Water Management Plan

Revision 2

U.S. Environmental Protection Agency
National Vehicle and Fuel Emissions Laboratory
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY
ANN ARBOR, MICHIGAN

WATER MANAGEMENT PLAN, REVISION 2

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1.0 IDENTIFIED WATER CONSERVATION OPPORTUNITIES

In May 2014, a water use and conservation assessment was conducted at the U.S. Environmental Protection Agency's (EPA's) National Vehicle and Fuel Emissions Laboratory (NVFEL) in Ann Arbor, Michigan. Under this Water Management Plan, NVFEL will consider implementing the potential water conservation and management opportunities identified during the water assessment, which are summarized in Table 1.

The rest of this Water Management Plan describes NVFEL's water reduction goals, water use trends, end uses of water, completed water efficiency projects, and drought management plans.

2.0 BACKGROUND AND PURPOSE

In 2007, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, called for federal agencies to reduce water use intensity by 2 percent per year between fiscal year (FY) 2007 and FY 2015 for a total reduction of 16 percent, compared to a FY 2007 baseline. This goal was revised and extended by EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*. EO 13514 calls for reducing potable water use intensity by 2 percent annually through FY 2020, relative to the FY 2007 baseline, for a 26 percent total reduction. Water use intensity is measured in gallons per gross square feet (gsf).

The implementation instructions for water efficiency and management provisions of EO 13514 direct that agencies replacing fixtures or other water-using products should purchase Federal Energy Management Program-designated or WaterSense® labeled products.

In addition to the potable water use reduction requirements, EO 13514 requires agencies to reduce industrial, landscaping, and agricultural (ILA) water use by 2 percent annually or 20 percent by the end of FY 2020, relative to an FY 2010 baseline (including non-potable sources). The EO also directs agencies to identify, promote, and implement water reuse strategies that reduce potable water use.

The Energy Independence and Security Act of 2007 directs agencies to complete comprehensive energy and water evaluations of 25 percent of covered facilities (i.e., those accounting for 75 percent of total energy use) each year; implement cost-effective measures identified through life cycle analyses; and measure and verify water savings.

In summary, existing EOs and federal law require substantial reductions in all forms of water use, as well as ongoing, regular assessments of facility water use to identify and implement saving opportunities.

This Water Management Plan has been developed to document and promote the efficient use of water at NVFEL, so that the facility can contribute to meeting these Agency-wide objectives.

Table 1. Potential Water Conservation Opportunities, NVFEL

Suggested Priority	Project Description	Project Cost	Potential Water Savings (gallons)	Potential Energy Savings (MMBtus)	Potential Utility Cost Savings	Potential Payback (years)
1	Install 0.5 gallon per minute (gpm) aerators on three lavatory faucets. [COMPLETED FOLLOWING ASSESSMENT]	$30	29,000	10	$310	0.1
2	Route reverse osmosis (RO) concentrate to cooling tower sump, install new partial water softening system, and install new meters to obtain sewer deduction credit. [PROJECT CURRENTLY IN PROGRESS]	$80,000	800,000	N/A	$26,000[a]	3.1
3	Replace three existing 2.5-gpm showerheads with WaterSense labeled models flowing at 1.75 gpm or less.	$90	1,000	1	$10	7.0
4a	Replace one existing urinal that flushes at 1.0 gallons per flush (gpf) with a WaterSense labeled model flushing at 0.125 gpf.	$1,000	9,000	N/A	$80	12.5
4b	If urinal replacement is not feasible at this time, replace 1.0-gpf flush valve insert with a new insert rated at 0.5 gpf. [COMPLETED FOLLOWING ASSESSMENT]	$50	5,600	N/A	$50	1.0

[a] Estimated based on cost savings from the water savings, as well as a sewer deduction credit for water from the RO system and water that is evaporated from the cooling tower.

3.0 FACILITY INFORMATION

NVFEL was constructed in 1970 to house offices, vehicle and engine testing laboratories, and support spaces. The laboratory and support spaces occupy a high-bay building subdivided into 20 individual test cells, five soak zones where vehicles are maintained at constant temperature conditions, and support and preparation areas. Offices occupy the three wings off the high-bay building. The facility is owned and operated by EPA.

Some NVFEL staff occupy a leased office building adjacent to the laboratory. This plan does not address any aspects of the leased office building; it focuses on water management at the laboratory facility owned and operated by EPA.

EPA awarded its first energy savings performance contract (ESPC) to NORESCO in 1998 for a comprehensive upgrade to the energy systems at NVFEL. This project completely replaced the building's heating and cooling infrastructure, significantly reduced energy and water use, and lowered facility maintenance and utility costs. Key components of the ESPC included replacing 36 rooftop air handling units and replacing existing equipment in the central heating and cooling

plant with one 440-ton and one 575-ton direct fired chiller-heater absorber, one 30-ton capacity high-efficiency condensing boiler, two 600-ton cooling tower cells with variable frequency fan drives, and a new pumping system. The upgraded chilled water system was sized to replace previous use of single-pass cooling water with recirculated chilled water.

Since 2010, NVFEL has completed three facility additions and replaced the vehicle fueling system. NVFEL is currently made up of 208,327 gsf of laboratory, office, and support space. As part of these renovations, NVFEL installed a new 800-ton chiller and new 800-ton cooling tower.

NVFEL is currently in the process of constructing a new addition that will house a four wheel drive electric dynamometer for testing of heavy duty, Class 8 vehicles. A new 300-ton, air-cooled satellite chiller is being installed to support this new addition.

NVFEL is occupied by approximately 150 employees. Additional staff occupy a leased office building next door and often conduct work at NVFEL. The facility operates on a flex time schedule, one shift per day from 5 a.m. to 6 p.m., Monday through Friday.

4.0 WATER MANAGEMENT GOALS

NVFEL achieves resource conservation goals by implementing its Environmental Management System (EMS) program. Within the EMS, NVFEL's potable water management goals include:

- Reduce facility potable water use and water intensity by meeting EPA's Sustainable Facilities Practices Branch's (SFPB's) ConservW target of 1 percent reduction in FY 2014 compared to FY 2013.

- Maintain water conservation efforts for landscaping.

5.0 WATER USE INFORMATION

NVFEL uses potable water primarily for cooling tower make-up, test chamber humidification, and restroom uses. Discussed further in Section 5.3, NVFEL's potable water use has decreased since the FY 2007 baseline year. The following sections provide additional details on NVFEL's water use.

5.1 Water Supply

City of Ann Arbor Water Utilities provides NVFEL's potable water and sewer service. NVFEL does not use any sources of non-potable fresh water.

5.2 Meters and Submeters

Incoming city water supply is metered. Flow totalizing meters are also installed on many of the subsystem flows. An inventory of metered flows is provided below:

- Potable water supply from the City of Ann Arbor
- Cooling tower make-up water

- Cooling tower blowdown
- Chilled water loop make-up
- Hot water loop make-up
- RO permeate used for test chamber humidification
- Sand filter flushing water
- Domestic hot water use

NVFEL is currently working on a project that will replace the existing meters on the cooling tower make-up and blowdown lines and install new meters on the RO feed water line and the fire system. The new meters will allow NVFEL to obtain a sewer deduction credit for water evaporated from the cooling tower and water used by the RO system. This project is further discussed in Section 5.4.

Under this Water Management Plan, facilities management staff will record meter readings at least monthly and report values to the Facilities Manager so that water use trends can be monitored on an ongoing basis and leaks or other malfunctions can be quickly identified. Any unexpected changes in water use will be investigated and resolved immediately.

5.3 Historical Water Use

In response to EO 13423, NVFEL set a FY 2007 potable water use intensity baseline of 33.65 gallons per gsf. In FY 2013, water use intensity had decreased to 25.82 gallons per gsf—a 23.3 percent reduction compared to the FY 2007 baseline. Figure 1 illustrates NVFEL's potable water use intensity from FY 2007 to FY 2013.

Described in Table 2, NVFEL completed several water efficiency projects since FY 2009 to contribute its water use reduction. While savings have been achieved through completed projects, the research process heat loads at NVFEL have been increasing, necessitating increased chiller and cooling tower capacity. Associated increases in cooling tower water use have offset some of the savings achieved.

Figure 1. Annual Potable Water Use Intensity, NVFEL, FY 2007–FY 2013

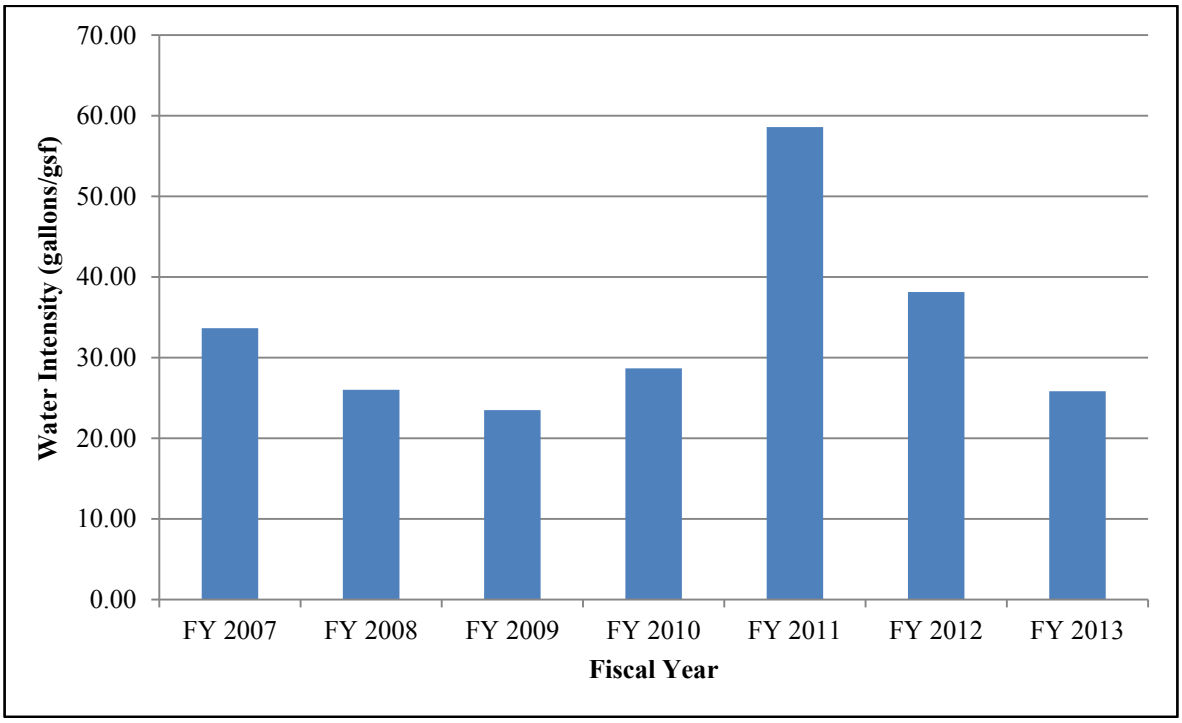


Table 2. Completed Water Efficiency Projects Since FY 2009, NVFEL

Project	Implementation Cost	Estimated Annual Water Savings (gallons)	Completion Year	Additional Notes
Process water	$1,000,000	Unknown	FY 2012	In FY 2012, NVFEL replaced all test dynamometers that use process water for resistance with dynamometers that use electric resistance.[1]
Faucet aerators	Unknown	Unknown	FY 2009	NVFEL retrofit 10 of 13 lavatory faucets with faucet aerators that flow at 0.5 gpm.
Toilets	$8,000	122,000	FY 2009	NVFEL replaced eight of 15 toilets with high-efficiency toilets flushing at 1.28 gpf. It is not cost effective to replace the remaining seven toilets which flush at 1.6 gpf.
Urinals	$5,000	57,000	FY 2009	NVFEL replaced four of five urinals with WaterSense labeled urinals flushing at 0.125 gpf.

[1] While water conservation was a benefit of this project, the upgrade to the dynamometers was driven by the need for improved technology. Estimated water savings from this project were never directly assessed.

5.4 End Uses of Water

Table 3 and Figure 2 describe the end uses of water at NVFEL.

Figure 3 provides a graph of NVFEL's monthly potable water use in FY 2013, which illustrates NVFEL's seasonal water use pattern that can be attributed to higher cooling tower make-up water demand in the summer months.

NVFEL's end uses of water are described in more detail in this section. Potential projects discussed in this section are summarized in Table 1.

Table 3. Major Water Uses, NVFEL, FY 2013

Major Process	FY 2013 Annual Water Use (gallons)	Percent of Total Potable Water Use (%)	Estimated Utility Costs[a]	Basis of Estimate
Cooling tower make-up	4,461,000	82.9	$41,000	Engineering estimate based on prorating metered data from March 2010 through June 2013.
RO system reject	322,000	6.0	$2,900	Engineering estimate based on the metered RO system permeate and the ratio of concentrate to permeate identified on the instantaneous flow meter readings from the RO system.
RO system permeate (used for test chamber humidification)	281,513	5.2	$2,600	FY 2013 meter readings.
Restroom fixtures	220,000	4.1	$2,000	Engineering estimate based on fixtures installed, occupancy, and daily usage factors.
Sand filter flushing	56,033	1.0	$500	FY 2013 meter readings.
Miscellaneous laboratory use	11,694	0.2	$100	Calculated by difference from known total water use and all other calculated water uses.
Vehicle washing	10,400	0.2	$90	Engineering estimate based on number of cars washed weekly.
Chilled water loop make-up	9,850	0.2	$90	FY 2013 meter readings.
Hot water loop make-up	7,500	0.1	$70	FY 2013 meter readings.
Total Potable Water Use	**5,379,990**	**100**		FY 2013 metered total.

[a] Utility cost is calculated using the most current water and sewer rates available. According to water and sewer bills provided by the City of Ann Arbor Water Utilities in March 2014, the incremental water rate applicable to NVFEL is $4.20 per 1,000 gallons and the incremental sewer rate applicable to NVFEL is $4.88 per 1,000 gallons.

Figure 2. Percentage of Potable Water End Uses, NVFEL, FY 2013

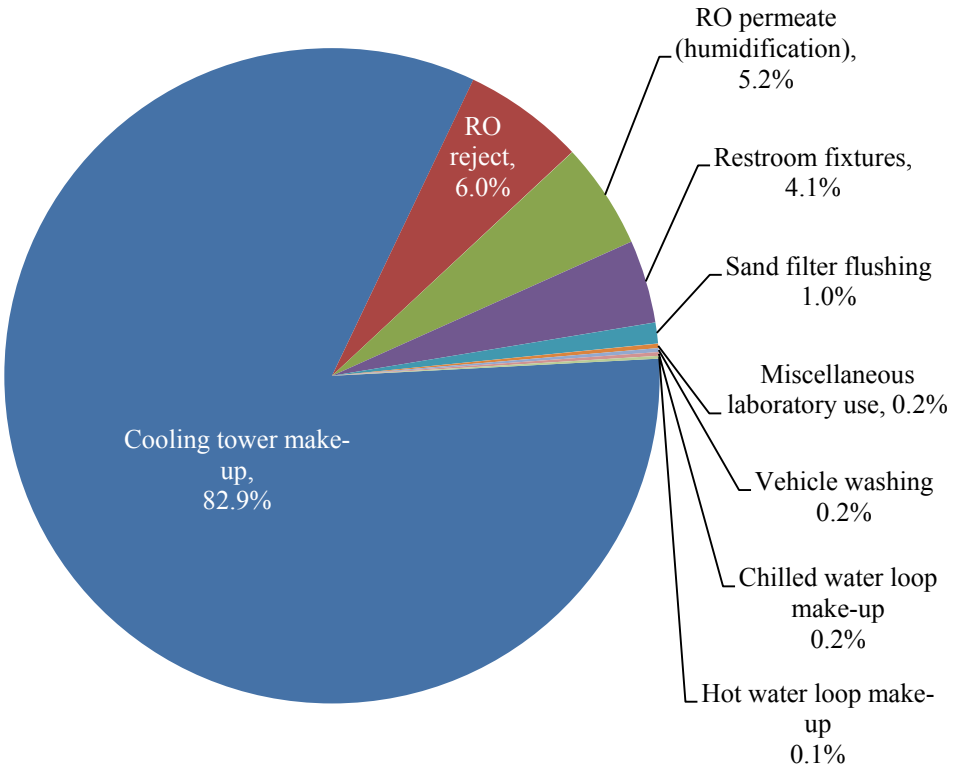
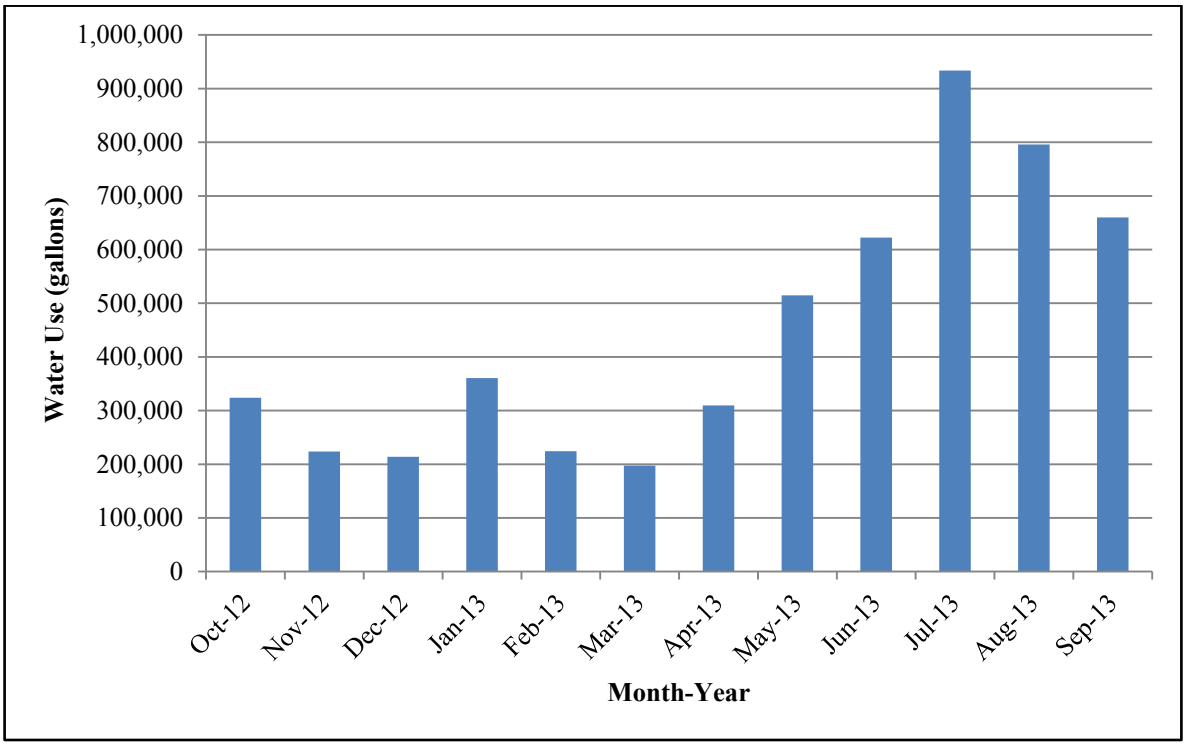


Figure 3. Monthly Water Use, NVFEL, FY 2013



Cooling Tower Make-Up

NVFEL's most significant water use is from operation of the cooling tower system, which accounts for approximately 83 percent of its annual water use. NVFEL's cooling tower system consists of an original tower with two 600-ton capacity cells and a newer 800-ton tower installed in 2013. Both towers are supplied with common condenser water. The cooling tower system is equipped with an ozone treatment system to reduce biological growth and a side stream sand filtration system to reduce solids build-up and enable a higher degree of cooling water recycle. The sand filtration system is flushed weekly, accounting for an additional 1 percent of the NVFEL's total water use.

Cooling tower blowdown is controlled based on water conductivity. The conductivity target for the system is 2,400 microSiemens per centimeter (*u*S/cm). Incoming city-supplied make-up water has a conductivity of approximately 600 to 800 *u*S/cm, depending on the time of year. Therefore, NVFEL's conductivity control point provides for approximately three to four cycles of concentration and efficient cooling tower water use.

NVFEL is in the process of implementing a project to improve operations of the cooling tower system and obtain a sewer deduction credit for water evaporated from the cooling towers. In coordination with its ESPC and the City of Ann Arbor Water Utilities, NVFEL plans to route RO reject water from the RO system to the cooling tower sump to use as make-up water. As part of this project, a water softener will be installed to treat a portion of the city water make-up, consequently lowering the amount of calcium entering the system. Since calcium is currently the constraining factor for increasing the cycles of concentration, lowering the calcium hardness will allow the cooling tower to operate at approximately five cycles, an increase over the existing operating cycles of three to four.

NVFEL is also installing new flow totalizing water meters on the cooling tower make-up water line, the cooling tower blowdown line, the RO feed water line, and the fire system in order to obtain a sewer deduction credit for the water that is lost from evaporation at the cooling towers and used for test chamber humidification rather than sent to the sewer. The RO feed water meter will allow NVFEL to obtain a sewer deduction for all of the water used by the RO system since the permeate water is used solely for test chamber humidification and the RO reject will be used as cooling tower make-up and will mainly be evaporated. City of Ann Arbor Water Utilities also requires that NVFEL install additional meters on the fire system in order to obtain a sewer deduction credit for water evaporated from the cooling tower. While the fire system does not use substantial water, City of Ann Arbor Water Utilities uses this meter as verification that blowdown of the cooling tower is not occurring through this water line. This project is anticipated to be completed by November 2014.

Reverse Osmosis System

NVFEL installed a water softener and RO system in 2005 to pre-treat water used for test chamber humidification. Feed water to the RO system comprises approximately 11 percent of NVFEL's total annual water use. The RO system is equipped with a level controller so that the system only operates on demand. The capacity of the RO system is 5,000 gallons per day. When operational, the system discharges approximately 1.1 gallons of reject water per gallon of

permeate. As stated earlier, NVFEL is in the process of routing the RO reject water to the cooling tower sump for use as cooling tower make-up and is pursuing a sewer deduction credit for water used by the RO system.

Restroom Fixtures

Approximately half of the toilets and 80 percent of the urinals installed at NVFEL are high-efficiency fixtures (1.28 gpf toilets and 0.125 gpf urinals). The remaining toilets and urinals are Energy Policy Act of 1992 (EPAct 1992)-compliant fixtures (1.6 gpf toilets and 1.0 gpf urinals). As a preventative maintenance measure, all flush valves in toilets and urinals are replaced once per year.

Ten of NVFEL's 13 lavatory faucets are high-efficiency models (0.5 gpm) with automatic sensors. The 0.5 gpm flow rate is lower than the EPAct requirement for faucets and is compliant with the American Society of Mechanical Engineers/Canadian Standards Association (ASME/CSA) standard for lavatory faucets in public use. This flow rate is sufficient for hand washing and is considered a best practice for lavatory sinks in public settings.

EPAct 1992-compliant showerheads (2.5 gpm) are installed in the shower room. Shower use is not prevalent at NVFEL.

Janitorial staff and employees are trained to report leaks or other maintenance problems. The facility operation and maintenance contractor performs a daily inspection of all restroom fixtures to maintain and ensure proper operation. Identified leaks or other maintenance problems are immediately corrected.

Table 4 provides an inventory of sanitary fixtures.

Table 4. Restroom Fixtures Inventory, NVFEL

Fixture Type	Flow Rate	Total Number
Toilets	1.6 gpf	7
	1.28 gpf	8
Urinals	1.0 gpf	1
	0.125 gpf	4
Lavatory faucets	2.2 gpm	3
	0.5 gpm	10
Showers	2.5 gpm	3

To reduce restroom water use, NVFEL will consider replacing the remaining urinal that flushes at 1.0 gpf with a WaterSense labeled urinal flushing at 0.125 gpf. Alternatively, if it is not feasible to replace the remaining urinal, NVFEL could replace the urinal flush valve insert with an insert rated at 0.5 gpf. If NVFEL decides to do this project, it should monitor the urinal to verify adequate performance and user satisfaction with the lower flush volume.

To further reduce restroom water use, NVFEL will consider installing 0.5 gpm aerators on the remaining three faucets with flow rates of 2.2 gpm, and if shower use increases, NVFEL will consider replacing existing showerheads with WaterSense labeled models that flow at 1.75 gpm or less.

Miscellaneous Laboratory Uses

Water is used for custodial activities and other miscellaneous laboratory water uses. Miscellaneous laboratory use accounts for less than 1 percent of NVFEL's total annual water use.

Vehicle Washing

Following vehicle emissions testing, vehicles are hand washed prior to returning them to the customers or manufacturers. According to facility management staff, approximately four vehicles are washed per week. Vehicle washing accounts for less than 1 percent of NVFEL's total annual water use.

Chilled Water Loop Make-Up

Prior to the ESPC, approximately 23,000,000 gallons of single-pass cooling water was used to cool the building air compressors and process chillers and to remove the heat load from engines being tested. As part of the ESPC, an upgraded cooling plant was installed which included a recirculated chilled water loop designed to provide cooling for all these applications. Recirculated chilled water is also available in each engine test cell for engine cooling. Less than 1 percent of NVFEL's total annual water use is from chilled water loop make-up.

Hot Water Loop Make-Up

Prior to the ESPC, three 700-horsepower boilers produced steam at 100 pounds per square inch (psi), which was distributed to the facility at 35 psi via a pipe loop. Approximately 1,000,000 gallons of water per year was used for boiler make-up. This system was replaced with high-efficiency condensing boilers and a new hot water piping distribution system. This heating plant upgrade eliminated steam condensate blowdown and significantly reduced make-up water demand. Hot water loop make-up now accounts for less than 1 percent of NVFEL's total annual water use.

6.0 DROUGHT CONTINGENCY PLAN

Water shortages are uncommon in Ann Arbor due to an abundant water supply. The City of Ann Arbor does not have an official water management plan specifically for droughts, but it does have a general emergency action plan, which may be implemented if a drought occurs. Historically, the only action that has been taken during previous droughts has been the restriction of landscape watering. NVFEL does not use any water for landscape irrigation.

In the event that voluntary or mandatory water use reductions are instituted by Michigan Department of Natural Resources or City of Ann Arbor Water Utilities, NVFEL will form a task

force of facility and operating personnel to identify and implement modifications to facility operations to achieve specified reductions in water use.