Miami Dade Water and Sewer Department
3071 S.W. 38th Avenue • Miami FL 33146

2009 Annual Water Loss Reduction Plan Implementation Status Report

March 2010

Report Prepared By:

Malcolm Pirnie, Inc.

5201 Blue Lagoon Drive
9th Floor
Miami FL 33126
(305) 716-4155

4163042

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1. Introduction

The South Florida Water Management District (SFWMD or District) requires Miami-Dade Water and Sewer Department (MDWASD) to prepare an annual status report of its 20-year water loss reduction plan (the Plan) implementation, per Limiting Condition 46 of the Miami-Dade County Water Use Permit. MDWASD retained Malcolm Pirnie, Inc. to prepare the current status report (2009 Annual Status Report) and provide assistance with the Plan implementation in 2010. This document is the 2009 Annual Status Report, which includes water audits as required by Limiting Condition 46.

1.1. Plan and Limiting Conditions

The Plan was based on an evaluation of MDWASD water supply and demand for Fiscal Year (FY) 2005. The Plan recommended real and apparent water loss mitigation approaches over the next 20 years with corresponding budget and implementation schedule recommendations. In May 2007, the SFWMD approved the Plan. Following SFWMD's approval, the District approved the issuance of a 20-year Water Use Permit (WUP) on November 15, 2007.

There are 58 listed "Limiting Conditions" associated with the approved Water Use Permit. Limiting Conditions 46 and 49 specifically apply to the implementation of the approved Water Loss Reduction Plan.

Key requirements of Limiting Condition 46 are:

- Quarterly determination of distribution system losses.
- Annual reporting of distribution system losses on March 15th of each year for the previous calendar year.
- Determination of losses in each water treatment plant.
- Water audit methods shall be in accordance with IWA/AWWA standard methodologies.
- Planned annual reporting of water loss reduction activities and expenditures for the subsequent calendar year.
- Annual reporting of water loss reduction trends and changes from previous years.
- Annual reporting of additional water loss reduction activities if supplies minus the sum of metered demand, cleaning gravity mains, and MDWASD facilities exceed ten percent.

The key requirement of Limiting Condition 49 is the water loss component of the water use compliance report due every five years to the SFWMD.

1.2. 2009 Water Loss Reduction Plan Implementation

In 2009, Malcolm Pirnie, Inc. assisted MDWASD with the first-year implementation of a 20-year Water Loss Reduction Plan (the Plan) in order to comply with Limiting Condition #46 of the WUP. The tasks below describe the extent of the Plan implementation in 2009. Follow-up (and deferred) activities in 2010 are indicated, where applicable.

Real Water Loss Reduction Plan Tasks Developed in 2009:

1.1 Prepared the 2008 water audits using the IWA/AWWA standard audit methodology (annual).

1.2 Performed the 2008 individual water treatment plant water audits (annual). Currently, the configuration of well meters may not allow for accurate flow measurement or testing. Because the SFWMD's methodology given for the estimate of the ten percent requirement does not allow for accounting of certain legitimate water uses or known system inaccuracies, it was recommended that the methodology used for the water treatment plant audits be discussed with the SFWMD (follow-up).

1.3 Documented procedures for management of real losses including the active leak detection program.

1.4 Researched and recommended computerized tools and tables to assess effectiveness of water loss reduction activities and expenditures. Implementation of these computerized tools is the next step (follow-up).

1.5 Performed comparative accuracy testing on supply Venturi meters at the Alexander Orr Plant. Testing at the Preston/Hialeah plants could not be performed due to major hurdles to install test taps such as constrained meter settings that may require potentially expensive fittings and installation labor costs. Identification of alternative approach or capital projects may be required to support meter testing (follow-up is deferred).

1.6 Performed comparative accuracy testing on four wholesale customer supply meters. Testing at other wholesale meters could not be performed due to major hurdles to install test taps such as constrained meter settings. Identification of alternative approach or capital projects may be required to support meter testing (follow-up is deferred).

1.7 Conducted wholesale customer unmetered connection investigation. The investigation is to be continued with physical inspections if refined water audits of the system support sufficient evidence on the potential existence of an unmetered

connection. Consequently, physical inspection follow-up is deferred upon the refinement of water audits.

1.8 Evaluated the distribution system leakage reduction plan, which was found to be effective in its approach to the overall reduction of real water losses in the water distribution system. Two findings stood out. The first is that the apparent severity of the leaks appears to have been reduced over time. The second is that the frequency of leaks has been reduced as well.

Apparent Water Loss Reduction Plan Tasks Developed in 2009:

2.1 Prepared an inventory of unmetered supplies and identified methods, if non-existing, to reduce them. Development of method for appropriately accounting fire department meter use was identified (follow-up).

2.2 Conducted site investigations of selected large meters to insure right sizing as well as meter type. Conducted field accuracy testing for nine selected commercial and industrial meters. This task is to be continually performed to cover entire inventory over time (follow-up is deferred).

2.3. As part of an initial meter change out program, tested a few turbine/positive displacement meters selected by MDWASD staff. MDWASD has since received a few new style "Omni" meters from Sensus for evaluation. These meters have the potential to provide a wide range of flow measurements similar to a compound meters but without some of the crossover issues of compound meters. Initial independent evaluation of "Omni" meters was recommended (follow-up is deferred).

2.4. Characterized residential water demand to determine average use at ultra-low flow, low-flow, medium-flow, high-flow, and ultra-high flow. Future update efforts to refine results were recommended (follow-up is deferred).

2.5. Utilized demand characterization and meter accuracy testing results to determine the economic optimum for residential meter replacement. Controlled monitoring and evaluations of overhauled meter accuracies were recommended to assess whether overhauling meters is more cost-effective than purchasing brand new meters. The cost-effectiveness of either option, if realized, could bring combined meter replacement cost savings and revenue gains (revenue loss reduction) amounting to over two million dollars every year (follow-up is deferred).

2.6. Reviewed meter sizing criteria for new commercial and industrial accounts. Development of appropriate meter sizing criteria and protocol was recommended (follow-up).

2.7. Prepared the 2008 Annual Status Report required by WUP Limiting Condition 46 (annual).

Tasks 1.1, 1.2, and 2.7, listed above, address annual requirements and therefore need to be performed every year in accordance with Limiting Condition 46. Tasks 1.2, 1.4, 2.1, and 2.6 have led to key follow-up activities in 2010 that warrant the development of the long-term water loss reduction program. Tasks 1.5, 1.6, 1.7, 2.2, 2.3, 2.4, and 2.5 have also led to follow-up activities, but they can be deferred and continued in the future upon the development of other tasks.

1.3. 2009 AMR Pilot Implementation

MDWASD performed an Automated Meter Reading (AMR) Residential Pilot Program with fixed network Advanced Metering Infrastructure (AMI) systems from two manufacturers: Itron, Inc. and Sensus Metering Systems, Inc. The pilot program was developed under the following three phases:

Phase 1 – Project Planning

Under Phase 1, a work plan associated with a new pilot residential AMI system was developed. The following tasks were performed:

1. Conducted a literature search to inventory and assess water utility users of AMI systems throughout the Country.
2. Based on literature search, five utilities were selected and interviewed to determine issues, costs, and benefits resulting from the implementation of AMI systems.
3. Developed a pilot plan identifying performance parameters and targets to be monitored in the pilot program in order to assess the compatibility of the selected AMI systems with identified program goals.

Phase 2 – Software & Hardware Deployment

Under Phase 2, the residential AMI pilot system was implemented and initiated. The following tasks were performed:

1. Installed hardware components associated with the two AMI systems in MDWASD's service area.

2. Installed required application software of the AMI systems in MDWASD's database system. Performed network testing for a 30-day period to ensure the operation of the application software.

Phase 3 – Monitoring & Analysis

Under Phase 3, the two AMI systems were operated to collect and monitor data generated by the systems. The following tasks were performed:

1. MDWASD's AMR pilot staff were trained by the AMI system manufacturers to operate and generate information from the installed AMI systems.

2. Collected and monitored data generated by the AMI systems as outlined in the pilot plan and as trained by the manufacturers.

3. Documented and analyzed the pilot results and the findings.

Key findings: MDWASD's AMR pilot program analyzed Itron and Sensus AMI systems and demonstrated that functional capabilities exist to efficiently monitor water conservation, improve customer service, enhance leak detection, and better manage system operations, planning, and monthly billing. Nonetheless, as AMI manufacturers continue to periodically update their capabilities, it is possible that by the time MDWASD is ready to initiate the full-scale AMI system implementation in its service area, newer versions of AMI systems with further enhanced capabilities might be available. Therefore, it was recommended by the pilot plan that a desktop re-assessment of AMI systems (including Itron, Sensus, and other vendors) be performed to update the pool of functionalities that can be reliably delivered.

Future actions: Detailed implementation planning for full scale implementation of the AMR system in the County will only commence if a decision is made by MDWASD to move ahead with a full scale implementation.

1.4. Current Plan Implementation Status

Table 1-1 summarizes the status, key findings, recommended follow-up activities, future actions, and anticipated 2010 monetary expenditures and associated water savings for each of the action items to be developed under Limiting Condition 46. This table is an update of Table 1-1 (same label) included in the 2008 Annual Water Loss Reduction Plan Implementation Status Report (2008 Annual Status Report) presented to the SFWMD in March 2009. 2010 monetary expenditures comprise readily identifiable cost items such as consulting fees. Cost of MDWASD field and office resources, such as labor, is not included in the estimate of 2010 monetary expenditures. It should be noted that 2009 monetary expenditures and associated water savings were presented in the past 2008 Status Report.

The following sections of this report provide supporting documentation for the specific action items indicated as follows:

- IWA/AWWA Water Audits (Items 15 and 17)
- SFWMD Water Audit, using accounting method indicated in LC#46 (Item 16)
- Water Treatment Plant Audit, evaluating water losses in the raw water transmission and water treatment plant (Item 3)

References to the above supporting documentation are **bolded** in Table 1-1. Table 1-2 expands on the status of the pilot fixed Automated Meter Reading (AMR) network implementation (Item 8, Table 1-1). Figure 1-1 shows the Sensus and Itron endpoints, Cell Control Units (CCU), and Tower Locations, indicated in Table 1-2.

MIAMI-DADE WATER AND SEWER DEPARTMENT
Table 1-1 WATER LOSS REDUCTION PLAN STATUS AND FOLLOW-UP ACTIVITIES

Line Item	Limiting Condition and Exhibit	Action Item	Status:	Key Findings / Recommended follow-up activities	Future Actions	Folloup activities in 2010	2010 Focus Activities	2010 Budgeted Monetary Expenditures ($dollars), [1], [2]	2010 Anticipated Water Savings
1	Limiting Condition 46, Exhibit 26	*Comparative accuracy testing of WTP meters* : This item requires MDWASD to perform comparative accuracy testing on the combined raw and finished water meters at its water treatment plants.	In-line Pitot testing was chosen to test the Veturi meters because of its high level of accuracy.Testing was conducted at the Alexander Orr Plant for four raw water Venturi Meters and five finished water meters. Test results state the level of accuracy for each Venturi meter tested. Testing for the raw and finished Venturi water meters at the Preston and Hialeah plants cannot be performed until test taps are installed.	Key findings: - Unable to install test taps needed to validate the level of metering accuracy at the Preston/Hialeah plants due to configuration issues. - Major hurdles to testing exist and thus this task should be deferred until alternate strategies can be developed and implemented. Recommended follow-up activities: - Further assess feasibility of achieving testing goals and devise and alternate approach. - Identify any capital projects that may be required to support meter testing.	- To be continued - Periodic review	No	-		Future reduction of potential production metering inaccuracies, if any.
2	Limiting Condition 46, Exhibit 26, Item 5.3.2.1	*Zone Management Pilot* : This item requires that MDWASD complete a Zone Management Pilot.	Based on additional data received and analysis performed after the February 2007 "Water Loss Reduction Plan," it appears that this strategy will provide minimal water savings when compared to other water loss production strategies being pursued. Therefore, no further action on this item is recommended. Letter regarding "the implementation of Zone Management and District Metered Area (DMA) pilot efforts" was included in the appendix of the 2008 Status Report.	Key findings: - Determined to be impractical application for this system. - No follow-up activities.	- None	-	-		N/A
3	Limiting Condition 46	*WTP Water Loss Audit* : This item requires MDWASD to audit water loss at its water treatment plants by comparing metered wellfield, raw water venturi, and finished water venturi meter data.	These audits were completed in **Section 4 of this report** by comparing the required flow data. In-plant water loss appears to be between 2%-3% for Hialeah/Preston WTPs, which is less than the 5% typical for conventional water treatment processes, and approximately negative 15% (apparent gains) for Alexander Orr WTP. Because meter accuracy testing of the Alexander Orr WTP performed in 2009 indicates an output metering accuracy of approximately 96.75%, the apparent Alexander Orr in-plant gains may be due to significant under registration of the inflow meters. Therefore, accuracy testing of the Alexander Orr influent raw water Venturi meters is recommended. Losses between the well meters and the plant Venturis was higher than expected due to potential inaccuracies in the well meter readings. Well meter testing is not possible due to meter configuration.	Key findings: - Configuration of well meters neither allow accurate readings nor testing. - Tapping of Hialeah/Preston pipes has been delayed due to technical concerns with tapping concrete mains and accessability issues. - Accuracy testing of the Alexander Orr influent raw water Venturi meters is necessary to dissipate the in-plant apparent flow gains. Recommended follow-up activities: - Perform comparative monitoring on the well meters versus the Venturi meters to estimate how the well meters are performing overall. - Evaluation of tapping alternatives for Preston/Hialeah pipes is required.	- To be continued - Recurring	Yes	Prepare 2009 WTP water loss audit.	$ 7,000	N/A
4	Limiting Condition 46, Exhibit 26, Items 5.3.2.4 and 5.3.2.8	*Leak response time reduction* : These items require MDWASD to reduce the time it takes its maintenance crews to respond to leaks and improve the speed and quality of its repairs. This is a "continuous improvement" item that extends to the end of the 20-year horizon.	MDWASD has increased the sensitivity of its leak detection program by reducing the distance between noise loggers and reducing the length of main surveyed at one time by leak detection crews, thereby reducing leak duration by reducing the time between leak initiation and detection. Over time, it is recommended that MDWASD maximize the use of its existing Maintenance Management System (MMS) to analyze the time between leak detection and repair to note year over year improvements, as well as differentiate between repairs of "new" leaks on a pipe segment and re-repairs on previously patched leaks.	Recommended follow-up activities: - Incorporate leak detection data into the Maintenance Management System (MMS) to keep track of leak response time and inventory repairs (i.e. new and repatches). - Perform a sample leak program, similar to that conducted in the Fall of 2008, every two years as a way to gauge the overall field effectiveness of the in-house program and provide oversight.	- To be continued - Periodic review	No	-		Quantification of water savings will begin once leak detection and repair times are quantified and benchmarked after MMS tracking strategies are developed.
5	Limiting Condition 46, Exhibit 26, Item 5.3.2.5	*Active leakage control program* : This item requires that MDWASD initiate an active leakage control and sounding program, including both unmanned (noise logger) and manned leak surveys.	Both unmanned and manned leak survey techniques are currently employed by MDWASD. A comparative leak survey performed by a consultant indicated that the distribution system level of leakage appears to have decreased over time. Based upon previous recommendations, MDWASD has reduced the distance between its noise loggers and thereby has increased the sensitivity of its leak detection which resulted in the significant reduction in leak volumes over time.	Key findings: - Level of leakage has been reduced over time. - Leak detection program has been effective at identifying leaks. - Analytical techniques can indicate whether one-year leak detection survey is too frequent for low incidence of leaks or too low for areas with high incidence of leaks. - Leak detection program efficiency can be enhanced by prioritizing survey frequency according to an economic return critierion and developing an adaptive strategy. - Alignment of system betterment investments with economic impact assessments of high leak incidences by service area section can build synergies between multiple leakage reduction investments and activities. Recommended follow-up activities: - Establish economic levels of return for each water service area section and establish priorities. - Evaluate historical trends to establish an adaptive strategy based on statistical analysis of leak incidences, investments, and others. - Align system betterment investments with economic impact assessments of leak incidences by service area section. - Perform a sample leak program, similar to that conducted in the Fall of 2008, every two years as a way to gauge the overall field effectiveness of the in-house program and provide oversight.	- To be continued - Periodic review	Yes	1. Implement methodology for a limited number of service area sections. 2. For each target area: - Establish economic levels of return for each water service area section and establish priorities. - Evaluate historical trends to establish an adaptive strategy based on statistical analysis of leak incidences, investments, and others. - Align system betterment investments with economic impact assessments of leak incidences by service area section.	$ 84,000	Approximately 6.5 BGY (or 18 mgd)
6	Limiting Condition 46, Exhibit 26, Line 13 of Table 5-2 and Item 6.3.4	*Comparative accuracy testing of Wholesale meters* : This item requires MDWASD to perform comparative accuracy testing on its wholesale customer venturi, turbine, and positive displacement meters.	Venturi Meter Sites: Consultant made suggestions for test tap locations. Test tap installations are pending. Turbine Meter Sites: Testing of 4 wholesale customer sites where two different sized meters were used in a "compound" setting has been completed and results are available in a report. Evaluation of other wholesale meters pending upon installation of additional test taps.	Key findings: - Four wholesale meters have been tested (turbine meters). - No venturi meter site has been tested. - Significant obstacles remain to test other meters, of which some may require capital projects. - Unable to refine water loss audit without all wholesale meter test results. Recommended follow-up activities: - Plan CIP/approach required for testing inaccessible meters.	- To be continued - Periodic review	No	-		N/A

Line Item	Limiting Condition and Exhibit	Action Item	Status:	Key Findings / Recommended follow-up activities	Future Actions	Folloup activities in 2010	2010 Focus Activities	2010 Budgeted Monetary Expenditures ($dollars), [1], [2]	2010 Anticipated Water Savings
7	Limiting Condition 46, Exhibit 26, Line 14 of Table 5-2 and Item 6.3.5	*Unmetered connection investigation* : These items require MDWASD to conduct an unmetered wholesale customer connection survey and analysis.	Initial investigation did not reveal the existence of a probable unmetered connection. If evidence becomes available of such a connection existing, future work may include the use of more advanced techniques (i.e. use of ground penetrating radar) to confirm the existence of suspected connections.	Key findings: - No direct evidence was identified. - Further analysis using other methods (i.e. ground penetrating radar) requires further assessment. Recommended follow-up activities: - Defer further actions until wholesale meter accuracy testing can be performed. This will help confirm in future water loss audits if significant unexplained discrepancies persist.	- Suspended	Deferred	-		Apparent losses could potentially amount to 5.2 mgd.
8	Limiting Condition 46, Exhibit 26, Line 15 of Table 5-2 and Line 10 of Table 6-2	*AMR Network* : This item requires MDWASD to have a pilot fixed Automated Meter Reading (AMR) network in place.	MDWASD performed an Automated Meter Reading (AMR) Residential Pilot Program with fixed network Advanced Metering Infrastructure (AMI) systems from two manufacturers: Itron, Inc. and Sensus Metering Systems, Inc.	Key findings: MDWASD's AMR pilot program analyzed Itron and Sensus AMI systems and demonstrated that functional capabilities exist to efficiently monitor water conservation, improve customer service, enhance leak detection, better management of system operations, planning, and monthly billing. Nonetheless, as AMI manufacturers continue to periodically update their capabilities, it is possible that by the time MDWASD is ready to initiate the full-scale AMI system implementation in its service area, newer versions of AMI systems with further enhanced capabilities might be available. Therefore, it was recommended by the pilot plan that a desktop re-assessment of AMI systems (including Itron, Sensus, and other vendors) be performed to update the pool of functionalities that can be reliably delivered.	- To be continued	Maybe	Detailed implementation planning for full scale implementation of the AMR system in the County will only commence if a decision is made by MDWASD to move ahead with a full scale implementation.		Savings anticipated to occur in the future.
9	Limiting Condition 46, Exhibit 26, Line 13 of Table 5-2	*GIS database enhancement* : This item requires MDWASD to enhance its GIS database.	MDWASD is currently enhancing its GIS database to include more information on its distribution system features (pipe lengths, diameters, materials, age in service, etc.).	Key findings: - Ongoing effort by MDWASD. - Use of future expanded features to be developed. Recommended follow-up activities: - Plan integrated use of expanded capabilities in asset management program. - May be deferred for future consideration.	- To be continued.	Deferred	-		Savings anticipated to occur in the future.
10	Limiting Condition 46, Exhibit 26, Item 6.3.1	*Unmetered water supply inventory and reduction* : This item requires MDWASD to reduce unmetered water supplies.	Malcolm Pirnie, Inc. reviewed current metering practices and provided recommendations for reducing unmetered supplies. Overall, MDWASD meters the great majority of its water use. The report identified fire fighting and main flushing as the largest unmetered uses in MDWASD's system. Although not metered, main flushing volumes are estimated using industry-accepted protocol and are consistently recorded. Usage by fire departments is currently neither estimated nor recorded, so recommendations on methods to collaborate with fire departments to better account for their water usage were made.	Key findings: - Use by fire department is neither estimated nor recorded. Recommended follow-up activities: - Develop method for appropriately accounting for fire department water use.	- To be continued	Yes	Develop method for appropriately accounting for fire department meter use.	$ 11,000	To be determined.
11	Limiting Condition 46, Exhibit 26, Line 15 of Table 5-2 and Line 10 of Table 6-2	*Commercial meter accuracy testing* : This item requires MDWASD to conduct field accuracy testing of commercial meters and begin improving meter accuracy.	Turbine Meter Sites: Testing of 9 commercial customer sites where two different sized meters were used in a "compound" setting has been completed and results are available in a report. Some commercial meter sites have proved to be challenging to test, not because of the sites, but because of circumstances (i.e. Jackson Hospital) such as not being allowed to shut down an entire line.	Recommended follow-up activities: - Perform recurring testing of commercial meters to cover entire inventory over time. Determine testing frequency by meter configuration based on economical and statistical analyses of commercial meter samples. - Install test taps at locations that have been evaluated and inspected where displacement meters and turbine meters were being used in a compound setting.	Ongoing through 20-year horizon	Deferred	-		Savings anticipated to occur in the future.
12	Limiting Condition 46, Exhibit 26, Item 6.3.3	*Commercial meter sizing crieteria* : This item requires MDWASD to review commercial meter sizing criteria.	Commercial meter sizing criteria was reviewed in 2008, and it has been recommended that MDWASD move to a more standardized approach consistent with current American Water Works Association (AWWA)-recommended practices.	Recommended follow-up activities: - Develop meter sizing criteria.	- To be continued	Yes	Develop meter sizing criteria.	$ 12,000	To be determined.
13	Limiting Condition 46, Exhibit 26, Item 6.3.3.2.1	*Compound meter usage comparison* : This item requires MDWASD to compare compound meter usage to similarly-sized turbine meter settings.	Because MDWASD rarely uses compound meters, no comparison has been made. However, the Meter Shop has obtained a few new style "Omni" meters from Sensus for evaluation that acts as compound meters. These have been installed by the utility and are currently operating. The initial evaluation appears to be promising concerning measurement of ultra low flows with a full range of high flows.	Recommended follow-up activities: - Document the initial evaluation of "Omni" meters.	- To be continued	Deferred	-		Savings anticipated to occur in the future.
14	Limiting Condition 46, Exhibit 26, Lines 11 and 12 of Table 6-2	*Residential meter economic optimum replacement* : This item requires MDWASD to characterize residential water demand patterns and determine economic optimum for residential meter replacement.	"Meter Master" loggers have been deployed to characterize residential demand since October 2008 and have been rotated through a representative set of meters on a weekly basis. Residential demand data, along with age and meter testing data, will be used to establish an economic optimum for meter replacement. Data collection has been completed.	Key findings: - Historically, MDWASD has repaired rather than renewed its meter inventory. Consequently, Sensus SR model is an old meter design that comprises most of its meter inventory. Current meter logging technology is not compatible with old Sensus SR meter models due to the effect of the thick cast bronze meter body on the sensing magnetic field. Recommneded follow-up activities: - Continue logging data from new-model meters installed in the system to update the assessment of the economic optimum replacement.	- To be continued	Deferred	-		Savings anticipated to occur in the future.
15	Limiting Condition 46	*IWA/AWWA Water Audits* : Limiting Condition 46 requires MDWASD to report unaccounted-for distribution system losses on an annual basis using IWA/AWWA methodology.	**IWA/AWWA water audits were completed and included with this report**. **An analysis of the audits' findings are included with this report as well (Section 2).**		Recurs annually	Yes	Conduct 2009 IWA/AWWA water audit.	$ 7,000	N/A

Line Item	Limiting Condition and Exhibit	Action Item	Status:	Key Findings / Recommended follow-up activities	Future Actions	Folloup activities in 2010	2010 Focus Activities	2010 Budgeted Monetary Expenditures ($dollars), [1], [2]	2010 Anticipated Water Savings
16	Limiting Condition 46	*SFWMD Water Audits* : Limiting Condition 46 requires MDWASD to describe water loss reduction activities if metered demand is more than 10% less than water supplied.	Water losses were calculated using the formula required by Limiting Condition 46. Since the overall water loss calculated using this method was greater than 10%, a list of water loss reduction activities to be conducted next year have been identified. **SFWMD Water Audits and next-year reduction activities are included in Section 3 with this report.**	Key findings: - The district's methodology given for the estimate of the 10 percent requirement does not allow for reasonable accounting of certain legitimate water uses or known system inaccuracies. Recommended follow-up activities: - Discuss with the district the methodology and the 10 percent requirement.	Recurs annually	Yes	Prepare 2009 SFWMD water loss audits. Meet with SFWMD to discuss method.	$ 19,000	N/A
17	Limiting Condition 46	*Water loss reduction effectiveness* : Limiting Condition 46 requires MDWASD to track water loss reduction effectiveness over time.	Reduction in water loss over time has been tracked via the annual "top down" IWA/AWWA water audit spreadsheets, as well as records of leak detection and repair data. **A review of the water loss effectiveness track is included in the aforementioned IWA/AWWA water audit section (Section 2).**	- See recommended follow-up activities under line item #5.	Recurs annually	Yes	As indicated under line #5 of this table.		Savings anticipated to occur in the future.
18	Limiting Condition 46	*Status report* : Limiting Condition 46 requires MDWASD to provide SFWMD with a status report for the water loss reduction plan implementation.	This status report summary and supporting data fulfilled this requirement of Limiting Condition 46.		Recurs annually	Yes	Prepare 2009 Annual Status Report	$ 10,000	N/A
								$ 150,000	**Realized water savings: Approx. 6.5 BGY, or 18 mgd.**

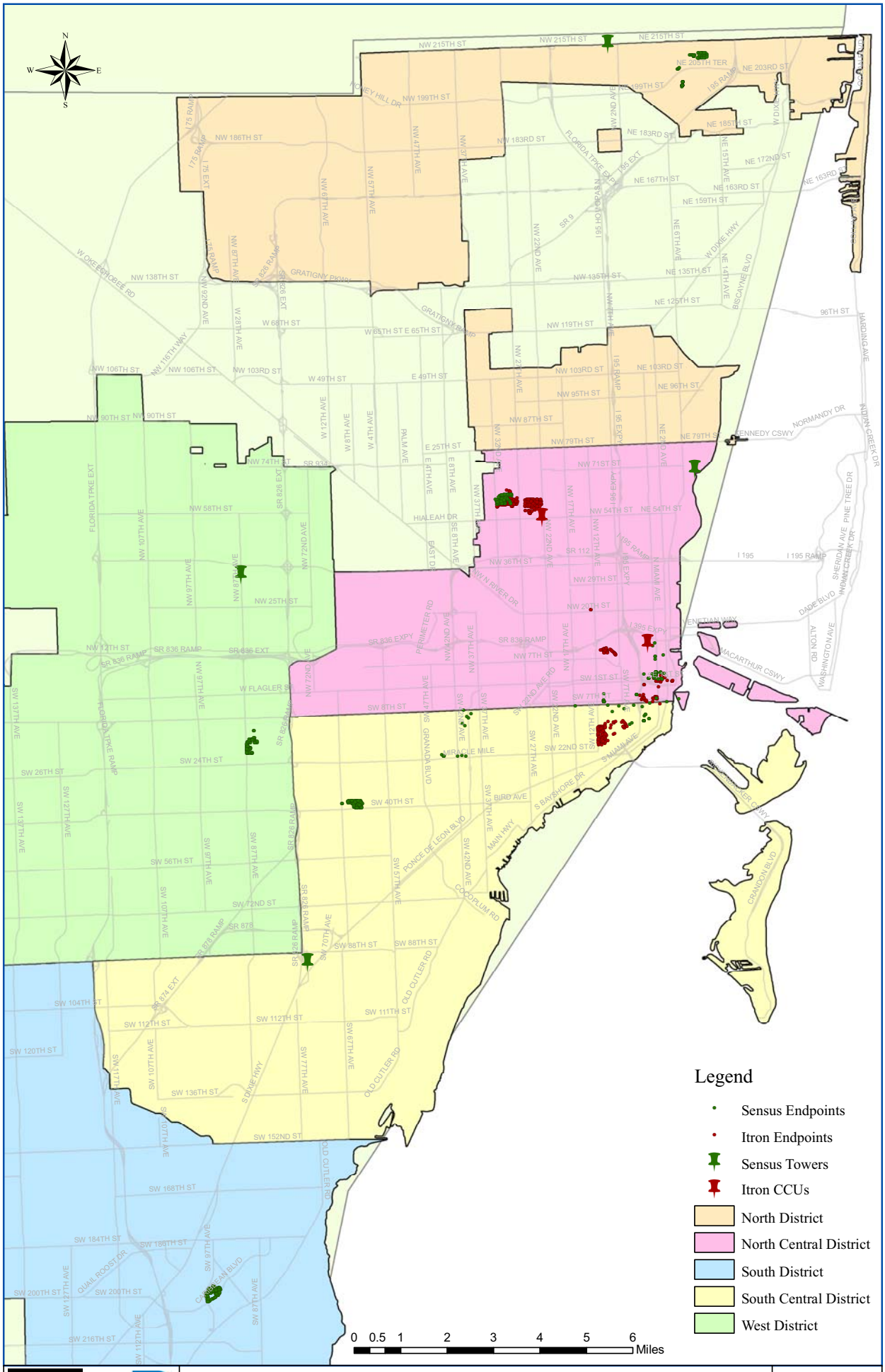
[1] Expenditures comprise readily identifiable cost items such as consulting fees. Cost of MDWASD internal resources (field/office), such as labor, is not included in expenditures.

[2] Going-concern costs of MDWASD business divisions such as the O&M Division, leak detection group, meter shop, and GIS department are not included as expenditures.

MIAMI-DADE WATER AND SEWER DEPARTMENT

Table 1-2: AMR PILOT STATUS REPORT

Line Item	Activity	Status	Completion Date
1	Hardware Installation	1,000 residential AMR endpoints (500 Sensus and 500 Itron) were installed in various locations across Miami-Dade County. Sensus and Itron data collection towers (4 Sensus towers and 2 Itron CCUs) that trasnmit automatic meter readings from AMR endpoints to the County's database system were installed. Figure 1-1 illustrates on a map the location of the endpoints and data collection towers.	Completed by March 2009
2	Software Installation	Itron software application 'SaveSource' and Sensus software application 'RNI Version 1.52' were installed in the County's data base system. Network testing was done for a 30-day period to ensure the operation of the application software.	Completed by May 2009
3	Literature Review and Survey	Conducted a literature review of AMR use in the water industry. In addition five utilities that currently have or have conducted pilots or full-scale implementation of AMR systems were surveyed.	Completed by March 2009
4	Pilot Plan and Leak Simulation Protocol	A pilot test plan was developed to outline the performance parameters and targets that are required to be monitored during the pilot in order to assess the compatibility of the AMR systems with the program goals. A leak simulation protocol was also incorporated into the pilot plan and focused on the use of MLog and Permalog technologies for leak detection in the distribution system.	Completed by July 2009
5	Pilot Monitoring and Testing	Pilot monitoring and testing was performed for four months (July 2009 through November 2009) with the Itron and Sensus AMR systems and the results were documented in a Pilot Report.	Completed by November 2009
6	Detailed Implementation Planning	Detailed implementation planning will only commence if a decision is made to move ahead with a full-scale implementation of AMR based on the results of the report.	TBD



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Miami Dade Water and Sewer Department / AMR Pilot Study

Sensus and Itron Endpoints, CCU and Tower Locations

Figure 1-1

2. IWA/AWWA Water Audits

This Section presents the annual IWA/AWWA water audits required by Limiting Condition #46 of the South Florida Water Management District (SFWMD) Water Use Permit (WUP).

2.1. Introduction

As part of the non-revenue water ("unaccounted-for water") loss reduction program, MDWASD has conducted water loss audits using the IWA/AWWA methodology. This methodology, which is considered to be a best management practice for controlling water loss, was utilized in the 2008 Annual Water Loss Reduction Plan Implementation Status Report (2008 Annual Status Report) and is utilized again in this 2009 Annual Status Report.

MDWASD has conducted "top down" IWA/AWWA water audits as a way to benchmark the effectiveness of its program over time. A top-down approach to a water loss audit relies on gathering data from records, procedures, and other information systems for which data is readily available. The top-down method can provide a preliminary assessment of water loss. The top-down audit also helps to identify components that require further validation. Ultimately, the water auditor can better validate and improve the accuracy of the water audit when it is augmented by component analysis, "bottom-up" field measurements, or both.

2.2. IWA/AWWA Water Loss Audit Context

According to planned revisions to AWWA M-36, "It is recommended that water utilities, state agencies and drinking water stakeholders avoid use of the imprecise term 'unaccounted-for' water." This is because, in a properly-conducted water audit, all losses are accounted for. In the IWA/AWWA water audit, all losses are accounted for using standard, rational terms and definitions, which are presented in Table 2-1.

Water losses (apparent or real) occurring in a distribution system (leakage, water theft, and/or meter inaccuracy) result in a potential loss of revenue to the water utility. The higher the Non-Revenue Water (NRW), the more economically inefficient is the water utility. The goal of the water audit using the "top-down" approach is to determine the difference between the total quantity of water produced and the amount of water billed. The difference is called NRW, previously labeled as "lost and unaccounted-for" water. A successful water audit accounts for all water losses. Therefore, there is no "unaccounted-for" water. A water audit provides the utility with detailed information about the distribution system and water users, leading towards better management of resources and, hence, an improved reliability.

Table 2-1:
Components and Definitions of the IWA/AWWA Water Balance

Water Balance Component	Definition
System Input Volume	The annual volume input (finished water) to the water supply system.
Authorized Consumption	The annual volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are authorized to do so.
Water Losses	The difference between System Input Volume and Authorized Consumption, consisting of Apparent Losses plus Real Losses.
Apparent Losses	Includes Unauthorized Consumption, all types of customer metering inaccuracies, and data handling errors.
Real Losses	The annual volumes lost through all types of leaks, breaks and overflows on mains, service reservoirs and service connections, up to the point of customer metering.
Revenue Water (or Billed Authorized Consumption)	Those components of System Input Volume which are billed and produce revenue.
Non-Revenue Water (NRW)	The difference between System Input Volume and Billed Authorized Consumption.

Source: Draft of AWWA M36 Proposed Revisions

With the help of a water audit, the amount of various types of losses can be determined or at least reasonably estimated, and the amount of revenue lost and energy costs wasted due to water loss can be calculated. Figure 2-1 summarizes the "Best Practice" standard water balance categories, based on the above definitions, calculated in the IWA/AWWA water loss audit. The performance indicators give a reliable assessment of water loss standing from operational, financial, and water resources management perspectives. They are effective in evaluating current standing, benchmarking with other utilities and for preliminary loss reduction target setting.

Figure 2-1: The IWA "Best Practice" Standard Water Audit

<table>
<tr><td rowspan="10">Water From Own Sources</td><td>Water Exported</td><td colspan="3">Billed Water Exported</td><td rowspan="2">Revenue Water</td></tr>
<tr><td rowspan="9">Water Supplied to the Retail Customers</td><td rowspan="3">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Unmetered Consumption</td><td rowspan="8">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Metered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflow at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections</td></tr>
<tr><td>Water Imported</td></tr>
</table>

One of the performance indicators for the distribution system calculated by the IWA/AWWA Water Audit Software is the Infrastructure Leakage Index (ILI). The ILI is calculated by dividing the Calculated Average Real Losses in the distribution system by the Unavoidable Annual Real Losses (UARL). The value of ILI acts as a good operational benchmark for control of real water loss.

UARL is "a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied," according to the definition provided by the Version 3.0 Water Audit Software published by the AWWA Water Loss Control Committee. The UARL estimates measured frequencies, flow rates and durations of background losses, reported leaks, and unreported leaks, as well as the relationship between pressure and leakage. An equation (also provided by the Water Audit Software) to estimate this value has been developed based on the length of mains in the distribution system (Lm), number of service connections (Nc), length of private pipe (i.e. service lines) (Lp), and distribution system operating pressure (P) in a system:

$$UARL\ (\text{gal/day}) = (5.41 * Lm + 0.15 * Nc + 7.51 * Lp) * P$$

The UARL is used as a benchmark to which a utility's actual real losses can be compared year over year. As described above, the ratio between a utility's current real losses and the UARL is the ILI. The initial target value or range for the ILI is often established as a preliminary benchmark in the early stages of a water audit, and the target is refined as the leakage management program moves forward. The selection of ILI target ranges is generally selected based on water resources, operational, and financial considerations. ILI target ranges are generally 1.0-3.0, 3.0-5.0, and 5.0-8.0 as described in Table 2-2. Generally, estimates of the ILI become more accurate as more and better data become available. Another feature of the ILI is that it allows for comparison between different utilities.

As an initial target, one of MDWASD's internal goals is to reduce the ILI to below 3.0. In the early stages of a utility's water loss reduction program, changes in the ILI year over year may be significantly affected by changes in the type and quality of data collected as the program becomes established.

Table 2-2:
Guidance on Target Infrastructure Leakage Index (ILI)

Target ILI Range	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 – 3.0	Available resources are very limited and/or environmentally unsound to develop	Leakage above this level requires expansion to existing infrastructure and/or new water resources	Water resources are costly to develop or purchase; ability to raise revenue(rates) is limited
3.0 – 5.0	It is believed that sufficient water resources are available for long term needs, using good leakage control	Existing water supply infrastructure capability is sufficient to meet long-term demand, with good leakage control	Water Resources can be developed or purchased at reasonable expense; rates can be increased
5.0-8.0	Water resources are plentiful, reliable and easily extracted	Superior reliability capacity and integrity of infrastructure	Low water purchase cost; customer affordability is not an issue

2.3. IWA/AWWA Water Loss Audit Data and Implementation

Calendar Year 2006, 2007, 2008, and 2009 IWA/AWWA Water Loss Audits were conducted using standardized software available through the AWWA. Data was collected from sources relevant to the calendar year being audited and entered into the IWA/AWWA water audit software as described in Table 2-3.

Average retail unit costs and average unit cost of water production were estimated in a manner consistent with sections 4.5.2 and 4.5.3 of the 2007 Water Loss Reduction Plan report, except that costs were estimated on a fiscal year basis and not a calendar year basis. The calculation of these costs based on fiscal year data greatly simplified analysis, and did not affect the estimation of the volume of water estimated to be lost through leakage.

For the 2006-2009 audits, pressure data at four points spaced throughout the distribution system were provided for the first quarter of 2008: these data were averaged and used as the average distribution system pressure for the 2006-2009 audits (52 psi). The UARL, which serves as the denominator for the ILI, is sensitive to average distribution system pressure. In a system as large and complex as MDWASD's, with over 5,680 miles of water mains (2009) and numerous water plants, booster stations, and storage structures, obtaining an accurate representative average system pressure requires a considerable modeling and analysis effort. While the water loss audits for the current year are improvement over the previous year due to the use of additional data, it has been recommended that MDWASD conduct more detailed system analysis and modeling to further characterize this value and, if possible, select representative points in the system to simplify analysis for future years.

Table 2-3 IWA/AWWA Water Loss Audit Input Data

Input Data	Definition/Source of the Data
Water Supplied	
Volume from own sources	Finished water produced by MDWASD's Alexander Orr and Hialeah/Preston WTPs.
Master meter error adjustment	CY 2009 accuracy testing results of the Alexander Orr WTP finished-water meters (97.60% combined meter accuracy) were accounted for. Accuracy tests of the Hialeah/Preston WTP finished-water meters are pending and therefore were not accounted for.
Water imported	Finished water purchased by MDWASD from the City of North Miami Beach and Homestead.
Water exported	Finished water sold by MDWASD to its fourteen water wholesale customers.
Authorized Consumption	
Billed metered	MDWASD retail billed and metered water - including residential, commercial, industrial, and irrigation customers.
Billed unmetered consumption	MDWASD currently does not have billed unmetered consumption.
Unbilled metered consumption	Includes water supplied to MDWASD facilities and cleaning gravity mains (Obtained from MDWASD's UFW loss historical table).
Unbilled unmetered consumption	Includes Fire Dept water use and flushing (donations and distribution) obtained from MDWASD UFW loss historical tables.
Water Losses	
Unauthorized consumption	Includes unathorized water withdrawn from hydrants, illegal connections, bypasses to consumption meter or meter reading equipment tampering. Following AWWA recommendations, the overall retail unauthorized consumption was estimated as 0.25% of the volume from own sources. 25 percent of the City of Hialeah wholesale flow was also included under this category to account for a potential wholesale unmetered connection - based on preliminary estimates from the unmetered connection investigation and analysis performed in 2009.
Customer metering inaccuracies	Apparent water losses caused by collective under-registration of customer water meters. In the abssence of updated estimates, 4.5% was used as indicated by the Water Meter Periodic Testing (PT) Program Evaluation performed by MDWASD in November 1995. Updating this under-registration estimate in the future is recommended to refine the results of the water audit.
Systematic Data Handling Errors	Apparent water losses caused by systematic data handling errors in the meter reading and billing system. Assumed to be 2.5 % (apparent loss) of the finished water produced and purchased in accordance with typical observations.
System Data	
Length of mains	Length of all transmission and distribution mains. 5,680.6 miles provided from MDWASD GIS data in 2009.
Number of active and inactive service connections	Number of service connections (by FY rather than CY)
Average length of customer service line	Length of customer service line between the Utility's service connection (curbstop) and the meter. Assumed to be 12 ft as indicated in the Unaccounted Water Loss Reduction Plan (Feb 2007)
Average operating pressure	52 psi average pressure estimate based on data collected from different zones.
Cost Data	
Total annual cost of operating system	Includes cost of water system operations, maintenance, repayment of capital bonds for infrastucture expansion or improvement, employee salaries or benefits, materials, equipment, insurance, fees, administrative costs and other costs to sustain drinking water supply (by FY rather than CY).
Customer Retail Unit Cost	Weighted average of individual costs and number of customer accounts in each class (by FY rather than CY). Calculated as annual retail revenue divided by annual retail sales volume.
Variable Production Cost	Estimated as total production cost of water (source of supply, power and pumping, and purification) divided by total volume of water supplied to the water distribution system including the imported water (by FY rather than CY).

In order to incorporate findings and results from the Plan implementation in 2009 in the water audit that could enhance the review and analysis of water losses, this 2009 Annual Status Report takes a water audit computational approach that is different from that used in the past 2008 Annual Status Report. While the current (2009) approach relies on the estimate of apparent water losses to solve for real water losses, the past (2008) approach relied on the estimate of real water losses (based on leak detection surveys) to solve for apparent water losses.

The water audit computational approach of this (2009) report can be summarized in two steps: (1) subtract authorized metered and unmetered consumption from the water supplied to estimate water losses; subsequently, (2) subtract apparent losses such as unauthorized consumption, customer metering inaccuracies, and systematic data handling errors from the water losses to estimate real water losses.

By contrast, the 2008 Annual Status Report assumed that leak detection estimates were the "best available data" to provide a reasonably accurate estimate of real losses in the distribution system. While the first step of the current and past water audit computational approaches were the same (indicated above), the second step of the past 2008 Annual Status Report subtracted leak detection water losses (assumed to be similar in magnitude to the real losses) from the overall water losses to estimate the apparent water losses.

The water audits in this report for CY2009 and the updates of CY2006, CY2007, and CY2008 have been refined relative to the past 2008 Annual Status Report water audits by introducing results obtained from water loss reduction plan tasks performed in 2009 as follows.

- Adjusting the Alexander Orr finished water production to account for 97.60 percent combined meter accuracy of the five Alexander Orr finished-water Venturi meters.

- Accounting for a potential unmetered connection as an apparent water loss estimated as approximately 25 percent of the water flow supplied to the City of Hialeah. This percent is estimated as the ratio between 1.9 billion gallons per year (5.2 mgd) of apparent water losses and 7.7 billion gallons per year of water sold to the City of Hialeah in FY2004 based on the analysis of the unmetered connection investigation performed in 2009.

It should be noted that accuracy testing results for the four wholesale meters and thirteen commercial meters tested in 2009 were not incorporated in this water audit because the number of wholesale and commercial meters tested do not provide sufficient statistical evidence to infer a conclusion. Testing of the remaining supply, wholesale, and commercial meters, which is currently deferred as described in the overall status report, will serve in the future to improve the accuracy of this "top-down" water loss audit.

Recent findings by MDWASD indicate that two Miami Beach meters, Normandy Isles and MacArthur Causeway meters, may have only partially captured total flows supplied to Miami Beach because of meter bypasses being partially open. The timing of meter bypasses being partially open is not exactly known: anecdotally, MacArthur Causeway meter could have been partially opened sometime around April 2007. Miami Beach bypassed flows have not been adjusted in the water loss audits of this 2009 Annual Status Report because currently there is not enough information (i.e. such as timing) that could support quantification. Nonetheless, the miscounting of these bypassed flows will be self-corrected in future water loss audits if Miami Beach meter bypasses are properly closed.

2.4. 2006-2009 IWA/AWWA Water Loss Audits Results

Detailed results of the water loss audits are presented for CY 2006, 2007, 2008, and 2009 in Appendix A. A summary of selected key input parameters and output results are presented in Table 2-4 and illustrated in Figure 2-2. It is important to note the following:

1. The accuracy of the water audits is affected by the accuracy of the supply and wholesale meters, the testing of which are currently deferred as described in Section 1. Consequently, the results presented in Table 2-4 may be refined in the future as the results of meter accuracy testing become available.

2. As indicated before, because suspected Miami Beach bypassed flows are not adjusted in these water loss audits they may be part of the estimated real water losses. If Miami Beach meter bypasses are properly closed over the course of this and coming years the next water loss audits will self-correct the miscounting of the bypassed flows.

Over the past four years, the total finished water supplied to retail customers has ranged between 250 and 267 mgd (91.1 and 97.5 billion gallons per year, BGY) as shown in Figure 2-2. Retail real water losses have increased approximately one percent every year from 17.5 percent (of the total retail water supplied) in 2006 to 21.2 percent in 2009. Non-revenue water losses (which include real water losses, apparent water losses, and unbilled authorized consumption) have increased less than one percent every year from 27.4 percent in 2006 to 30.2 percent in 2009. ILI has increased from 9.1 in 2006 to 10.5 in 2009, with a brief ILI decline (down to 8.6) in 2007. Figure 2-2 illustrates that while water supplied have slightly decreased over the past few years, real water losses have increased almost at the same pace. These results require further investigation.

It should be noted that the unaccounted-for water loss estimated in Section 3 using the SFMWD methodology is approximately 25 percent in 2009. Such estimate is approximately 4 percent greater than the 21.2 percent result presented in Table 2-4 mainly due to the difference in how unbilled authorized consumption and apparent losses

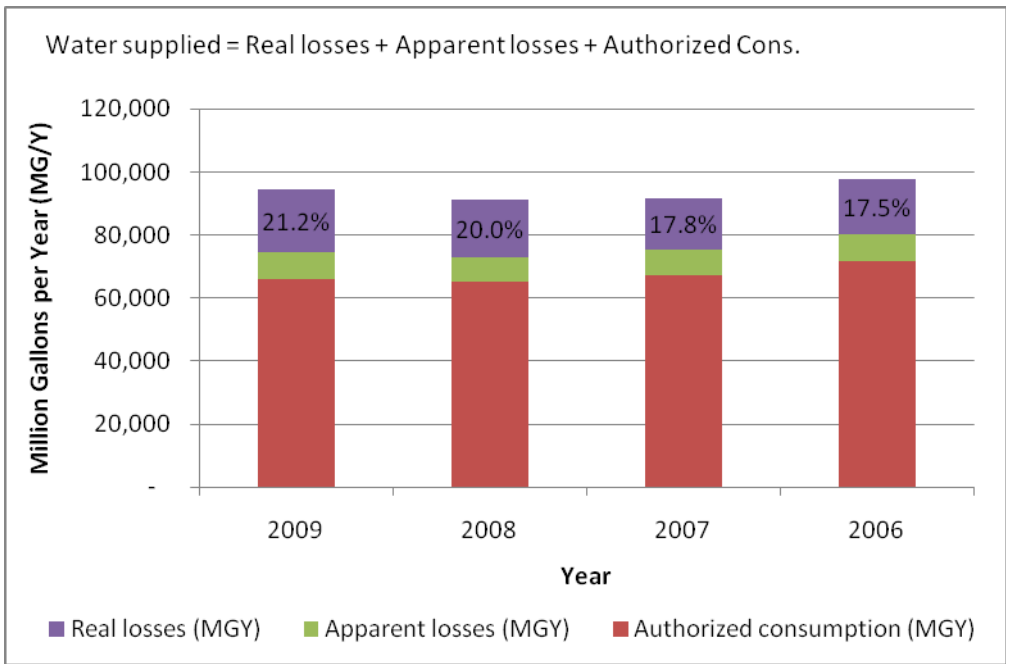
are treated by the accounting methodologies; while the IWA/AWWA accounts for them, the SFWMD methodology does not.

Table 2-4:
IWA/AWWA Water Audit Key Input Parameters and Output Results

Retail Parameters	2009	2008	2007	2006
Water Supplied (MGY)	94,473	91,132	91,704	97,540
Authorized consumption (MGY)	66,181	65,274	67,062	71,538
Apparent losses (MGY)	8,271	7,623	8,307	8,883
Real losses (MGY)	20,020	18,235	16,335	17,118
Water losses (apparent plus real)	28,291	25,858	24,642	26,001
Non-revenue water (MGY)	28,530	26,129	25,210	26,691
Performance indicators	**2009**	**2008**	**2007**	**2006**
Infrastructure Leakage Index (ILI)	10.5	9.6	8.6	9.1
Real water loss (percent)	21.2%	20.0%	17.8%	17.5%
Non-revenue water (percent)	30.2%	28.7%	27.5%	27.4%

**MGY: Million gallons per year*

Figure 2-2: IWA/AWWA Water Audit Results



A potential factor affecting the ILI's representation of actual system conditions is that the inaccuracies of the plant finished water and wholesale meters have not yet been fully quantified, although the testing program is underway as described in the status report. Quantification of, and accounting for, inaccuracies in supply and wholesale meters is critical to obtaining a meaningful ILI. ILI is very sensitive to supply meter inaccuracies – for example, if the finished water and wholesale customers under-registered (or over-registered) by an average of approximately 5 percent, the ILI would reduce (or increase) by approximately 33 percent. This difference is enough to move a utility into a higher or lower ILI range that is not truly representative of its performance.

Increases in ILI and real losses from 2006-2009, while possibly indicative of an issue and worthy of additional investigation, must be interpreted in the context of the available data, the underlying assumptions, the additional quantification of supply/wholesale meter accuracy and assumed average system pressures that remains to be verified, and the fact that the final quarter of 2009 has not yet been audited and therefore all water sales may not yet be accounted for.

Although the water loss reduction plan was implemented fairly recently, MDWASD has made considerable progress in initiating the implementation of the recommendations therein. In these early stages, MDWASD is focused on better quantifying the nature and extent of water losses, which will allow it to strategically target and reduce water losses in the future. Current and additional strategies to reduce water losses that are recommended or underway are described in Section 1 of this report.

2.5. Top-Down versus Bottom-Up Real Water Loss Estimates

Table 2-5 shows the top-down versus bottom-up real water loss estimates. Taking the top-down approach, real water losses are estimated using the IWA/AWWA water audit methodology as the difference between water supplied and apparent water losses. The latter includes unauthorized consumption (i.e. potential unmetered connection), customer metering inaccuracies, and systematic data handling errors. The magnitude of each apparent water loss component is based on an educated guess that cannot be accurately estimated. Taking the bottom-up approach, real water losses are assumed to be similar in magnitude to the leak detection estimates provided by MDWASD leak detection surveys. It should be noted that the bottom-up estimate is an approximate estimate of detected leakage, which does not include background and undetected leakage. Water supplied values, included in Table 2-5, are used as the denominator of the real water loss percent estimate (relative to water supplied) under the two approaches. Similarly, unavoidable annual real losses (UARL), also included in Table 2-5, are used as the denominator of the ILI estimate under the two approaches.

Table 2-5:
Top-Down versus Bottom-Up Real Water Loss Estimates

Retail Parameters	2009	2008	2007	2006
Water supplied (MGY)	94,473	91,132	91,704	97,540
Unavoidable annual real losses (UARL, MGY)	1,909	1,903	1,898	1,884
Real losses (MGY, Top-down estimate)	20,020	18,235	16,335	17,118
Real losses (MGY, Bottom-up estimate)	6,539	16,826	13,570	12,409
Performance indicators	**2009**	**2008**	**2007**	**2006**
Real loss percent (Top-down estimate)	21.2%	20.0%	17.8%	17.5%
Real loss percent (Bottom-up estimate)	6.9%	18.5%	14.8%	12.7%
Top-down over bottom-up ratio	3.1	1.1	1.2	1.4
ILI based on top-down estimate	10.5	9.6	8.6	9.1
ILI based on bottom-up estimate	3.4	8.8	7.1	6.6

From 2006 through 2008, both top-down and bottom-up real water loss estimates were very close in magnitude with top-down/bottom-up ratios between 1.1 and 1.4. On the other hand, in 2009, the top-down real water loss estimate was approximately three times greater than its counter-part bottom-up estimate. This change is due to recent changes incorporated in the leak detection estimates by MDWASD, such as changes in the assumption of leak duration and leak flow computation.

While the top-down real water loss estimate is a catch-all value, the bottom-up estimate is an approximate leak estimate that does not include background and undetected leakage. Therefore, top-down and bottom-up estimates cannot be the same. In other words, top-down over bottom-up ratio should never be one. Nonetheless, keeping track of how these estimates move relative to each other over time can help to reciprocally validate them. For instance, the fact that the top-down estimate did not significantly change over time as much as the bottom-up estimate did in 2009 (relative to past years) indicates that the recent changes to the leak flow computations may have been the main cause for the significant decrease of the bottom-up estimate rather than an actual change in the frequency and magnitude of the leaks detected. Evaluating what estimate (whether top-down or bottom-up) is closer to the actual real water loss will only be possible over time with additional data collection and water system corrections that can further refine the results of the water audits.

3. SFWMD Water Audits

3.1. Determination of Water Loss per Limiting Condition 46

Under Limiting Condition 46 of the 20-year water use permit, MDWASD is required to compute "unaccounted-for" water (UFW) loss based on information contained in its internally-developed water loss accounting spreadsheet. According to this limiting condition, "In the event that the difference between the volume of water produced (from the treatment plant) and purchased and the sum of the metered and user sale amounts exceeds 10 percent of the treated water produced, the permittee shall include in the annual report a description of additional actions which will be implemented the following year(s) to reduce the losses to less than ten percent." Using the SFMWD methodology, a summary of the water loss calculations for Calendar Year (CY) 2009 is presented in Table 3-1.

Table 3-1: Unaccounted-For Water Loss Calculation using Limiting Condition 46 Criteria

Quarter	FW Produced / Purchased (MG)	Water Sold (MG)	Water Adjustments (MG)		District's UFW Loss (MG)	District's UFW Loss (%)
			Cleaning Gravity Mains	MDWASD Facilities		
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6) = (1) - [(3)+(4)+(5)]*	*(7) = (6)/(2)*
Jan-Mar 2009	28,495	21,425	1.258	0.642	7,068	25%
Apr-Jun 2009	28,602	21,632	1.178	0.729	6,968	24%
Jul-Sep 2009	28,387	21,752	1.711	0.584	6,633	23%
Oct-Dec 2009	28,742	21,371	0.000	0.589	7,370	26%

The description of Table 3-1 is provided below:

- 'FW Produced / Purchased [Column (2)]' includes finished water volumes produced at the County's WTPs and finished water purchased from the Cities of North Miami Beach and Homestead.
- 'Water Sold [Column (3)]' includes finished water sold to retail and 14 wholesale customers.
- 'Water Adjustments for Cleaning Gravity Mains [Column (4)]' includes water supplied to clean sewer mains and gravity mains.
- 'Water Adjustments for MDWASD Facilities [Column (5)]' includes water supplied to WTPs and other MDWASD facilities.
- 'Districts UFW Loss [Column (6)]' shows the unaccounted-for water loss volumes calculated in accordance with the SFWMD's guidelines.

- 'Districts UFW Loss % [Column (7)]' shows the unaccounted-for water loss percentage calculated in accordance with the SFWMD's guidelines.

It should be noted that the water adjustment for calculating the unaccounted-for water loss volumes does not include authorized water consumptions that are unmetered and unbilled such as distribution system flushing, firefighting, etc. nor does it include estimates of system inaccuracies. The SFWMD methodology is further discussed later in this section. With the assistance of Malcolm Pirnie, Inc., MDWASD will revise the water loss methodology to take into account other legitimate usage, apply "best practice" loss estimation techniques, and focus the permit requirements on more effectively reducing actual water lost from the system. This will then be presented to the District for review and approval.

3.2. Discussion of Water Loss Data

Findings and observations from the UFW loss calculations for CY 2009 and how they compare to past years results are listed below:

- Total finished water produced and purchased by the County, finished water sold to retail and wholesale customers, and water adjustments (except for cleaning gravity mains) remained fairly constant in CY 2009.
- Unaccounted-for water losses between 23 and 26 percent in CY 2009 are consistent with past year UFW losses: approximately 21, 22, and 24 percent in 2006, 2007, and 2008, respectively. The average UFW loss for 2009 is approximately 25 percent, which follows the one-percent increasing trend observed for the past few years. The reason for the increasing UFW loss requires further investigation, as no obvious reason for it has been identified.

It is important to note that 2009 is the second full year following the acceptance of the water loss reduction plan, whose time stretches over the 20-year horizon of the water use permit. Consequently, many of the initial activities, such as meter testing, are still to be implemented over time in order to better define the scope and nature of water loss in MDWASD's system. Tasks which are intended to actually reduce the amount of leakage, including improving the speed and quality of leak detection and repair, are generally "continuous improvement" items stretched over the 20-year time frame.

3.3. Water Loss Activities for Next Year

Since MDWASD was above the 10 percent threshold for water losses, as calculated by the methodology described in Section 3.1, the list of water loss reduction activities to be performed next year are provided below that will assist with fulfilling this requirement.

To continue to reduce water losses, MDWASD will continue to implement its long-term water loss reduction plan, while following the recommended activities listed in Table 1-1 of this report. Specific activities anticipated to be completed in CY 2010 include:

- Meet and discuss with the SFWMD, the methodology required by the District for the estimation of the 10 percent requirement. Currently, the District's methodology does not allow for accounting of certain legitimate water uses or known system inaccuracies.

- Develop and reduce supporting data for enhanced (efficiency) analysis of leak detection program.

- Establish basis/approach for leak detection program realignment with an adaptive strategy that can enhance the leak detection program effectiveness over time by prioritizing survey frequency according to an economic return criterion.

- Implement analytical techniques to enhance the effectiveness of the piping replacement program. These analytical techniques seek an economic balance between the costs of replacement and the benefits that accrue from the reduction of water losses, leak inspections, and pipe repairs.

- Develop a method for appropriately accounting for fire department water use.

- Develop appropriate meter sizing criteria and protocols in accordance with anticipated water demand, water demand profile, meter location, meter setting design requirement, and service line specifications.

4. SFWMD Water Treatment Plant Audit

The purpose of this section is to meet the requirements of Limiting Condition 46 of the Water Use Permit (WUP) by comparing metered raw water well flows, metered raw water influent, and finished water effluent at MDWASD's three main water treatment plants (WTPs).

4.1. Introduction

The majority of MDWASD's service area is supplied by three water treatment plants: (1) Alexander Orr, Jr. (Orr) WTP, (2) John E. Preston (Preston) WTP, and (3) Hialeah WTP.

All three WTPs treat raw water from Biscayne aquifer wellfields. Table 4-1 presents the list of wellfields that supply the three WTPs. The raw water transmission mains from the wellfields that supply Hialeah and Preston WTPs are interconnected such that any of the wellfields can supply either or both WTPs. Wellfields supplying the Hialeah/Preston plants are not interconnected with those that supply the Orr plant. Raw water flows are metered individually by well meters at the wellfield and metered in aggregate by inflow meters at each water treatment plant.

Table 4-1: Biscayne Aquifer Wellfields that Supply MDWASD's Major WTPs

Well Field	Number of Raw Water Wells
Hialeah/Preston WTPs	
Hialeah Wellfield	3
John E. Preston Wellfield	7
Miami Springs Wellfield	20
Medley Wellfield	4
Northwest Wellfield	15
Hialeah Wellfield	3
Orr WTP	
Alexander Orr Wellfield	10
Snapper Creek Wellfield	4
Southwest Wellfield	17
West Wellfield	3
Total Number of Wells	**83**

Source: MDWASD staff

In addition to the wellfields listed in Table 4-1, MDWASD also draws water from five wellfields that supply the South Dade water treatment facilities, which account for approximately 10 percent of the raw water supply. A total number of 95 raw water wells (including the South Dade treatment facilities) supply the MDWASD's WTPs. The MDWASD also has Aquifer Storage Recovery (ASR) and Floridan blending capabilities, which are not currently being used at any of the WTPs. It should be noted that WTP audits for the South Dade treatment facilities are not part of this report.

MDWASD's three major WTPs use an enhanced lime softening treatment process in which water is treated with lime to remove hardness, as well as activated silica as a flocculent aid. At the Hialeah/Preston WTPs ferric sulfate is also added to remove color and natural organic matter. The Hialeah/Preston WTPs are interconnected prior to the high service distribution pumping system and essentially function as a single plant. Waste solids from the softening process are either recycled through a high temperature recalcination process that converts them back to lime, or disposed of in sludge lagoons. Prior to disposal, solids are thickened/dewatered and the water recovered from the thickening process is returned to the head of the plant. Remaining moisture in the solids prior to disposal or recycling represents the net water loss in the solids handling process.

Typically, the "real" water loss in a conventional treatment process is approximately 3 to 5 percent of raw water supplied. As mentioned above, solids produced by MDWASD plants are either recycled or pumped into a lagoon. Prior to recalcination, water is extracted from the solids via centrifugation and returned to the treatment process. Water vaporized during the heating of the solids to convert them back to lime is not recovered. Additionally, solids that are not recalcinated are pumped in a slurry (2 to 4 percent solids) to large lagoons, where excess water either percolates back into the Biscayne aquifer or evaporates. Small amounts of water are also used (lost) for monitoring plant performance. Water may also be lost via undetected leaks in water treatment plant structures and piping.

In addition to real losses, apparent water loss may also occur as a result of errors in the individual well meters, raw water supply Venturi meters, and finished-water effluent meter readings. Metered raw water flows and finished water flows for the plants are analyzed in the following sub-sections to quantify the overall water losses at the Orr and Hialeah/Preston WTPs.

4.2. Relevant Investigations in 2009

Since the preparation of the water audits included in the 2008 Annual Status Report, two relevant investigations pertaining to the water accounting and meter accuracy of the raw-water wellhead meters and the raw-water and finished-water Venturi meters at the plant were completed in 2009 and documented in the following reports:

1. Supply Meter Inspection and Testing Report completed by Malcolm Pirnie, Inc. in August 2009.

2. Water Use Accounting Update Report on Limiting Condition 48 completed by CDM in September 2009.

Following are the main findings from both reports that are relevant to this Section:

1. Because some of the current raw-water well meter configurations neither allow for accurate reading or testing, MDWASD is currently working on a Wellfield Condition Assessment.

2. Over a 3-month period (April 2009 through June 2009), combined raw-water well meter readings were on average 17.2 percent less than the raw-water influent meter readings at the Alexander Orr WTP (adjusted for no SCADA data based on daily pump run hours). Similarly, raw-water well meter readings were on average 15.2 percent less than the raw-water influent meter readings at the Hialeah/Preston WTP. These results indicate that the current raw-water well meter installation may not represent accurate measurements of the individual well water flows. Additionally, because the raw-water well meters have a different accuracy rating than the raw-water influent meters, the aggregated sum of the raw-water well meters cannot be directly compared to the raw-water influent meters at the plants.

3. Raw-water influent meters (four total) at the Alexander Orr WTP were tested using a Pitot tube in March 2009. The extended test results indicated that the three oldest raw-water influent Venturi meters (#1 48-inch meter, #2 54-inch meter, and #3 72-inch meter) could over register typical flow conditions by 6 percent. On the other hand, the fourth 72-inch raw-water influent Venturi meter had better accuracy with less than 0.5% over registration. Given the flow distribution across the meters during the extended test, the combined raw-water influent Venturi meter accuracy at the Orr WTP was 103.2 percent (3.2 percent over registration).

4. Finished-water effluent meters (five total) at the Alexander Orr WTP were tested using a Pitot tube in March 2009. The extended test results indicated that three of the finished-water effluent Venturi meters (#1 48-inch meter, #2 60-inch meter, and #4 72-inch meter) were collectively under registering 6.44 percent while the other two finished-water effluent Venturi meters (#3 72-inch and #5 72-inch) were collectively over registering 3.5 percent. Given the flow distribution across the meters during the extended test, the combined finished-water effluent Venturi meter accuracy at the Orr WTP was 97.6 percent (2.4 percent under registration).

5. Based on raw-water influent and finished-water effluent metered flows (April – June 2009) at the Alexander Orr WTP, in-plant water losses are approximately 10 percent. However, because raw-water influent Venturi meters are over registering 3.2 percent and finished-water effluent Venturi meters are under registering 2.4 percent (See two previous items), "apparent" in-plant water losses of approximately 5.6 percent can be anticipated to be miscounted in the difference of raw-water and finished-water metered flows. Therefore, after adjusting for "apparent" losses, in-plant real water losses are approximately 4.4 percent, which are within the real water loss range anticipated for a lime softening treatment process.

6. Raw-water influent meters (two total) and finished-water effluent meters (three total) at the Hialeah/Preston WTP are not currently testable and most have constrained meter settings for setting up test taps.

7. Based on raw-water and finished-water metered flows (April – June 2009) at the Hialeah/Preston WTP, in-plant water losses are approximately 6 percent.

8. Raw water flow through the booster pump station installed in 2004 at the John E. Preston WTP is not currently counted in the Monthly Operating Reports (MOR). MORs from 2004 to present only account for the raw water being recorded through the raw water Venturi meters. After adjusting for the booster pump raw water flows, the Hialeah/Preston in-plant water losses are approximately 11 percent.

4.3. Raw Water Flows Metered at Wells vs. WTP Venturi Meters

Tables 4-2 and 4-3 compare (a) the raw water flows metered at the wellfields and (b) the raw-water influent flow metered at the WTPs. Individual flow meters on MDWASD's raw-water wells were installed in 2008 and since MDWASD has reported monthly raw-water well flows based on data generated by these meters. In the tables, positive values indicate net decreases (quantity loss) in water flow, while negative values indicate net increases (quantity gains). This convention was selected because water loss is expected to occur, rather than "apparent" water gain, in a pressurized pipeline.

Table 4-2: Hialeah/Preston Raw Water Flows from Wells vs. WTP Venturi Meters

Month	Well Flows (MG)	Plant Venturi Flows (MG)	Volume Difference (MG)	Percent Difference
January 2009	4462.7	4821.9	-359.2	-8%
February 2009	3962.3	4325.3	-363.0	-9%
March 2009	4412.6	4824.0	-411.4	-9%
April 2009	1878.9	4674.6	-2795.6	**-149%***
May 2009	2889.4	4832.5	-1943.1	**-67%***
June 2009	4156.4	4413.3	-256.9	-6%
July 2009	4547.6	4657.5	-109.9	-2%
August 2009	4437.0	4843.6	-406.6	-9%
September 2009	4263.7	4485.1	-221.4	-5%
October 2009	4277.3	4742.5	-465.2	-11%
November 2009	4334.1	4700.3	-366.2	-8%
December 2009	4438.9	4664.0	-225.1	-5%

Source: Quarterly reports submitted to the SFWMD for CY2009

** Data outliers*

Table 4-3: Orr WTP Raw Water Flows from Wells vs. WTP Venturi Meters

Month	Well Flows (MG)	Plant Venturi Flows (MG)	Volume Difference (MG)	Percent Difference
January 2009	4289.8	5279.1	-989.3	-23%
February 2009	3818.6	4876.4	-1057.8	-28%
March 2009	4278.7	5532.4	-1253.7	-29%
April 2009	4085.0	5290.1	-1205.0	-29%
May 2009	4289.6	5441.3	-1151.7	-27%
June 2009	3916.0	5079.9	-1163.9	-30%
July 2009	4268.3	4962.3	-694.0	-16%
August 2009	4400.5	4881.8	-481.3	-11%
September 2009	3806.9	4225.9	-419.0	-11%
October 2009	4233.3	4995.6	-762.4	-18%
November 2009	4001.3	4676.2	-674.8	-17%
December 2009	4025.7	5015.4	-989.8	-25%

Source: Quarterly reports submitted to the SFWMD for CY2009

Negative losses in Tables 4-2 and 4-3 indicate "apparent" water gains that may be due to raw-water well meter under registration. Specifically, the results tabulated in Tables 4-2 and 4-3 indicate the following:

- In 2009, raw-water well meter readings were on average 7.4 percent less than the raw-water influent meter readings at the Hialeah/Preston WTP. This estimate assumes that March 2009 and April 2009 larger-than-usual water "gains" in Table 4-2 are data outliers.

- Similarly, also in 2009, raw-water well meter readings were on average 22 percent less than the raw-water influent meter readings at the Alexander Orr WTP.

The raw-water metering differences indicated above are consistent with those presented in the Water Use Accounting Update Report completed in September 2009 and restated below (See main finding #2 in page 4-3), which also indicate "apparent" water gains:

- From April 2009 through June 2009, raw-water well meter readings were on average 15.2 percent less than the raw-water influent meter readings at the Hialeah/Preston WTP.

- From April 2009 through June 2009, raw-water well meter readings were on average 17.2 percent less than the raw-water influent meter readings at the Alexander Orr WTP.

MDWASD plans to investigate, and where possible, improve the calibration, selection, and/or configuration of the raw-water well meters. Due to the large number of raw-water well meters (one at each of 95 wells), the testing and calibration process is very time-intensive and labor-intensive.

4.4. WTP Metered Inflows vs. Outflows

Hialeah/Preston and Alexander Orr WTPs influent and effluent flows are Venturi metered. Tables 4-4 and 4-5 compare raw-water and finished water flows at the Hialeah/Preston and Alexander Orr WTPs, respectively.

Table 4-4: Hialeah/Preston WTPs Raw Water and Finished Water Flows

Month	Raw Water Flows (MG)	Finished Water Flows (MG)	Volume Difference (MG)	Percent Difference
January 2009	4821.9	4498.5	323.4	7%
February 2009	4325.3	4049.6	275.7	6%
March 2009	4824.0	4535.1	289.0	6%
April 2009	4674.6	4368.8	305.7	7%
May 2009	4832.5	4520.8	311.7	6%
June 2009	4413.3	4138.0	275.3	6%
July 2009	4657.5	4373.2	284.3	6%
August 2009	4843.6	4553.0	290.6	6%
September 2009	4485.1	4179.4	305.7	7%
October 2009	4742.5	4462.6	279.9	6%
November 2009	4700.3	4387.1	313.2	7%
December 2009	4664.0	4367.0	297.0	6%

Source: Quarterly reports submitted to the SFWMD for CY2009

Table 4-5: Orr WTP Raw Water and Finished Water Flows

Month	Raw Water Flows (MG)	Finished Water Flows (MG)	Volume Difference (MG)	Percent Difference
January 2009	5279.1	4815.3	463.7	9%
February 2009	4876.4	4402.3	474.1	10%
March 2009	5532.4	4958.4	574.0	10%
April 2009	5290.1	4820.1	470.0	9%
May 2009	5441.3	4925.3	516.0	9%
June 2009	5079.9	4603.2	476.7	9%
July 2009	4962.3	4841.3	121.0	2%
August 2009	4881.8	4716.5	165.2	3%
September 2009	4225.9	4666.0	-440.1	-10%*
October 2009	4995.6	4862.3	133.3	3%
November 2009	4676.1	4505.0	171.1	4%
December 2009	5015.4	4743.5	271.9	5%

Source: Quarterly reports submitted to the SFWMD for CY2009

** Data outlier*

The results tabulated in Tables 4-4 and 4-5 corroborate the magnitude of the in-plant water losses estimated in the Water Use Accounting Update Report completed in September 2009 as restated below (See main findings #5, #7, and #8 in page 4-3):

- Before adjusting for "apparent" losses and the booster pump raw water flows, in-plant water losses at the Hialeah/Preston WTP were approximately 6 percent from April 2009 through June 2009.

- Similarly, before adjusting for "apparent" losses, in-plant water losses at the Alexander Orr WTP were approximately 10 percent from April 2009 through June 2009.

Although large quantities of water are used in the process for backwashing filters, feeding chemicals, etc., the great majority of this water is recycled back into the treatment process. Since all large process recycle streams occur internal to the plant – that is, downstream of the raw-water influent meters and upstream of the finished-water effluent meters – recycling these flows does not result in any amount of water being counted twice by plant meters.

4.5. Recommendations

Because the results of these water treatment plant audits are consistent with the findings of the past year (2009) investigations, their recommendations (which still apply) are summarized below with others derived in this Section.

- While raw-water well meters can provide useful data from an operational and well maintenance standpoint, well meter data should not be used to represent water withdrawals. Instead, raw-water flows metered by influent Venturi meters at the WTPs may be used as proxy figures of water withdrawal and adjusted by adding an estimate of raw water transmission losses.

- Correcting the raw-water influent and finished-water effluent Venturi meter inaccuracies at the Alexander Orr WTP would eliminate (or reduce) the 5.6-percent "apparent" water losses miscounted in the current "in-plant" water loss estimates. Assessing what it would entail to correct these meter inaccuracies may be considered.

- Because major hurdles to testing the accuracy of the Venturi meters at the Hialeah/Preston WTPs exist, MDWASD may consider alternative strategies that can be feasibly and economically developed and implemented.

Appendix A

IWA/AWWA Water Loss Audits

AWWA WLCC Free Water Audit Software: Reporting Worksheet

WAS v4.1

Back to Instructions

? Click to access definition

Water Audit Report for: MIAMI DADE WATER & SEWER DEPARTMENT
Reporting Year: 2009 (1/2009 - 12/2009)

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

<< Enter grading in column 'E'

Volume from own sources:	9	114,052.000	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment (enter positive value):	5	1,437.252	under-registered	MG/Yr
Water imported:	8	174.410	MG/Yr	
Water exported:	9	21,191.140	MG/Yr	
WATER SUPPLIED:		94,472.522	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:
Billed metered:	9	65,942.930	MG/Yr		
Billed unmetered:	n/a	0.000	MG/Yr		
Unbilled metered:	7	6.691	MG/Yr		
Unbilled unmetered:	7	231.443	MG/Yr		231.443
AUTHORIZED CONSUMPTION:		66,181.064	MG/Yr		

Use buttons to select percentage of water supplied OR value

WATER LOSSES (Water Supplied - Authorized Consumption)

28,291.458 MG/Yr

Apparent Losses

				Pcnt:	Value:
Unauthorized consumption:	6	2,308.026	MG/Yr		2,308.026
Customer metering inaccuracies:	7	3,107.574	MG/Yr	4.50%	
Systematic data handling errors:	5	2,855.668	MG/Yr		
Apparent Losses:		8,271.267			

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 20,020.191 MG/Yr

WATER LOSSES: 28,291.458 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 28,529.592 MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	8	5,680.6	miles	
Number of active AND inactive service connections:	8	417,983		
Connection density:		74	conn./mile main	
Average length of customer service line:	8	12.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	7	52.0	psi	

COST DATA

Total annual cost of operating water system:	7	$167,864,883	$/Year
Customer retail unit cost (applied to Apparent Losses):	7	$2.57	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	7	$708.47	$/Million gallons

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	30.2%
Non-revenue water as percent by cost of operating system:	21.2%
Annual cost of Apparent Losses:	$21,257,157
Annual cost of Real Losses:	$14,183,705

Operational Efficiency Indicators

Apparent Losses per service connection per day:	54.22	gallons/connection/day
Real Losses per service connection per day*:	131.23	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	2.52	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	1,908.52	million gallons/year
From Above, Real Losses = Current Annual Real Losses (CARL):	20,020.19	million gallons/year
Infrastructure Leakage Index (ILI) [CARL/UARL]:	10.49	

* only the most applicable of these two indicators will be calculated

WATER AUDIT DATA VALIDITY SCORE:

***** YOUR SCORE IS: 76 out of 100 *****

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Master meter error adjustment
2: Volume from own sources
3: Systematic data handling errors

For more information, click here to see the Grading Matrix worksheet

AWWA WLCC Free Water Audit Software: Water Balance

WAS v4.1

Water Audit Report For:	Report Yr:
DEPARTMENT	2009

<table>
<tr><td rowspan="2">Own Sources
(Adjusted for known errors)
115,489.252</td><td rowspan="2">Water Exported
21,191.140</td><td colspan="4">Billed Water Exported</td></tr>
<tr><td rowspan="2">Authorized Consumption
66,181.064</td><td rowspan="2">Billed Authorized Consumption
65,942.930</td><td>Billed Metered Consumption (inc. water exported)
65,942.930</td><td rowspan="2">Revenue Water
65,942.930</td></tr>
<tr><td>Billed Unmetered Consumption
0.000</td></tr>
<tr><td rowspan="4">Water Supplied
94,472.522</td><td rowspan="2">Unbilled Authorized Consumption
238.134</td><td>Unbilled Metered Consumption
6.691</td><td rowspan="2">Non-Revenue Water (NRW)
28,529.592</td></tr>
<tr><td>Unbilled Unmetered Consumption
231.443</td></tr>
<tr><td rowspan="3">Water Losses
28,291.458</td><td rowspan="3">Apparent Losses
8,271.267</td><td>Unauthorized Consumption
2,308.026</td></tr>
<tr><td>Customer Metering Inaccuracies
3,107.574</td></tr>
<tr><td>Systematic Data Handling Errors
2,855.668</td></tr>
<tr><td>Water Imported
174.410</td><td rowspan="3">Real Losses
20,020.191</td><td>Leakage on Transmission and/or Distribution Mains
Not broken down</td></tr>
<tr><td colspan="2"></td><td>Leakage and Overflows at Utility's Storage Tanks
Not broken down</td></tr>
<tr><td colspan="2"></td><td>Leakage on Service Connections
Not broken down</td></tr>
</table>

AWWA WLCC Water Audit Software: Reporting Worksheet

WASv3.0

Back to Instructions

? Click to access definition

Water Audit Report for: Miami-Dade Water and Sewer Department
Reporting Year: 2008

Please enter data in the white cells below. Where possible, metered values should be used; if metered values are unavailable please estimate a value. Indicate this by

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

Volume from own sources:	M	112,326.000	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment:	E	1,047.221	under-registered	MG/Yr
Water imported:	M	777.077	MG/Yr	
Water exported:	M	23,018.746	MG/Yr	
WATER SUPPLIED:		91,131.552	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:
Billed metered:	M	65,002.084	MG/Yr		
Billed unmetered:	E	0.000	MG/Yr		
Unbilled metered:	M	10.065	MG/Yr		
Unbilled unmetered:	E	261.354	MG/Yr		261.354
AUTHORIZED CONSUMPTION:		65,273.503	MG/Yr		

Use buttons to select percentage **OR** value

WATER LOSSES (Water Supplied - Authorized Consumption)

25,858.049 MG/Yr

Apparent Losses

				Pcnt:	Value:
Unauthorized consumption:	E	1,732.404	MG/Yr		1732.404
Customer metering inaccuracies:	E	3,063.400	MG/Yr	4.50%	
Systematic data handling errors:	E	2,827.577	MG/Yr		
Apparent Losses:		7,623.381	MG/Yr		

Real Losses

Real Losses = (Water Losses - Apparent Losses): 18,234.668 MG/Yr

WATER LOSSES: 25,858.049 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 26,129.468 MG/Yr

SYSTEM DATA

Length of mains:	M	5,622.0	miles	
Number of active AND inactive service connections:	M	418,258		
Connection density:		74	conn./mile main	
Average length of customer service line:	E	12.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	E	52.0	psi	

COST DATA

Total annual cost of operating water system:	M	**$148,172,696**	$/Year
Customer retail unit cost (applied to Apparent Losses):	E	**$2.38**	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	E	**$660.94**	$/Million gallons

DATA REVIEW - Please review the following information and make changes above if necessary:

- Input values should be indicated as either measured or estimated. You have entered:
  - **8 as measured values**
  - **10 as estimated values**
  - **0 as default values**
  - **0 without specifying measured, estimated or default**
- Water Supplied Data: No problems identified
- Unbilled unmetered consumption: No problems identified
- Unauthorized consumption: No problems identified
- It is important to accurately measure the master meter - you have entered the measurement type as: measured
- Cost Data: No problems identified

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume:	28.7%
Non-revenue water as percent by cost:	20.5%
Annual cost of Apparent Losses:	$18,143,647
Annual cost of Real Losses:	$12,052,022

Operational Efficiency Indicators

Apparent Losses per service connection per day:	49.94	gallons/connection/day
Real Losses per service connection per day*:	119.44	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	2.30	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	1,903.37	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.58	

* only the most applicable of these two indicators will be calculated

AWWA WLCC Water Audit Software: Water Balance

WASv3.0

Water Audit Report For:	Report Yr:
Department	2008

Own Sources (Adjusted for known errors): 113,373.221

Water Imported: 777.077

Water Supplied: 91,131.552

Water Exported: 23,018.746

Billed Water Exported

Authorized Consumption: 65,273.503

- **Billed Authorized Consumption**: 65,002.084
  - Billed Metered Consumption (inc. water exported): 65,002.084
  - Billed Unmetered Consumption: 0.000
- **Unbilled Authorized Consumption**: 271.419
  - Unbilled Metered Consumption: 10.065
  - Unbilled Unmetered Consumption: 261.354

Water Losses: 25,858.049

- **Apparent Losses**: 7,623.381
  - Unauthorized Consumption: 1,732.404
  - Customer Metering Inaccuracies: 3,063.400
  - Systematic Data Handling Errors: 2,827.577
- **Real Losses**: 18,234.668
  - Leakage on Transmission and/or Distribution Mains: Not broken down
  - Leakage and Overflows at Utility's Storage Tanks: Not broken down
  - Leakage on Service Connections: Not broken down

Revenue Water: 65,002.084

Non-Revenue Water (NRW): 26,129.468

AWWA WLCC Water Audit Software: Reporting Worksheet

WASv3.0

Back to Instructions

? Click to access definition

Water Audit Report for: Miami-Dade Water and Sewer Department
Reporting Year: 2007

Please enter data in the white cells below. Where possible, metered values should be used; if metered values are unavailable please estimate a value. Indicate this by

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

Volume from own sources:	M	115,206.600	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment:	E	1,466.164	under-registered	MG/Yr
Water imported:	M	546.710	MG/Yr	
Water exported:	M	25,515.692	MG/Yr	
WATER SUPPLIED:		91,703.782	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:
Billed metered:	M	66,493.534	MG/Yr		
Billed unmetered:	E	0.000	MG/Yr		
Unbilled metered:	M	10.632	MG/Yr		
Unbilled unmetered:	E	557.620	MG/Yr		557.620
AUTHORIZED CONSUMPTION:		67,061.786	MG/Yr		

Use buttons to select percentage OR value

WATER LOSSES (Water Supplied - Authorized Consumption)

24,641.996 MG/Yr

Apparent Losses

				Pcnt:	Value:
Unauthorized consumption:	E	2,279.514	MG/Yr		2279.514
Customer metering inaccuracies:	E	3,133.704	MG/Yr	4.50%	
Systematic data handling errors:	E	2,893.833	MG/Yr		
Apparent Losses:		8,307.051	MG/Yr		

Real Losses

Real Losses = (Water Losses - Apparent Losses): 16,334.945 MG/Yr

WATER LOSSES: 24,641.996 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 25,210.248 MG/Yr

SYSTEM DATA

Length of mains:	M	5,622.0	miles	
Number of active AND inactive service connections:	M	416,620		
Connection density:		74	conn./mile main	
Average length of customer service line:	E	12.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	E	52.0	psi	

COST DATA

Total annual cost of operating water system:	M	$139,582,152	$/Year
Customer retail unit cost (applied to Apparent Losses):	E	$2.24	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	E	$551.84	$/Million gallons

DATA REVIEW - Please review the following information and make changes above if necessary:

- Input values should be indicated as either measured or estimated. You have entered:
  - **8 as measured values**
  - **10 as estimated values**
  - **0 as default values**
  - **0 without specifying measured, estimated or default**
- Water Supplied Data: No problems identified
- Unbilled unmetered consumption: No problems identified
- Unauthorized consumption: No problems identified
- It is important to accurately measure the master meter - you have entered the measurement type as: measured
- Cost Data: No problems identified

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume:	27.5%
Non-revenue water as percent by cost:	20.0%
Annual cost of Apparent Losses:	$18,607,795
Annual cost of Real Losses:	$9,014,276

Operational Efficiency Indicators

Apparent Losses per service connection per day:	54.63	gallons/connection/day
Real Losses per service connection per day*:	107.42	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	2.07	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	1,898.18	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	8.61	

* only the most applicable of these two indicators will be calculated

AWWA WLCC Water Audit Software: Water Balance

WASv3.0

Water Audit Report For:	Report Yr:
Department	2007

Own Sources (Adjusted for known errors) **116,672.764**	Water Exported **25,515.692**			Billed Water Exported	
	Water Supplied **91,703.782**	Authorized Consumption **67,061.786**	Billed Authorized Consumption **66,493.534**	Billed Metered Consumption (inc. water exported) **66,493.534**	Revenue Water **66,493.534**
				Billed Unmetered Consumption **0.000**	
			Unbilled Authorized Consumption **568.252**	Unbilled Metered Consumption **10.632**	Non-Revenue Water (NRW) **25,210.248**
				Unbilled Unmetered Consumption **557.620**	
		Water Losses **24,641.996**	Apparent Losses **8,307.051**	Unauthorized Consumption **2,279.514**	
				Customer Metering Inaccuracies **3,133.704**	
				Systematic Data Handling Errors **2,893.833**	
Water Imported **546.710**			Real Losses **16,334.945**	Leakage on Transmission and/or Distribution Mains **Not broken down**	
				Leakage and Overflows at Utility's Storage Tanks **Not broken down**	
				Leakage on Service Connections **Not broken down**	

AWWA WLCC Water Audit Software: Reporting Worksheet

WASv3.0

Back to Instructions

? Click to access definition

Water Audit Report for: Miami-Dade Water and Sewer Department
Reporting Year: 2006

Please enter data in the white cells below. Where possible, metered values should be used; if metered values are unavailable please estimate a value. Indicate this by selecting a choice from the gray box to the left, where M = measured (or accurately known value) and E = estimated.

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

WATER SUPPLIED

Volume from own sources:	M	124,507.500	Million gallons (US)/yr (MG/Yr)	
Master meter error adjustment:	E	1,572.713	under-registered	MG/Yr
Water imported:	M	514.072	MG/Yr	
Water exported:	M	29,054.682	MG/Yr	
WATER SUPPLIED:		97,539.602	MG/Yr	

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:	Value:
Billed metered:	M	70,849.015	MG/Yr		
Billed unmetered:	E	0.000	MG/Yr		
Unbilled metered:	M	18.638	MG/Yr		
Unbilled unmetered:	E	670.779	MG/Yr		670.779
AUTHORIZED CONSUMPTION:		71,538.432	MG/Yr		

Use buttons to select percentage OR value

WATER LOSSES (Water Supplied - Authorized Consumption)

26,001.170 MG/Yr

Apparent Losses

				Pcnt:	Value:
Unauthorized consumption:	E	2,418.394	MG/Yr		2418.394
Customer metering inaccuracies:	E	3,339.313	MG/Yr	4.50%	
Systematic data handling errors:	E	3,125.539	MG/Yr		
Apparent Losses:		8,883.247	MG/Yr		

Real Losses

Real Losses = (Water Losses - Apparent Losses): 17,117.923 MG/Yr

WATER LOSSES: 26,001.170 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 26,690.587 MG/Yr

SYSTEM DATA

Length of mains:	M	5,622.0	miles	
Number of active AND inactive service connections:	M	412,121		
Connection density:		73	conn./mile main	
Average length of customer service line:	E	12.0	ft	(pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	E	52.0	psi	

COST DATA

Total annual cost of operating water system:	M	$133,012,384	$/Year
Customer retail unit cost (applied to Apparent Losses):	M	$2.20	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	M	$516.19	$/Million gallons

DATA REVIEW - Please review the following information and make changes above if necessary:

- Input values should be indicated as either measured or estimated. You have entered:
  - **10 as measured values**
  - **8 as estimated values**
  - **0 as default values**
  - **0 without specifying measured, estimated or default**
- Water Supplied Data: No problems identified
- Unbilled unmetered consumption: No problems identified
- Unauthorized consumption: No problems identified
- It is important to accurately measure the master meter - you have entered the measurement type as: measured
- Cost Data: No problems identified

PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume:	27.4%
Non-revenue water as percent by cost:	21.6%
Annual cost of Apparent Losses:	$19,543,144
Annual cost of Real Losses:	$8,836,101

Operational Efficiency Indicators

Apparent Losses per service connection per day:	59.05	gallons/connection/day
Real Losses per service connection per day*:	113.80	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	2.19	gallons/connection/day/psi
? Unavoidable Annual Real Losses (UARL):	1,883.92	million gallons/year
? Infrastructure Leakage Index (ILI) [Real Losses/UARL]:	9.09	

* only the most applicable of these two indicators will be calculated

AWWA WLCC Water Audit Software: Water Balance

WASv3.0

Water Audit Report For:	Report Yr:
Department	2006

<table>
<tr><td rowspan="8">Own Sources
(Adjusted for known errors)
126,080.213</td><td rowspan="8">Water Supplied
97,539.602</td><td rowspan="4">Authorized Consumption
71,538.432</td><td rowspan="2">Billed Authorized Consumption
70,849.015</td><td>Billed Metered Consumption (inc. water exported)
70,849.015</td><td rowspan="2">Revenue Water
70,849.015</td></tr>
<tr><td>Billed Unmetered Consumption
0.000</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
689.417</td><td>Unbilled Metered Consumption
18.638</td><td rowspan="3">Non-Revenue Water (NRW)
26,690.587</td></tr>
<tr><td>Unbilled Unmetered Consumption
670.779</td></tr>
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<tr><td colspan="3">Billed Water Exported</td><td>Leakage on Service Connections
Not broken down</td></tr>
</table>