5-3 C_MMS_Material_FK

C_MMS_Material_FK is a foreign key that connects the TBL_MATERIAL_2003 table with the MMS_MATERIAL lookup table. The MMS_MATERIAL table contains description of material used, class of material, and unit of measurement of quantity of materials. The C_MMS_Material_FK attribute is equivalent to C_Key attribute of the MMS_MATERIAL table.

2-A-4-5-4 C_Material_Class

C_Material_Class attribute provides a class of material used for a maintenance task. It contains 98 different material classes. For example, aggregate and chips are classified as '02-787U' and sand as '03-787V'.

2-A-4-5-5 C_Material_Name

C_Material_Name attribute provides the name of material used for a maintenance task. For example, aggregate, sand, chips, barbed wire, and glass beads.

2-A-4-5-5-1 Anomaly

The C_Material_Name attribute contains same material name with different character lengths. For example, some records have 'Aggregate' with a character length of nine while some records have 'Accident' with the character length of 45 including spaces. Such discrepancy causes an error while querying information based on material name in BI project.

2-A-4-5-5-2 Recommendation

The incorrect character length of the values can be corrected and made consistent by removing the unwanted spaces in the C_Material_Name attribute.

2-A-4-5-6 C_Desc_UOM

C_Desc_UOM attribute provides a unit of measurement to quantify material used in a maintenance task.

2-A-4-5-7 N_Std_Ucost

N_Std_Ucost attribute provides a standard cost per unit of material used in a maintenance task. The values in this attribute ranges from '0' to '650'.

2-A-4-5-8 N_Labor_Ucost

N_Labor_Ucost attribute provides a labor cost per unit of materials used in a maintenance task. This attribute contains either '0' or 'null' values in the database.

2-A-4-5-9 N_Qty_Used

N_Oty_Used attribute provides the quantity of material used in a task. The values in this attribute ranges from '0' to '2071338'.

2-A-4-5-10 C_MMS_Stockpile_Detail_FK

C_MMS_Stockpile_Detail_FK attribute is a foreign key that connects the TBL_MATERIAL_2003 table with the MMS_STOCKPILE_DETAIL table. The MMS_STOCKPILE_DETAIL table contains information related to materials that are stored and handled as stockpiles.

2-A-4-6 TBL_LOCATION Table

TBL_LOCATION table contains detailed location information of a maintenance site. It includes route numbers, road-network designator codes, route direction, mileposts, and county of a maintenance site. This table contains 1,533,979 records with 22 attributes. Table 2-A-31 illustrates the attributes present in the TBL_LOCATION table.

TABLE 2-A-31 Attributes in TBL_LOCATION Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Key	Char(28 Byte)	No
C_Tsk_Task_FK	Char(23 Byte)	No
C_MMS_Ri_Road_FK	Char(3 Byte)	Yes
C_MMS_Ri_County_FK	Char(2 Byte)	Yes
N_MP_From	Number(10,2)	Yes
N_MP_To	Number(10,2)	Yes
C_Side_Direction	Varchar2(4 Byte)	Yes
C_Lane_Number	Varchar2(7 Byte)	Yes
N_MP_From_Offset	Number(8,2)	Yes
N_MP_To_Offset	Number(8,2)	Yes
C_Tsk_LOC_Ramp	Varchar2(10 Byte)	Yes
C_Tsk_LOC_Shld	Varchar2(10 Byte)	Yes
C_Tsk_LOC_Lane	Varchar2(10 Byte)	Yes
C_Road	Varchar2(3 Byte)	Yes
C_Alt	Varchar2(1 Byte)	Yes
C_Alt_Park	Varchar2(1 Byte)	Yes
C_Code	Varchar2(2 Byte)	Yes
C_Post_Direction	Varchar2(1 Byte)	Yes
C_County	Varchar2(20 Byte)	Yes
L_Selected	Number(1,0)	Yes
N_Depth	Number(4,2)	Yes
D_Tsk_Task_Date	Date	Yes

2-A-4-6-1 C_Key

C_Key attribute is a primary key of the TBL_LOCATION table, which is a unique number assigned to each maintenance site.

2-A-4-6-2 C_Tsk_Task_FK

C_Tsk_Task_FK is a foreign key that connects the TBL_LOCATION table with the TBL_TASK table. This attribute is equivalent to C_Key attribute of the TBL_TASK table.

2-A-4-6-3 C_MMS_RI_Road_FK

C_MMS_RI_Road_FK attribute is a foreign key that connects the TBL_LOCATION table with the MMS_RI_ROAD lookup table. The MMS_RI_ROAD table contains a description of a route

where a maintenance task was performed. The description includes route number, alternate route, posted direction, and route name.

2-A-4-6-3-1 Anomaly

The C_MMS_RI_Road_FK attribute contains route codes '427' and '44' in 7,927 records, which are not available in the MMS_RI_ROAD lookup table. These records are provided in an Excel worksheet, *TBL_LOCATION_RI_ROAD*, of an Excel document, *MMS*.

2-A-4-6-3-2 Recommendation

If the anomaly was introduced during data entry, it could be corrected by investigating the maintenance management system documents. If not, descriptions of these route codes need to be updated in the MMS_RI_ROAD lookup table.

2-A-4-6-4 C_MMS_RI_County_FK

C_MMS_RI_County_FK is a foreign key to connect the TBL_LOCATION table with the MMS_RI_COUNTY lookup table. The MMS_RI_COUNTY table provides name and code of county. For example, 'CC' is assigned to Carson City County. There are 19 distinct county codes present in the TBL_DATAMART_SUMMARY table including Mohave County of Arizona and Mono County of California.

2-A-4-6-5 N_MP_From and N_MP_To

N_MP_From and N_MP_To attributes provide begin and end mileposts of a roadway maintenance segment.

2-A-4-6-5-1 Anomalies

- The TBL_LOCATION table has a record with negative milepost values in N_MP_From and N_MP_To attributes. Table 2-A-32 includes this record with negative values as the beginning and the end milepost.

TABLE 2-A-32 Negative Milepost Values in N_MP_From and N_MP_To Attributes

C_ Key	C_Desc_ Cause	D_Task _Date	C_ Code	C_ Road	C_ County	N_MP_ From	N_MP_ To
296600	Normal Maintenance	26-Sep-07	SR	359	Mineral County	-21.8	-21.8

- The TBL_LOCATION table contains four records with milepost values equal to or greater than 800 for IR15. Similarly, it contains seven records with milepost greater than 800 for US95. Table 2-A-33 illustrates such milepost values in N_MP_From and N_MP_To attributes for IR15 and US95 routes. IR15 has a maximum milepost value of 12.776 and US 95 has a maximum milepost value of 665.940 in Nevada.

TABLE 2-A-33 Incorrect Milepost Value in N_MP_From and N_MP_To Attributes

C_Key	N_MP_ From	N_MP_ To	C_ Road	C_ Code	C_Post_ Direction	C_County	D_Tsk_ Task_ Date
160387	12062	12062	15	IR	N	Clark County	24-Oct-05
90567	8900	8900	95	US	N	Clark County	1-Jun-04
770	8311	8311	95	US	N	Clark County	7-Oct-03
248301	8208	8208	95	US	N	Clark County	30-May-07
385813	7566	7566	95	US	N	Clark County	9-Dec-09
240440	3839	3839	15	IR	N	Clark County	4-Apr-07
566996	3820	3820	50	US	E	Eureka County	23-Jan-13
315715	3100	3100	15	IR	N	Clark County	22-Aug-08
116080	1210	1260	50	US	E	Douglas County	10-Dec-04
375298	840	840	6	US	E	Mineral County	29-Sep-09
360047	800	800	80	IR	E	Humboldt County	28-May-09

2-A-4-6-5-2 Recommendations

- It appears that decimals were not included. If NDOT has the correct N_MP_From, N_MP_To values, and milepost location of the road maintenance segment for the site, it can be appended in this table.

2-A-4-6-6 C_Post_Direction

C_Post_Direction attribute provides a posted direction of a route.

2-A-4-6-7 C_Road

C_Road attribute contains three-digit numbers assigned to a route. For example, I15 route the C_Road attribute has value ‘015’. The TBL_LOCATION table contains null values in C_Road attribute associated with 90 records. This attribute can have null values. However, if route information is available in maintenance management documents, it can be appended in the database.

2-A-4-6-8 C_Alt

C_Alt attribute provides an alternate route of a road where maintenance task is performed. This is usually provided to inform an availability of access alternate route.

2-A-4-7 MMS_STOCKPILE_DETAIL Table

MMS_STOCKPILE_DETAIL table contains information related to stockpile of materials for maintenance activities. The information includes material type, location, and maintenance division of stockpiles. This table has foreign keys to MMS_MATERIAL, MMS_RI_ROAD,

MMS_DIST, and MMS_DIVI tables. It contains 508 records with 11 attributes. Table 2-A-34 illustrates the attributes present in the MMS_STOCKPILE_DETAIL table.

TABLE 2-A-34 Attributes in MMS_STOCKPILE_DETAIL Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Comments	Varchar2(250 Byte)	Yes
C_Key	Varchar2(6 Byte)	No
C_Location_Name	Varchar2(80 Byte)	Yes
C_MMS_Dist_FK	Char(1 Byte)	No
C_MMS_Divi_FK	Char(3 Byte)	No
C_MMS_Material_FK	Char(4 Byte)	No
C_MMS_Ri_County_FK	Char(2 Byte)	No
C_MMS_Ri_Road_FK	Char(3 Byte)	Yes
C_Stock_Id	Varchar2(80 Byte)	Yes
N_Active	Number(1,0)	Yes
N_Mp_From	Number(6,2)	Yes

2-A-4-7-1 C_Key

C_Key is a primary key of the MMS_STOCKPILE_DETAIL table, which is an indexed sequential number assigned to a stockpile.

2-A-4-7-2 C_Stock_ID

C_Stock_ID attribute provides a stockpile identification number. This number is unique to each stockpile.

2-A-4-7-2-1 Anomaly

The C_Stock_ID attribute contains repeated stock identification number for a record, which is I active status. Table 2-A-35 illustrates this record with repeated stock IDs.

TABLE 2-A-35 Records with Repeated Stock ID in MMS_STOCKPILE_DETAIL

C_Key	C_MMS_RI _Road_FK	C_Mms_RI_ County_FK	C_MMS_ Divi_FK	C_Stock _ID	C_Location_ Name	N_MP _From	N_ Active
1363	58	8	304	460207	Wmca - Salvage Yard	0	1

2-A-4-7-2-2 Recommendation

The repetition occurred due to old records and not updated in the database. The record with only C_Key ‘1363’ is in active status. If NDOT has information for these stockpiles, they can be updated in the database.

2-A-4-7-3 C_Location_Name

C_Location_Name attribute provides a location of a stockpile. For example, Stock ID 430107 is located at four miles east of US 93A.

2-A-4-7-4 C_MMS_RI_Road_FK

C_MMS_RI_Road_FK attribute is a foreign key that connects the MMS_STOCKPILE_DETAIL table with the MMS_RI_ROAD lookup table. The MMS_RI_ROAD table contains description of a route in which a maintenance task was performed. The description includes route number, alternate route, posted direction, and route name.

2-A-4-7-4-1 Anomaly

The C_MMS_RI_Road_FK attribute contains route code '427' in seven records that is not available in the MMS_RI_ROAD lookup table. These records are provided in an Excel worksheet, *Stockpile_MMS_RI_Road*, of an Excel document, *MMS.*

2-A-4-7-4-2 Recommendation

If the anomaly was introduced during data entry, it could be corrected by investigating the maintenance management system documents. If not, description of the route code needs to be updated in the MMS_RI_ROAD lookup table.

2-A-4-7-5 C_MMS_RI_County_FK

C_MMS_RI_County_FK is a foreign key to connect the MMS_STOCKPILE_DETAIL table with the MMS_RI_COUNTY lookup table. The MMS_RI_COUNTY table provides name and code of a county. County codes present in MMS_STOCKPILE_DETAIL provide the county information of a stockpile.

2-A-4-7-6 C_MMS_Material_FK

C_MMS_Material_FK is a foreign key that connects the MMS_STOCKPILE_DETAIL table with the MMS_MATERIAL lookup table. This attribute provides a description of material stored as a stockpile. The MMS_MATERIAL table contains description of material used, class of material, and unit of measure of quantity of materials.

2-A-4-7-7 C_MMS_Dist_FK

C_MMS_Dist_FK is a foreign key that connects the MMS_STOCKPILE_DETAIL table with the MMS_DIST table. The MMS_DIST table provides a district number, district headquarter location, and city name. The MMS_STOCKPILE_DETAIL table has six sub-districts and Carson City for stockpile location.

2-A-4-7-8 C_MMS_Divi_FK

C_MMS_Divi_FK attribute is used as a foreign key to connect the MMS_STOCKPILE_DETAIL table with MMS_DIVI lookup table. This foreign key is equivalent with the C_Key of the MMS_DIVI table. This attribute provides the detailed information related to a stockpile handling division from the MMS_DIVI table.

2-A-4-7-9 N_MP_From

N_MP_Form attribute provides a mile marker position of a stockpile. The mile marker position is calculated based on the corresponding begin and end mile markers of a route segment.

2-A-4-7-10 N_Active

N_Active attribute indicates if a stockpile is active or inactive. It has codes: ‘0’ for inactive and ‘1’ for active material.

2-A-4-8 TSK_STOCKPILE_TRANS Table

TSK_STOCKPILE_TRANS table provides information related to transactions of handling stockpiles such as stockpile total cost, type of transaction, quantity of stockpiles, and appropriate work order numbers. This table has foreign keys to MMS_MATERIAL, MMS_MAT_UOM, LST_EMP, LST_EQU_CAT, TBL_TASK, and STOCKPILE_DETAIL tables. It contains 235,779 records with 19 attributes. Table 2-A-36 illustrates the attributes present in the TSK_STOCKPILE_TRANS table.

TABLE 2-A-36 Attributes in TSK_STOCKPILE_TRANS Table

COLUMN_NAME	DATA_TYPE	NULLABLE
C_Apr_Wo_Misc	Varchar2(12 Byte)	Yes
C_Comments	Varchar2(250 Byte)	Yes
C_Invoice_MMS_Mat_UOM_FK	Char(2 Byte)	Yes
C_Invoice_MMS_Material_FK	Char(4 Byte)	Yes
C_Key	Varchar2(28 Byte)	No
C_Lst_Emp_FK	Char(9 Byte)	Yes
C_Lst_Equ_Cat_FK	Char(3 Byte)	Yes
C_Related_Stockpile_Detail_FK	Varchar2(6 Byte)	Yes
C_Stockpile_Detail_FK	Varchar2(6 Byte)	No
C_Trans_Code	Varchar2(3 Byte)	No
C_Trans_Login_ID	Varchar2(10 Byte)	No
C_Tsk_Task_FK	Char(23 Byte)	Yes
D_Trans_Date	Date	No
D_Tsk_Task_Date	Date	No
N_Invoice_Qty	Number(10,2)	Yes
N_Material_Cost_Qty	Number(10,2)	Yes
N_Moisture_Percent	Number(3,3)	Yes
N_Trans_Qty	Number(10,2)	No
N_Trans_Total_Cost	NUMBER(10,2)	No

2-A-4-8-1 C_Key

C_Key attribute is a primary key of the TSK_STOCKPILE_TRANS table, which is an indexed sequential number assigned to each transaction of a stockpile.

2-A-4-8-2 C_Tsk_Task_FK

C_Tsk_Task_FK is a foreign key that connects the MMS_STOCKPILKE_DETAIL table with the TBL_TASK table. This attribute is equivalent to C_Key attribute of the TBL_TASK table.

2-A-4-8-3 C_Stockpile_Detail_FK

C_Stockpile_Detail_FK is a foreign key to connect the TSK_STOCKPILE_TRANS table with the MMS_STOCKPILE_DETAIL table. This attribute is equivalent to C_Key attribute of the MMS_STOCKPILE_DETAIL table.

2-A-4-8-4 C_Related_Stockpile_Detail_FK

C_Related_Stockpile_Detail_FK is a foreign key that connects the TSK_STOCKPILE_TRANS table with the MMS_STOCKPILE_DETAIL table. The C_Related_Stockpile_Detail_FK attribute requires values when more than one stockpile is used for a task. The values in this attribute are only available when two or more stockpiles are used for same maintenance task. For example, a record with a task code '100887' has '0197' value in C_Stockpile_Detail_FK and '0199' value in C_Related_Stockpile_Detail_FK. Similarly, other record with same task code '100887' has '0199' value in C_Stockpile_Detail_FK and '0197' value in C_Related_Stockpile_Detail_FK.

2-A-4-8-5 C_Trans_Code

C_Trans_Code attribute provides a stockpile transaction code. Descriptions of codes used in this attribute are present in MMS_SP_TRANS_CODE table. For example, description '030' in C_Trans_Code is available as 'Purchased' in the MMS_SP_TRANS_CODE table. The TSK_STOCKPILE_TRANS table contains 11 distinct transaction codes in the C_Trans_Code attribute.

2-A-4-8-6 N_Trans_Qty

N_Trans attribute provides a quantity during stockpile transaction.

2-A-4-8-7 N_Invoice_Qty

N_Invoice_Qty attribute provides a quantity of stockpile as listed in the invoice.

2-A-4-8-8 N_Material_Cost_Qty

N_Material_Cost_Qty attribute provides a quantity of the stockpile material that affects a material cost.

2-A-4-8-9 C_Apr_Wo_Misc

C_Apr_Wo_Misc attribute provides an approved work order number related to the handling of stockpiles.

2-A-4-8-10 N_Trans_Total_Cost

N_Trans_Total_Cost attribute provides a total cost of various transactions associated with a stockpile. The values in this attribute are calculated in different ways depending on the type of transaction and business rule. For example, N_Trans_Total_Cost is zero for transactions that come under category 'free' and 'Material Used'. These categories are provided in the MMS_SP_TRANS_CODE table.

2-A-4-8-11 D_Trans_Date

D_Trans_Date attribute provides a transaction date of a stockpile. It contains dates from 04-10-2003 to 05-05-2014.

2-A-4-8-12 C_Invoice_MMS_Mat_UOM_FK

C_Invoice_MMS_Mat_UOM_FK attribute is a foreign key that connects the TSK_STOCKPILE_TRANS table with MMS_MAT_UOM lookup table. The MMS_MAT_UOM lookup table provides units of measurement of materials. The C_Invoice_MMS_Mat_UOM_FK attribute contains seven distinct units of measurement of stockpiles such as tons, pounds, and gallons.

2-A-4-8-13 C_Invoice_MMS_Material_FK

C_Invoice_MMS_Material_FK attribute is a foreign key to connect the TSK_STOCKPILE_TRANS table with the MMS_MATERIAL table. The MMS_MATERIAL table contains description of material used, class of material, and unit of measure of quantity of materials. The C_Invoice_MMS_Material attribute contains 19 distinct materials as listed in the invoice.

2-A-4-8-14 C_Lst_Emp_FK

C_Lst_Emp_FK attribute is a foreign key to connect the TSK_STOCKPILE_TRANS table with the LST_EMP table. The LST_EMP lookup table provides full names of the employees, their pay rates and work termination dates. The C_Lst_Emp attribute contains 1,053 distinct employee IDs that are available in C_Key attribute of the LST_EMP table.

2-A-4-8-15 C_Lst_Equ_Cat_FK

C_Lst_Equ_Cat_FK attribute is a foreign key to connect the TSK_STOCKPILE_TRANS table with the LST_EQU_CAT table. The LST_EQU_CAT table contains information related to the categories of equipment, and their hourly rental rates. The C_Lst_Equ_Cat_FK attribute contains 57 distinct equipment categories that are available in C_Key attribute of the LST_EQU_CAT lookup table.

2-A-4-8-15-1 Anomaly

C_Lst_Equ_Cat_FK attribute contains a record with value ‘71’ that is not available in the LST_EQU_CAT lookup table. This lookup table contains value ‘071’ as equipment category code instead of ‘71’.

2-A-4-8-15-2 Recommendation

The value ‘71’ in the C_Lst_Equ_Cat_FK attribute can be corrected to ‘071’ value in the TSK_STOCKPILE_TRANS table.

2-A-4-8-16 N_Moisture_Percent

N_Moisture_Percent attribute provides a percentage of moisture present in a stockpile. The values in this attribute ranges from '0' to '0.18'.

2-A-4-9 TBL_STOCKPILE_CALCULATION Table

TBL_STOCKPILE_CALCULATION table provides costs of stockpiles. It contains stockpile quantity on hand, unit cost of material, and the total cost of stockpiles. It contains 235,768 records with five attributes. Table 2-A-37 illustrates the attributes present in the TBL_STOCKPILE_CALCULATION table.

TABLE 2-A-37 Attributes in TBL_STOCKPILE_CALCULATION Table

COLUMN_NAME	DATA_TYPE	NULLABLE
N_Key	Number(12,0)	No
C_Stockpile_Trans_FK	Varchar2(28 Byte)	No
N_QoH	Number(10,2)	No
N_SP_Cost	Number(10,2)	No
N_Unit_Cost	Number(10,2)	No

2-A-4-9-1 N_Key

N_Key attribute is a primary key of the TBL_STOCKPILE_CALCULATION table, which is an indexed sequential number assigned to each stockpile cost.

2-A-4-9-2 C_Stockpile_Trans_FK

C_Stockpile_Trans_FK attribute is a foreign key to connect the TBL_STOCKPILE_CALCULATION table with the TSK_STOCKPILE_TRANS table. This attribute contains 235,768 distinct values that are present in the C_Key attribute of the TSK_STOCKPILE_TRANS table.

2-A-4-9-3 N_QoH

N_QoH attribute provides a total available quantity of stockpiles. This also includes the quantity of stockpiling materials that are allocated for any maintenance task. The values in this attribute ranges from '-32508' to '331930.6'. It includes 572 records with '0' values. Based on the NDOT's response, the negative values in this attribute are for adjustments.

2-A-4-9-4 N_Unit_Cost

N_Unit_Cost attribute provides unit cost of a stockpiling material. The values in this attribute varies from '-2448.56' to '58137.15'.

2-A-4-9-5 N_SP_Cost

N_SP_Cost attribute provides cost of stockpiles. It is a product of unit cost and quantity on hand of stockpiling materials. The values in this attribute varies from '-414036.6' to '3531712.45'. Based on the NDOT's response, the negative values in this attribute are for adjustments in cost.

ACRONYMS

MMS - Maintenance Management System

NDOT - Nevada Department of Transportation

UNLV - University of Nevada, Las Vegas

BI - Business Intelligence

SQL - Structured Query Language

IFS - Integrated Financial System

APPENDIX A

LOOK UP Tables

The following 25 look up tables are considered relevant for the BI project:

A-1 MMS_CAUSE Table

MMS_CAUSE table is a lookup table that provides 18 different possible causes that lead to perform various maintenance tasks. C_Key is a primary key of this table. Each C_Key is associated with a description of cause for performing a maintenance task. Table 2-A-38 illustrates codes and descriptions of all 18 causes of maintenance tasks.

TABLE 2-A-38 Type of Causes in MMS_CAUSE Table

C_Key	C_Desc
01	Special Event
02	Vandalism
03	Act of Nature
04	Defective Materials
05	Adopt - A - Highway
06	Excessive Load Weight
07	Road Closure
08	Planned Betterment
09	Accident
10	Complaint
11	Normal Maintenance
12	Community Service
13	Agreement Preparation / Inspection
14	Expelling Live Animals from R/W
21	Graffiti
41	Remove Animal Droppings
42	Homeless Clean Up
43	Sign Retro-Reflectivity Inspection

A-2 MMS_DIVI Table

MMS_DIVI table is a lookup table that contains detailed information related to a maintenance task division such as supervisor of a task, location information of a division, district ID, and crew size. This table has 132 divisions. Table 2-A-39 illustrates example of different divisions and the associated descriptions as provided in the MMS_DIVI table.

TABLE 2-A-39 Example of Different Divisions in MMS_DIVI Table

C_ Div	C_ Key	C_ Foreman	C_ Level	C_Location	C_ MMS_ Dist_ FK	C_ Old _ Div	N_ Crew _Size	N_Reg _Hrs
C017	017			Location HQ	7		0	8
C020	020			Materials Administration HQ	7		0	8
C035	035			Right of Way Carson City HQ	7		0	8
C101	101	000006065		L. V. Admin	1	101	0	8
C126	126	000027682	4	Mountain Springs	1	126	0	10
C175	175	000031191		Goldfield	2	175	0	10
C321	321			Elko Stockpile Control	4	321	0	8
C355	355	000014075		Bridge Maintenance	4	355	0	10
C370	370	000033295		Winn Mntc Crew 1	5	370	0	8
C371	371	000025562		Battle Mountain	5	371	0	8
C372	372	000006541		Orovada	5	372	0	8
C373	373	000022340		Quinn River	5	373	0	8
C374	374	000007852		Winn Mntc Crew 2	5	374	0	8
C380	380	000026311		Ely Mntc Crew 1	6	380	0	10
C384	384	000025260		Eureka	6	384	0	10

A-3 MMS_TASK Table

MMS_TASK lookup table contains descriptions of maintenance tasks, number of crew hours and labor hours, number of supervisors and workers involved in a maintenance task. It contains 127 distinct tasks. In addition, this table has foreign keys to MMS_TSK_GRP, MMS_TSK_ACCU, and MMS_ACCOUNT lookup tables, which are further, described in this appendix.

A-4 MMS_RI_ROAD_RMID Table

The MMS_RI_ROAD_RMID table provides route maser ID and full name of routes. This table also includes the posted direction and status of routes. In addition, this table has a foreign key to the MMS_RI_SYS table, which is discussed in this appendix.

A-5 MMS_RI_ROAD Table

MMS_RI_ROAD table contains descriptions of routes where maintenance tasks were performed. The information included is route number, alternate route, posted direction, and route name. This table has 490 distinct routes with descriptions .In addition, this table contains foreign keys to MMS_RI_SYS and MMS_RI_COUNTY tables, which are described in this appendix.

A-6 MMS_RI_COUNTY Table

MMS_RI_COUNTY lookup table provides name and code of county. For example, ‘CC’ code is assigned to Carson City County. There are 19 distinct county codes present in the MMS_RI_COUNTY table including Mohave County of Arizona and Mono County of

California. In addition, it includes a record with C_Key '99', which has null value in other attributes.

TABLE 2-A-40 List of Counties in MMS_RI_COUNTY Table

C_KEY	C_INITIALS	C_NAME
01	CC	Carson County
02	CH	Churchill County
03	CL	Clark County
04	DO	Douglas County
05	EL	Elko County
06	ES	Esmeralda County
07	EU	Eureka County
08	HU	Humboldt County
09	LA	Lander County
10	LN	Lincoln County
11	LY	Lyon County
12	MI	Mineral County
13	NY	Nye County
14	PE	Pershing County
15	ST	Storey County
16	WA	Washoe County
17	WP	White Pine County
21	MO	Mohave County (AZ)
22	MN	Mono County (CA)
99		

A-7 LST_EMP Table

LST_EMP is a look up table, which provides information related to employees. It contains employee ID, full name, pay rates, and work termination dates of the employees. This table has 10 attributes and includes information of 4,200 employees involved in maintenance tasks. C_Key is a primary key for this table that indicates the employee ID of a maintenance crew member.

A-8 LST_EQU_CAT Table

LST_EQU_CAT table contains information about categories of equipment, and their hourly rental rates. It contains 96 different equipment categories used for maintenance tasks.

A-8-1 Anomaly

This table contains eight records with an hourly rental rate of equipment equal to zero. Table 2-A-41 illustrates the example of this anomaly.

TABLE 2-A-41 Hourly Rental Rate Equal to Zero in LST_EQU_CAT Table

C_Key	C_Class	C_Class_Desc	N_Rent_Rate	N_Active
8	08D	CONCRETE SAW	0	0
10	08F	GENERATOR	0	0
11	08G	LPG WEED BURNER	0	0
13	08H	PAVEMENT SAW	0	0
49	08I	SPREADER BOX	0	0
52	68	SCREENING PLANTS	0	0
53	08J	WELDER	0	0
54	08K	WEED SPRAYER	0	0

A-8-2 Recommendation

The hourly rental can be zero if equipment is owned by NDOT itself. However, if the equipment is not owned by NDOT and is rented, the correct rental hour needs to be updated in the database.

A-9 MMS_MATERIAL Table

MMS_MATERIAL lookup table contains description of material used, class of material and unit of measure of quantity of materials. This table includes descriptions of 92 different types of materials used in maintenance tasks.

A-10 MMS_MAT_UOM Table

MMS_MAT_UOM is a lookup table, which provides units of measurement of quantity of materials. It includes 15 types of units including ‘Pound’ as an inactive unit as shown in Table 2-A-42.

TABLE 2-A-42 MMS_MAT_UOM Lookup Table as in MMS Database

C_Key	C_Desc	N_Active
1	Miles	1
3	Sack	1
4	Tons	1
5	Linear Feet	1
6	Cubic Feet	1
7	Cubic Yards	1
8	Square Feet	1
9	Pounds	1
10	Gallons	1
11	Pound	0
13	Ounce	1
14	Each	1
15	Dollars	1

A-11 MMS_SP_MAT_CONV Table

MMS_SP_MAT_CONV table provides conversion factors for the unit of measurement during purchase of stockpiling materials to the unit of measurement of materials to be used in the site. Table 2-A-43 illustrates the MMS_SP_MAT_CONV table as available in the MMS database.

TABLE 2-A-43 MMS_SP_MAT_CONV Lookup Table as in the MMS Database

C_Key	C_Purchase_Uom_FK	C_MMS_Mat_Uom_FK	N_Conv_Purch_To_Mat
0001	4	7	1.5
0002	4	7	1.25
0003	4	7	1.2
0006	4	7	1
0011	4	7	1
0047	4	7	1.8
0063	4	7	1.5

A-12 MMS_ACCOUNT Table

MMS_ACCOUNT is a lookup table that contains information related to MMS accounts or projects such as Scenic Byways Projects, Special Projects, Stockpile Acquisition, and Highway Investment. This table includes 66 different accounts in active status. Table 2-A-44 illustrates examples of MMS_ACCOUNT table as available in the database.

TABLE 2-A-44 MMS_ACCOUNT Lookup Table as in the MMS Database

C_KEY	C_DESC_ACCOUNT	N_ACTIVE
4601	Administrative SPR 99	1
3601	Administrative SPR 99	1
1660	Agreements with Government Entities - Federal	1
9660	Agreements with Government Entities - State	1
1650	Agreements with Non-Government Entities - Federal	1
9650	Agreements with Non-Government Entities - State	1
9901	Buildings and Grounds	1
9187	Contract Maintenance Activities	1
1620	Cooperative Agreements for Fencing - Federal	1
9620	Cooperative Agreements for Fencing - State	1
4614	Database Management SPR 99	1
3614	Database Management SPR 99	1
9181	District Administration	1
9182	District Headquarters and Maintenance Stations	1
1189	Emergency Response - Federal	1
9189	Emergency Response - State	1

A-13 MMS_TSK_ACCU Table

MMS_TASK_ACCU is a lookup table, which provides unit of measurement for the quantity of task accomplished. It has 17 such measurement units as Cubic Feet, Man Hours, Striping Miles, and Gallons. Table 2-A-45 illustrates the MMS_TSK_ACCU table as provided in the database.

TABLE 2-A-45 MMS_TSK_ACCU Lookup Table as in the MMS Database

C_KEY	C_DESC	N_ACTIVE
1	Cubic Feet	1
6	Cubic Yards	1
11	Each	1
16	Fence Miles	1
18	Gallons	1
4	Lbs. Filler Material	1
7	Linear Feet	1
5	Man Hours	1
12	Pilot Line Miles	1
3	Pounds Per Mile	1
8	Shoulder Miles	1
2	Square Feet	1
14	Square Yards	1
13	Striping Miles	1
9	Sweeping Miles	1
10	Traveled Miles	1
1	Treated Lane Miles	1

A-14 MMS_TSK_EQU Table

The MMS_TSK_ EQU table provides quantity of each type of equipment used on a maintenance task. In addition, this table has foreign keys to lookup tables LST_EQU_CAT and MMS_TSK, which are discussed in this appendix.

A-15 MMS_TSK_GRP Table

The MMS_TSK_GRP table provides description and status for group of maintenance tasks. In addition, this table has a foreign key to lookup table MMS_TSK_PGM, which is discussed in this appendix.

A-16 MMS_TSK_MAT Table

The MMS_TSK_MAT table provides quantity of material used on a task. In addition, this table has foreign keys to lookup tables MMS_MATERIAL and MMS_TSK, which are discussed in this appendix.

A-17 MMS_TSK_PGM Table

MMS_TSK_PGM is a lookup table, which provides codes, descriptions, and status of programs related to maintenance tasks. The MMS_TSK_PGM table includes 17 active maintenance task programs that are illustrated in table 2-A-46.

TABLE 2-A-46 MMS_TSK_PGM Lookup Table as in the MMS Database

C_KEY	C_PGM_DESC	N_ACTIVE
100	Administration	1
101	Flexible Pavement Program	1
102	-General Time	1
111	Rigid Pavement	1
112	Misc. Concrete Repair	1
131	Roadside Maintenance Program	1
133	Roadside Cleanup	1
134	Maintenance of Roadside Facilities	1
135	Maintenance of Roadside Appurtenances	1
141	Traffic Services	1
151	Snow And Ice Control Program	1
161	Structure Maintenance Program	1
182	Maintenance of District Facility	1
254	Roadside Betterment Program	1
256	Surface Treatment Betterment Program	1
261	Traffic Services Betterment Program	1
270	Stockpile Production Program	1

A-18 MMS_DIST Table

MMS_DIST is a lookup table that provides information associated with districts of Nevada. It contains district number, district head quarter location, and city name. This table contains seven records: six sub-districts and Carson City. Table 2-A-47 illustrates the MMS_DIST table as provided in the database.

TABLE 2-A-47 MMS_DIST Lookup Table as in the MMS Database

C_KEY	C_DISTRICT	C_LOCATION	C_NAME	N_ACTIVE
1	1	L. V. Admin	L.V.	1
2	5	Tono Admin	Tono	1
3	2	Reno Admin	Reno	1
4	3	Elko Admin	Elko	1
5	6	Winn Admin	Winn	1
6	4	Ely Admin	Ely	1
7	9	Carson City (1263 S. Stewart St.)	H.Q.	1

A-19 TBL_NET_ELIGIBLE_EQU Table

The TBL_NET_ELIGIBLE_EQU table contains information related to equipment that can be used to perform a maintenance task. It has a foreign key to connect the TBL_NET_ELIGIBLE_EQU table with the LST_EQU_CAT table. It contains 15 active equipment classes with their hourly rental rates. Table 2-A-48 illustrates the TBL_NET_ELIGIBLE_EQU table as provided in the database.

TABLE 2-A-48 TBL_NET_ELIGIBLE_EQU Lookup Table as in the MMS Database

C_Key	C_Lst_Equ_Fk	C_Class	C_Class_Desc	N_Rent_Rate	N_Active
1	012	10	CREW CAB	1.78	1
2	019	11F	SERVICE (INCLUDES UTILITY TRUCKS)	8.49	1
3	022	13	TANDEM AXLE DUMP TRUCKS	3.09	1
4	068	4	VAN	1.39	1
5	016	11C	LUBE TRUCKS	26.08	1
6	017	11D	TRASH COMP. TRK OR LITR PU MACH.	6.99	1
7	018	11E	1 TON DUMP TRUCKS	5.68	1
8	020	11G	FLAT RACK WITH ATTENUATOR	14.61	1
9	021	12	SINGLE AXLE DUMP TRUCKS	2.23	1
10	024	15	AWD DUMP TRUCKS	3.48	1
11	002	1	SEDANS	1.35	1
12	005	3	3/4 TON PICK UPS	1.45	1
13	007	5	1/2 TON PICK UPS	1.29	1
14	065	13A	TANDEM AXEL DUMP / ATTENUATOR	21.09	1
15	066	12A	SINGLE AXEL DUMP / ATTENUATOR	15.62	1

A-20 MMS_RI_SYS Table

MMS_RI_SYS is a lookup table that provides different system designations codes and descriptions of roadway network. For example, ‘IR’ code is provided for ‘Interstate’ and ‘SR’ code is provided for ‘State Route’. Table 2-A-49 illustrates the MMS_RI_SYS table as provided in the MMS database.

TABLE 2-A-49 MMS_RI_SYS Lookup Table as in the MMS Database

C_Key	C_Code	C_Name	N_Active
2	SR	State Route	1
3	P	Park	1
4	IR	Interstate	1
5	FR	Frontage Road	1
6	ER	Escape Ramp	1
7	WS	Welcome Station	1
8	RP	Rest Park	1
9	SP	State Park	1
10	AR	Access Road	1
1	US	US Route	1
21	MY	Maintenance Yard	1

A-21 MMS_BETTERMENTTASK Table

MMS_BETTERMENTTASK is a lookup table that provides description of the betterment tasks that are performed as a part of maintenance management. This table includes 46 such betterment tasks as roadway capacity improvements, install new traffic signs, and repair bridge superstructure. Table 2-A-50 illustrates the MMS_BETTERMENTTASK table as provided in the database.

A-22 MMS_BETTERMENT Table

The MMS_BETTERMENT table provides detailed information on MMS Betterment task that are performed as a part of maintenance management. According to NDOT, this information is specifically maintained for reports needed by the maintenance crews.

A-23 MMS_FLOOD Table

The MMS_FLOOD table provides history of flood, potential cause, and associated damage. According to NDOT, this information is specifically maintained for reports needed by the maintenance crews.

A-24 MMS_TSK_CAT Table

The MMS_TSK_CAT table provides description of categories of tasks performed such as Dig, Grade, and Barricade. Table 2-A-51 illustrates the MMS_TSK_CAT table as provided in the MMS database.

A-25 MMS_SP_TRANS_CODE Table

MMS_SP_TRANS_CODE is the lookup table that provides description of different transaction codes used for stockpiles. It contains 11 transaction codes and descriptions as illustrated in Table 2-A-52.

TABLE 2-A-50 MMS_BETTERMENTTASK Lookup Table as in the MMS Database

N_KEY	C_TASK_DESC	N_ACTIVE
1	Base & Surface Repair	1
2	Chip	1
3	Clean Or Repair Structure Drainage	1
4	Clean Or Repair Tunnels	1
5	Concrete Joint Filling Weakened Sawed Joints	1
6	Fog / Flush	1
7	Inspect / Repair / Install Tortoise Fence	1
8	Install New Traffic Signs	1
9	Landscape With Turf	1
10	Landscape Without Turf	1
11	Maintain / Repair Pedestrian Structures	1
12	Maintain Rest Areas	1
13	Maintain Rock Mulch	1
14	Maintenance Patching (less than 500 ft)	1
15	Micro Surfacing / Slurry Seal	1
16	Overlay / Inlay (over 500 ft)	1
17	Permanent Patching / Spall Repair PCCP	1
18	Repair / Install Barbed Wire, Fabric Fences and Gates	1
19	Repair / Install Barrier Rail	1
20	Repair / Install Chain Link, Snow Fence and Gates	1
21	Repair / Install Curb, Gutter, Sidewalk or Wheelchair Ramp	1
22	Repair / Install Drop Inlets	1
23	Repair / Install Glare Screen Or Glare Fence	1
24	Repair / Replace / Extend or Install Culverts	1
25	Repair / Replace / Extend Reinforced Concrete Boxes	1
26	Repair / Replace / Install Cable Barrier	1
27	Repair / Replace / Install Cattle Guard	1
28	Repair / Replace / Install End Treatment Or Impact Attenuator	1
29	Repair / Replace / Install Guard Rail	1
30	Repair / Replace Bridge Expansion Joints, Compression Seals	1
31	Repair / Replacement Of Traffic Signs	1
32	Repair / Reshape / Construct Ditches or Channels	1
33	Repair Bridge Deck / Approach Slabs	1
34	Repair Bridge Superstructure	1
35	Repair Fill and Cut Slopes	1
36	Repair Retaining, Sound Or Bin Walls	1
37	Repair Slope Paving	1
38	Reseeding	1
39	Roadway Capacity Improvements	1
40	Sand	1
41	Scrub Seal	1
42	Solar Lighting	1
43	Structure & Tunnel Lights	1
44	Surface Profiling	1
45	Yard Work	1
46	Street Lights	1

TABLE 2-A-51 MMS_TSK_CAT Lookup Table as in the MMS Database

C_KEY	C_CATEGORY	N_ACTIVE
002	Dig	1
003	Grade	1
004	Paint	1
005	Barricade	1
006	Stratus	1
007	Repair	1
001	Haul	1

TABLE 2-A-52 MMS_SP_TRANS_CODE Lookup Table as in the MMS Database

C_KEY	C_DESC
010	Audit
020	Free
030	Purchased
040	Contract
050	Labor
060	Equipment Cost
070	Transfer In
080	Transfer Out
090	Adjustment
100	Material Used
110	Material Cost

APPENDIX B

B Tables related to MMS Reporting System

The following five tables include information related to the reports generated by the current MMS reporting system. These tables are considered relevant and will be used in the BI project.

B-1 MMS_RPT_LST Table

The MMS_RPT_LST table includes a list of reports that can be generated in in the MMS Reporting System. This table includes 86 reports with description. The reports are categorized into 12 groups, which are used as a report filter in the MMS reporting system

B-2 MMS_RPT_PARAM_OBJ Table

The MMS_RPT_PARAM_OBJ table includes a list of attributes and associated tables to generate reports in the MMS reporting system. The table has three foreign keys: C_Rpt_Parameters_FK, C_MMS_Rpt_SQL_FK, and C_Main_Pages_FK. The first two attributes are used to relate MMS_RPT_PARAMETERS and MMS_RPT_SQL tables respectively. Based on the available information in MMS database schema, the purpose of having C_Main_Pages_FK is not clear.

B-3 MMS_RPT_PARAMETERS Table

MMS_RPT_PARAMETERS is a look up table, which has a list of parameters used to create reports in the MMS reporting system. Table 2-A-53 includes all 17 parameters included in the MMS_RPT_PARAMETERS lookup table.

TABLE 2-A-53 MMS Report Parameters

C_Key	C_Parameter
1	Betterments
2	Cause
3	County
4	Date
5	Division
6	Equipment
7	Labor
8	Material
9	Pay Period
10	Road
11	Stockpile
12	Task
13	Road_County_MP
14	Stockpile_Class
15	Fiscal_Year
16	Work-Order
17	Cntrline_Mile

B-4 MMS_RPT_SQL Table

The MMS_RPT_SQL table includes a list of SQL quarries required to run to create reports in the MMS Reporting System. It includes tables, attributes, and SQL operations required to execute to develop all 86 reports listed in the MMS_RPT_LST table.

B-5 MMS_RPT_TSK_STANDARDS Table

The MMS_RPT_TSK_STANDARDS table includes the standard quantity and type of material, and number and category of equipment required to perform maintenance tasks. It includes three foreign keys: C_MMS_Task_FK, C_Lst_Equ_Cat_FK, and C_MMS_Material_FK, which are used to establish relationships with MMS_TASK, LST_EQU_CAT, and MMS_MATERIAL table respectively.