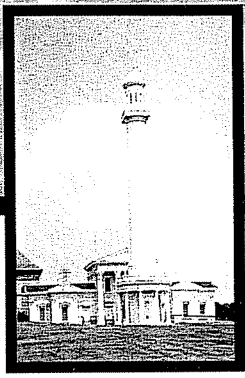
INAL REPORT



2002–2021 FACILITIES PLAN

VOLUME 2 OF 2

Capital Program Elements

LOUISVILLE WATER COMPANY

BLACK & VEATCH Corporation

2002

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

List of Tables

List of Tables

List of Figures

Page or Following Page

Executive Summary

Louisville Water Company (LWC or the Company) has long been a leader in the water industry, as demonstrated by its high level of customer satisfaction and widespread recognition among its peers. However, the Company understands that is must continue to evolve to adapt to a changing industry and to continue its excellent performance.

To best serve its drinking water customers, LWC continuously monitors its business environment and develops plans to effectively meet evolving conditions. LWC periodically prepares a facilities plan to guide its operations and capital programs. In 2000, LWC commissioned Black & Veatch to prepare the *2002-2021 Facilities Plan* to identify operational and capital improvements for the upcoming 20-year planning period. This *Volume 2 – Capital Program Elements* reports on the Capital Improvements Program developed for the *2002-2021 Facilities Plan.*

Objectives

The objectives for the *2002-2021 Facilities Plan* were confirmed by the Steering Committee on August 27, 2001 and are restated as follows.

- Project 2001-2020 water sales and demands for the 23-County Metropolitan Service Area using 2000 U.S. Census data.

- Define anticipated requirements to be imposed by regulations.

- Review and update regionalization planning based on current conditions, including Kentucky Senate Bill 409 provisions.

- Estimate 2001-2020 water quantity and quality requirements based on projected customer expectations and regulatory factors.

- Evaluate feasible water supply and treatment alternatives to meet projected demands for the planning period.

- Consider the reliability and role of aging infrastructure for the long-term plan.

- Evaluate the application of advanced treatment technologies, including riverbank filtration.

- Determine transmission and storage infrastructure required for delivery of water to satisfy customers and meet regulatory requirements.

- Define the next major infrastructure rehabilitation and replacement program.

- Prepare a 20-year capital program that provides for efficient and wise investment.

- Review Company operations and programs and provide suggestions to further enhance the following:
    - Financial capacity to implement the plan.
    - Infrastructure operational efficiency.
    - Service to internal and external customers.

Water Sales Projections

Water sales were estimated for this plan using customer projections and historical demand analyses. Dr. Paul Coomes of the University of Louisville provided Black & Veatch with customer projections for the 23-County Extended Metropolitan Service Area based on year 2000 Census data. Historical water use and plant production records were reviewed to determine usage rates, trends, and demand factors. From this data, year 2020 Annual Average Day and Maximum Average Day demands were estimated. Table ES-1 shows a comparison of current and projected 2020 demands. These quantities include water sales to retail and existing wholesale customers.

Table ES-1
Water Demand Summary
(million gallons per day)

Demand Condition	Year 2000	Year 2020	% Increase
Average Day Demand	129.9	158.3	21.8
Maximum Day Demand	192.8	232.6	23.0

Regulatory Assessment

The United States Environmental Protection Agency will enact significant new drinking water standards within the next few years. Primary among these will be requirements to limit disinfection byproducts and microbiological pathogens in drinking water. LWC appears well positioned for compliance with disinfection byproducts requirements. However, LWC has realized and planned for capital improvements to increase microbiological pathogen removal under provisions of the proposed Stage 2 Long-Term Enhanced Surface Water Treatment Rule. The proposed compliance deadline for this rule is November 2009.

Water Supply and Treatment Facilities

Using the projected demands and proposed new treatment standards, the existing water supply and treatment facilities were evaluated to determine their capacity to meet needs for the planning period. The ability of the existing supply and treatment facilities to supply the demands is summarized in Table ES-2.

Table ES-2
Water Demand Summary
(million gallons per day)

Service Area	2020 Maximum Day Demand	Existing Plant Capacity	Reserve Capacity
Crescent Hill Water Treatment Plant (CHWTP)	139.5	180	40.5
B. E. Payne Water Treatment Plant (BEPWTP)	93.1	60	(33.1)
Total	**232.6**	**240**	**7.4**

Table ES-2 shows the existing plant capacity of 240 mgd exceeds the estimated 2020 Maximum Day demand of 232.6 mgd. Thus, no increase in treatment capacity is required. However, BEPWTP, currently being expanded from 45 to 60 mgd capacity, will have a projected capacity shortage of 33.1 mgd in 2020, while CHWTP will have 40.5 mgd of reserve capacity, based on the areas the plants currently serve. LWC has implemented projects and plans to overcome the BEPWTP capacity shortfall by pumping treated water between service areas in the distribution system. This approach remains valid and transmission mains to be constructed for the transfer should be completed early in the capital program.

Although production capacity is sufficient, supply and treatment facilities improvements will be required for improved operational reliability and enhanced treatment. Considerations for the development of capital improvement alternatives are listed below.

- **Economy**
  - Capital funds must be used wisely and efficiently.
  - No more infrastructure will be built than what is required to meet Company goals.
  - New treatment alternatives will be considered if large increments of capacity are required or if economically justified to replace aging infrastructure.

- **Water Quality**
  - Treated water quality will exceed regulatory requirements.
  - Multiple treatment barriers will be planned for using advanced treatment.
  - Finished water quality produced at all plants will be comparably equal.
  - Conventional treatment processes will be optimized to achieve Phase IV certification for the AWWA Partnership for Safe Water Program.
  - Reliable taste and odor removal will be provided.

- **Facilities**
  - Sixty (60) mgd riverbank infiltration (RBI) supply will be constructed for BEPWTP.
  - Riverbank infiltration will be considered as a supply alternative for CHWTP.
  - Pellet reactors will be considered as an alternative technology for softening.
  - Biologically active up-flow filters ahead of conventional dual media filters will be considered for removal of tastes and odors and organics.

With installation of RBI supply confirmed for B. E. Payne WTP, advanced treatment alternatives were considered for Crescent Hill WTP. Advanced treatment technologies capable of removing microbiological pathogens (e.g. *Cryptosporidium*) were reviewed, including riverbank infiltration (RBI), ultraviolet (UV) radiation, ozonation, membrane filtration, and activated carbon adsorption.

Several supply and treatment options were developed for CHWTP, with the following objectives assumed for the creation of these alternatives:

1. Production of a high-quality finished water that meets or exceeds all applicable current and anticipated future regulatory requirements;
2. Ability to produce and deliver finished water that is essentially identical to that produced at BEPWTP following conversion to full RBI supply; and
3. Ability to effectively address aesthetic concerns such as periodic taste and odor occurrences associated with the current Ohio River supply.

The CHWTP supply and treatment alternatives which evaluated were as follows:

- **Alternative C1:** Provide for 180 mgd firm capacity with full RBI (collector well) supply, aeration, and continuous softening of a portion of the total plant flow. With RBI, this alternative provides for advanced treatment and taste and odor control through riverbank infiltration, powdered activated carbon addition, and ultraviolet (UV) disinfection (if required for future regulatory compliance).
- **Alternative C2:** Provide for 180 mgd firm capacity with Ohio River supply through the Zorn intake, improved conventional treatment, softening of a portion of the total plant flow, taste and odor control with PAC and ozonation, and advanced treatment with biological filtration and ultraviolet (UV) disinfection.
- **Alternative C3:** Provide for 180 mgd firm capacity with Ohio River supply through the Zorn intake, improved conventional treatment, softening of a portion of the total plant flow, conventional filtration, taste and odor control with PAC and post-filter granular activated carbon (GAC), and ultraviolet (UV) disinfection.
- **Alternative C4:** Provide for 180 mgd firm capacity with Ohio River supply through the Zorn intake, high-rate conventional sedimentation, softening of a portion of the total plant flow, and advanced treatment with membrane filtration, post-filter granular activated carbon adsorption, and ultraviolet (UV) disinfection.

The primary components for each alternative are summarized in Table ES-3.

Table ES-3
Supply and Treatment Alternatives for CHWTP

Alternative	Capacity (mgd)	Supply Component	Softening	Advanced Treatment Components	Taste & Odor Control Components
C1	180	Collector Wells	Continuous	RBI, UV	RBI, PAC
C2	180	Zorn PS	As Needed	Ozone, BF, UV	PAC, Ozone
C3	180	Zorn PS	As Needed	GAC, UV	PAC, GAC
C4	180	Zorn PS	As Needed	MF, GAC, UV	PAC, GAC

Abbreviations:
BF – Biologically Active Filtration
GAC – Granular Activated Carbon
MF – Membrane Filtration
PAC – Powdered Activated Carbon
PS – Pump Station
RBI – Riverbank Infiltration
UV – Ultraviolet Disinfection

Two versions of alternative C1 were evaluated: C1A was RBI supply without UV disinfection, and C1B was identical except UV was included.

Table ES-4 presents the present worth costs for each of the alternatives, including probable project capital costs for the treatment facilities (less the present worth of their remaining value at the end of the planning period) and their respective annual operation and maintenance costs over a planning period of 20 years. An interest rate of 7.5 percent was assumed. This cost analysis indicates that Alternatives C1A and C1B would be the most desirable options strictly from an overall project cost perspective.

Table ES-4
Present Worth Cost Comparison for CHWTP Treatment Alternatives

Alternative	Probable Capital Cost, $	Projected Annual O&M Cost, $/yr	Present Worth, $*
C1A: RBI Supply w/UV	116,000,000	2,290,000	129,000,000
C1B: RBI Supply wo/UV	103,000,000	1,770,000	111,000,000
C2: Ohio River w/Ozone	70,000,000	6,570,000	154,000,000
C3: Ohio River w/GAC	114,000,000	6,880,000	174,000,000
C4: Ohio River w/membranes & GAC	204,000,000	5,270,000	254,000,000

*20 years, 7.5% interest rate; includes present worth of projected remaining value of facilities at end of planning period.

The relative benefits of the various alternatives were also compared. Results of the benefits comparison suggest that Alternative C1 would be the most desirable, by a relatively small margin.

The resulting recommended supply and treatment recommendation for LWC is summarized below. Key points are highlighted along with relevant elements associated with those points.

➢ **Adopt Alternative C1A as the treatment improvement plan for CHWTP.**

- Investigate and confirm the sustainable RBI capacity for CHWTP. Using RBI as the supply source for Crescent Hill will be dependant upon ensuring that adequate volumes of water are available.

- Verify that LWC's assumptions regarding geology and property acquisition are correct for the areas where collector wells are proposed. These aspects of the RBI plan are important for assessing the scope, limitations, and cost of this approach.

- Confirm process design assumptions for CHWTP through pilot testing. Although LWC has some operational experience with RBI supply at BEPWTP, it would be useful to determine more accurately the effects and operational adjustments associated with changing the plant's source of supply.

➢ **Coordinate installation of UV at CHWTP with conversion of BEPWTP to full RBI supply.**

- In order to satisfy LWC's goal of avoiding any disparity in finished water quality between the two plants, it is recommended that ultraviolet disinfection systems be incorporated into Crescent Hill simultaneously with B. E. Payne switching to total RBI supply. Current projections are that the additional RBI wells will be operational about 2007. Although installing UV at CHWTP will not make the resulting treated water a duplicate of that from BEPWTP, it will represent a considerable improvement and provide some of the same benefits as RBI.

➢ **Plan completion of the RBI supply source for CHWTP to coincide with installing UV systems at BEPWTP.**

- When RBI is ready for CHWTP, install UV at BEPWTP. When this step is completed, the two plants will effectively produce identical quality finished water.

Delivery and Storage Facilities

Working with LWC staff, the demand projections were utilized to evaluate the transmission system (booster pump stations, storage tanks, and transmission mains) and determine needed improvements for the facilities plan. Recommended projects to improve reliability, increase system pressures, and meet growing demands are described in Chapter 6 and shown on Figure 6-3. Table ES-5 summarizes the recommended transmission system improvements.

Table ES-5
Delivery and Storage Recommendations Summary

Improvements	Number of Projects	Total Units	% Increase	Capital Cost Opinion
Storage Tanks	19	13,150,000 Gallons	22	$23,550,000
Booster Pump Stations	12	41,130,000 gallons/day	37	$8,070,000
Transmission Mains	41	458,100 linear feet	19	$69,280,000
			Total	**$100,900,000**

Table ES-6
Capital Improvements Program
2002-2021 Facilities Plan

Budget Area	Budget Item No.	Prior	2002	2003	2004	2005	2006	2002-2006	2007 - 2011	2012 - 2021	2002 - 2021
2002 Preliminary Budget											
Totals (Gross)			$74.214.807	$70.316.741	$69.086.572	$61.213.926	$54.017.426	$328.849.472	$252.592.190	$0	$581.441.662
Totals (Net)			$50.873.015	$47.874.918	$49.661.127	$40.704.906	$36.169.558	$225.283.524	$166.676.888	$0	$391.960.412
Comparison of 2002 Preliminary Budget Costs and 2002 - 2021 Facilities Plan Recommendation Costs											
Source of Supply											
2002 Preliminary Budget	11	$1.800.000	$5.650.000	$5.300.000	$15.000.000	$11.400.000	$12.000.000	$49.350.000	$48.400.000	$0	$97.750.000
2002-2021 Facilities Plan	11	$1.250.000	$1.800.000	$2.250.000	$2.150.000	$4.700.000	$17.500.000	$28.400.000	$79.500.000	$14.000.000	$121.900.000
Variance			($3.850.000)	($3.050.000)	($12.850.000)	($6.700.000)	$5.500.000	($20.950.000)	$31.100.000	$14.000.000	$24.150.000
Zorn Pumping Station											
2002 Preliminary Budget	12	$0	$225.000	$550.000	$150.000	$1.700.000	$0	$2.625.000	$0	$0	$2.625.000
2002-2021 Facilities Plan	12		$0	$445.000	$580.000	$2.015.000	$0	$3.040.000	$0	$750.000	$3.790.000
Variance			($225.000)	($105.000)	$430.000	$315.000	$0	$415.000	$0	$750.000	$1.165.000
Crescent Hill Pump Station											
2002 Preliminary Budget	13	$205.000	$275.000	$225.000	$225.000	$200.000	$1.800.000	$2.725.000	$0	$0	$2.725.000
2002-2021 Facilities Plan	13		$75.000	$200.000	$225.000	$425.000	$2.000.000	$2.295.000	$0	$0	$2.295.000
Variance			($200.000)	($25.000)	$0	$175.000	$200.000	$430.000	$0	$0	$430.000
Boosted Pressure System											
2002 Preliminary Budget	14	$0	$235.000	$800.000	$50.000	$300.000	$0	$1.385.000	$250.000	$0	$1.635.000
2002-2021 Facilities Plan	14		$70.000	$1.150.000	$0	$850.000	$0	$2.070.000	$950.000	$5.000.000	$8.020.000
Variance			($165.000)	$350.000	($50.000)	$550.000	$0	$685.000	$700.000	$5.000.000	$6.385.000
Storage Facilities											
2002 Preliminary Budget	15	$230.000	$3.895.000	$4.110.000	$3.250.000	$3.475.000	$1.275.000	$16.005.000	$6.575.000	$0	$22.580.000
2002-2021 Facilities Plan	15		$2.125.000	$4.725.000	$3.250.000	$2.500.000	$400.000	$13.000.000	$8.700.000	$5.200.000	$26.900.000
Variance			($1.770.000)	$615.000	$0	($975.000)	($875.000)	($3.005.000)	$2.125.000	$5.200.000	$4.320.000
Crescent Hill Filtration Plant											
2002 Preliminary Budget	16	$2.350.000	$2.845.000	$4.585.000	$5.735.000	$5.135.000	$1.285.000	$19.585.000	$8.550.000	$0	$28.135.000
2002-2021 Facilities Plan	16		$2.115.000	$5.215.000	$3.865.000	$7.865.000	$12.645.000	$31.705.000	$11.895.000	$10.350.000	$53.950.000
Variance			($730.000)	$630.000	($1.870.000)	$2.730.000	$11.360.000	$12.120.000	$3.345.000	$10.350.000	$25.815.000
B. E. Payne Water Treatment Plant											
2002 Preliminary Budget	18	$500.000	$6.220.000	$7.200.000	$3.700.000	$210.000	$3.780.000	$21.110.000	$15.550.000	$0	$36.660.000
2002-2021 Facilities Plan	18		$2.100.000	$13.815.000	$6.880.000	$1.230.000	$4.625.000	$28.650.000	$21.300.000	$5.000.000	$54.950.000
Variance			($4.120.000)	$6.615.000	$3.180.000	$1.020.000	$845.000	$7.540.000	$5.750.000	$5.000.000	$18.290.000
Distribution Buildings/ Facilities Improvement											
2002 Preliminary Budget	22	$150.000	$327.500	$352.500	$27.500	$27.500	$27.500	$762.500	$137.500	$0	$900.000
2002-2021 Facilities Plan	22		$328.000	$853.000	$1.328.000	$1.328.000	$1.663.000	$5.498.000	$3.638.000	$275.000	$9.410.000
Variance			$500	$500.500	$1.300.500	$1.300.500	$1.635.500	$4.735.500	$3.500.500	$275.000	$8.510.000
Main Replacement & Rehabilitation Program											
2002 Preliminary Budget	63	$0	$10.500.000	$10.500.000	$10.500.000	$4.500.000	$4.500.000	$40.500.000	$24.500.000	$50.000.000	$115.000.000
2002-2021 Facilities Plan	63		$8.500.000	$8.500.000	$8.500.000	$7.000.000	$7.000.000	$39.500.000	$35.000.000	$58.500.000	$133.000.000
Variance			($2.000.000)	($2.000.000)	($2.000.000)	$2.500.000	$2.500.000	($1.000.000)	$10.500.000	$8.500.000	$18.000.000
Transmission Improvements (Gross)											
2002 Preliminary Budget	65	$2.333.500	$2.729.400	$4.996.100	$6.580.000	$10.412.000	$7.810.000	$32.527.500	$47.254.000	$0	$79.781.500
2002-2021 Facilities Plan	65		$5.369.000	$6.534.000	$9.948.000	$16.072.000	$10.103.000	$48.026.000	$38.319.000	$14.062.000	$100.407.000
Variance			$2.639.600	$1.537.900	$3.368.000	$5.660.000	$2.293.000	$15.498.500	($8.935.000)	$14.062.000	$20.625.500
Variance Totals (Gross)			($10.419.900)	$5.068.400	($8.491.500)	$6.575.500	$23.458.500	$16.469.000	$48.085.500	$63.137.000	$127.690.500
Revised Budget											
Totals (Gross)			$63.794.907	$75.385.141	$60.595.072	$67.789.426	$77.475.926	$345.318.472	$300.677.690	$63.137.000	$709.132.162

Table ES-7 Recommended Capital Projects over $2,000,000 Years 2002-2021 Costs	
Project Description	**$**
BI:11 Source of Supply	
Advanced Treatment Technology Phase II (BEPWTP RBI)	29,750,000
Long-Term RBI Supply (CHWTP)	91,200,000
BI:13 Crescent Hill Pump Station	
Header and Yard Piping Improvements	2,200,000
BI:14 Booster Pressure System	
B-32 English Station Standpipe Booster Pump Station	5,000,000
B:15 Storage Facilities	
Cardinal Hill Reservoir Improvements	2,400,000
Sandblast / Recoat Storage Facilities	4,250,000
B:16 Crescent Hill Filter Plant	
Replace Clearwell Floor at CHFP	2,150,000
Alternate Disinfection Process	13,000,000
Drainage and Solids Handling Improvements	4,200,000
Filter and Backwash Systems Renovation	7,300,000
BI:18 B. E. Payne WTP	
Solids Lagoon Renovations	17,950,000
Expansion and Reliability Improvements	20,500,000
Coagulation and Softening Basin Renovation Program	2,100,000
Alternative Disinfection Process	4,500,000
BI:22 Distribution Buildings/Facilities Improvements	
Security Program	4,000,000
Bullitt County Distribution Operations Building	2,000,000
BI:63 Main Replacement and Rehabilitation Program Capital Improvements Program	
Water Main Replacement Program (Annual, through 2004)	4,000,000
Water Main Replacement Program (Annual, 2005 and 2006)	5,000,000
Water Main Rehabilitation Program (Annual, through 2004)	4,000,000
BI:65 Transmission Improvements Capital Improvements Program	
T-1B Prospect Tank to Hillcrest along Highway 42	2,227,000
T-10A US Highway 60: English Station Rd. to Jefferson / Shelby County Line	4,009,000
T-11A Snyder Transmission 48": I-64 to Taylorsville Rd.	4,500,000
T-13A Snyder Transmission 36": Taylorsville Rd. to Billtown Rd.	5,000,000
T-14 Fern Valley Rd. 30": Fern Valley Rd. to Smyrna BPS	2,393,000
T-18 Cardinal Hill Reservoir Secondary Supply: St. Andrews and New Cut	7,085,000
T-21 National Turnpike / South Park Fairdale Rd. to North Lakeview Dr.	3,037,000
T-24 I-65 Transmission: Hwy 61 from Gap in Knob Tank to Highway 480 Bypass	3,048,000
T-29 Snyder Transmission: English Station to I-64	2,537,000
T-29A Snyder Transmission: English Station to Tank to I-64	3,080,000
T-3 I-265 Transmission: Wolf Pen Branch to Westport Rd.	7,540,000
T-33 Bardstown Road, Snyder Highway to County Line	4,698,000
T-9, Segment 1 Westport BPS to Lake Ave. at Herr Lane and Lyndon Lane	2,280,000
T-9A Oxmoor: Lake Avenue to Linn Station / Ellingsworth 36"	4,876,000
T-39 US Highway 31W: St. Andrews Church Road to Bethany Lane	2,923,000

Table ES-7 Recommended Capital Projects over $2,000,000 Years 2002-2021 Costs	
Project Description	**$**
T-40 US Highway 31W: Gagel to St. Andrews Church Road	3,393,000
01-744 Kentucky / Glenmary / Oak 48" Transmission Main Rehabilitation and Replacement	15,270,000

1.0 Introduction

1.1 Background

To best serve its drinking water customers, Louisville Water Company (LWC) continuously monitors its business environment and develops plans to effectively meet evolving conditions. For this endeavor, LWC periodically prepares a facilities plan to guide its operations and capital programs. In 2000, LWC commissioned Black & Veatch to prepare this *2002-2021 Facilities Plan* to identify operational and capital improvements for the upcoming 20-year planning period.

1.2 Objectives

The objectives for the *2002-2021 Facilities Plan* were confirmed by the LWC Board of Water Works in a Steering Committee Meeting on August 27, 2001. The objectives are as follows:

- Project 2001-2020 water sales and demands for the 23-County Metropolitan Service Area using 2000 U.S. Census data.
- Define anticipated requirements to be imposed by regulations.
- Review and update regionalization planning based on current conditions, including Kentucky Senate Bill 409 provisions.
- Estimate 2001-2020 water quantity and quality requirements based on projected customer expectations and regulatory factors.
- Evaluate feasible water supply and treatment alternatives to meet projected demands for the planning period.
- Consider the reliability and role of aging infrastructure for the long-term plan.
- Evaluate the application of advanced treatment technologies, including riverbank filtration.
- Determine transmission and storage infrastructure required to deliver water that satisfies customers and meets regulatory requirements.
- Define the next major infrastructure rehabilitation and replacement program.
- Prepare a 20-year capital program that provides for efficient and wise investment.

- Review Company operations and programs and provide suggestions to further enhance the following:
  - Financial capacity to implement the plan.
  - Infrastructure operational efficiency.
  - Service to internal and external customers.

1.3 Report Format

The 2002-2021 Facilities Plan is presented in a two-volume report as follows:

- Volume 1 – Institutional, Managerial, and Financial Elements
- Volume 2 – Capital Program Elements

Volume 1 of the Facilities Plan primarily focuses on findings and recommendations relating to LWC operations and programs.

Volume 2 presents findings and recommendations relating to capital facilities improvements for the 20-year planning period.

2.0 Overview of Existing Infrastructure

Evaluation of existing infrastructure is a key element of any facilities planning effort. The physical condition and capacity of facilities to provide continued reliable service during the planning period relate directly to the amount of required capital investment. This section presents the following:

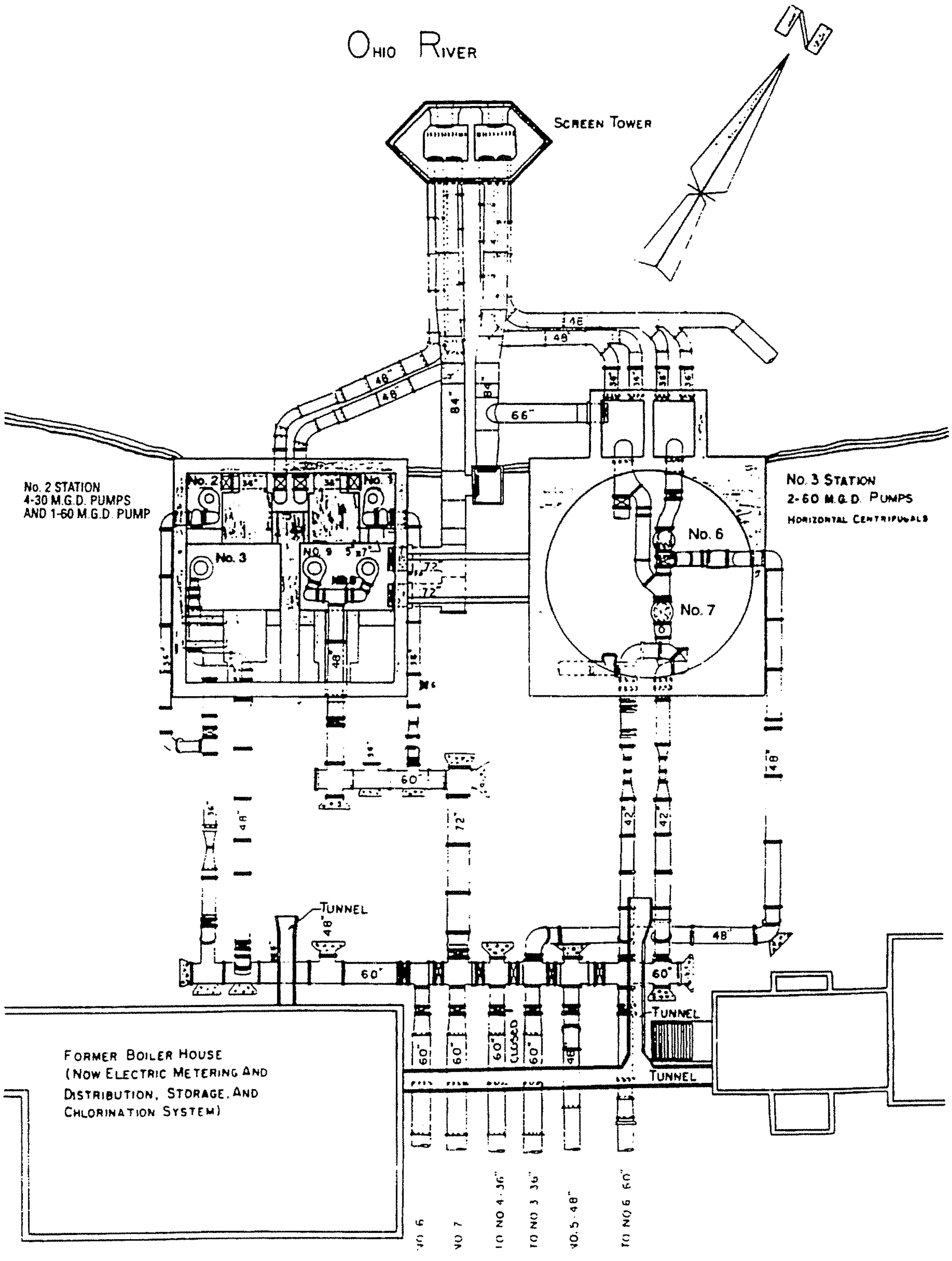
- Overview description of LWC's primary production and service infrastructure.
- Capacity determination for existing treatment, pumping, and storage facilities.

Descriptions are presented for the following major facilities:

- Zorn Avenue Pump Station
- Crescent Hill Water Treatment Plant
- B. E. Payne Water Treatment Plant
- Distribution System
  - Storage reservoirs
  - Booster pumping stations
  - Storage tanks and standpipes
  - Water mains
- Allmond Avenue Distribution Service Center

2.1 Zorn Avenue Pump Station

Zorn Avenue Pump Station (ZPS) supplies raw water from the Ohio River to the Crescent Hill Water Treatment Plant. ZPS has evolved considerably from its original construction in the 1850s to present. ZPS facilities that currently remain in service include the screen tower, Station No. 2, and Station No. 3. The ZPS site plan arrangement is shown on Figure 2-1. Station No. 1 was built in the 1850s but was removed from service after Station No. 2 was placed in service in the 1890s. The screen tower was originally constructed in 1910 and houses four mechanical screens that remove debris from the raw water prior to pumping. Station No. 2 has a wetwell configuration and was completed in 1893. Station No. 3 has a drywell configuration and was built in 1918. By 1950, electric-powered centrifugal pumps replaced steam-driven pumps in both stations. Improvements since then have consisted mainly of equipment replacements. Chemical feed equipment was installed to control zebra mussels. Equipment characteristics are summarized in Table 2-1.



Note:
Figure generated from LWC Engineering Drawing

BLACK & VEATCH
Corporation

Louisville Water Company
Louisville, Kentucky
2002 - 2021 Facilities Plan

ZORN AVENUE PUMP STATION
SITE PLAN

Figure 2-1

CYGNET 12/20/01
66603-1000-WTUP-C-N0000124C

Table 2-1 Zorn Avenue Intake Tower and Pump Station – Equipment Characteristics	
Intake Tower	
Number of screens	4
Type	Mechanical
Pumping station capacity	
Firm capacity, mgd	240
Total installed capacity, mgd	300
Pumps	
Number	7
Type	
Nos. 1, 2, 3, 8, and 9	Vertical centrifugal, constant speed
Nos. 6 and 7	Horizontal centrifugal, constant speed
Rated capacity, each, mgd	
Pumps 1, 2, 8, and 9	30
Pump 3, 6, and 7	60
Rated head, ft	200
Speed, rpm	
Nos. 1, 2, 8, and 9	600
No. 3	400
No. 6	450
No. 7	514
Motor horsepower, each	
Nos. 1, 2, 8, and 9	1,250
No. 3	1,750
No. 6	2,500

ZPS discharges to four raw water mains: two 60-inch concrete mains and 48-inch and 36-inch unlined cast iron mains. The 36-inch main was installed in the 1850's and is not used on a regular basis. The other three mains are utilized to convey raw water approximately 2.2 miles to the pre-sedimentation basins at the Crescent Hill Water Treatment Plant.

2.2 Crescent Hill Water Treatment Plant

The Crescent Hill Water Treatment Plant (CHWTP) includes facilities that traditionally have been called the Crescent Hill Filter Plant and Crescent Hill Pump Station. CHWTP treats Ohio River water using conventional water treatment processes: flocculation, coagulation, filtration, and disinfection. Ferric chloride is used as the coagulant chemical. Chorine is used for disinfection, with ammonia added to produce chloramines and create a disinfectant residual. Treated water is pumped by the Crescent Hill Pump Station to the Cardinal Hill Reservoir. Design characteristics for the process facilities are summarized in Table 2-2.

Table 2-2
Crescent Hill Water Treatment Plant – Design Characteristics

Crescent Hill Reservoirs	
Number	2
Designation	North and South
Effective storage volume, total, MG	106
Sidewater depth, ft	19
Rapid Mix System	
North	
Configuration	In-line flow tube
Number	2
Inlet/outlet diameter, in.	60
Throat diameter, in.	36
South	
Configuration	In-line flow tube
Number	2
Inlet/outlet diameter, in.	72
Throat diameter, in.	42
Flocculation Basins	
North	
Number of basins	4
Volume, each, cu ft	37,200
Sidewater depth, ft	22
Flocculation Equipment	
Type	Paddle-wheel
Number of shafts, each basin	1
South	
Number of basins	4
Volume, each, cu ft	100,800
Sidewater depth, ft	25
Flocculation Equipment	
Type	Paddle-wheel
Number of shafts, each basin	1
Coagulation Basins	
North	
Number of basins	4
Type	Center-feed, upflow
Surface area, each, sq ft	22,500
Sidewater depth, ft	28
Volume, each, cu ft	696,000
South	
Number of basins	4
Type	Center-feed, upflow
Surface area, each, sq ft	32,400
Sidewater depth, ft	24
Volume, each, cu ft	833,500
Softening Rapid Mix Basins	
Configuration	Single cell, mechanical mixing
Number of basins	2
Volume, each, cu ft	20,100

Table 2-2
Crescent Hill Water Treatment Plant – Design Characteristics

Slow Mixing Basins	
Number of basins	6
Volume, each, cu ft	
Nos. 1 and 2	146,300
Nos. 3 and 4	150,100
Nos. 5 and 6	166,700
Sidewater depth, ft	16
Detention time @ 180 mgd, min	55
Flocculation Equipment	
Type	Paddle-wheel
Number of shafts, each basin	3
Softening Basins	
Number of basins	6
Type	Center-feed, upflow
Surface area, each, sq ft	40,000
Sidewater depth, ft	16
Volume, each, cu ft	704,400
Recarbonation Basins	
Number of basins	3
Volume, each, cu ft	
No. 1	46,500
No. 2	79,300
No. 3	73,400
CO_2 Reaction Basins	
Number of basins	3
Volume, each, cu ft	
No. 1	461,600
No. 2	454,200

Table 2-2
Crescent Hill Water Treatment Plant -- Design Characteristics

Granular Media Filters	
South	
Number	6
Designation	Nos. 1-6
Dimensions, each, ft	52.67 x 40.5
Surface area, each, sq ft	2,133
Surface area, total, sq ft	12,798
Filter box depth, ft	
Media	
Anthracite	
Depth, in.	18
Effective size, mm	0.80 – 0.90
Sand	
Depth, in	12
Effective size, mm	0.45 – 0.55
Gravel	
Depth, in	12
Underdrain type	Leopold block
Air Scour System	
Diameter of header, in	12
Number of distribution tubes, each filter	12
Diameter of distribution tubes, in.	0.125
Wash Water Troughs	
Number, each filter	12
Material	Concrete
North	
Number	12
Designation	Nos. 7 – 18
Dimensions, each, ft	46.5 x 23.0
Surface area, each, sq ft	1,069.5
Surface area, total, sq ft	12,834
Filter box depth, ft	9.58
Media	
Anthracite	
Depth, in.	10
Effective size, mm	0.9
Sand	
Depth, in	16
Effective size, mm	0.44
Gravel	
Depth, in	2
Effective size, in.	#10 mesh – 3/16"
Depth, in	3
Effective size, in.	3/16" – 3/8"
Depth, in	4
Effective size, in.	3/8" – ¾"
Depth, in	5
Effective size, in.	3/4" – 1 ½"
Underdrain type	Cast iron laterals

Table 2-2 Crescent Hill Water Treatment Plant – Design Characteristics	
North Granular Media Filters (continued)	
Surface Wash Agitators	
Number, each filter	7
Diameter, in.	2
Wash Water Troughs	
Number, each filter	3
Material	Cast iron
Old East	
Number	8
Designation	Nos. 19 – 26
Dimensions, ft	42.0 x 50.0
Surface area, each, sq ft	2,100
Surface area, total, sq ft	16,800
Filter box depth, ft	12
Media	
Anthracite	
Depth, in	15
Effective size, mm	0.80 – 0.90
Sand	
Depth, in.	12
Effective size, mm	0.45 – 0.55
Gravel	
Depth, in.	2
Effective size, in.	#10 mesh – 3/16"
Depth, in.	2
Effective size, in.	3/16" – 3/8"
Depth, in.	2
Effective size, in.	3/8" – ¾"
Depth, in.	2
Effective size, in	¾" – 1 ½"
Underdrain type	Leopold block
Surface Wash Agitators	
Number, each filter	20
Diameter of sweeps, ft.	9'-6"
Diameter of laterals, in.	3
Wash Water Troughs	
Number, each filter	12
Material	Cast iron
New East	
Number	7
Designation	Nos. 27 – 33
Dimensions, ft	50.0 × 42.0
Surface area, each, sq ft	2,100
Surface area, total, sq ft	14,700
Filter box depth, ft	12
Media	
Anthracite	
Depth, in	18
Effective size, mm	0.80 – 0.90

Table 2-2
Crescent Hill Water Treatment Plant – Design Characteristics

New East Granular Media Filters (continued)	
Sand	
Depth, in.	12
Effective size, mm	0.45 – 0.55
Gravel	
Depth, in.	12
Underdrain type	Wheeler bottom panels
Surface Wash Agitators	
Number, each filter	20
Diameter of sweeps, ft.	8
Diameter of laterals, in.	3
Wash Water Troughs	
Number, each filter	12
Material	Concrete
Total filter area, all filters, sq ft	57,132
Clearwell	
Number	1
Volume, MG	25
Sidewater depth, ft	22
High Service Pump Station	
Pump station capacity	
Firm, mgd	235
Installed, mgd	285
Number of pumps	7
Type	
Pumps 2 and 8	horizontal
Pumps 4, 5, 6, 7, and 10	vertical
Rated capacity, each, gpm	
Pumps 2, 4, and 10	34,720
Pumps 5 and 6	20,830
Pump 7	24,310
Pump 8	27,780
Rated head, ft	
Pumps 2, 4, 5, 6, 7, and 10	180
Pump 8	200
Speed, rpm	
Pump 2	514
Pumps 4 and 10	600
Pumps 5, 6, 7, and 8	720
Motor horsepower, hp	
Pumps 2 and 4	2,000
Pumps 5, 6, and 7	1,250
Pumps 8 and 10	1,500

Chemical storage and feed facilities are provided for potassium permanganate, copper sulfate, powdered activated carbon, chlorine, ferric chloride, cationic polymer, alum, lime, soda ash, coagulant, ammonia, carbon dioxide, and fluoride. Information regarding the existing chemical storage and feed facilities at CHWTP is presented in Table 2-3. It should be noted that alum, soda ash, and carbon dioxide are not currently applied at the CHWTP, so information on these chemical systems was not provided.

Table 2-3
Crescent Hill Water Treatment Plant
Design Characteristics of Chemical Storage and Feed Facilities

Potassium Permanganate	
Number of feeders	1
Capacity, each, pph	21 – 313
Average dosage, mg/L	1.0
Dosage range, mg/L	0.5 – 3.0
Storage form	Dry, 110-lb totes
Storage capacity	Multiple totes
Copper Sulfate	
Number of feeders	1
Capacity, each, pph	100
Average dosage, mg/L	1.0
Dosage range, mg/L	1.0
Storage form	Dry, in silo
Storage capacity, lbs	128,000
Days supply @ 180 mgd	84
Powdered Activated Carbon	
Number of pumps	3
Capacity, each, gph	2 @ 250, 1 @ 700
Average dosage, mg/L	6.0
Dosage range, mg/L	3.6 – 60
Storage form	Liquid slurry
Storage capacity	2 bunkers @ 60,000 gallons each
Days supply @ 180 mgd and max dosage	2
Chlorine	
Number of feeders	4
Capacity, each, ppd	3 @ 4,000, 1 @ 2,000
Average dosage, mg/L	4.2
Dosage range, mg/L	3.6 – 12.0
Storage form	Dry, 90-ton rail cars
Storage capacity, tons	180
Days supply @ 180 mgd and max dosage	20
Ferric Chloride	
Number of feeders	4
Capacity, each, gph	500
Average dosage, mg/L	8.4
Dosage range, mg/L	2.4 – 24.0
Storage form	Liquid, in underground tanks
Storage capacity	2 tanks @ 41,000 gallons each
Days supply @ 180 mgd and max dosage	11

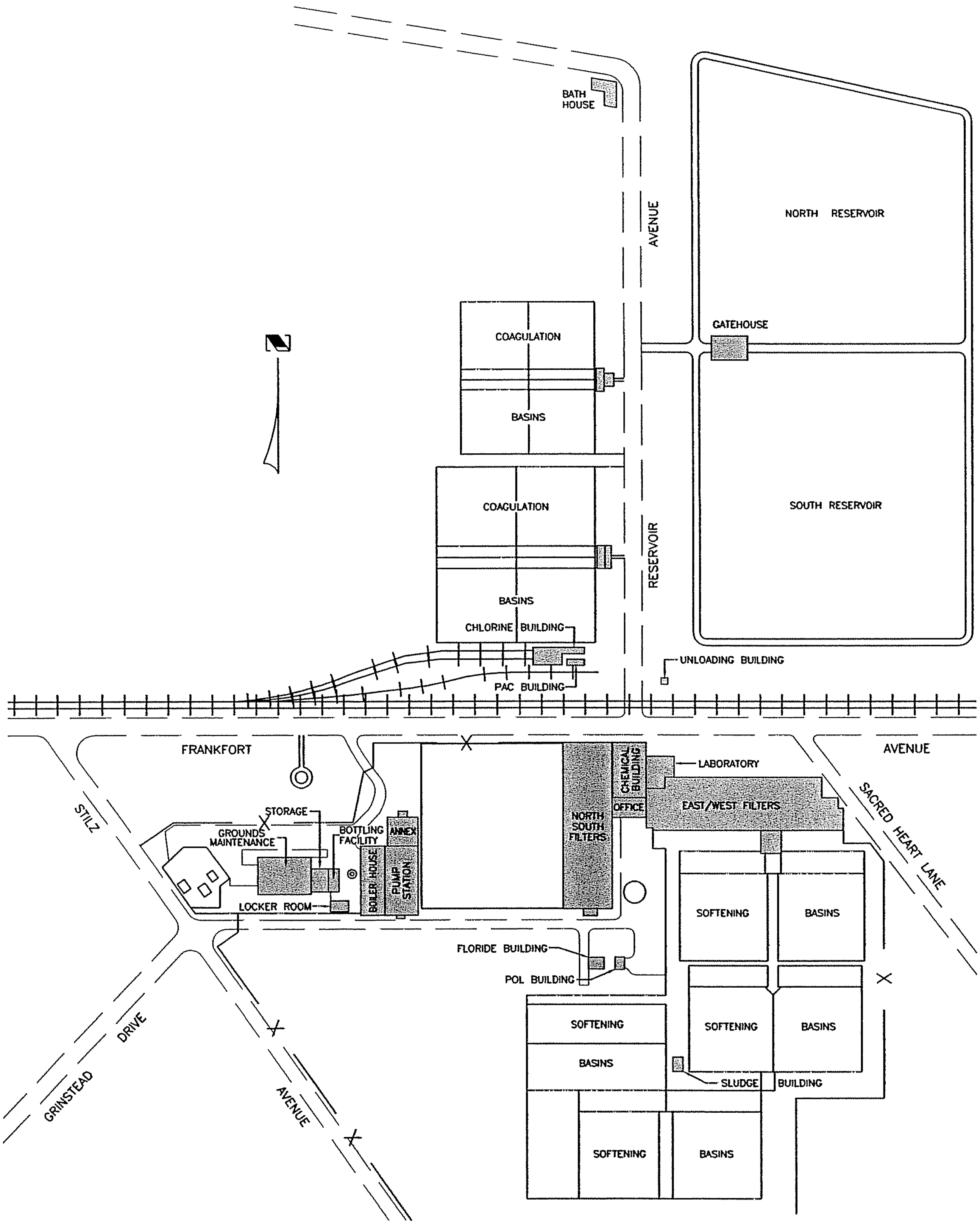
Table 2-3
Crescent Hill Water Treatment Plant
Design Characteristics of Chemical Storage and Feed Facilities

Cationic Polymer	
Number of feeders/blenders	4
Capacity, each, gpd	2 @ 480, 1@ 25, 1 @ 60
Average dosage, mg/L	1.0
Dosage range, mg/L	0.5 – 1.0
Storage form	Liquid, in tank
Storage capacity, gallons	19,000
Days supply @ 180 mgd and max dosage	41
Lime	
Number of slakers	2
Capacity, each, pph	4,000
Average dosage, mg/L	9.6
Dosage range, mg/L	7.2 – 54
Storage form	Dry pebble
Storage capacity	2 silos @ 283,000 lbs each
Days supply @ 180 mgd and max dosage	7
Ammonia	
Number of feeders	6
Capacity, each, pph	3 @ 30, 1 @ 50, 1 @ 75, 1 @ 14
Average dosage, mg/L	0.8
Dosage range, mg/L	0.6 – 0.8
Storage form	Gas, compressed
Storage capacity, gallons	12,000
Days supply @ 180 mgd and max dosage	12
Fluoride	
Number of feeders	2
Capacity, each, gph	75
Average dosage, mg/L	1.0
Dosage range, mg/L	1.0
Storage form	Liquid, hydrofluorosilic acid
Storage capacity	2 tanks @ 8,400 gallons each
Days supply @ 180 mgd	21

The Crescent Hill plant layout and simplified process schematic are shown on Figures 2-2 and 2-3, respectively.

2.2.1 Hydraulic Capacity

The hydraulic capacity of the CHWTP has been studied previously and is well documented. LWC staff has reported that the maximum capacity of the plant with all process basins in service is 180 to 190 mgd. The plant hydraulic throughput was field tested to 170 mgd for the previous Facilities Plan, and a hydraulic model reportedly estimated the maximum capacity to be 185 mgd. For the 2002 – 2021 Facilities Plan, a more conservative hydraulic capacity of 180 mgd nominal will be utilized.



CYGNET 12/21/01
66603-1000-WTUP-C-N00001 24G

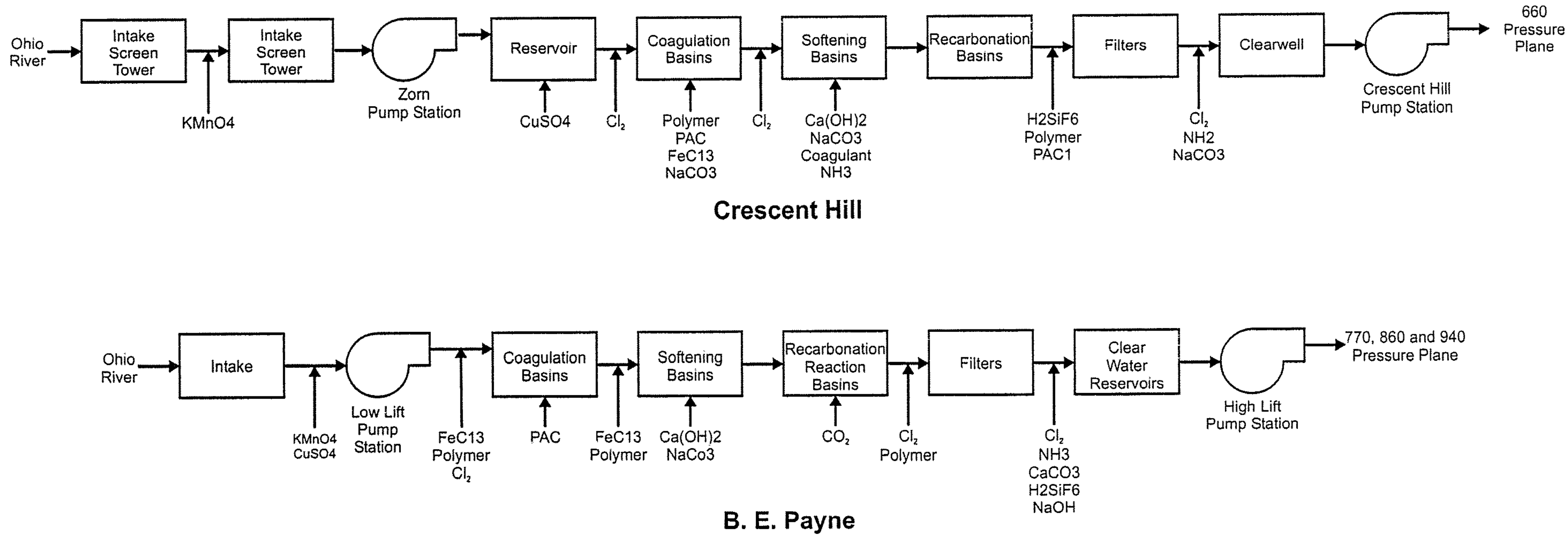
BLACK & VEATCH Corporation

Louisville Water Company
Louisville, Kentucky
2002 - 2021 Facilities Plan

CRESCENT HILL WATER TREATMENT PLANT

Figure 2-2

CYGNET 01/23/02
66603-1000-WTUP-C-N000018JB



Note:
All chemicals may not be fed to all locations at a given time.

BLACK & VEATCH
Corporation

Louisville Water Company
Louisville, Kentucky
2002 - 2021 Facilities Plan

TREATMENT PLANT PROCESS SCHEMATIC

Figure 2-3

2.2.2 Process Capacity

The design capacity and criteria of the unit processes at the CHWTP were evaluated and compared to the requirements of the Kentucky Division of Water (KDOW) and Black & Veatch design standards. The results of the review are presented in Table 2-4. Operating parameters for the unit processes are shown in the table for plant flow rates of 100 and 180 mgd, the approximate average day demand projected for 2020 and the plant hydraulic capacity, respectively. The shaded areas indicate operating parameters that exceed applicable design criteria. Facilities improvements must take into consideration that settled and softened water turbidities could increase as the coagulation and softening basins become stressed hydraulically.

Table 2-4
Crescent Hill Water Treatment Plant – Process Capacity Summary

Unit Process	Black & Veatch Standard	KDOW Limit	100 mgd	180 mgd
Flocculation				
Detention Time, min	30 – 45	40 – 60	59	33
Coagulation[1]				
Surface Loading Rate, gpm/sq ft	≤ 0.5	≤ 0.75	0.31	0.57
Detention Time, min	N/A	≥ 240	293	370
Weir Overflow Rate, gpd/ft				
Nos. 1 – 4	≤ 20,000	N/A	17,220	30,780
Nos. 5 – 8	≤ 20,000	N/A	20,300	36,940
Softening[1]				
Surface Loading Rate, gpm/sq ft	0.5 – 0.7	0.75	0.29	0.52
Detention Time, min	N/A	240	302	169
Filtration[1]				
Filtration Rate, gpm/sq ft	≤ 5	≤ 5	1.2	2.2
Clearwell Storage				
Volume, MG	≥ 15%	15%	25%	14%

(1) Assuming equal surface loading between all units.

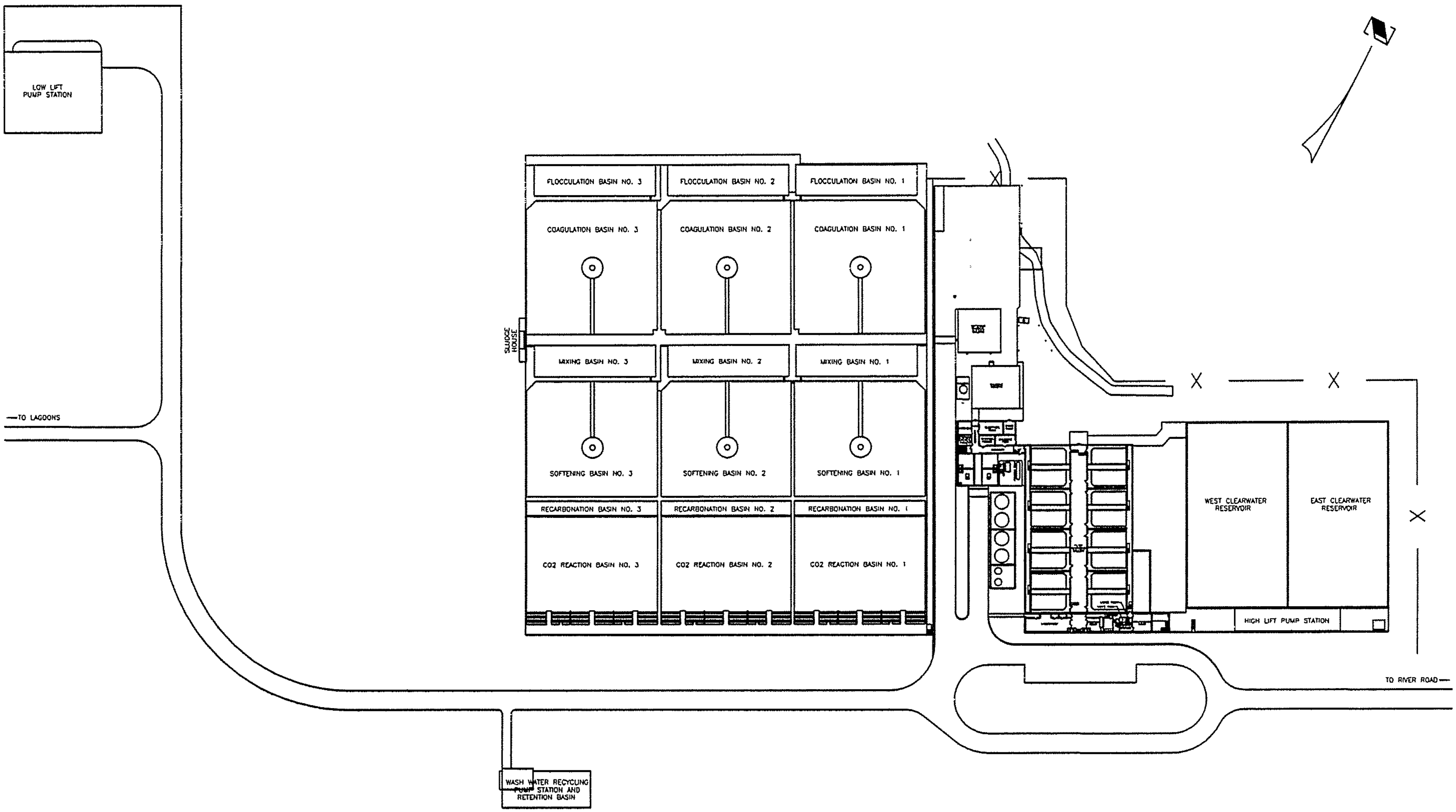
2.3 B. E. Payne Water Treatment Plant

The B. E. Payne Water Treatment Plant (BEPWTP) includes a riverbank infiltration collector well, a low service pump station, treatment processes, and a high service pump station. The BEPWTP treats raw water from the Ohio River using the following conventional water treatment processes: flocculation, coagulation, softening, filtration, and disinfection. Ferric chloride is used as the coagulant chemical. Chorine is used for disinfection, with ammonia added after filtration to produce chloramines to create a disinfectant residual. Treated water is pumped by the B. E. Payne High Service Pumping Station to the 860-Pressure Plane of the distribution system. Design characteristics for the process facilities are summarized in Table 2-5. The plant layout and simplified process schematic are shown on Figures 2-4 and 2-3, respectively.

Table 2-5
B. E. Payne Water Treatment Plant – Design Characteristics

Collector Well	
Design capacity, mgd	15
Caisson depth, ft	105
Caisson diameter, inner, ft	16
Horizontal screen laterals	
Number	7
Length, each, ft	200 – 240
Diameter, each, ft	1
Pumping station capacity	
Firm, mgd	10
Installed, mgd	20
Number of pumps	2
Type	Vertical turbine
Rated capacity, each, gpm	6,940
Rated head, ft	150
Speed, rpm	1,190
Motor horsepower, hp	350
Low Service Pump Station	
Pumping station capacity	
Firm, mgd	62
Installed, mgd	86
Number of pumps	4
Type	Horizontal centrifugal, constant-speed
Rated capacity, each, gpm	
Pump 1	9,800
Pumps 2, 3, and 4	16,700
Rated head, each, ft	
Pump 1	63
Pumps 2, 3, and 4	75
Speed, rpm	720
Motor horsepower, hp	
Pump 1	200
Pumps 2, 3, and 4	400
Rapid Mix Basins	
Configuration	Single-cell, mechanical mixing
Number of basins	3
Volume, each, cu ft	2,490
Detention time @ 60 mgd, sec	80
Number of mixers, each basin	3
Mixer motor power, hp	7.5

CYGNET 12/20/01
66603-1000-WTUP-C-N0000124F



BLACK & VEATCH Corporation

Louisville Water Company
Louisville, Kentucky
2002 - 2021 Facilities Plan

B. E. PAYNE
SITE PLAN

Figure 2-4

Table 2-5
B. E. Payne Water Treatment Plant – Design Characteristics

Flocculation Basins	
Number of basins	3
Volume, each, cu ft	89,470
Sidewater depth, ft	17
Type	Paddle-wheel
Number of shafts, each basin	2
Motor power, hp	7.5
Coagulation Basins	
Number of basins	3
Type	Center-feed, upflow
Surface area, each, sq ft	22,500
Sidewater depth, ft	16
Volume, each, cu ft	396,100
Softening Mixing Basins	
Number of basins	3
Volume, each, cu ft	90,830
Sidewater depth, ft	17
Detention time @ 60 mgd, min	49
Flocculation Equipment	
Type	Paddle wheel
Number of shafts, each basin	3
Mixer motor power, hp	6, 10, 13.3, or 20
Softening Basins	
Number of basins	3
Type	Center-feed, upflow
Surface area, each, sq ft	22,500
Sidewater depth, ft	16
Volume, each, cu ft	396,100
Recarbonation Basins	
Number	3
Volume, each, cu ft	47,090
CO_2 Reaction Basins	
Number	3
Volume, each, cu ft	245,530

Table 2-5
B. E. Payne Water Treatment Plant – Design Characteristics

Granular Media Filters	
Number	8
Surface area, each, sq ft	1,760
Surface area, total, sq ft	14,080
Media	
Sand	
Depth, in	9
Effective size, mm	0.44 – 0.55
Anthracite	
Depth, in	18
Effective size, mm	0.85 – 0.90
Underdrain type	Clay tile
Surface Wash Agitators	
Number, each filter	16
Diameter of sweeps, ft	9'-6"
Diameter of laterals, in.	2
Wash Water Troughs	
Number, each filter	6
Material	Concrete
Clear Water Reservoirs	
Number	2
Volume, each, MG	3
Sidewater depth, ft	15
High Service Pump Station	
Pump Station Capacity	
Installed, mgd	60
Firm, mgd	45
Number of pumps	4
Type	Vertical turbine, constant speed
Rated capacity, each, gpm	10,420
Rated head, ft	480
Speed, rpm	1,186
Motor horsepower, hp	1,500
Wash Water Pumps	
Number of pumps	2
Type	Vertical turbine, constant-speed
Rated capacity, each, gpm	27,780
Rated head, ft	46
Speed, rpm	70
Motor horsepower, hp	400

Chemical storage and feed facilities are provided for potassium permanganate, copper sulfate, powdered activated carbon, ferric chloride, cationic polymer, alum, lime, soda ash, carbon dioxide, chlorine, ammonia, and fluoride. Chemical storage and feed equipment is located in the filter and chemical building and the softening chemical building. Information regarding the existing chemical storage and feed facilities is presented in Table 2-6. It should be noted that soda ash and carbon dioxide are not currently applied at the BEPWTP, so information on these chemical systems was not provided.

Points of application in the treatment process are illustrated in Figure 2-3.

Table 2-6
B. E. Payne Water Treatment Plant
Design Characteristics of Chemical Storage and Feed Facilities

Potassium Permanganate	
Number of feeders	1
Capacity, each, pph	50
Average dosage, mg/L	0.5
Dosage range, mg/L	0.5 – 3.0
Storage form	Dry, 110-lb totes
Storage capacity	Multiple totes
Copper Sulfate	
Number of feeders	1
Capacity, each, pph	50
Average dosage, mg/L	1.0
Dosage range, mg/L	1.0
Storage form	Dry, in 110-lb totes
Storage capacity	Multiple totes
Powdered Activated Carbon	
Number of pumps	3
Capacity, each, gph	2 @ 91, 1 @ 325
Average dosage, mg/L	6.0
Dosage range, mg/L	3.6 – 60
Storage form	Liquid slurry
Storage capacity	2 bunkers @ 40,000 gallons each
Days supply @ 60 mgd and max dosage	4
Chlorine	
Number of feeders	4
Capacity, each, ppd	2 @ 3,000, 2 @ 500
Average dosage, mg/L	4.8
Dosage range, mg/L	3.6 – 9.6
Storage form	Dry, in 1-ton containers
Storage capacity, tons	24
Days supply @ 60 mgd and max dosage	10

Table 2-6
B. E. Payne Water Treatment Plant
Design Characteristics of Chemical Storage and Feed Facilities

Ferric Chloride	
Number of pumps	5
Capacity, each, gph	3 @ 38, 2 @ 237
Average dosage, mg/L	8.4
Dosage range, mg/L	2.4 – 24.0
Storage form	Liquid, in underground tanks
Storage capacity	2 tanks @ 38,500 gallons each
Days supply @ 60 mgd and max dosage	31
Cationic Polymer	
Number of feeders/blenders	2
Capacity, each, gph	1 @ 4.0, 1@ 2.5
Average dosage, mg/L	1.0
Dosage range, mg/L	1.0
Storage form	Liquid
Storage capacity	3 tanks @ 1,700 gallons each
Days supply @ 60 mgd	33
Lime	
Number of slakers	2
Capacity, each, pph	2,000
Average dosage, mg/L	9.6
Dosage range, mg/L	1.2 – 54
Storage form	Dry pebble
Storage capacity	2 silos @ 280 tons each
Days supply @ 60 mgd and max dosage	41
Ammonia	
Number of rotameters	2
Capacity, each, pph	16
Average dosage, mg/L	0.8
Dosage range, mg/L	0.6 – 2.4
Storage form	Gas, compressed
Storage capacity, gallons	1,800
Days supply @ 60 mgd and max dosage	9
Fluoride	
Number of pumps	2
Capacity, each, gph	12
Average dosage, mg/L	1.0
Dosage range, mg/L	1.0
Storage form	Liquid, hydroflourosilic acid
Storage capacity	2 tanks @ 5,000 gallons each
Days supply @ 60 mgd	38

2.3.1 Hydraulic Capacity

The hydraulic capacity of BEPWTP is currently limited to 45 mgd by the firm capacity of the High Service Pump Station. However, a project is currently underway to expand the BEPWTP to 60 mgd capacity by 2003. The expanded capacity of 60 mgd will be used for the 2002 – 2021 Facilities Plan.

2.3.2 Process Capacity

The design capacity and criteria of the unit processes at the BEPWTP were evaluated and compared to the requirements of the Kentucky Division of Water (KDOW) and Black & Veatch design standards. The results of the review are presented in Table 2-7. Operating parameters for the unit processes are shown in the table for a plant flow rate of 60 mgd.

Table 2-7
B. E. Payne Water Treatment Plant – Process Capacity Summary

Unit Process	Black & Veatch Standards	KDOW Limit	60 mgd
Rapid Mixing			
Detention Time, sec	≤ 60	≤ 60	80
Flocculation			
Detention Time, min	40 – 60	40 – 60	48
Coagulation[1]			
Surface Loading Rate, gpm/sq ft	≤ 0.5	≤ 0.75	0.62
Detention Time, min	≥ 240	≥ 240	210
Weir Overflow Rate, gpd/ft	≤ 20,000	N/A	33,330
Softening Mixing			
Detention Time, min	N/A	40 – 60	49
Softening[1]			
Surface Loading Rate, gpm/sq ft	0.5 – 0.7	≤ 0.75	0.62
Detention Time, min	N/A	≥ 240	210
Filtration[1]			
Filtration Rate, gpm/sq ft	N/A	≤ 5	2.96
Clearwell Storage			
Volume	N/A	15%	10%

[1]Assuming equal surface loading between all units.

The shaded areas in Table 2-7 indicate operating parameters that exceed applicable design criteria. Facilities improvements must take into consideration that settled and softened water turbidities could increase as the coagulation and softening basins become stressed hydraulically.

2.4 Transmission System

The transmission system for LWC conveys treated water from CHWTP and BEPWTP to the distribution system and LWC's customers. The transmission system consists of reservoirs, booster pumping stations, tanks and standpipes, and water mains 16 inches and larger in size. The system operates within six primary Pressure Planes: 660-, 770-, 820-, 860-, 900-, and 940-foot elevations. A schematic of LWC's transmission system is shown on Figure 2-5.

2.4.1 Storage Reservoirs

The transmission system currently has three storage reservoirs. A summary of the design characteristics for the reservoirs is shown in Table 2-8.

Table 2-8
Storage Reservoirs – Design Characteristics

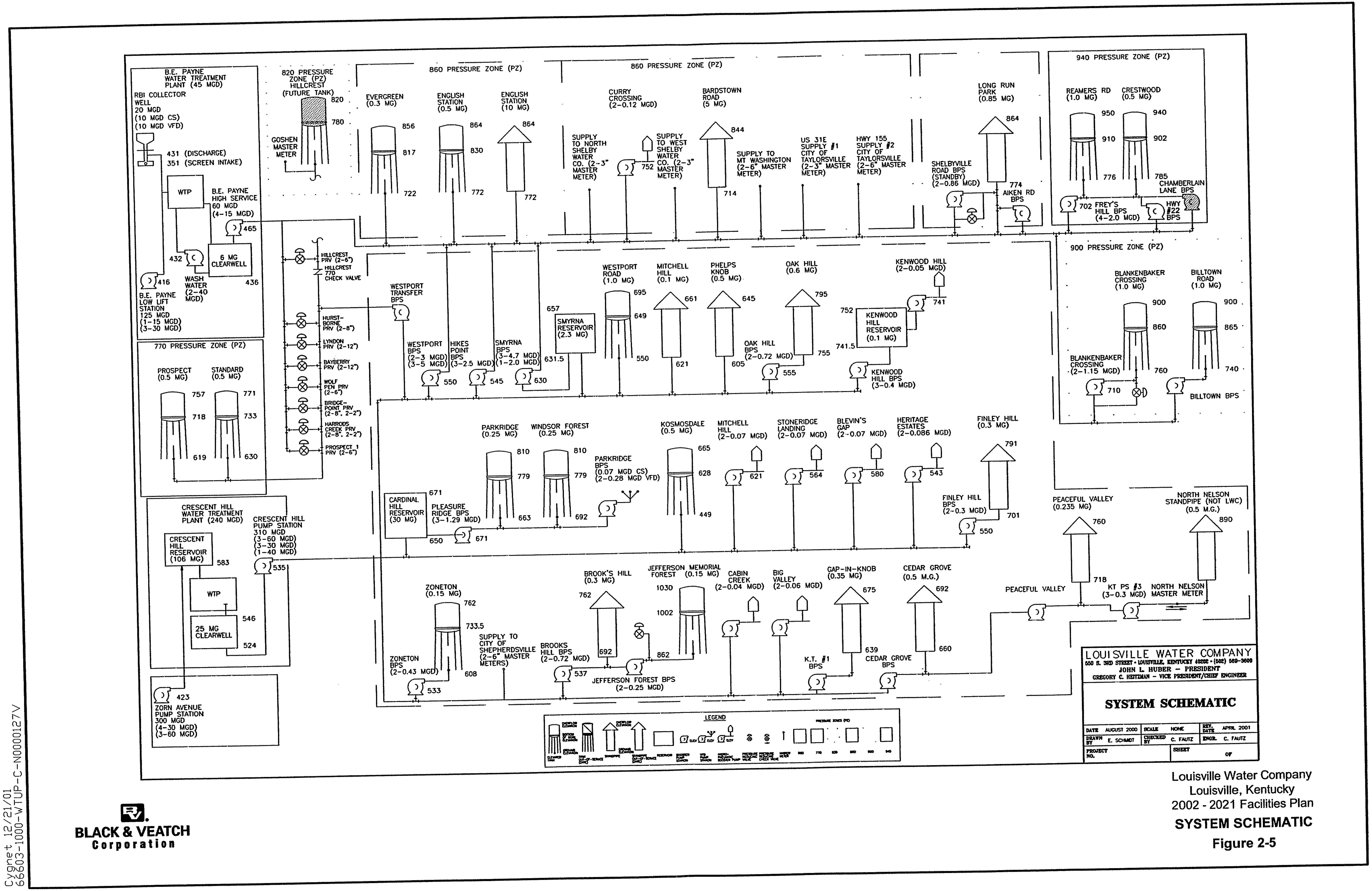
Reservoir	Storage Volume MG	Pressure Plane, Ft	Sidewater Depth Ft
Cardinal Hill	30	660	21
Smyrna	2.3	660	25.5
Kenwood Hill	0.1	660	10.5

2.4.2 Booster Pumping Stations

The transmission system currently has 31 booster pumping stations (BPSs). A summary of the design characteristics for the pumping stations is shown in Table 2-9.

Table 2-9
Booster Pumping Stations – Design Characteristics

Booster Pumping Station	Pressure Plane	Firm Capacity, mgd	No. of Pumps	Pump Type	Pump Capacity, each gpm	Motor Power Hp
Westport Transfer[1]	660 to 860	51.1	8	Horizontal centrifugal	2 @ 3,500 5 @ 6,250 1 @ 3,470	2 @ 150 5 @ 500 1 @ 225
Westport	660 to 860	16.0	5	Horizontal centrifugal	3 @ 3,470 2 @ 2,080	200
Hikes Point	660 to 860	5.0	3	Horizontal centrifugal	1,740	125
Smyrna	660 to 860	11.4	4	horizontal centrifugal	3 @ 3,240 1 @ 1,600	3 @ 300 1 @ 150
Oak Hill	660	0.72	2	horizontal centrifugal	500	40
Kenwood Hill	660	0.8	3	vertical turbine	280	15
Kenwood Hill II	660	0.05	2	horizontal centrifugal	35	3
Pleasure Ridge Park (PRP)	660	2.58	3	vertical turbine	900	50



Cygnet 12/21/01 66603-1000-WTUP-C-N0000127V

BLACK & VEATCH Corporation

Louisville Water Company
Louisville, Kentucky
2002 - 2021 Facilities Plan

SYSTEM SCHEMATIC

Figure 2-5

Table 2-9
Booster Pumping Stations – Design Characteristics

Booster Pumping Station	Pressure Plane	Firm Capacity, mgd	No. of Pumps	Pump Type	Pump Capacity, each gpm	Motor Power Hp
Parkridge	660	0.36	3	horizontal centrifugal	1 @ 49 2 @ 200	1 @ 5 2 @ 15
Mitchell Hill	660	0.07	2	horizontal centrifugal	49	3
Stonebridge Landing	660	0.07	2	horizontal centrifugal	49	3
Blevin's Gap	660	0	1	horizontal centrifugal	49	3
Heritage Estates	660	0.086	2	horizontal centrifugal	60	3
Finley Hill	660	0.3	2	horizontal centrifugal	210	15
Zoneton	660	0.43	2	horizontal centrifugal	300	10
Brooks Hill	660	0.72	2	vertical turbine	500	40
Jefferson Forest	660	0.25	2	horizontal centrifugal	170	20
Cabin Creek	660	0.04	2	horizontal centrifugal	28	3
Big Valley	660	0.06	2	horizontal centrifugal	42	5
KT No. 1	660	0.58	2	horizontal centrifugal	400	10
Cedar Grove	660	2.0	3	horizontal centrifugal	700	40
Peaceful Valley	660	1.2	3	horizontal centrifugal	400	30
KT No. 3	660	0.6	3	horizontal centrifugal	210	50
Curry Crossing	860	0.12	2	horizontal centrifugal	83	5
Shelbyville Road	860	0.86	2	horizontal centrifugal	600	15
Aiken Road	860	2.0	3	horizontal centrifugal	700	30
Blankenbaker Crossing	900	1.15	2	horizontal centrifugal	800	30
Shady Acres	900	2.0	3	horizontal centrifugal	700	40
Frey's Hill	940	6.0	4	horizontal centrifugal	1,390	125
Highway 22	940	2.0	3	horizontal centrifugal	700	40
Chamberlain Lane	940	3.0	3	horizontal centrifugal	1,050	50

[(1)] Westport Transfer Booster Pumping Station is intended to replace Westport Booster Pumping Station.

2.4.3 Storage Tanks and Standpipes

The transmission system currently has 26 elevated tanks and standpipes for storage. A summary of the design characteristics is presented in Table 2-10.

Table 2-10
Storage Tanks and Standpipes – Design Characteristics

Tank or Standpipe	Storage Capacity MG	Pressure Plane ft	Overflow Elevation ft	Bottom Elevation Ft	Ground Elevation ft
Westport Road	1.0	660	695	649	550
Mitchell Hill	0.1	660	661	N/A	621
Phelps Knob	0.5	660	645	N/A	605
Oak Hill	0.6	660	795	N/A	755
Parkridge	0.25	660	810	779	663
Windsor Forest	0.25	660	810	779	692
Kosmosdale	0.5	660	665	628	449
Finley Hill	0.3	660	791	N/A	701
Zoneton	0.15	660	762	733.5	608
Brook's Hill	0.3	660	762	N/A	692
Jeff. Mem. Forest	0.15	660	1030	1002	862
Gap-In-Knob	0.35	660	675	N/A	639
Cedar Grove	0.5	660	692	N/A	660
Peaceful Valley	0.235	660	760	N/A	716
North Nelson(1)	0.5	660	890	N/A	844
Prospect	0.5	770	757	718	619
Standard	0.5	770	771	733	630
Hillcrest2	NA	820	820	780	NA
Evergreen	0.3	860	856	817	722
English Sta. Tank	0.5	860	864	830	772
English Sta. Standpipe	10	860	864	N/A	772
Bardstown Road	5	860	844	N/A	714
Long Run Park	0.85	860	864	N/A	774
Blankenbaker Cr.	1.0	900	900	860	760
Billtown Road(2)	1.0	900	900	865	740
Reamers Road	1.0	940	950	910	776
Crestwood	0.5	940	940	902	785

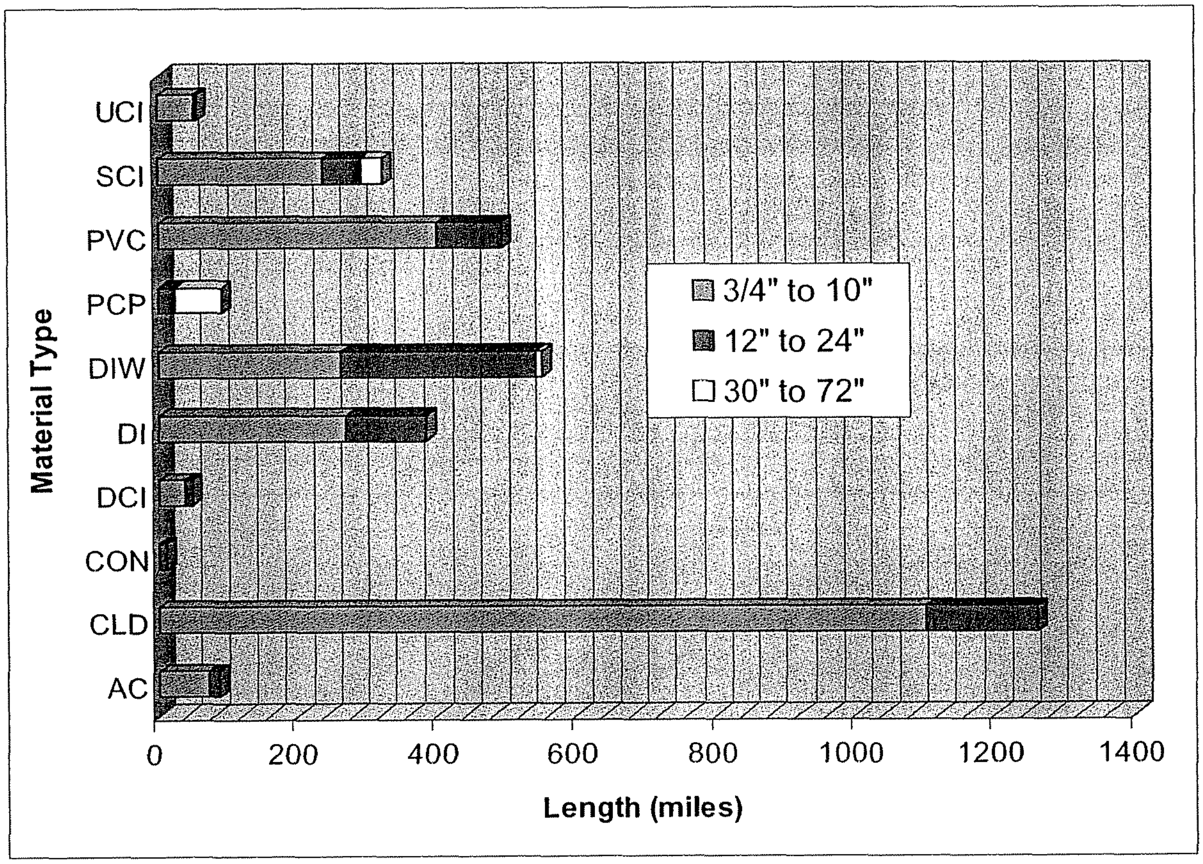
(1)Wholesale customer tank.
(2)Future tank, not in service yet.
NA – Not Available

2.4.4 Water Mains

LWC transmission and distribution systems consist of 3,332 miles of water mains that serve 249,684 customers, excluding public fire hydrant accounts. As of December 31, 2000, there were 272,320 water service connections and hydrants. Most of the water mains are 60 inches in diameter or smaller, with limited lengths of 72-inch diameter mains. The system mains are constructed of lined and unlined cast iron, lined ductile iron, asbestos-cement, concrete, and polyvinyl chloride (PVC). Figure 2-6 shows the length of distribution piping in various materials and sizes. Piping materials with a total length in use of 10 miles or less (galvanized steel, reinforced concrete, cement-lined sand cast iron, high-density polyethylene, unclassified, and copper) are not indicated on the figure.

Figure 2-6

Comparison of Distribution Piping by Length, Material, and Size



UCI = undesignated cast iron
SCI = unlined sand cast iron
PVC = polyvinyl chloride
PCP = prestressed concrete pipe
DIW = cement-lined ductile iron polywrapped
DI = cement-lined ductile iron
DCI = unlined DeLavaud cast iron
CON = concrete
CLD = cement-lined DeLavaud cast iron
AC = asbestos-cement

2.5 Allmond Avenue Distribution Center

The Allmond Avenue Distribution Center was built in phases from 1967 to 1972. It serves as LWC's center of distribution system operations and maintenance. The Center houses and supports LWC personnel working in the function areas of: distribution system operations and maintenance, water meter reading and maintenance, construction inspection, and fleet management. The Center has approximately 164,000 square feet of building floor space and a 375,000-square foot paved area that is used for parking of LWC's fleet vehicles and for a large materials storage yard. The yard supplies pipe, valves, hydrants, other materials to LWC and private contract work crews performing water main repairs, rehabilitation, and construction; fire hydrant maintenance and replacement; and lead service line replacement activities. Vehicle maintenance operations are performed at the Center. The building is of masonry construction and the yard has concrete paving.

3.0 Water Sales Projections

3.0 Water Sales Projections

The purpose of this chapter is to provide LWC with updated population, customer, water sales and demand projections for the 2001-2020 planning period. The demand projections will be used to evaluate needs and improvements for water supply, treatment and delivery facilities.

The *1995-2015 Facilities Plan* projections called for a decrease in total water sales, resulting from the impacts of water-conserving plumbing devices. The predicted reductions in per-customer use have not been observed. The projections in this report show increasing water use trends and resulting higher total demands.

Projections for this report were expanded to include the 23-County Extended Metropolitan Service Area (MSA), the area economically influenced by the City of Louisville. The water sales projections for the counties surrounding Jefferson County are based on available information for actual water utility uses, as reported in Volume 1 of this report.

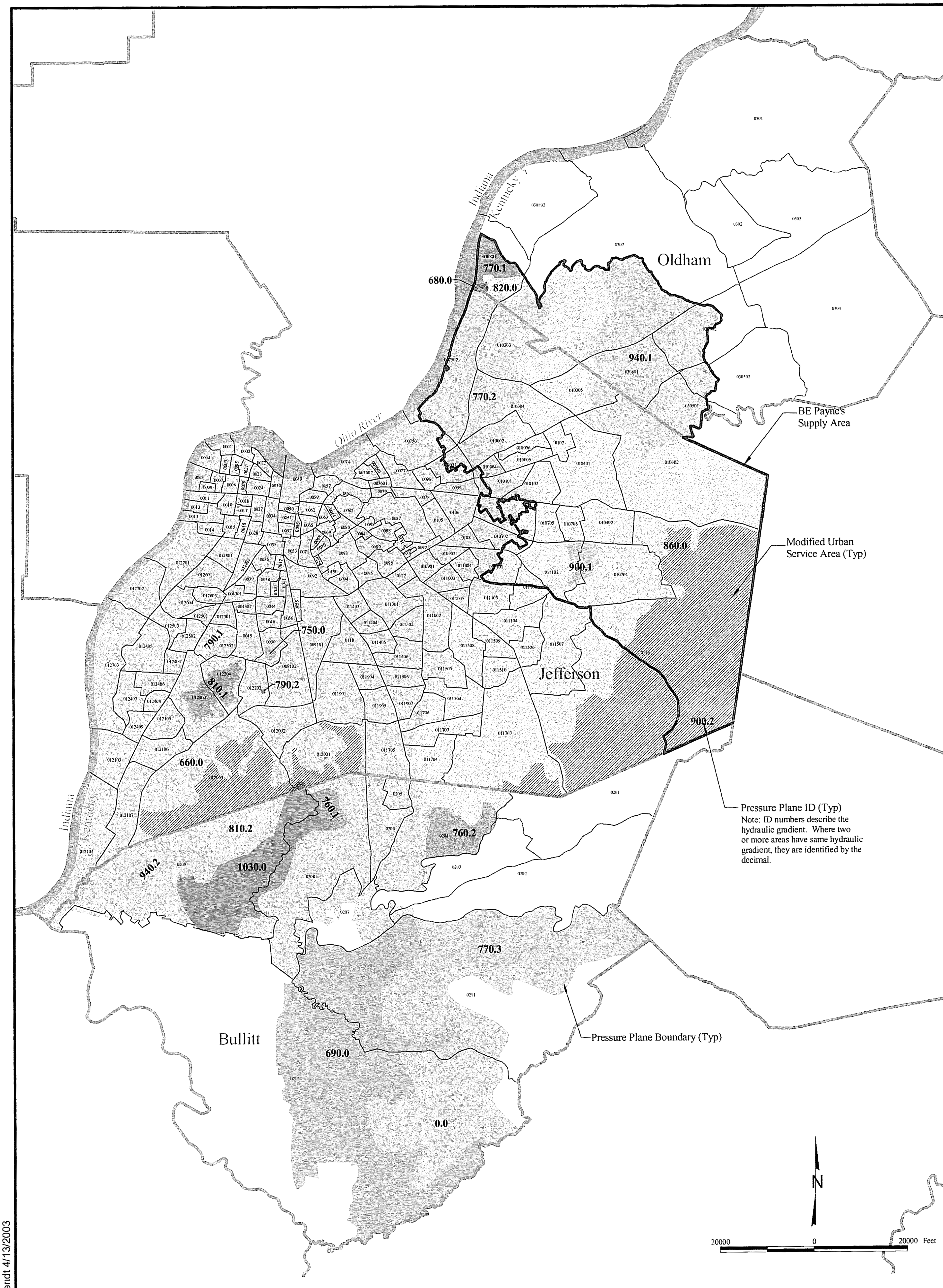
Projections were prepared for each census tract in the 23-County MSA. Figure 3-1 shows the census tracts in the current retail and wholesale service areas, along with the current LWC pressure plane areas. GIS techniques were used to assign water use rates to census tracts, and to accumulate the census tract projections to pressure planes and potential regionalization service areas.

3.1 Jefferson County Population and Customer Forecasts

3.1.1 Methodology

The Appendix includes the report *Economic, Demographic, and Water Sales Forecasts, 2000 to 2025, for the Louisville Economic Area*, prepared for this Plan by Dr. Paul Coomes of the University of Louisville. The current projections are an update of previous projections based on an established methodology and the latest data. The projections were expanded for this Plan to cover the 23-county MSA. The forecasts for 2000 through 2025 include:

1. Population and households in a 23-county region around Louisville and for approximately 300 census tracts.
2. Jobs by county of work and by major industry for each of the 23 counties.



Legend

- 0212 Census Tract and Number
- **660.0** Pressure Plane and Number
- County Boundary

Louisville Water Company
2002-2021 Facilities Plan

EXISTING PRESSURE PLANES AND CENSUS TRACTS

BLACK & VEATCH Corporation

Figure 3-1

D:\projects\Louisville\Apr\Louisville Lendt 4/13/2003

3. Water consumers and usage – by residential, commercial and wholesale customers – for the existing LWC service territory.

The projections are founded on economic forecasts of employment and job growth for the metropolitan area, and related national trends and projections. A shift-share model is used to relate the growth and forecasts in the Louisville region with that of the US economy. The shift-share model is a commonly used model for regional economic analysis and forecasting, providing more detail than the commonly used simple trend analysis would provide. Employment growth (by place of residence) is related to job growth (by place of employment) and an analysis of commuter and migration patterns of the labor force. Population forecasts are based on an analysis of historical trends by county, forecasts made by the State of Kentucky, and the results of the economic forecasts. For county forecasts, the methodology allocates the regional forecast totals to the counties based on projections of the annual change in each county's share of the forecasted growth. During the previous "Cornerstone 2020" forecasts, the county forecasts were reviewed by a local task force and consensus forecasts were developed.

The forecast methodology is appropriate and useful for LWC facility planning. It has evolved during the past several forecast updates. With each update, the methodology and scope of the forecasts has been improved and expanded.

Future enhancements to the methodology could consider:

- Incorporating land use data; such as, developed and undeveloped acreage, land use holding capacity, density patterns, developable and undevelopable land, building permit data, and planning and zoning data.
- Incorporating utility expansion plans, such as water main expansion plans, proposed new wastewater collection and conveyance system facilities, and other infrastructure plans.
- Enhancing per-customer water use estimates and possible conservation impacts.
- Evaluating the impacts of increased automatic irrigation systems.
- Enhanced wholesale customer water usage and wholesale customer growth forecasts.

3.1.2 LWC Customer Forecast

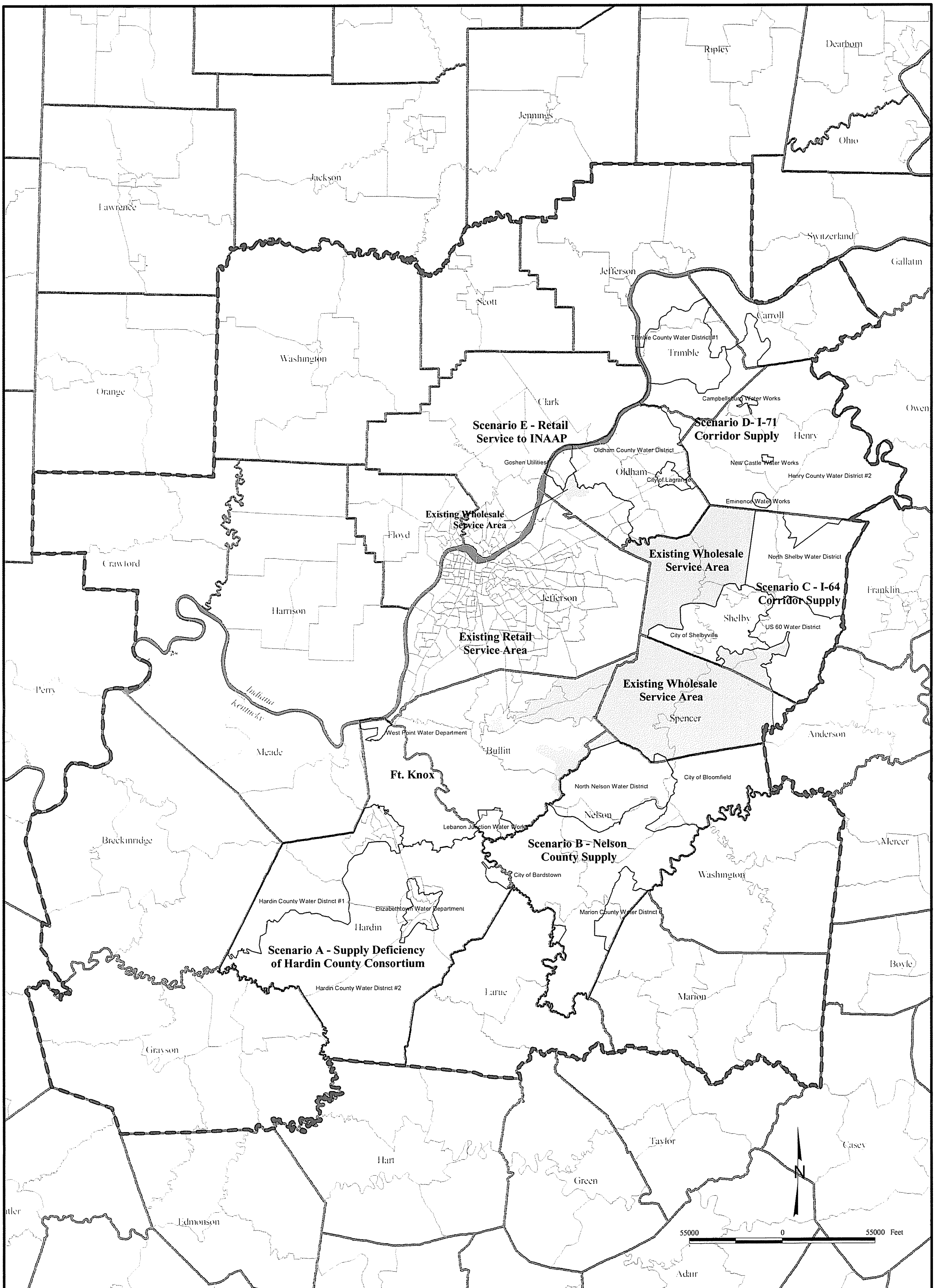
Table 3-1 presents the forecast of customers by classification for the LWC retail service area.

Table 3-1
Annual Customer Count Forecasts

Year	Residential	Commercial	Industrial	Total – Excluding Wholesale	Wholesale
1998	210,953	20,404	367	231,724	8,375
1999	217,668	21,154	362	239,184	10,749
2000	223,273	21,580	354	245,207	12,183
2001	224,060	21,893	351	246,304	12,318
2002	224,850	21,905	347	247,102	12,464
2003	225,643	21,995	343	247,981	12,621
2004	226,439	22,184	339	248,962	12,785
2005	227,238	22,408	335	249,981	12,944
2006	228,039	22,580	331	250,950	13,106
2007	228,843	22,758	327	251,928	13,268
2008	229,650	22,915	323	252,887	13,430
2009	230,460	23,062	319	253,840	13,596
2010	231,273	23,224	314	254,811	13,762
2011	231,563	23,372	310	255,245	13,829
2012	230,917	23,482	306	254,705	13,724
2013	231,908	23,610	302	255,820	13,920
2014	232,831	23,729	298	256,857	14,107
2015	233,736	23,849	294	257,878	14,291
2016	234,628	23,970	289	258,888	14,476
2017	235,493	24,098	285	259,876	14,657
2018	236,363	24,225	281	260,869	14,841
2019	237,203	24,356	277	261,836	15,022
2020	238,012	24,493	273	262,778	15,198

3.2 Metered Sales

LWC provided summary tables for a number of services and annual consumption by user class and pressure plane. The Company used GIS spatial analysis techniques to generate the tables. A comparison of historical metered sales to recent LWC Annual Reports shows that consumption estimates for "Municipal" and "Fire Services & Fire Hydrants" are not included. Historical metered sales are summarized in Table 3-2 and shown on Figure 3-2.



Legend

- 23 County Expanded Metro Service Area
- Water District Boundaries
- Census Tracts
- Ohio River
- County Boundaries

Louisville Water Company
2002-2021 Facilities Plan

REGIONALIZATION SCENARIOS

BLACK & VEATCH Corporation

Figure 3-2

D:\projects\Louisville\Apr\Louisville Lendt 4/13/2003

Table 3-2
LWC Historical Metered Sales (mgd)

Date	Residential	Commercial	Industrial	Wholesale	Total
1971	33.36	23.92	30.44	1.54	89.27
1972	34.04	24.87	31.77	1.72	92.41
1973	34.03	27.20	33.33	1.78	96.35
1974	35.01	27.14	31.63	2.01	95.79
1975	35.49	23.65	31.52	2.11	92.77
1976	35.15	24.09	34.33	1.77	95.34
1977	36.13	26.70	35.77	1.73	100.33
1978	39.00	29.06	34.36	1.94	104.36
1979	36.95	26.71	32.54	2.00	98.20
1980	38.75	26.89	30.03	2.08	97.74
1981	38.30	26.54	28.09	2.12	95.04
1982	38.73	26.65	25.59	2.04	93.01
1983	41.51	27.75	23.30	2.13	94.69
1984	40.44	28.86	23.96	2.33	95.58
1985	40.23	29.28	21.41	2.31	93.22
1986	41.01	30.17	19.91	2.52	93.61
1987	40.60	30.58	19.81	2.75	93.74
1988	43.56	32.33	19.42	2.77	98.07
1989	39.83	32.21	18.60	3.00	93.65
1990	40.28	34.74	19.82	3.64	98.47
1991	41.32	36.47	19.24	2.11	99.15
1992	38.70	35.74	17.65	2.10	94.18
1993	39.82	36.75	17.74	2.21	96.52
1994	42.48	38.69	17.80	2.36	101.33
1995	41.79	39.51	17.85	2.64	101.79
1996	41.30	40.82	17.39	2.95	102.46
1997	41.99	41.30	16.91	3.12	103.30
1998	41.43	42.35	16.24	3.22	103.24
1999	46.77	42.64	16.15	4.18	112.30
2000	43.66	45.20	14.76	4.68	105.75

3.3 Non-Metered Water Ratio

LWC provided a summary of annual water delivered to mains and water sold for 1989 to 2000. The non-metered water is the difference between water delivery and sales. Since 1997, LWC's annual reports have chosen not to estimate the portion of non-metered water that may be due to authorized use, such as hydrant flushing or municipal uses. As summarized in Table 3-3, non-metered water has averaged 13.9 percent of delivery. Since 1997, non-metered water has been about 14.5 percent of water delivery.

An allowance for non-metered water of 15 percent of water delivery is assumed for the projection of water demands. The ratio may tend to decrease in the future due to LWC's efforts such as the pipeline replacement and rehabilitation program and leak detection program, and may tend to increase due to causes such as increased hydrant flushing and acquisition of existing distribution systems.

Table 3-3
Water-Delivered-to-Mains and Water Consumption

Year	Water Delivered to Mains AAD (mgd)	Water Consumption (mgd)	Non-Metered Water (mgd)	Non-Metered Water Ratio
1989	109.60	96.74	12.87	11.74%
1990	114.11	101.40	12.70	11.13%
1991	118.28	101.90	16.38	13.85%
1992	109.96	96.09	13.86	12.61%
1993	114.14	98.59	15.55	13.63%
1994	124.21	103.68	20.53	16.53%
1995	121.98	103.74	18.24	14.95%
1996	121.27	104.10	17.17	14.16%
1997	123.63	105.59	18.04	14.59%
1998	124.27	105.72	18.55	14.93%
1999	134.50	115.04	19.46	14.47%
2000	127.16	108.97	18.19	14.30%
Average				13.90%

Water consumption by "Municipal" and "Fire Services & Fire Hydrants", reported in the annual reports, totaled 2.73 mgd in 1999, and 3.22 mgd in 2000. A comparison of "Water Consumption" (including "Municipal" and "Fire Services & Fire Hydrants" consumption) to the metered sales is shown in Table 3-4.

Table 3-4
Water Consumption (Annual Reports) vs. Water Sales

Year	Water Consumption (mgd)	Water Sales (mgd)	Consumption by Municipal and Fire Services & Fire Hydrants	
			Total (mgd)	% of Water Consumption
1989	96.74	93.65	3.09	3.2 %
1990	101.40	98.47	2.93	2.9 %
1991	101.90	99.15	2.75	2.7 %
1992	96.09	94.18	2.05	2.1 %
1993	98.59	96.52	2.07	2.1 %
1994	103.68	101.33	2.35	2.3 %
1995	103.74	101.79	1.95	1.9 %
1996	104.10	102.46	1.64	1.6 %
1997	105.59	103.30	2.29	2.2 %
1998	105.72	103.24	2.48	2.3 %
1999	115.04	112.30	2.74	2.4 %
2000	108.97	105.75	3.22	3.0 %

3.4 Per Customer Water Use Rates

Historical annual sales per customer for residential, commercial, and industrial customers were analyzed separately and are discussed in the following paragraphs.

3.4.1 Residential Customers

The historical trends in residential customers and water sales from 1971 through 2000 were reviewed. While the number of residential customers has continued to increase, the usage per customer has been fairly stable except for a period of increase in the mid-1980s. A linear regression trend was calculated for a 30-year period and the more recent 9-year trend. In both cases, the regression shows a very slight positive trend but the annual increase is not significant. The average annual sales per customer were also analyzed for each period from the most recent 3-years period through the most recent 12-year periods and for a 30-year period. While the 30-year average sales were 75,000 gallons per year, the 3 to 12 year averages ranged between 73,000 to 74,000 gallons per year, with 7 of 10 periods rounding to 74,000 gallons. To provide a conservative forecast, residential use was assumed constant at the 10-year average use rate plus one standard deviation, or 76,000 gallons per customer per year.

3.4.2 Commercial Customers

The review of historical commercial customers versus water usage per customer indicates an increasing trend for both customers and usage per customer, with considerable variability in the 1980s. A trend regression testing 30-year and 11-year periods indicates a significant positive relationship between year and commercial sales per customer. Because of the variation in water sales per customer prior to 1990, it was decided to use the 11-year trend. Over the past 11 years the commercial sales per customer has tended to increase approximately 4,835 gallons per year. The regression equation is:

*Commercial Sales per Customer = -8,910,149 * 4,835 (year).*

3.4.3 Industrial Customers

Review of the historical trends in industrial customers versus water usage per industrial customer indicates a long-standing decline in the number of industrial customers and usage per customer. After analysis of the trend over various timeframes, Black & Veatch chose a 15-year period for the regression analysis, from 1986 through 2000, which indicates a decline of approximately 103,000 gallons per customer per year.

3.4.4 Forecasts of Water Sales

The sales per customer indicated above were used along with Dr Coomes' forecasts of customers by customer class to forecast total water sales for each customer class. The forecasts of water sales, customers and sales per customer for each customer class are shown in Table 3-5. Wholesale water sales were forecast, according to Dr. Coomes' methodology, based on his forecasts of wholesale – residential customers and wholesale – commercial customers and assumes that wholesale sales are 90 percent residential and 10 percent commercial. The revised forecasts and analysis of sales per customer discussed above are provided to LWC in the spreadsheet *B&VBaseCaseWater01.xls*.

Table 3-5
Annual Water Sales Forecasts (1,000 gallons)

Year	Residential	Commercial	Industrial	Wholesale	Total
2000	15,937,596	16,498,751	5,387,815	1,709,445	39,533,607
2001	17,028,587	16,740,957	5,300,583	1,795,982	40,866,109
2002	17,088,637	16,856,235	5,202,500	1,813,335	40,960,706
2003	17,148,898	17,032,196	5,107,821	1,837,426	41,126,340
2004	17,209,372	17,285,771	5,018,695	1,870,158	41,383,997
2005	17,270,059	17,568,833	4,926,925	1,906,392	41,672,210
2006	17,330,961	17,812,359	4,833,765	1,938,536	41,915,621
2007	17,392,077	18,063,028	4,739,067	1,971,715	42,165,886
2008	17,453,408	18,297,980	4,645,336	2,003,367	42,400,092
2009	17,514,956	18,527,046	4,552,672	2,034,574	42,629,248
2010	17,576,721	18,769,527	4,460,779	2,067,527	42,874,553
2011	17,598,768	19,002,137	4,369,648	2,092,182	43,062,736
2012	17,549,689	19,205,154	4,279,451	2,100,297	43,134,591
2013	17,625,019	19,423,848	4,190,216	2,133,291	43,372,374
2014	17,695,166	19,636,333	4,101,761	2,164,801	43,598,061
2015	17,763,949	19,850,978	4,014,125	2,196,487	43,825,539
2016	17,831,757	20,067,884	3,927,429	2,228,431	44,055,500
2017	17,897,435	20,291,876	3,841,666	2,260,979	44,291,957
2018	17,963,592	20,515,756	3,756,657	2,293,782	44,529,788
2019	18,027,434	20,744,603	3,672,573	2,326,902	44,771,513
2020	18,088,908	20,979,787	3,589,416	2,360,490	45,018,601

3.5 County Demand Forecasts

Annual average day water demand forecasts for each county and census tract in the 23-county study area were developed. These forecasts are based on an analysis of customers and water usage for water utilities in each of the counties. Volume 1 of this facility plan includes data collected for the significant water utilities in each county. Where data was available, the numbers of customers and average day demands reported for the utilities providing service in each county were analyzed to establish a best-available estimate of the county-wide average day demand per customer. The county average of the utility specific average day demand per customer was based on the available data and excluded utilities where average day demand was missing. The county averages are summarized in Table 3-8 for counties where an estimate was possible. For the four Indiana counties (Crawford, Jefferson, Scott and Washington), where estimates were not available, the average of utilities in Clark, Floyd and Harrison counties was used, or 240 gallons per customer per day.

The forecasted annual average day requirement by county is shown in Table 3-6.

Table 3-6
Summary of Projected Annual Average Day Demand by County –
23 County Area Excepting Jefferson County
(1,000 Gallons per Day)

County	2000	2001	2002	2003	2004	2005	2010	2015	2020
Indiana Counties									
Clark	14,454	14,819	14,986	15,156	15,319	15,498	16,144	16,909	17,864
Crawford	1,003	1,027	1,037	1,047	1,056	1,066	1,100	1,139	1,190
Floyd	9,106	9,323	9,414	9,507	9,595	9,692	10,015	10,440	10,975
Harrison County IN	3,811	3,924	3,987	4,050	4,112	4,178	4,447	4,743	5,100
Jefferson	2,916	2,978	2,998	3,019	3,037	3,059	3,109	3,186	3,294
Scott	2,120	2,172	2,195	2,218	2,241	2,265	2,350	2,448	2,570
Washington	2,463	2,532	2,568	2,604	2,639	2,676	2,821	2,992	3,199
Kentucky Counties									
Breckinridge	1,882	1,936	1,965	1,993	2,021	2,051	2,169	2,301	2,460
Bullitt	5,210	5,423	5,568	5,715	5,862	9,927	11,075	12,343	13,823
Carroll	1,162	1,190	1,202	1,214	1,225	1,238	1,279	1,326	1,387
Grayson	3,656	3,762	3,818	3,876	3,931	3,991	4,228	4,492	4,812
Hardin	11,177	11,403	11,458	11,514	13,312	11,622	11,703	11,931	12,264
Henry	1,788	1,841	1,871	1,900	1,929	1,983	2,108	2,246	2,411
Larue	1,261	1,296	1,314	1,333	1,351	1,370	1,444	1,527	1,628
Marion	4,887	5,020	5,083	5,146	5,207	5,274	5,518	5,806	5,780
Meade	2,519	2,591	2,630	2,668	2,706	2,747	2,907	3,014	3,034
Nelson	4,228	4,391	4,498	4,607	4,715	4,829	5,332	5,896	6,212
Oldham	7,829	8,210	8,479	8,752	9,023	9,568	10,893	12,360	13,696
Shelby	3,764	3,927	4,038	4,150	4,262	4,419	4,948	5,524	6,130
Spencer	642	680	710	741	771	809	958	1,124	1,293
Trimble	907	945	971	998	1,025	1,083	1,212	1,356	1,469
Washington	1,348	1,376	1,385	1,394	1,402	1,412	1,434	1,461	1,412
23-County Area Totals (Excepting Jefferson County)									
Total (1,000 gpd	88,133	90,767	92,176	93,601	96,742	100,757	107,193	114,565	122,003
Total (BGY)	32.17	33.13	33.64	34.16	35.31	36.78	39.13	41.82	44.53

3.6 High Service Pumping

Historical monthly high service pumping for 1995 through 2000 was provided by LWC. The calendar year totals are summarized in Table 3-7.

Table 3-7 Total Annual WTP High Service Pumping (mgd)			
Year	B. E. Payne WTP	Crescent Hill WTP	Total
1995	26.06	101.06	127.12
1996	25.03	100.81	125.84
1997	25.86	101.82	127.68
1998	26.01	100.20	126.21
1999	33.43	106.18	139.61
2000	35.22	94.78	130.00

The total "high service pumping" from the water treatment plants is greater than "water delivered to mains". The difference represents treated water used at the treatment plants. A comparison of the two values is shown in Table 3-8.

Table 3-8 High Service Pumping vs. Water-Delivered-to-Mains			
Year	High Service Pumping(1)	Water Delivered to Mains(2)	Percent Difference
1995	127.12	121.98	4.13%
1996	125.84	121.27	3.71%
1997	127.68	123.63	3.22%
1998	126.21	124.27	1.55%
1999	139.61	134.50	3.73%
2000	130.00	127.16	2.21%

(1)High service pumping as shown in Table 1 of this memorandum.
(2)Water delivered to mains as shown in Table 2 of this memorandum.

3.7 Maximum Day and Maximum Hour Demands

Historical maximum day pumpage is provided in LWC's annual reports and is summarized in Table 3-9 for 1995 through 2000.

Table 3-9 Historical Maximum Day Pumpage			
Year	Water Delivered to Mains AAD (mgd)	Maximum Daily Pumpage MD (mgd)	MD:AAD Ratio
1995	121.98	168	1.38
1996	121.27	173	1.43
1997	123.63	182	1.47
1998	124.27	173	1.39
1999	134.50	198	1.47
2000	127.16	190	1.49

LWC provided SCADA information for key supply and delivery facilities, for the entire week containing the day of maximum day production for years 1999 and 2000. The data included the pumping rates and storage facility water levels. This data allowed for calculation of demands for the 660 Pressure Plane and its dependent planes, and for the Elevated Service Area (ESA).

Pumping information was provided for the high service pumps at the water treatment plants and the transfer pumps from 660 to 860 Pressure Planes. In addition, pumping information was provided for the Frey's Hill Booster Pumping Station that delivers water from the 860 Pressure Plane to the 940 Pressure Plane.

Water levels were provided for fifteen storage facilities totaling 52.8 million gallons capacity. Data was not available for twelve storage facilities totaling 5.3 million gallons of storage (including the 1.0 MG Billtown Road elevated tank). The contribution of these tanks was not included in the demand calculations.

Water demands were calculated for each 15-minute interval, and then averaged to determine hourly demands. Table 3-10 shows the resulting daily and maximum hourly demands for the each of the 1999 and 2000 peak use days.

Table 3-10
June 2000 Maximum Day and Maximum Hour Demands (mgd)

Pressure Plane	Maximum Day	Maximum Hour	MH:MD Ratio
Year 1999 Demands			
Sunday, July 25, 1999			
ESA	57.26	89.18	1.56
660	132.01	193.01	1.46
Total System	189.27	282.20	1.49
Tuesday, July 27, 1999			
ESA	52.02	83.86	1.61
660	135.74	198.15	1.46
Total System	187.76	280.15	1.49
Friday, July 30, 1999			
ESA	58.76	87.63	1.49
660	136.68	186.00	1.36
Total System	195.43	257.56	1.32
Year 2000 Demands			
Sunday, June 11, 2000			
ESA	64.84	90.58	1.40
660	113.45	158.07	1.39
Total System	178.29	247.08	1.39
Monday, June 12, 2000			
ESA	65.86	96.02	1.46
660	120.28	158.17	1.32
Total System	186.14	254.19	1.37
Tuesday, June 13, 2000			
ESA	66.82	103.37	1.55
660	122.23	164.79	1.35
Total System	189.05	261.18	1.38

The calculated maximum day demands account for changes in storage reservoir volumes over the day. The maximum day demand in Table 3-10 of 189 mgd is close to the maximum daily pumpage of 190 mgd shown in Table 3-13.

The maximum hour to average day ratio for year 2000 is calculated to be 2.05 (261.18 mgd / 127.16 mgd = 2.05).

The *1995-2015 Facilities Plan* uses a maximum day to average day peaking factor of 1.5, which is consistent with historical peaking factors. The *1995-2015 Facilities Plan* did not indicate the historical or projected maximum hour peaking factors.

Future peak demands were calculated by applying the annual average day projection by the design demand ratios shown in Table 3-11.

Table 3-11
Water Demand Peaking Factors

Service Area	Ratio, MD/AD	Ratio, MH/MD
Elevated Service Area	1.70	1.50
660 Pressure Zone and Dependent Zones	1.40	1.45
Wholesale Customers and Regionalization Scenarios A, B, E	1.50	1.00
Regionalization Scenarios C, D	1.55	1.00

3.8 Projected Retail Service Area Water Demands

Tables 3-12, 3-13, and 3-14 show the projected annual average day, maximum day, and maximum hour water demands for each pressure plane in the existing service area. Wholesale customers are included. The maximum day and hour demands are calculated as the average day demand times the demand factors developed previously.

Table 3-12
Average Day Projection of Water-Delivered-to-Mains (mgd)

Pressure Zone	2000	2001	2002	2003	2004	2005	2010	2015	2020
Elevated Service Area Pressure Planes									
680.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
770.1	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.13	0.14
770.2	5.12	5.36	5.44	5.53	5.63	5.74	6.25	6.39	6.55
770.3	3.67	3.87	3.95	4.04	4.14	4.24	4.75	4.90	5.08
770.4	3.05	3.17	3.19	3.22	3.25	3.50	3.68	3.84	4.03
820.0	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.09
860.1	9.97	10.47	10.66	10.87	11.11	11.36	12.58	12.92	13.34
860.2	6.88	7.27	7.45	7.64	7.84	8.09	9.16	9.55	10.00
860.3	0.56	0.61	0.63	0.65	0.68	0.71	0.84	0.86	0.89
900.1	5.47	5.73	5.81	5.91	6.02	6.13	6.68	6.80	6.96
900.2	0.09	0.10	0.10	0.11	0.11	0.12	0.14	0.14	0.15
940.1	2.84	2.99	3.08	3.17	3.26	3.42	3.85	4.22	4.55
950.1	0.55	0.60	0.63	0.67	0.70	0.74	0.91	0.91	0.92
Subtotal	**38.37**	**40.32**	**41.11**	**41.97**	**42.92**	**44.23**	**49.04**	**50.76**	**52.71**
660 Pressure Plane and Dependent Planes									
770.5	0.07	0.07	0.07	0.07	0.07	0.12	0.13	0.14	0.16
1030.0	0.16	0.17	0.17	0.17	0.17	0.27	0.26	0.30	0.33
660.0	85.70	88.00	87.65	87.44	87.42	88.85	88.53	90.64	93.29
690.0	0.27	0.28	0.29	0.30	0.30	0.52	0.57	0.64	0.71
750.0	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
760.1	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.06	0.07
760.2	0.15	0.15	0.16	0.16	0.16	0.28	0.31	0.34	0.38
770.5	0.30	0.31	0.32	0.33	0.35	0.59	0.67	0.75	0.84
790.1	0.35	0.36	0.36	0.36	0.35	0.35	0.34	0.35	0.36
790.2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
810.1	0.69	0.72	0.72	0.73	0.73	0.74	0.78	0.79	0.81
810.2	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05
940.2	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04
Subtotal	**87.97**	**90.34**	**90.01**	**89.83**	**89.84**	**92.04**	**91.93**	**94.29**	**97.23**
Total Existing Retail Area	**126.34**	**130.66**	**131.12**	**131.80**	**132.76**	**136.27**	**140.96**	**145.04**	**149.95**
Existing Wholesale Service Area	**3.59**	**3.77**	**3.91**	**4.05**	**4.19**	**5.74**	**6.67**	**7.49**	**8.37**
Total Existing Service Area	**129.93**	**134.43**	**135.03**	**135.85**	**136.95**	**142.01**	**147.63**	**152.54**	**158.32**

Table 3-13
Maximum Day Projection of Water-Delivered-to-Mains (mgd)

Pressure Zone	2000	2001	2002	2003	2004	2005	2010	2015	2020
Elevated Service Area Pressure Planes									
680.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
770.1	0.16	0.16	0.17	0.17	0.17	0.18	0.19	0.21	0.24
770.2	8.70	9.11	9.24	9.40	9.57	9.76	10.63	10.86	11.14
770.3	6.25	6.58	6.72	6.87	7.04	7.21	8.08	8.33	8.64
770.4	5.19	5.38	5.42	5.47	5.53	5.95	6.26	6.53	6.85
820.0	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.14	0.15
860.1	16.94	17.79	18.12	18.48	18.89	19.32	21.38	21.96	22.67
860.2	11.70	12.36	12.66	12.98	13.33	13.75	15.57	16.23	17.00
860.3	0.96	1.03	1.07	1.11	1.16	1.20	1.44	1.47	1.51
900.1	9.30	9.73	9.88	10.05	10.23	10.43	11.36	11.57	11.84
900.2	0.16	0.17	0.17	0.18	0.19	0.20	0.24	0.24	0.25
940.1	4.83	5.08	5.23	5.39	5.54	5.81	6,54	7.18	7.74
950.1	0.94	1.02	1.08	1.13	1.19	1.25	1.54	1.54	1.56
Subtotal	**65.23**	**68.54**	**69.89**	**71.35**	**72.97**	**75.18**	**83.36**	**86.29**	**89.61**
660 Pressure Plane and Dependent Planes									
770.5	0.09	0.10	0.10	0.10	0.10	0.17	0.18	0.20	0.22
1030.0	0.23	0.23	0.23	0.23	0.23	0.38	0.37	0.41	0.47
660.0	119.98	123.20	122.71	122.42	122.38	124.39	123.94	126.89	130.60
690.0	0.38	0.40	0.41	0.42	0.43	0.72	0.80	0.89	0.99
750.0	0.25	0.26	0.26	0.26	0.25	0.25	0.25	0.25	0.26
760.1	0.04	0.04	0.04	0.04	0.04	0.07	0.07	0.08	0.09
760.2	0.20	0.21	0.22	0.22	0.23	0.39	0.43	0.48	0.53
770.5	0.42	0.44	0.45	0.47	0.48	0.82	0.94	1.05	1.17
790.1	0.49	0.51	0.50	0.50	0.50	0.49	0.48	0.49	0.50
790.2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
810.1	0.97	1.00	1.01	1.02	1.03	1.04	1.09	1.11	1.13
810.2	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.07	0.08
940.2	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05
Subtotal	**123.15**	**126.48**	**126.02**	**125.76**	**125.77**	**128.86**	**128.70**	**132.00**	**136.13**
Total Existing Retail Area	**188.39**	**195.02**	**195.90**	**197.11**	**198.74**	**204.05**	**212.06**	**218.29**	**225.74**
Existing Wholesale Service Area	**5.38**	**5.66**	**5.86**	**6.08**	**6.29**	**8.61**	**10.01**	**11.24**	**12.56**
Total Existing Service Area	**193.77**	**200.68**	**201.77**	**203.19**	**205.03**	**212.65**	**222.06**	**229.53**	**238.30**

Table 3-14 Maximum Hour Projection of Water-Delivered-to-Mains (mgd)									
Pressure Zone	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2010**	**2015**	**2020**
Elevated Service Area Pressure Planes									
680.0	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
770.1	0.24	0.25	0.26	0.26	0.26	0.28	0.29	0.33	0.37
770.2	13.48	14.11	14.33	14.56	14.83	15.12	16.48	16.83	17.26
770.3	9.68	10.20	10.41	10.64	10.91	11.18	12.52	12.91	13.38
770.4	8.04	8.34	8.40	8.48	8.57	9.22	9.70	10.12	10.63
820.0	0.15	0.16	0.16	0.16	0.17	0.18	0.19	0.21	0.24
860.1	26.26	27.58	28.09	28.65	29.27	29.95	33.14	34.04	35.14
860.2	18.14	19.16	19.62	20.12	20.67	21.31	24.14	25.16	26.35
860.3	1.49	1.59	1.66	1.72	1.79	1.86	2.22	2.28	2.34
900.1	14.41	15.09	15.32	15.57	15.86	16.17	17.60	17.93	18.35
900.2	0.24	0.26	0.27	0.28	0.29	0.31	0.37	0.38	0.39
940.1	7.49	7.88	8.11	8.35	8.59	9.01	10.14	11.13	11.99
950.1	1.46	1.59	1.67	1.75	1.85	1.94	2.39	2.39	2.41
Subtotal	**101.11**	**106.24**	**108.32**	**110.59**	**113.10**	**116.53**	**129.21**	**133.74**	**138.90**
660 Pressure Plane and Dependent Planes									
770.5	0.13	0.14	0.14	0.14	0.15	0.24	0.26	0.29	0.32
1030.0	0.33	0.34	0.34	0.34	0.34	0.55	0.54	0.60	0.68
660.0	173.98	178.64	177.92	177.50	177.46	180.36	179.71	183.99	189.37
690.0	0.55	0.57	0.59	0.60	0.62	1.05	1.16	1.29	1.44
750.0	0.37	0.37	0.37	0.37	0.37	0.37	0.36	0.37	0.37
760.1	0.06	0.06	0.06	0.06	0.06	0.11	0.11	0.12	0.14
760.2	0.30	0.31	0.32	0.32	0.33	0.56	0.63	0.69	0.77
770.5	0.61	0.64	0.66	0.68	0.70	1.19	1.37	1.52	1.70
790.1	0.72	0.73	0.73	0.72	0.72	0.72	0.69	0.71	0.73
790.2	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
810.1	1.40	1.45	1.46	1.48	1.49	1.51	1.59	1.61	1.64
810.2	0.05	0.06	0.06	0.06	0.06	0.09	0.09	0.10	0.11
940.2	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.07	0.08
Subtotal	**178.57**	**183.39**	**182.73**	**182.36**	**182.37**	**186.85**	**186.61**	**191.40**	**197.38**
Total Existing Retail Area	**279.68**	**289.63**	**291.05**	**292.95**	**295.47**	**303.38**	**315.82**	**325.14**	**336.29**
Existing Wholesale Service Area	**5.38**	**5.66**	**5.86**	**6.08**	**6.29**	**8.61**	**10.01**	**11.24**	**12.56**
Total Existing Service Area	**285.06**	**295.29**	**296.91**	**299.03**	**301.76**	**311.99**	**325.82**	**336.38**	**348.84**

3.9 Regionalization Scenarios

3.9.1 Definition of Scenarios

Five scenarios for potential extension of LWC water service were developed for this plan. They are described in detail in Volume 1 of this report and are listed below.

- Scenario A – Hardin County
- Scenario B – Nelson County
- Scenario C – I-64 Corridor
- Scenario D – I-71 Corridor
- Scenario E – Indiana Army Ammunition Plant Retail Service.

3.9.2 Water Demand and LWC Regionalization Potential Projections

Future annual average day water demands for each regionalization scenario area were determined based on the census tract demand projections and scenario boundaries. Peak demands were determined using the peaking factors shown in Table 3-11. The existing water supply for the entities in each scenario area, considering known current water treatment plant or well supply plans, is listed in Table 3-15. The potential regionalization demand, or the projected total demand less the existing supply, is shown in Tables 3-16, and 3-17 for annual average day and maximum day conditions, respectively. No peaking allowance is provided for rates above maximum day rates for the regionalization supplies.

Table 3-15
Regionalization Scenario Areas Existing Supply Capabilities (mgd)

Regionalization Scenario	2000	2001	2002	2003	2004	2005	2010	2015	2020
A	11.92	11.92	11.92	11.92	11.92	11.92	11.92	11.92	11.92
B	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
C	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60
D	11.72	11.72	11.72	11.72	11.72	11.72	11.72	11.72	11.72
E	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Supply	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**

Table 3-16
Regionalization Scenario Demands and Potential Supply – Annual Average Day (mgd)

Regionalization Scenario	2000	2001	2002	2003	2004	2005	2010	2015	2020
Projected Average Day Demand									
A	10.57	10.80	10.88	10.96	12.70	11.12	11.33	11.55	11.87
B	4.07	4.23	4.33	4.44	4.54	4.67	5.15	5.69	6.01
C	2.67	2.78	2.85	2.92	2.99	3.09	3.42	3.81	4.25
D	7.80	8.16	8.42	8.67	8.93	9.42	10.69	11.97	13.17
E	1.98	2.03	2.06	2.08	2.11	2.14	2.24	2.35	2.47
Total Regionalization	27.09	28.01	28.54	29.08	31.28	30.44	32.83	35.36	37.77
LWC Regionalization Potential									
A	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.45
E	1.93	1.98	2.01	2.03	2.06	2.09	2.19	2.30	2.42
Total Potential Demand	1.93	1.98	2.01	2.03	2.84	2.09	2.19	2.55	3.88

Table 3-17
Regionalization Scenario Demands and Potential Supply – Maximum Day (mgd)

Regionalization Scenario	2000	2001	2002	2003	2004	2005	2010	2015	2020
Projected Average Day Demand									
A	15.85	16.21	16.32	16.44	19.05	16.67	16.99	17.32	17.81
B	6.11	6.35	6.50	6.66	6.81	7.00	7.72	8.54	9.01
C	4.14	4.31	4.42	4.53	4.64	4.80	5.30	5.90	6.59
D	12.09	12.65	13.04	13.44	13.84	14.61	16.58	18.55	20.42
E	2.97	3.05	3.09	3.13	3.17	3.21	3.37	3.52	3.71
Total Regionalization	41.16	42.56	43.37	44.20	47.51	46.29	49.95	53.84	57.53
LWC Regionalization Potential									
A	3.93	4.29	4.40	4.52	7.13	4.75	5.07	5.40	5.89
B	0.11	0.35	0.50	0.66	0.81	1.00	1.72	2.54	3.01
C	0.00	0.00	0.00	0.00	0.04	0.20	0.70	1.30	1.99
D	0.37	0.93	1.32	1.72	2.12	2.89	4.86	6.83	8.70
E	2.92	3.00	3.04	3.08	3.12	3.16	3.32	3.47	3.66
Total Potential Demand	7.33	8.56	9.27	9.98	13.22	12.00	15.66	19.55	23.24

Utilization of the demand projections for the development of infrastructure alternatives is addressed in Chapter 5 later in this report.

4.0 Regulatory Assessment

During the 20-year planning period, additional Federal drinking water regulations will likely become effective, requiring the LWC to meet increasingly stringent finished water quality standards. Facilities improvements may be required to maintain compliance with these requirements. This chapter presents a summary of current and pending regulations with which the LWC must comply. A discussion of the LWC's current compliance status and strategies to comply with pending and future regulations is also presented.

4.1 Data Review

An abbreviated review of historical plant performance and water quality data was conducted using information provided by LWC for the Crescent Hill and B. E. Payne water treatment facilities and the distribution system served by these facilities. The data reviewed included the following:

- Raw water alkalinity, total hardness, turbidity, temperature, flow, total hardness, total coliform, *E. Coli.*,*Giardia*, and *Cryptosporidium.*
- Settled water turbidity.
- Ferric chloride and lime dosage rates (data provided for CHWTP only).
- Finished water alkalinity, total hardness, pH, chloramine residual, turbidity, fluoride concentration, and temperature.
- Distribution system total coliform and total trihalomethane concentrations.

Selected raw, intermediate, and finished water quality parameters for the Crescent Hill and B. E. Payne water treatment plants are summarized in Tables 4-1 and 4-2.

Table 4-1
Crescent Hill Water Treatment Plant
Water Quality Summary

Parameter	Average	Range
Alkalinity, mg/L as $CaCO_3$		
Raw[(1)]	87	65-107
Finished[(2)]	75	46-110
Total Hardness, mg/L as $CaCO_3$		
Raw[(1)]	141	101-178
Finished[(2)]	153	114-206
pH, units		
Finished[(1)]	8.9	8.1-9.5
Turbidity, ntu		
Raw[(1)]	44	6-100
Settled[(3)]	1.5	0.4-10
Finished[(1,2)]	0.08	0.03-0.15
Temperature, degrees F		
Raw[(1)]	52	32-78
Finished[(1)]	53	34-80
Fluoride, mg/L		
Finished[(2)]	0.99	0.76-1.21
Chloramine, mg/L		
Finished[(1)]	2.6	2.4-3.1

[(1)]January 2001 – June 2001
[(2)]January 2000 – December 2000
[(3)]June 2000 – May 2001

Table 4-2
B. E. Payne Water Treatment Plant
Water Quality Summary

Parameter	Average	Range
Alkalinity, mg/L as $CaCO_3$		
Finished[(2)]	95	69-134
Total Hardness, mg/L as $CaCO_3$		
Finished[(2)]	174	129-222
pH, units		
Finished[(1)]	8.3	7.7-9.8
Turbidity, ntu		
Raw[(1)]	40	1.3-220
Settled[(3)]	2	0.16-9.7
Finished[(1,2)]	0.09	0.05-0.81
Fluoride, mg/L		
Finished[(2)]	0.99	0.34-2.55
Chloramine, mg/L		
Finished[(1)]	2.6	2.3-3.1

[(1)]January 2001 – June 2001
[(2)]January 2000 – December 2000
[(3)]June 2000 – May 2001

4.2 Regulatory Requirements

4.2.1 Current Regulations

The LWC is currently required to comply with a number of regulations including the following: Safe Drinking Water Act of 1974, the 1986 and 1996 Amendments to the Safe Drinking Water Act, the Stage 1 Disinfection By-Products Rule, the Interim Enhanced Surface Water Treatment Rule, Consumer Confidence Reports Rule, Arsenic Rule, and Radionuclides Rule. The 1986 Amendments to the Safe Drinking Water Act include the Surface Water Treatment Rule, Lead and Copper Rule, and Total Coliform Rule.

Most of these current regulations have been in effect for several years, and LWC is familiar with compliance requirements. Therefore, information on only the most recently finalized and pending/future rules are summarized below.

4.2.1.1 Stage 1 Disinfection By-Products Rule

Stage 1 of the Disinfection By-Products Rule (DBPR) was finalized during late November 1998 and became effective during January 2002 for systems serving 10,000 or more consumers and treating surface water or groundwater under the direct influence of surface water. Under the Stage 1 DBPR, the maximum contaminant level (MCL) for total trihalomethanes (TTHMs) has been reduced to 0.080 mg/L. New MCLs have been established for total haloacetic acids, bromate (a by-product of disinfection using ozone), and chlorite ion (a by-product of disinfection using chlorine dioxide). Maximum residual disinfectant levels (MRDLs) and MRDL goals (MRDLGs) have been established for free chlorine, chloramine, and chlorine dioxide.

The Stage 1 DBPR establishes a new MCL of 0.060 mg/L for total haloacetic acids (referred to as HAA5, as five of the nine known haloacetic acid compounds will be regulated under the Stage 1 rule). New MCLs for bromate and chlorite ion of 0.010 mg/L and 1.0 mg/L, respectively, have also been established. Compliance with these MCLs will be assessed based on the "running annual average" of quarterly monitoring data. The maximum allowable disinfectant residual in the water leaving the treatment facility, based on a running annual average of monthly monitoring data, is 4.0 mg/L for free chlorine and chloramines and 0.8 mg/L for chlorine dioxide. (Higher residuals are permissible on a short-term basis if necessary to address specific water quality problems, providing that running annual average concentrations do not exceed the MRDLs).

A primary goal of the DBPR is to reduce the levels of organic/humic compounds (collectively referred to as DBP precursors) which react with chlorine-based disinfectants to form DBPs. This is to be accomplished through operation of treatment facilities in an enhanced coagulation or enhanced softening mode, which will typically involve increases in coagulant dosages and/or adjustment of operating pH to optimize the removal of the precursor compounds. Precursor removal is to be quantified by measuring the removal of total organic carbon (TOC) across the treatment process. In general, for systems with average source water TOC concentrations exceeding 2.0 mg/L, enhanced coagulation/ enhanced softening treatment will be required.

Minimum TOC removal levels are summarized in Table 4-3. TOC removals are to be determined monthly, and compliance is assessed quarterly based on a running annual average of monthly TOC removals.

Table 4-3
Step 1 TOC Removal Requirements for Enhanced Coagulation/Enhanced Softening

Source Water TOC, mg/L	Percent TOC Removal Required at Indicated Source Water Alkalinity		
	0 – 60 mg/L	>60 – 120 mg/L	>120 mg/L[1]
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

[1]Systems practicing softening must meet the TOC removals shown in this column.

The DBPR also provides alternative compliance criteria that are independent of the TOC removal criteria discussed above. Systems will be exempt from the enhanced coagulation/enhanced softening requirements if any of the following conditions are met:

- The source water TOC is less than 2.0 mg/L (calculated quarterly as a running annual average of monthly monitoring data).
- The treated water TOC is less than 2.0 mg/L (calculated quarterly as a running annual average of monthly monitoring data).
- The source water TOC is less than 4.0 mg/L, the source water alkalinity is greater than 60 mg/L (as $CaCO_3$), and the system is achieving TTHM concentrations less than 0.040 mg/L and HAA5 concentrations less than 0.030 mg/L.
- The running annual average TTHM concentration is less than 0.040 mg/L, and annual average HAA5 concentration is less than 0.030 mg/L, when only free chlorine is used for disinfection and maintenance of a residual in the distribution system. (Note that systems using chloramines would not comply with these conditions).
- The source water specific ultraviolet absorbance [SUVA, defined as the ratio of the water's ultraviolet absorbance at 254 nm (UV_{254}) to its dissolved organic carbon (DOC)

concentration] prior to any treatment is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average of monthly monitoring data.

- The finished water SUVA is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average of monthly monitoring data. (This measurement must be made prior to the addition of a chemical oxidant, which will likely be problematic for most utilities).

Systems that elect to utilize one of these alternative criteria must still conduct monthly raw and treated water TOC monitoring.

Water systems were required to have monitoring plans available by January 30, 2002 that define how the system will demonstrate compliance with Stage 1 DBPR requirements. Systems serving populations greater than 3,300 were to submit the plans to the state regulatory agency by February 10, 2002. The monitoring plans must include sampling locations, treatment techniques, and a description of how the system will determine compliance with the regulations. If the system sells water to a consecutive system, the monitoring plan must reflect the entire distribution system served.

In addition to the monitoring plan requirements specified by the U. S. Environmental Protections Agency (USEPA), there are a number of requirements specific to the State of Kentucky. As required by the Kentucky Division of Water (KDOW), the water producer is responsible for monitoring throughout the entire distribution system. Therefore, maximum residence time samples must be representative of the entire distribution system. Consecutive systems that receive water are required to cooperate in development of the monitoring plans and to monitor MRDLs similar to total coliform. Consecutive systems must revise distribution operation and maintenance practices to minimize potential violations of the MCLs for TTHMs and HAA5s. These revisions include line flushing and replacement, alteration of disinfection points, and minimizing retention times within treated water storage facilities. Operational changes must be approved by KDOW prior to implementation.

4.2.1.2 Interim Enhanced Surface Water Treatment Rule

The Interim Enhanced Surface Water Treatment Rule (IESWTR) was finalized during late November 1998 and became effective during January 2002 for systems serving 10,000 or more consumers. The rule applies to systems using surface water or groundwater under the influence of surface water. The primary objectives of this rule are to improve the control of microbial pathogens in drinking water (particularly *Cryptosporidium*) and to guard against significant increases in microbial risk that might occur when systems implement the Stage 1 DBPR.

Primary requirements of the IESWTR are as follows:

- Systems with annual average DBP levels within 80 percent of the new Stage 1 DBPR MCLs (i.e., >0.064 mg/L for TTHMs or 0.048 mg/L for HAA5) for the most recent 12-month monitoring period are required to prepare a "disinfection profile" for state review prior to altering disinfection practices to reduce DBP concentrations. The disinfection profile is a compilation of daily criteria that affect the overall efficacy of the disinfection process, collected over a minimum of one year. The average level of microbial inactivation for each month is developed from the disinfection profile, and the lowest monthly average inactivation becomes the disinfection benchmark. A minimum of one year and a maximum of three years of daily disinfection performance data must be used to develop the disinfection profile. If the State does not approve changes in disinfection, systems must develop alternate ways of reducing DBPs to meet the new MCLs.
- Allowable finished water turbidity is reduced from the 0.5 NTU level allowed under the Surface Water Treatment Rule to 0.3 NTU. This standard applies to the combined filtered water, and a minimum of 95 percent of the monthly turbidity measurements must meet the revised turbidity criteria. The turbidity of the combined filter effluent cannot exceed 1 NTU at any time. (The current SWTR allows for a maximum filter effluent turbidity of 5 NTU).
- Continuous turbidity monitoring is required for each filter, and specific performance criteria will apply to each filter. Systems must record the results of individual filter turbidity monitoring at 15-minute intervals and must maintain records of individual filter performance for a minimum of three years.
- Systems treating surface water, or groundwater under direct surface water influence, and serving more than 10,000 consumers must achieve at least a 2-log (99 percent) removal of *Cryptosporidium*. (The regulation states that systems that comply with the revised turbidity requirement of 0.3 NTU are assumed to be achieving compliance with the 2-log *Cryptosporidium* removal requirement).
- States are required to conduct sanitary surveys for all public water systems (regardless of size) no less frequently than every three years.

Under the IESWTR, systems are required to provide "an exceptions report to the State on a monthly basis." Exceptions to be reported consist of the following:

- Any individual filter with a turbidity level greater than 1.0 NTU based on two consecutive measurements 15 minutes apart.
- Any individual filter with a turbidity level greater than 0.5 NTU at the end of the first four hours of operation, based on two consecutive measurements 15 minutes apart.

A "filter profile" is to be produced if "no obvious reason for the abnormal filter performance can be identified." Other requirements are as follows:

- If an individual filter has turbidity levels greater than 1.0 NTU, based on two consecutive measurements 15 minutes apart at any time in each of three consecutive months, the water system is required to conduct a self-assessment of the filter utilizing "relevant portions" of guidance issued by EPA under its Comprehensive Performance Evaluation (CPE) program.
- If an individual filter has turbidity levels greater than 2.0 NTU based on two consecutive measurements 15 minutes apart at any time in each of two consecutive months, the water system will arrange for a CPE to be conducted by the State or a third party approved by the State. The State will ensure that the recommendations resulting from the CPE are implemented.

Methods for conducting CPEs and individual filter performance assessments are detailed in the April 1999 EPA publication *Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions.*

4.2.1.3 Radionuclides

Radionuclides normally present problems for systems that treat groundwater from deep wells or that are located downstream from an industrial source of radiation. A proposed rule for several radionuclides (radon, radium, alpha, beta, and photon emitters, and radium) was released in 1991 but not finalized until December 2000. This rule established a new MCL for uranium of 30 ug/L; however, EPA elected to retain the MCLs for radium and alpha, beta, and photon emitters established under the original Safe Drinking Water Act in 1976 with no modifications. (The new regulation does include separate monitoring requirements for radium-228 under the combined MCL for radium-226 and radium-228).

Monitoring for radionuclides is required quarterly for four consecutive quarters. However, the State may waive the monitoring requirements for the final two quarters in a period if the samples from the previous two quarters produce non-detectable results.

4.2.1.4 Arsenic Rule

EPA proposed revisions to the current drinking water standard for arsenic during May 2000 and promulgated a new MCL of 0.010 mg/L during January 2001. The new MCL becomes effective five years after promulgation, i.e., during January 2006. Some aspects of the rule, such as monitoring and reporting requirements, will be effective prior to January 2006, but the original MCL of 0.05 mg/L will remain effective until January 2006. Utilities must begin providing health information and data on treated water arsenic concentrations in their annual

Consumer Confidence Report by July 2002 if the water supply contains more than 0.005 mg/L of arsenic.

Considerable controversy currently surrounds the regulation of arsenic in drinking water supplies, and during March 2001, EPA announced its intention to withdraw this regulation as currently promulgated to allow further review. However, on October 31, 2001, the EPA Administrator announced that the Agency would retain the 0.010 mg/L MCL, and that the original compliance date of January 2006 would not be altered.

4.2.1.5 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was proposed concurrently with the LT1ESWTR during April 2000, but promulgated as a separate regulation during June 2001. Provisions of the FBRR addressing in-plant recycling of wastestreams apply to all systems that treat surface water and groundwater under the direct influence of surface water and that practice conventional treatment or direct filtration. In addition to filter backwash flows, recycle streams covered under this regulation consist of sludge thickener supernatant and flows associated with sludge dewatering processes. Plants practicing recycle of these streams within the treatment plant must return them to a location such that all unit processes of the conventional or direct filtration process are employed in the treatment of the recycle flow. (This location will typically be the plant headworks prior to the addition of coagulant).

All systems that recycle these flows must submit a plant process schematic to the state regulatory agency for review by December 2003 showing the current recycle return location and the proposed return location that will be used to establish compliance. Data on typical recycle flow rates, maximum recycle flow rates, plant design capacity, and state-approved maximum operating capacity must also be submitted to the state regulatory agency by December 2003. Systems must also collect and maintain additional information on filter operating data, recycle flow treatment provided, physical dimensions of recycle flow equalization and/or treatment units, and recycle flow rate and frequency data for review and evaluation by the state regulatory agency beginning June 2004.

Systems must comply with the recycle return provisions of the FBRR no later than June 2004. If the system requires capital improvements to modify the location of the recycle return, these improvements must be in place and operational by June 2006. The regulation does not address recycle of filter-to-waste flows. Process solids recycle flows from lime softening and contact clarification units are also not covered by the FBRR. However, softening systems may not return spent filter backwash, thickener supernatant, or liquids from solids dewatering processes to a location that does not incorporate all unit treatment processes.

4.2.2 Pending Regulations

4.2.2.1 Stage 2 Disinfection By-Products Rule

The *Stage 2 M-DBP Agreement in Principle* will be the basis for EPA's development of Stage 2 of the DBPR, which is currently scheduled to be finalized during November 2003. A draft version of the proposed rule was made available for review during November 2001. The Stage 2 DBPR requirements will apply to all community water systems and non-transient non-community water systems that add a disinfectant [other than ultraviolet (UV) irradiation] or deliver water that has been disinfected. Key points pertaining to the Stage 2 DBPR are summarized below.

Under the Stage 2 DBPR, MCLs would remain at the levels established under the Stage 1 rule, i.e., TTHMs = 0.080 mg/L and HAA5 = 0.060 mg/L. However, monitoring procedures and schedules would be modified to ensure that the data obtained more closely represents actual long-term exposure conditions.

Initial compliance efforts will focus on identifying points within the system where DBP concentrations are typically highest, and would involve the following:

- For systems serving 10,000 or more consumers; one year of monitoring of TTHM and HAA5 concentrations at 60-day intervals (+/- 3 days) at 8 additional locations within the distribution system. (Systems served by more than one treatment facility would be required to monitor at 8 locations per treatment plant). For systems that maintain a free chlorine residual within the distribution system, the 8 monitoring sites per plant would consist of (1) one sample near the distribution system entry point, (2) two sites considered to reflect "average" system DBP concentrations, and (3) five sites considered to reflect "maximum" system DBP concentrations. For systems that maintain a chloramine residual within the distribution system, the 8 monitoring sites per plant would consist of (1) two samples near the distribution system entry point, (2) two sites considered to reflect "average" system DBP concentrations, and (3) four sites considered to reflect "maximum" system DBP concentrations. This monitoring, referred to in the draft proposed regulation as the Initial Distribution System Evaluation (IDSE) monitoring study, would be conducted in addition to the quarterly compliance monitoring conducted under the current TTHM regulation and the impending Stage 1 DBPR. A report summarizing the IDSE monitoring results must be submitted to the State/Primacy Agency within two years of promulgation of the Stage 2 DBPR.

- Following completion of the IDSE, systems will recommend new or revised monitoring sites to their State/Primacy Agency based on their IDSE study.

Monitoring site locations (four per system if served by a single treatment plant; four per system per plant if served by multiple treatment plants) are to be selected as follows:

- One location representative of average conditions from among current Stage 1 DBPR monitoring locations.
- One location representative of highest HAA5 concentrations identified under the IDSE.
- Two locations representative of highest TTHM concentrations identified under the IDSE.

Quarterly monitoring of DBP concentrations at four locations per plant within the distribution system would continue to be conducted for compliance monitoring purposes. At least one quarterly monitoring period would be required to reflect "peak historical" DBP formation level periods, and systems will be required to monitor on a regular schedule of approximately every 90 days. MCL compliance will be determined based on a "Locational Running Annual Average" (LRAA) basis, i.e., a running annual average must be calculated at each monitoring location. Systems will be required to comply with the Stage 2 MCLs in two phases:

- 3 years after promulgation, all systems must comply with locational running annual average MCLs of 0.120 mg/L for TTHMs and 0.100 mg/L for HAA5 at current Stage 1 DBPR monitoring sites, while continuing to comply with the Stage 1 MCLs of 0.080 mg/L for TTHMs and 0.060 mg/L for HAA5. (These are currently being referred to as "Stage 2A" requirements).
- 6 years after promulgation (with an additional two-year extension available if capital improvements are required), large and medium-sized systems must comply with locational running annual average MCLs of 0.080 mg/L for TTHMs and 0.060 mg/L for HAA5 at the approved sampling locations identified under the IDSE. (These are currently being referred to as "Stage 2B" requirements).

Should an MCL be exceeded at one or more system monitoring points (based on annual running average DBP concentrations), the system would be considered to be in violation of the Stage 2 regulation, regardless of results for the remaining monitoring sites. This represents a major change from current Stage 1 DBPR requirements, as the "system averaging" concept would be eliminated under the Stage 2 regulation.

Considerable pressure to reduce the Stage 1 MCL for bromate to 0.005 mg/L or less currently exists, as ongoing research suggests that this contaminant may be more carcinogenic than originally believed. (This change would primarily impact utilities practicing ozonation for primary disinfection and/or utilities that employ high dosages of sodium hypochlorite). However, *Stage 2 M-DBP Agreement in Principle* recommends that the MCL for bromate remain at the current value of 0.010 mg/L. As part of this agreement, EPA would commit to review the bromate MCL as part of the six-year regulatory review process required under the Safe Drinking Water Act to determine whether the MCL should remain at 0.010 mg/L or be reduced to 0.005 mg/L or lower.

4.2.2.2 Long-Term Enhanced Surface Water Treatment Rule

A long-term Enhanced Surface Water Treatment Rule, which will extend the IESWTR requirements to systems serving less than 10,000 consumers, was promulgated during January 2002, and will become effective during January 2005. This regulation is currently being referred to as the Stage 1 Long-Term Enhanced Surface Water Treatment Rule, or LT1ESWTR.

A long-term Stage 2 ESWTR (currently being referred to as the LT2ESWTR) is expected to be promulgated during November 2003. This rule will apply to all public water systems that use surface water or groundwater under the direct influence of surface water. Recommendations presented in the *Stage 2 M-DBP Agreement in Principle* and a November 2001 preproposal regulation draft include an initial period of raw water microbial monitoring, with treatment requirements established based on microbial contaminant levels present in the supply. Utilities serving 10,000 or more consumers and practicing conventional treatment (coagulation, sedimentation, and filtration) would be required to conduct monthly monitoring of the raw water supply for *Cryptosporidium*, *E. coli*, and turbidity over a 24-month period. Specific regulatory compliance requirements would then be established based on the following:

- If monthly samples are collected, classification is to be based on the highest 12-month running annual average.
- If the system conducts monitoring twice per month, classification is to be based on a two-year mean value of all monitoring data. (This increased monitoring must be conducted at evenly distributed time intervals over the two-year period).

Systems would be exempt from source water *Cryptosporidium* monitoring if 2.5 logs of *Cryptosporidium* removal/inactivation is provided in addition to conventional treatment. If monitoring is required, systems serving 10,000 or more consumers must submit a report summarizing the monitoring results to their state agency within 30 months of promulgation of this regulation.

Additional treatment requirements under the LT2ESWTR, based on average raw water *Cryptosporidium* oocyst concentrations, are summarized in Table 4-4.

Table 4-4
***Cryptosporidium* Treatment Requirements under LT2ESWTR**

Raw Water *Cryptosporidium* Conc., oocysts per Liter[(1)]	Additional Treatment Required for Conventional Treatment Systems in Full Compliance with IESWTR
Cryptosporidium < 0.075/L	No action required
0.075/L ≤ *Cryptosporidium* <1.0/L	1-log treatment[(2)]
1.0/L ≤ *Cryptosporidium* <3.0/L	2-log treatment[(3)]
Cryptosporidium ≥ 3.0/L	2.5-log treatment[(3)]

[(1)]Based on maximum value for 12-month running annual average, or 2-year mean if semi-monthly monitoring is conducted.
[(2)]Systems may use any combination of technologies to achieve 1-log credit.
[(3)]Systems must achieve at least 1-log of total treatment requirement using ozone, chlorine dioxide, UV irradiation, membranes, bag/cartridge filters, or in-bank filtration.

Under the regulatory provisions presented in the November 2001 preproposal draft, systems would chose technologies to comply with additional treatment requirements from a "toolbox" of options, including improved watershed control, improved treatment system and/or disinfection performance, and additional treatment barriers.

Specific tools and associated potential log treatment credits are summarized in Table 4-5. It is emphasized that EPA will request comment on the proposed log credits presented in Table 4-5 and may modify assigned credits in the final rule based on comments received.

Table 4-5
Microbial Toolbox Options, Log Credits, and Design/Implementation Criteria

Toolbox Option	Proposed *Cryptosporidium* Log Credit
Watershed Control Program	0.5-log credit for State-approved program comprising EPA specified elements; Potential for additional credit based on *Cryptosporidium* reduction demonstrated through monitoring.
Alternative Source / Intake Management	No presumptive credit. Systems may be assigned to a lower bin based on *Cryptosporidium* monitoring at new intake location. Re-binning would occur after system begins using new intake location.
Off-Stream Raw Water Storage (1)	0.5-log credit for reservoir with hydraulic residence time (HRT) of at least 21 days: 1.0-log credit for reservoir with HRT of a least 60 days.
Presedimentation Basin (1)	0.5-log credit with continuous operation and coagulant addition. Max loading rate of 1.6 gpm/sq ft, mean influent turbidity ≥ 10 NTU or max influent turbidity ≥ 100 NTU.
Lime Softening	0.5-log credit for second stage softening with coagulant addition.
Bank Filtration (1)	0.5-log credit for 25 ft. setback; 1.0-log credit for 50 ft. setback.
Lower Finished Water Turbidity	0.5-log credit for combined filter effluent turbidity ≤0.15 NTU in 95% of samples each month. 1.0-log credit for individual filter effluent turbidity ≤0.15 NTU in 95% of samples each month.
Slow Sand Filters	2.5-log credit as add-on technology.
Second Stage Filtration	0.5-log credit for second separate filtration stage in treatment process.
Membranes (MF, UF, NF, RO)	Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing.
Bag Filters	1-log credit with demonstration of at least 2-log removal efficiency in challenge test; State may award greater credit.
Cartridge Filters	2-log credit with demonstration of at least 3-log removal efficiency in challenge test; State may award greater credit.
Chlorine Dioxide	Log credit based on demonstration of compliance with CT table or alternative values approved by State.
Ozone	Log credit based on demonstration of compliance with CT table or alternative values approved by State.
UV	Log credit based on demonstration of compliance with UV dose table or alternative values approved by State.
Demonstration of Performance	1.0-log credit if average spore removal ≥ 4-log based on one year of weekly monitoring.

(1) Credit available only if source water *Cryptosporidium* monitoring was conducted prior to Option.

Following completion of source water monitoring and system classification based on monitoring results, systems will have three years to meet the additional treatment requirements presented in Table 4-4. The State agency will have the authority to grant systems an additional two-year extension to comply when capital investments are necessary. Systems currently using ozone, chlorine dioxide, UV irradiation, or membranes (in addition to conventional treatment) may receive credit for those technologies towards meeting the requirements presented in Table 4-4. The *Agreement in Principle* and the preproposal draft state that the additional treatment requirements in Table 4-4 are based in part on the assumption that conventional treatment plants currently in compliance with the IESWTR are achieving an average of 3-log removal of *Cryptosporidium* oocysts.

Four years after completion of initial system classification, EPA will initiate a stakeholder process to review available microbial analytical methods and the classification structures. This process will develop the basis for a second round of national assessment monitoring. Six years after completion of initial system classification, systems will be required to conduct a second round of source water monitoring "equivalent or superior to the initial round from a statistical perspective." This process could result in system reclassification (to determine additional treatment requirements for *Cryptosporidium*) under the current regulatory structure or in promulgation of a revised regulation, which reflects recommended changes developed during the stakeholder process.

Compliance schedules for the LT2ESWTR will be contingent upon (1) the availability of sufficient analytical capacity at approved laboratories to conduct the required *Cryptosporidium* and *E. coli* analyses, and (2) the availability of software for transferring, storing, and evaluating the results of all of the microbial analyses. If either of these two items is determined to be insufficient to support the level of analytical testing required, then monitoring, implementation, and compliance schedules for both the LT2ESWTR and the Stage 2 DBPR will be delayed by an equivalent time period.

If the scenario discussed above is promulgated as currently recommended, many utilities practicing conventional treatment should begin considering having a process to provide an additional 1-log to 2.5-log removal/inactivation of *Cryptosporidium* oocysts in operation by May 2009. (May 2011, if significant capital improvements are required, with state regulatory agency approval). Based on current research results, it appears that only ozone and ultraviolet UV irradiation are feasible disinfection alternatives for inactivation of *Cryptosporidium* oocysts. In addition, the recommended plan suggests that membrane filtration processes, such as microfiltration and ultrafiltration, would be an acceptable substitute for inactivation processes.

The *Agreement in Principle* states that "based on available information, EPA believes that UV disinfection is available and feasible", and that "the availability of UV disinfection is a fundamental premise of this *Agreement in Principle*". However, it is recognized that additional information is needed with regard to engineering issues and to assist Stage regulatory agencies in approving this technology.

Concurrent with publication of the proposed LT2ESWTR, EPA therefore will publish the following:

- Information on UV radiation doses and contact times required to achieve up to 3 logs inactivation of *Giardia* and *Cryptosporidium* and up to 4 logs inactivation of viruses.
- Minimum standards to determine if UV systems are acceptable for compliance with drinking water requirements, including a Validation Protocol and a description of onsite monitoring requirements to ensure ongoing compliance with required dosage levels.
- An UV guidance manual, which is to facilitate design and planning of UV systems and to familiarize State agencies and utilities with design and operational issues.

The November 2001 pre-proposal draft of the LT2ESWTR includes disinfection profiling and benchmarking requirements for *Giardia* cysts and viruses similar to those included in the Interim Enhanced Surface Water Treatment Rule. These requirements would apply only to surface water systems that are also required to monitor source water *Cryptosporidium* concentrations under the LT2ESWTR. Disinfection profiles must be prepared using weekly *Giardia* and virus inactivation data over a one-year period; this data must be representative of inactivation levels provided through the entire treatment facility, and not just for certain treatment segments. Systems serving more than 10,000 consumers would need to begin collecting data needed to develop disinfection profiles within 24 months of promulgation of the LT2ESWTR. The draft proposed rule does include provisions for utilization of existing ("grandfathered") *Giardia* and virus inactivation data in preparing disinfection profiles, providing that the existing data meets specified requirements.

4.2.2.3 Radon Rule

The EPA proposed new regulations for radon during October 1999, with final promulgation scheduled for March 2002. However, at this time the schedule for promulgation of the final rule is uncertain, but it is anticipated that a final rule will be issued by mid-2002. Two alternative compliance approaches were included in the proposed radon rule:

- States can elect to develop programs to address the health risks from radon in indoor air through adoption and implementation of a multimedia mitigation program. Under this approach, individual water systems would be required to reduce radon levels in the treated water to 4,000 pCi/L or lower. EPA will encourage States to adopt this approach, as it is considered the most cost-effective way to achieve the greatest reduction in radon exposure risk.
- If the State elects not to develop a multimedia radon mitigation program, individual water systems will be required to reduce radon levels in their system's treated water to 300 pCi/L or to develop local multimedia mitigation programs and reduce radon levels in drinking water to 4,000 pCi/L.

Water systems with radon levels at or below 300 pCi/L would not be required to treat their water to remove radon. States will likely be granted fairly wide latitude in developing and implementing the multimedia mitigation programs, and it is expected that the programs will differ significantly from state to state. The need for radon treatment will be based on results of quarterly monitoring, and compliance must be achieved beginning in June 2004. (If the state regulatory agency commits to the multimedia mitigation and alternative MCL compliance approach within 90 days of final promulgation of the rule, it will be granted an additional 18 months to achieve compliance, i.e., the effective date would be extended until December 2005). Considerable controversy currently surrounds the regulation of radon in drinking water supplies, and modification of this regulation as currently proposed could significantly alter the requirements contained in the final rule.

4.2.3 Future Regulations

In addition to the pending regulations discussed above, there are several additional regulations that will eventually be promulgated under the current Safe Drinking Water Act agenda. These rules will be promulgated under the procedures established by the 1996 Amendments to the Act, meaning that EPA will no longer establish an MCL for a contaminant based solely on projected health related issues. The 1996 Amendments require the use of sound science and allow for consideration of other factors such as cost, benefits, and competing risks.

4.2.3.1 Sulfate

Under the 1996 Safe Drinking Water Act Amendments, EPA is to evaluate the need to regulate sulfate in drinking water; this determination was to be made by August 2001 (this was not completed, and at this time the schedule for making this determination is uncertain). If the need to regulate sulfate is indicated, EPA must propose an MCL by August 2003 and finalize a regulation by February 2005. Recently completed studies, however, have suggested that there may not be sufficient evidence to warrant regulation of sulfate.

4.2.3.2 Drinking Water Contaminants Candidate List

During February 1998, EPA finalized the first Drinking Water Contaminant Candidate List (CCL), which will be used to set regulatory, research, and occurrence-investigation priorities. This list included 19 chemicals and one microbial contaminant, which the Agency considered as "high priority" with respect to determination of the need to regulate. During November 1999, EPA narrowed this list of 20 contaminants to a total of 12. The Agency was to select five or more contaminants from this list and decide by August 2001 whether to regulate them (this was not completed at the time of writing this report).

The 12 contaminants under consideration for future regulation are summarized in Table 4-6.

Table 4-6 **Contaminants To Be Considered for Future Regulation**
Acanthamoeba (guidance for contact lens wearers)
Naphthalene
Hexachlorobutadiene
1,3-dichloropropene
Aldrin
Dieldrin
Metolachlor
Metribuzin
Sodium (guidance)
Manganese
Boron
Sulfate

4.2.3.3 Other Rules

Additional rules are likely to be proposed by the EPA, but these will primarily address administrative issues such as the reformatting of drinking water amendments, streamlining of public notification requirements, and analytical methods updates. EPA presently plans to defer action on regulation of contaminants such as nickel and atrazine, and has indicated that it likely will not propose a new regulation for aldicarb until August 2004, with a final regulation expected by August 2005.

4.3 Regulatory Schedule

The EPA's current regulatory promulgation schedule is presented in Table 4-7. Table 4-7 includes both existing and pending/future Safe Drinking Water Act regulations.

Table 4-7
Schedule for Promulgation of Safe Drinking Water Act Regulations

Regulation	Proposed	Final	Effective
Fluoride	11/85	04/86	10/87
8 VOCs (Phase I)	11/85	07/87	01/89
Surface Water Treatment Rule	11/87	06/89	06/93
Coliform Rule	11/87	06/89	12/90
Lead & Copper	08/88	06/91	01/92[1]
Minor Revisions	04/98	01/2000	01/2001
26 Synthetic Organic Contaminants[2] 7 Inorganic Contaminants (Phase II)	05/89	01/91	07/92
MCLs for barium, pentachlorophenol (Phase II)	01/91	07/91	01/93
Phase V Organics, Inorganics	07/90	07/92	01/94
Radionuclides (Phase III) – except radon	07/91	12/2000	12/2003
Radon	11/99	mid-2002	mid-2005[3]
Sulfate	12/94	Schedule for Decision to Regulate is uncertain at this time	
Disinfectants / Disinfection By-Products			
Stage 1	07/94	12/98	01/2002[4,5]
Stage 2	11/2002	11/2003	11/2009[6]
Information Collection Rule (ICR)	02/94	05/96	07/97
Interim Enhanced SWTR	07/94	12/98	01/2002[4]
Stage 1 – Long-Term Enhanced SWTR	04/2000	01/2002	01/2005[3]
Stage 2 – Long-Term Enhanced SWTR	11/2002	11/2003	05/2009[7]
Consumer Confidence Reports Rule (CCR)	02/98	08/98	09/98
Unregulated Contaminants (monitoring)[8]	02/99	09/99	01/2001
Ground Water Rule (GWR)	05/2000	12/2002	12/2005[3]
Filter Backwash Recycling Rule (FBRR)	04/2000	06/2001	06/2004[9]
Arsenic	06/2000	02/2002	01/2006[10]

(1) Start date for tap monitoring; systems serving more than 50,000 consumers.
(2) MCL, MCLG for atrazine to be reconsidered.
(3) Assumes regulation in effect 3 years after final promulgation.
(4) For systems serving more than 10,000 consumers.
(5) Effective 01/2004 for groundwater and small surface water systems.
(6) Phased compliance schedule; 11/2009 is projected deadline for compliance with locational TTHM and HAA5 values of 0.080 mg/L and 0.060 mg/L, respectively.
(7) Phased compliance schedule; 05/2009 is projected deadline for compliance with additional Cryptosporidium treatment requirements.
(8) Tiered monitoring approach pending availability of analytical methods.
(9) Deadline for modifying recycle point location, if required. 2-year extension available if capital improvements required.
(10) Deadline for compliance with revised arsenic MCL.

4.4 Partnership for Safe Water

LWC is a prominent member of the *Partnership for Safe Water,* a voluntary cooperative venture of six organizations (including EPA and AWWA) and U.S. drinking water systems. The organizations entered into a partnership in 1995 with the nation's drinking water systems to encourage these systems to voluntarily adopt operational and administrative practices which would yield improvements in plant performance, primarily with respect to turbidity of the treated water.

The *Partnership* program consists of four phases. Phase I is essentially an agreement to complete the program through Phase III. Phase II consists of collection and analysis of historical turbidity removal data to establish baseline plant performance conditions. Under Phase III, utilities review their plant operation using guidelines provided in the *Partnership* guidance manual to identify areas that may limit performance and then prepare and submit a self-assessment report. The objective of Phase IV is to provide recognition to plants that have achieved the highest possible levels of performance with respect to turbidity removal. (Participation in Phase IV is voluntary and is not required for continued membership in Phase III of the *Partnership* program).

In general, under Phase IV, utilities must demonstrate that they are meeting or surpassing the performance goals outlined in EPA's "Composite Correction Program". These performance goals include the following:

- Settled water turbidity less than 1.0 NTU 95 percent of the time when raw water turbidity is less than or equal to 10 NTU, and less than 2.0 NTU 95 percent of the time when raw water turbidity is greater than 10 NTU.
- Filtered water turbidity less than 0.1 NTU 95 percent of the time, based on maximum values recorded during 4-hour time increments.
- Maximum filtered water turbidity of 0.3 NTU
- Maximum filtered water turbidity following backwash of 0.3 NTU.
- Maximum backwash recovery period of 15 minutes (i.e., return to less than 0.1 NTU operating turbidity in 15 minutes or less).

Systems must submit documentation of optimized performance for review by the Program Effectiveness Assessment Committee (PEAC). The PEAC will then make a determination if the utility has achieved the Phase IV goals. Systems must maintain the performance goals and continue to submit performance data on an annual basis in order to retain Phase IV status.

LWC has completed Phases I to III and is collecting data for the Phase IV review. It is LWC's goal to achieve Phase IV performance goals and certification.

4.5 LWC Regulatory Compliance Status

The following presents the results of an abbreviated assessment of LWC's ability to comply with current, pending, and future regulatory requirements. This assessment is based primarily on information provided by LWC staff and on limited review of historical plant performance and water quality data.

4.5.1 Current Regulations

LWC complies with all current state and federal water quality and treatment requirements. The finished water easily complies with the 0.5 NTU maximum level under the current Surface Water Treatment Rule and should also easily comply with the 0.3 NTU maximum level under the Interim Enhanced Surface Water Treatment Rule. KDOW does not currently require daily calculation of disinfection "CT" values; however, LWC staff indicate that current disinfection practices with respect to compliance with *Giardia* and enteric virus inactivation requirements have been reviewed and approved by KDOW. Lead and copper concentrations at consumer taps were below the EPA-specified Action Levels during initial monitoring and subsequent follow-up monitoring. While problems were experienced during May 1997 with respect to compliance with requirements for coliform organisms within the distribution system, recent construction of dedicated system monitoring facilities has resulted in significant decreases in coliform-positive monitoring samples.

Total trihalomethane concentrations within the distribution system during 2000 averaged 0.022 mg/L, which is significantly less than the revised MCL of 0.080 mg/L under the Stage 1 DBPR. Average HAA5 concentrations within the distribution system are reported to be approximately 0.020 mg/L, which is also significantly less than the new MCL of 0.060 mg/L under the Stage 1 DBPR. The existing treatment facilities should not experience difficulties in achieving the minimum average 25 percent TOC removal requirement that will likely be required under the Stage 1 DBPR. (TOC concentrations within the Ohio River currently average approximately 3.0 - 3.3 mg/L, and the current treatment processes typically reduce TOC to approximately 2.1 - 2.2 mg/L).

Assuming that annual average TTHM and HAA5 concentrations remain at less than 0.040 mg/L and 0.030 mg/L, respectively, and that source water average TOC concentrations remain at less than 4.0 mg/L, LWC will also be eligible for reduced monitoring under the Stage 1 DBPR. (Under the reduced monitoring schedule, LWC would have to collect quarterly DBP monitoring samples at only two system locations (one per plant), rather than eight locations (four per plant), as required under the routine monitoring schedule).

The only currently regulated synthetic organic contaminant (SOC) periodically present in the source water is atrazine. LWC has adopted a 0.002 mg/L "action level" for atrazine at the Crescent Hill plant to determine when addition of powdered activated carbon should be initiated to ensure compliance with the 0.003 mg/L atrazine MCL.

In addition to meeting all current regulatory requirements, LWC has completed the first three Phases of the *Partnership for Safe Water* program and intends to secure recognition at the Phase IV level for both of the existing treatment facilities. Staff report that filters at the B. E. Payne plant typically require up to 5 hours to achieve an operating turbidity of 0.1 NTU following backwashing. Therefore, filter performance improvements will be needed to comply with the Phase IV *Partnership* goals for turbidity removal following return of a backwashed filter to service.

4.5.2 Pending Regulations

Several rules are scheduled for promulgation and implementation within the next few years. Because these rules have not yet been formally proposed, their relative impact on current treatment operations at the Crescent Hill and B. E. Payne Water Treatment Plants is difficult to predict with any certainty at this time. However, Black & Veatch maintains close contact with EPA officials involved in the preparation of these new regulations, and the information presented in this section reflects the latest thinking with regard to these regulations. The information presented herein should be reviewed and revised as necessary when the rules are proposed and finalized.

A summary of key compliance dates is presented in Table 4-8.

Table 4-8
Key Dates for SDWA Regulations

Date	Regulation	Activity / Compliance Requirements
Jan. 1, 2002	IESWTR	(1) Combined Filter Effluent Turbidity: 0.3 NTU max for minimum of 95% of monthly measurements (2) Performance requirements for individual filters (3) Monitor individual filters @ 15 minute intervals
Jan. 1, 2002	Stage 1 DBPR	(1) Revised MCL for TTHM (2) New MCLs for HAA5, chlorite, chlorine dioxide (3) MRDLs for chloramines, chlorine dioxide (4) TOC removal requirements
Jan. 2002	Stage 1 DBPR	Initiate monthly source water, finished water TOC monitoring
Dec. 8, 2003	Radionuclides	Revised MCLs for radionuclides effective
Nov. 2003	LT2ESWTR Stage 2 DBPR	Scheduled regulatory promulgation date.
Feb. 2004[(1)]	LT2ESWTR	Deadline for submittal of source water monitoring schedule to KDOW
Aug. 2004[(2)]	Stage 1 DBPR	Recommended deadline for initiating IDSE monitoring
May 2004[(1)]	LT2ESWTR	Deadline for initiating 2-year source water *Cryptosporidium*, *E. coli*, & turbidity monitoring program
Nov. 2005[(2)]	Stage 2 DBPR	Deadline for submittal of report to KDOW summarizing IDSE monitoring results
Nov. 2005[(1)]	LT2ESWTR	Begin disinfection profiling[(3)]
May 2006[(1)]	LT2ESWTR	Deadline for submittal of results of 2-year source water monitoring program to KDOW
Nov. 2006[(2)]	Stage 2 DBPR	Compliance with "Stage 2A" MCLs at individual system monitoring sites
Nov. 2006[(1)]	LT2ESWTR	(1) KDOW determines *Cryptosporidium* bin classification (2) Complete disinfection profiling with one year of data[(3)]
May 2009[(1)]	LT2ESWTR	(1) Deadline for compliance with additional *Cryptosporidium* treatment requirements[(4)] (2) Deadline for submittal of documentation for utilization of microbial toolbox options to KDOW
Nov. 2009[(2)]	Stage 2 DBPR	Compliance with "Stage 2B" MCLs at individual system monitoring sites[(4)]

(1)Assumes promulgation of LT2ESWTR during November 2003.
(2)Assumes promulgation of Stage 2 DBPR during November 2003.
(3)Unless KDOW approves use of existing disinfection profiling data.
(4)Extension of up to two years can be granted by KDOW if capital improvements are required to achieve compliance.

4.5.2.1 Stage 2 Disinfection By-Products Rule

Stage 2 of the Disinfection By-Products Rule is currently scheduled for promulgation during November 2003. The information presented below is based on review of the *Stage 2 M-DBP*

Agreement in Principle, which will serve as the basis for EPA's development of the Stage 2 DBPR, and a November 2001 preproposal draft regulation issued by EPA for stakeholder review. It is emphasized that EPA may elect to modify these regulatory provisions, based on public comment received following formal proposal of the regulation and/or new information developed during the regulatory promulgation process.

LWC staff report that maximum TTHM concentrations at the current individual system monitoring sites during summer months are approximately 0.070 mg/L or less. HAA5 concentrations are also reported to be approximately 0.020 mg/L. These data suggest that LWC should easily comply with the Stage 2A TTHM and HAA5 MCLs of 0.120 mg/L and 0.100 mg/L, respectively, at individual monitoring sites using current disinfection practices. Compliance with the more restrictive Stage 2B TTHM and HAA5 MCLs of 0.080 mg/L and 0.060 mg/L, respectively, at revised individual system monitoring locations should also be achieved. (As chloramines are utilized for residual maintenance within the distribution system, DBP concentrations throughout the system should be relatively consistent). Based on the above considerations, the only significant impact of this regulation on current LWC treatment practices will be the increased analytical costs incurred during the initial one-year period of expanded system monitoring.

4.5.2.2 Stage 2 Long-Term Enhanced Surface Water Treatment Rule

As discussed above, a long-term Stage 2 ESWTR (currently being referred to as the LT2ESWTR) is expected to be proposed during November 2002 and promulgated in November 2003. As this rule has not been formally proposed, it is not prudent to make any firm recommendations regarding what LWC should do to prepare to comply with specific requirements of this regulation. It is emphasized that EPA may elect to modify the regulatory provisions based on public comments and/or new information.

LWC has monitored source water *Cryptosporidium* concentrations at the Zorn Pump Station using EPA Method 1623 since late 1999. Discussions with LWC staff indicate that monitoring conducted to date suggests that the utility will likely be placed in the second bin as indicated in Table 4-4 (1-log additional treatment, based on a maximum 12-month running average *Cryptosporidium* concentration between 0.075/L and 1.0/L). It is not clear at this time if existing *Cryptosporidium* monitoring data developed by LWC can be utilized under the LT2ESWTR to determine bin classification in lieu of further monitoring following promulgation of this regulation. (Existing data would need to be submitted to KDOW, and the Department would then render an opinion regarding the need for any additional monitoring data). Therefore, firm conclusions regarding probable compliance requirements cannot be developed until the *Cryptosporidium* monitoring that will be required under the LT2ESWTR is completed. However, should continued monitoring of Ohio River *Cryptosporidium* concentrations confirm classification of LWC in the second bin, it may be possible to achieve compliance through utilization of one or more of the microbial toolbox components outlined in Table 4-5. Toolbox options that could potentially be used to achieve a minimum 1-log of additional *Cryptosporidium* oocyst removal/inactivation are as follows:

- Pretreatment
  - Off-stream raw water storage with detention for 60 days
  - In-bank filtration (i.e., riverbank infiltration) with 50-ft setback, or horizontal collector wells with laterals at least 50 feet below riverbed.
- Improved treatment
  - Lower finished water turbidity (individual filter effluent turbidity < 0.15 NTU in 95% of samples each month).
  - Membrane filtration
- Improved disinfection
  - Ozone
  - UV irradiation
- Demonstration of performance
  - Average aerobic spore removal >4-log based on one year of weekly monitoring.

Considering average production rates for LWC's treatment facilities, raw water storage and detention as likely required by the rule would not be cost effective. Therefore, riverbank infiltration is the only pretreatment alternative that would be feasible for LWC. Also, current research results suggest that only ozone and UV irradiation are feasible disinfection alternatives for inactivation of *Cryptosporidium* oocysts. In addition, the *Agreement in Principle* suggests that membrane filtration methods such as microfiltration and ultrafiltration would be an acceptable substitute for inactivation processes. Membrane processes provide physical removal of *Giardia* cysts as well as *Cryptosporidium* oocysts.

Based on information presented in the *Stage 2 M-DBP Agreement in Principle*, it was initially believed that an additional 1-log *Cryptosporidium* removal/inactivation credit could be obtained by achieving and maintaining Phase IV status under the *Partnership for Safe Water*. However, this provision was not included in the draft proposed regulation issued during November 2001. (LWC has successfully fulfilled the requirements of Phases I – III of the *Partnership*, which is summarized in Section 4.3.)

As discussed in section 4.2.2.2 above, LWC will likely be required to prepare *Giardia* and virus inactivation profiles under the LT2ESWTR. This would involve development of data required to document the total level of *Giardia* and virus inactivation achieved within the treatment facilities at least once per week over a period of at least one year, beginning two years after promulgation of this regulation (i.e., by November 2005, if this regulation is promulgated as currently scheduled). As disinfection CT values maintained within the treatment facilities are not currently determined, LWC will need to develop procedures for obtaining the data required to prepare the *Giardia* and virus inactivation profiles.

4.6 Regulatory Compliance Strategy

Based on the assessment of the LWC's existing supply and treatment facilities and current operating practices with respect to regulatory compliance requirements, it is recommended that the compliance strategy for this 2002 – 2021 Facilities Plan be based on the following considerations:

- Supply and treatment facilities should be improved to achieve compliance with anticipated *Cryptosporidium* removal/inactivation requirements under the LT2ESWTR and to support LWC's voluntary goal of certification for Phase IV of the *Partnership for Safe Water*.
- Although historical *Cryptosporidium* monitoring data for LWC's Ohio River supply suggest that provisions for an additional 1-log of treatment will be required, applicability of this data with respect to probable LT2ESTWR source water monitoring requirements is unknown at this time. Therefore, for capital budgeting purposes, facilities improvements should be based on providing at least 2-logs of additional treatment for *Cryptosporidium* at the CHWTP.
- For contingency planning, should LWC be required to provide 2 logs or greater additional *Cryptosporidium* treatment at CHWTP, the capital program budget should include provisions for advanced treatment based on one or more of the following technologies:
  - Ultraviolet (UV) disinfection
  - Membrane filtration
  - Riverbank infiltration