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Acronyms and Abbreviations

CCP	Car Cleaning Platform
CDPH	California Department of Public Health
CNG	compressed natural gas
D18	Bus Yard Division 18
D20	Rail Red Line Main Yard Division 20
EMS	Environmental Management System
Gateway	Gateway Headquarters
GHGs	greenhouse gases
GPCD	gallons per capita daily
gpd	gallons per day
gpf	gallons per flush
gph	gallons per hour
gpm	gallons per minute
gpv	gallons per vehicle
EMS	Environmental Management System
FTA	Federal Transit Administration
ICF	ICF International
ISO	International Organization for Standardization
LADBS	Los Angeles County Department of Building and Safety
LADWP	Los Angeles Department of Water and Power
LEED	Leadership in Energy and Environmental Design
LF	linear feet
Metro	Los Angeles County Metropolitan Transportation Authority
Mgal	million gallons
MSIP	Metro Sustainability Implementation Plan
NTU	Nephelometric Turbidity Units
O&M	operation and maintenance
OMB	U.S. Office of Management and Budget
OSHA	U.S. Department of Labor Occupational Safety and Health Administration

Plan	Water Action Plan
ppm	parts per million
RO	reverse osmosis
TDS	Total Dissolved Solids
WBMWD	West Basin Municipal Water District

Executive Summary

One of the key elements of the Los Angeles County Metropolitan Transportation Authority's (Metro) sustainability program is the development and implementation of a Water Action Plan (Plan) that will reduce water consumption in a cost effective manner. This Plan analyzes recent trends and current water consumption at selected Metro divisions to better understand the relationship between current equipment, practices and total water use. The Plan provides strategies for water conservation as recommendations and cost-benefit analysis of those recommended actions for Metro's consideration to reduce water consumption, and recommends next steps for the refinement, implementation, and ongoing optimization of the Plan and its associated strategies for conservation.

The intent of this Plan is to determine the potential for water conservation opportunities and cost-saving measures consistent with Metro's environmental policies and its future implementation of an Environmental Management System (EMS). The Plan will inform other Metro projects as part of the overall sustainability program for water use to be strategically aligned with other resource elements (e.g., fuel use, greenhouse gas [GHG] emissions, etc.).

The primary objectives of this Plan are to:

1) Obtain water usage data from current equipment and operational practices representative of water use throughout Metro's maintenance divisions.
2) Identify reasonable, cost-effective water conserving strategies that can be replicated system-wide.
3) Provide appropriate economic analysis of the costs and benefits for water conservation strategies including substitution of non-potable water supplies.

The results of this Plan can help inform Metro's decisions about future investment in sustainability strategies. The following water conservation strategies have been developed based upon a review of the existing facilities, operations, and water usage at selected divisions:

- Municipal Recycled Water Substitution for Bus Washing (Bus Facilities);
- Municipal Recycled Water Substitution for Car Washing (Rail Facilities);
- Municipal Recycled Water Substitution for Landscape Irrigation (Bus and Rail Facilities);
- Extension of Bus Runoff Capture On-Site Reclamation (Bus Facilities);
- Replacement of Sanitary Fixtures (Bus and Rail Facilities);
- On-Site Gray Water (Bus and Rail Facilities);
- Replacement of Steamer (Bus facilities);
- Replacement of Car Wash Facility (Rail Facilities);
- Replacement of Engine Compartment Cleaner (Bus Facilities);

- Replacement of Under Chassis Washer (Bus Facilities);
- Replacement of Air Scrubbing Water Curtain (Rail Facilities);
- Replacement of Small Parts Washer (Bus Facilities);
- Assessing Education and Outreach Measures (Rail and Bus Facilities, Gateway Headquarters); and
- Water Conservation at Gateway Headquarters and MSSC (Gateway Headquarters, MSSC).

Anticipated water demands, including a reasonable range of potential conservation savings were developed for each conservation strategy. Total water savings were estimated at both the bus and rail divisions at 204 million gallons per year (627 AFY). Conservation measures may provide 40 percent water savings.

A three-step path forward was recommended for refinement, implementation, and, ongoing optimization of the Water Action Plan and its associated strategies for conservation.

Step one is coordination by Metro's Environmental Compliance and Services Department with internal and external stakeholders. Step one ensures that issues are identified and understood, that strategies are appropriately prioritized for integration into both the sustainability plan, and the EMS, and, that collaboration with Metro's broader policies, goals and objectives is maintained.

Step two is the controlled implementation or piloting of the top rated strategies at Divisions 18 and 20. Divisions 18 and 20 thereby serve as water conservation laboratories for verification of water savings, retrofit costs, and cost savings. Piloting would also provide the hands-on opportunity for Metro staff to gain construction and operating experience with conservation strategies.

Strategies would be fine tuned through piloting to meet Metro's specific operational requirements. Previously installed sub-meters will be re-used, providing ongoing data and benchmarks for comparison of water use before and after strategy implementation. A "Path Forward" report would be prepared to update schedules and budgets for Metro-wide water conservation deployment.

In Step three, remaining Metro divisions would be surveyed for suitability to conservation strategy retrofits. Site specific conditions would be documented. Opportunities and constraints to implementation would be identified. As appropriate, planning and engineering documents would be developed to meet site constraints. Total water conservation savings would be evaluated using appropriate metrics such as recycle rate for bus and car washing equipment. Availability of municipal recycled water would be identified. Landscaping areas under irrigation would be measured. Leakage surveys and audits of interior and exterior water use would be completed. The Gateway Headquarters and the Metro Support Services Center would undergo water use audits to confirm performance of water conservation equipment and identify additional strategies. As necessary, the Water Action Plan would be updated to remain current with implementation plans, and planned conservation savings.

Table ES-1. Bus and Rail Cost Benefit Analysis Summary

Conservation Strategy	All Bus and Rail Facilities							
	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Net Benefit (Benefit-Cost) ($)	Gallons Saved Per Revenue Hour	B/C Ratio	Payback Period (considering O&M)
1. Municipal Recycled Water For Bus Washing	105,894,912	325	135,000	360,043	1,396,715	13.24	11.35	1.50
2. Municipal Recycled Water For Car Washing	2,641,920	8	45,000	8,983	-6,786	4.03	0.85	20.04
3. Municipal Recycled Water For Landscape Irrigation	1,818,624	6	540,000	6,183	-513,695	0.23	0.05	349.33
4. Extension of Bus Wash On-Site Reclamation	44,544,000	137	120,000	2,400	3,060,689	5.57	26.51	0.64
5. Replacement of Sanitary Fixtures	16,374,688	50	252,320	0	931,937	1.89	4.69	3.63
6. On-Site Gray Water Reclamation with Standard Fixtures	13,201,920	41	528,000	10,560	247,095	1.53	1.47	11.59
7. Replacement of Steamer	9,161,865	28	154,740	3,095	257,329	1.15	2.66	6.39
8. Replacement of Car Wash Facility	528,384	2	1,200,000	24,000	-1,570,195	0.81	-0.31	-55.16
9. Replacement Engine Compartment Cleaner	403,690	1	154,740	3,095	-186,927	0.05	-0.21	-81.81
10. Replacement of Under Chassis Washer	35,040	0	156,000	3,120	-64,316	0.00	-3.95	-4.53
11. Replacement of Air Scrubbing Water Curtain	23,859	0	24,000	1,000	-39,291	0.04	-0.64	-26.71
12. Replacement of Small Parts Washer	13,140	0	89,940	1,799	-119,884	0.00	-0.33	-51.11
Subtotal	194,642,042	597	3,399,740	424,277	3,392,672	28.52	–	–
Note 1: Education Related Conservation Measures assume an addition water savings of 1% of overall equipment based measure savings use per year for five years	9,732,102	30	–	21,214	169,634	1.12	10.47	5.67
Annual Total (After 5 Years)	204,374,144	627	3,399,740	445,491	3,562,305	–	–	–

1. Introduction

One of the key elements of Metro's sustainability program is the development and implementation of a Water Action Plan that will reduce water consumption in a cost effective manner. This Plan analyzes recent trends and current water consumption at selected Metro divisions to better understand the relationship between current equipment, practices and total water use. The Plan provides strategies for water conservation as recommendations and cost-benefit analysis of those recommended actions for Metro's consideration to reduce water consumption.

1.1 Project Background

Metro's sustainability goal is to *be the transportation industry leader in maximizing sustainability efforts and benefits for Los Angeles County's people, economy, and environment* (Metro 2008). In June 2008, the Metro Board adopted the *Metro Sustainability Implementation Plan* (MSIP) (Metro 2008) that identified short-term projects and general guidelines to serve as the basis for specific long-term sustainability project development. In April 2009, Metro adopted the *Metro Environmental Policy* to provide guidance in carrying out the Metro's ongoing commitment to move people efficiently and effectively, using EMS as its primary tool.

One of the projects identified in the MSIP was preparation of a *Baseline Sustainability Report* (Metro 2009b) to better understand and promote sustainable operations throughout Metro. The report measured Metro's current performance to set targets, direct resources, and improve performance. One of the key findings was that water use was growing at a faster rate than increases to transit service (i.e., revenue hours, as reported annually to the National Transit Database). It was concluded that approximately 80 percent of Metro's water is used for washing bus and rail cars. Therefore, water usage is directly related to vehicle revenue hours. Given the likelihood for future water restrictions in Los Angeles County, and expected increases in water prices, Metro made a commitment to significantly reduce its water use. A key recommendation of the MSIP was development of a Water Action Plan to identify water saving measures and improve sustainability performance system-wide.

1.2 Purpose and Objectives

The intent of this Plan is to determine the potential for water conservation opportunities and cost-saving measures consistent with Metro's environmental policies and its future implementation of an EMS. The purpose of the Plan is to provide recommendations for cost effective implementation of water conservation strategies. The Plan will inform other Metro projects as part of the overall sustainability program for water use to be strategically aligned with other resource elements (e.g., fuel use, greenhouse gas [GHG] emissions, etc.).

The primary objectives of this Plan are to:

1) Obtain water usage data from current equipment and operational practices representative of water use throughout Metro's maintenance divisions.

2) Identify reasonable, cost-effective water conserving strategies that can be replicated system-wide.

3) Provide appropriate economic analysis of the costs and benefits for water conservation strategies including substitution of non-potable water supplies.

1.3 Regulatory Framework

California has determined that the waste and unreasonable use of water is unconstitutional. Article 10, Section 2 of the California Constitution declares that the general welfare of the state requires that its water resources be put to beneficial use and that waste and unreasonable use of water be prevented. Consistent with that determination, the following statewide legislation has been passed, and requirements for their implementation mandated as part of the California Water Code and State Civil Code.

While these provisions generally are required for compliance by California water suppliers, their implementation will ultimately impact Metro's operations. Therefore, identifying and proactively implementing water conservation strategies will avoid any punitive measures that Metro's water providers may implement to achieve compliance. Additionally, conserving water has a direct relationship to economic performance. Saving water saves money and lowers Metro's costs of operations.

Water Use and Conservation Policy

Metro adopted a Water Use and Conservation Policy statement in July 2009 to conserve the use of potable water resources at its facilities in the most cost-effective and efficient manner. This policy ensures that Metro curtail the use of potable water only to essential services during periods when statewide water conservation measures are in effect, and also prohibits uses including:

- Use of water hoses to wash hard or paved surfaces;
- Continuous leaking of water from pipes or fixtures;
- Washing vehicles with hoses without self-closing water shut-off values;
- Irrigation during periods of rain or causing excess irrigation water to sheetflow;
- Irrigation between the hours of 9:00 A.M. and 4:00 P.M.;
- Irrigation of landscaping more than the required watering times;
- Irrigation of large landscaped areas where rain sensors are not installed; and
- Use of non-recirculating systems in new conveyor car wash systems.

The policy also describes the procedures for using potable water for pressure washing activities, construction, and new construction planning, integration of design practices established by the Leadership in Energy and Environmental Design (LEED) guidelines and operations.

Senate Bill x7 7

In November 2009, California passed Senate Bill X7 7 (Steinberg) requiring the state to achieve a 20 percent reduction in urban per capita water use by December 31, 2020. California will be required to reduce its per capita water use by 20 percent from the current statewide estimate of 192 gallons per capita daily (GPCD) to 154 GPCD, which would amount to an annual statewide savings of approximately 1.59 Million Acre Feet (State Water Resources Control Board et al. 2010). Each hydrological region in the state was given a water conservation target; the South Coast hydrologic region will be required to meet a target of 149 GPCD. The state would be required to make incremental progress towards this goal by reducing per capita water use by at least 10 percent on or before December 31, 2015. The bill requires urban retail water suppliers to develop final and interim urban water use targets.

The *20X2020 Water Conservation Plan* (State Water Resources Control Board et al. 2010) was prepared to guide the state's urban water efficiency and conservation opportunities for the next ten years and beyond, to achieve the 20 percent per capita reduction target. The plan promotes legislative initiatives to incentivize water agencies to promote water conservation, and creates evaluation and enforcement mechanisms to ensure regional and statewide goals are met. The plan applies to potable water use, including all residential, commercial, institutional, and industrial users as well as non-revenue water. Non-potable recycled water is excluded. The use of recycled water to augment surface supplies as well as municipal stormwater capture is considered a new supply option without specified use reduction targets.

Senate Bill 407

Pertinent elements of Senate Bill 407 (2009) enacted in February 2009, changed portions of State Civil Code to require the replacement of all non-water conserving plumbing fixtures, in commercial properties built prior to 1994 with water conserving fixtures by January 2019. All non-compliant fixtures are to be replaced as a condition for issuance of a certificate of final permit approval for all building alternations or improvements. Non-compliant plumbing fixtures are intended to mean the following: toilets using more than 1.6 gallons per flush (gpf); urinal using more than 1.0 gpf; shower heads using more than 2.2 gallons per minute (gpm); and interior faucets using more than 2.2 gpm.

2. Existing Metro Service System

2.1 Metro Transit Network

In April 1993, the California State Legislature created Metro through the merger of the Los Angeles County Transportation Commission and the Southern California Rapid Transit District. Metro is responsible for operating the clean air compressed natural gas (CNG)-powered Metro bus fleet, Rapid Bus lines, and Metro's Rail Lines. In addition to its operating functions, Metro funds and constructs multimodal transportation solutions throughout Los Angeles County (Metro 2009a).

Metro's Rapid Bus program provides service throughout Los Angeles County, and since December 2000 has expanded to operate along 20 corridors to carry over 185,000 passengers daily (Metro 2009a). Metro operates a total of 11 bus divisions throughout the County. The total Metro fleet includes 2,635 buses, of which 129 are diesel powered and 2,506 are CNG powered. On average 2,261 buses are in service during the weekday.

Metro's Rail Lines operates out of 62 stations and covers over 79 miles of track. Operations include the Purple, Red, Blue Green, and Gold lines. Approximately 260,000 passengers use Metro's rail service each weekday. During the heavy peak travel times, there are as many as 250 trains operating throughout the system. Metro employs over 1,100 persons including train operators, mechanics, track engineers, clerks, and safety inspectors as part of the rail program (Metro 2009a).

Metro's 2009 ridership activity for its rail and bus activities are provided in Table 1.

Table 1. 2009 Ridership and Vehicle Revenue Hours

	Heavy Rail	Light Rail	Motor Bus (Directly Operated)	Motor Bus (Purchased)	Vanpool (Purchased)	METRO Total	Rail Total	Bus &Van Pool Total
Unlinked Passenger Trips	47,453,332	44,087,245	358,090,027	12,895,867	2,602,003	465,128,474	91,540,577	373,587,897
Vehicle Revenue Hours	262,017	393,755	7,026,975	496,904	422,155	8,601,806	655,772	7,946,034

In addition to the bus and rail facilities, Metro's Gateway Headquarters (Gateway) is located at One Gateway Plaza near Union Station. Gateway houses an estimated 1,800 employees and is the center of Metro's administrative and support services.

2.2 Water Use and Trends

The following information was taken from the *Towards a Sustainable Future: June 2009 Baseline Sustainability Report* (Metro, 2009b) and *Moving Towards Sustainability: 2010*

LACMTA Sustainability Report (Metro, 2010), which found that Metro's water use is growing at a faster rate than increases to transit service, and water consumption reductions are necessary in order to maintain cost effectiveness. The analysis provided in the report looked only at Los Angeles Department of Water and Power (LADWP) accounts (water bills), which comprise the majority (approximately 65 percent) of Metro's water use. LADWP 2008 water rates were used in the calculation and analysis of water savings and water costs for this report. In 2009, Metro used 25 percent more water from LADWP than in 2002, and 10 percent less compared to 2008, but Metro revenue hours increased only 6 percent in that time (Metro, 2010). Water costs increased nearly 28 percent from 2002 to 2009; more than $1 million on LADWP water in 2009. See Figure 1 below for a graphical representation of changes in water use.

Figure 1. Changes in Metro Water Use (2002-2009); [Metro 2010]

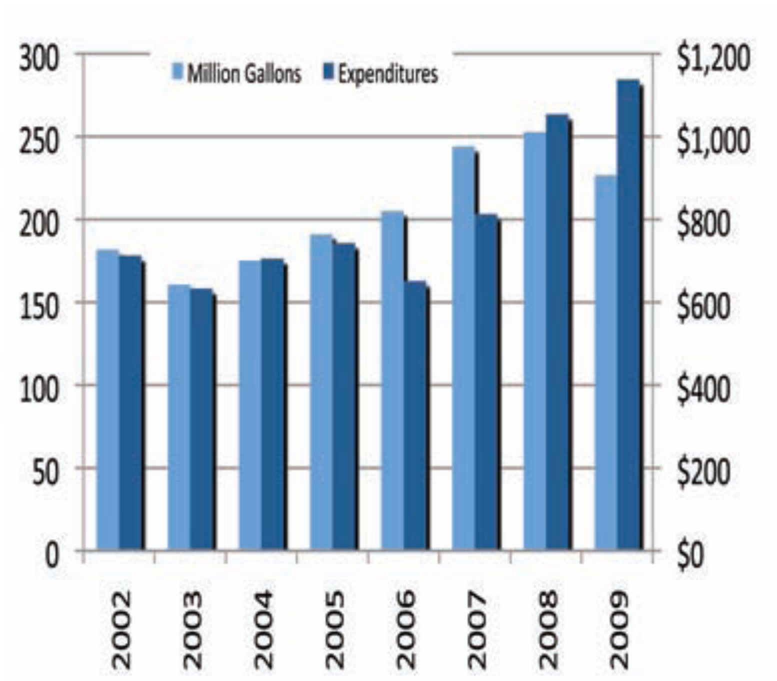


Figure 2 and Figure 3 illustrate LADWP water use in gallons per revenue hour and gallons per boarding over the period 2002 through 2009.

Figure 2. Gallons Per Revenue Hour (2002–2009); [Metro 2010]

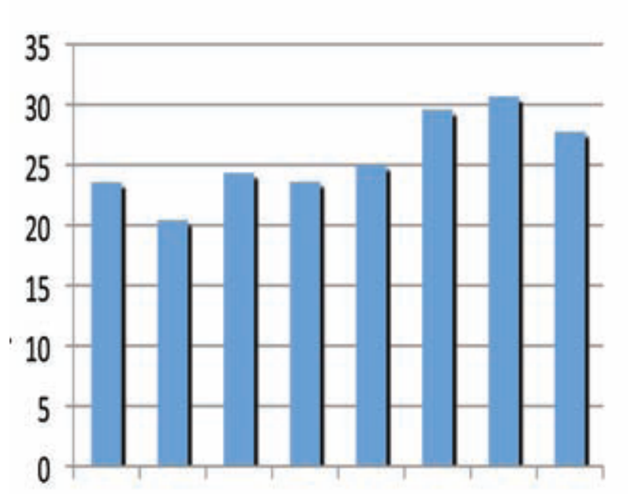
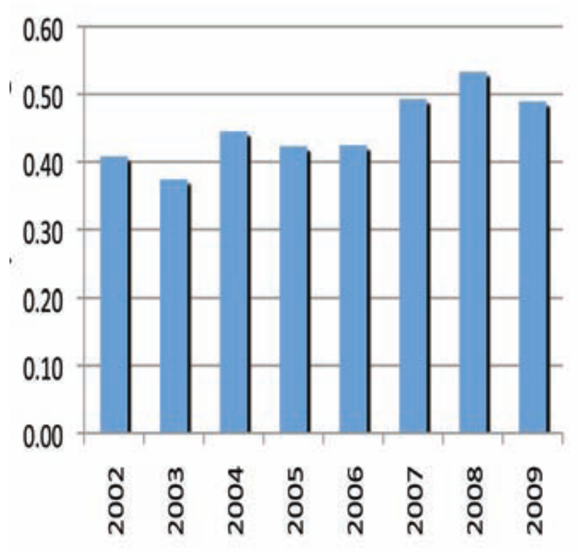
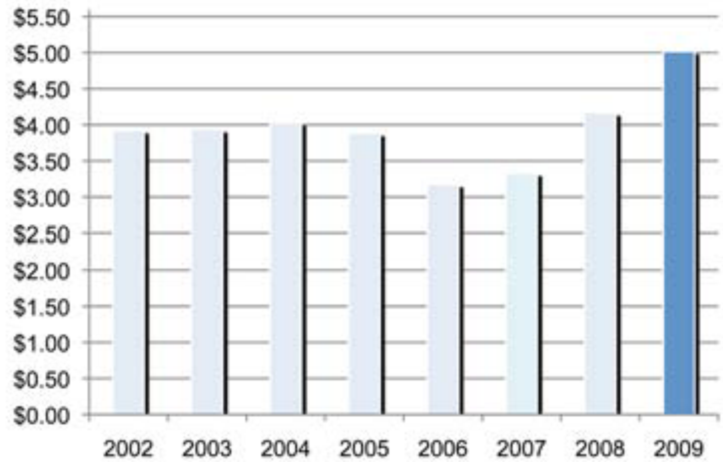


Figure 3. Gallons Per Boarding (2002–2009); [Metro 2010]



Between 2002 and 2009, the average water cost per gallon grew about 28 percent; overall water use increased by only 25 percent resulting in a total water expenditure increase of 60 percent. Sewer expenditures increased 10 percent in that time. In 2002, Metro spent $713,000 on water and $539,000 on sewer (adjusted for inflation). In 2009, Metro spent more than $1 million on water and $590,000 on sewer, which translates to a real dollar increase of $425,000 on water and $51,000 on sewer. The added cost was attributed to Metro's growing consumption and the increasing cost of water. After adjusting for inflation, the average cost of water grew 28 percent between 2002 and 2009 (does not include sewer costs), which is continued to increase (Metro 20010). Figure 4 illustrates the rising cost of water between 2002 and 2009.

Figure 4. Average LADWP Water Cost per Thousand Gallons—2009 Dollars (2002–2009); [Metro 2010]



In 2009, daily division water use varied from a low of 1,300 gallons at Division 12, to a high of 56,000 gallons at the Gateway Headquarters. Average daily water costs varied between $14 (Division 12) and $279 per day (Gateway) (Metro 20010). Figure 5 and Figure 6 present water use and expenditures at major Metro facilities.

Figure 5. Average LADWP Daily Water Use in Gallons by Major Facility (2009); [Metro 2010]

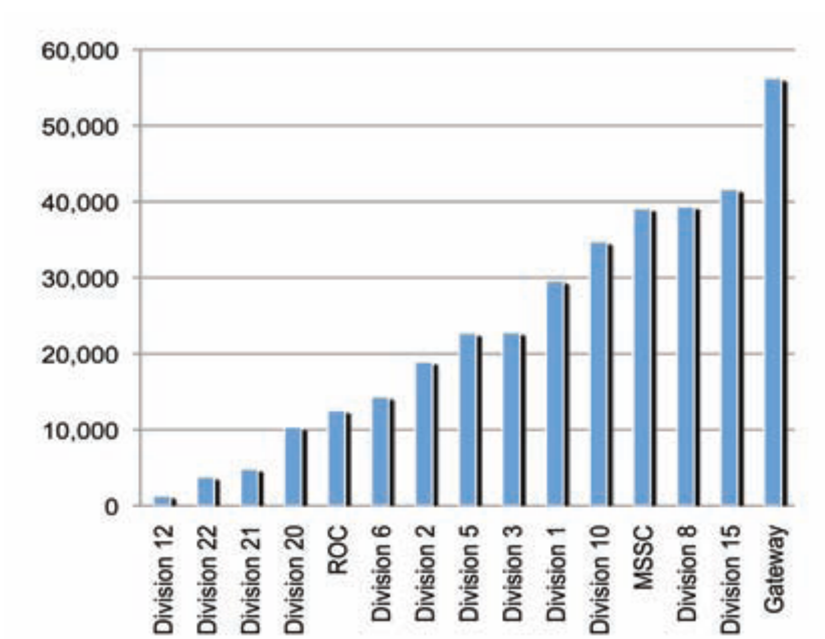
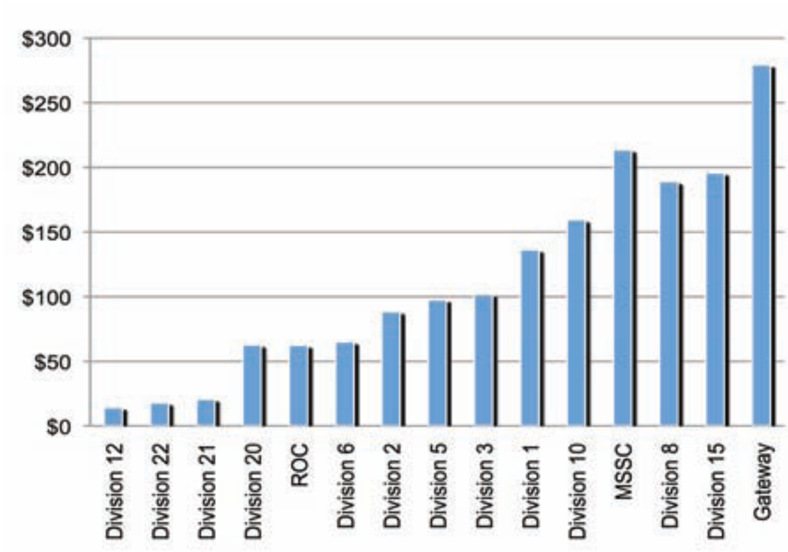


Figure 6. Average LADWP Daily Water Expenditures by Major Facility (2009); [Metro 2010]



2.3 Existing and Planned Water Conservation Measures

Metro has been making introductory installation of waterless urinals, low-flow toilets, and high efficiency faucets at several divisions. Metro is actively replacing all non-conserving faucets, urinals and toilets at the Gateway Headquarters. Metro continues to install conservation features as part of standard retrofits and has taken several steps to proactively reduce water consumption throughout all of its operations (Metro 2009c) per the Water Use and Conservation Policy.

3. Data Collection and Analysis

3.1 Methodology

The water conservation and potable water replacement strategies have been developed based on the following methodology:

- Observations of Current Operations and Equipment
- Initial Assessment of Operations, Equipment Water Use and Water Billing Records
- Data Logging of Actual Water Use
- Analysis of Logged Water Use Data
- Application of Results

The following terms used throughout this Plan have specific meaning related to the observations and strategy development for water conservation:

- **End-Use:** The point, facility or piece of equipment where water is actually used. Examples of typical end-uses are toilet flushing, sinks, urinals, bus and rail car washing bays.
- **Data Logging:** The process for acquiring information on the actual use of water.
- **Disaggregation:** The process of segregating out the data associated with each of the individual uses of water recorded at a single point.
- **Flow Trace Wizard:** The software used to read the acquired data and assist in the process of disaggregation into each end use recorded.
- **Meter:** The water meter or meters installed and operated by the water provider through which a site receives its total water supply.
- **Sub-Meter:** Additional meters set by this project to better isolate the water use by a specific piece of equipment or end-use.
- **Water Purveyor:** Suppliers of water to Metro**:** In this study the two water purveyors are LADWP and the California Water Company (Cal Water).
- **Recycled Water:** Term used to define municipal recycled water, a non-potable supply of water originating as municipal wastewater, that has been cleaned to standards established by the State and may be made available for a variety of uses including irrigation, bus and rail car washing.

Observations

Relevant data was collected to develop a comprehensive understanding of existing water use at selected divisions. Data review included Cal Water and LADWP billing records and plumbing as-built diagrams. After reviewing relevant data, onsite interviews with facility managers to discuss water conservation opportunities within the sites; verify major water using equipment, operational practices and behaviors; administrative procedures, obtain loading data and catalogue information of major maintenance equipment; and inform managers of the Plan in order to solicit feedback.

Initial Assessment

Metro identified two divisions as representative of the equipment and operations for rail and bus maintenance facilities. Bus Yard Division 18 (D18) and Rail Red Line Main Yard Division 20 (D20) were selected by Metro for discrete and focused logging of water use. A complete physical site investigation and screening of the selected divisions was conducted on February 9 and 10, 2010 to confirm suitability of existing water meters for data logging; identify all major end uses of water; review all aspects associated with water use at the sites; confirm the facility fence line relative to water use and discharge; inspect installed equipment and sub-metering opportunities; observe site activities to understand current operational standards; and identify and review associated regulatory constraints.

Coordination with purveyors of alternative water supplies confirmed their availability to Metro, discussed supply reliability and water quality consistent with Metro's requirements for bus and rail cleanliness.

Data logging was conducted at the selected sites. Through the review of relevant data, and from the information obtained during the site visits, a plan was prepared for field deployment of data logging equipment.

Data Logging

Field data logging was conducted over a two-week period during typical division operations to provide information on the timing and volumes of water by end-use. An end-use of water refers to the point at which a given piece of equipment places water into use. Typical end-uses are sinks, toilets, bus washing equipment, etc.

Data Analysis

Statistical analysis of logged data was performed to verify sample representation. Since the use of water is measured at either the main water meter or installed sub-meters, the logged data may represent many uses occurring simultaneously. It is therefore necessary to disaggregate the recorded or logged meter data into its various end-uses. The disaggregated data was used to determine daily total water use for selected divisions. Data provided in this report includes:

- Total metered water use at the sites;
- Data from the data loggers summarized on a daily basis to show total daily water use for the site with descriptive statistics; and
- Normalized daily use by cars or buses washed.

Application of Results

Based upon the review of logged water data at the selected divisions, water conservation strategies were developed to identify the greatest potential water savings opportunities. A cost benefit analysis was developed for each of the water strategies to determine its financial feasibility. Cost-benefit analysis is a commonly used financial tool for evaluating projects to determine if a given project will result in benefits above its proposed costs. Cost-benefit analyses commonly calculate the net benefits, or total benefits minus total costs, to determine if the net benefits of a given project are positive. Another commonly used metric is the benefit-cost ratio, or the total benefits divided by the total costs. A benefit-cost ratio greater than 1 suggests that a project will result in benefits over and above its proposed costs.

In order to compare the costs and benefits of a project, cost-benefit analysis involves calculating the net present value of a project's costs and benefits, or the sum of the present values of the cash flows for both benefits and costs. Calculating the present value of cash flows, and thus the net present value of costs and benefits, requires information on the length (i.e., number of years) of the project and the suggested discount rate. A discount rate is used in recognition of the fact that a dollar in future years is not worth the same as a dollar today. The choice of a discount rate is subjective, though the U.S. Office of Management and Budget (OMB), in its guidance for conducting regulatory analyses (OMB Circular A-4), suggests using discount rates of 3 percent and 7 percent for calculating net present values.

For the purpose of conducting cost-benefit analyses of the proposed water conservation strategies, the costs and benefits of the different measures were estimated. The benefits of the strategies are calculated from the water savings that result from using recycled water based upon the current costs of potable and recycled water. These benefits are expressed as an annual avoided cost (i.e., savings) of water from installing and using a given strategy. Costs of the strategies result from upfront capital costs and annual operation and maintenance (O&M) costs. It was assumed that the capital costs would accrue in the first year, and the O&M costs would accrue annually. For the cost-benefit analyses of the strategies, a 40-year time horizon and a 5 percent discount rate was assumed. Using these parameters, the net benefits and benefit-cost ratio for the proposed water conservation strategies were calculated.

Capital or construction costs and O&M cost were estimated based on experience with similar projects and estimates provided by equipment vendors. The economic analysis was presented in business case terms considering the water savings for each strategy per revenue hour for the bus and or rail system.

3.2 Water Use Analysis

Metro identified two sites (D18 and D20) as being representative of the typical facilities and operational facilities throughout the system. Gateway Headquarters is the largest water user at Metro; therefore a preliminary evaluation of water use at Gateway was also conducted.

Facility Profile (Division 18)

D18 was selected by Metro for data logging because it represents a typical Metro Bus Division given water using equipment and operation. Potable water is provided to Division 18 by Cal Water. This general description of D18 equipment and operations is based upon information collected during staff interviews and a physical site investigation and water fixture review conducted on February 9, 2010.

D18 is located in Carson, California, at 450 West Griffith Street, and was constructed in 1984. D18 serves as a bus maintenance and washing facility, and employee break station. Maintenance repair is performed for roughly 30 buses per day; buses are serviced every 3,000 miles or approximately every 6 months. Approximately 2,000 buses are washed per day throughout all of Metro bus facilities, and roughly 180 buses are washed per day at D18. Based upon discussions with staff, bus washing typically occurs between 5:30 P.M. to 2:00 A.M. and most frequently between December and April.

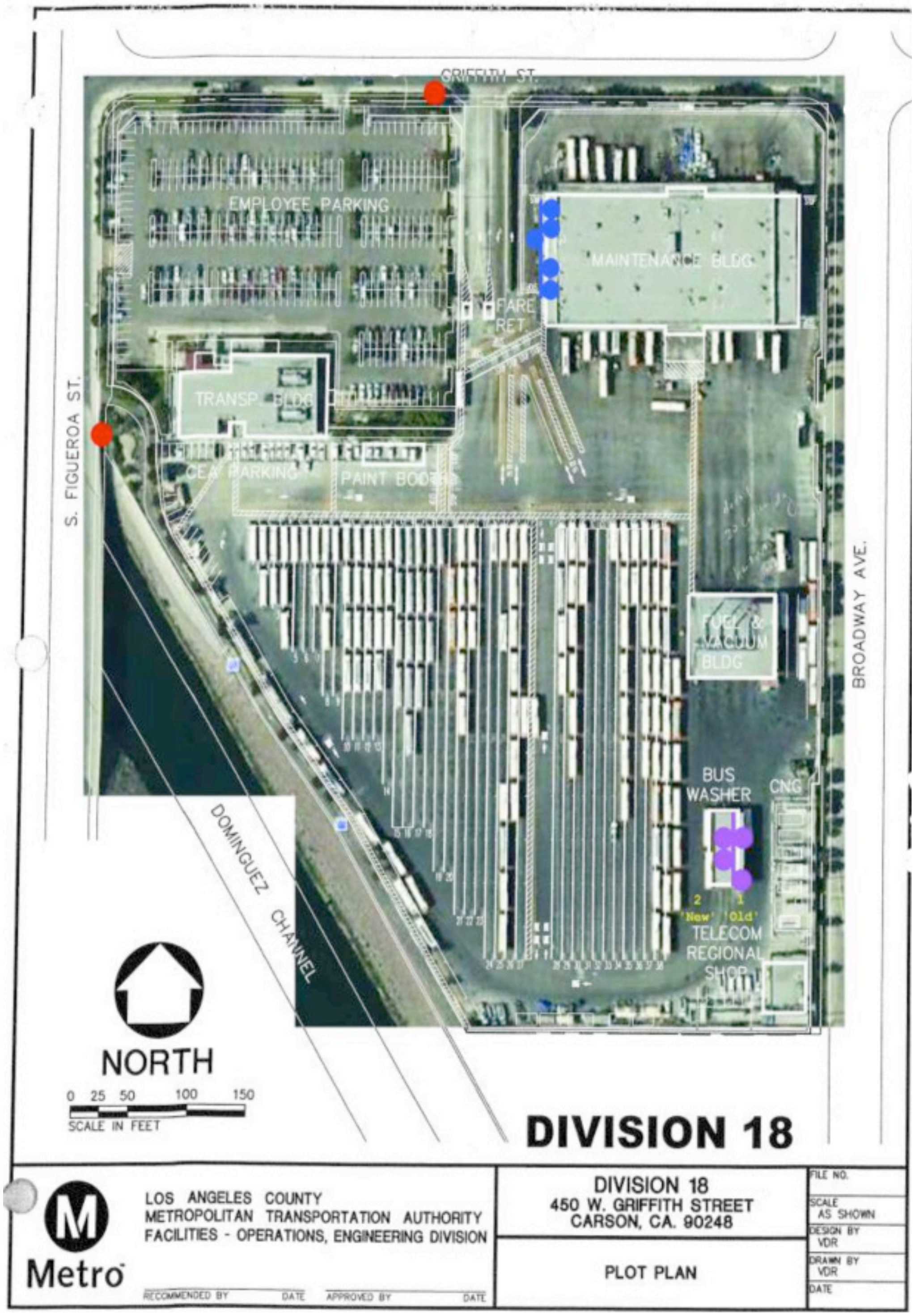
There are approximately 600 employees stationed at D18; operators have a 4-5 hour shift and return to D18 for a 2- to 3hour break before returning to work. Employees typically work three shifts, seven days per week.

D18 facilities (from north to south) are:

- A maintenance building where the majority of the bus maintenance activities occur;
- A transportation building that provides services for off duty employees and administrative offices;
- A fuel and vacuum building used for bus detailing and interior bus washing;
- Two exterior bus washing facilities (bays); and
- A telecom regional shop housing staff offices.

There are no evaporative cooling facilities at D18. Figure 7 presents a layout of D18 facilities and locations of water meters.

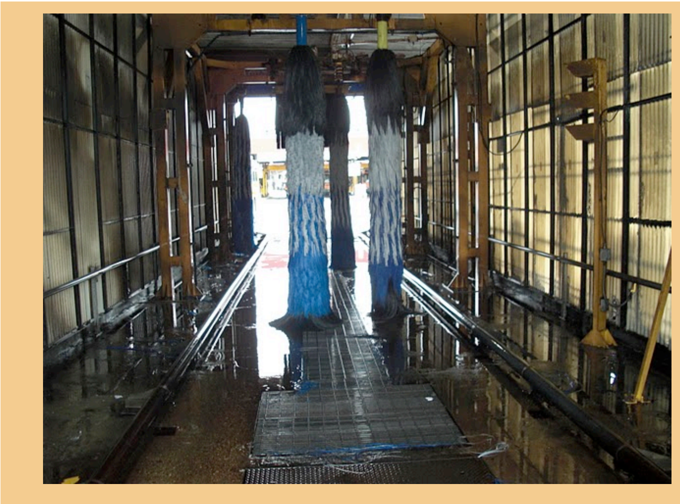
Figure 7. Aerial Division 18 with meter locations



(red)	Cal Water meters
(blue)	Steam wash sub-meters
(purple)	Wash bay sub-meters

Bus Washing Facility

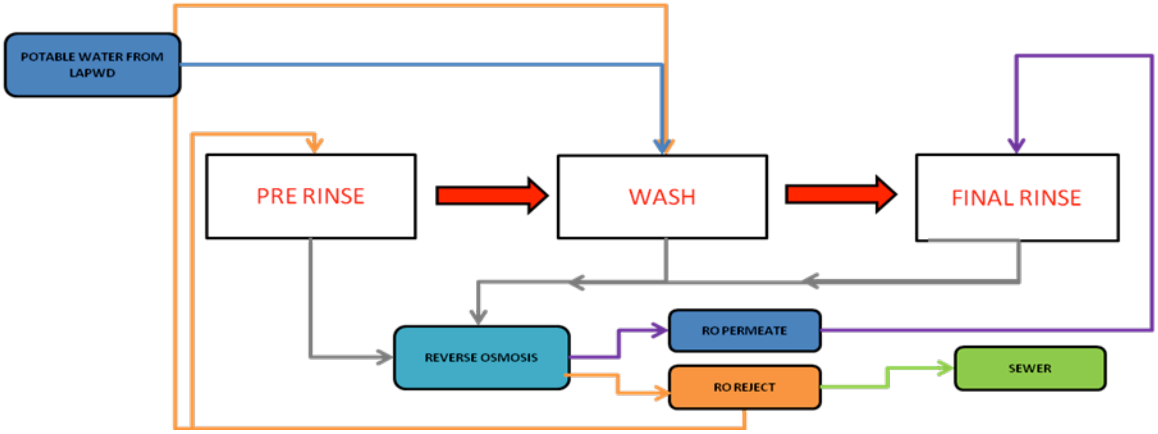
The bus washing facility consists of two bus wash bays (Washer 1 and Washer 2) located on the south side of D18. The second bus washing facility (Washer 2) at D18 was constructed in



2008; however, during the data logging period Washer 2 was used less often than Washer 1. Most Metro Bus Divisions have one bus washing facility, with the exception of Divisions 5, 8, 9, 10, and 18.

Figure 8 presents a schematic of the bus washing process. Bus washing consists of a pre-wash, wash, and final rinse. Both Washers include an on-site reclamation system that captures runoff water for reuse in the wash process, and a reverse osmosis (RO) filter that cleans the water for use in the final rinse. The RO filters reduce the Total Dissolved Solids (TDS) in the water to produce a pure water (permeate) that is low in minerals to prevent water spotting after the final rinse. As part of the RO process, the RO filters discharge mineral water (referred to as reject) that is plumbed back into the bus wash process and is reused for washing. After a bus has been washed, water drains through the grated floor to a clarifier for capture and recycling; however only a portion of runoff from the bus washing facilities reaches the clarifiers as the run-out areas do not extend far enough to capture all of the drainage.

Figure 8. Schematic Bus Wash Water Flow Diagram



The newer design of Washer 2 uses fewer pumps, different clarifiers, and a different layout than Washer 1.

Maintenance Building

The largest end uses of water at the maintenance building are the steam pressure washer (Whitco Cleaning Systems), small parts cleaner (Insta Clean Small Parts Washing Unit), under carriage washer (Chassi Jet), and hot water pressure washer (Hydrotek). The steam pressure washer is used to degrease and clean engines and equipment. The steam pressure washer has no auto shut off valve and is operated intermittently throughout the day; it uses approximately 10 gpm when in operation. The small parts cleaner is on a cycle/timer and runs on demand. The under carriage washer has a cycle operation, is used on-demand and infrequently. Due to the high content of solids and grease, the wash water at the maintenance facility is impractical to recycle.

Approximately 150 employees work at the D18 maintenance building. The maintenance building includes men's and women's locker rooms, kitchens, and bathrooms that contribute to the water use in the facility. Individual point-of-use cartridge filters are deployed throughout the maintenance building for on-site improvement of potable water.

Table 2 presents a summary of water end use fixtures located at Division 18.

Table 2. D18 Water Fixture Data

	Toilets/Urinals (1)	Sinks (2)	Showers (1)	Other Water Features
Women's Facilities				
Locker Room - Maintenance Building	3 toilets	3	1	
Restrooms – Maintenance and Transportation Buildings	4 toilets (1.6 gpf)/ 2 toilets	6	1	
Men's Facilities				
Locker Room - Maintenance Building	3 toilets/ 4 urinals	2	2	
Restrooms – Maintenance and Transportation Buildings	4 toilets/ 3 urinals/ 4 waterless urinals/ 5 toilets (1.6 gpf w/ dual flush)/ 1 urinal (less 1 gpf)	11	2 (manual shut off)	
Kitchen (Maintenance Building and Transportation Building)		2		1 ice machine/ 1 commercial beverage vending machine

Table 2. D18 Water Fixture Data (continued)

	Toilets/Urinals (1)	Sinks (2)	Showers (1)	Other Water Features
Break Room/Office (Maintenance Building and Transportation Building)		2		1 ice machine
Janitor Closet (Maintenance Building and Transportation Building)		2		
TOTAL	12 toilets/ 9 toilets (1.6 gpf)/ 7 urinals/ 1 urinal (less than 1 gpf)/ 4 waterless urinals	28	6	2 ice machines/ 1 commercial beverage vending machine

Notes:

(1) Except as otherwise noted, all restrooms are equipped with pre-1986 toilets, urinals and shower heads

(2) All utility sinks are manually operated and not equipped with infrared sensors or foot pedals.

Transportation Building

The transportation building primarily services off duty employees and houses administrative offices. Individual point-of-use cartridge filters are deployed throughout the transportation building for staff use.

Fuel Station

The fuel station is used for bus detailing and internal washing. Internal bus washing is performed using towels and mops, and is considered a low water use. Approximately 20 buses are serviced at the fuel station per day. Metro currently uses an offsite laundry service for cleaning, and is considering purchasing an onsite washing unit.

Landscaping

Division 18 has minimal ornamental landscaping around the perimeter of the site, which is irrigated by spray irrigation. Several broken sprinklers were observed around the site at the time of the evaluation.

Data Logging Results and Analysis (Division 18)

An initial site review and plumbing inspection of Division 18 was performed to determine existing main and sub-meter locations and appropriate locations for data logging equipment. This section presents a review of the historical water use at D18 and the results of the data logging effort at the sub and main meters.

There are two active Cal Water meters at D18 presented in Figure 10. The steam pressure washer and small parts cleaner at the maintenance building, and the bus wash bays are supplied from the main meter, along with other site uses such as indoor (office) and miscellaneous uses. Meter locations for two Cal Water meters, six (one fixed, five temporary) maintenance building submeters, and seven (2 fixed, 1 temporary at Washer 1, and 2 fixed, 3 temporary at Washer 2) bus wash sub-meters are shown in Figure 10.

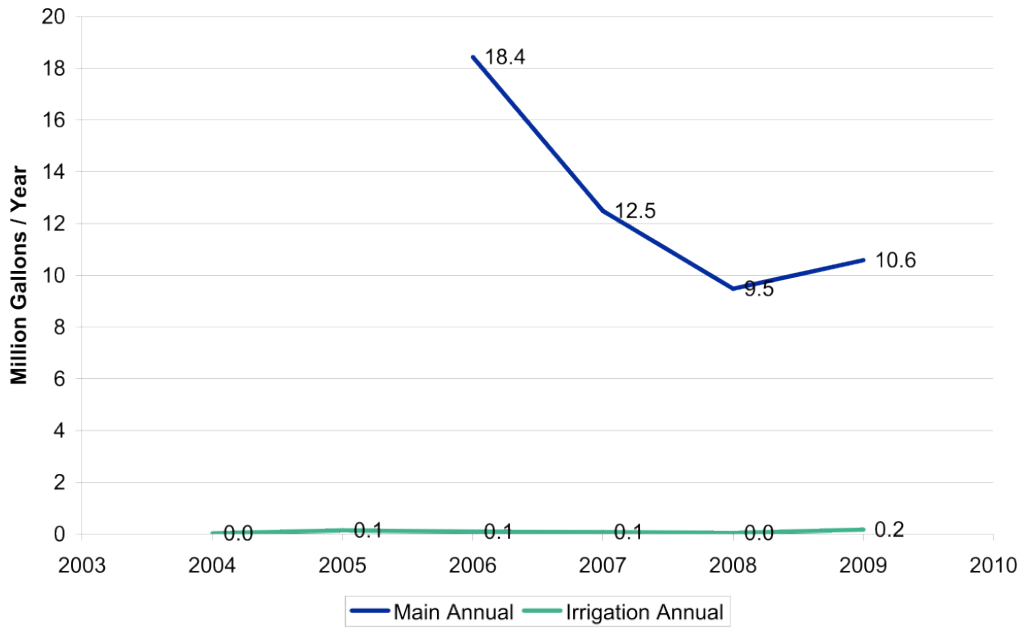
Cal Water meter identification and meter readings are presented in Table 3 . The main meter (3" x 4" Precision-brand) located on Griffith Street delivers all of the process water used at the site. This meter recorded an average water use of 28,992 gallons per day (gpd) in 2009. Some irrigation along the west of D18 flows through a separate meter (Badger 70 1") along S. Figueroa Street, which recorded an average use of 475 gpd of water in 2009.

Table 3. D18 Cal Water Meters and Annual History

Approximate Street Address	Account Number	Make and Model	2008			2009		
			Gallons	AF	GPD	Gallons	AF	GPD
D18 Main:								
450 W Griffith St, Gardena, CA 90248	5939300000	Precision 3" x 4"	9,481,648	29.1	25,977	10,581,956	32.5	28,992
D18 Irrigation:								
Figueroa Bridge & Dominguez Channel Carson CA	5482966523	Badger 70 1"	41,140	0.1	113	173,536	0.5	475
		Facility Total:	9,522,788	29.2	26,090	10,755,492	33.0	29,467

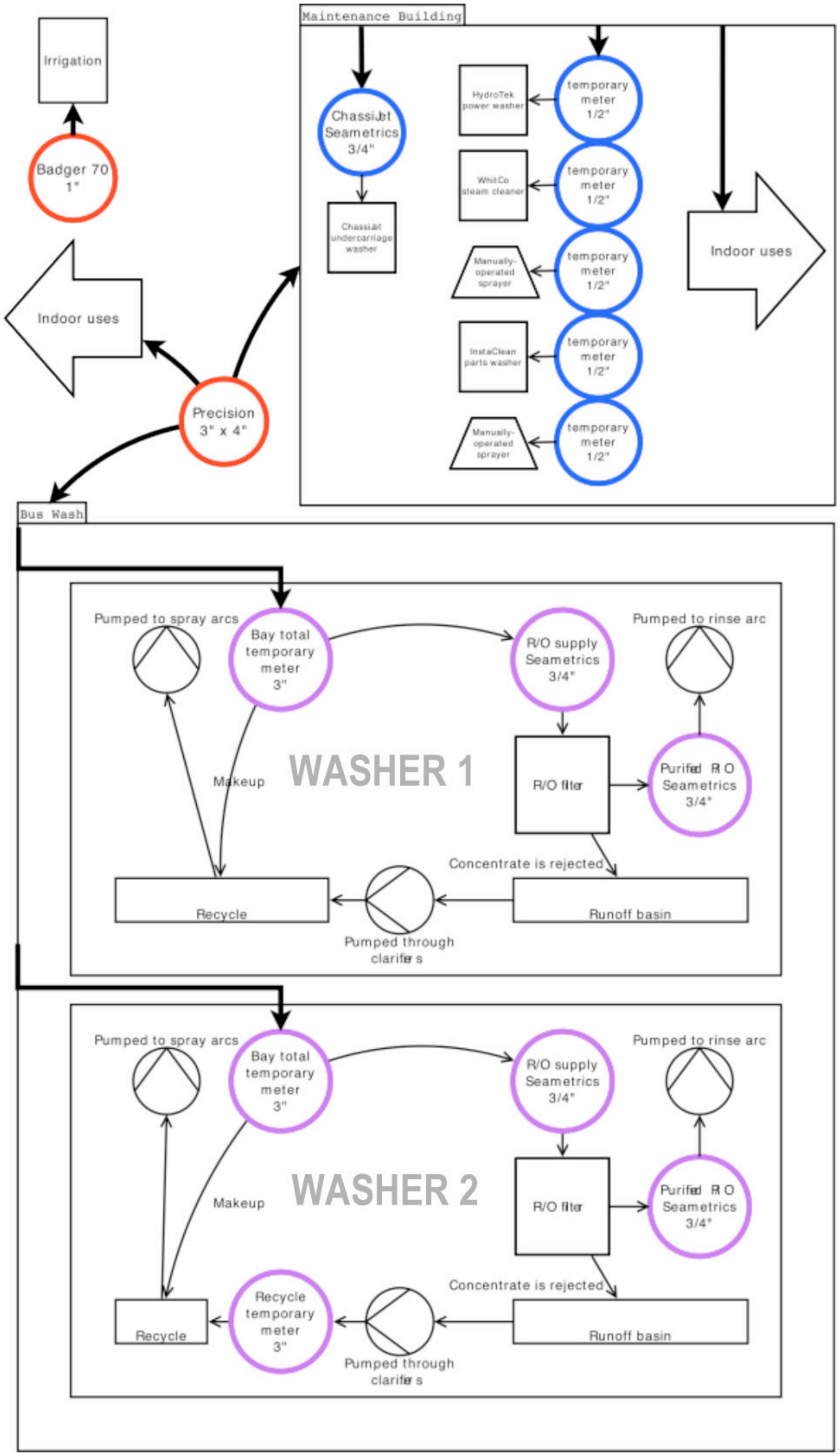
Figure 9 shows historical usage for the above mentioned meters with a decreasing trend since 2006, from a recent annual high of 18.5 million gallons (Mgal) to the latest 10.7 Mgal in 2009. Metro staff provided the following explanation for the observed decrease: the bus wash recycling system was disabled before early 2007 when bus wash controls were repaired; leaking underground lines were repaired in 2007; and a new steamer with timer shut-off control (manual start timer) was installed in April 2007, replacing a model without an automatic shut-off.

Figure 9. D18 Historical Billed Use



The Cal Water meter (Precision 3"x4") along Griffith Street measures all of the water flowing into the site. As part of the data logging effort, sub-meters (Seametrics) were installed to monitor flow at the major water using facilities (i.e., maintenance building, bus wash bays) using the main Cal Water meter. A total of five sub-meters were installed, one at the under carriage washer and four at the bus wash bays, as shown in Figure 10. These meters were installed on April 8, 2010 along with eight temporary meters that were removed April 20, 2010.

Figure 10. D18 Existing and Installed Meter Layout

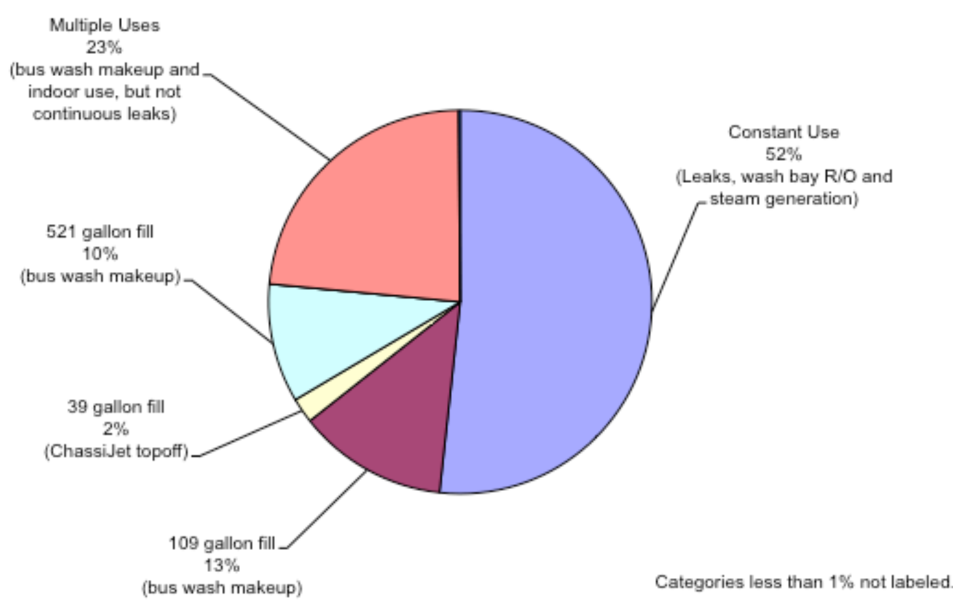


Daily Disaggregated Operations

Based on repeating flow patterns through the main meter, water use was disaggregated into discrete events using TraceWizard software. Flow trace analysis allows identification of specific water use events based on their flow and volume characteristics. These events can then be linked to specific water using devices (end-uses) in the facility through more detailed on-site auditing.

Discrete flow events for all end-uses of water were categorized based on flow rates, duration, and time-of-day. In general, these characteristics identify certain equipment and often a small number of fixtures account for a majority of the water use. Limitations to this technique arise when equipment is used simultaneously, which tends to mask the individual events. For example, simultaneous events flowing at variable rates will appear in combination as a single event at a high flow rate. Disaggregating simultaneous events may result in a mixed-use category where no further disaggregation is possible. Figure 11 presents the disaggregated water use by volume.

Figure 11. Disaggregated Water Use Summary by Volume



Some observations about the flow trace data collected at D18:

- No uses are characteristic of evaporative cooling.
- Constant use averages 825 gallons per hour (gph) (13.8 gpm), with relatively little influence from the number of vehicles washed. Based on the facilities on site, the constant use is believed to be RO draw, steam generation or other unaccounted for use. This flow may be masking the presence of a leak.
- Two categories of filling events, 109 gallons and 521 gallons on average, are highly influenced by the number of vehicles services. These events are likely make-up fills for the bus wash systems. These events would be part of the bus wash make-up sub-metering above.
- Filling events averaging 39 gallons occur throughout the day and account for 2 percent of the daily flow. Based on the facilities on site, these are either the under carriage washer or makeup fills for the bus wash system.
- The Multiple Uses category contains events that cannot be individually distinguished, and includes proportions of all other uses (i.e., bus wash make-up or indoor use) except constant flow. This appears to be very highly influenced by the number of vehicles washed throughout the day; uses contributing to this category are almost certainly bus washing equipment.
- TraceWizard distinguished a few toilet flushes at an average of 3.3 gpf. Compared to the major uses on site, most toilet use is likely indistinguishable in the Multiple Uses category. Indoor water use was not separately measured as part of the data logging effort.

Table 4 shows the daily water use recorded during the logging period for the main meters at D18, disaggregated to the extent possible.

Table 4. TraceWizard Analysis on D18

			Duration (seconds)			Volume (Gallons)			
	Events	Total Gallons	Average	Standard Deviation	Highest Flow Rate GPM	Min	Max	Average	Standard Deviation
Constant		217813.5			220.7				
109 gal fill	486	53174.3	117.2	29.9	167.1	66.6	173.4	109.4	22.1
39 gal fill	230	8955.7	54.0	24.2	104.1	15.0	68.1	38.9	9.8
521 gal fill	81	42182.3	268.1	95.6	519.2	189.1	943.0	520.8	131.2
Leak	65	16.7	70.6	36.9	0.3	0.0	0.9	0.3	0.2
Multiple Uses	1587	98342.3	111.9	133.7	199.7	0.3	725.5	62.0	111.4
Toilet	182	592.5	14.3	12.0	29.4	2.4	6.4	3.3	0.9

The 2009 historical average daily water use at D18 was approximately 38,232 gallons. The majority of water was used for bus washing, but there was a small amount used in the maintenance building for pressure washing and parts washing. During the logging period a total of 1,943 buses were washed (1,561 at Washer 1 and 382 at Washer 2). Taking into consideration recycling that occurs at D18, typical use of potable water per bus ranged from 157 to 212 gallons per bus, which substantially reduces water use per bus ratio.

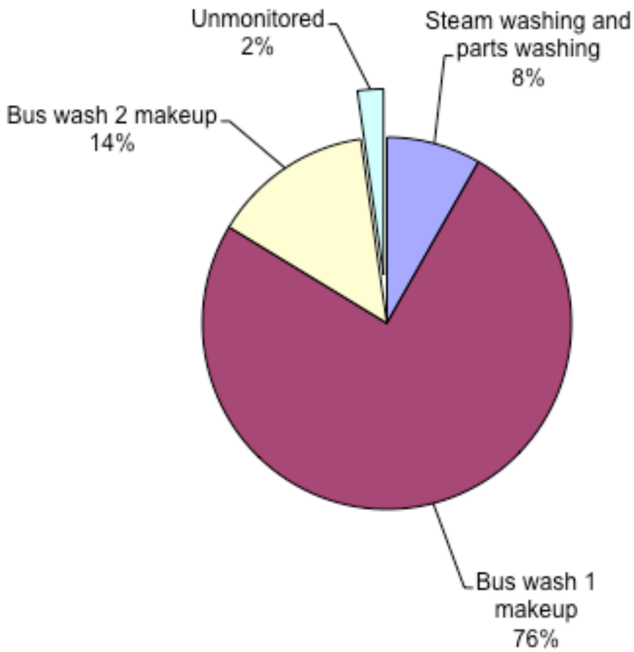
A fairly constant flow of 825 gph was also noted on the flow trace analysis. This is a substantial amount of water, and should be investigated to determine if it consists of leaks or other constant uses that could otherwise be eliminated. The toilet flushes that can be identified on the flow trace analysis appear to be 3.5 gpf toilets, which could easily be replaced along with shower and faucet aerators.

During the data logging period, the main meter recorded an average of 38,232 gpd with the irrigation meter shut off. This is approximately 10,000 gpd higher than the historical 2009 daily average. Sub-meter flows account for 98 percent of the main meter flow. Facility totals for the study period are shown in Table 5 and Figure 12.

Table 5. Average Daily Data Logging Totals (April 8 to April 20, 2010)

Meter	Ave Logged Use (gpd)	Percent of Total (%)
Bus Wash 1	29,082	76%
Bus Wash 2	5,389	14%
Maintenance Building steam and parts washing	3,169	8%
Unmonitored, including indoor use at Maintenance Building	592	2%
Main	38,232	100%

Figure 12. D18 Logged Use by Facility



D18 Bus Wash Facility

Approximately 1,943 bus washes were observed during the data logging, which provides a good understanding of the water use for bus washing. Dual bus wash bays on the south side of D18 account for 90 percent of water use at this site. Both bays include a recycle system, as well as RO filters that produce purified water. Reject water from the RO system is recycled to the storage tank and used as part of the initial wash water. Therefore, as long as the capacity of recycled water storage is not exceeded, the RO units do not create extra process water demand. Depending on the capacity of recycled water storage, the RO filter does not necessarily create extra process demand because the high mineral content water removed from the RO system (referred to as reject) is recycled to the storage tank and used as part of the initial wash water.

Water used for washing is a balance between recycled water, which can accumulate grit and suspended solids that limit effectiveness, and fresh make-up water. Total water use refers to the volume pumped through spray arcs, and make-up refers to the demand to replace lost recycled water with fresh water. Water used for rinsing is a balance of potable water, which can leave spots on the finish, and RO product water. Overall, total water used cannot be entirely drawn from the recycle system; some fresh water will ordinarily be consumed with this design.

RO filters produce pure water (referred to as permeate or product water) and mineral reject water from incoming water supply. During the logging period, the RO rate at both wash bays was between 24 and 27 percent, which means for every gallon of permeate, about 3 gallons of reject are produced. The permeate is pumped to and stored in a tank, while the reject is discharged into the recycle system to be reused for washing.

It is important to note that subsystems on each bus wash can be controlled by individual valves. At the beginning of the data logging effort, the RO systems were both active. Patterns of use by the maintenance staff observed during the logging period suggest the preference for Bay 1 over Washer 2. At the beginning and end of the logging period, Washer 2 was apparently closed for maintenance; it was unclear whether this is representative of longer-term use.

Vehicle counts were collected based on control circuit activity. There are two bus models washed at D18: articulated three-axle buses and smaller two-axle buses. The method of vehicle counting did not distinguish between models.

Wash Washer 1

Washer 1 is the older of the two wash bays. During the logging period, Washer 1 accounted for 81 percent of all buses washed. Two fixed meters were installed on this system, and one temporary meter was used during the logging period. Meters monitored total make-up water to Washer 1, total water to the RO filter, permeate produced by the RO filter, along with pump duty cycles and vehicle counts. An average of 270.1 gallons per vehicle is used, of which 211.9 gallons (79 percent) comes from potable make-up and 58.2 gallons (21 percent) is recycle. Of the water delivered through the meter, 91 percent is used directly for wash water make-up and 9 percent goes to the RO system, as shown in Figure 13.

Figure 13. Washer 1 End-Uses for Portable Makeup Water

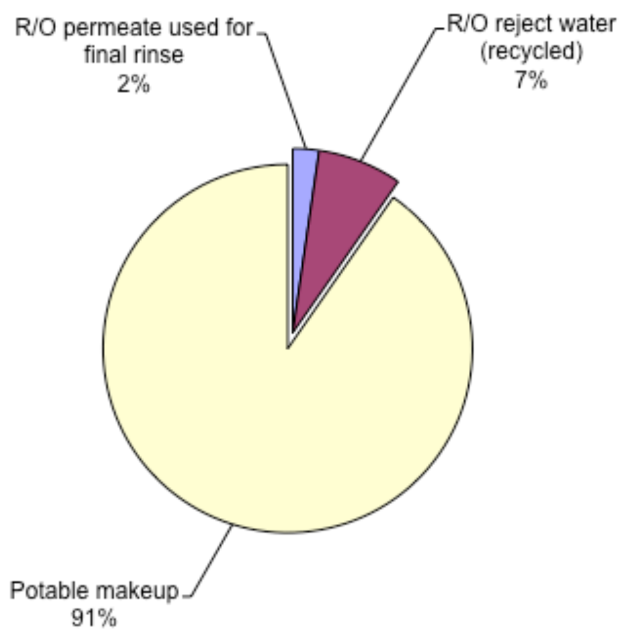


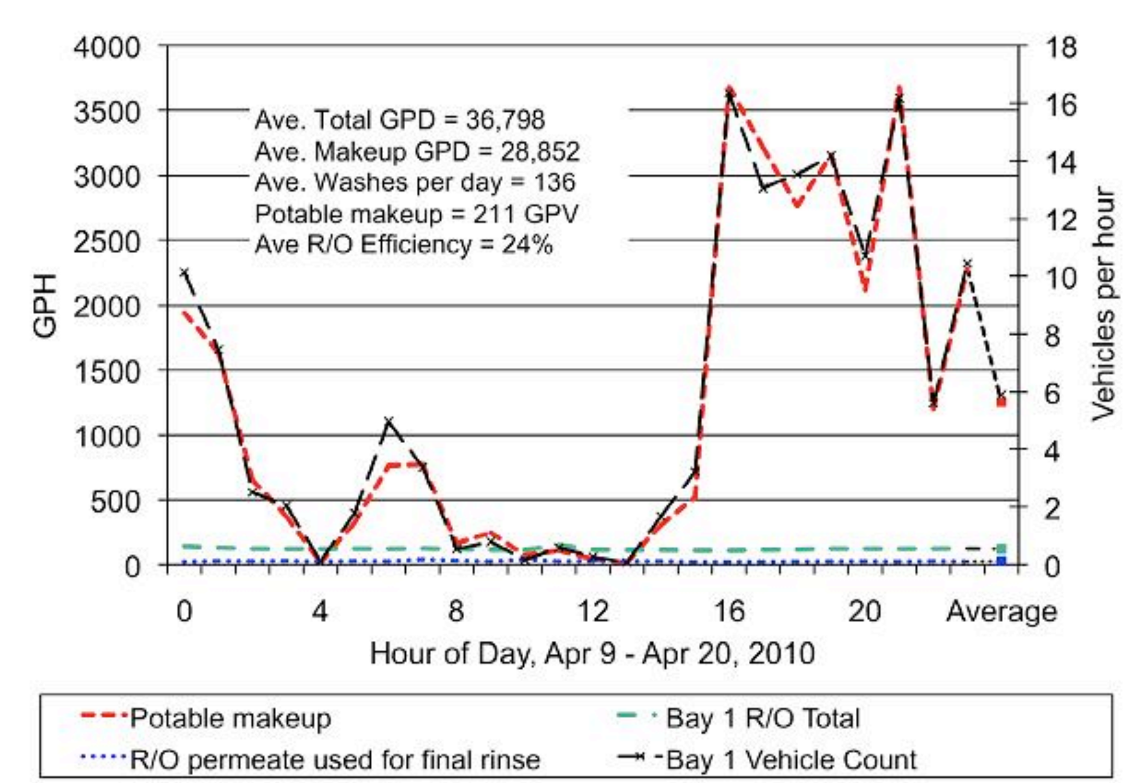
Table 6 shows the estimated daily water use for the main meter, shown as potable make-up water, reverse osmosis use, estimated recycle water delivered from the clarifier system, and the total wash water applied to the buses (potable make-up plus recycle). Table 6 shows a logging average of 29,082 gpd of total fresh water use at Washer 1 for 136 vehicles per day, including 28,852 gpd of make-up and RO. The last column of Table 6 shows the estimated potable make-up use normalized on the basis of the number of buses washed. The descriptive statistics for the data are shown at the bottom of the table. On an overall basis, Washer 1 uses an average of 212 gallons of make-up water per vehicle. More details about the individual uses are provided below.

Table 6. Washer 1 Daily Logged Volume (gpd)

	Vehicles	Potable Makeup	RO Total	RO Permeate	Est. Wash Total	Est. Recycled Portion	Daily RO Rate	Makeup gpv
9-Apr	166	26700	1720	530	44490	40%	31%	161
10-Apr	105	20900	3030	890	28493	27%	29%	200
11-Apr	103	17000	2920	840	28103	40%	29%	165
12-Apr	130	26500	2160	580	34996	24%	27%	205
13-Apr	143	33700	3030	850	38508	12%	28%	236
14-Apr	184	42400	3300	800	49172	14%	24%	230
15-Apr	146	36100	3260	760	39288	8%	23%	247
16-Apr	194	43700	2920	670	51644	15%	23%	226
17-Apr	108	22700	2910	760	29403	23%	26%	210
18-Apr	97	16500	2880	420	26412	38%	15%	171
19-Apr	140	33700	2850	320	37727	11%	11%	241
20-Apr	47	10700	1010	160	13406	20%	16%	230
Overall	1561	330600	31990	7580	421642	22%	24%	211.9
Days	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Average	136	28852	2791.9	661.5	36798			211.9
Median	135	26600	2915	715	36362	21%	25%	218
StDev	41	10518.3	686.3	233.2	10732.8	11%	6%	26
95% Confidence	24	6215.8	405.6	137.8	6342.6	7%	4%	15

The average logged hourly flow for Washer 1 end-use is shown in Figure 14 along with the number of vehicles washed. This graph shows a very close relationship between the hourly water use and the number of buses washed. It is also important to note that during the data logging period, the major portion of bus washing occurs between 4:00 P.M. and 03:00 A.M. The minimum occurs from 4:00 A.M. to 2:00 P.M.

Figure 14. Average Hourly Usage at D18 Washer 1



Average logged daily makeup for Washer 1 and total RO are shown in Figure 15 along with the number of vehicles washed. The RO filter ran continuously with only one interruption on April 12, 2010 from noon to 6:00 P.M. A portion of the flow trace analysis for the main meter during the period from 10:00 A.M. to 4:00 P.M. is shown in Figure 16. This shows a constant flow through the meter of 8 to12 gpm. This flow should be investigated further in order to confirm; it could be due to either leakage, a malfunctioning device, operation of the RO unit, or activities in the maintenance building.

Figure 15. Flow Through Main Meter during Period of Minimum Washing (10:00 A.M. to 4:00 P.M.)

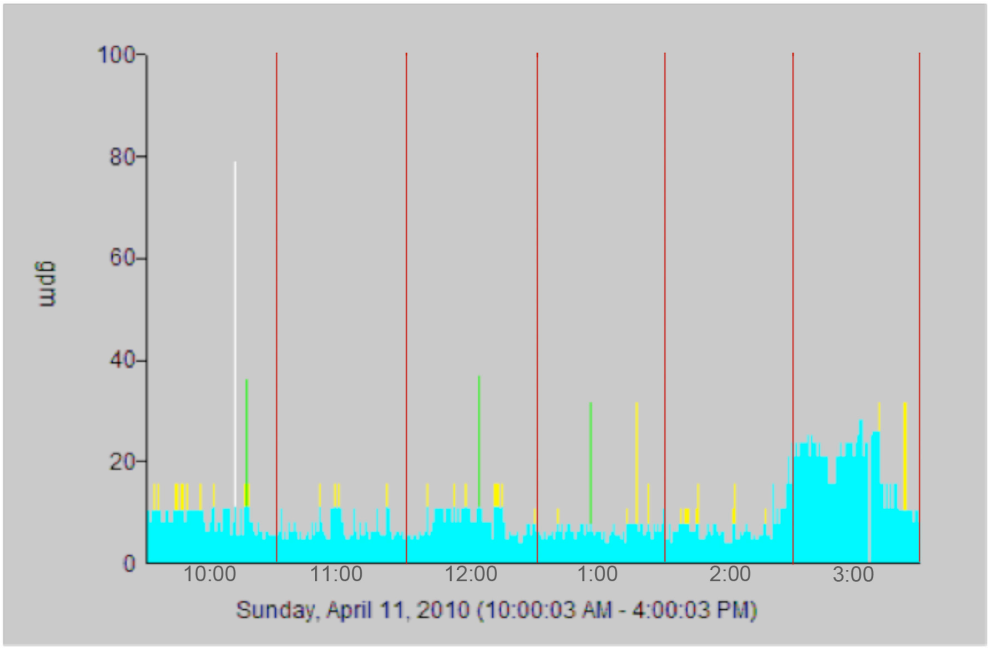
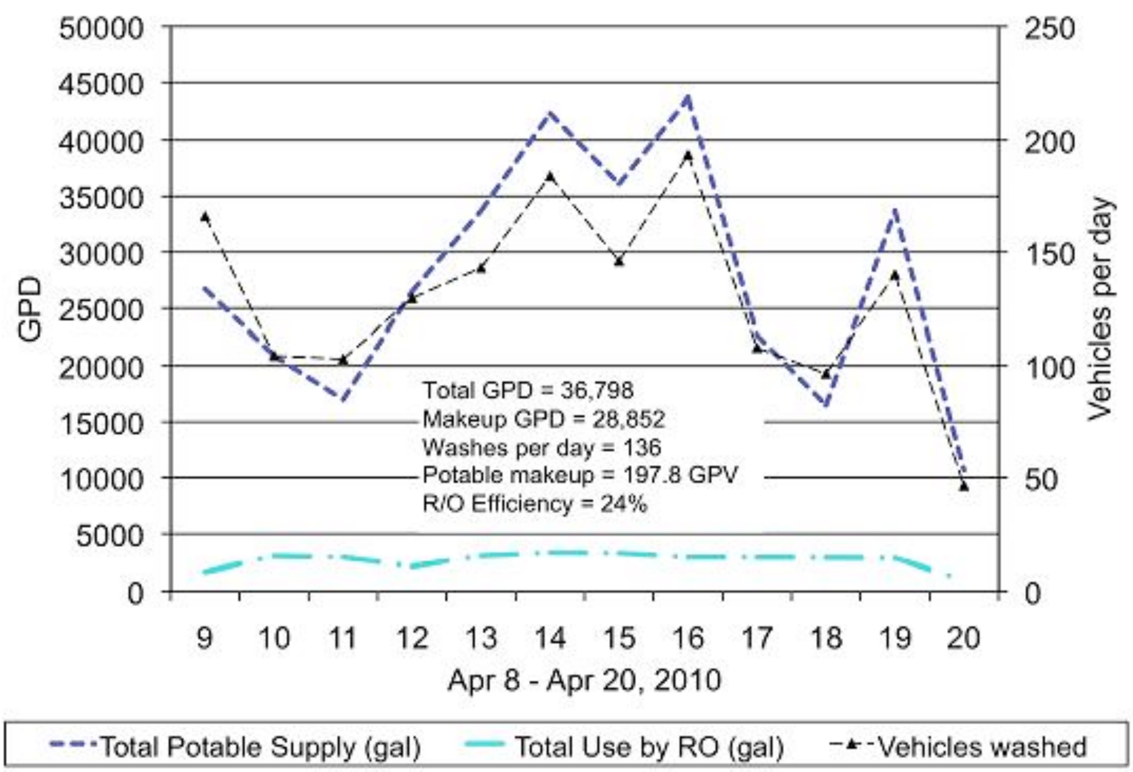


Figure 16. Average Daily Usage at D18 Washer 1



Wash Washer 2

As mentioned previously, Washer 2 was constructed in 2008; however, the logging period accounted for only 19 percent of all buses washed and used only 16 percent of flow to the bays. Two fixed meters and two temporary meters were used during the logging period.

Maintenance issues may have closed Washer 2 at some points during logging. The newer design of Washer 2 uses fewer pumps, different clarifiers and a different plumbing layout than Washer 1. Perhaps because of these design differences, Washer 2 used on average 21 percent less potable make-up per bus washed than Washer 1. Table 7 lists the daily water use monitored through the various sub-meters at Washer 2. Table 7 shows a logging average of 8,468 gpd of total use and 5,389 gpd of make-up and RO for 37 vehicles per day at Washer 2. Note that the average gallons of make-up water per vehicle washes was only 157 gallons, compared to 21 gallons per vehicle (gpv) for Washer 1.

Table 7. Washer 2 Daily Logged Volume (gpd)

	Vehicles	Potable Makeup	Recycle Flow	RO Total	RO Permeate	Wash Total	Recycled Portion	Daily RO Eff.	Makeup gpv
9-Apr	34	3400	4800	2400	100	8200	59%	4%	100
10-Apr	29	3800	4000	7300	120	7800	51%	2%	131
11-Apr	7	1900	2300	200	320	4200	55%	160%	271
12-Apr	53	6000	7200	100	750	13200	55%	750%	113
13-Apr	36	5500	4500	4800	570	10000	45%	12%	153
14-Apr	53	9400	3000	3800	810	12400	24%	21%	177
15-Apr	29	5900	1400	100	620	7300	19%	620%	203
16-Apr	56	8800	2600	0	650	11400	23%		157
17-Apr	23	5000	1400	0	390	6400	22%		217
18-Apr	12	2300	800	0	470	3100	26%		192
19-Apr	40	6300	1800	900	560	8100	22%	62%	158
20-Apr	10	1200	400	700	160	1600	25%	23%	120
Total	382	59500	34200	20300	5520	93700	36%	27%	155.8
Days	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Average	34.6	5388.7	3097.4	1838.5	499.9	8486.0			155.8
Median	31.5	5250.0	2450.0	450.0	515.0	7950.0	25%	23%	157.3
Standard Deviation	16.9	2573.8	1969.5	2403.6	243.1	3619.0	16%	290%	49.3
95% Confidence	10.0	1521.0	1163.9	1420.4	143.7	2138.7	9%	171%	29.1

Meters monitored the total make-up water to Washer 2, recycled flow from the clarifiers, total water to the RO filter, permeate produced by the RO filter, along with pump duty cycles and vehicle counts. An average of 245.3 gallons per vehicle is used, of which 155.8 gallons

(64 percent) is potable make-up and 89.5 (37 percent) is recycle. Of the potable water delivered to Washer 2, 9 percent ends up as RO permeate and 25 percent shows up in the wash system as reject, as shown in Figure 17.

Monitoring at Washer 2 also included the recycle line from the cyclonic clarifiers. Average logged hourly flow for recycle and Washer 2 end-uses is shown in Figure 18 with the number of vehicles washed. Again, this figure shows the close correlation between water use and car washing.

Figure 17. Washer 2 End-Uses for Potable Water

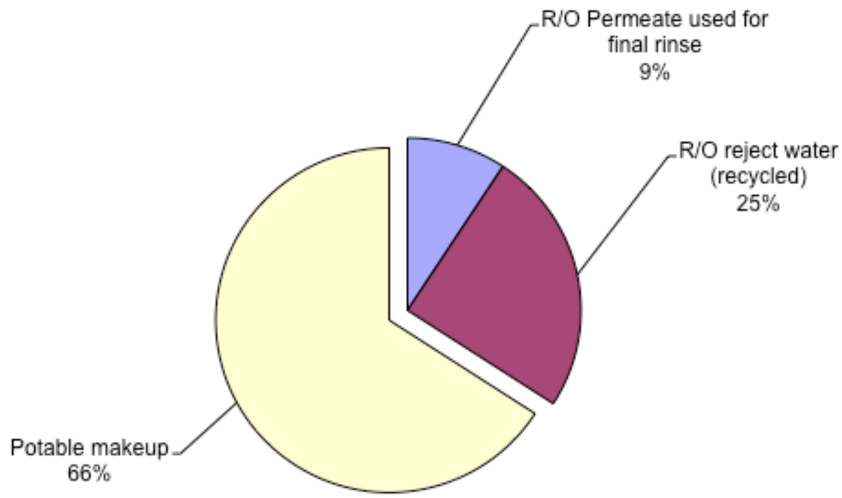
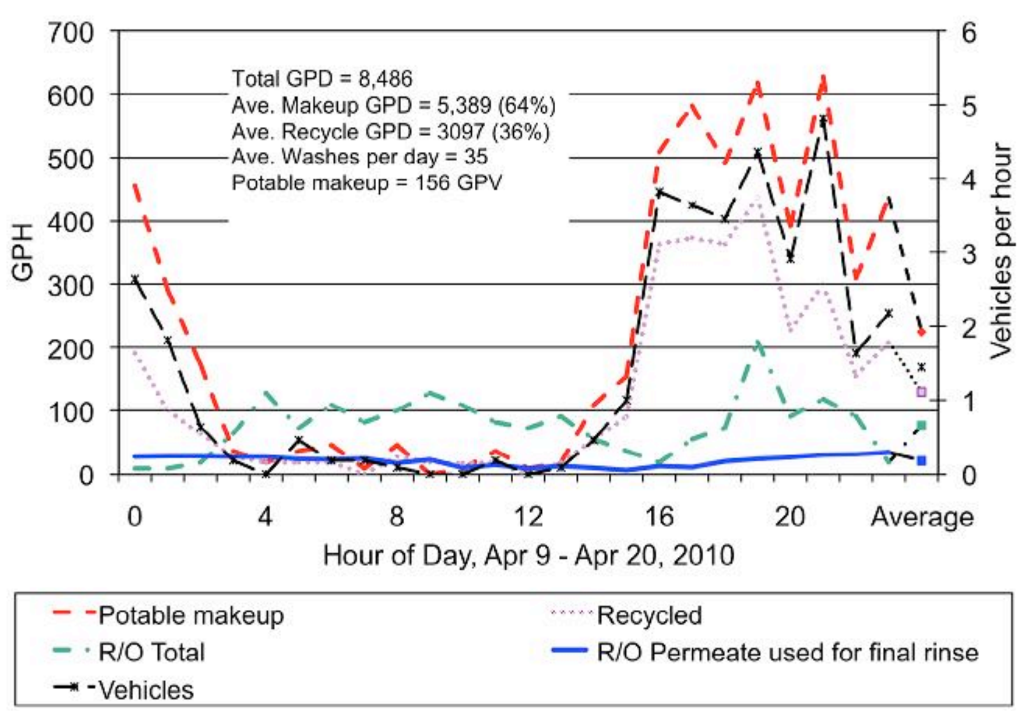
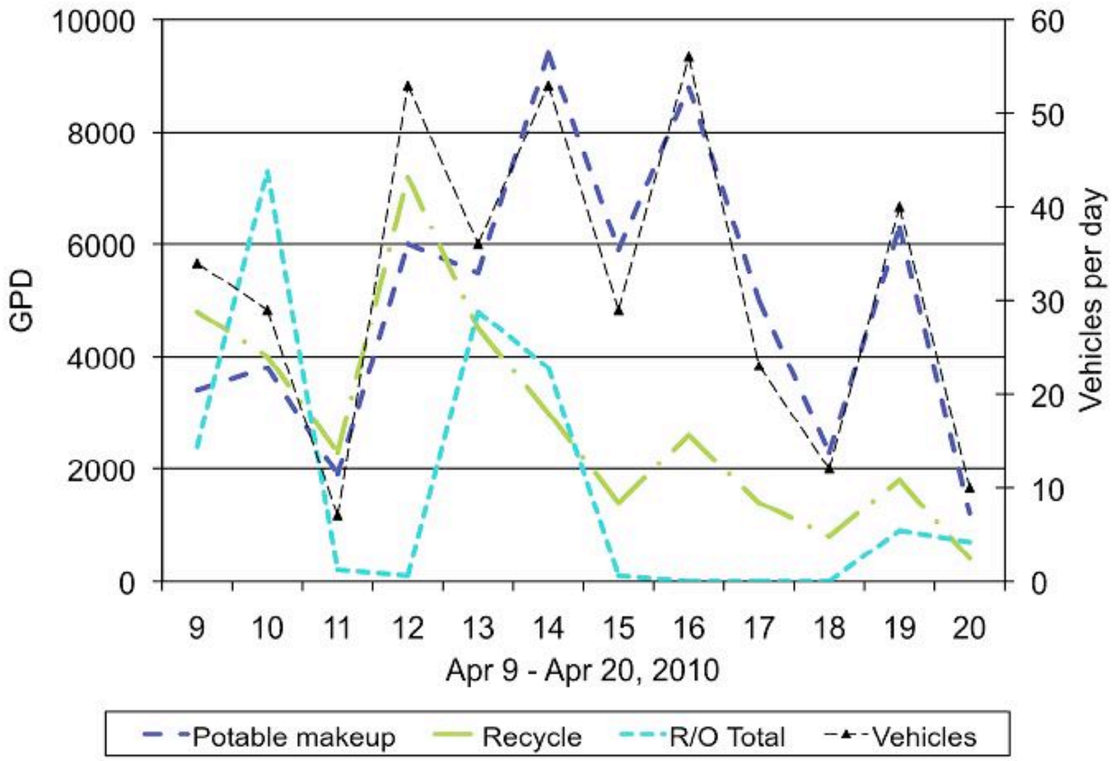


Figure 18. Hourly Usage at D18 Washer 2



Average logged daily make-up for Washer 2, total RO and recycle flow are shown in Figure 19, along with the number of vehicles washed. Controls for the RO filter appear to be adjusted several times during the logging period, which is standard protocol at D18. This figure shows that during the first part of the period the recycle rate was higher and potable water use was lower, while during the last half of the flow trace analysis less recycle and more potable water was used.

Figure 19. Daily Usage at D18 Washer 2

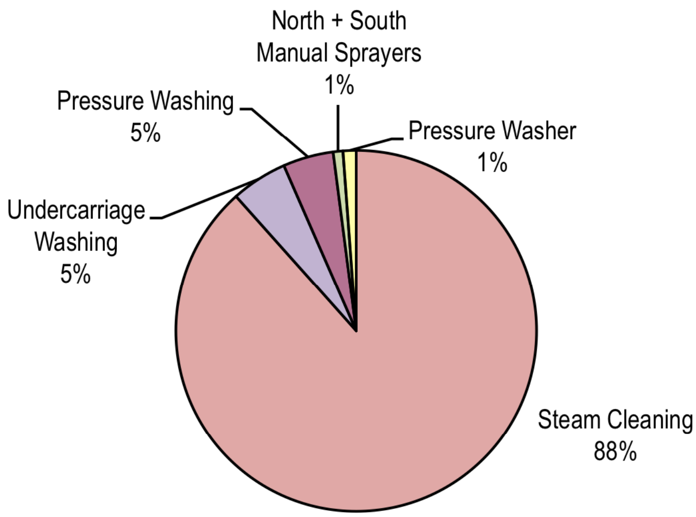


D18 Maintenance Building

The maintenance building washing facilities consist of under carriage washing and engine compartment cleaning, using potable supply from the main meter. A significant proportion of use at this facility is hot water. End-uses at the maintenance building include once-through manually-operated sprayers and automatic and manual power washers. Unlike the bus wash, the steam and power washing facilities do not recycle wash water. Recycling bus wash water is much easier than using effluent from steam and power washing, which tends to have a much higher grit, grease and oil content. Note that indoor and sanitary uses are included as part of the unmonitored 2 percent of main meter flow.

One fixed and five temporary sub-meters were installed at the maintenance building. Most of the washing equipment is plumbed with hose bib fittings at low flow rates; before the data logging, none of the facilities at the maintenance building had a dedicated sub-meter. Steam and power washing averaged 3,169 gpd over the logging period. Proportional water use for each washing function is broken down in Figure 20.

Figure 20. End-Use Totals for D18 Maintenance Building



The highest water use equipment at the maintenance building is a hot pressure washer (or steam wand) using over 2,800 gpd, or 88 percent of the maintenance building washing. As a result of its outdated design, hot water is constantly running though the wand, but used only intermittently since the installation of the timer control. Daily use for this and other equipment is shown in Table 8. This facility is a good candidate for installation of a permanent meter for future end-use monitoring.

Table 8. Maintenance Building Washing Fixtures (gpd)

Day	Hours of Monitoring	ChassiJet under-Carriage Washer	Hydrotek Pressure Washer	InstaClean	North Manual Spray	South Manual Spray	WhitCo Steam Cleaner	Total
4/8	9	129	12	1	2	2	1,941	2,087
4/9	24	0	47	41	15	23	1,967	2,093
4/10	24	16	147	37	2	9	1,852	2,063
4/11	24	171	120	52	1	4	3,459	3,807
4/12	24	351	201	41	67	2	2,867	3,529
4/13	24	195	87	24	39	2	3,258	3,605
4/14	24	137	51	60	37	4	2,938	3,227
4/15	24	156	178	27	4	0	3,065	3,430
4/16	24	174	149	78	18	14	2,192	2,625
4/17	24	160	105	7	0	4	2,552	2,828
4/18	24	182	219	44	3	0	3,582	4,030
4/19	24	187	252	16	36	0	2,712	3,203
4/20	11	31	127	13	14	25	760	970
Total	284	1,889	1,695	441	238	89	33,145	37,497
Average GPD	160	143	37	20	8	2,801	3,169	
Average GPH	6.7	6.0	1.6	0.8	0.3	116.7	132.0	

Facility Profile (Division 20)

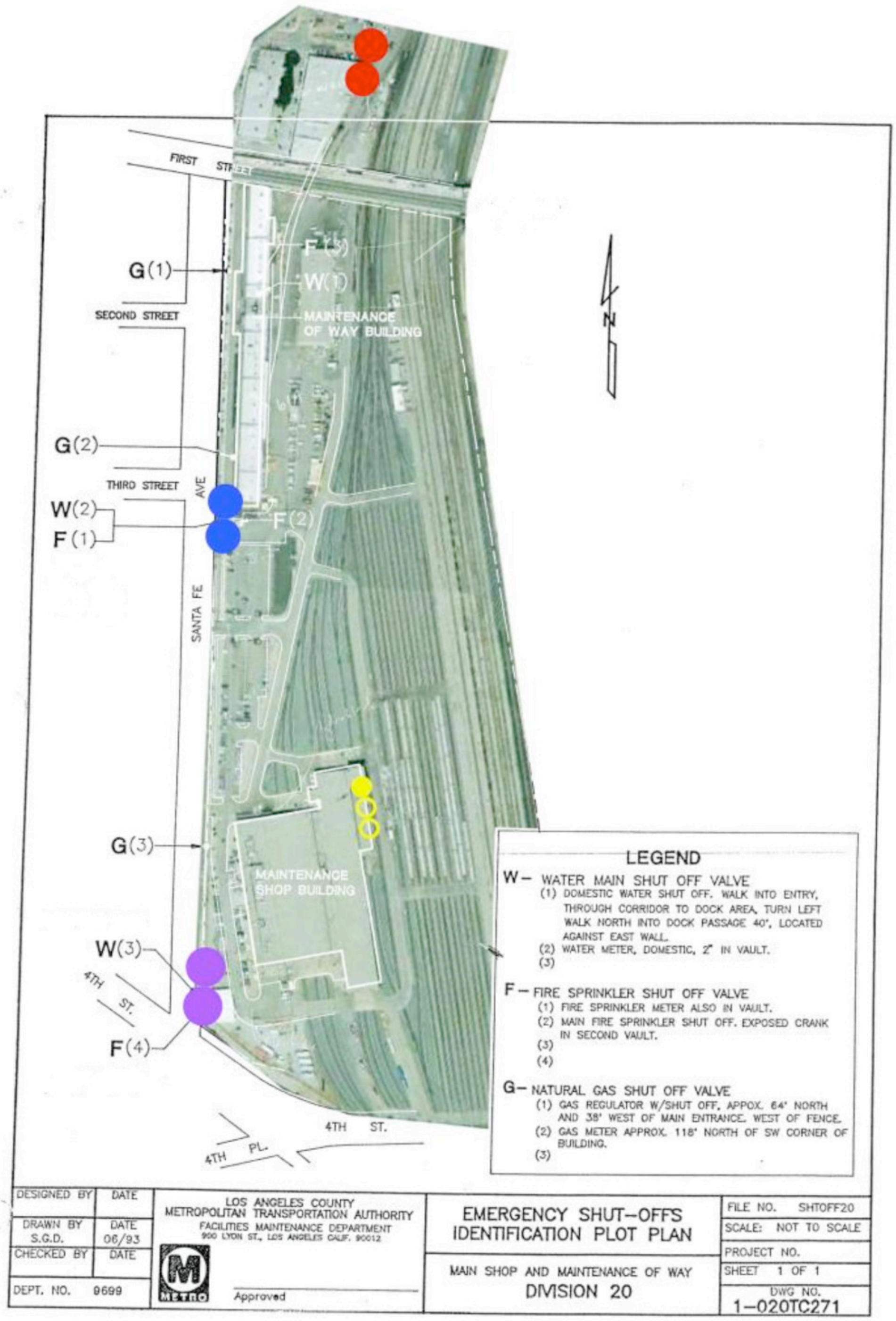
Division 20 (D20) was selected by Metro for data logging because it represents a typical Metro Rail Division. With its planned conversion to newer car washing equipment, the site has benefits to providing insight to historical, current, and post-retrofit operations and water use. This general description of D20 facilities is based on information collected during staff interviews, physical site investigation, and water fixture review conducted on February 10, 2010.

D20 is a train car maintenance and service facility constructed in 1989, with the exception of Buildings 61A and 61B that are of the original Los Angeles rail line. All of Metro's rail facilities have a centralized management system and use similar equipment to D20. There is no irrigated acreage at D20; however some rail divisions (e.g., Division 11) may have a minor amount of irrigated acreage. There are no cooling towers at D20 or at any other Metro rail divisions. The facilities at D20 are comprised of (from south to north):

- Maintenance Shop Building where all of the cars are serviced and majority of employees are stationed;
- Blow down area including water curtain on exhaust ventilation;
- Car Cleaning Platform (CCP) used to clean interior of rail cars;
- Building 61A that serves light administration and field crews;
- Building 61B that consists of a store room and nonrevenue maintenance; and
- Rail Car Wash facility.

Figure 21 presents a layout of D20 facilities and water meter locations.

Figure 21. Aerial Division 20 with Meter Locations



(red)	Car wash meters
(blue)	61A meters
(purple)	61B meters
(yellow)	Water curtain sub-meter

Potable water is provided to D20 from LADWP. According to the facility manager, approximately 20 percent of water is recovered onsite for reuse. A dual piping system (industrial and domestic) exits at D20; the industrial water system is fed from the potable supply through backflow prevention devices throughout the facility.

Rail Car Wash Facility

The D20 rail car wash facility is an automatic remote-operated drive through booth located on a side-rail at the north side of the site. Car washing mostly occurs mid-morning (between 8:00 A.M. and 10:00 A.M.). A hot water pressure system is also operated as needed at the site of the car maintenance facility. A wash reclaim and recycle system is also installed; a portion of water used for rinsing can be monitored by a separate miniature turbine-design water meter. The existing RO system at the rail car wash facility is currently turned off and its normal recycling ratio is unknown; however there is a sub-meter installed on the recycling water line.

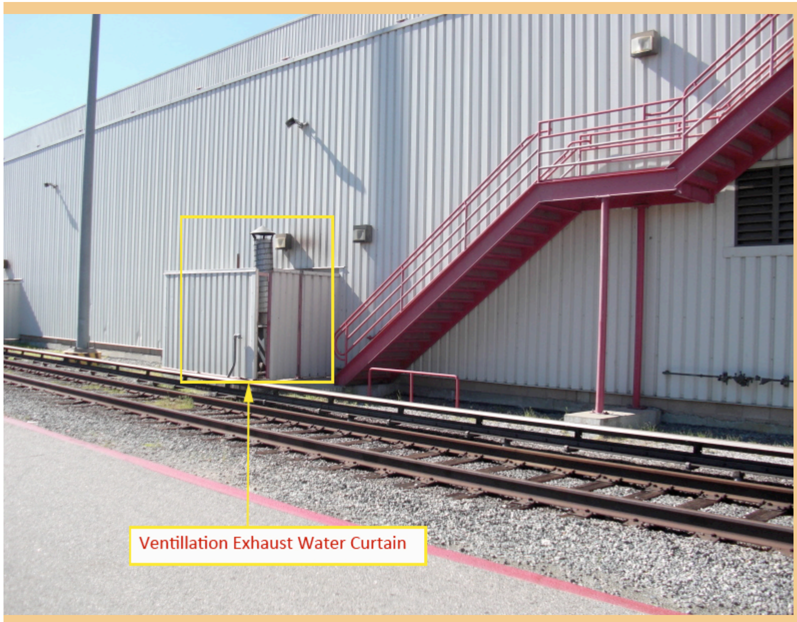
The rail car wash will be replaced and upgraded by Metro within the next two years as part of ongoing site expansion. It is anticipated that a more efficient car washing and water reclamation system will be provided.

Car Cleaning Platform

The CCP is used to clean the interior of cars by hand using buckets and mops. Water use for car cleaning is estimated at approximately 5 gallons per car. Metro has plans to extend the CCP north and south to add 2 additional platforms. The only water end-use fixture unit at the CCP is a utility sink that provides the bucket fill source.

Maintenance Shop Building

The maintenance shop building's major water uses consist of a water curtain used on the air ventilation exhaust system and a parts washer (EHGV Hydroblaster).



The water curtain is used to clean air from the prep area where cars are blow-off before maintenance. Air is exhausted from the maintenance building and run through a water curtain prior to discharge. The water curtain serves as an air scrubber removing collected dust prior to air discharge. Water at the blow down area is used primarily for mechanical parts maintenance and cleaning at rate of approximately 2 to 4 gpm when in use.

Floor cleaning within the maintenance shop building is completed with mops or with an automated power sweeper (approximately 20 gallon capacity machine). The automated power sweeper is used infrequently.

The Butler Building serves as an auxiliary storeroom adjacent to the maintenance shop that houses fire service and parts storage. No water end-uses are associated with the storeroom.

The maintenance shop building has restrooms, a kitchen, and other water end-use fixtures that contribute to the water use at D20.

Building 61A

Building 61A serves light administration, field crews, and has approximately 20 offices. The water fixtures found at Building 61A include toilets, sink, and showers. No upgrades to any of the water fixtures are planned at Division 20; however there were 2 to 3 waterless urinals recently installed at Building 61A.

Building 61B

Building 61B includes a store room and other non-revenue maintenance facilities. Major water end use equipment consists of a parts washer and pressure washer. There are also 3 water cooler fans.

Table 9 presents a summary of water fixtures located within Division 20.

Table 9. Division 20 Water Fixtures

	Toilets/Urinals (1)	Sinks (2)	Showers (1)	Other Water Features
Kitchen – Maintenance Shop Building		1		1 ice machine
Janitor Closet (Maintenance Shop Building, 61A, 61B)		3		
Interior of Maintenance Building		1		2 portable water cooler fans
Women's Restroom – (Maintenance Shop Building, 61A, 61B)	7 / 2 toilets (1.6 gpf)	8 / 1 utility sink	3	
Men's Restroom – (Maintenance Shop Building, 61A, 61B)	3 urinals (2 gpf)/ 5 toilets (2 gpf)/ 3 urinals/ 4 toilets/ 2 waterless urinal/ 5 toilets (1.6 gpf)/ 1 urinal (1 gpf)/ 1 toilet (1 gpf)	11	3	
Office Break Room 61A		1		
61A Interior Misc Fixtures				2 eyewash stations, 1 ice machine
TOTAL	11 toilets/ 5 toilets (2 gpf)/ 5 toilets (1.6 gpf)/ 1 toilet (1 gpf)/ 3 urinals/ 3 urinals (2 gpf)/ 1 urinal (1 gpf)/ 2 waterless urinals	25/ 1 utility sink	6	2 ice machines; 2 portable water cooler fans; 2 eyewash stations

Notes:

(1) Except as otherwise noted, all restrooms are equipped with pre-1986 high volume flushing toilets, urinals and shower heads

(2) All utility sinks are manually operated and not equipped with infrared or foot pedals.

Landscaping

There is no landscaping irrigation at Division 20.

Data Logging Results and Analysis (Division 20)

An initial site review and plumbing inspection of Division 20 was performed to review site facilities and operations, as well as to determine existing main and sub-meter locations and appropriate locations to employ data logging equipment. This section presents a review of the historical water use at D20 and the results of the data logging effort at the sub- and main-meters.

The data logging effort focused on the rail car wash facility, Buildings 61A and 61B. Each of the three facilities has a dedicated LADWP water meter, shown in Table 10, along with two fire suppression meters unrelated to daily water consumption. The rail car wash has two meters (Neptune 2" T-10s) located outside the site fence, which are manifolded into a single service line. Building 61A is served by one meter (2" Neptune T-10) located in the site parking lot. Building 61B is also served by one meter (2" Neptune T-10) located at the southwest corner of the site. The data logging monitored these four meters as well as a fixed sub-meter for water curtains adjacent to the CCP.

LADWP historical water use for these meters is shown in Table 10.

Table 10. D20 LADWP Meters and Annual History

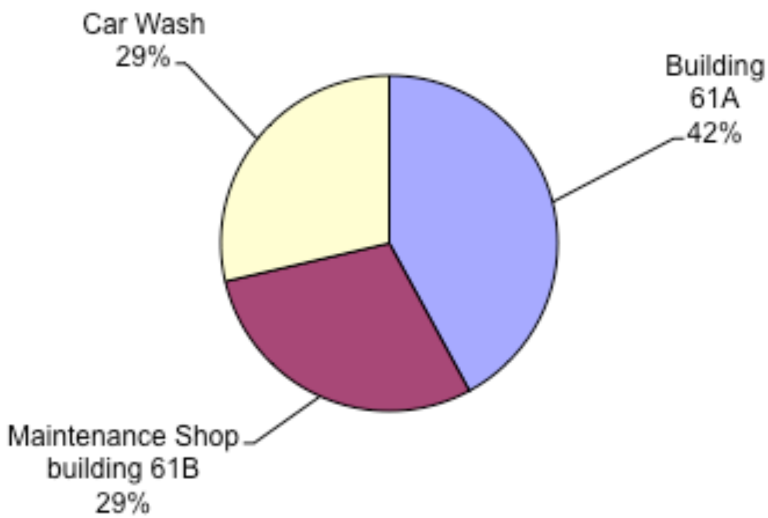
	Approximate Street Address	Meter Number	Make and Model	2008			2009		
				Gallons	AF	GPD	Gallons	AF	GPD
D20 Car Wash:									
"	801 Banning St (outside D20 fenceline in a parking lot)	90034073	2" Neptune T-10	373,252	1.1	1,014	318,648	1.0	873
		90034082	2" Neptune T-10	385,968	1.2	1,049	330,616	1.0	906
			Car wash total:	759,220	2.3	2,063	649,264	2.0	1,779
D20 Building 61A Office:									
"	304 S Santa Fe Ave	90034080	2" Neptune T-10	1,656,072	5.1	4,500	1,733,864	5.3	4,750
		7198567	Hershey (fire suppression)	0	0.0	0	0	0.0	0
D20 Building 61B Maintenance Shop:									
"	300 S Santa Fe Ave	7232919	Hershey (fire suppression)	0	0.0	0	0	0.0	0
		90034079	2" Neptune T-10	1,611,940	4.9	4,380	2,033,812	6.2	5,572
Facility Total:				4,027,232	12.4	10,944	4,416,940	13.6	12,101

Over the data logging period, the daily water use at D20 averaged 9,600 gpd, which was 2,501 gpd less than the 2009 annual average. Historically, 85 percent of D20 water use is indoor, with the rail car wash using 15 percent outdoors. During the logging period 71 percent of the water was used indoor for Buildings 61A and 61B, while the car wash used 29 percent outdoors for the rail car wash. Daily logged use for D20 is shown in Table 11 and Figure 22.

Table 11. D20 Average Daily Logged Volume

Meter	Average Daily Use (GPD)	% Total
Office (Building 61A)	4,113	42%
Maintenance Shop (Building 61B)	2,867	29%
Car Wash	2,620	29%
Total	9,600	100%

Figure 22. D20 Logged Use by Facility



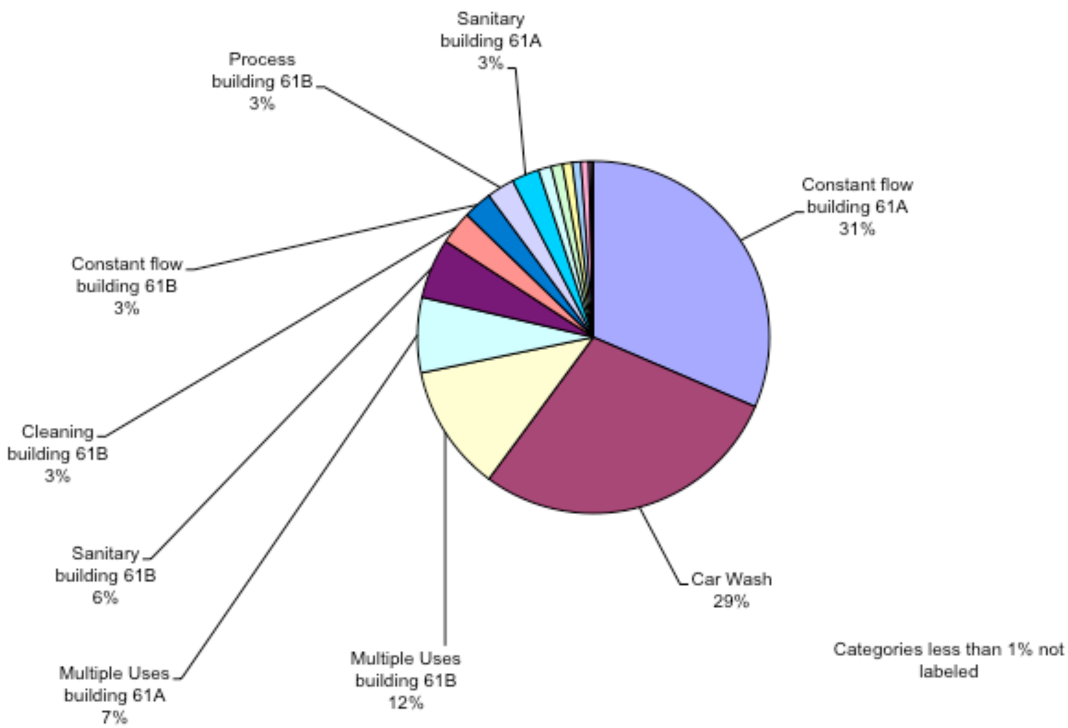
D20 Disaggregated Water Use

Flow data acquired from LADWP meters serving Buildings 61A and 61B were analyzed using TraceWizard software. Flow trace analysis allows identification of specific water use events based on their flow and volume characteristics. These events can then be linked to specific water using devices (end-uses) in the facility through more detailed on-site auditing.

As described above, discrete flow events for all end-uses of water were categorized based on flow rates, duration, and time-of-day. In general, these characteristics identify certain equipment and often a small number of fixtures account for a majority of the water use. Limitations to this technique arise when equipment is used simultaneously, which tends to mask the individual events. For example, simultaneous events flowing at variable rates will appear in combination as a single event at a high flow rate. Disaggregating simultaneous events may result in a mixed-use category where no further disaggregation is possible.

Figure 23 presents the disaggregated end-uses of water at D20. At both Buildings 61A and 61B, constant use was detected. Some end-uses, such as toilet flushing, faucet use and showering, are represented only when these events occur, which is rare. Based on the employee shift schedule at D20, bathroom use likely peaks between shift changes, resulting in multiple simultaneous water use events. Thus, the Multiple Use category is judged to contain a high proportion of small events, like toilet flushing, faucet use and showering, and a low proportion of constant- and high-flow-rate mechanical processes. Moreover, these small events are proportionally underrepresented in the total.

Figure 23. D20 Disaggregated End Use Total



These end-uses are based on fixtures and processes statistically described in Table 12. Note that constant use is flow occurring at a steady rate, and may not occur as independent events. Table 13 gives a daily interpretation of these flows.

Table 12. D20 Disaggregated End Uses

Building		Events	Total Gallons	Duration (seconds)		Highest Flow Rate GPM	Volume (gallons)			
				Average	Standard Deviation		Min	Max	Average	Standard Deviation
61A	Cooling		37031.1			16.0				
61A	Multiple Uses	4531	8131.4	67.2	94.5	54.6	0.1	57.7	1.8	3.6
61A	Toilet	879	2972.8	65.4	62.7	29.0	1.5	10.7	3.4	1.0
61A	Faucet	79	925.3	412.4	365.7	36.2	1.5	50.9	11.7	11.0
61A	4.0 GPM process	12	230.6	430.0	307.7	50.6	2.1	43.4	19.2	14.7
61A	Leak	2364	202.2	65.9	60.2	0.4	0.0	1.2	0.1	0.1
61A	6.4 GPM process	2	69.8	655.0	63.6	15.4	5.8	64.1	34.9	41.2
61B	Multiple Uses	5539	13686.3	56.2	69.3	50.4	0.1	65.3	2.5	3.9
61B	Toilet	1741	6491.8	33.8	27.6	38.6	1.9	7.7	3.7	0.8
61B	9PM process	24	3608.1	1177.5	264.0	37.0	19.3	229.4	150.3	61.6
61B	Cooling	5	3112.6	17868.0	21592.8	2.2	167.1	2027.6	622.5	793.4
61B	4.0 GPM process	68	2987.7	603.2	452.6	40.2	8.4	197.9	43.9	39.4
61B	Leak	4609	1394.8	116.5	144.8	0.4	0.0	3.5	0.3	0.3
61B	6.4 GPM process	21	1240.3	643.3	322.8	33.8	15.7	136.8	59.1	31.4
61B	Faucet	56	1047.5	565.4	350.1	23.2	2.5	48.1	18.7	11.5
61B	29.0 GPM process	1	836.3	1760.0		29.0	836.3	836.3	836.3	

Table 13. D20 Disaggregated End Use Daily Logged Volume (gpd)

Logging Day	Car Wash GPD	Office (Building 61A)							
		4.0 GPM Process	6.4 GPM Process	Faucet	Cooling	Leak	Multiple Uses	Sanitary	61A Main Total
6-Apr	7465.4								
7-Apr	5248.4	0.0	0.0	36.9	2648.4	12.4	991.3	200.1	3889.1
8-Apr	7285.2	0.0	0.0	0.0	3079.4	8.3	835.7	318.9	4242.2
9-Apr	2756.6	4.0	5.8	28.3	3088.0	8.6	774.9	302.4	4211.9
10-Apr	231.9	0.0	0.0	225.5	3041.2	23.5	251.2	123.3	3664.7
11-Apr	600.3	0.0	64.1	88.7	3074.3	21.3	288.3	131.3	3667.9
12-Apr	197.1	27.8	0.0	59.4	3101.8	17.8	675.2	271.3	4153.2
13-Apr	3494.4	0.0	0.0	133.0	3096.9	15.4	1098.5	252.7	4596.4
14-Apr	3614.1	0.0	0.0	54.6	3098.1	16.2	761.1	385.0	4315.1
15-Apr	5583.6	80.6	0.0	73.3	3099.1	13.2	1049.8	281.0	4597.1
16-Apr	1234.5	118.2	0.0	113.0	3102.7	17.6	656.6	282.2	4290.3
17-Apr	613.0	0.0	0.0	70.5	3091.8	13.8	383.2	124.3	3683.5
18-Apr	190.3	0.0	0.0	40.6	3095.0	23.7	365.0	180.3	3704.5
19-Apr	355.2	0.0	0.0	36.9	3102.2	14.3	896.2	391.3	4440.8
Overall	2619.8	19.1	5.8	76.8	3070.4	16.1	674.4	246.2	4108.8

Table 13. D20 Disaggregated End Use Daily Logged Volume (gpd) (Continued)

Logging Day	Maintenance Shop (Building 61B)										
	29.0 GPM Process	4.0 GPM Process	6.4 GPM Process	9PM Process	Faucet	Cooling	Leak	Multiple Uses	Sanitary	Water Curtain	61B Main Total
7-Apr	0.0	0.0	0.0	8.0	65.0	0.0	124.7	967.0	561.4	8.0	1726.1
8-Apr	0.0	359.6	43.9	3.0	83.0	344.2	121.7	1463.3	640.5	35.0	3059.2
9-Apr	0.0	0.0	122.7	3.0	175.5	0.0	139.3	1170.9	688.0	2.0	2299.4
10-Apr	836.4	74.3	160.6	2.0	79.3	0.0	130.1	520.8	332.7	3.0	2136.2
11-Apr	0.0	41.9	86.4	2.0	73.5	0.0	126.1	606.6	428.0	1.0	1364.5
12-Apr	0.0	534.6	61.4	2.0	72.4	443.6	121.7	1527.8	608.2	40.0	3371.6
13-Apr	0.0	686.5	109.6	2.0	84.1	297.0	99.8	1732.4	620.2	33.0	3631.6
14-Apr	0.0	363.9	45.2	2.0	78.5	0.0	114.7	1656.1	553.4	0.0	2813.7
15-Apr	0.0	74.8	0.0	2.0	105.4	0.0	139.9	1451.7	684.7	3.0	2458.6
16-Apr	0.0	737.3	256.2	2.0	91.1	2026.2	48.2	1257.1	425.7	178.0	4843.7
17-Apr	0.0	0.0	83.6	2.0	49.7	0.0	125.5	530.5	389.2	1.0	1180.6
18-Apr	0.0	0.0	196.1	2.0	35.9	0.0	113.4	617.5	384.3	1.0	1349.4
19-Apr	0.0	211.9	137.7	0.0	160.1	0.0	92.2	1232.3	842.1	1.8	2676.3
Overall	69.5	248.1	103.0	2.3	87.0	258.3	115.6	1136.5	539.1	24.9	2559.5

Note that the disaggregated Maintenance Shop main includes flow to the water curtain sub-meter.

D20 Constant Use

Constant use combined from the 61A and 61B meters is the largest end-use at D20, accounting for 33 percent of total flow. The average flow of the constant use is similar at both sites (~2.0 gpm) and could possibly be the same type of equipment. It is interesting to note that Building 61A runs continuously during the entire flow trace. At Building 61B, however, the use is intermittent and only occurs for 4 days out of 12, all of which fall on weekdays. Figure 24 shows a typical daily profile of the constant demand over the logging period. The constant use is at a small enough flow rate where it could be attributed to a leaky toilet. A portion of the flow trace analysis from approximately 2:00 A.M. to 8:00 A.M. is shown in Figure 25. This figure indicates the base or constant flow that occurs throughout the logging period shown in solid dark blue.

Figure 24. Hour-of-Day Profile for D20 Constant Flow

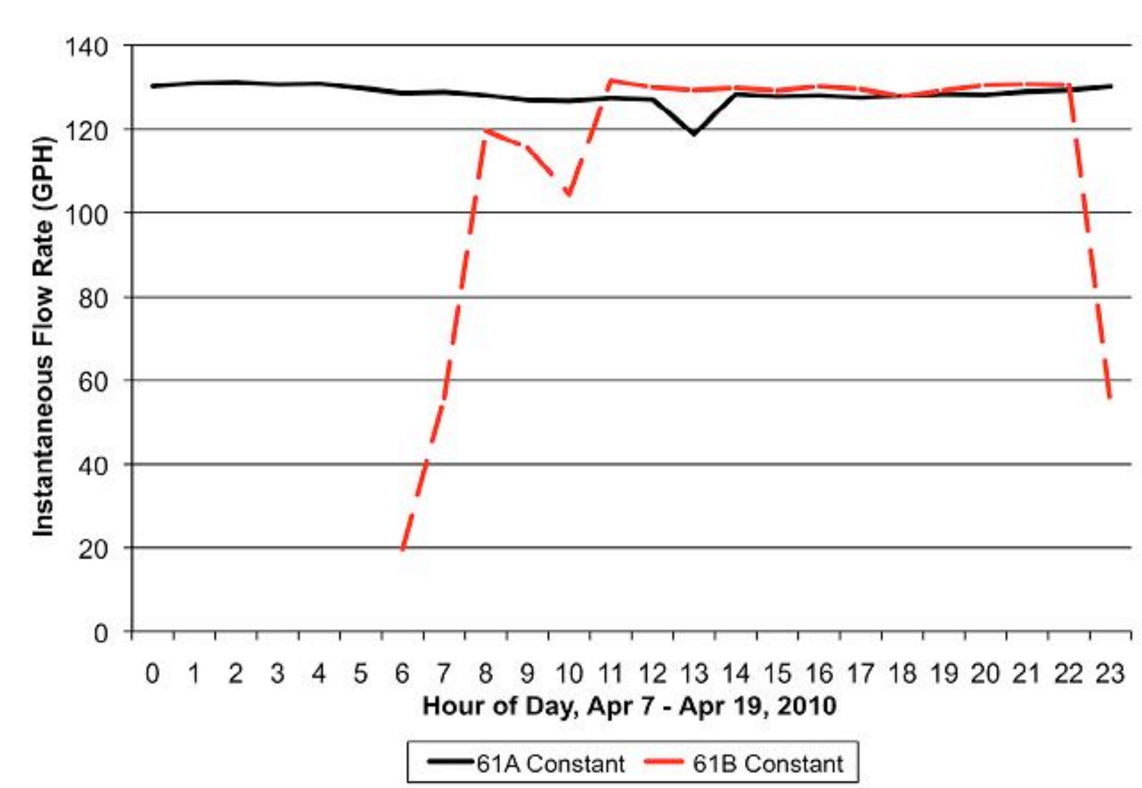
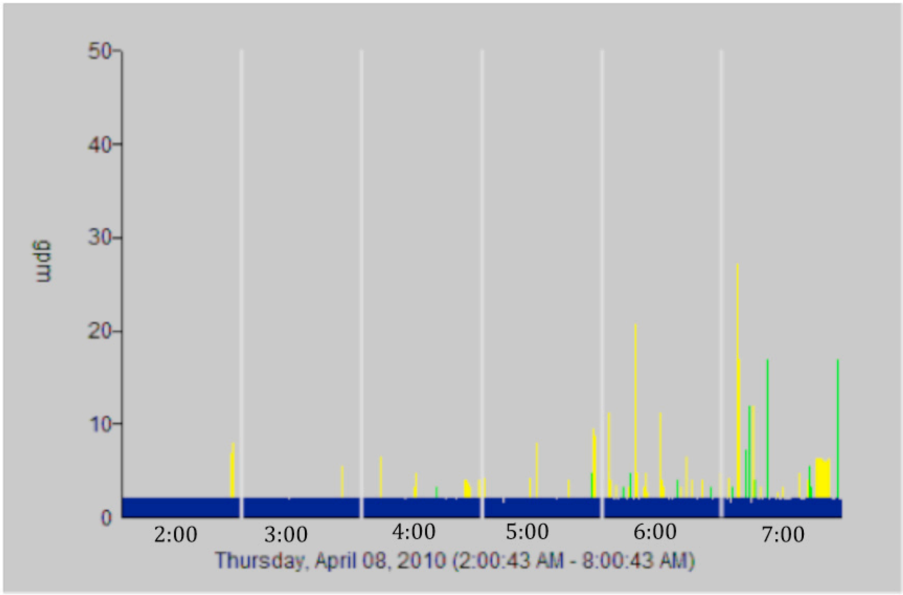


Figure 25. Constant Flow Through Building 61A Meter 2:00 AM until 8:00 AM



Observations from the data logged at D20 is as follows:

- Constant flow at Building 61A is 24-hour, occurring independently of daily occupancy or heat load.
- The same pattern at Building 61B appears controlled and independent of the air scrubber. This is characteristic of a manually-controlled scheduled process.
- Whatever is accounting for the 2 gpm constant demands at both buildings 61A and 61B should be identified, since it accounts for a large volume of water
- From its appearance on the flow trace analysis the constant flow through the meter at 61B could easily be a 2 gpm leak given that it never varies or ceases during the entire logging period.

The difference in flow between buildings 61A and 61B is 2,812 gpd, which is close to the 2,705 gpd difference between the historical (annual) and logged 61B daily average. This suggests that 61B equipment ran continuously through 2009. The possibility of a leak should be eliminated through on-site audit and leak detection.

D20 Maintenance Shop Air Scrubber

A meter (3/4" Seametrics) was installed for the air curtains located on the east end of the maintenance shop. This line also supplies indoor hose bibs. Average daily use during the logging period, shown above in Table 14, was 24.9 gpd.

D20 Rail Car Wash

The rail car wash facility is a remote-operated booth on the north side of D20. Though a wash recycle system is operating, this system is considered an outdated design and has been replaced at other rail facilities with a new wash system. Specifically at D20, the portion of water used for rinsing can be monitored with a separate miniature water meter, though this meter does not support data logging. Rinse water is carbon-filtered and softened through equipment that is timed for routine overnight backwash. Lastly, a RO filter for final rinse water is installed but has been permanently disabled.

The rail car wash is served by the two meters (parallel 2" Neptune) located at 801 Banning Street, which is outside the D20 fence line. Between April 6, 2010 and April 19, 2010 an average of 30.5 cars were washed daily for an average demand of 2,580 gpd. Figure 26 shows the difference between make-up flow and number of cars washed. Logging statistics are shown in Table 14.

Figure 26. D20 Car Wash Daily Totals

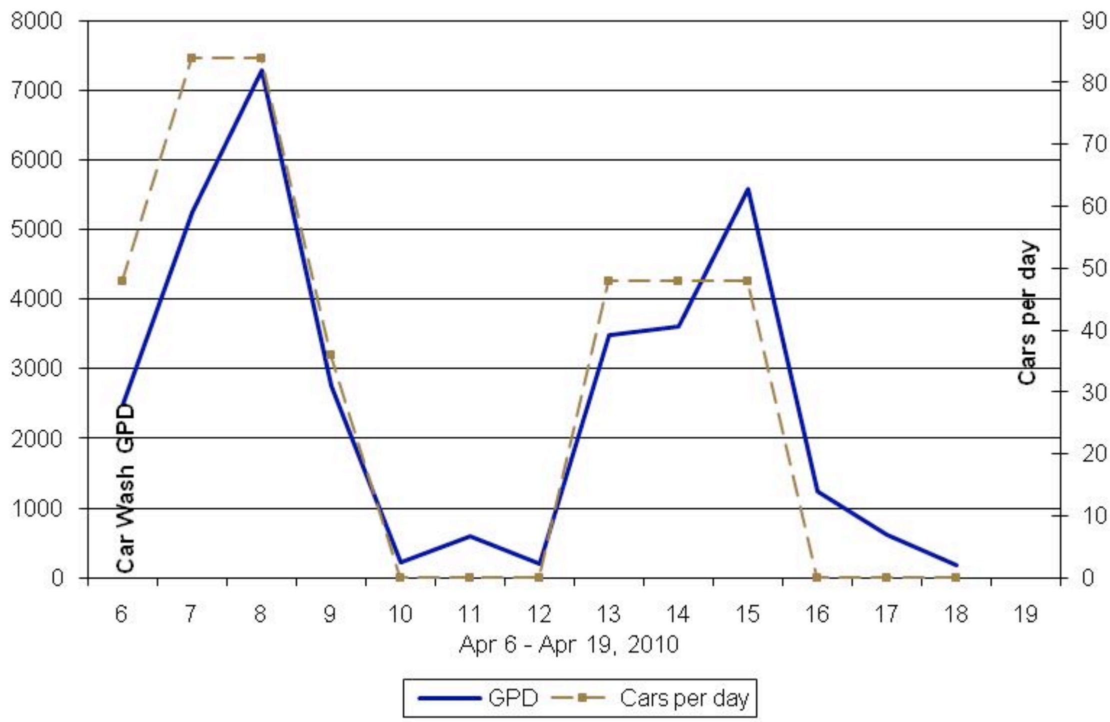


Table 14. D20 Car Wash Logging Statistics

Water Use Category	Value	Units
Study average gallons per car—this is the observed use rate	84.7*	GPV
Variable average gallons per car—this is the forecasting average	74.5–77.9	GPV
Fixed processes—this is added to daily forecast	330	GPD
Cars washed during logging	396	
Average cars per day during logging	30.5	
Average use and 95% confidence interval	2,580	±419 GPD

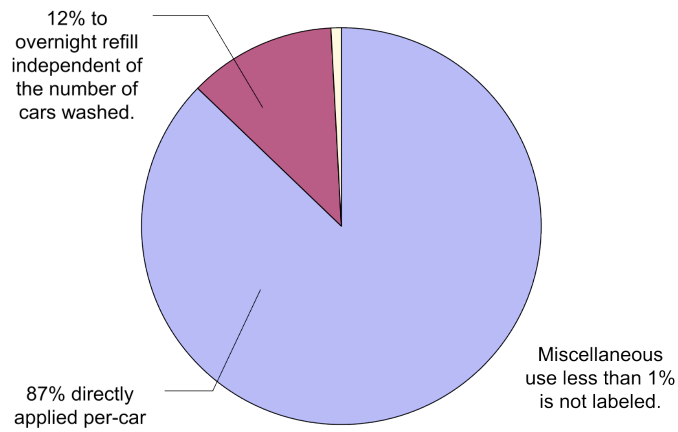
* Average including high water use days, and may not be indicative of normal wash days.

End-uses at the rail car wash include make-up, automated filter processes, and very small miscellaneous use. Make-up is directly related to the number of cars washed; automated processes run overnight and are independent of the number of cars washed the day before. There is no recycle occurring at this facility, so all of the wash water used on the cars comes directly from the potable supply. Daily totals during the logging period are shown in Table 15 and proportional use is shown in Figure 27.

Table 15. Car Wash Daily Logged Volume

Day	Cars Washed	Total Logged (gal)	Est. Makeup (gal)	Est. Overnight (gal)	Est. Misc (gal)	Average GPV
6-Apr	48	2,488	3,583	0	21	51.8
7-Apr	84	5,248	6,270	309	21	62.5
8-Apr	84	7,285	6,270	309	21	86.7
9-Apr	36	2,757	2,687	309	21	76.6
10-Apr		232	0	309	21	
11-Apr		600	0	309	21	
12-Apr		197	0	309	21	
13-Apr	48	3,494	3,583	309	21	72.8
14-Apr	48	3,614	3,583	309	21	75.3
15-Apr	48	5,584	3,583	309	21	116.3
16-Apr		1,234	0	309	21	
17-Apr		613	0	309	21	
18-Apr		190	0	309	21	
Overall	396	33,538	29,557	3,706	275	84.7

Figure 27. D20 Car Wash Proportional Demand



Data Logging Summary

The D20 rail facility uses substantially less water per day than does the bus washing facility. The rail car washing unit uses approximately 1,800 gpd, or approximately 85 gallons per car. This represents 30 percent of the total on-site water use. The Building 61A accounts for 40 percent of the total water use and uses over 4,100 gpd; this facility shows a very constant 2 gpm flow that could easily be attributed to a leak, however should be investigated further. Building 61B uses approximately 30 percent of the total D20 water.

Gateway Headquarters

Gateway Headquarters is the largest water user at Metro; therefore a preliminary evaluation of water use at Gateway was also conducted. The focus of this Plan was at the maintenance divisions with data logging conducted at sites D18 and D20. The conservation potential associated with commercial buildings such as Gateway is fairly well documented. Therefore, evaluation of water use involved a preliminary survey on February 11, 2010 to obtain a general understanding of the end-uses of water and to review ongoing end use retrofits.

Gateway is a 15-year old structure with 650,000 square-feet and 27 floors. Major interior water uses include cooling towers, restroom and employee break rooms, a sheriff's office, cafeteria, and electrolyzed water system for degreasing cleaners and sanitizers.

Approximately 25 out of the 27 floors contain the same water end-use facilities: i.e., one men's restroom (all with waterless urinals), one women's restroom, drinking fountain, and a kitchenette with one sink. Roughly 1,800 employees work out of Metro headquarters, including approximately 209 Los Angeles County sheriffs.

The cooling towers have the largest water demand at Gateway. The cooling towers are comprised of six units installed during the building's original construction. Cooling towers are used to regulate temperature by dissipating heat from recirculating water. Cooling tower water use is estimated at 1,000 gpd. A sub-meter was installed on the cooling tower water supply, but was not functional at the time of the site visit. Therefore Metro is currently unable to calculate water losses at the cooling towers. A new meter is planned for installation to accurately quantify water use. It was estimated that the existing cooling towers have roughly 10 to 15 years remaining useful life.

The cafeteria at Gateway is estimated to have a total of 1,200 transactions per day for breakfast and lunch. End use equipment consists of food preparation and hand wash sinks, an ice machine, a dishwasher, and beverage vending machines. Approximately 90 percent of Gateway printing is done at the in-house print shop. The major water using equipment at the print shop is the Heidelberg Speedmaster offset printing press, which uses approximately 2 to 3 gallons water per day. The other printers use no more than 3 to 6 gallons every 2 to 3 weeks.

4. Recommendations

Metro is developing an Environmental Management System (EMS) as a tool for environmental policy compliance. An EMS is a collection of best practices to ensure environmental compliance at all of Metro's levels of organization. The EMS process is cited by the Federal Transit Administration (FTA) as a transit property's clearest commitment to environmental compliance and stewardship.

Metro's EMS is based on the International Organization for Standardization (ISO) 14001 standards. ISO 14001 provides the framework for an EMS, and confirms its global relevance for operations in an environmentally sustainable manner.

Consistent with Metro's goals and cost for the EMS, this Water Action Plan serves as one of the many elements to achieve energy and cost savings. This plan identifies pertinent environmental laws and regulations, and identifies some of the resources, roles and responsibilities and develops an overall target for water savings based on observed water use patterns and records.

Recommendations made herein are consistent with the ISO 14001 standards for the establishment of a framework for the ongoing monitoring, reporting and improvement of Metro's plans for water conservation and replacement of water supplies for the savings of potable water.

4.1 Water Conservation Strategies

The following water conservation strategies have been developed based upon a review of the existing facilities, operations, and water usage at Divisions 18 and 20. Water savings are presented as typical daily savings for rail and bus facilities. Of the 18 major Metro Divisions, 11 (1, 2, 3, 5, 6, 7, 8, 9, 10, 15, and 18) are related to bus and van transportation, 4 are related to rail (11, 20, 21, and 22), non-revenue vehicles is Division 4, the Metro Service Support Center (MSSC) is Location 30, and the Metro Gateway Headquarters is Location 99. There are also numerous Metro properties (e.g., rail stations, bus stations, customer service centers, etc.) throughout Los Angeles County. Equipment and operations observed and evaluated at Divisions 18 and 20 are assumed to be typical for their transportation type. Therefore, the calculated water savings represent potential water savings across all of Metro's Divisions.

A financial analysis and benefit/cost ratio for the first 13 strategies is analyzed based upon an average life-cycle of 40 years, and a discounting factor of 5 percent. Appendix A presents the financial analysis tables for each strategy. Water savings per revenue hour are presented based upon Metro's 2009 ridership of approximately 8,000,000 bus revenue hours, and 656,000 rail revenue hours. Annual water use is based upon an operating year of 256 days.

On-site rainwater harvesting was also considered as a potential opportunity for potable water savings. Rainwater would be collected on-site and conveyed and stored in existing underground storage tanks at D18. Based upon typical rainfall at D18, approximately 170,000 gallons per year of rainwater may be collected as site run-off. Because of the regional Mediterranean climate, rainwater can only be collected during the winter season and could not be relied upon as a source throughout the summer months. Additional site grading, piping and pumping would be required to convey run-off to the storage tanks to bring the stored water to its end uses. Additional treatment may be required to eliminate pollutants contributed to runoff such as petroleum hydrocarbons and particulates. Review of the complexity of the on-site retrofit and cost effectiveness of the alternatives concluded the alternative to be infeasible without additional detailed on-site engineering evaluation beyond the scope of this investigation.

Strategy 1

Municipal Recycled Water Substitution for Bus Washing (Bus Facilities)

Municipal recycled water may be substituted for potable water supplies where available. Use of recycled municipal wastewater is allowable by the Title 22 regulations of the California Code of Regulation provisions for the use of recycled water.

Use of recycled water at Metro facilities should be considered on a site specific basis considering the quality of the available recycled water and the retrofit requirements to modify existing plumbing, consistent with applicable state requirements. Pursuant to Section 60307, Article 3, Chapter 3, recycled water may be used for commercial car washing, including hand washes if the recycled water is not heated, where the general public is excluded from the washing process. Recycled water must be disinfected tertiary water, with a turbidity of no greater than 2 Nephelometric Turbidity Units (NTU), does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU.

The cost effectiveness of recycled water use is dependent upon the availability and proximity of existing recycled water infrastructure, as well as the amount of recycled water that may be used as substitute to potable water. Recycled water is widely available throughout Los Angeles County by several municipal agencies including LADWP and West Basin Municipal Water District (WBMWD) as presented in Figure 28.

Data logging has identified that, on average, bus and car washing represents 90 percent of the total water use. Sanitary end uses for toilet and urinal flushing represent 1 percent of total water use. Therefore, the incremental benefit of recycled water use for toilet, urinal flushing and other interior uses is anticipated to be relatively small and the retrofit costs for dual plumbing relatively high. Additionally, strategies that would convert sanitary end-use fixtures to high efficiency and waterless fixtures are known to have a high cost benefit without the extensive retrofit costs.

Retrofit of existing interior facilities to a dual plumbed system for the provision of recycled water at toilet and urinals is therefore not considered. The age of the existing facilities and the high cost to meet the requirements for cross-connection between the potable and recycled water systems and the relatively low volume of these end-uses make retrofit of existing interior facilities infeasible.

Use of municipal recycled water is recommended for bus washing throughout Metro's bus facilities. As discussed above, the bus washing process includes a preliminary rinse, wash, and final rinse. Water treated through an RO system is used to prevent spotting during the final rinse process. Concentrate reject from the RO system is conveyed back to the wash system for blending with potable water and drain water collected from the wash facilities.

Higher concentration of TDSs (over 350 parts per million [ppm]) in recycled water may contribute to spotting (Brown 2000). Recycled water quality is approximately 1000 ppm TDS, as reported by LADWP. Recycled water may be used in the preliminary rinse and wash processes, but not used for the final rinse process to reduce spotting with RO treatment.

TDS from the recycled water could be reduced through the on-site RO treatment system and used for the final rinse of the wash process in addition to the preliminary rinse and wash, resulting in potable water savings of approximately 34,471 gpd at each bus wash facility.

An evaluation of the RO treatment system to lower the TDS of recycled water to reduce spotting potential in the final rinse would be required. Further, increased use of the RO treatment system used to treat recycled water for the final rinse would impact the energy and power used for the system.

Quantitative Results

A potable water savings of 413,652 gpd could be achieved from use of recycled water for bus washing at all Metro bus facilities.

Energy Impacts

Additional energy may be required for additional treatment at the RO treatment system to accommodate the higher TDS water. Additional energy may be expended by the municipal recycled water purveyor for additional treatment and conveyance to the site.

Cost: Capital/O&M

It is assumed that municipal recycled water is readily available and no costs would be incurred for repayment of existing extension of new recycled water transmission pipelines. It is assumed that approximately 600 linear feet (LF) of onsite pipelines may be required for conversion of the bus wash system to municipal recycled water at each facility. Based upon correspondence with LADWP, the cost of recycled water is estimated by LADWP to be a 20 percent discount from potable water cost. Estimated annual cost of water for recycled water for all bus facilities is estimated to be $360,043.

Financial Analysis

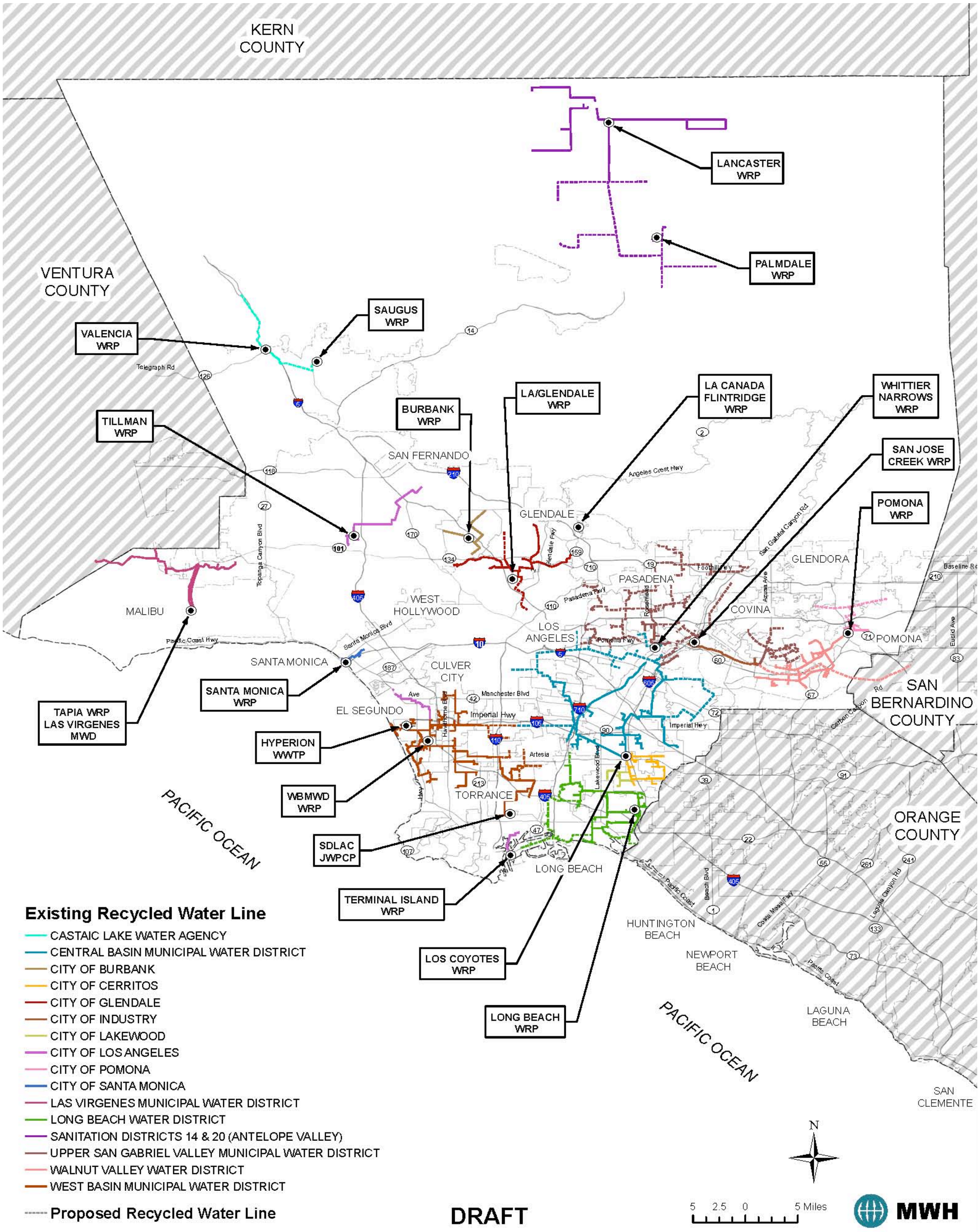
The anticipated benefits are calculated based on the cost differential between potable and recycled water, as well as the capital cost investment for retrofit of the existing facilities and on-going operations and maintenance. The life cycle benefits are estimated at $1,531,715 system wide. The life cycle costs are $135,000 system wide. The system wide net benefits are $1,396,715.

The Benefit/Cost Ratio is 11.35

Business Case

Water saved (for all bus facilities) per revenue hour is 13.24 gallons.

Figure 28. Los Angeles County Recycled Water Systems (LACRWAC) March 2008



Strategy 2

Municipal Recycled Water Substitution for Car Washing (Rail Facilities)

Regulatory requirements for the use of municipal recycled water at rail facilities is the same as described for Metro's bus facilities.

Use of municipal recycled water is recommended for car washing throughout Metro's rail facilities.

Quantitative Results

A potable water savings of 10,329 gpd could be achieved from use of recycled water for car washing at all Metro rail facilities.

Energy Impacts

Additional energy may be expended by the municipal recycled water purveyor for additional treatment and conveyance to the site.

Cost

It is assumed that municipal recycled water is readily available and no costs would be incurred for repayment of existing extension of new recycled water transmission pipelines. It is assumed that approximately 600 LF of onsite pipelines may be required for conversion of the car wash system to municipal recycled water at each facility. The cost of recycled water is estimated by LADWP to be a 20 percent discount from potable water cost. Estimated annual cost of water for recycled water for all rail facilities is estimated to be $9,000.

Financial Analysis

The anticipated benefits are calculated based on the cost differential between potable and recycled water, as well as the capital cost investment for retrofit of the existing facilities and on-going operations and maintenance. The life cycle benefits are estimated at $38,215 system wide. The life cycle costs are $45,000 system wide. The system wide net benefits are -$6,786.

The Benefit/Cost Ratio is 0.85.

Business Case

Water saved (for all rail facilities) per revenue hour is 4.0 gallons.

Strategy 3

Municipal Recycled Water Substitution for Landscape Irrigation (Bus and Rail Facilities)

Metro may convert to the use of recycled water for on-site irrigation, following permit application and approvals from the local recycled water purveyor and the California Department of Public Health (CDPH). A separate, dedicated meter for recycled water would be obtained from the recycled water provider. All hosebibs will be designed as quick-coupling, all irrigation facilities constructed according to the Title 22, Chapter 3 regulations of the California Code of Regulations provisions for the use of “purple pipe” and associated purple designation for all onsite irrigation equipment and facilities. Engineering plans for the recycled water system and conversion from potable water should be prepared and reviewed with CDPH to ensure that the conversion is compliant with appropriate Title 22 separation design and construction standards. A “spool” of the potable water supply pipe would be engineered and constructed to facilitate its removal to effectively separate the potable irrigation system from the future recycled water irrigation system, the potable irrigation meter removed, and the former potable pipeline trench then backfilled. A pressure test should be conducted in coordination with the water provider. After conversion to recycled water use and pursuant to the requirements of CDPH, signs would be erected onsite to inform staff and the public of the safe and compliant use of recycled water for on-site irrigation. Staff would be educated in the on-site irrigation uses and prohibitions associated with reclaimed water such as no off-site run-off or drift.

Quantitative Results

Approximately 7,104 gpd of potable water could be saved by substitution with municipal recycled water for landscape irrigation throughout Metro’s bus and rail facilities.

Energy Impacts

Additional energy may be expended by the municipal recycled water purveyor for additional treatment and conveyance of recycled water to Metro sites. However, regionally, recycled water purveyors are completing their systems regardless of the participation by Metro. Therefore, there is no additional off-site energy demand generated by this strategy.

Cost: Capital/O&M

It is assumed that municipal recycled water is readily available and no costs would be incurred for existing or new recycled water transmission pipelines. It is assumed that an average of 1,000 LF of onsite pipeline retrofit would be required for conversion of the irrigation system to municipal recycled water at each site at a cost of approximately $45,000 at each site. Additional anticipated costs for inspection and engineering review are also included. Annual cost of recycled water for landscape irrigation is estimated to be $6,185 throughout all Metro bus facilities.

Financial Analysis

The anticipated benefits are calculated based on the cost differential between potable and recycled water, as well as the capital cost investment for retrofit of the existing facilities and on-going operations and maintenance. The life cycle benefits are estimated at $26,305 system wide. The life cycle costs are $540,000 system wide. The net benefits are -$514,695.

The Benefit/Cost Ratio is 0.05.

Business Case

Water saved (for all bus and rail facilities) per revenue hour is 0.23 gallons.

Strategy 4

Extension of Bus Runoff Capture On-Site Reclamation (Bus Facilities)

Run off from the buses at the bus washing Washers is typically collected through floor grates, treated in a clarifier, and returned for use within the wash cycle. The current configuration of the run-off collection does not allow for all of the run-off from the buses to be collected following a bus wash. Water run-off from the buses continues after they have passed the collection floor grates. Air blowers are automatically activated to enhance the runoff while buses are on the floor grates. However, it was observed during data logging that air blowers are not consistently operated. Additionally, speed restriction during bus drive through should be strictly enforced to maximize the recapture of run-off.

Extension of the floor grates beyond the bus washing bays would allow for more run-off water to be collected for reclamation and reuse within the wash cycle.

Additionally, as an operational procedure, the air blowers should be in operation to remove the excess rinse water from the buses as they exit the wash bay.

Quantitative Results

Metro has estimated that approximately 100 gallons of water are collected from each bus travelling at 2 miles per hour on the floor gates. The existing floor grates are estimated to extend approximately 50 feet. It is estimated that an additional 50 gallons of water per bus could be collected by extending the floor grates an additional 50 feet, ensuring that the air blowers are in operation, maintaining the 2 mph speed limit, approximately 14,500 gpd of water could be saved at each bus facility, or 174,000 gpd for all bus facilities.

Energy Impacts

Consistent use of the air blowers would increase onsite power consumption.

Cost

Estimated capital cost to extend the run-out area is approximately $10,000 at each facility.

Financial Analysis

The anticipated benefits are calculated based on the cost differential between potable and on-site reclaimed water, as well as the capital cost investment for installation of new facilities and on-going operations and maintenance. The life cycle benefits are estimated at $3,180,689 system wide. The life cycle costs are $120,000 system wide. The system wide net benefits are $3,060,689.

The Benefit/Cost Ratio is 26.51

Business Case

Water saved (for all bus facilities) per revenue hour is 5.6 gallons.

Strategy 5

Replacement of Sanitary Fixtures (Bus and Rail Facilities)

Existing standard flow sanitary fixtures installed prior to 1992 should be replaced with high efficiency, low flow models. Toilets should be dual flushed or low flow with no more than 1.6 gallons per flush. Urinals should be waterless models. Sinks should be infrared sensor or pedal operated. Shower head should be low flow with no more than 1.6 gpm flow rate. Sinks should be no more than 2.2 gpm flow rate.

Quantitative Results

Approximately 4,056 gpd may be conserved by the replacement of sanitary fixtures at D18.

Approximately 3,823 gpd may be conserved by the replacement of sanitary fixtures at D20.

Total conservation potential is approximately 4,691,000 gallons per year for the data logged facilities. Throughout Metro's rail and bus divisions, this would provide a savings of approximately 16 million gallons per year.

Energy Impacts

Use of low flow showerheads and faucets will reduce energy consumption consistent with the volume of hot water conserved.

Cost

Capital costs for the replacement of sanitary fixtures at Metro's rail and bus divisions are estimated to be $252,320. Estimates for the capital costs for replacement of sanitary fixtures take rebates offered by the water purveyors into account.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings as well as the capital cost investment for retrofit of the existing facilities and on-going operations and maintenance. The life cycle benefits are estimated at $1,184,257 system wide. The life cycle costs are $252,320 system wide. The system wide net benefits are $931,937.

The Benefit/Cost Ratio is 4.69.

Business Case

Water saved (for all bus and rail facilities) per revenue hour is 1.89 gallons.

Strategy 6

On-Site Graywater Reclamation with Standard Fixtures (Bus and Rail Facilities)

Graywater, or wash water from showers and sinks, may be captured and removed from the existing plumbing to the wastewater stream and re-used on-site as a substitution for potable water in limited applications. The Los Angeles County Department of Building and Safety (LADBS) has authority for the permitting and review of graywater use and systems throughout the County. Currently, there are no applicable water quality standards for onsite treatment of graywater. However, the County provides only for the approved use of graywater in residential buildings. It is therefore recommended that any plans for the development and on-site use of graywater first be coordinated with representative of LADBS to verify applicable regulations. The LADBS allows only the following sources of graywater: untreated wastewater that has not been contaminated by toilet waste or unhealthy bodily washes. Graywater includes waste from showers, bathroom wash basins, but does not include kitchen sinks or dishwashers. LADBS allows the use of residential graywater only for subsurface irrigation. Therefore, use by Metro would be limited to only those sites that currently or plan to provide onsite irrigation. Conversion from existing spray to subsurface irrigation would be required (if approved for Metro facilities). Since discharge to surface water is specifically exempted, it is not known if graywater could be used for onsite bus and car washing.

Additional plumbing would be required to reconfigure the existing waste drainage pipelines. Treatment may be required for use of graywater for bus and car washing, if approved. Prior to reuse, Metro is encouraged to discuss graywater limitations with LADBS.

Quantitative Results

Approximately 3,438 gpd of graywater can be used for potable water substitution at each bus facility and 2,580 gpd at each rail facility, or 51,576 gpd at all Metro facilities.

The estimation of potable water savings is based upon the existing standard efficiency

Energy Impacts

Some pumping may be required to convey graywater to appropriate use sites. Energy related to additional treatment may also be required.

Cost

Estimated capital costs for conversion to graywater use is approximately $33,000 at each facility.

Financial Analysis

The anticipated benefits are calculated based on the cost differential between potable and graywater, as well as the capital cost investment for installation of new pipelines, retrofit of the existing facilities and on-going operations and maintenance. The life cycle benefits are estimated at $775,095 system wide. The life cycle costs are $247,095 system wide. The system wide net benefits are $247,095.

The Benefit/Cost Ratio is 1.47.

Business Case

Water saved (for all bus and rail facilities) per revenue hour is 1.53 gallons.

Strategy 7

Replacement of Steamer (Bus facilities)

The existing steamer should be replaced with a high efficiency model. It is estimated that the steamer wand uses approximately 2,789 gpd. Because of the modern design that incorporates a positive trigger value, higher efficiency models may use only 697 gpd.

Quantitative Results

Approximately 2,092 gpd may be conserved by the replacement of the existing steamer wand with a higher efficiency model at each bus facility.

Energy Impacts

The existing steamer wand is operated by natural gas. The high efficiency steamer would be operated by natural gas, using 289 kWh.

Cost

Capital costs for the replacement of steamer wands at each Metro's bus division is $7,500.

Financial Analysis

The anticipated benefits are calculated based on the cost of the water savings, as well as the capital cost investment for installation of new equipment and on-going operations and maintenance. The life cycle benefits are estimated at $412,069 system wide. The life cycle costs are $154,740 system wide. The system wide net benefits are $257,329.

The Benefit/Cost Ratio is 2.66.

Business Case

Water saved (for all bus facilities) per revenue hour is 1.2 gallons.

Strategy 8

Replacement of Car Wash Facility (Rail Facilities)

The existing car wash system is considered to be an outdated design using approximately 2,580 gallons per day at each rail facility. A high efficiency system saving approximately 20 percent of potable water should be installed.

Typical drive through train washing plant. Note special track drainage.

Quantitative Results

Replacement of the existing car wash system could yield a water savings of approximately 516 gpd at each rail facility or 528,384 gallons per year at all Metro rail facilities.

Energy Impacts

Higher efficiency car washers would also provide greater energy savings.

Cost

Capital costs of a car wash facility is approximately $300,000 at each rail site, with annual operations and maintenance costs of $6,000.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings, as well as the capital cost investment for installation of new facilities and on-going operations and maintenance. The life cycle benefits are estimated at -$370,195 system wide. The life cycle costs are $1,200,000 system wide. The system wide net benefits are -$1,570,195.

The Benefit/Cost Ratio is -0.31.

Business Case

Water saved (for all bus facilities) per revenue hour is 0.8 gallons.

Strategy 9

Replacement of Engine Compartment Cleaner (Bus Facilities)

The existing engine compartment cleaner system, or hot water pressure washer, is considered to be an outdated design using approximately 158 gallons per day at each bus facility. A high efficiency system saving approximately 92 gpd of potable water should be installed.

Quantitative Results

Replacement of the existing car wash system could yield a water savings of approximately 437,330 gallons per year for all Metro bus facilities.

Energy Impacts

Higher efficiency engine compartment cleaners would also provide greater energy savings.

Cost

Capital cost of a high efficiency engine compartment cleaner is approximately $13,000 per site.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings, as well as the capital cost investment for installation of new facilities and on-going operations and maintenance. The life cycle benefits are estimated at -$32,187 system wide The life cycle costs are $154,740 system wide. The system wide net benefits are -$185,927.

The Benefit/Cost Ratio is -0.21.

Business Case

Water saved (for all bus facilities) per revenue hour is 0.05 gallons.

Strategy 10

Replacement of Under Chassis Washer (Bus Facilities)

The existing under chassis water units use approximately 158 gallon per day. The existing units should be replaced with higher efficiency models.

Quantitative Results

Replacement of the existing under chassis washer may yield approximately 8 gpd of water savings at each bus facility, or 37,960 gallons per year at all Metro bus facilities.

Energy Impacts

Higher efficiency washers would also provide greater energy savings.

Cost

Capital costs for the equipment are approximately $13,000. Annual operations and maintenance of the equipment are assumed to by 2 percent of the capital costs at $260 per year.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings, as well as the capital cost investment for installation of new facilities and on-going operations and maintenance. The life cycle benefits are estimated at -$51,316 system wide. The life cycle costs are $156,000 system wide. The net benefits are -$207,316.

The Benefit/Cost Ratio is -0.33.

Business Case

Water saved (for all bus facilities) per revenue hour is 0.004 gallons.

Strategy 11

Replacement of Air Scrubbing Water Curtain (Rail Facilities)

The existing air scrubbing water curtain uses approximately 2,500 gpd at each facility and should be replaced with a higher efficiency air scrubber equipment to reduce water use.

Quantitative Results

Replacement of the water curtain with an air scrubber would yield approximately 23 gpd in water savings at each rail facility or 23,859 gallons per year at all Metro rail facilities.

Energy Impacts

Higher efficiency car washers would also provide greater energy savings.

Cost

Capital costs of replacement of the water curtains are approximately $6,000.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings, as well as the capital cost investment for installation of new facilities and on-going operations and maintenance. The life cycle benefits are estimated at -$15,291 system wide. The life cycle costs are $24,000 system wide. The system wide net benefits are -$39,291.

The Benefit/Cost Ratio is -0.64

Business Case

Water saved (for all rail facilities) per revenue hour is 0.04gallons.

Strategy 12

Replacement of Small Parts Washer (Bus Facilities)

The existing small parts washer uses approximately 63 gpd. The existing small parts washer should be replaced with a high efficiency model that incorporates better water and energy saving measures.

Quantitative Results

Approximately 3 gpd at each bus facility could be saved by replacement of the existing small parts washer, or 13,140 gallons per year throughout all Metro bus facilities.

Energy Impacts

Higher efficiency washers would also provide greater energy savings.

Cost

Capital costs for the equipment are approximately $13,000 for each unit. Annual operations and maintenance of the equipment are assumed to by 2 percent of the capital costs at $260 per year.

Financial Analysis

The anticipated benefits are calculated based on the cost of water savings, as well as the capital cost investment for installation of new equipment and on-going operations and maintenance. The life cycle benefits are estimated at -$29,994 system wide. The life cycle costs are $89,940 system wide. The system wide net benefits are -$119,884.

The Benefit/Cost Ratio is -0.33.

Business Case

Water saved (for all bus facilities) per revenue hour is 0.002 gallons.

Strategy 13

Assessing Education and Outreach Measures (Rail and Bus Facilities, Gateway Headquarters)

Some water conservation strategies that provide demand management lack specific numeric estimates of actual annual water conserved. These strategies are related to behavioral modification of employees and patrons and consist of education and outreach. This section presents an overview of the recommended education and outreach strategies with estimates of conventional and water conservation savings based on professional judgment.

Education

An employee training program will initially educate and continually update staff on the importance of water conservation as it relates to their work environment and procedures. More specifically, these strategies will educate staff on the proper implementation of equipment operation, maintenance and inspection procedures. Additionally, conservation practices are highlighted and their identification incentivized to the individual. The proposed water conservation strategies outlined in other portions of this Plan can therefore more reliably achieve and maintain identified conservation savings by integrating the strategies directly into the site's staffing practices. Delivery of these strategies would be tailored for on-site use to attain and maintain conservation savings.

Metro is currently completing its EMS pilot effort. By using EMS principles for the identification, correction and monitoring of water use and conservation measures, Metro can incentivize its employees to actively participate in the implementation of its water use and conservation policy. By raising water use and conservation to this level of employee involvement, additional conservation opportunities may be identified for continuous improvements.

Outreach

Metro buses, trains, and vans provide the opportunity to expose a wide population to the need, purpose of and participation in water conservation practices. Metro can display appropriate signage promoting water conservation within its stations and vehicles. Signs placed in staff and visitor serving restrooms reinforce the need for conservation of sanitary water uses and describe the benefits of high efficiency fixtures.

Education and Outreach Conservation Savings

For the purposes of this Plan, it was necessary to apply professional judgment to estimate the anticipated water conservation savings that would yield from education and outreach measures. It is reasonable to assume that the use of the education and outreach strategies described herein would provide an estimated additional 1 percent water savings per year above that resulting from the Equipment-Based (or non-behavioral) conservation strategies.

It is estimated that an additional 1 percent water conservation improvement would result each year for the first 5 years of project operations. This estimate is based on initial start-up operations, focus on the issue, the routine of project operations, and the identification of new and more water conserving practices and procedures that would likely be expected to result from operations within the positive, incentivized environment that is intended to result from these strategies.

Perhaps more significantly, the anticipated results of the education and outreach strategies is the preservation or “conservation hardening” of the water savings that will result. Stated differently, the education and outreach strategies would result in permanent savings without degradation. This can be concluded because of the ongoing nature of these strategies as they are integrated into the business practices.

The five-year horizon of conservation improvements applied to these strategies is realistic. It is believed that all reasonable operations strategies associated with education and outreach will have been explored, tested and optimized within that five-year period, and that these savings will then be maintained at a consistent level throughout the life of the project.

In comparison to conventional operations without the education and outreach efforts, it is believed that the associated water conservation savings described above would not be achievable. Therefore, no conservation savings are identified for education and outreach without the implementation of these strategies as described above.

Measurement

Measurement (water use data logging) and auditing (site audits) of actual water use characteristics are understood to be necessary for the maintenance of conservation savings.

Site audits of interior and exterior water use are typically offered by California public water suppliers. Audits identify leaks, off-specification performance of equipment and provide updates on the potential for retrofit and or maintenance of existing equipment and practices.

Audits would be performed on an annual basis to ensure achievement and maintenance of water conservation anticipated from the proposed strategies, considering the inclusion of a suite of other water conserving practices and facilities.

Water use data logging (including the use of sub-metering on specified end use facilities) provides direct, higher resolution and more immediate feedback to project operations than can be achieved from utility metering by the water supplier. Data logging identifies out of specification operations and reports reinforce conservation achievements to the staff and project operators.

Together these measurement strategies do not provide additional water conservation savings; however, their importance to the data logging and site audits provide a significant assurance that the conservation benefits are sustainable and that reporting requirements are achieved.

Strategy 14

Water Conservation at Gateway Headquarters and MSSC (Gateway Headquarters, MSSC)

The following water conservation strategies are recommended for implementation at the Gateway Headquarters and MSSC:

- Continue retrofit of all faucets, toilets, urinals and showerheads to high efficiency equipment. Continue water conserving operations at the Gateway cafeteria, print shop and at other major water using operations.
- Continue to provide water conservation educational materials and reminders throughout the buildings.
- Conduct interior water use evaluations and leak surveys to identify and prioritize repairs of existing pipelines and replacement of other end-use equipment.

- Conduct exterior water use evaluations and leak surveys to identify and prioritize repairs of existing irrigation pipelines and equipment. Work with landscape professionals to identify native vegetation and properly zone all irrigation based on plant type and irrigation requirements. Convert all irrigation controllers to ET -based (smart) controllers. Convert all spray irrigators to matched-precipitation type equipment. Convert all ornamental irrigation to drip-type. Reduce or eliminate all turf. Ensure appropriate use of mulch throughout all planted areas.
- Identify the availability and cost effectiveness to the conversion and use of recycled municipal wastewater for irrigation purposes.
- At the Gateway Headquarters, following replacement of the meter to the cooling towers water supply pipeline, conduct a study of the overall cooling tower water use. This study should evaluate the potential benefit-cost and water savings for the optimization of the cooling tower water use, evaluate the potential to increase the number of operational cycles for each fill, prior to blow-down, and, as appropriate, identify the costs of equipment repair and replacement. As appropriate to the findings of this study, consider the potential costs and benefits of using recycled water for cooling tower make-up.

4.2 Summary

Table 16, Table 17, and Table 18 summarize the anticipated conventional water demand, proposed water demand of each conservation strategy and the anticipated annual maximum and minimum water savings resulting from Plan implementation. Water savings estimated from both the bus and rail divisions are 204 million gallons per year (627AFY). Conservation measures may provide 40 percent savings of conventional water demands.

Table 16. Bus Cost Benefit Analysis Summary

Conservation Strategy	Typical Bus Facility									All Bus Facilities					
	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	B/C Ratio	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Gallons Saved Per Revenue Hour
1. Municipal Recycled Water For Bus Washing	34,471	0	34,471	8,824,576	27.08	37,504	11,250	30,004	11.35	105,894,912	325	450,053	135,000	360,043	13.24
2. Municipal Recycled Water For Car Washing	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Municipal Recycled Water For Landscape Irrigation	592	0	592	151,552	0.47	644	45,000	515	0.05	1,818,624	6	7,729	540,000	6,183	0.23
4. Extension of Bus Wash On-Site Reclamation	34,471	19,971	14,500	3,712,000	11.39	15,776	10,000	200	26.51	44,544,000	137	189,312	120,000	2,400	5.57
5. Replacement of Sanitary Fixtures	5,604	1,548	4,056	1,038,328	3.19	4,413	15,420	–	4.69	12,459,936	38	52,955	185,040	0	1.56
6. On-Site Gray Water Reclamation with Standard Fixtures	34,471	31,034	3,438	880,000	2.70	3,740	33,000	660	1.47	10,560,000	32	44,880	396,000	7,920	1.32
7. Replacement of Steamer	2,789	697	2,092	763,489	2.34	2,276	12,895	258	2.66	9,161,865	28	27,310	154,740	3,095	1.15
8. Replacement of Car Wash Facility	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9. Replacement Engine Compartment Cleaner	158	66	92	33,641	0.10	100	12,895	258	-0.21	403,690	1	1,203	154,740	3,095	0.05
10. Replacement of Under Chassis Washer	158	150	8	2,920	0.01	9	13,000	260	-3.95	35,040	0	104	156,000	3,120	0.00
11. Replacement of Air Scrubbing Water Curtain	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12. Replacement of Small Parts Washer	63	60	3	1,095	0.00	3	7,495	150	-0.33	13,140	0	39	89,940	1,799	0.00

Table 16. Bus Cost Benefit Analysis Summary (Continued)

Conservation Strategy	Typical Bus Facility									All Bus Facilities					
	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	B/C Ratio	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Gallons Saved Per Revenue Hour
Subtotal	112,777	53,525	59,251	15,407,601	47.28	64,466	160,955	32,305	–	184,891,207	567	773,586	1,931,460	387,654	23.11
Note 1: Education Related Conservation Measures assume an addition water savings of 1% of overall equipment based measure savings use per year for five years	112,777	53,525	2963	770380	2	3,223	–	1,615	–	9,244,560	28	38,679	–	19,383	–
Annual Total (After 5 Years)	225,553	107,051	62,214	16,177,981	50	67,689	160,955	33,920	–	194,135,767	596	812,265	1,931,460	407,037	–

Table 17. Rail Cost Benefit Analysis Summary

Conservation Strategy	Typical Rail Facility									All Rail Facilities					
	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	B/C Ratio	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Gallons Saved Per Revenue Hour
1. Municipal Recycled Water For Bus Washing	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Municipal Recycled Water For Car Washing	2,580	0	2,580	660,480	2.03	2,807	11,250	2,246	1.12	2,641,920	8	11,228	45,000	8,983	4.03
3. Municipal Recycled Water For Landscape Irrigation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Extension of Bus Wash On-Site Reclamation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Replacement of Sanitary Fixtures	5,092	1,269	3,823	978,688	3.00	4,159	16,820	–	0.93	3,914,752	12	16,638	67,280	0	5.96
6. On-Site Gray Water Reclamation with Standard Fixtures	2,580	0	2,580	660,480	2.03	2,807	33,000	660	23.00	2,641,920	8	11,228	132,000	2,640	4.03
7. Replacement of Steamer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8. Replacement of Car Wash Facility	2,580	2,064	516	132,096	0.41	561	300,000	6,000	0.01	528,384	2	2,246	1,200,000	24,000	0.81
9. Replacement Engine Compartment Cleaner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10. Replacement of Under Chassis Washer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11. Replacement of Air Scrubbing Water Curtain	23	0	23	5,965	0.02	25	6,000	250	0.05	23,859	0	101	24,000	1,000	0.04
12. Replacement of Small Parts Washer	–	–	–	–	–	–	–	–	0.01	–	–	–	–	–	–

Table 17. Rail Cost Benefit Analysis Summary (Continued)

Conservation Strategy	Typical Rail Facility									All Rail Facilities					
	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	B/C Ratio	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Gallons Saved Per Revenue Hour
Subtotal	12,856	3,333	9,522	2,437,709	7.48	10,360	367,070	9,156	–	9,750,835	30	41,441	1,468,280	36,623	14.86
Note 1: Education Related Conservation Measures assume an addition water savings of 1% of overall equipment based measure savings use per year for five years	–	–	–	121,885	0.37	518	–	458	–	487,542	1	2,072	0	1,831	–
Annual Total (After 5 Years)	–	–	–	2,559,594	7.86	10,878	367,070	9,613	–	10,238,377	31	43,513	1,468,280	38,454	–

Table 18. Bus and Rail Cost Benefit Analysis Summary

Conservation Strategy	All Bus and Rail Facilities							
	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Estimated Capital Cost ($)	Estimated Annual O&M Cost	Net Benefit (Benefit-Cost)	Gallons Saved Per Revenue Hour	B/C Ratio	Payback Period (considering O&M)
1. Municipal Recycled Water For Bus Washing	105,894,912	325	135,000	360,043	1,396,715	13.24	11.35	1.50
2. Municipal Recycled Water For Car Washing	2,641,920	8	45,000	8,983	-6,786	4.03	0.85	20.04
3. Municipal Recycled Water For Landscape Irrigation	1,818,624	6	540,000	6,183	-513,695	0.23	0.05	349.33
4. Extension of Bus Wash On-Site Reclamation	44,544,000	137	120,000	2,400	3,060,689	5.57	26.51	0.64
5. Replacement of Sanitary Fixtures	16,374,688	50	252,320	0	931,937	1.89	4.69	3.63
6. On-Site Gray Water Reclamation with Standard Fixtures	13,201,920	41	528,000	10,560	247,095	1.53	1.47	11.59
7. Replacement of Steamer	9,161,865	28	154,740	3,095	257,329	1.15	2.66	6.39
8. Replacement of Car Wash Facility	528,384	2	1,200,000	24,000	-1,570,195	0.81	-0.31	-55.16
9. Replacement Engine Compartment Cleaner	403,690	1	154,740	3,095	-186,927	0.05	-0.21	-81.81
10. Replacement of Under Chassis Washer	35,040	0	156,000	3,120	-64,316	0.00	-3.95	-4.53
11. Replacement of Air Scrubbing Water Curtain	23,859	0	24,000	1,000	-39,291	0.04	-0.64	-26.71
12. Replacement of Small Parts Washer	13,140	0	89,940	1,799	-119,884	0.00	-0.33	-51.11
Subtotal	194,642,042	597	3,399,740	424,277	3,392,672	28.52	–	–
Note 1: Education Related Conservation Measures assume an addition water savings of 1% of overall equipment based measure savings use per year for five years	9,732,102	30	–	21,214	169,634	1.12	10.47	5.67
Annual Total (After 5 Years)	204,374,144	627	3,399,740	445,491	3,562,305	–	–	–

5. Next Steps

The following three steps are recommended for the refinement, implementation, and, ongoing optimization of the Water Action Plan and its associated strategies for conservation.

5.1 Step I. Metro Confirmation

Metro's Environmental Compliance and Services Department will take the lead in coordinating with the appropriate internal and external stakeholders to ensure that their issues associated with the Water Action Plan are identified and understood. They will review the water conservation and potable water supply substitution strategies identified herein and will verify consensus on their prioritization for implementation. They will facilitate integration of the Water Action Plan as a key element of Metro's sustainability plan, confirm appropriate inclusion into the Environmental Management System and maintain collaboration with Metro's broader policies, goals and objectives.

5.2 Step II. Proof of Concept

Metro will select the most environmentally and financially advantageous water conservation strategies for controlled implementation at Divisions 18 and 20. Divisions 18 and 20 will thereby serve as water conservation laboratories to facilitate the verification and piloting of the anticipated water savings and retrofit costs, cost savings and provide appropriate hands-on opportunities for Metro to gain first hand construction and operational experience with conservation strategies. As necessary, strategies will be fine tuned to optimize deployment and meet Metro's specific requirements. The planned retrofit of Division 20's car wash will provide additional opportunities for data gathering on the cost effectiveness of modern car washing equipment. Previously installed sub-meters will be re-used to provide ongoing water use data and will provide a benchmark for water use before and after implementation of conservation strategies.

A "Path Forward" document will be prepared to update schedules and budgets for Metro-wide water conservation. This document will be used to present actual water conservation savings, benefit-cost analysis, and, make appropriate refinements to the prioritization for strategy implementation.

5.3 Step III. Site Verification

Remaining Metro divisions will be surveyed for their suitability to water conservation strategy retrofits previously piloted at Divisions 18 or 20. Site specific conditions will be documented. Opportunities and constraints to implementation will be identified. As appropriate, individual planning and engineering documents would be developed to meet individual site constraints.

Anticipated water conservation strategy performance would be evaluated. Metrics such as recycle rate for bus and car washing equipment would be confirmed, and adjusted, as needed. Proximity and availability to supplies of municipally recycled water would be identified.

Landscaping areas under irrigation would be measured. Leakage surveys and audits of interior and exterior water use would be completed in coordination with local water providers.

Water use audits would be conducted at the Gateway Headquarters and the Metro Support Services Center to confirm the performance of water conservation equipment and identify additional strategies, such as cooling tower optimization.

As necessary, the Water Action Plan would be updated to remain current with implementation plans, and planned conservation savings.

6. References

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7. Appendix A
Water Fixture Replacement and Graywater Savings

Table A-1. Water Fixture Replacement and Graywater Savings

	Division 18								Division 20								Total			
Conservation Strategy	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Conventional Potable Water Use (gpd)	BMP Potable Water Use (gpd)	Anticipated Water Savings (gpd)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Dollars Saved Per Year ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Anticipated Annual Water Savings (gpy)	Anticipated Annual Water Savings (AFY)	Estimated Capital Cost	Estimated Annual O&M Cost ($)
Municipal Recycled Water For Bus Washing	34,471	0	34,471	8,824,576	27.08	37,504	11,250	42,779						-			8,824,576	27.08	11,250	42,779
Municipal Recycled Water For Car Washing									2,580	0	2,580	660,480	2.03	2,807	11,250	1,968	660,480	2.03	11,250	1,968
Municipal Recycled Water For Landscape Irrigation	592	0	592	151,552	0.47	644	45,000	735					0.00	-			151,552	0.47	45,000	735
On-Site Gray Water Reclamation with Standard Fixtures	34,471	31,034	3,438	880,000	2.70	3,740	33,000	660	2,580	0	2,580	660,480	2.03	2,807	33,000		1,540,480	4.73	66,000	660
On-Site Gray Water Reclamation with High Effeciency Fixtures	34,471	33,865	606	155,200	0.48	660	94,300	1,886	2,580	2,096	484	124,000	0.38	527			279,200	0.86	94,300	1,886
Extension of Bus Wash On-Site Reclamation	34,471	19,971	14,500	3,712,000	11.39	15,776	10,000	200					0.00	-			3,712,000	11.39	10,000	200
Replacement of Sanitary Fixtures	5,604	1,548	4,056	1,038,328	3.19	4,413	61,300	1,226	5,092	1,269	3,823	978,688	3.00	4,159	72,450	1,449	2,017,016	6.19	133,750	2,675
Replacement of Steamer	2,789	697	2,092	763,489	2.34	2,276	13,000						0.00	-			763,489	2.34	13,000	-
Replacement of Small Parts Washer	63	60	3	1,095	0.00	3	7,500						0.00	-			1,095	0.00	7,500	-
Replacement of Under Chassis Washer	158	150	8	2,920	0.01	9	13,000						0.00	-			2,920	0.01	13,000	-
Replacement Engine Compartment Cleaner	158	66	92	33,641	0.10	100	13,000						0.00	-			33,641	0.10	13,000	-
Replacement of Car Wash Facility									2,580	2,064	516	132,096	0.41	561	300,000	6,000	132,096	0.41	300,000	6,000
Replacement of Air Scrubbing Water Curtain									23	0	23	5,965	0.02	25	6,000	250	5,965	0.02	6,000	250
Subtotal	147,248	87,390	59,858	15,562,801	47.76	65,125	301,350	47,485	15,436	5,429	10,007	2,561,709	7.86	10,887	422,700	9,667	18,124,509	55.62	724,050	57,152
Note 1: Education Related Conservation Measures assume an addition water savings of 1% of overall equipment based measure savings use per year for five years				778140	2							128085	0.39				906225	3		
Annual Total (After 5 Years)				16,340,941	50							2,689,794	8.25				19,030,735	58		

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