Small System Operation and Maintenance - A Local Experience

Austin Pomeroy
Public Works Foreman
Town of Placentia

Presentation Purpose

- To give a local example of small systems
- Provide information concerning the operation and maintenance of those systems
- Generate discussion with the owners/operators of other small systems

Presentation Outline

- **Background**
- **Water System Infrastructure**
  - Intakes
  - Disinfection Systems
  - Distribution Systems
  - Water Treatment Plant
- **Operation and Maintenance**
  - Workforce
  - Schedule
  - Records
  - New Initiatives as a result of Training
    - Unidirectional Flushing
    - Leak Detection
  - Greatest Problem
- **Discussion**

Background - Placentia

- Originally populated by Basques fishermen early in the 16th century
- First water mains installed in 1890
- Towns of Dunville, Jerseyside, Placentia and Freshwater amalgamated in 1994 to form the present municipality of Placentia

Background - Placentia

Background - Placentia

- Population

1991	1996	2001
5515	5013	4426

Water System Infrastructure

- Amalgamation lead to four isolated water systems being operated by the Public Works Department

- Four sets of:
  - Intakes
  - Disinfection Systems
  - Distribution Systems

One:

Water Treatment Plant

Water System Infrastructure

- Intakes

Dunville – Wyses Pond

Jerseyside and Placentia – Larkins Pond

Placentia (Alternate) – SE River

Freshwater and Argentia – Clarkes Pond

Water System Infrastructure

- Primary/Secondary Disinfection Systems

Dunville – Ozone/Chloramines

Jerseyside and Placentia – Gas Chlorination

Placentia (Alternate) – Gas Chlorination

Freshwater and Argentia – Gas Chlorination

Water System Infrastructure

- Primary/Secondary Disinfection Systems

Gas Chlorination

Ozone/Chloramines

Water System Infrastructure

- Secondary Disinfection Systems

Jerseyside and Placentia

Liquid Chlorination Booster

Gas Chlorination Booster

Water System Infrastructure

- Distribution System

• Screens	4 Sets
• Pumps	16
• Water Meters	6
• Piping	38 km
• Valves	300 + (Assorted)
• Storage Tanks	4
• Hydrants	200
• Service Lines	1200

Water System Infrastructure

- Distribution System
  - Screens

Water System Infrastructure

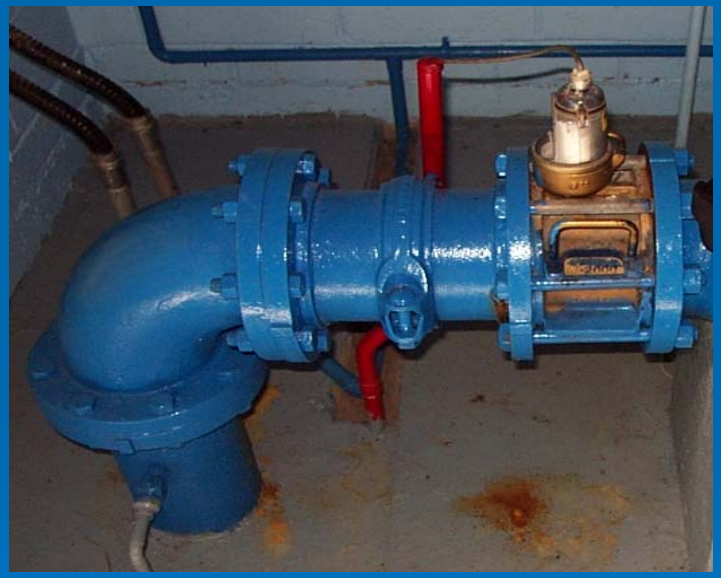
- Distribution System
  - Pumps

In-Line Booster (Turbine)

Vertical Turbine

Water System Infrastructure

- Distribution System
  - Water Meters



Water System Infrastructure

- Distribution System
  - Piping
    - 38 kilometers of water main
    - Range in size from 1.5” to 12”
    - Ductile Iron (DI), Cast Iron (CI), Asbestos Cement (AC), Polyethylene (PE) and Polyvinyl Chloride (PVC)
    - Oldest pipes installed in 1890

Water System Infrastructure

- Distribution System
  - Valves

Main Line Gate Valve

Water System Infrastructure

- Distribution System
  - Valves

Pressure Reducing Valve (PRV)

Air Release Valves

Water System Infrastructure

- Distribution System
  - Storage Tanks

In-Ground Concrete Reservoir

Water System Infrastructure

- Distribution System
  - Storage Tanks

Standpipes

Water System Infrastructure

- Distribution System
  - Hydrants
    - 200 dry barrel hydrants

Water System Infrastructure

- Dunville Water Treatment Plant

  - Treatment plant originally installed due to taste and odour complaints
  - Average raw water colour over 30 TCU was also a concern

Water System Infrastructure

- Dunville Water Treatment Plant

Design Specifications:

- 200 gpm
- Raw water colour of 45 TCU
- Raw water turbidity of 5 NTU

Treatment Process:

- Ozonation
- Filtration
- Secondary Disinfection
- pH Adjustment

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process:

- Ozonation

Air Compressor

Ozone Generator

Contact Chamber

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process:

- Filtration

Dual Media Filters

Sludge Lagoon

Clear Water Chamber

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process:

- Secondary Disinfection

Chlorine Addition

Ammonia Addition

Residual Testing

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process:

- pH Adjustment

Lime and Soda Ash Mixing

Injection

pH Testing

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process:

- pH Adjustment

Prior to installing pH adjustment equipment the maintenance crew were repairing approximately 75 leaks per year. Since the installation, the number of leaks has dropped to 3-4 leaks per year.

Water System Infrastructure

- Dunville Water Treatment Plant

Treatment Process Outcomes:

Parameter	Before Treatment	After Treatment
Colour (TCU)	40	15
pH	6.0	7.0
Leaks	75 per year	3-4 per year
Complaints	**MANY**	**NONE**

Operation and Maintenance

- Workforce

  - Status 5 - Fulltime Operators
    1 - Fulltime Works Foreman

  - Certification
    6 - Operators with Water Distribution Level One
    3 - Operators with Water Treatment Level One

Operation and Maintenance

- Schedule

  - Daily - Pump systems, chlorine systems, chlorine residual, water levels, flow rates, and pressure + Dunville plant (Next Slide)
  - Weekly - Clean screens, run diesel pumps, visual inspection of storage tank exteriors and clean compressor filters
  - Monthly - Grease motors, pumps and blower
  - Yearly - Flush distribution system (twice), inspect storage tank interiors and conduct leak detection survey

Operation and Maintenance

- Schedule

As the preceding slide indicates, operation and maintenance is happening on a “seven days a week” basis

Operation and Maintenance

- Records

TOWN OF PLACENTIA

OPERATOR INSPECTION CHECKLIST

Dunville Water Treatment Plant for the Week of _____

Item	Freq.	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Cl_2 Levels/Rate (chlorine)	2 X Daily							
Ph Levels	2 X Daily							
Pressure Switches	2 X Daily							
Check & Record Pressure Reading (see reverse)	2 X Daily							
Ph, Color, CL, Flow	2 X Daily							
Check & Record Water Levels (see reverse(	2 X Daily							
Check Reservoir/Filters	2 X Daily							
Check Wet Well	2 X Daily							
Check Ozone Generator (leaks/gauges/fault lights)	Daily							
Check Compressor	Daily							
Check Belts	Daily							
Drain Trap	Daily							
Lime/Soda Ash	Daily							
Clean Compressor Filters	Weekly							
Grease Blower	Monthly							
Grease Motors	Monthly							
Check Brushes	3 Months							
Check Reservoir - Clean if Necessary	Yearly							
Replace Brushes	3 Years							
Clean Screens	Weekly							
Operator Initial:								

* *See Reverse for Comments and Recorded Readings*

23-Jan-01

Operation and Maintenance

- Records

Check Wet Well	2 X Daily	
Check Ozone Generator (leaks/gauges/fault lights)	Daily	
Check Compressor	Daily	
Check Belts	Daily	
Drain Trap	Daily	
Lime/Soda Ash	Daily	
Clean Compressor Filters	Weekly	
Grease Blower	Monthly	

Operation and Maintenance

- Records

TOWN OF PLACENTIA

OPERATOR INSPECTION CHECKLIST

Dunville Water Treatment Plant for the Week of _____

Date	Comments	Pressure Reading (Kpa)	Water Level (m)	Ph/Color/CL/Flow
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				

Operation and Maintenance

- Records

S.E. Road, Meter Bldg.
Log Book

Town of Placentia
Public Works

2004

Month	Flow	Flow	Cl2 Residual	Cl2 Residual	Pump Pr.	Vacuum	Chlorine
	Forward	Reverse	Free	Total	< >	< >	Remaining
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
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27							
28							
29							
30							
31							

Operation and Maintenance

S.E. Road, Meter Bldg.
Log Book

Town of Placentia
Public Works

2004

Month	Flow	Flow	Cl2 Residual	Cl2 Residual	Pump Pr.	Vacuum	Chlorine
	Forward	Reverse	Free	Total	< >	< >	Remaining
1							
2							
3							
4							

Operation and Maintenance

- Schedule
  - Ongoing Repairs

Operation and Maintenance

- Schedule
  - Ongoing Repairs – Tools and Equipment

Operation and Maintenance

- Schedule
  - Ongoing Repairs – Tools and Equipment

Operation and Maintenance

- New Initiatives as a result of training

Unidirectional Flushing

Leak Detection

Operation and Maintenance

- New Initiatives as a result of training

  - Unidirectional Flushing

  - Isolation of pipe segments and flushing in a sequential manner from source to periphery
  - Involves closing off valves in a section of the system to create a single path of flow in the section (i.e. all water being flushed from the system passes through the entire length of the section being flushed).

Operation and Maintenance

- New Initiatives as a result of training

  - Unidirectional Flushing - PURPOSE

- Ensures that the water velocity along the pipe section remains relatively constant and that sediment remains suspended until removed (if high enough velocity).

Target velocities:

- 3.0 feet per second - sediment
- 5.0 feet per second - biofilm

Operation and Maintenance

- New Initiatives as a result of training

  - Unidirectional Flushing

  How do we know when we have reached 3.0 feet per second or 5.0 feet per second?

  - Measure flow with PITOT guage
  - Use table to compare flow to pipe diameter

Operation and Maintenance

- New Initiatives as a result of training
  - Unidirectional Flushing

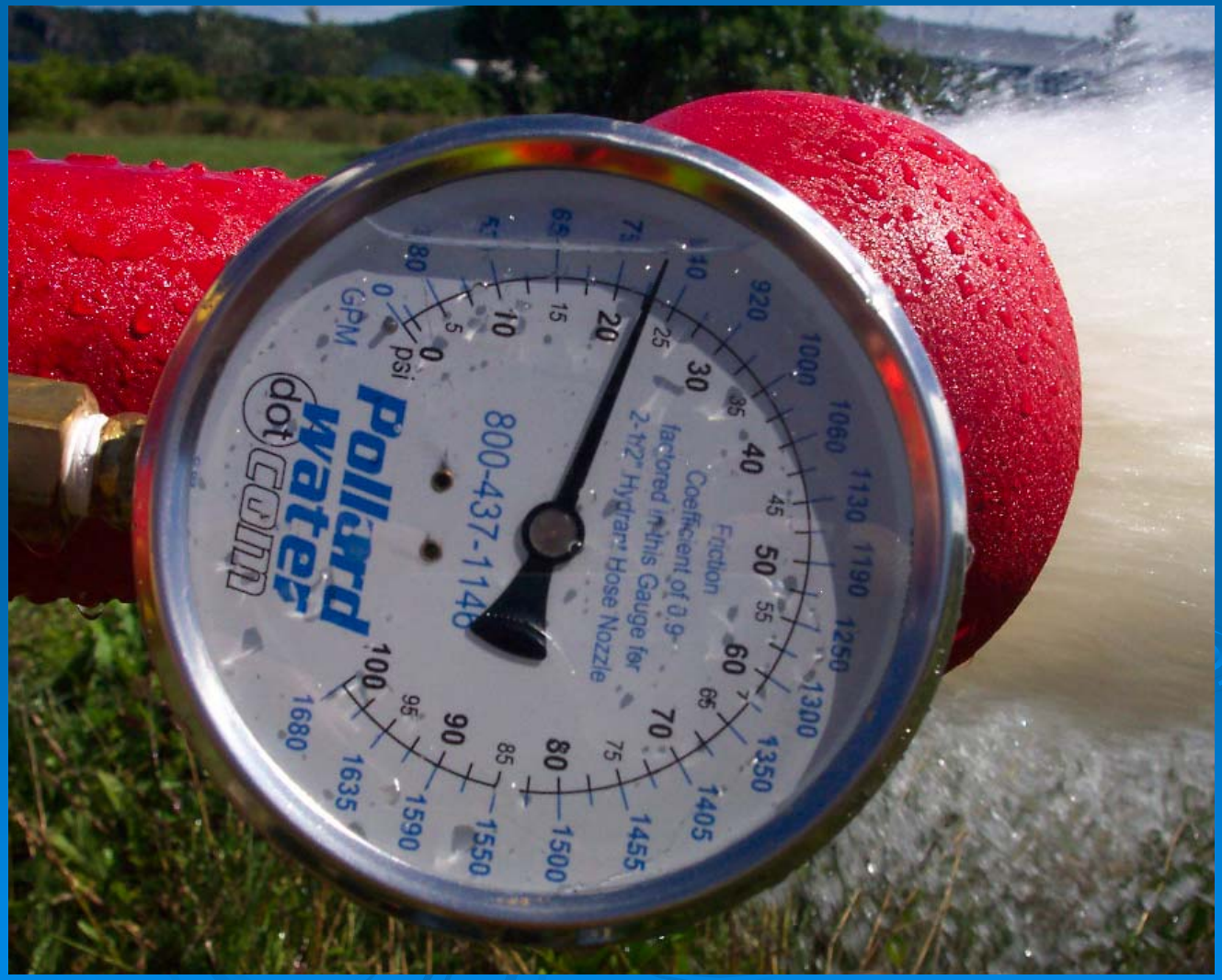
Flow Measurement with Pitot Guage

Operation and Maintenance

- New Initiatives as a result of training

Unidirectional Flushing

Flow Measurement with Pitot Guage



Operation and Maintenance

- New Initiatives as a result of training

Unidirectional Flushing

Table - Flow Vs. Diameter Opening

Flow (Imperial gmp and US gpm) and Velocity(fps) in Water Mains

		Pipe Diameter (in.)									
Flow	**Flow**	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**
USgpm	**Igpm**										
24	**20**	2.4									
36	**30**	3.7	0.9								
48	**40**	4.9	1.2	0.5							
60	**50**	6.1	1.5	0.7	0.4						
96	**80**	9.8	2.4	1.1	0.6	0.4					
120	**100**		3.1	1.4	0.8	0.5	0.3				
240	**200**		6.1	2.7	1.5	1.0	0.7	0.5			
360	**300**		9.2	4.1	2.3	1.5	1.0	0.7	0.6		
480	**400**			5.4	3.1	2.0	1.4	1.0	0.8	0.6	
600	**500**			6.8	3.8	2.4	1.7	1.2	1.0	0.8	0.6
720	**600**			8.2	4.6	2.9	2.0	1.5	1.1	0.9	0.7
840	**700**			9.5	5.4	3.4	2.4	1.7	1.3	1.1	0.9
960	**800**			10.9	6.1	3.9	2.7	2.0	1.5	1.2	1.0
1080	**900**				6.9	4.4	3.1	2.2	1.7	1.4	1.1
1200	**1000**				7.7	4.9	3.4	2.5	1.9	1.5	1.2
1320	**1100**				8.4	5.4	3.7	2.7	2.1	1.7	1.3
1440	**1200**				9.2	5.9	4.1	3.0	2.3	1.8	1.5
1560	**1300**				10.0	6.4	4.4	3.2	2.5	2.0	1.6
1680	**1400**					6.9	4.8	3.5	2.7	2.1	1.7
1800	**1500**					7.3	5.1	3.7	2.9	2.3	1.8
1920	**1600**					7.8	5.4	4.0	3.1	2.4	2.0
2040	**1700**					8.3	5.8	4.2	3.3	2.6	2.1
2160	**1800**					8.8	6.1	4.5	3.4	2.7	2.2
2280	**1900**					9.3	6.5	4.7	3.6	2.9	2.3
2400	**2000**					9.8	6.8	5.0	3.8	3.0	2.4
2520	**2100**					10.3	7.1	5.2	4.0	3.2	2.6
2640	**2200**						7.5	5.5	4.2	3.3	2.7
2760	**2300**						7.8	5.7	4.4	3.5	2.8
2880	**2400**						8.2	6.0	4.6	3.6	2.9
3000	**2500**						8.5	6.2	4.8	3.8	3.1
3120	**2600**						8.8	6.5	5.0	3.9	3.2
3240	**2700**						9.2	6.7	5.2	4.1	3.3
3360	**2800**						9.5	7.0	5.4	4.2	3.4
3480	**2900**						9.9	7.2	5.6	4.4	3.6

Operation and Maintenance

- New Initiatives as a result of training

Unidirectional Flushing

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1080	**900**				6.9	4.4	3.1	2.2	1.7	1.4	1.1

Operation and Maintenance

- New Initiatives as a result of training

  - Unidirectional Flushing

  Outcomes:

- Have removed much more sediment as evidenced by darker water colour from hydrants during flushing and longer time to return to clear
- Much easier to maintain chlorine residuals in distribution system
- **Reduced consumer complaints regarding discoloured, foul smelling water**

Operation and Maintenance

- New Initiatives as a result of training

  - Leak Detection

  - The use of sonic devices to locate underground leaks in a water system

Operation and Maintenance

- New Initiatives as a result of training

Leak Detection

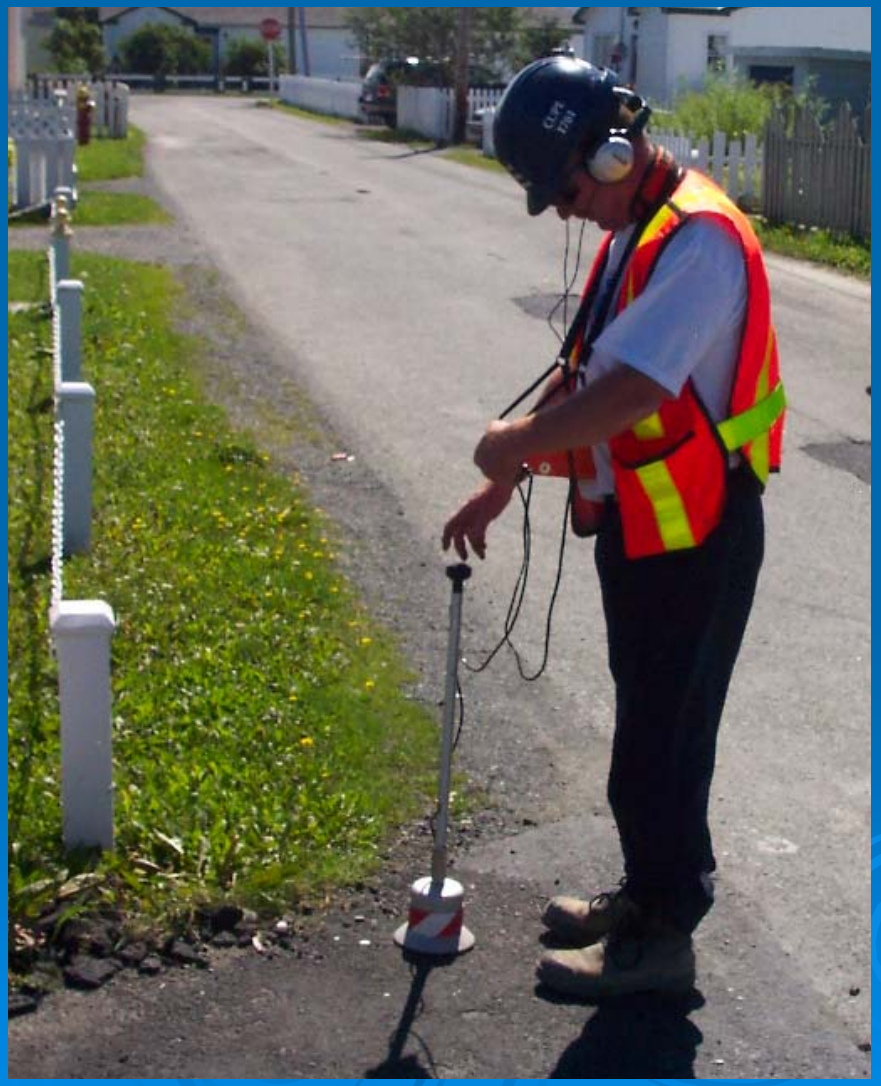
Geophones in Use

Operation and Maintenance

- New Initiatives as a result of training

Leak Detection

Electronic Equipment in Use



Operation and Maintenance

- New Initiatives as a result of training
  - Leak Detection

- Water usage should be approximately 450 litres/person/day (100 gal/person/day) which includes an allowance for leakage

- In modern residential neighborhoods with no commercial or industrial water use and no leaks water use is approximately 200 litres/person/day (45 gal/person/day)

Operation and Maintenance

- New Initiatives as a result of training

  - Leak Detection

- Water usage in Freshwater was approximately 500 gpm or 3200 litres/person/day

- This is 7 times the normal water usage of 450 litres/person/day

Resulted in high costs, low pressures and consumer complaints

Operation and Maintenance

- New Initiatives as a result of training

  - Leak Detection - Freshwater

  - Hired two new people
  - Purchased electronic leak detection equipment and leased a half tonne pickup
  - Provided time for training with equipment and familiarization of the Freshwater system

Operation and Maintenance

- New Initiatives as a result of training

  - Leak Detection - Freshwater

  Outcomes:

  - Water usage dropped from 500 gpm to 100 gpm or from 3200 litres/person/day to 650 litres/person/day
  - Higher pressure
  - Lower costs
  - **Fewer consumer complaints**

Operation and Maintenance

- New Initiatives as a result of training

  - Leak Detection - Freshwater

  Problems:

  - Few drawings of the Freshwater system
  - Old system with many small leaks – difficult to pinpoint
  - Lack of continued funding to sustain an ongoing leak detection program. Flow is currently about 200 gpm or 950 litres/person/day

Operation and Maintenance

- Greatest Problem
  - Too many tasks with too few resources

Like the majority of Newfoundland and Labrador communities, the operation of Placentia's water systems is the responsibility of the Public Works employees. These same public works employees are responsible for many other aspects of the town's operation. In many instances, time is simply not available to complete all tasks.

Operation and Maintenance

- Greatest Problem

Town of Placentia
Maint. Schedule

06-04-99

Property	D	W	M	3 m	Y
Dunv. Water Tr. Plant					
Ozone Generator, check, (maint.) Filters changed/cleaned	x		x		
Overhauled					x
Pump system, Soda ash/lime sys. filters. (clean,grease,)	x		x		
Fwtr. / Jsyd. / Plac. Water Tr. Plants / Pump Stn.					
Pump system, CL_2 Sys. check	x				
Clean, Grease			x		
Screens, (clean). Diesel pumps, (run)		x			
Lift Stns.					
Check	x				
Cleaned.				x	
Total insp.					x
Sewer Sys.					
Manholes, Inspected					x
Outfalls, checked				x	
Cleaning performed, (as needed).					
Trouble Areas, checked frequently					
Drainage syst.					
Catch Basins, cleaned					x
Ditches culverts, cleaned, *(trouble areas more frequently)					*x
Roads					
Continuous					
Hydrants					
Flushed, checked					(2) x
Winterize					x
Reservoirs					
Visual		x			

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Operation and Maintenance

- Greatest Problem

Town of Placentia
Maint. Schedule

06-04-99

Property	D	W	M	3 m	Y
Loader, Dump Truck					
Maint performed based on hours.					
Vehicles					
Cleaned, inspected.		x			
Maint. As required					
Sanders					
Inspected	x				
Cleaned, greased		x			
Stripped down, cleaned, repaired, painted, prep.for lay-up					x

Operation and Maintenance

- Greatest Problem
  - Solution ????

Recent history as shown that water systems MUST be operated in such a way that clean and safe drinking water is delivered to the consumer.

Budgetary constraints result in tough choices for municipal leaders.

What costs more, water or gas?

Costs per litre of various fluids

Perfume (Chanel Nº 5)	$2,816.90	Whole Milk	$1.60
Dom Perignon Champagne	$199.99	Soda Pop	$1.39
Domestic Beer	$4.02	Apple Juice	$1.38
10-30w motor oil	$2.49	Gasoline	$0.73
Bottled Water (1 L)	$1.70	Tap Water *	$0.0005

* Average consumption charge in 2003

Source: ACWWA, Go With the Flow, Issue # 43, July 2004, Acticle Key Positions of ACWWA

Small System Operation and Maintenance - A Local Experience

Discussion