MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH DISTRICT

DESIGN CONCEPT
FOR TREATMENT PLANT IMPROVEMENTS

MAY 1992

AMERICAN WATER WORKS SERVICE COMPANY
VOORHEES, NEW JERSEY

SCHEDULE
JSY-3

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EXECUTIVE SUMMARY

The Missouri-American Water Company is an investor owned water utility and is a subsidiary of the American Water Works Company, Inc. The St. Joseph District of Missouri-American Water Company provides water service to approximately 96,000 residents in Buchanan County and portions of Andrew County in northwestern Missouri, and through water resale, to portions of Doniphan County in Kansas. Service is also provided to adjacent areas through a series of water districts. Current daily system deliveries average 17 million gallons per day, with a maximum day delivery of 25 million gallons per day.

Treatment and pumping facilities are located adjacent to the Missouri River approximately two miles northwest of the City of St. Joseph. The original facilities date back to 1892, with additional facilities being constructed in 1899, 1913, 1925, 1956, 1962, 1965, and 1985.

A multi-phase plan has been developed to improve the performance, reliability, operational flexibility, and capacity of the treatment facilities at St. Joseph. Improvements are planned as three projects to be built over the next several years concluding in 1999. The improvements are being phased in over a period of years to allow water rates to minimize the magnitude of each individual rate filing. The design of all three phases is to be done concurrently in 1992 and 1993 to assure an integrated design is perfotmed, and to permit accurate construction cost estimation upon completion of the design. The projects are listed below:

Phase 1 - Clarification and Chemical Improvements

Phase 2 - Clearwell, Filters, Chemical Improvements,and Pumping Improvements

Phase 3 - Additional Filters

The improvements planned for the first phase of construction include Superpulsator clarifiers to replace the three existing sedimentation basins. Pretreatment chemical system facilities are also to be constructed in Phase 1. The design of Phase 1 will be completed in the first quarter of 1993. The project will be bid in the last quarter of 1993 with construction to begin in early 1994 with completion in early 1995.

Phase 2 improvements include construction of four filters with a combined capacity of 12 million gallons per day, a clearwell to provide post-filtration disinfection contact time, a transfer/high service pump station to deliver water from the new clearwell to the existing clearwell and to the distribution system, laboratory/support building, and a distributed control system for the treatment plant. Post-chemical improvements, including chlorination facilities are also planned for Phase 2. Construction is planned for 1996-1997.

Phase 3 improvements consist of construction of six additional filters with a combined capacity of 18 million gallons per day. Construction of the filters is scheduled for 1998-1999. Upon completion of the improvements, the 24 original filters and their superstructure are to be demolished.

I. INTRODUCTION

A. Source of Supply

The St. Joseph District of the Missouri-American Water Company withdraws water from the Missouri River for treatment and distribution to customers in the St. Joseph area. The Water Company's treatment facilities are located at River Mile 452 of the Missouri-River, approximately two miles northwest of the City of St. Joseph.

The Missouri River above St. Joseph drains a watershed of more than 424,000 square miles in the states of Nebraska, North Dakota, South Dakota, Montana, Iowa, and Colorado. The Army Corps of Engineers operates several reservoirs and dams on the river above St. Joseph and controls flows and levels according to several criteria. Average flow past St. Joseph is 40,950 CFS, with a minimum flow of 2,300 CFS in January, 1937.

The rich farmlands of the watershed produce high turbidities during spring and fall run off events. Farming activity also releases herbicides and pesticides such as Alachlor and Atrazine into the river, especially during spring runoff. With limited monitoring, levels of Atrazine have peaked above 10 ug/l, and Alachlor has been detected above 1 ug/l during May and June 1991. The lack of urban and industrial activity on the river above St. Joseph has limited the number of point sources of contamination of the river.

B. Plant Operating Data

A narrative of the existing plant facilities and their operation is provided in Appendix A.

A monthly summary of the plant's operation is presented in Table 1. Note that chemical application is shown in pounds per million gallons.

The first stage (presedimentation) clarifiers have proven to be effective in reducing the turbidity loading on downstream processes using relatively low dosages of cationic polymer. Turbidity data for the 12 month period ended October 1991, provided in Appendix B, show the average raw turbidity to be 427 JTU with a range of 9 - 6167 JTU. The clarifier's effluent turbidities averaged 14 NTU and ranged from 4 - 193 NTU.

First stage clarifier operation at peak loading rates has not degraded performance. Analysis of data for the 16 highest daily flows with surface loading rates of 1.97 gpm/sf to 2.18 gpm/sf showed turbidity removal averaged 93% with a range of 89% to 96%.

Historical data show that peak clarifier effluent turbidities of approximately 600 NTU have passed through the clarifiers and also through Basin No. 1 before being coagulated and removed in Basin No. 2 and Basin No. 3.

Lime is used in pretreatment to maintain a plant effluent pH of approximately 7.5 or higher. Corrosion control is based on the Langelier Index. This strategy has been effective judging by the lead and copper sampling results to date. Much of the time, especially when raw turbidities are low and large alum doses are

TABLE 1. PLANT OPERATING DATA

PURIFICATION PLANT REPORT
ST. Joseph, MO - Missouri-American Water Co
January 1989 - July 1991

	PUMPAG	FILTERS		CHEMICAL USAGE (LBS/MG)							PHYSYCAL - CHEMICAL ANALYSIS															
	Water Processed	NO Wash	Wash Water	Cl2 Gas			Cationic Polymer				Turbidity NTU			Color		pH			Alkalinity mg/L		Hardness mg/L		Fluoride mg/L		Chlorine mg/L	
MONT	x1000G		x1000G	Pre	Post	Alum	C-Aid	F-Aid	PAC	LIME	Raw	Set	Eff	Raw	Eff	Raw	Set	Eff	Raw	Eff	Raw	Eff	Raw	Eff	Set	Eff
1	498666	372	10358	43.7	0.1	93	2.8	0.90	0.0	35	75.0	4.0	0.41	9	0	8.2	8.1	7.7	188	183	262	267	0.00	0.00	2.40	2.40
2	426278	326	8864	43.7	0.1	105	3.2	0.92	0.0	42	58.0	4.0	0.54	7	0	8.1	8.0	7.7	184	178	262	262	0.00	0.00	2.40	2.40
3	487973	387	10602	59.0	0.2	278	7.4	1.99	0.0	122	302.0	4.0	0.42	15	0	8.0	8.0	7.6	164	151	235	244	0.00	0.00	2.40	2.40
4	494825	360	9314	47.7	0.3	64	4.1	1.19	0.0	12	124.0	3.0	0.26	9	0	8.1	8.0	7.6	159	151	234	234	0.00	0.00	2.40	2.40
5	534590	372	8943	48.2	0.2	52	3.0	0.04	0.0	1	124.0	3.0	0.24	9	0	8.3	8.1	7.7	162	154	242	240	0.00	0.00	2.40	2.40
6	533707	360	8710	49.7	0.1	98	7.0	0.59	0.0	31	861.0	3.0	0.26	9	0	8.1	8.0	7.6	154	144	232	229	0.00	0.00	2.40	2.40
7	623594	372	9171	50.3	0.1	61	4.1	0.01	0.0	0	174.0	3.0	0.30	8	0	8.2	8.0	7.5	149	140	231	229	0.71	1.06	2.40	2.40
8	596015	371	8848	48.5	0.2	73	4.5	0.23	0.0	10	280.0	3.0	0.29	7	0	8.2	8.0	7.6	151	142	236	232	0.65	0.99	2.40	2.40
9	512151	372	8926	48.8	0.2	140	8.1	0.95	0.0	40	604.0	3.0	0.31	15	0	8.1	8.0	7.6	135	124	202	203	0.63	1.05	2.40	2.40
10	515127	371	7842	42.5	0.1	69	2.2	0.00	0.0	0	61.0	2.0	0.28	7	0	8.3	8.1	7.7	160	152	246	243	0.71	1.02	2.40	2.40
11	479439	360	7368	37.7	0.0	58	2.1	0.00	0.0	0	58.0	2.0	0.34	7	0	8.3	8.1	7.7	182	172	267	262	0.72	1.05	2.40	2.40
12	538037	371	7919	42.7	0.0	67	4.1	0.93	0.0	0	36.0	3.0	0.46	5	0	8.0	7.9	7.5	193	182	275	272	0.75	1.04	2.40	2.40
1	530104	369	7766	41.2	0.0	77	3.9	1.56	0.0	22	31.0	3.0	0.36	5	0	8.1	8.0	7.6	175	167	249	249	0.64	0.89	2.40	2.40
2	467822	322	6976	37.2	0.0	88	5.1	1.45	0.0	26	51.0	3.0	0.39	6	0	8.1	8.1	7.7	176	168	246	247	0.61	0.94	2.40	2.40
3	524974	356	7037	42.9	0.1	197	7.4	1.79	0.0	73	340.0	3.0	0.38	8	0	8.1	8.0	7.6	172	161	241	243	0.56	0.95	2.40	2.40
4	487204	345	6126	44.1	0.2	69	3.6	1.25	0.0	1	70.0	2.0	0.30	6	0	8.3	8.1	7.6	168	158	250	246	0.62	1.08	2.40	2.40
5	517771	357	6181	48.8	0.3	153	10.0	0.63	0.0	58	1121.0	3.0	0.28	10	0	8.1	8.1	7.6	152	146	228	236	0.63	1.01	2.40	2.40
6	535096	345	6407	53.8	0.6	372	11.4	1.36	0.0	104	1890.0	3.0	0.26	13	0	7.8	7.8	7.4	145	133	220	235	0.59	1.04	2.40	2.40
7	603978	364	7185	54.4	0.2	96	6.2	0.83	0.0	21	565.0	3.0	0.30	8	0	8.0	7.9	7.5	166	155	253	250	0.67	1.09	2.40	2.40
8	581165	372	6777	53.3	0.1	62	8.4	0.64	0.0	4	384.0	3.0	0.23	10	0	8.1	7.9	7.5	159	142	231	222	0.65	1.07	2.40	2.40
9	580093	360	6522	52.6	0.1	60	4.4	1.86	0.0	4	63.0	3.0	0.37	4	0	8.3	8.1	7.6	165	156	247	243	0.68	1.07	2.40	2.40
10	539758	370	6323	37.9	0.1	51	3.8	0.27	0.0	0	70.0	2.0	0.28	3	0	8.4	8.1	7.7	163	153	245	238	0.67	1.03	2.40	2.40
11	485190	350	6276	36.1	0.0	51	6.2	0.00	0.0	0	91.0	2.0	0.34	3	0	8.3	8.1	7.8	193	183	264	257	0.60	1.01	2.40	2.40
12	499235	367	10083	38.2	0.1	60	6.2	0.81	0.0	0	59.0	3.0	0.39	3	0	7.9	7.8	7.5	210	197	275	269	0.58	0.97	2.40	2.40
1	513375	351	9989	39.3	0.0	50	4.6	0.93	0.0	0	14.0	3.0	0.39	4	0	8.1	8.0	7.7	184	174	266	263	0.70	1.07	2.40	2.40
2	443595	321	9581	54.7	0.1	354	13.0	1.69	5.5	149	151.0	3.0	0.53	13	0	7.9	8.0	7.5	157	146	218	235	0.58	0.97	2.40	2.40
3	454012	365	10309	47.1	0.0	125	10.9	1.43	0.0	30	397.0	3.0	0.35	14	0	7.9	7.9	7.4	170	161	231	237	0.55	1.04	3.00	2.80
4	447865	358	9639	44.1	0.1	96	11.4	0.68	0.0	25	758.0	2.0	0.27	9	0	7.7	7.8	7.3	161	149	235	231	0.62	1.16	2.80	2.60
5	470736	371	10516	47.6	0.5	94	12.6	1.00	0.0	29	952.0	2.2	1.00	15	0	7.9	7.8	7.4	159	150	233	236	0.65	1.22	2.70	2.50
6	553795	360	10807	57.0	0.4	204	17.1	0.85	0.0	67	2155.0	2.0	0.24	20	0	7.8	7.9	7.4	147	135	212	216	0.63	1.08	3.00	2.80
7	654123	372	11586	56.6	0.0	46	6.2	0.59	0.0	3	310.0	3.0	0.23	13	0	8.2	8.2	7.5	163	154	241	240	0.69	1.18	3.40	3.00

not required, upward pH adjustment is not needed and lime is not fed.

The coagulated pH of 7.8 to 8.1 with aluminum sulfate as the coagulant probably results in substantial aluminum concentrations in the plant effluent because of the solubility of aluminum in that pH range.

Filter effluent turbidity averaged 0.35 NTU for the 36 month period ended December 1991, with several daily averages greater than 0.5 NTU. Substantially lower filter effluent turbidities have been reported since changeout of filter media in all 24 filters at the end of 1991.

Chlorine is usually applied at the inlet to Basin No. 3, with resulting total trihalomethane annual running average concentrations of approximately 0.060 mg/L. Plant effluent free chlorine residuals are generally in the 2-3 mg/L range. Little post-chlorine is fed as pre-chlorine residuals carry through the plant.

Fluoride is added to the water in the form of hydrofluosilicic acid, and has been added since 1989.

C. Critique of Existing Facilities

The water supply treatment and pumping facilities at St. Joseph have been constructed, modified, and expanded as pumping demands and water quality goals were met. The last two major improvements were the addition of 6 gravity filters in 1956 and the addition of single stage flocculation and continuous sludge removal in one basin in 1965.

1. FILTER PERFORMANCE

The thrust of the Surface Water Treatment Rule is to reduce the threat of waterborne disease by requiring more effective particle removal through the pretreatment/filtration process, and by providing effective disinfection for viruses and Giardia cysts. The new regulations emphasize continuous effective treatment to minimize the passing of viruses and waterborne cysts. The use of this treatment technique was chosen as a better alternative than requiring frequent monitoring for Giardia, other pathogenic protozoa, viruses, legionella bacteria, and other bacteria.

Compliance is now based on samples collected every six (6) hours, rather than a monthly or daily average. Regulations require that 95% of the samples must be equal to or below 0.5 NTU each month. The regulations recommend the use of filter-to-waste piping to dispose of the filtered water at the beginning of the filter cycle because of the degraded effluent quality during the initial stages of each filter run. Filter rates must be changed slowly to avoid "sloughing" particluates into the filter effluent.

A review of monthly averages of filter effluent turbidities indicates that the system would not meet the new turbidity standards several months each year. Although a filter media replacement program has resulted in reduced the filter effluent turbidities, it remains doubtful the turbidity regulations can be consistently met.

The existing filters at St. Joseph have deficiencies in several key areas. Eight of the twenty four filters have no flow metering or loss-of-head controls. The remaining 16 filters have this type equipment, but it is obsolete and is not operable. Ten filters have obsolete valves for which replacement parts are not available. Filter-to-waste capability is not provided in any of the filters.

Contributing to the poor filter effluent quality is the shearing of floc through piping and hydraulic jumps in the sedimentation basins.

The existing sand media filters are currently rated for 2 gpm/sf, for a combined filtration capacity of 21.2 million gallons per day. Peak system delivery requirements have reached 25 million gallons per day. Filtration capacity of 30 million gallons per day is needed.

2. DISINFECTION

The Surface Water Treatment Rule has also addressed disinfection requirements as a second barrier to bacteria, viruses, and Giardia cysts. Effective disinfection is based on contact time requirements that are a function of the particular disinfectant, disinfectant concentration, Ph, and temperature.

The benefit of disinfection must be weighed against the formation of disinfection by-products (DBP), and their health impacts. For chlorine, the most effective means of providing effective disinfection while minimizing DBP formation is to provide the disinfection after removal of disinfection by-product precursors. For this reason, providing the disinfection barrier in the clearwell is considered the optimal location for providing the required disinfection.

The St. Joseph plant has very little disinfection contact time capability after the filters. A 1 million gallon capacity clearwell is available, but the round, unbaffled configuration provides little contact time.

3. SYNTHETIC ORGANIC CHEMICAL (SOC) REMOVAL

The widespread use of pesticides and herbicides in the vast watershed of the Missouri River result in these SOC's being present in St. Joseph's source of supply. With limited monitoring, Atrazine and Alachlor have been detected at significant concentrations for extended periods through spring/early summer.

The existing treatment process is not equipped to efficiently remove pesticides and herbicides. Powdered activated carbon (PAC) can be efffective, but is not an efficient technology where the pesticides are present for extended periods of time, or where their presence cannot be reliably predicted. The use of granular activated carbon (GAC) in filter-adsorbers, or in post-filtration contactors is the most effective means of pesticide removal. Studies indicate the pesticides and herbicides are generally strongly adsorbed onto the GAC. The GAC is effective for a number of years before being exhausted.

4. OPERATIONAL FLEXIBILITY/RELIABILILTY

The need to maximize the effectiveness of the filtration step on a continuous basis requires a reliable treatment process. A key component of reliability is the flexibility to operate while equipment is out of service for maintenance or inspection.

The treatment facilities at St. Joseph are lacking in the area of operational flexibility. A common filter effluent header links all the filters to the transfer pump suction well. Maintenance of the filter effluent valving requires a plant shutdown, and a problem anywhere along the length of the header would affect all the filters and limit the capacity to continue treating water.

All filtered water must pass through the transfer pump suction well. There is no means of bypassing the structure in order to perform repair or inspection.

Flocculation and continuous sludge removal is provided in one basin only. None of the basins are subdivided, requiring the entire basin to be removed from service to perform maintenance or inspection on any one piece of equipment.

5. FACILITY SAFETY

The St. Joseph facilities are lacking in safety for personnel in comparison to modern treatment plants. The existing filter gallery is small, filled with obstacles, poorly illuminated, poorly ventilated and presents a hazardous environment to work in.

Another example of a hazardous environment is the necessity of cutting ice away from the sedimentation basin walls during cold winters. Some winters are so cold the de-icing systems are ineffective in preventing ice freezing across the basins. Workers must use tools such as chainsaws to cut away the ice before it has the opportunity to cause failure of the basin walls. Although workers are tethered and wear lifejackets, this type operation is deplored from a safety viewpoint but has been necessary to protect the structures from extensive damage.

6. HUMAN RESOURCES

The current facilities require substantial labor to manually wash filters; maintain obsolete filter valves, actuators, and controls; deal with dry alum; transport chlorine containers between the two chlorination rooms; transport polymer from the bulk storage tank to the intake;

maintain long lengths of deicer piping; and break ice from around the perimeter of the sedimentation basins. More efficient facilities will allow the focus of the labor force to be shifted away from labor intensive type manual activity to more beneficial use of their talent.

7. PLANNING FOR FUTURE IMPROVEMENTS

At present, the site has negligible undeveloped area. The plant is bounded by the Missouri River and it's floodplain, and the railroad and associated easement.

In planning the facility improvements, expansion and integration of potential future processes must be considered. Two examples of potential future processes are alternative disinfectants such as ozone, and treatment residual processing. The best use must be made of the limited space available to avoid having to locate future facilities off-site.

8. SUMMARY OF NEEDED IMPROVEMENTS

It is clear that while the treatment plant has met past expectations in terms of quantity of water delivered and water quality, the existing facilities will not reliably meet the water quality standards of the near future. The following improvements are needed:

1. Renovation or replacement of filtration facilities.
2. Granular activated carbon is needed in the process to remove pesticides and herbicides. Filter

adsorbers are preferred because of good performance at a much lower capital cost compared to post contactors.

3. New chemical facilities to allow alternative chemicals to be used, provide better control of chemical processes, and improve chemical handling safety.

4. Additional baffled clearwell storage for disinfection contact time.

5. Replacement of the transfer pumping station to increase reliability and to allow proper hydraulic functioning of the filter rate controllers.

6. General support facilities such as offices, laboratory, control room, and restrooms.

7. Additional reliability in flocculation and settling facilities.

8. More rapid process response in pretreatment.

9. More efficient facilities that are less labor intensive to operate and maintain.

10. Facilities that are safer to maintain and operate.

11. Implementation of a moderate degree of instrumentation and automation to monitor and control the treatment process.

12. All improvements must be coordinated, to avoid unnecessary duplication of capital improvements in meeting current and future water quality regulations.

D. Project Status and Schedule

A document titled Engineer's Report and Preliminary Design Concept was prepared by the American Water Works Service Company and submitted to the State of Missouri Department of Natural Resources in December, 1991. The report was essentially an abbreviated version of the design concept presented here, with operating data from other American System Superpulsator installations and pilot reports.

The report was conditionally approved pending the results of pilot testing with the Superpulsator and filters. The State's correspondence, dated February 11, 1992 is enclosed as Appendix A.

The Water Company and the Service Company have met with the Public Service Commission to discuss the project a number of times, and are planning additional discussions with the Commission prior to construction.

The Water Company has not made a formal public announcement of the planned improvements to date. An announcement will be made after completion of the design, and an accurate construction cost estimate is available.

A schedule has been prepared for the project, and a portion of it is presented below:

August 1992	Initiate detailed design
March 1993	Complete design of Phase 1-File permit applications
May 1993	Complete design of Phase 2 and Phase 3
October 1993	Bid Phase 1
February 1994	Begin construction of Phase 1
May 1995	Complete construction of Phase 1
March-May 1995	Update design of Phase 2 - File permit applications
October 1995	Bid Phase 2
February 1996	Begin construction of Phase 2
August 1997	Complete construction of Phase 2

April-May 1997	Update design of Phase 3 - file permit applications
September 1997	Bid Phase 3
February 1998	Begin construction of Phase 3
February 1999	Complete construction of Phase 3

II. PHASE 1 IMPROVEMENTS DESIGN CONCEPT

A. Raw Water Metering and Flow Control

Two 20/24-inch cast iron lines and one 36-inch concrete line convey raw water to the two first stage clarifiers from low service pumps No. 9,12,and 15. The line closest to Basin No. 3 is reported to be very shallow and would have to be relocated if any regrading is done in that area. A segment of the two 20/24 inch lines will be replaced with a 36-inch line to provide the desired 45 MGD hydraulic capacity, consolidate piping, and facilitate raw water metering and control. Economics will be a factor in deciding how much of the piping to replace.

A magnetic flow meter and flow control valve are to be installed in each 36-inch line, within concrete vaults. The economics of reducing to 24-inch piping for metering will be evaluated in flow meter sizing. Magnetic meters have been selected for this application because of the periodic high solids content of the raw water. Other type meters are not suitable for this service.

B. First Stage (Presedimentation) Clarifiers

The effluent weirs of the two steel clarifiers are the hydraulic highpoint for all downstream treatment facilities. Increasing the height of the clarifiers may be justified to improve plant hydraulics and minimize construction costs of the Superpulsators and the below ground clearwell.

The feasibility/economics of raising the gradient from the clarifiers is to be evaluated in the design process. The alternatives include modification of the existing steel tanks, in-kind replacement of the clarifiers, and use of alternative technology such as plate settlers.

Additional presedimentation capacity is to be planned in the final design for future installation to accommodate plant expansion and reliability.

Number of Units	2
Unit Dimensions	
Diameter	75-feet
Depth	19-feet
Volume	630,000 gallons

As the first stage of clarification, the presedimentation clarifiers fulfill the State of Missouri's requirement for two treatment trains operated in series. Cationic polymer is fed to the suction of the raw water pumps in the Screen Well. It is necessary to allow the capability of feeding alum and chlorine to the raw water in the Screen Well also.

C. Superpulsator Clarifiers

Four Superpulsator upflow solids contact clarifiers are to be constructed to clarify the effluent of the presedimentation (first stage) clarifiers and prepare the water for filtration. The Superpulsator clarifier effluent will be directed to the existing filters through Basin No. 1 until new filtration facilities are completed in Phase 3. The Superpulsators are to be enclosed in a heated building to protect the clarifiers from snow and ice.

The conceptual design has located the Superpulsators in Basin No. 1. See the conceptual layouts in Appendix D and refer to Section II-G for a brief discussion of facility location issues. Construction of the Superpulsators in Basin No. 1 would allow Basin No. 2 to be removed from service as the Superpulsators would provide the entire pretreatment capacity.

The Superpulsator clarifier was selected for use because of excellent turbidity removal across a wide range of turbidities, efficient coagulant utilization, capability to hold powdered activated carbon in suspension for enhanced organics removal, ease of operation, continuous sludge removal, minimal maintenance requirements, and a surface loading rate which, due to the resulting compact size, permits the treatment unit to be protected from freezing enclosed within a building at a reasonable cost.

On-site pilot testing is being conducted under the direction of American Water Works Service Company during the Summer of 1992 to evaluate performance with the high turbidities that come with runoff. Pilot testing protocol is included in Appendix E.

Two stage rapid mixing will be provided immediately upstream of the Superpulsators to initiate floc formation prior to entry into the clarifiers. The rapid mix tanks are the primary feed locations for several pretreatment chemicals.

First stage rapid mixing will perform rapid dispersion of coagulants and other chemicals. Dispersion will be accomplished with a single speed radial turbine mixer to generate the high shear forces necessary for rapid dispersion.

The second stage of mixing provides high intensity flocculation to initiate floc development prior to entry to the solids contact blanket of the Superpulsator. The second stage mixer will be equipped with a variable frequency drive (VFD) to allow adjustment of mixing intensity.

First Stage Rapid Mix	
Number of Units	(1)
Detention Time (15 mgd each)	15 sec
Mean Velocity Gradient	1000 sec
Second Stage Rapid Mix	
Number of Units	(1)
Detention Time (15 mgd each)	120 sec
Mean Velocity Gradient	0 - 200 sec
Number of Superpulsator Units	(4)
Surface loading rate (30 MGD)	3 gpm/sf

The Superpulsator equipment is proprietary, marketed by Infilco Degremont. The standard design will be augmented where necessary to provide additional operating conveniences. These conveniences include generous access hatches to all portions of the clarifiers, drains located and sized for ease of draining and cleaning the units, flushing water supply to assist in cleaning drained units, provisions to draw off volumes of sludge required under high turbidity conditions, and provisions to discourage plugging of sludge drawoff lines. An effective means to periodically remove floating scum accumulations from the water surface of the clarifiers is to be provided. A mechanical means of lifting the plates from the Superpulsators is also necessary. The capability to transfer a portion of the solids blanket from one unit to another to assist in startup of a drained unit is to be provided.

Process wastes from the first stage clarifiers, Superpulsator clarifiers, and filters will be returned to the Missouri River as currently practiced. However, the layout, hydraulics and piping of the new facilities will be configured to facilitate potential future handling of treatment residuals.

D. Chemical Storage and Feed Improvements

New pretreatment chemical facilities are to be provided within, or adjacent to the Superpulsator Clarifier Building. The range of chemical dosages for each chemical is listed in Appendix F.

Secondary containment is to be provided for all liquid and slurried chemicals, including drums, to control leaks and spills. The American Water Works Company Engineering Standard for Liquid Chemical Systems is furnished as Appendix G to guide the design of liquid chemical systems. Dilution water is to be provided for most chemicals.

New pretreatment hydrated lime bulk storage and feed equipment is to be located adjacent to the rapid mix tanks. Gravity flow of lime solution from the feeders to the rapid mix tanks is desired. Delivery line lengths are to be minimized because of clogging problems due to the hardness of eductor water supply.

Liquid coagulant storage and feed equipment is to be provided in the clarifier building to replace the existing dry alum facilities. Liquid coagulant facilities are to be compatible with both alum and ferric chloride. Because of the large volume of storage required, bulk coagulant is to be stored in three cells constructed of cast-in-place concrete with a flexible liner. A porous fabric is to be located between the liner and concrete to conduct any leakage to a detection sump. The concrete is to receive a protective coating, and be reinforced with epoxy coated steel bars as additional protection against corrosion.

Two alum/primary coagulant feed systems are required because of the wide range of dosages used at the plant for turbidity removal. The "normal range" system will be used for dosages of 5-50 mg/L, while the "high range" system will cover the 30-120 mg/L range. An appropriately sized daytank will be used with the normal range system, while the high range system will draw directly from a bulk storage tank.

Coagulant aid polymer is to be stored in a bulk storage tank with separate feed systems for dosing the influent to the presedimentation clarifiers (at the Screen Well), and the influent to the Superpulsator clarifiers.

Filter aid polymer, and clarifier blanket control polymer storage and feed facilities are to be provided and housed in the Clarifier Building as part of Phase 2. Manually operated batch type preparation systems are preferred over automated systems. Automated polymer preparation systems generally have significant maintenance and cleaning requirements which are not justified for intermittent or low rate application.

A powdered activated carbon slurry system is also to be provided in the clarifier building. Twin concrete tanks are to be provided, but only one tank is to be outfitted with two speed mixer, air sparger, level probes, etc. The second tank can be outfitted at some future date if required.

Plant chlorination facilities are to be replaced and consolidated as part of Phase 2 construction. The existing chlorination facilities are to be modified to deliver chlorine to the inlet of the presedimentation clarifiers, flash mixer, high intensity flocculation stage, and to the Superpulsator effluent channel.

E. Instrumentation and Control

A personal computer based Distributed Control and Instrumentation System (DCIS) is to be provided to monitor process operation and performance, and control chemical feed rates. The focus of the system in Phase 1 will be pretreatment (raw water flow, chemical storage and feed, and raw/clarified water quality). Chemical feed rates will be paced with raw water flow. The DCIS system will be extensively expanded in Phase 2 to interface with all faciltites such as filters, pumps, etc.

The DCIS will utilize Bristol Babcock intelligent distributed process controllers Model 3330/3335. The network monitor consisting of personal computer, CRT, keyboard, and printer(s) will be located in the existing operators station for Phase 1. Fiberoptic cable is to be used as the data highway for communications.

Local control panels are to be provided for each chemical system to indicate local alarms, tank levels, and equipment status.

F. Architectural/Structural

The Superpulsator/Chemical Building will have walls constructed of concrete block/brick veneer, concrete block/precast panels, or a mixture of the two to provide a durable, low maintenance, and attractive exterior. The roof will be membrane roofing over precast concrete, supported with steel columns. The appearance of the building should blend with the Pump Building and be compatible with the Chemical Building as these two existing structures are to be retained.

The Superpulsator Building's interior is to be utilitarian, with epoxy painted concrete block walls. Epoxy painted concrete floors are desired to provide an attractive appearance.

Plentiful lighting and forced ventilation is to be provided, as it is anticipated there will be few windows in the structure. The heating system for the Superpulsator area is to be designed to prevent freezing, while not requiring excessive operating costs. Chemical feed areas are to be heated to approximately 60 degrees. It is expected that natural gas will be available to heat the building.

All new facilities will be accessible to the physically handicapped through elevators, ramps, etc.

A soil boring report from the design of the original Chemical Building is provided as Appendix H to assist in planning foundation designs. Note that the Chemical Building is founded on caissons extending to rock. The one million gallon clearwell, constructed in 1985, is founded on piling.

G. Utilities

1. Sanitary Wastes

The existing plant has very limited sanitary facilities. It is reported that a septic system, located near the river bank, receives wastes from the existing restroom. It is assumed that all other wastes discharge to the river.

In all proposed facilities, floor drains are to be routed to the sanitary waste disposal system, unless otherwise noted.

A replacement septic system will likely be required. It is reported that the nearest sanitary sewer is several miles away.

2. Natural Gas

Heating oil and propane gas are used in the heating systems of the existing plant. Natural gas is reported to be available nearby. All new facilities are to be heated with natural gas.

H. Location of Facilities

The proposed facilities have been conceptually located in Basin No. 1. See Appendix D for conceptual layouts. The Superpulsator foundations and clearwell will be located below the bottom of all of the three sedimentation basins, so demolition of a basin bottom is inevitable.

Basin No. 3 was originally proposed as the location for most of the facilities, but was not large enough for a flexible layout for the proposed facilities.

Construction in Basin No. 2 was also considered, but the large amount of concrete fill used in the leveling of the basin floor during the 1965 improvements would be difficult and expensive to remove. Additionally, locating facilities in Basin No. 2 would result in additional costs to minimize disruptions to plant operation.

The issue of facility siting is to be reevaluated by the design consultant.

I. Future Facilities

Plans will be made as to plan how potential future processes would be integrated into the planned improvements, if ever required. The potential future processes to be considered are ozonation in pretreatment, ammonia facilities, additional presedimentation capacity, and additional filters and Superpulsators. The location of the facilities is to be identified in the design memorandum, but is not necessary on the contract drawings. Design of ozonation facilities, including electrical requirements is not required. For ammonia facilities, space should be provided in the planned improvements for ammonia feed equipment, and a location selected for bulk storage tanks.

The design memorandum is to identify how the proposed facilities would tie into potential treatment residuals processing facilities such as washwater clarifiers and thickeners.

III. PHASE 2 IMPROVEMENT DESIGN CONCEPT

A. Filtration

Four filters are to be constructed in Phase 2 with a nominal rating of 3 mgd each for a combined capacity of 12 mgd. When the four filters are put in service, a number of the original 24 filters will be retired, but a filtration capacity of at least 28 mgd will be maintained.

Number of Filters (Phase 3)	4
Filtration Area	700 sf
Filter Media	12" graded gravel 10" sand 30" GAC
Empty Bed Contact Time	6 minutes
Filter Rate	3.3 gpm/sf

Filter Auxiliaries

* Full Flow Filter to Waste
* Air Wash
* Electric motor actuated butterfly valves
* Individual Effluent Turbidimeters
* Loss of Head Indicators
* Effluent Venturi Meter
* Butterfly Valve Effluent Control Valve

Concurrent air/water wash is to be provided. The air is to be introduced through a lateral system located above the filter gravel. Underdrain type is to be clay tile with dual lateral.

Two filters are to be equipped with loss of head probes at various filter media depths to monitor the loss of head throughout the filter. This feature will assist in optimizing treatment and extending filter runs.

A master filter rate setpoint shall be used to set individual filter rate setpoints. Level in the filter influent conduit shall bias the filter setpoint to maintain filter influent level.

The filter gallery is to be sized to allow maintenance of piping and valves. The filter gallery is to be dehumidified to minimize condensation and subsequent corrosion of piping, and to prolong the life of electric valve actuators and other instrumentation.

The concept of routing a filter influent flume along the ends of the filters, rather than piping in the pipe gallery is to be evaluated. The use of a flume is likely to be economically advantageous since a velocity of less than two feet per second must be maintained in the filter influent line. The concept of a flume for delivering filtered water to the clearwell is to be evaluated.

Process wastes from the first stage clarifiers, Superpulsator clarifiers, and filters will be returned to the Missouri River as currently practiced. However, the layout, hydraulics and piping of the new facilities will be configured to facilitate potential future handling of treatment residuals.

The drain for filter to waste is to be separate from the spent backwash water drain to allow direct recycling of filter to waste water.

Access is to be provided around the filters to allow for changing out the granular activated carbon. Sleeves in the walls provide access for hoses needed to move the carbon in and out of the filters. Sufficient water supply is needed in the filter area for carbon eductor supply, and for routine cleaning.

The filters will be separated from the operating floor by a wall, with vision panels and doors, along the end of the filters to make the filter operating floor a room separate from the filters. Generous lighting and ventilation is to be provided in the filter area and the filter operating floor.

B. Clearwell

A new clearwell is to be constructed below the proposed filters to provide post-filtration disinfection contact time and provide a source of filter backwash water for new filters. The entire clearwell is to be constructed in Phase 2. The new clearwell will discharge to a new Transfer Pump Station and operate in series with the existing 1 million gallon above ground clearwell.

Serpentine clearwell baffling, and inlet and outlet baffling is to be provided to maximize disinfection contact time. The clearwell is to be designed such that half of the clearwell may be taken out of service for inspection and maintenance. Sizing of the clearwell will be based on delivering a CT (chlorine residual multiplied by contact time) of 58 mg/l-minutes to achieve a 0.5 log giardia inactivation in post-treatment, prior to the 1 million gallon above ground clearwell. A 1,600,000 gallon clearwell is required assuming the following conditions:

pH	8
Temperature	0.5 degrees C
Free Chlorine Residual	2 mg/L
Baffling Factor	0.7
Clearwell operating half full	
30 MGD production rate	

C. Pump Station

A new pumping station is proposed in Phase 2 to transfer water from the proposed clearwell to the 1 million gallon above ground storage tank, provide backwash water for the new filters, and deliver water to the distribution system.

The pumping station is to be constructed with two separate suction wells to allow one half to be taken out of service for inspection or maintenance.

The pump station is to be equipped with the following vertical pumps for transfer duty: one 15-mgd pump, one 10-mgd pump, and one 5 mgd pump. The head requirements of delivering water to the aboveground tank are similar to the head needed for filter backwashing. (The overflow elevation of the above-ground tank is 849.5 feet.) One 15-mgd pump is to be the primary backwash pump, but the backwash supply can come off the transfer pump header if the dedicated pump is out of service. Note that a second 15-mgd transfer pump will be installed in Phase 3.

The pump station will be designed for gradual conversion to a high service pump station over the next few decades. As replacement or additional high service pumps are required, they will be installed in the new pump station. As the conversion occurs, transfer pumps will be replaced with high service pumps. Eventually, the one million gallon above-ground clearwell will not be needed.

A 6 million gallon per day capacity high service pump is to be installed in Phase 2 to pump directly from the transfer pump suction well into the distribution system. The pump is to be variable speed, equipped with a variable frequency drive.

The pump station will be equipped with cranes and hoists to maintain the pumps and motors, and load them onto trucks.

D. Laboratory and Support Facility

In Phase 2, a new support facility is to be constructed. The support facility is to be the operation center with control room, laboratories, and offices. The support facility will likely be the focus of many public tours. The building layout and architecture are to highlight the control room and the laboratories. In addition, it is desired to provide a view of the river from the building.

The support facility is to be centrally located to provide convenient access to chemical storage and feed equipment, clarification, and filters for the operators.

It is anticipated the hallways will have glazed facing tile and terrazzo floors. Offices will have drywall/wallpaper/paneling.

Laboratories will have ceramic tile walls with sheet vinyl flooring.

All facilities are to be accessible to the physically handicapped. Elevators will be required to provide access to multiple stories, such as pipe galleries, etc.

The following rooms (facilities) are needed with approximate areas delineated (sf):

1. Men's restroom, showers, and locker room. Locker room is to be adequate for 15 men.
2. Women's restroom, showers, locker room. Locker room is to be adequate for 5 women.
3. Mud room for boot washing and general cleanup at service entrance - (120 sf).
4. Multi-purpose room for training/conference and lunch, equipped with a kitchenette - (230 sf).
5. Workshop area for light duty work such as electrical and electronics testing and repair, and spare parts storage - (150 sf).
6. Control room for pump operator and plant operator - (500 sf).
7. Operator's process control laboratory, adjacent to the control room. (150 sf)
8. Main laboratory suitable for two analysts performing wet chemistry, and record keeping. (250 sf) Bacteriological work area is to be enclosed as a separate room - (200 sf) .

9. A room adjacent to the main laboratory to accommodate installation of an atomic absorption spectrophotometer or gas chromatograph - (150 sf).
10. A storage room for laboratory supplies and for potential expansion of laboratory - (150 sf).
11. Offices for the Production Superintendent, and Water Quality Superintendent-(160 sf each). The Assistant Production Superintendent, Production Supervisor, and Chemist will be located in a single large office with moveable partitions - (320 sf).
12. Men's and women's restrooms located near the offices for the use of guests and supervisory personnel.
13. A multi-purpose room for storage and review of plant drawings, files, and office machines such as copier and fax machine - (150 sf). The concept of making this room adjacent to the training/lunch room with a removable partition is to be evaluated.
14. Janitor's closet for cleaning equipment and supplies.
15. Storage closet for long tables and chairs used in the training/conference/lunch room.

Actual requirements will be refined in preliminary meetings between the Water Company, System Engineering, and the design consultant.

Laboratory waste holding facilities will be required for certain testing reagants as sewer is not available.

Continuous samples from multiple process locations are to be brought back to the operator's laboratory for periodic grab sample analysis.

E. Post-Chemical Facilities

Post-chemical storage and feed facilities are required as part of Phase 2. This equipment will include hydrofluosilicic acid system, and caustic soda. New chlorination facilities are also required in Phase 2. Space will be set aside in new buildings for ammonia feed for chloramination of plant effluent. Ammoniation equipment will not be provided.

It may be prudent to provide space for the above post-chemical facilities in the Superpulsator/Chemical building in Phase 1, and install the equipment in Phase 2. This idea will be evaluated by the consultant in laying out the facilities.

Chlorine facilities for the plant (pretreatment and post-treatment) will be consolidated as part of the Phase 2 chemical improvements. The chlorine system will utilize ton cylinders and evaporators to meet the treatment requirements. A packaged chlorine scrubber unit will be installed to minimize the quantity of chlorine gas released during a major incident.

F. Instrumentation and Controls

The Distributed Control and Instrumentation System (DCIS) installed in Phase 1 for the pretreatment chemicals is to be expanded upon to provide comprehensive control and monitoring of all process and pumping operations in the treatment plant (excluding the existing facilities). Data that is currently brought in from the distribution system such as tank levels, etc. will be displayed and monitored through the DCIS.

The expanded DCIS is to be based on the Bristol Babcock personal computer based Network 3000 hardware. Redundant data concentrators, uninterruptible power supply, and two network monitors (personal computer, keyboard, mouse, 20-inch CRT, printer) will be located in the control room. A network will allow supervisors to access real time and archived data from the DCIS from their offices.

At present, two operators man the treatment plant each shift. It is anticipated that with the proposed improvements, only one operator will be required per shift.

Ancillary annunciator panels in the control room are not required. A pager type system will allow the operator(s) to be warned of alarms as they move about the plant.

The architecture and finishes of the control room are to be commensurate with the significance of the function. The Water Company expects visits to the control room to be a memorable experience to the public as they tour the facility.

The logic for the backwashing the filters will be contained in the intelligent distributed process controllers, currently Bristol Babcock Model 3330/3335. Each filter will have a local console to allow filter valves to be operated locally through switches on the panel. Detailed design of the filter consoles is to be delayed until 1995 when the instrumentation design for Phase 2 will be updated and completed prior to bidding and permitting.

G. Maintenance Building and Garage

The existing Chemical Building located adjacent to Water Works Road is to be converted to a maintenance building for storage of tools, parts and supplies. The building will provide a location for "dirty" maintenance jobs such as arc welding, etc. Lighting, ventilation, and water/waste systems will have to be upgraded.

A three bay garage is to be constructed adjacent to the building in the area now occupied by the lime silo. The garage will house ditch pumps, boat, and a vehicle. Garage door height is to be 8-feet, as backhoes and other construction equipment will not be stored in the garage.

IV. PHASE 3 IMPROVEMENT CONCEPT

A. Additional Filtration Capacity

Phase 3 includes construction of six filters (18 MGD combined capacity) identical to the four constructed in Phase 2, above the clearwell constructed in Phase 2. Filtration capacity after completion of plant improvements is to be 30 mgd. Upon completion of Phase 3, all of the original filters will be retired.

B. Transfer Pumping

A second 15 MGD pump will be installed in the Phase 2 Pump Station as part of Phase 3. In addition, a 36-inch transfer line will be run to the above ground clearwell in parallel with the 24-inch line installed in Phase 2. The two lines will provide sufficient capacity, and will provide additional reliability and operational flexibility than a single line.

C. Demolition

The existing structures running parallel to the railroad tracks will be demolished (filters, boiler room, etc). The likely high service line running through the boiler room will have to be relocated. In addition, Basin No. 3 will no longer be needed and will be demolished/filled as required.

The original Pumping Station with low service and high service pumps will remain.

APPENDIX A

EXISTING FACILITY NARRATIVE

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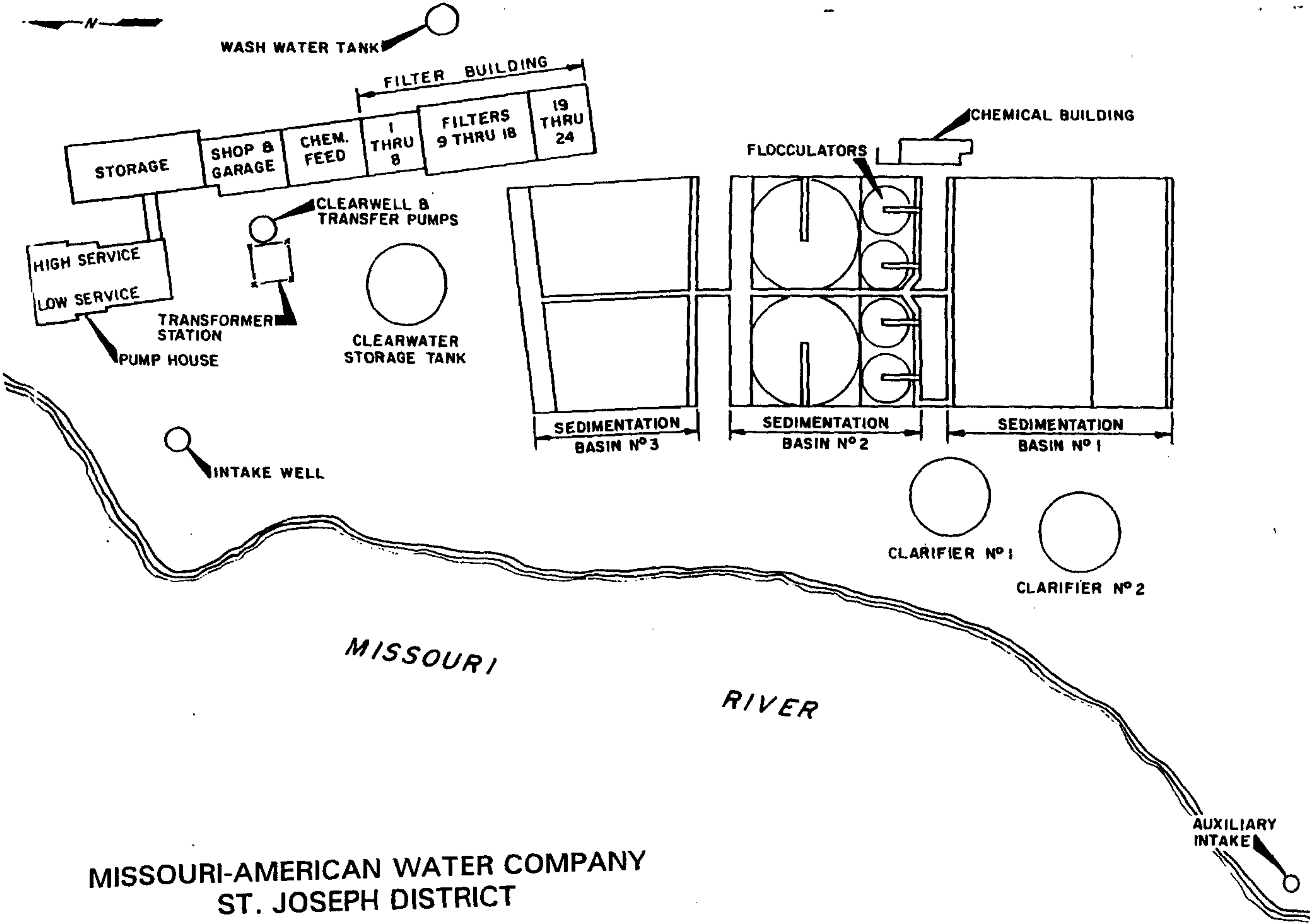
EXISTING FACILITY NARRATIVE

Production facilities at St. Joseph consist of a surface water purification plant on the Missouri River upstream of the City. The plant is located about two miles northwest of St. Joseph. The Missouri River is the sole source of supply. Three intake lines, a 24-inch and two 36-inch pipes convey water some 110 feet from the river to an 18 foot 2-inch diameter raw water suction well. A sheet pile structure along the river bank protects the intake pipes from floating debris and river barge traffic. These raw water pipelines operate as siphons with jet eductors to prime and maintain the siphon. The raw water well is equipped with a travelling screen to remove large debris from the water ahead of the low service pumps.

An auxiliary intake is located about 1,000 feet downstream of the primary intake. The auxiliary intake consists of one 15 MGD vertical turbine pump enclosed in a small building at the southern end of the Water Company property. The pump takes suction from a 24-inch line extending into the River about 30 feet beyond the bank and pumps to the two raw water clarifiers. Water from the auxilliary pump can bypass the clarifiers an go directly to settling basin No. 1. The auxiliary intake is not used under normal conditions except for periodic tests to ensure that the pump and the intake line remain operational.

Three low service pumps, Nos. 9, 12 and 15, are available for normal plant operations. Pump No. 10 is the auxiliary intake pump. The characteristics of all the low service pumps are listed in Table 1.



MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH DISTRICT

PLAN OF MAIN STATION

Table 1 : Low Service Pumps
St. Joseph Service Area

Pump No.	Year Installed	HP	Head	Rated Capacity MGD
9	1953	125	45	13.0
10	1953	250	70	15.0
12	1956	150	35	15.0
15	1962	200	50	19.0

The total rated capacity of the four pumps is 62 MGD and a rated capacity of 43 MGD is available with the largest unit out of service. Water from the low service pumps is discharged into two 24-inch pipes and one 36-inch pipe which deliver the water into two circular steel clarifiers. The clarifiers are 75 feet in diameter with a capacity of 630,000 gallons each. At the recent 23 MGD maximum day system demand rates the detention time provided by the clarifiers was 1.3 hours, and the surface loading was 2592 GPD per square foot. Water is introduced into the central influent well of each clarifier by a 30-inch inlet pipe. Flow is from the central influent well radially to a circular launder around the circumference of the clarifier. The clarifier has a straight side height of 19 feet 8-inches. A rotating scraper mechanism collects settled particles and concentrates them at the sump near the center of the unit. A 12-inch drain is provided to blow off settled solids.

Effluent from the twin clarifiers is directed through a network of 24-inch, 30-inch and 36-inch pipes to settling basin No. 1, a 5 MG concrete basin with nearly square dimensions (211 ft. by 213 ft.). Basin No. 1 was constructed in 1924 and has a depth of 15.8 feet. Detention time at a 23 MGD plant rate is 5.2 hours. Surface loading is 495 gpd/sf and flow through-velocity is 0.011 ft. per second. Water is introduced to Basin No. 1

through a one-foot wide inlet flume with orifices in the bottom for even flow distribution to the settling basin. A single vertical-slotted baffle is placed at the one-third point of the basin to maintain an even flow pattern through this otherwise open, sheet flow facility. The basin outlet consists of a 5 ft. wide concrete flume with adjustable metal v-notch weirs. Basin No. 1 can be by-passed via piping connections from the two clarifiers to the inlet of Basin No. 2.

Basin No. 2 is a 4.0 MG rectangular concrete basin, 175 foot by 209 foot in size constructed in 1907 with a depth of 16.5 feet. The basin inlet is a concrete flume connected to the outlet flume of Basin No. 1. A mechanical mixer is installed in a mixing chamber between the outlet flume of Basin No. 1 and the inlet flume of Basin No. 2, directly downstream of a chemical feed vault. All flow is channeled through the flash mixer compartment via a baffle which creates upward flow through the mixer to the inlet flume. The inlet flume is 4 foot wide and has a series of orifices in the bottom to distribute the flow into the flocculating chamber of the basin. Four 45-foot diameter paddle-type flocculators agitate the water in the first 60 foot section of Basin No. 2. Basin depth is 16.5 feet.

A wooden baffle wall with vertically slotted openings in the lower half section directs the water from the flocculating chamber to the settling chamber. The settling chamber is equipped with two circular, solids-collection mechanisms consisting of truss mounted scrapers and corner cleaning extensions which direct the settled solids to a sump. Detention time in the flocculating compartment is 1.4 hours at a 23 MGD plant production rate. Detention time in the settling basin section is 2.7 hours and surface loading is 629 gpd/sf. Water exits Basin No. 2 through an array of launders with adjustable v-notch weir plates. A flume down the center of the basin provides a bypass when the basin is in need of cleaning. De-icer piping is provided at key locations in the basins.

Basin No. 3 is used for plain sedimentation and chlorine contact time. It is a concrete and brick basin constructed in 1899 with a 3.0 MG capacity and a shape that is nearly rectangular. The width of the basin (perpendicular to the flow) is 210.5 feet while the length of the basin on one end is 156 feet and on the other end 176.5 feet.

Water is distributed to the basin via a connecting concrete flume from Basin No. 2. The inlet flume has bottom orifices for flow distribution. Detention time in the basin is 5.2 hours at a 23 MGD plant production rate. Surface loading is 593 gpd/sf. Basin depth is 12.5 feet and the flow through velocity is 0.014 ft/sec at a 23 MGD rate. Water exits the basin through an array of launders equipped with adjustable v-notch weirs into a 42-inch settled water pipe. A bypass flume is positioned down the middle of the basin to allow draining the basin for cleaning and maintenance.

The 42-inch settled water line from Basin No. 3 branches into two legs to supply the filters via a partially looped system of 30 and 36-inch pipes. Twenty-four concrete filters are in existence. These were constructed in three stages. All of the filters are equipped with sand and gravel media. Table 2 lists the filter unit characteristics.

Table 2: Filter Characteristics
St. Joseph Service Area

(MGD)					Filter Capacity	
Filter Numbers	Year Constructed	Bed Size	Filter Area (SF)		at 2 GPM/SF	
			Each	Total	Each	Total
1-8	1913	12'x17'-6"	210	1,680	0.60	4.84
9-18	1925	16'x22'	352	3,520	1.01	10.14
19-24	1956	16'-7"x22'	365	2,190	1.05	6.30
					TOTAL	21.28

The original eight filters are operated with manual gate valves, one for each for influent, effluent, wash, waste and rinse. There are no surface wash or air wash facilities, but the filter beds are manually water jetted during each backwash cycle. The original strainer bottoms have been replaced with Leopold tile underdrains. The filter gallery has an open channel drain for all backwash waste water. Gallery access is available only through hatches in the operating floor. The wash water line is steel. There is no loss-of-head or rate-of-flow equipment.

Filter units 9 through 18 are operated by means of hydraulic cylinder actuated gate valves, except for the rinse valve which is operated by manual handwheel. Loss-of-head and rate-of-flow equipment is inoperable. The original strainer filter bottoms are still in use. There are no facilities for surface wash or air wash, but the filter beds are manually water-jetted during backwash. The gallery is accessible through the gallery of filters 19 through 24 or through hatches in the operating floor.

Filters 19 through 24 are equipped with hydraulically operated butterfly valves. The filters have Leopold bottoms and a fixed surface wash system is present. The filter gallery is accessible from an outside stairway as well as from matches in the operating floor. Loss-of-head and rate-of-flow equipment is inoperable.

The filtered water is collected from all of the filter units by one 36-inch pipe which conveys the water to the transfer pump suction well. There is no alternate path of flow for the filtered water and there are no isolating valves on the filtered water line.

Six vertical turbine transfer pumps are installed in a building on top of the transfer well. Various combinations of these six pumps are used to match plant production rates, keeping the transfer suction well within operable limits and pumping all filtered water to the adjacent 1.0 MG ground level clearwater storage tank. The clearwater storage tank is a prestressed concrete vessel 70 feet in diameter by 35 feet high, and the transfer pumping facilities were constructed in 1984 to maintain positive head on the high service distributive pumps while allowing greater flow through the plant. Each of the six transfer pumps is a vertical turbine unit rated for 7 MGD at 40 feet of head.

Water from the clearwater storage tank flows by gravity to four high service pumps whose characteristics are listed in Table 3.

Table 3: High Service Pump Characteristics
St. Joseph Service Area

Pump No.	Year Installed	HP	Head (ft)	Rated Capacity (MGD)
8	1953	600	330	9.36
11	1954	400	330	6.05
13	1962	800	345	11.50
14	1962	800	345	11.50

The high service pumps discharge into three transmission mains: a 16-inch, a 24-inch and a 30-inch main, which deliver water to the nearby Hill Reservoir No. 1 and Hill Reservoir No. 2 and to the distribution system. The Hill Reservoirs serve as the main service floating storage and provide for flexibility in plant pumping rates.

Wash water for the filters is provided by a 105,00 gallon steel wash water tank, 30 feet in diameter by 20.5 feet high, located on the bluff above the plant. The tank is filled from the high service pump discharge piping through an altitude valve. Wash rates of 15 gpm per square foot of filter area are used for all filters units. Normal wash duration is 3 to 4 minutes but wash duration under springtime periods of high turbidity is 5 minutes or more. Under these adverse raw water quality conditions it becomes necessary at times to consecutively wash filters 24 hours per day, and the flow available from the wash water tank is supplemented by water from the high service pipelines.

Chemicals Storage and Feed

Chemical feed at the St. Joseph plant includes polymer (coagulant aid and filter aid), lime, alum, carbon and chlorine. A summary of pertinent data on the chemical feed systems is shown in Table 4.

Table 4: Chemical Feed Systems

Chemical	Year	No.	Make - Type	Point of Application
Alum, Granular	1965	2	BIF 25-12 Granular Alum feeders with two Duriron solution pumps.	Inlet Basin No. 2 at Flash Mixer (Alternate Inlet Basin No. 1).
Chlorine (Pre)	1968	1	W&T 1000 PPD, Series V-800	Inlet Basin No. 3 (Alt.- Inlet Basin No. 2)
Chlorine (Pre)	1985	1	W&T 2000 PPD, Series V-800	Inlet Basin No. 3 (Alt.- Inlet Basin No. 2)
Chlorine (Pre)	1981	2	W&T 2000 PPD, Series V-800	Inlet Basin No. 3 (Alt.- Inlet Basin No. 2)
Chlorine (Post)	1986	2	W&T 500 PPD, Series V-500	Filter Effluent
Chlorine (Post)	1967	1	W&T 400 PPD, Series V-800	Clearwell Effluent
Polymer	1968	1	7,000 gallon & 4,500 fiberglass storage tank.	
	1961	1	W&T Series A-747 Diaphragm pump.	Screen well (coagulant aid).
	1973	1	W&T Series A-747 Diaphragm pump.	Outlet of Basin No. 3 (filter aid).
	1979	1	W&T Series Model 44-747 M 1 Metering pump.	Standby
Lime, Hydrated	1968	1	60,000 lb. capacity blow-in storage tank and air transfer to feeder system.	
	1968	2	W&T G-100 Belt Gravimetric feeders - 8-600 PPH each.	Inlet Basin No. 2 or Inlet Basin No. 3.
Carbon	1968	1	W&T A-728, 172 PPH feeder bucket elevator and dust collector.	Inlet Basin No. 1 or Inlet Basin No. 2