

CMAP



An Assessment of Water Loss Among Lake Michigan Permittees in Illinois

July 2014

Acknowledgments

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For more information, contact CMAP's Tim Loftus, Project Manager, at tloftus@cmap.illinois.gov.

CMAP is the region's official comprehensive planning organization. Its GO TO 2040 planning campaign is helping the region's seven counties and 284 communities to implement strategies that address transportation, housing, economic development, open space, the environment, and other quality of life issues.

See www.cmap.illinois.gov for more information.

Note: After an initial and limited printing in May 2014, some data and text were revised in Tables 1 and 2, Figure 1, and in the discussion of value and volume of water lost in 2012.

Front and back cover images by Tania Liu.

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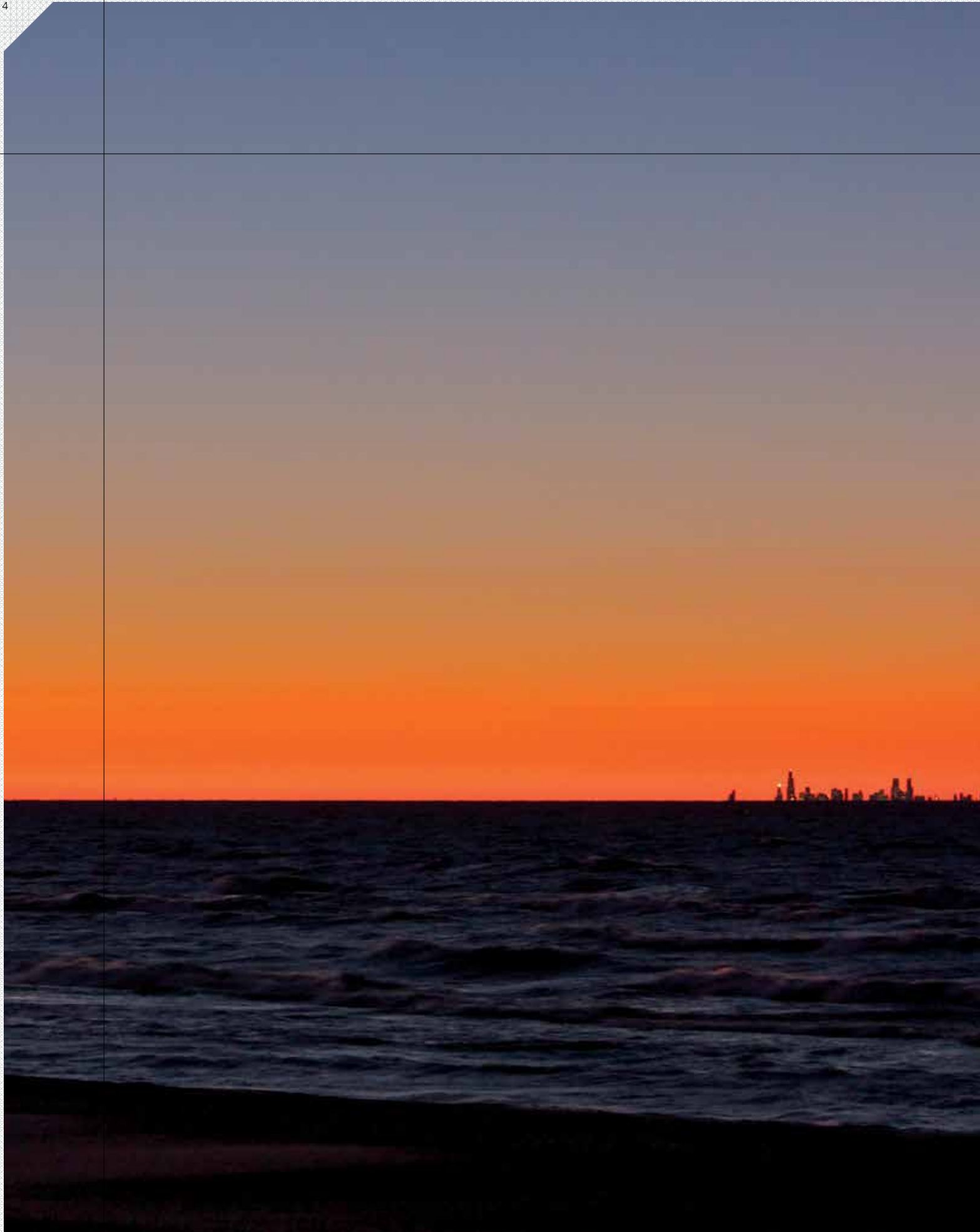


Image by Anne Hornyak.

Executive Summary

Lost potable water, stemming from aging and leaky infrastructure, is a waste of taxpayer dollars and the commodity itself. The magnitude of the problem, judging by well-documented estimates of the investment needed in infrastructure maintenance and repair, is considerable both at the national level and within the metropolitan Chicago region. Lost potable water is of particular concern in the Chicago region given the rules that govern use of Lake Michigan water and the terms of the Great Lake Compact with its emphasis on conservation and efficiency.

CMAAP staff partnered with the Center for Neighborhood Technology (CNT) and the Illinois Department of Natural Resources' (IDNR) Office of Water Resources (OWR) through its Lake Michigan Water Allocation Program in an effort to improve understanding of the water-loss control practices and challenges faced by community water suppliers whose source of water is Lake Michigan. The effort involved analysis of water-use data (2007-12) compiled by IDNR from annual audit reports required of communities with an allocation of lake water; an Internet-based survey questionnaire featuring 23 questions sent to 172 community water suppliers with public infrastructure to manage; site visits with six communities for an in-depth discussion of the water-loss control issues; and additional site visits with three communities to begin to gauge response to the industry standard water-loss control tool available to help solve the problem.

Data analysis reveals that, over the course of the six years studied, approximately 21 percent of 195 permittees lost water at a rate that exceeded the eight percent annual water-loss standard IDNR sets as a condition of permit. The problem would have been far more pervasive, however, if loss totals included an amount of water loss that has been historically excused by IDNR. While the regulatory agency now seeks to eliminate the “maximum unavoidable loss” allowance and transition to a new nonrevenue water standard, data suggest that over 60 percent of permittees would be out-of-compliance if the new proposed standard existed during the period of analysis.

The survey of community water suppliers and corresponding data analysis led to revelations in the following topic areas: water-loss control policy and audit methods; water-loss control practices, plan of action, and communication; retail value of lost water and water rates; infrastructure funding and investment; and challenges faced. The survey also collected data on age of meters, average number of water main breaks per year, and gallons of water lost to actual leaks, among other matters. Survey respondents have a median population served of 20,000 and median number of service connections of 6,700. Data indicate that water loss appears to be more severe with smaller systems.

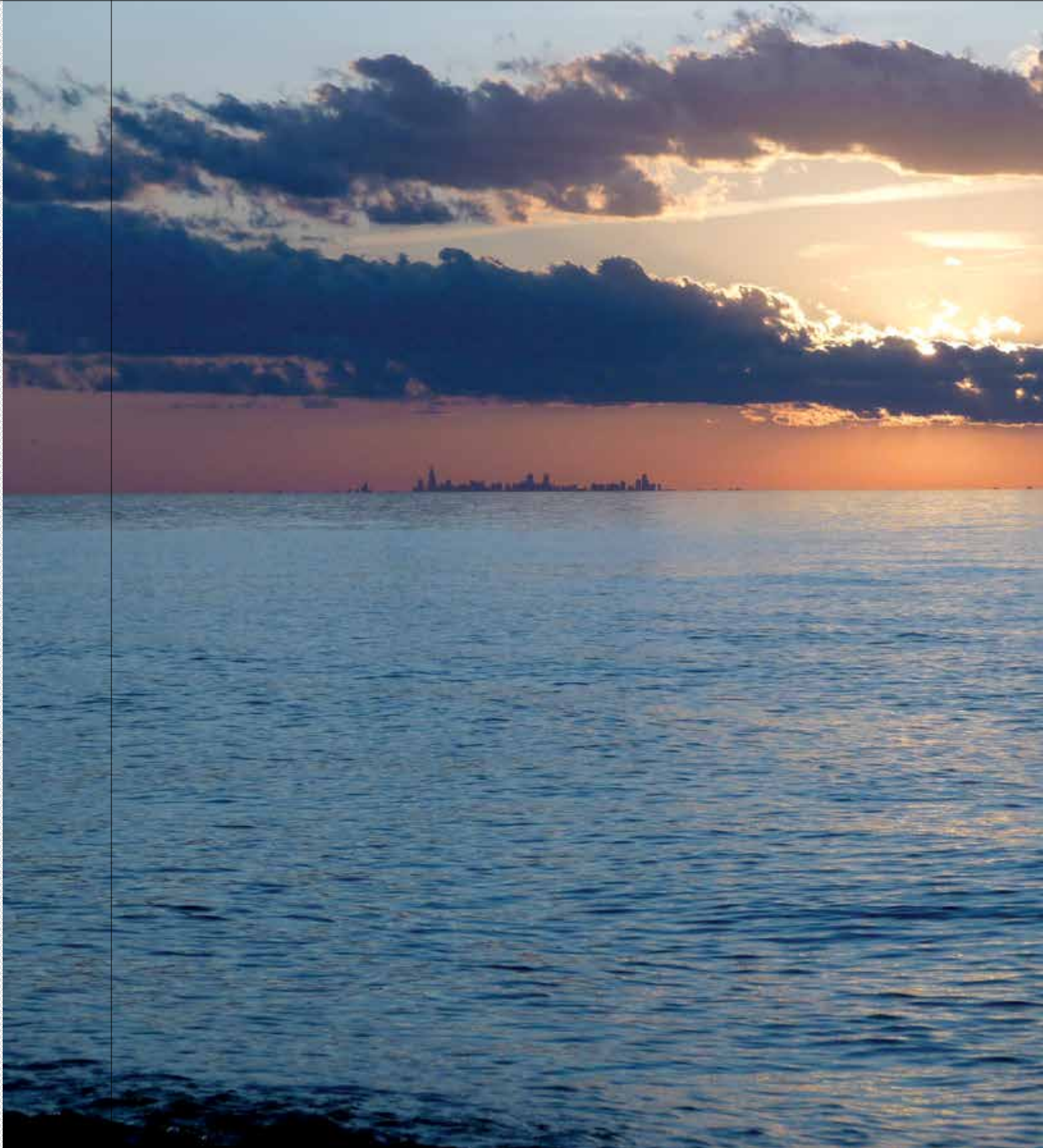
Site visits were designed for a more qualitative discussion with water department directors and village managers and were limited to a small sample of permittees. Select site visits gauged village staff reaction to the American Water Works Association (AWWA) M36 audit tool and revealed encouraging responses regarding the tool’s ease of use and power to better inform decision-making. While the ten communities with the most chronic water-loss problem were approached first for site visits, most were not receptive to meeting despite IDNR’s request for cooperation. Discussions that were had were instructive for both the project team and the village staff nonetheless.

The report concludes with seven recommendations for IDNR:

1. IDNR should request that a formal water-loss control policy be adopted by each permittee that incorporates asset management, uses the AWWA M36 water audit method, and acknowledges commitment to attaining the proposed new regulatory standard that is a condition of permit for Lake Michigan water.
2. IDNR should 1) request that permittees share water-loss information with customers on a regular basis as part of their requirement to develop and implement a public program to encourage reduced water use; 2) increase their frequency of communication with permittees beyond an annual newsletter to include more guidance and/or performance-related information; and 3) ensure that expanded communication is also directly sent to city/village managers in addition to the public works directors that are the typical recipient of news and information from the Lake Michigan Water Allocation Program office.
3. IDNR should require use of the AWWA M36 water audit method by permittees. Doing so will be the most effective way to capture the components of both revenue and nonrevenue water and maintain consistency with a new regulatory standard. The new annual audit form administered by IDNR should also collect water rate information previously collected every five years. The new audit form should also collect evidence of a permittee’s public program related to the required adoption of conservation practices.
4. IDNR should strengthen its longstanding recommendation that permittees develop water rate structures that discourage excessive water use, including charging water rates that reflect full cost of service delivery. To that end, IDNR should request of permittees basic benchmarking for full cost service and annual reporting of associated metrics. IDNR should partner with others as appropriate and necessary to provide guidance, outreach, education, and technical assistance.
5. IDNR should be more proactive in making clear to elected officials that cooperation with IDNR regulation, guidance, recommendations, and requests is expected of permittees that agree to participate in a regulatory program that features an allocation of Lake Michigan water.

To better position IDNR as a source of technical assistance and key collaborator in working to reduce water loss, the following recommendations are made:

6. With or without the assistance of nonregulatory regional partners, IDNR should ensure that outreach, education, and technical assistance with the M36 tool is provided to permittees given its ability to assist permittees with water loss control. This will also enable a smooth transition to use of this tool.
 7. In regards to Governor Quinn's Clean Water Initiative, IDNR should coordinate with Illinois Environmental Protection Agency, the Illinois Finance Authority, and Illinois Department of Commerce and Economic Opportunity to align programmatic objectives and requirements of permittees/applicants to support replacement and repair of drinking water infrastructure. This source of funding is not meant to supersede the role of water rates as the ideal mechanism for funding investment, but may be appropriate for systems that meet debt-related benchmarks.
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Introduction

Millions of gallons of water are lost to leaky pipes each and every day. The American Society of Civil Engineers (ASCE) estimates that there are about 240,000 water-main breaks annually in the U. S. and gives the nation's drinking water infrastructure a grade D.¹ The ASCE 2013 grade for Illinois drinking water infrastructure is a D+. The issue of water loss is not “top of mind” among the general public and one reason could be that the infrastructure responsible for water delivery and related loss is underground, out of sight, and out of mind.

While zero water loss is neither realistic nor economically feasible, lost water is a financial burden on taxpayers nonetheless. The burden stems from unrecovered costs incurred by a community water supplier for withdrawal (i.e., pumping) from a surface- or groundwater source, treatment of raw water to drinking water standards, and distribution from the treatment plant to households and other users. If treated water is purchased from another supplier, as is the case with most communities that use Lake Michigan, the wholesale price paid for this “imported” water is lost along with the commodity itself.

In Illinois the magnitude of water loss is best understood among those communities that use Lake Michigan for their drinking water. First, tapping our Great Lake under a water-use permit system that is unique within Illinois, 214 permittees² in five northeastern Illinois counties must abide by certain conditions of use, including one related to water loss, as directed by the IDNR's Lake Michigan Water Allocation Program. Secondly, the only communities in the region that routinely report annual estimates of water loss are those that use Lake Michigan as their drinking water source.

Project Purpose

The purpose of this Local Technical Assistance (LTA) project is to assist the IDNR OWR Lake Michigan Water Allocation Program with developing a keener understanding of the water-loss practices and challenges of community water suppliers that they regulate under a water-use permit system for allocations of Lake Michigan drinking water. To that end, CMAP partnered with the Center for Neighborhood Technology (CNT) to improve understanding of the factors that could be related to chronic water loss, and provide recommendations to IDNR for enhancing their lake water management program.

¹ American Society of Civil Engineers 2013 Report Card for America's Infrastructure. Available at <http://www.infrastructurereportcard.org/a/#p/home>.

² This number includes 11 communities or census-designated places that were granted permits in 2011, but are not yet receiving lake water. The number also includes places served by investor-owned utilities, seven large individual users (e.g., Shedd Aquarium), six sanitary districts, and one community that remains on groundwater in lieu of using their allocation of lake water (i.e. Lockport).

The Role of IDNR in Water Use/Loss

The Department of Natural Resources Act (20 ILCS 801/5-5) defines the powers and duties of IDNR's OWR with respect to studying, planning, and coordinating the sound management of water resources. This role includes addressing issues of flooding, dams, navigation, and the general conservation of water resources in addition to providing conflict resolution and legislative proposals related to water. Other authority gives OWR a key role in drought response. And following a longstanding role in state/regional water supply planning, IDNR is now in consultation with others throughout Illinois regarding potential enhancements to their water supply planning program.

Managing the Illinois Diversion

Closer to the matter of water loss, OWR's Lake Michigan Water Allocation Program has the responsibility of keeping the State of Illinois in compliance with a U.S. Supreme Court Consent Decree that governs the Illinois diversion of Lake Michigan.³ To do so, the Illinois General Assembly passed the Level of Lake Michigan Act⁴ (originally P.A. 76-1844 (1969), more recently P.A. 83-1405) in 1984. In 1980 the rules that guide allocation and enforcement proceedings conducted by IDNR pursuant to this Act were codified in Title 17, Illinois Administrative Code, Part 3730 and have remained essentially unchanged since then. Maintaining annual water loss below an upper threshold of eight percent is among several conservation oriented conditions of permit that a community water supplier agrees to for an allocation of Lake Michigan water.

It should be noted that IDNR is meeting its essential obligation to keep Illinois in compliance with the U.S. Supreme Court Consent Decree that limits the volume of lake water diverted to 3,200 cubic feet per second or about 2.1 billion gallons of water a day. IDNR has earned all due credit, therefore, for achieving the primary goal of the Lake Michigan Water Allocation Program to date.

IDNR has proposed changes to rules that govern permittees and their allocation of Lake Michigan water. The proposed changes concern Maximum Unavoidable Loss (MUL) and unaccounted-for-flow (UFF). MUL is an estimate of water loss based on age and type of pipe and counted among other accounted-for water factors. MUL essentially allows for an IDNR approved write-off of lost water and thus, does not count towards the eight percent water loss standard that is a condition of permit. UFF is self-explanatory, but somewhat of a misnomer as it is possible to account for all water including both real and apparent losses.

Among other things, proposed changes will, 1) eliminate the MUL allowance in annual audits of water use/loss that are required of permittees, and 2) change the water-loss standard (i.e., maximum allowable annual loss as a condition of permit) from the current eight percent UFF standard to a 10 percent Nonrevenue Water standard after a four-year transition period. A 12 percent nonrevenue water standard will be set during the transition period. While the proposed change to an eventual 10 percent standard amounts to a one percent increase in allowable loss compared to old rules, the elimination of MUL as proposed makes the change an effective decrease in allowable loss for most permittees as illustrated in Table 1.⁵

The Great Lakes Compact Water Conservation and Efficiency Programs

The Great Lakes Compact, signed into state and federal law in 2008, aims to keep Illinois' out-of-basin diversion of Lake Michigan water unique among all users throughout the Great Lakes Basin. A primary objective of the Compact is a ban on diversion of water outside the Great Lakes Basin. While Illinois' use of lake water is governed by the aforementioned Consent Decree rather than the Compact, Illinois is a signatory to the Compact and obligated to adhere to its conservation program provisions as outlined in Section 4.2. Among those provisions is a goal of, "Promoting the efficiency of use and reducing losses and waste of water."⁶ Thus, enhancing IDNR's program for managing allocations of lake water and water loss in particular is warranted.

The Compact requires annual reporting on states' conservation and efficiency efforts and, therefore, adds another lens of scrutiny on water loss reduction activities within Illinois and other Great Lakes states. To that end, IDNR developed Illinois' Lake Michigan Water Conservation Goals and Objectives as required by the Compact.⁷ Key among them and most relevant here is, "Establish standards for good water system management and leakage control by the owner/operator of a water supply system."

3 U.S. Supreme Court. *Wisconsin v. Illinois*, 449 U.S. 48 (1980). Illinois access to Lake Michigan is limited to 3,200 cubic feet per second or about 2.1 billion gallons of water each day. Domestic pumpage or that part of the Illinois diversion of Lake Michigan that includes over 200 permits for an allocation of lake water, is the largest component among several that account for Illinois' legal yet limited access to lake water.

4 615 Illinois Compiled Statutes 50/.

5 UFF and its proposed replacement, nonrevenue water, are not directly comparable standards. In addition to the current 8% UFF standard, permittees are allowed up to an additional 1% water use estimated for such activities as street cleaning and hydrant flushing. Such activities

are accounted for under the old accounting system, and thus, not part of UFF, but will become part of nonrevenue water under proposed changes.

6 Great Lakes - St. Lawrence River Basin Water Resources Compact (December 13, 2005). Article 4: Water Management and Regulation, Section 4.2 Water Conservation and Efficiency Programs.

7 For information pertaining to the Lake Michigan Allocation Program, including the Lake Michigan Water Conservation Goals and Objectives, see <http://www.dnr.illinois.gov/waterresources/pages/lakemichiganwaterallocation.aspx>.

The Local Water-Loss Problem

While Illinois is meeting its court-ordered diversion limit, many community water suppliers in the allocation program are having problems maintaining compliance with their permit for lake water. Specifically and as shown in Figure 1 (page 14), 21 percent of permittees on average are exceeding the 8 percent annual water-loss standard set by IDNR.⁸ Furthermore, the water-loss reporting form used by IDNR and their permittees — LMO-2 — appears to be part of the problem.

Why does this matter to IDNR? Water issues are increasingly attracting both public and political attention across the country. The higher profile of water is due in part to greater media attention to matters ranging from local water-main breaks to a looming water shortage at the scale of the Colorado River Basin. An apparent greater frequency of droughts, floods, intense storms, and other occurrences provide some explanation too. For example, severe-to-extreme drought has gripped Illinois twice in the last nine years. Water waste/loss must be quantified and addressed in any drought preparedness and response plan that expects to have legitimacy with the public.⁹ Also water rates are rising and generating greater public scrutiny. Rising water rates have led some communities to question the feasibility of remaining with their current water wholesaler, a previously rare discussion. All such matters have bearing on IDNR water resource management.

There are other reasons why water loss is of increasing concern to IDNR. The value of water, a topic of growing interest, will increase as Lake Michigan allocations reach 100 percent of available water for domestic pumpage.¹⁰ Chronic or excessive water loss means that a community's water allocation is potentially set too high. An allocation that accommodates excessive water loss, when multiplied by numerous communities with a similar problem, could reduce the amount of water available for new allocations in the future. While Lake Michigan is not 100 percent fully allocated, the findings in *Water 2050*¹¹ suggest that the possibility of full allocation exists as population continues to grow. Such a future scenario, should it occur, will come at a time when some groundwater-dependent communities could be seeking an alternate supply of drinking water, as many communities in the region have historically found in Lake Michigan.

Water resource issues and public interest alike are more likely to escalate than not. It is critical, therefore, that IDNR is viewed as an effective steward of this public and finite resource. Thus, circumstances, issues of water loss, and this project's findings conspire to provide IDNR with a timely opportunity to strengthen its role as the State's lead water resource steward. Logic suggests that maintaining a state of water security throughout Illinois demands as much.

Project Activities in the LTA Memorandum of Understanding with IDNR

The project covered the period February through December 2013. Project activities include:

1. Permittee water-loss data analysis for years 2007-12.
2. A web-based survey questionnaire sent to all public water suppliers (i.e., both municipal-run and investor-owned water utilities).
3. Site visits and interviews with a limited number of permittees.
4. Additional site visits and interviews to explore permittee reaction to the AWWA M36 water loss auditing and best practices methodology.
5. Analysis of findings and production of a final report.

8 As a condition of permit issuance, annual water loss, or so-called unaccounted-for-flow (UFF), must be limited to eight percent or less of permittee net annual pumpage.

9 American Water Works Association, 2011. Drought Preparedness and Response: Manual of Water Supply Practices – M60. First Edition.

10 Under the current scheme of diversion accounting and without substantive changes to stormwater management, the amount of water available for new domestic pumpage allocations is approximately 4% of water already allocated to over 200 permittees.

Put another way, 96% of Lake Michigan water estimated to be available for domestic pumpage is allocated to existing permittees.

11 CMAP, 2010. Water 2050: Northeastern Illinois Regional Water Supply / Demand Plan. Available at <http://www.cmap.illinois.gov/livability/water/water-2050-implementation>.



Image courtesy of the Village of Westmont.

Water Loss Data Analysis, 2007-12

Data compiled from LMO-2 forms submitted annually by permittees to IDNR were studied to understand the scope of water loss. For our purposes, 195 community water supply permittees, most commonly a municipal-run system, were selected for analysis from among the more diverse list of 214 permittees.¹²

For the most recent year of reporting, LMO-2 forms for 195 community water systems indicate that 22.187 billion gallons were lost in 2012; enough water to fill 33,617 Olympic-sized pools.¹³ Put another way, this quantity of lost water is enough to provide the residential needs of over 698,000 people for one year.¹⁴ While Table 1 suggests that on average, permittees as a collective are reporting annual water loss, expressed as UFF, below the 8 percent permit threshold, water loss is more pervasive once the estimate of MUL is considered. Furthermore, other analysis suggests that to the degree there is a problem, it is not limited to just a few permittees. For example, over the course of six years studied, the number of permittees that are out-of-compliance ranges from 36 to 43 out of 195 considering UFF alone (Table 2). This subset of permittees with the most chronic water loss problem represents on average, 21 percent of community water supply permittees.

For the permittees exceeding the historic eight percent permit limit, water loss is problematic for both of the reasons already mentioned and because the issue will become more apparent once other lost water can no longer be written off under the MUL accounting category as proposed by IDNR. Considering all permittees, Figure 1 illustrates the extent of the water-loss issue over the six years studied. Here, an assumption is made that the amount of water loss quantified as MUL is on par with the accuracy of the amount tallied as UFF. Water-loss performance is also measured against a 10 percent nonrevenue-water standard proposed by IDNR following elimination of MUL and a four-year transition period. If such a standard existed today, the water-loss problem would remain pervasive with over 60 percent of permittees being out-of-compliance (Figure 1).¹⁵

¹² There were 203 permittees during 2007-10.

¹³ An Olympic-sized pool is 2 meters deep, 25 meters wide, and 50 meters long or 2,500 cubed meters. 1 meter cubed is equivalent to about 264 gallons of water.

¹⁴ Water use is based on 87 gallons per capita per day, the mean value reported in "Residential Water Use in Northeastern Illinois" a research report by Benedykt Dziegielewski, SIUC, 8/25/2009. Available at <http://www.cmap.illinois.gov/documents/10180/14452/NE+IL+Residential+Water+Use.pdf/9a07c0d8-3733-48c3-94f6-abaa5bad1477>.

¹⁵ There will be a four-year transition period where the new water-loss standard will initially be set at 12 percent and then transition to an eventual 10 percent nonrevenue-water standard.

Table 1. Permittee water-loss statistics relative to net annual pumpage, 2007-12

	2007	2008	2009	2010	2011	2012
Average unaccounted-for-flow (UFF) (%)	5.6	5.6	5.4	4.9	5.2	5.4
Average maximum unavoidable loss (MUL) (%)	6.6	6.5	7.0	7.3	7.4	7.3
Average combined UFF+MUL (%)	12.0	12.2	12.4	12.1	12.6	12.5
Range of UFF (%)	0 - 46	0 - 37	0 - 30	0 - 25	0 - 33	0 - 29
Range of MUL (%)	0 - 63	0 - 18	0 - 13	0 - 16	0 - 16.5	0 - 23

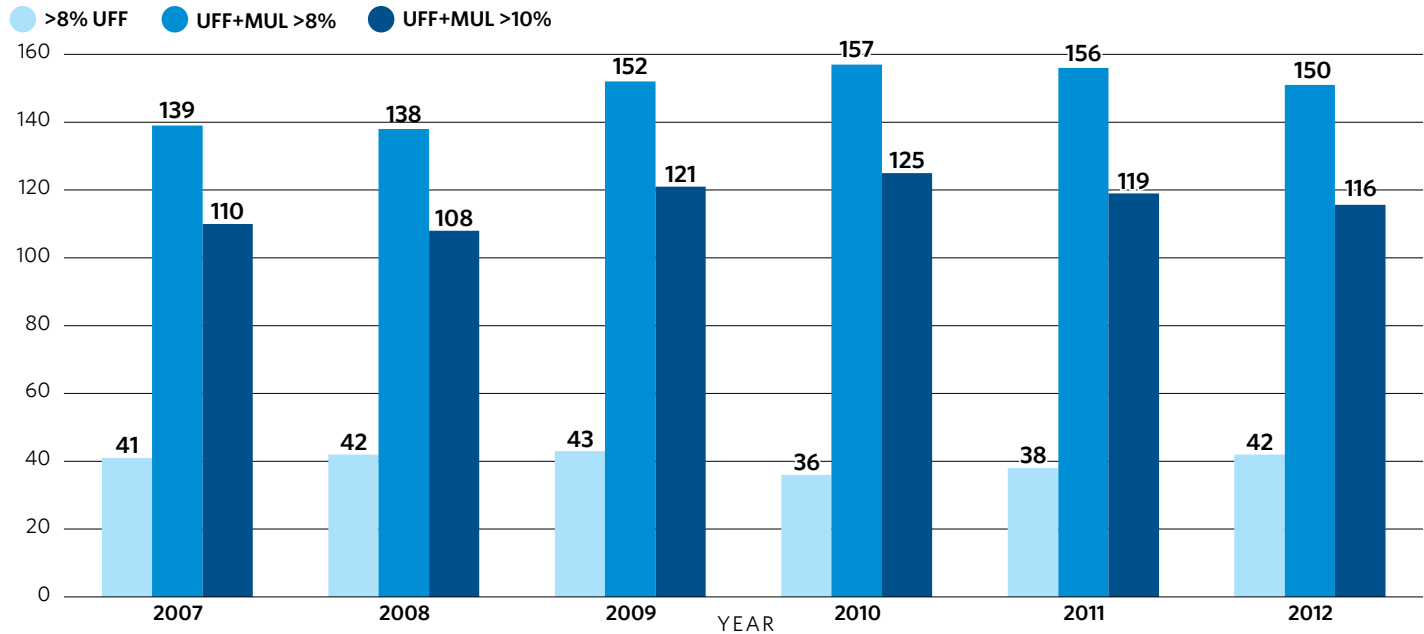
The composition of permittees varied each year due to reporting and data errors; n=193 in 2007 and 2008, n=194 in 2011, and n=195 in 2009, 2010, and 2012. All values expressed as a percentage of net annual pumpage; averages are calculated using arithmetic mean values. MUL: Maximum unavoidable loss; UFF: Unaccounted for flow. Source: Illinois Department of Natural Resources, 2014.

Table 2. Permittees exceeding the eight percent UFF water-loss standard and average UFF, 2007-12

	2007	2008	2009	2010	2011	2012
Number of permittees	41	42	43	36	38	42
Average UFF (%) of noncompliant permittees	11.4	11.7	12.0	10.3	11.7	11.5

The composition of permittees varied each year due to reporting and data errors; n=193 in 2007 and 2008, n=194 in 2011, and n=195 in 2009, 2010, and 2012. Average UFF is calculated using median values. UFF: Unaccounted for flow. Source: Illinois Department of Natural Resources, 2014.

Figure 1. Permittee water loss relative to current and potential future thresholds, 2007-12, by number of permittees



The composition of permittees varied each year due to reporting and data errors; n=193 in 2007 and 2008, n=194 in 2011, and n=195 in 2009, 2010, and 2012. MUL: Maximum unavoidable loss; UFF: Unaccounted for flow. Source: Illinois Department of Natural Resources, 2014.



Image by PMonaghan.

Web-Based Survey Questionnaire

IDNR issued a formal communication to permittees to introduce the LTA partnership with CMAP and CNT and explain its purpose and rationale (Appendix A). In the letter of project introduction, IDNR provided a link to the web-based survey crafted by CMAP and CNT and asked community water supply permittees for their cooperation in responding. IDNR indicated that survey results would be reported in aggregate only.

Survey questions were designed to improve understanding of permittee practices, constraints, and obstacles related to water-loss control. The survey was distributed via SurveyMonkey, an Internet-based survey tool and featured 23 questions (Appendix B). Prior to release, the survey was reviewed by IDNR. Additionally, the survey was beta-tested with a few permittees which resulted in some last-minute refinements. The survey was sent to 172 permittees that are community water suppliers with public infrastructure to manage. We received 91 responses of which 78 were fully completed surveys and 13 were partially completed. Comprehensiveness of survey completion aside, the response rate is 52.9 percent.

To check for nonresponse bias, a t-test was computed twice to test the null hypothesis that two group means, population and percent UFF, for both survey respondents and nonrespondents are equal. Depending on the level of significance chosen, one test yields mixed results when comparing groups based on population, but there is no evidence of nonresponse bias when testing a comparison of UFF (Table 3).¹⁶

Survey results are discussed below under six themes that emerged from the set of survey questions.

Table 3. T-test for equality of means between survey respondents and nonrespondents

VARIABLE	GROUP ^a	N	MEAN	STANDARD DEVIATION	t ^b	df ^c	P-VALUE (2-TAILED)
Population	1	91	29,589	33,515	2.46	164.08	0.016
	0	80 ^d	18,798	24,533			
UFF (%)	1	89 ^e	4.96	4.655	1.95	134.57	0.053
	0	80 ^e	6.78	7.044			

UFF: Unaccounted for flow.

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. aGroup 0: Nonrespondents, Group 1: Respondents. bEqual variances not assumed. cdf: degrees of freedom. dChicago was removed given large population size. eThree permittees were removed as their reported %UFF is subdivided.

¹⁶ At a significance level of 0.05, a p-value of 0.016 for comparing population means indicates that the observed test statistic (t) of 2.46 would be highly unlikely under the null hypothesis. Thus, the null hypothesis is rejected; there is a difference in mean values of population served between those permittees that responded to the survey and those that did not. At the 0.05 level, therefore, there is some bias towards larger systems responding to the survey. At a significance level of 0.01, however, the null hypothesis is narrowly accepted as true: there is no nonresponse bias. For the other test comparing UFF means, the p-value of 0.053 is not significant at either 0.05 or 0.01 significance level and thus, the null hypothesis is accepted: no difference between groups and, therefore, no nonresponse bias.

Water-Loss Control Policy and Audit Methods

In response to a question that was designed to determine if permittees have a formal water-loss control policy, 74 percent indicated that no formal policy exists. Seven percent of respondents reported that the IDNR imposed eight percent UFF standard was essentially their community policy. Seventeen percent of respondents gave an answer that was neither “yes” nor “no,” but best categorized as “other.” Two percent of respondents indicated that their community has a formal policy.¹⁷ A total of 90 permittees responded to this question.

Our survey determined that two-thirds of respondents rely exclusively on the LMO-2 for yearly audits with the other third performing another type of water-loss audit in addition to LMO-2. Of the latter group of respondents that perform other audit practices, over half compare the amount of purchased water to that sold. Since the vast majority of permittees, over 90 percent, are purchasing treated water from another local government (versus withdrawing directly from the lake and treating the raw water to potable standards), this approach clearly reveals to the utility the extent of water lost. However, the comparison does not provide information as to the source of this loss. Such information is critical if a permittee is to reduce loss effectively. Six percent of permittees that perform other types of water audits in addition to the LMO-2 indicated they use the AWWA M36 method.¹⁸

Related to the last question, permittees were asked if they use the AWWA M36 water auditing and loss control methodology. Eighty-nine percent of respondents indicated either “no” or “not familiar with this methodology.” The M36 method is endorsed by both the American Water Works Association and the International Water Association and thus, is the industry standard for water audits and loss control programs. Of those that responded “no” the most common reasons given were that the AWWA M36 is not necessary / required or LMO-2 is sufficient.

Water-Loss Control Practices, Plan of Action, and Communication

Permittees were asked to describe their water department/utility’s plan of action for reducing water loss. The top three most common answers were:

1. Leak detection and repair – 63 percent of respondents
2. Meter testing/repair/replacement/calibration – 53 percent
3. Current planning (recommended or if funds allow) for water main replacement – 30 percent

Just three percent of respondents indicated that there is no formal plan of action. Related to the above, permittees were asked via two separate questions to identify the types of activities that they regularly (i.e., annually) and periodically (i.e., every two to five years) employ regarding water loss control from a set list of eight practices. Table 4 illustrates the choices made by the ninety-one permittees that responded to the question.

In order to determine how well water-loss information is communicated to different audiences, permittees were asked if their water department communicates water-loss information to their customers. Nearly two-thirds of respondents (89) indicated “no” (Figure 2).

Permittees were asked about the frequency with which their water department communicates water-loss information to their city/village elected officials. Figure 3 shows that this information is presented most commonly once per year.

17 To be fair, the survey did not provide permittees with a definition for what constitutes a “formal policy.” Rather, some potential examples were provided (e.g., ordinance, resolution, goal statement) as guidance.

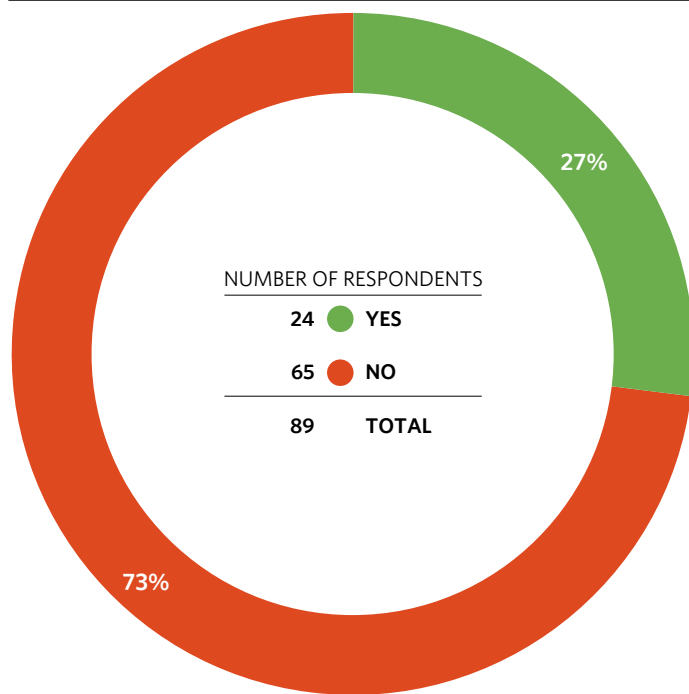
18 The International Water Association (IWA) and the AWWA developed a best management practice tool for water loss auditing in the industry. This free water audit software and corresponding manual (M36) outline a methodology designed to assist water utilities in better managing their infrastructure assets through improved water loss auditing and control. The method features universal definitions for all major forms of water consumption and water loss as well as performance indicators that allow water utilities to assess their water loss and set priorities.

Table 4. Type of water-loss control activities employed by permittees

WATER-LOSS CONTROL ACTIVITY	EMPLOYED ANNUALLY (%)	EMPLOYED PERIODICALLY (%)
Regular meter readings and upgrades	92	74
Annual capital improvement budgets for repair / replacement of pipes and mains	76	71
Acoustic leak detection	65	66
Annual water-loss auditing	54	43
Retain the services of an outside engineering/consulting firm	48	47
Pressure adjustment analysis	7	14
Other/none	1	5

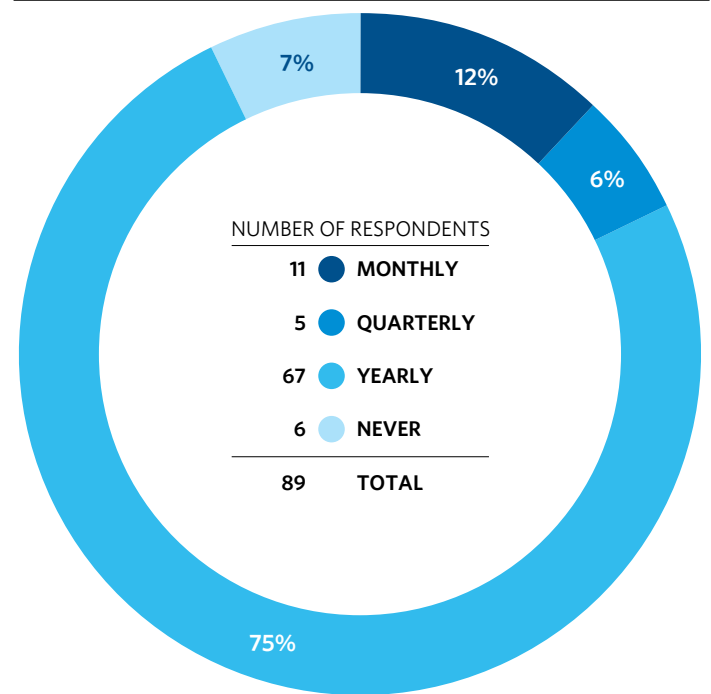
Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 91 respondents; more than one answer could be selected.

Figure 2. Percentage of permittees communicating water-loss information to customers



Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The chart represents 89 respondents.

Figure 3. Frequency of communication with elected officials regarding water-loss information



Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The chart represents 89 respondents.

Retail Value of Lost Water and Water Rates

Permittees were asked to estimate separately the retail value of lost water due to water-main breaks and lost water not related to water mains (i.e., secondary pipes) in 2012 (Table 5). Assigning a retail value to real water loss will overestimate the value of lost water since lost water doesn't replace or reduce the sale of water, but it was thought to be a more readily available number than utility costs incurred to produce the lost water. At a minimum the value of real water loss will be equal to the price paid to a wholesaler if finished water is purchased. Alternately, if a community water supplier withdraws from a raw source, then the value of lost water will be equal to the costs incurred to withdraw/pump, treat, and distribute water to customers (i.e., the production cost). In both cases, the costs incurred will be less than a retail price charged to the end user.

Table 5 indicates great variability in the retail value of lost water with the estimated value of lost water from secondary pipes exceeding that from main breaks. This should come as no surprise since there are typically many more miles of secondary pipes than there are of water mains. Understanding costs associated with lost water will help inform an infrastructure investment strategy to reduce loss since each individual system has an optimum level of water loss below which it is not economically viable to pursue.

Another question was directed at discovering how water departments charge residential customers for water use (Table 6). Ninety-nine percent of respondents use one of two types of volumetric rate charges: uniform or block. One can infer from these results that 99 percent of respondents have a metered customer base which allows for volumetric rate charges. Just nine percent of respondents use an inverted block rate structure to incentivize for water conservation.

A follow-up question, posed to those respondents (61 of 75) who charge a uniform volumetric rate, asked about the current residential water rate charged per thousand gallons of water sold (Table 7). The average rate charged of \$6.66 is more than double the rate charged by the City of Chicago (\$2.89/1,000 gallons in 2013) and over 27 percent higher than an average of all permittee rates surveyed by IDNR in 2010.¹⁹ The retail value of lost water, an overestimate of value as described above, when applied to the total UFF reported in LMO-2 forms for 195 CWS, results in an upper-bound value \$147.77 million.

Table 5. Estimated retail value of lost water in 2012

AVERAGE AND RANGE	RETAIL VALUE (\$) OF WATER LOSS: MAIN BREAKS ^a	RETAIL VALUE (\$) OF WATER LOSS: SECONDARY PIPES ^b	RETAIL VALUE (\$) OF WATER LOSS: ALL PIPES
Mean	99,721	211,455	311,176
Median	31,000	94,733	125,733
Minimum	288	207	495
Maximum	936,748	1,910,000	2,846,748

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. a:66 respondents; b:64 respondents; last column is the sum of the other two.

Table 6. Types of rate structures used by permittees

TYPE OF RATE STRUCTURE	PERCENT (%) OF RESPONDENTS
Uniform (volumetric) rate	73
Uniform (volumetric) rate with minimum charge	15
Inverted Block Rate	9
Declining Block Rate	1
No Rate	1

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 75 respondents.

Table 7. Average flat rate charged for water

AVERAGE	RATE (\$) / 1,000 GALLONS
Mean	6.66
Median	6.45

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 75 respondents.

¹⁹ IDNR Lake Michigan Water Rate Survey 2010, \$5.22 / 1,000 gallons average residential rate. Available at http://www.dnr.illinois.gov/WaterResources/Documents/WaterRateSurvey_2010.pdf.

Infrastructure Funding and Investment

From a set list of answers, permittees were asked to identify their source(s) of funding for drinking water infrastructure repair and replacement. Water-rate revenue is the source of funding for the vast majority of permittees. General obligation bonds are utilized by over one-third of those who responded and state revolving loan funds are used by over one-fifth (Table 8).

Permittees were then asked to identify the amount of money that their water department has invested in capital equipment (e.g., meters, pumps, water mains, other pipes, etc.) during the three years 2010-2012. Results are presented in Table 9.

Table 8. Source of funding for drinking water infrastructure, repair, and replacement

SOURCE OF FUNDING	PERCENT (%) OF RESPONDENTS
Water rate revenue	89
General obligation bonds	37
State revolving loan funds	23
Other	9

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 79 respondents; more than one answer could be selected.

Table 9. Investment in capital equipment, 2010-12

AVERAGE AND RANGE	AMOUNT INVESTED (\$)	NUMBER OF SERVICE CONNECTIONS	AMOUNT INVESTED (\$) PER SERVICE CONNECTION ^a
Median	1,500,000	6,608	\$244.57
Minimum	7,500	259	\$14.04
Maximum	9,400,000	25,000	\$5,571.43

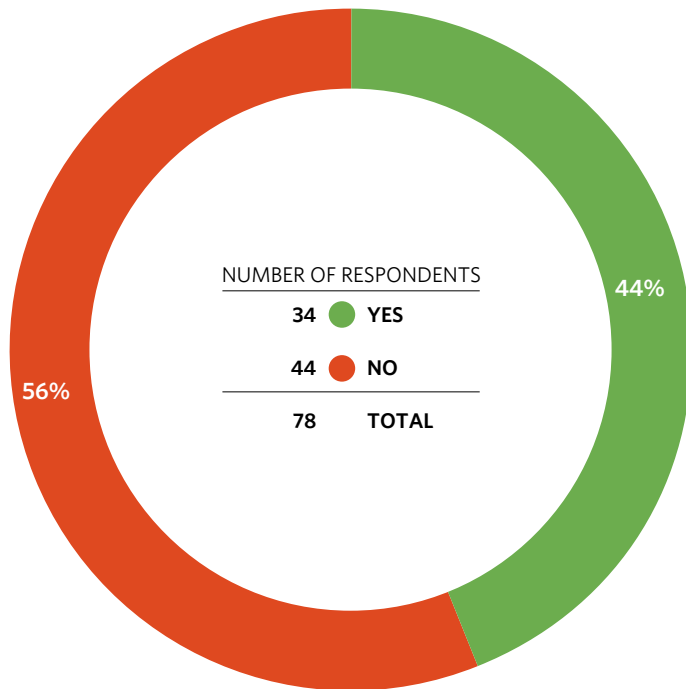
Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 72 respondents who provided complete information for both amount invested and the number of service connections; one wholesaler was not included due to incomplete data on direct service connections. ^aValues in this column are derived from analysis of respondents' quotients, not from dividing one table column with another.

Challenges Faced

Water departments face many challenges and constraints while delivering potable water on demand, every day, and with minimal loss or disruption. Permittees were asked if they had ever needed to implement a water-use restriction due to a water shortage caused by either a drought condition or system capacity limit. Forty-four percent of respondents indicated “yes” (Figure 4).

To examine if status of compliance with the eight percent UFF standard is related to the use of water-use restrictions, a cross-tabulation and Chi-square test was performed to test the null hypothesis that there is no relationship between UFF compliance and the use of water-use restrictions. The analysis and observed Chi-square value provide evidence to reject the null hypothesis and instead, acknowledge that it is more likely for communities that are out of compliance with the eight percent UFF standard to implement water-use restrictions than it is for those permittees whose report UFF below the eight percent standard (Table 10).²⁰

Figure 4. Permittees using water use restrictions due to a water shortage



Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The chart represents 78 respondents.

Water planners and others often hear about how usage restrictions, such as might occur in response to a water conservation program, are unattractive to a municipal water department because reduced water sales could result in lost revenue. Thus, permittees were asked how they deal with the potential conflict between a water-use restriction and the sale of water as a revenue generator. A set list of potential answers was provided (Table 11). Respondents most commonly indicate a lack of any apparent conflict.

Table 10. Cross tabulation of Water use restrictions by compliance with eight percent UFF water-loss standard

PERMITTEE USE OF WATER RESTRICTIONS	UFF COMPLIANT	NOT UFF COMPLIANT
Yes	28	6
No	38	6

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 78 respondents.

Table 11. Ways to resolve a potential conflict between revenue from water sales and usage restrictions

HOW A POTENTIAL CONFLICT IS DEALT WITH	PERCENT (%) OF RESPONDENTS
Does not recognize this as a conflict, has not been an issue, do not have water restrictions, or does not apply.	35%
Water rates are set based on usage and restrictions in mind.	31%
Did not answer the question / other response	27%
Reduce capital or other expenditures when revenue declines.	6%
Subsidize water operations from other sources (general fund, emergency fund, government loans and grants).	5%
Restrictions are seen as a way to avoid greater infrastructure costs.	5%

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 78 respondents; more than one answer could be selected.

²⁰ The obtained Chi-square value is 5.0. At an alpha or significance level of 0.05 and 1 degree of freedom (df), the tabled Chi-square value is 3.841. The probability of obtaining a value larger than the tabled value due to chance variation is only 5 out of 100. Because this is unlikely, there is evidence to reject the null hypothesis — that there is no difference in the use of water restrictions between UFF compliant and UFF noncompliant permittees — and instead, accept that there is dependence among these two variables.

Table 12. Challenges faced in relation to water-loss control

TYPE OF CHALLENGE	PERCENT (%) OF RESPONDENTS
Funding for and cost of replacing aging infrastructure	55%
Difficulty in detecting and fixing leaks	16%
Water loss is not perceived as a challenge	16%
Identifying faulty meters, upgrading meters, or other metering improvements	9%
Difficulty with staffing levels	7%
Establishing rates appropriately to capture the true cost of providing water	7%
Unmetered or unauthorized water use	5%
Other	18%

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 76 respondents; more than one answer could be selected.

Table 13. Relationship between funding as a challenge and system size as measured by average number of service connections

VARIABLE	GROUP ^a	N	MEAN	STANDARD DEVIATION	t ^b	df ^c	P-VALUE (2-TAILED)
Funding identified as a challenge	1	42	7,736	5,506.18	0.048	67.54	0.96
	0	36	7,803	6,751.29			

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 78 respondents. ^aGroup 0: Nonrespondents, Group 1: Respondents. ^bEqual variances not assumed. ^cdf: degrees of freedom.

Permittees were presented with a list of challenges related to water-loss control that their water department might potentially face and asked to select any that applied (Table 12). The issue of funding for infrastructure replacement was the most common challenge selected.

To examine whether the size of the system as measured by the number of service connections is different between respondents who identified funding as a challenge and those who didn't, a t-test was computed. The t-test yielded a p-value of 0.96, indicating that there is no significant difference in system size when it comes to the relationship between size and funding as a challenge to system operations (Table 13). Put another way, funding as a challenge to a water utility operation occurs regardless of system size.

General Characteristics of the Survey Respondents

Permittees were asked a variety of questions that were designed to learn about the scale of their operations. For example, Table 14 illustrates two measures of water department size.

Water meters play a crucial role in quantifying both use and loss, permittees were asked about the average age of various types of meters in their service area (Table 15.)

To develop a sense of the magnitude of loss due to water main breaks and other pipes, permittees were asked about the average annual number of water main breaks during the four-year period of 2009-12 (Table 16).

When asked about the trend in main breaks over the same four-year period, a solid majority of respondents indicated that there was no trend and that the annual number of breaks was fairly consistent (Figure 5).

Lastly, permittees were asked to estimate the amount of water that their system lost in 2012 due to both main breaks and other types of pipes (i.e., real loss). Table 17 reveals the magnitude of water lost among respondents. Not all respondents provided values for both types of water loss. This can be partially explained, perhaps, by the possibility that some permittees did not have main breaks in 2012.

Table 18 reveals that respondents provided an estimate for the amount of water lost that approximates the amount reported as UFF in the LMO-2; instead of providing an estimate of total water lost, which would be the sum of UFF and MUL as reported in the LMO-2. Water loss reported as MUL appears to be discounted one way or another. Elimination of MUL as proposed should clarify the status of this water for the mutual benefit of permittee and regulator alike. Table 19 indicates that water loss appears to be more severe with smaller systems than with the largest ones reporting.

Table 14. Measures of water system size

AVERAGE	POPULATION SERVED ^a	NUMBER OF SYSTEM CONNECTIONS ^b
Mean	27,933	7,885
Median	20,000	6,700

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. ^a89 respondents; ^b88 respondents.

Table 15. Average age of water meters

TYPE OF METER	AVERAGE AGE (IN YEARS) ^a
Residential	13.22
Commercial	11.95
Industrial	10.95

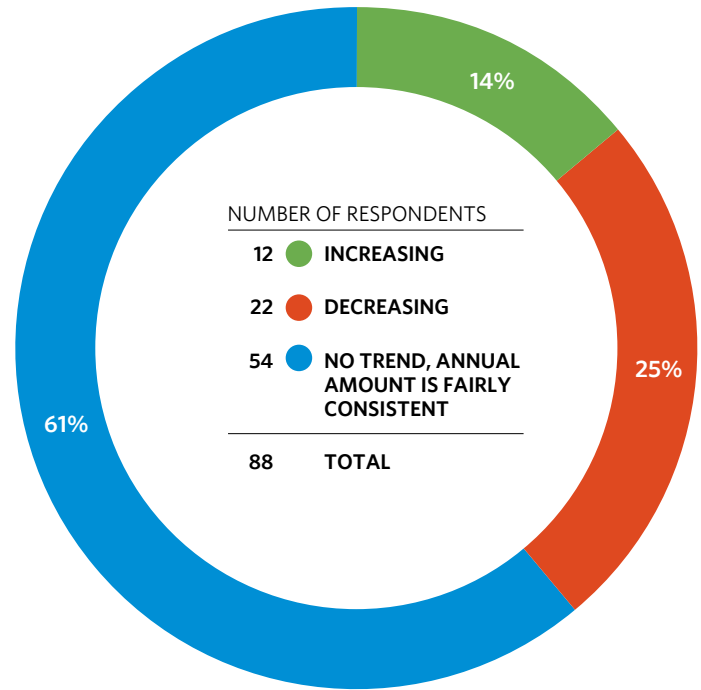
Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. ^a89 respondents; however 17 responses were disregarded due to answers indicating number of meters instead of average age of meters

Table 16. Average number of water main breaks per year, 2009-12

RANGE OF ANNUAL WATER MAIN BREAKS	PERCENT (%) OF RESPONDENTS ^A
0 - 10	19%
11 - 25	27%
26 - 50	19%
51 - 100	25%
> 100	9%
Approximate median value = 30.4^b	

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. ^a88 respondents. ^bSpecial calculation for data in a grouped frequency distribution.

Figure 5. Permittees perception of the trend in main breaks, 2009-12



Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The chart represents 88 respondents.

Table 17. Gallons of water lost to actual leaks, 2012

AVERAGE AND RANGE	GALLONS LOST TO MAIN BREAKS ^a	GALLONS LOST TO OTHER SYSTEM LEAKS ^b	TOTAL GALLONS LOST ^c
Mean	13,572,405	33,796,821	44,549,097
Median	5,000,000	10,000,000	16,628,000
Minimum	40,000	10,000	50,000
Maximum	121,000,000	144,540,000	254,000,000

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. ^a67 respondents; ^b68 respondents, ^c72 respondents.

Table 18. Comparison of gallons of water lost (2012) reported by survey respondents and their 2012 LMO-2

AVERAGE AND RANGE	TOTAL GALLONS LOST IN CNT AND CMAP SURVEY	TOTAL GALLONS OF UFF	TOTAL GALLONS OF UFF + MUL
Mean	44,549,097	44,052,564	108,884,401
Median	16,628,000	22,903,750	78,292,500
Minimum	50,000	0	4,745,000
Maximum	254,000,000	251,966,800	436,175,000

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 72 respondents; comparison was performed for only those permittees who provided an estimate of lost water in the CNT and CMAP Water Loss Survey

Table 19. Total gallons lost by system size, 2012

GROUPED RESPONDENTS	NUMBER OF SERVICE CONNECTIONS	AVERAGE NUMBER OF SERVICE CONNECTIONS	AVERAGE GALLONS LOST	AVERAGE TOTAL GALLONS LOST PER SERVICE CONNECTION
1st Quartile	16 - 3,003	1,724	21,969,139	12,740
2nd Quartile	3,004 - 6,513	4,839	27,890,422	5,764
3rd Quartile	6,514 - 11,814	8,200	50,646,206	6,176
4th Quartile	11,815 - 25,000	16,766	77,690,622	4,634

Source: Center for Neighborhood Technology and Chicago Metropolitan Agency for Planning Water Loss Survey, 2013. The table represents 72 respondents.

Site Visits to Discuss Permittee Practices and Challenges

In order to develop a more in-depth understanding of permittee water-loss practices, challenges, and priorities, six site visits were conducted each with a mix of water department staff and municipal leaders such as a village manager or clerk participating. The visits included 4 of 10 permittees with the most chronic water-loss problem during the six years studied. They ranged in size, from 2,000 to over 20,000 service connections, with staff numbers ranging from as little as six to as many 43 employees.

While only a small percentage of community water supply permittees were interviewed, the results of these qualitative conversations provide insight on the practices and challenges facing permittees. Permittees who granted site visits were promised that information shared would be used only in the aggregate and the source of information (i.e., their identity) would remain anonymous. See Appendix C for an outline of the questions asked.

Key issues that emerged from the interviews are summarized below:

- All utilities visited except one said that current water rates cover costs for operations. As for infrastructure reinvestment needs, all utilities stated that they rely on outside funding for large capital improvement projects and infrastructure upgrades, mainly through leveraging existing assets and rates in the bond market. Very few have applied for funding through other sources such as the State Revolving Loan Funds.
 - All utilities interviewed, regardless of whether they are in compliance with IDNR's water-loss rules, attribute water-loss issues to a combination of old water mains, pipes, and outdated meters. Almost all of them have embarked on new projects within the past two years to address water loss. These various practices include acoustic leak detection, valve testing, meter upgrades, investments in leak detection software and/or SCADA systems, pressure management improvements, and informal accounting reviews of billed vs. distributed water.
 - The need for more money and staff resources is seen as the main limitation to greater investment, which may explain why the permittees described how infrastructure upgrades appear to be typically instigated by external factors, such as when a failure or significant problem occurs, or when related roadway infrastructure is being addressed.
 - Utilities that purchase water indicate that water loss is discussed in financial cost terms while utilities that produce their own water supplies have not discussed water loss in this way.
 - There is variance in how often the issue of water-loss is discussed with senior and elected officials within the municipality. For example, two utilities have weekly to monthly meetings with their officials on the topic, while others only discuss water loss within the context of infrastructure needs during yearly budget reviews. Those utilities that are out of compliance with the Lake Michigan Water Allocation program rules seem to have more frequent communication with senior and elected officials.
 - None of the utilities interviewed perform formal, annual water-loss audits outside of completing a regulatory requirement to fill out the annual LMO-2 form for submittal to IDNR, which contains some information about water loss. There was mixed opinion about the usefulness of the LMO-2 form beyond its role in reporting against the regulatory requirements of the IDNR Lake Michigan Water Allocation Program.
 - All utilities visited state they would be interested in learning more about the AWWA water-loss auditing methodology, often referred to as M36, and felt that additional training and support using M36 would be well received by municipal officials.
 - During several site visits, concern was voiced regarding potential/proposed IDNR rule changes to water-loss regulations. Many of those interviewed believe they are doing what they can to address water loss and are concerned that assigning an upper water-loss threshold (i.e., specific maximum percentage) is arbitrary. Thus, these permittees expressed concern about future noncompliance.
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Site Visits to Explore Usefulness of AWWA M36 Methodology

The AWWA M36 methodology and free on-line tool provides an industry backed, best practice approach for helping utilities audit and understand their water-loss and better target any investment aimed at controlling this loss. Advocates of the methodology have proposed to IDNR that it should replace usage of the current LMO-2 form, claiming that it provides a more accurate picture of water loss and can also help permittees better manage their water.

Separate site visits were conducted in order to better discern how useful the AWWA M36 methodology and free on-line software might be for permittees when either conducting annual water loss audits or trying to better understand where loss might be occurring. The project team sat down with three permittees and walked them through the M36 software and its data requirements. After walking through the software, interviewees were asked to share their general thoughts about the M36 auditing method. See Appendix C for an outline of the questions asked. Permittees were promised that any information shared would be reported only in the aggregate and that their identity would remain anonymous.

The following observations were made as a result of this work:

- Staff was unanimous in their enthusiasm for the software. All interviewees thought this type of audit will not only be useful to their utility, but will also allow them to better prioritize water loss control practices.
- All three utilities believe that it will take about the same number of people in-house to complete the M36 methodology as it currently takes to fill out the IDNR LMO-2 form, and that no new municipal relationships (e.g., coordination with other departments) will be necessary to perform an audit of this nature.
- When asked if their utility is willing to put into place some operational practices to improve data quality and collection in order to use the software, all utilities answered in the affirmative noting that not much, if anything, will be required in order to implement the methodology. All felt they were in a position to be able to use the software without too much effort within the year.
- One utility observed that it might be difficult for some utilities to define certain data points required to use the tool such as identifying what a utility's drinking water cost of service might be separate from other public works functions such as stormwater management, streets and sanitation, etc. They noted that technical assistance on how these values should be calculated might be necessary.
- All thought that the tool could be helpful when having conversations with elected officials about water loss, and yearly budgeting for such issues.



Image by Joey Lax-Salinas.

Discussion and Recommendations

A great opportunity exists for IDNR to enhance its leadership role both in Illinois and within the Great Lakes Basin as well. IDNR has created the structure for success in Lake Michigan stewardship, and with the enhancements recommended here, this structure can serve as a model for other communities, most notably those that are groundwater-dependent and not currently reporting water loss with the same consistency as communities using Lake Michigan water. The IDNR model for water resource stewardship can also serve as an inspiration for other Great Lakes states dealing with similar issues of water-loss auditing and control.

Our research confirms that water loss is a chronic problem for many communities now and will become problematic for many more once lost water that has been traditionally excused (i.e., MUL) is counted as nonrevenue water as proposed. An average of 40 permittees, or 21 percent of community water suppliers (CWS), exceeded the eight percent loss threshold over the six years studied. That number grows to 117 permittees, or 60 percent of CWS, if both MUL were eliminated today and the loss threshold set at 10 percent as is expected in the near future. How long will this magnitude of noncompliance be allowed to last before some begin to question whether the regulatory framework aimed at managing the situation is judged to be not working? Perhaps another valid question to ask is whether the problem of water loss can be solved by regulation?

LMO-2 data for all CWS permittees indicate that over 22.187 billion gallons of water were reported lost in 2012. The value of that water today lies somewhere between \$64.1 and \$147.77 million. (The lower bound is derived from the 2013 price charged by the City of Chicago, the primary wholesaler of water in the region.²¹) With Lake Michigan approaching full allocation for Illinois and taxpayer dollars being wasted along with the water itself, greater awareness of the issue, followed by local actions, are necessary and appropriate. IDNR's role in the matter is unique and essential, but the problem cannot be solved without active permittee cooperation.

The discussion and recommendations that follow can be viewed in two parts: the first part aims at supporting IDNR as a regulator and offers five recommendations to help IDNR meet its statutory obligations. The recommendations present opportunities, born of this project's findings, for enhancing the regulatory program mandate to minimize water loss. The second part, including two more recommendations, aims at IDNR as a source of assistance for permittees as a transition period gets underway in 2014 regarding water-loss accounting and infrastructure repair.

Lastly, there are many permittees that are managing water loss effectively and remaining in compliance with the regulatory program. A closer look at these permittees' practices would likely be instructive for those that are struggling with water loss.

²¹ City of Chicago. Effective January 1, 2014, the water rate will increase by 15% and the sewer rate will increase from 92% to 96% of the water charge. The metered water charge will be \$3.31 per 1,000 gallons (or \$24.80 per 1,000 cubic feet). The metered water charge in 2012 was \$2.51/thousand gallons (or \$18.75/thousand cubic feet).

The IDNR Regulatory Program

The matter of water-loss control begs for stronger policy and programmatic guidance. For example, there is no state guidance or requirement for a community to adopt a formal water-loss control policy. While one might argue that the eight percent annual maximum loss threshold is a formal policy that a community essentially adopts upon becoming a permittee, it is not apparent from either survey data collected or the extent of the water-loss problem such as it is that the linkage is well understood between the elected officials that set policies, including water rates, and the public works staff charged with managing drinking water infrastructure. Establishing a clearly defined water loss control policy will be helpful in opening up lines of communication between elected officials, staff, and the general public. As important, a formal water-loss control policy will help improve the water-waste issue.

What might a formal water-loss policy look like? The best practice measure for water loss is the Infrastructure Leakage Index, (ILI).²² The ILI is the ratio of current annual real losses (CARL)²³ to unavoidable annual real losses (UARL).²⁴ The ILI is a measure of performance that gauges system infrastructure management on a system-by-system basis. But an important consideration for water managers facing limited budgets is the economics of the water loss policy. Asset management is a best practice that can help balance the economic costs of infrastructure improvements with the resulting benefits,²⁵ and determining the economic level of leakage (ELL) can be used to appropriately scale a leak detection program taking financial and economic concerns into consideration.²⁶

Thus, **IDNR should request that a formal water-loss control policy be adopted by each permittee that incorporates asset management, uses the AWWA M36 water audit method, and acknowledges commitment to attaining the proposed new regulatory standard that is a condition of permit for Lake Michigan water.**

Based on survey data and site visit interviews, there appears to be insufficient communication about water loss within a municipality. Survey responses make clear that the vast majority of policy makers (i.e., elected officials) are hearing about water loss just once per year or less and about two-thirds of communities do not disclose water loss information to their customers. This practice essentially removes the community from any awareness of the issue and stifles potential for discussion within the community regarding problem resolution. Additionally, since water-use restrictions by permittees are related to noncompliance with the water-loss standard, enhanced communication of the issue should also help give permittees a platform for discussing water-rate requirements in order to invest in water-loss reduction. Infrequent discussion among elected officials and a lack of transparency with the public minimizes the attention that chronic water-loss requires. **IDNR should 1) request that permittees share water-loss information with customers on a regular basis as part of their requirement to develop and implement a public program to encourage reduced water use; 2) increase their frequency of communication with permittees beyond an annual newsletter to include more guidance- and/or performance-related information; and 3) ensure that expanded communication is also sent directly to city/village managers in addition to the public works directors that are the typical recipient of news and information from the Lake Michigan Water Allocation Program office.**

What other institutional factors might help explain chronic noncompliance with the water-loss standard? It's possible that an overreliance on the LMO-2 audit is at least partially responsible for the extent of noncompliance. For example, the MUL is likely a culprit, but since IDNR is moving to eliminate MUL from the annual accounting of water use/loss, there is no point in going beyond acknowledgement of its historic role in the water-loss equation. Suffice it to say, reporting water loss for what it is will be instructive for both permittees and IDNR in terms of setting priorities and understanding the value of nonrevenue water.

Another example of institutional hindrance is that the LMO-2 form is completed manually and does not feature any mechanism to distinguish between apparent losses and real losses of water. Rather, the LMO-2 arrives at an unaccounted-for-flow figure (i.e., lost water) by way of a simple subtraction of accounted-for-flow²⁷ from net annual pumpage. This difference in accounting methodology is

22 International Water Association (IWA) and the American Water Works Association (AWWA).

23 According to the AWWA M36 water audit, Current Annual Real Losses = water losses minus the sum of apparent losses. The M36 audit auto-generates CARL as part of the water balance calculations.

24 According to the AWWA M36 audit, Unavoidable Annual Real Losses is an operational (versus financial) performance indicator that is auto-generated from previously input system information.

25 Allbee, Steve and Duncan Rose. Advanced Asset Management Practices for Water and Wastewater Utilities Workshop Proceedings, May 13-15, 2013. Madison, Wisconsin. College of Engineering Department of Engineering Professional Development Course #N775.

26 Strategic Management Consultants. Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning. Contract 26777, October 2012. Produced for the Environment Agency in collaboration with The Water Services Regulation Authority (Ofwat) and The Department for Environment, Food and Rural Affairs (Defra), United Kingdom. Available at http://www.ofwat.gov.uk/sustainability/waterresources/leakage/rpt_com121012smcscell.pdf.

27 Accounted-for-flow is the sum of three components: 1. total use (residential, commercial/manufacturing, municipal, construction), 2. total hydrant use (including sewer and street cleaning), and 3. maximum unavoidable loss (the sum of eight estimates based on miles of two types of pipe, four age classes of pipe, and leakage rates assigned to each age/type category).

critical since the two types of water loss — apparent and real — can be explained in the M36 method by six different pathways, each with a best practice available as an appropriate response for addressing the issue. In summary, the complex task of water-loss control requires a more robust auditing tool to understand the issue: a tool that not only churns out numbers, but is sophisticated enough to guide a system manager in identifying issues and priorities with the nuance and power that are typical of application software.

IDNR should require use of the M36 water audit method by permittees. Doing so will be the most effective way to capture the components of both revenue and nonrevenue water and maintain consistency with a new regulatory standard. The new annual audit form administered by IDNR should also collect water rate information previously collected every five years. The new audit form should also collect evidence of a permittee’s public program related to the required adoption of conservation practices.²⁸

What might the above have to do with water rates? Eighty-nine percent of survey respondents indicate that the source of funding for drinking water infrastructure repair and replacement is water-rate revenue. A little over one-third of respondents depend on general obligation bonds and less than a quarter rely on state revolving loan funds. Put another way, the primary source of funding for drinking water infrastructure among the vast majority of permittees surveyed, amounts to a \$2/month contribution by each water user or approximately \$5.58/month per household.²⁹

When typical monthly expenses incurred for cell phone service and cable/satellite television are considered, there is ample evidence to conclude that the investment rate in infrastructure repair and replacement is grossly inadequate given the importance of the service provided and, indeed, expected. The magnitude of the water waste problem confirms as much. So what do water rates look like?

Water rate analysis is complex as rates are influenced at a minimum by a combination of operating expenses and debt; neither one of which was explored in this project. Some basic information is presented, nonetheless, from survey data collected. The average flat rate charged among survey respondents is \$6.66/1,000 gallons.³⁰ Nearly three-quarters of respondents charge a flat volumetric rate with another 15 percent of permittees charging a flat rate with an additional minimum charge. Just nine percent of respondents employ an increasing block rate structure, a form of conservation

pricing. For comparison, utilities surveyed across the country in 2010 by AWWA and reported by others³¹ show that 47 percent of utilities surveyed use increasing block structures while 29 percent use a uniform rate structure. One might infer that using water rates to incentivize conservation is being adopted more readily in other parts of the country despite the fact that IDNR recommends that all permittees adopt water rate structures which will discourage excessive water use.

Survey data and feedback from the site visits demonstrate a close relationship between water rates and a utility’s ability to reinvest in infrastructure. Given this, it is apparent that greater attention to water rates is necessary in order to affect both short- and long-term solutions for funding improvements in water-service infrastructure and reducing both water waste and revenue loss. Additionally, any attempt to move water rates towards full cost of service pricing is necessary for understanding the value of water whether lost or delivered. In turn, an improved understanding of the financial costs to the water utility from lost water (i.e., a lower bound of value of water since utility financial costs do not typically include scarcity or opportunity costs) provides a solid basis for comparison with the costs of leak detection and repair that is part of a more comprehensive utility management strategy.³² This understanding enables a water department/utility to determine a level of water loss below which it will be economically infeasible to achieve.³³ **IDNR should strengthen its longstanding recommendation that permittees develop water rate structures that discourage excessive water use, including charging water rates that reflect full cost of service delivery. To that end, IDNR should request of permittees basic benchmarking for full cost service and annual reporting of associated metrics.³⁴ IDNR should partner with others as appropriate and necessary to provide guidance, outreach, education, and technical assistance for these practices.**

A synthesis of the project experience leads CMAP and CNT project staff to recommend that, **IDNR should be more proactive in making clear to elected officials, that cooperation with IDNR regulation, guidance, recommendations, and requests, is expected of permittees that agree to participate in a regulatory program that features an allocation of Lake Michigan water.**

28 17 ILAC 3730. Allocation of Water From Lake Michigan.

29 Based on 2.68 persons per household from the 2010 Census for the CMAP region.

30 Most permittees purchase treated water from either the City of Chicago or an intermediary that purchases from Chicago. There are other wholesalers that withdraw directly from the lake too among the sixteen permittees that are “direct diverters.”

31 Bianca Rahill-Marier and Upmanu Lall, 2013. America’s Water: An Exploratory Analysis of Municipal Water Survey Data. Available at http://blogs.ei.columbia.edu/wp-content/uploads/2013/10/Bianca-paper_FINAL_10-15-13-1.pdf.

32 A comprehensive management strategy will include such activities as system condition assessment and asset management. For more discussion see U.S. EPA, Office of Water,

Sustainable Infrastructure program at http://water.epa.gov/infrastructure/sustain/asset_management.cfm.

33 The median retail value of water loss in 2012 from both water mains and other pipes is \$125,733 per system.

34 Benchmarking metrics for full cost include: operating ratio, debt service coverage ratio, active debt per customer, and percent of annual operating expenditures in cash reserves. The calculations involved and resultant benchmarks are straightforward. See, “Full-Cost Water Pricing Guidebook for Sustainable Community Water Systems”. A CMAP, Illinois-Indiana Sea Grant, and the University of Illinois Extension collaboration supporting the work of Margaret Schneemann, Water Resource Economist. November 2012. Available at <http://www.cmap.illinois.gov/livability/water/water-reports>.

IDNR Assistance and Collaboration

While any regulatory program features an inherent “stick” for gaining compliance, the matter of water loss, pervasive as it is, will also benefit from any offer of “carrots.” IDNR has an opportunity, if not obligation, to help permittees in some fashion to reduce water loss and maintain compliance with conditions of permit. Solving the problem will likely require a new level of collaboration perhaps between the regulator and regulated community. And with other organizations sharing interest in the issue, IDNR is not without other potential collaborators in helping the regulated community achieve 100 percent compliance.

Oddly, the industry standard M36 method is still largely an unknown among a majority of permittees. Yet those few permittees that received an introduction to the methodology, admittedly a limited sample, were unanimous in their positive response regarding its ease of use and the information that the tool provides to resolve water loss. This bodes well for all involved as both new rules proposed by IDNR and an old problem call for a new approach. **With or without the assistance of nonregulatory regional partners, IDNR should ensure that outreach, education, and technical assistance with the M36 tool is provided to permittees given its ability to assist permittees with water-loss control. This will also enable a smooth transition to use of this tool.**

Water loss is a condition of infrastructure health. Regular meter readings and replacement programs and repair/replacement of water mains and other pipes are the most common types of water-loss control activities employed by permittees. Acoustic leak detection is another practice that the majority of survey respondents employ. This matches well with those interviewed who attributed water-loss largely to a combination of old pipes and water mains, and old meters that often employ an obsolete (and less accurate) measurement technology as compared to new meters available today.

For example, over the course of the past four years, more than half of the survey respondents (53.4 percent) are averaging 26 or more main breaks per year for systems that serve on average, 20,000 people via 6,700 connections.³⁵ The median quantity of water lost estimated from main breaks is 5,000,000 gallons in 2012. The majority of respondents indicated that in lieu of any trend, main breaks are fairly consistent in number during the four-year period of focus: 2009-2012. As for leakage in the system not attributed to main breaks, respondents reported a median, aggregate of 10 million gallons of potable water lost due to leaks in 2012 alone. And regarding meters, survey respondents are managing residential, commercial, and industrial meters with an average age of 13, 12, and 11 years respectively. Studies have shown that meter replacement can be economically optimal at age 16.³⁶

Clearly, reinvestment in water service infrastructure will be necessary in order to reduce growing water waste. Related to the apparent need for an ongoing program of infrastructure replacement and repair is the funding necessary to implement the program. On average, permittees are investing about \$500,000 per year of late in capital equipment or about \$22.70 per person served.³⁷ When asked, the most common response permittees chose from a list of challenges related to water-loss control was funding for and cost of replacing aging infrastructure.

In regards to Governor Quinn’s Clean Water Initiative, **IDNR should coordinate with Illinois EPA, the Illinois Finance Authority, and Illinois Department of Commerce and Economic Opportunity to align programmatic objectives and related requirements of permittees/applicants to support replacement and repair of drinking water infrastructure. This source of funding is not meant to supersede the role of water rates as the ideal mechanism for funding investment, but may be appropriate for systems that meet debt-related benchmarks.**

³⁵ Population served and number of system connections are median values derived from survey data.

³⁶ Hans D. Allender, 2000. Determining the Economical Optimum Life of Residential Water Meters. Water and Wastes Digest, available at <http://www.wwdmag.com/meters/determining-economical-optimum-life-residential-water-meters>.

³⁷ Median value of capital equipment investment reported by survey respondents; divided by median value of population served (22,018).

Summary of Report Recommendations

To enhance IDNR's leadership role and achieve compliance among all permittees with its regulatory program, the following recommendations are made:

1. IDNR should request that a formal water-loss control policy be adopted by each permittee that incorporates asset management, uses the AWWA M36 water audit method, and acknowledges commitment to attaining the proposed new regulatory standard that is a condition of permit for Lake Michigan water.
2. IDNR should 1) request that permittees share water-loss information with customers on a regular basis as part of their requirement to develop and implement a public program to encourage reduced water use, 2) increase their frequency of communication with permittees beyond an annual newsletter to include more guidance- and/or performance-related information, and 3) ensure that expanded communication is also directly sent to city/village managers in addition to the public works directors that are the typical recipient of news and information from the Lake Michigan Water Allocation Program office.
3. IDNR should require use of the M36 water audit method by permittees. Doing so will be the most effective way to capture the components of both revenue and nonrevenue water and maintain consistency with a new regulatory standard. The new annual audit form administered by IDNR should also collect water rate information previously collected every five years. The new audit form should also collect evidence of a permittee's public program related to the required adoption of conservation practices.
4. IDNR should strengthen its longstanding recommendation that permittees develop water rate structures that discourage excessive water use, including charging water rates that reflect full cost of service delivery. To that end, IDNR should request of permittees basic benchmarking for full cost service and annual reporting of associated metrics. IDNR should partner with others as appropriate and necessary to provide guidance, outreach, education, and technical assistance.
5. IDNR should be more proactive in making clear to elected officials, that cooperation with IDNR regulation, guidance, recommendations, and requests, is expected of permittees that agree to participate in a regulatory program that features an allocation of Lake Michigan water.

To better position IDNR as a source of technical assistance and key collaborator in working to reduce water loss, the following recommendations are made:

6. With or without the assistance of nonregulatory regional partners, IDNR should ensure that outreach, education, and technical assistance with the M36 tool is provided to permittees given its ability to assist permittees with water loss control. This will also enable a smooth transition to use of this tool.
7. In regards to Governor Quinn's Clean Water Initiative, IDNR should coordinate with Illinois EPA, the Illinois Finance Authority, and Illinois Department of Commerce and Economic Opportunity to align programmatic objectives and requirements of permittees/applicants to support replacement and repair of drinking water infrastructure. This source of funding is not meant to supersede the role of water rates as the ideal mechanism for funding investment, but may be appropriate for systems that meet debt-related benchmarks.



Image courtesy of the Village of Oak Park.

Appendix A: Letter of Request for Cooperation from IDNR



Illinois Department of Natural Resources

One Natural Resources Way Springfield, Illinois 62702-1271
<http://dnr.state.il.us>

Pat Quinn, Governor
Marc Miller, Director

April 1, 2013

Dear Lake Michigan Water Allocation Permittee:

It is my pleasure to announce that the Illinois Department of Natural Resources has entered into a Memorandum of Agreement with the Chicago Metropolitan Agency for Planning (CMAP) as part of their Local Technical Assistance Program. The purpose of this collaboration, which also includes the Center for Neighborhood Technology (CNT), is to undertake a project to improve our understanding of the obstacles and underlying constraints faced by public water suppliers within the Lake Michigan water service area regarding water loss control. This project also seeks to update our understanding of best water loss control practices employed throughout the region.

To begin this project, CMAP and CNT are conducting a web-based survey of all community water supply permittees. The link to this survey is:

<http://www.surveygizmo.com/s3/1203108/IDNR-Lake-Michigan-Permittee-Questionnaire>

I know that all of you are very busy, but we need your participation in order to gain a more complete understanding of the challenges and issues you face in operating and maintaining your water system. **I'm asking for your cooperation. It is not a long survey, so please take a few minutes and respond to the survey at your earliest convenience, but no later than April 19, 2013.**

I want to emphasize that your survey response will only be used by the project partners as part of their work under our agreement, and that reporting of survey results will be done in aggregate. I thank you for your time and cooperation in completing this survey. If you have any questions as you work through the survey please feel free to contact Dr. Tim Loftus, Water Resources Planner with CMAP at 312-386-8666. Thank you.

Sincerely,

Daniel Injerd, Chief
Lake Michigan Management

Appendix B: Web-Based Survey Questions

1. Please describe your water department/utility's water loss control policy (e.g., ordinance, resolution, goal statement), or let us know if no formal policy exists.
 2. Please describe your water department/utility's plan of action for reducing water loss (commonly referred to as "unaccounted for water").
 3. a. In addition to the Annual Water Use Audit Form (LMO-2), does your water department/utility perform any other types of yearly water loss audits?
b. Please describe your other annual audit practices below.
 4. What types of activities does your water department/utility regularly (i.e., annually) employ regarding water loss control? (please select any that apply)
 - a. Water loss policy with set targets
 - b. Annual water loss auditing
 - c. Acoustic leak detection practices
 - d. Pressure adjustment analysis
 - e. Regular meter readings and upgrades
 - f. Annual capital improvement budgets for repair and replacement of pipes and mains
 - g. Retain the services of an outside engineering/consulting firm
 - h. Other/none.
 5. What types of activities does your water department/utility periodically (i.e., every 2-5 years) employ regarding water loss control? (please select any that apply)
 - a. Water loss policy with set targets
 - b. Annual water loss auditing
 - c. Acoustic leak detection practices
 - d. Pressure adjustment analysis
 - e. Regular meter readings and upgrades
 - f. Annual capital improvement budgets for repair and replacement of pipes and mains
 - g. Retain the services of an outside engineering/consulting firm
 - h. Other/none.
 6. a. Does your water department/utility communicate water loss information to its customers?
b. How often and by what means do you inform your customers?
 7. How often does your water department/utility communicate water loss information to your elected officials (i.e., city council or village board)?
 - a. Monthly
 - b. Quarterly
 - c. Yearly
 - d. Never
 8. a. Does your utility use the AWWA M36 water auditing and loss control methodology?
 - i. Yes
 - ii. No
 - iii. Not familiar with this methodology
 - b. What do you believe are the top two benefits provided to your utility from this auditing method?
 - c. Please describe or list reasons for why your utility is not using the AWWA M36 water auditing methodology.
-

9. What is the population of your utility service area?
 10. How many connections do you serve in your system?
 11. Thinking about your entire utility service area, what is the average age of different types of meters?
 - a. Residential meters
 - b. Commercial meters
 - c. Industrial meters
 12. What is the average, annual number of main breaks your system has had within the last four years (2009-2012)?
 - a. 0-10
 - b. 11-25
 - c. 26-50
 - d. 51-100
 - e. 100 and above
 13. Over the last four years, the trend in main breaks for your system is:
 - a. Increasing
 - b. Decreasing
 - c. No trend, the annual amount is fairly consistent.
 14. How many gallons of water do you estimate your system actually leaked (i.e., real loss) due to main breaks in 2012?
 15. How many gallons of water do you estimate your system actually leaked (i.e., real loss) not related to main breaks in 2012?
 16. What is the estimated retail value of the lost water due to main breaks in 2012?
 17. What is the estimated retail value of the lost water not related to main breaks in 2012?
 18. How does your water department/utility charge residential customers for water use (e.g., flat fee, volumetric rate, etc.), and what are your current residential water charges and rates?
 - a. What is the current water rate charged to your customers?
 - i. Residential
 - ii. Commercial
 - iii. Industrial
 19. What sources of funding does your utility currently use for drinking water infrastructure repair and replacement?
 - a. General obligation bonds
 - b. Water rate revenue
 - c. State revolving loan funds
 - d. Other
 20. How much money has your utility invested in capital equipment (e.g., meters, pumps, water mains, pipes) over the past three years (2010-2012)?
 21. Has your utility ever needed to implement water use restrictions due to a water shortage such as drought conditions or system capacity limits?
 22. Since the sale of water is a revenue generator, and water use restrictions can limit this revenue stream, how does your utility deal with this potential conflict?
 23. Please tell us about any challenges your utility faces in relation to managing water loss control.
-

Appendix C: Site Visit Questions

Permittee Site Visit Questions

Public Works or Water Department Staff and Operations:

1. How many staff members are assigned to drinking water supply provision?
2. Do you conduct annual water loss audits – if so, what method do you use?
3. Do you make Capital Improvement Plans based-on auditing results?
4. What is your average annual operating budget for water supply?
5. Where does funding for water supply infrastructure upgrades come from?
6. What do you generally attribute relatively large water loss to for so long? (asked of select permittees.)
7. How useful is the LMO-2 form required yearly by IDNR to your utility?
8. What might you need, if anything, to better manage/control water loss?

Elected Officials and Water Loss:

9. Characterize the understanding or attitude of your elected officials regarding water loss. For example, do they have a good understanding of the current situation? How are they engaged in this matter and in what way(s) are they involved?
10. Is the value of unrecovered costs associated with water loss generally well understood? Put another way, is water loss discussed in terms of unrecovered costs?
11. Where does the issue of water loss in supply distribution infrastructure rank on the list of city/village priorities?

Water Rates:

12. Do current rates cover costs for operations?
How about for infrastructure re-investment needs?
13. How often is the relationship between water rates and water system needs (e.g., infrastructure maintenance/repair) discussed amongst staff and elected officials?
14. How supportive are elected officials of rates increases in order to support system maintenance and upgrades?

Closing Questions:

15. Do you believe that your data collection, analysis, and records management activities are sufficient to have a good understanding of how your water system functions and is maintained?
16. Are you interested in applying the AWWA water loss / audit methodology to help solve the problem?
17. Would municipal officials be supportive of training and improved water loss auditing and planning for managers and operators of the water system?
18. What is the city/village plan for reducing water loss and coming into compliance with IDNR rules and regulations?

M36 Questions

1. What are some general thoughts you have about this auditing process/software?
2. Do you see this type of audit as a useful practice for your utility?
3. Would this audit process allow you to better prioritize water loss control practices?
4. How many individuals from the utility/municipality do you think it would require to complete all data points for this audit software?
5. What new bridges or relationships within your utility/municipality would be required in order to perform an audit of this nature per year?
6. Given the type of data required to fill out the M36 software, how plausible would it be for your utility to complete an audit using the software today? Next year?
7. Is your utility willing to put into place some operational practices to improve data quality and collection, which would allow you to work through this software more easily on a yearly basis?
8. Would your utility be willing to be a part of the AWWA WLCC's compiler program whereby the national committee would assist with working through the audit and validation process in exchange for recording and keeping public your audit information?

Appendix D: Acronyms

AWWA	American Water Works Association
ASCE	American Society of Civil Engineers
CMAP	Chicago Metropolitan Agency for Planning
CNT	Center for Neighborhood Technology
CWS	Community water suppliers
FTA	Federal Transit Administration
HUD	U.S. Department of Housing and Urban Development
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
ILI	Infrastructure Leakage Index
LTA	Local Technical Assistance
LMO-2	Annual Water Use Audit Form
MUL	Maximum Unavoidable Loss
OWR	Office of Water Resources
UFF	Unaccounted-for-flow



Chicago Metropolitan
Agency for Planning

233 South Wacker Drive, Suite 800
Chicago, IL 60606

312-454-0400
info@cmap.illinois.gov
www.cmap.illinois.gov



2125 W. North Avenue
Chicago, IL 60647

773-278-4800
info@cnt.org
www.cnt.org