Exhibit No.:	
Issue(s):	Review of Project Options
Witness/Type of Exhibit:	Lee/Rebuttal
Sponsoring Party:	Public Counsel
Case No.:	WA-97-46 (Lead) and WF-97-241

REBUTTAL TESTIMONY

OF

GARY M. LEE

Submitted on Behalf of
the Office of the Public Counsel

MISSOURI-AMERICAN WATER COMPANY

Case No. WA-97-46 (Lead) and WF-97-241

May 6, 1997

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the matter of the Application of Missouri-American Water Company for a Certificate of Convenience and Necessity to Lease, Operate, Control, Manage and Maintain a New Source of Supply in Andrew County, Missouri	))))))	Case No. WA-97-46

AFFIDAVIT OF GARY M. LEE

STATE OF ~~MISSOURI~~) KANSAS
) ss
COUNTY OF JOHNSON)

Gary M. Lee, of lawful age and being first duly sworn, deposes and states:

1. My name is Gary M. Lee. I am a consultant retained by the Office of the Public Counsel.

2. Attached hereto and made a part hereof for all purposes is my rebuttal testimony consisting of pages 1 through 17, and Exhibits A through G.

3. I hereby swear and affirm that my statements contained in the attached testimony are true and correct to the best of my knowledge and belief.

Gary M. Lee

Subscribed and sworn to me this 6TH day of May, 1997.

Ruth A. Burch
Notary Public

My commission expires RUTH A. BURCH My Appt. Exp. 9-2-97

REBUTTAL TESTIMONY
OF
GARY M. LEE

AMERICAN WATER COMPANY

CASE Nos. WA-97-46 and WF-97-241

Q. PLEASE STATE YOUR NAME, TITLE, AND BUSINESS ADDRESS.

A. My name is Gary Michael Lee. I am a registered professional engineer in the State of Missouri and serve as president of Archer Engineers, Kansas City, Missouri. My business address is:

Archer Engineers
324 E. 11th, Suite 2305
Kansas City, MO 64106

My qualifications are outlined in the resume provided as Exhibit A to this rebuttal testimony.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. I will be responding to the direct testimony of Robert J. Gallo, William F. L'Ecyer, David A. Livingstone, Bernard F. Meyer, Wayne D. Morgan, and John S. Young, Jr., filed on behalf of the Missouri-American Water Company, Case No. WA-97-46/WF-97-241. I will be examining the deposition taken by the "company" as represented by these individuals and as represented by "company" documents referenced by these witnesses in their direct testimony. My testimony is limited to the "company" position taken with respect to the need for facility improvements and the technical merits of the improvement plan proposed by the "company."

Q. PLEASE DESCRIBE COMPANY DOCUMENTS WHICH YOU HAVE REVIEWED IN PREPARATION OF YOUR TESTIMONY.

A. Missouri-American Water Company, Case Nos. WA-97-46 and WF-97-241, Direct Testimony.

Missouri-American Water Company, St. Joseph Ground Water Source of Supply and Water Treatment Plant Feasibility Study, Volume I, Summary Report, Exhibit A.

Missouri-American Water Company, St. Joseph Ground Water Source of Supply and Water Treatment Plant Feasibility Study, Volume II, Exhibit B, Exhibit C, Exhibit D, Exhibit E.

Missouri-American Water Ground-Water Supply and Treatment Project for St. Joseph, May 1996.

Hydrogeological Evaluation, Area C, For Missouri American Water Co., St. Joseph, Missouri.

Preliminary Value Engineering Report, St. Joseph Ground Water Treatment Plant, Missouri-American Water Company.

Missouri-American Water Company, St. Joseph, Missouri, Ground Water Characterization and Pilot Treatment Study.

Q. IN ASSESSING THE NEED FOR THIS PROJECT, HAVE YOU REVIEWED THE PROJECTED WATER DEMANDS FOR THE COMPANY'S SERVICE AREA?

A. Based upon information obtained from the Mo-Kan Regional Planning Commission and the Urban Information Center, University of Missouri-St. Louis, the population projections used by the company appear appropriate; however, it should be noted that an argument could be advanced for zero growth given the service area's population trends over the past twenty years. Exhibit B illustrates the residential projections using the above sources compared to MAWC's projection.

It should be noted that the water use over the last 20 years has not exhibited a growth in system demand. This is evidenced in Exhibit C which was obtained from the company's 1994 Comprehensive Planning Study. As a result, any projected growth in system demand over the next ten to fifteen years is highly suspect. The company's forecast of an average daily demand in the year 2009 of 17.34 MGD is approximately 1.0 MGD in excess of the 1999 projection and the actual average day experienced in the years 1988 through 1991.

The maximum to average day demand rate has ranged from 1.26 to 1.60 over the last twenty years. Based upon this information, the use of a 1.60 maximum to average day demand ratio when applied to future projections again appears reasonable and prudent. It should also be noted that this factor is well within the range experienced by other similar communities as evidenced in Exhibit D.

Based upon the above review, the following design water demands for the year 2009 are appropriate:

Average Day	17.34
Maximum Day	27.74

Q. ARE YOU FAMILIAR WITH THE STATE AND FEDERAL DRINKING WATER REGULATIONS?

A. Yes. I have worked in the field of water supply engineering since 1971 and am currently active in my profession. In the course of executing my professional responsibilities, I have become knowledgeable of the federal Safe Drinking Water Act and various rules and regulations promulgated by the U.S. Environmental Protection Agency. In addition, I have worked specifically in the State of Missouri in the water supply field since 1975. During this period, I have gained a working knowledge of the state law, and rules, regulations, and guidelines promulgated by the Missouri Department of Natural Resources (MoDNR).

Q. PLEASE DESCRIBE THE PROPOSED SAFE WATER DRINKING ACT (SWDA) REGULATIONS YOU ARE AWARE OF WHICH THE COMPANY'S EXISTING WATER TREATMENT FACILITY MAY BE SUBJECT TO IN THE FUTURE.

A. Based upon the 1996 reauthorization of the Federal Safe Drinking Water Act (SWDA) and discussions with the Missouri Department of Natural Resources, there are certain rule changes which significantly impact the existing treatment facilities. These rules involve the following:

1. The Enhanced Surface Water Treatment Rule which requires treatment plants to meet a turbidity limit of 0.5 N.T.U. in 95% of the filtered water samples.

2. The Disinfection By-Products rule which requires TTHM's to be less than 0.1 mg/L and Haloacetic Acids to be less than 0.06 mg/L. Although other SWDA rules may impact the existing plant, these rules pose the most serious challenges to the existing processes.

Q. HOW WILL THE ABOVE PROPOSED REGULATIONS IMPACT THE COMPANY'S EXISTING TREATMENT PLANT AND PROCESSES?

A. In order to meet these regulations, the existing plant may be subject to the following modifications or combination of modifications:

a. Enhanced Coagulation

b. Conversion of disinfection processes to a Chlorine Dioxide Chloramine or Ozone system

c. Enhanced use of powdered activated carbon

All of the above process changes are significant and affect both capital expenditures and increased operation and maintenance costs. The existing facility is not easily modified to incorporate the above changes. All such modifications are likely to be costly.

Q. ARE THERE UNCERTAINTIES RELATED TO THE PROPOSED RULE CHANGES YOU'VE DISCUSSED ABOVE WHICH MAY MATERIALLY AFFECT YOUR ESTIMATION OF THE OVERALL IMPACT TO THE COMPANY'S EXISTING TREATMENT FACILITIES?

A. There are public discussions being held by the EPA which would lower the maximum contaminant levels (MCL) to 0.8 mg/L for TTHM and 0.03 mg/L for Haloacetic Acid. There is no set promulgation date for such rule changes; but, it is likely that we may experience such changes within the next five years.

Q. PLEASE DESCRIBE ANY OTHER PROPOSED REGULATIONS THAT YOU ARE AWARE OF WHICH THE COMPANY'S EXISTING WATER TREATMENT FACILITY MAY BE SUBJECT TO IN THE FUTURE.

A. Permitting issues surrounding the discharge of plant residuals to the Missouri River continue to be ill defined. At this time, no new NPDES permits are being issued. The existing plant, like many facilities along the Missouri River in Missouri, is discharging under an expired NPDES permit. This is not an issue only for St. Joseph, Missouri, but for all utilities along the Missouri River.

The residual disposal issue is likely to evolve into a major capital expense for this existing facility once the State and U.S. EPA finally settle on permit terms. The use of enhanced coagulant and powdered activated carbon to meet SDWA rules will only serve to aggravate this situation.

Q. IF RULES ARE PROMULGATED WHICH PRECLUDE THE COMPANY FROM RETURNING RESIDUALS TO THE MISSOURI RIVER, WHAT MODIFICATION TO THE EXISTING TREATMENT PLANT AND PROCESSES WILL BE NECESSARY?

A. The Company would be required to landfill or land apply residuals at a MoDNR approved site. This would require transporting of residuals which would also require dewatering of residual sludges.

Q. WILL THE IMPACT YOU MENTION ABOVE CONCERNING THE RETURN OF RESIDUALS TO THE MISSOURI RIVER SIMILARLY IMPACT OTHER LARGE WATER UTILITIES IN THE STATE OF MISSOURI IF SUCH RULES ARE ADOPTED?

A. All water utilities along the Missouri River are faced with this issue. Those facilities employing softening are facing higher concerns because of the composition of their sludges.

Q. HAS A SPECIFIC FUTURE DATE BEEN SET AT WHICH OR BY WHICH THE MISSOURI DNR WILL MAKE A DETERMINATION AS TO WHETHER THE AFFECTED WATER UTILITIES MAY CONTINUE RETURNING RESIDUALS TO THE MISSOURI RIVER?

A. No. This matter is still in negotiation between the Missouri River States including the State of Missouri and the U.S. EPA.

Q. IN YOUR PROFESSIONAL CAPACITY, CAN YOU MAKE A REASONABLE PREDICTION WHEN SUCH A DECISION WILL BE MADE?

A. I am uncertain as to when this matter will be resolved.

Q. PLEASE DESCRIBE THE UNCERTAINTIES THAT REGULATORY IMPACTS IMPOSE ON THIS WATERWORKS UTILITY.

A. While it is certain that the above regulatory issues will cause improvements to be made to the existing treatment process, a great deal of uncertainty remains. It is uncertain, for instance, as to the following:

SWDA Regulations

1. Future turbidity limitations below 0.5 NTU.
2. Future TTHM and Haloacetic Acid limitations below 0.1 mg/L and 0.06 mg/L, respectively.

NPDES Permitting

3. The final NPDES ruling regarding residual disposal.

These uncertainties are raised because they ultimately and significantly impact decisions regarding improvements to the existing facilities. The uncertainties are caused by two separate activities -- SWDA and NPDES. It is known that both activities are being addressed by the EPA, but no clear date of resolution can be predicted. Unfortunately, there is no recognizable schedule for when these uncertainties will be resolved. Their impacts are likely to become applicable to whatever project is currently advanced.

Q. ARE YOU FAMILIAR WITH THE FINISHED WATER QUALITY PRODUCED BY THE EXISTING WATER FACILITY? PLEASE DESCRIBE.

A. Exhibit E illustrates the typical finished water quality the company obtains through the existing process. This quality is typical of conventional surface water treatment plants using the Missouri River as a raw water source. As noted before, SDWA rules increase disinfection by-product restrictions. This facility has demonstrated difficulties in meeting THM standards. Plant improvements could be constructed which would bring this plant into compliance with SDWA rules. The most significant water quality issue affecting the comparison of alternative improvement plans is related to hardness. An annual average hardness of 267 mg/L as $CaCo_3$ has been reported by the Company. This would be considered a moderately hard water.

Additionally, the company has reported chronic taste and odor complaints related to water quality. It is noted that given the surface water supply of the existing facility, the origin of such problems are likely organic and treatable using powdered activated carbon.

Q. THE COMPANY HAS PROPOSED THE CONSTRUCTION OF A NEW WATER TREATMENT PLANT. IS THE PROPOSED WATER QUALITY OF THE FINISHED WATER PRODUCED BY THE NEW FACILITY EQUIVALENT TO THE EXISTING FINISHED WATER QUALITY?

A: The proposed new water plant would provide the following enhancements to finished water quality over the existing facility:

1. Reduced THM formation (with the notation that as influence of the Missouri River increases on the proposed aquifer, this enhancement could be reduced, particularly if chlorine remains as the primary oxidant of iron).
2. Taste and odor complaints should be reduced without the requirement to add P.A.C. as the introduction of organic matter in the raw water supply will be greatly reduced.

Of great concern, however, is the fact that total hardness concentration is likely to rise from an annual average of 267 mg/L as $CaCo_3$ to 500 to 600 mg/L as $CaCo_3$.. The company expects the hardness to decrease as the influence of the Missouri River on the aquifer increases; but, this is an uncertain event. If such a premise does prove correct, however, it may likely adversely impact the enhancements described above. Removal of hardness using lime is proposed by the company should hardness removal be required. This is an acceptable approach; but, I believe it should be incorporated into the remote site ground water alternative.

Reducing hardness by 250 to 350 mg/L using lime would require the additional annual allowance of approximately $247,000 for chemicals in the annual operation and maintenance projections.

This would also increase the capital cost of the project by $2,659,000.

The company has assured itself that the likelihood of these water quality issues arising after construction of the new improvements is limited. It should be noted that the exact water quality projections cannot be determined. The economic analysis relies heavily on the projected parameters being correct at least with acceptable ranges. This once again places an element of uncertainty into the proposed project.

Q. THE COMPANY HAS PROPOSED TO DECOMMISSION THE EXISTING TREATMENT FACILITIES AND DEVELOP A NEW GROUND WATER SOURCE AND TREATMENT PLANT AT A REMOTE SITE. ARE YOU IN AGREEMENT WITH THE COMPLETE DECOMMISSIONING OF THE EXISTING FACILITIES AND DEVELOPMENT OF A NEW GROUND WATER SOURCE AND TREATMENT PLANT AT A REMOTE SITE?

A. No, I do not agree. I believe instead that it may be more prudent to decommission the existing plant over a longer period of time while phasing in the new improvements. There are a number of uncertainties in the proposed plan to construct an entirely new facility using ground water located at a site remote from the existing plant. These uncertainties are summarized as follows:

1. Federal Safe Drinking Water Act and associated rules and regulations continue to evolve. It is likely that given the high demand being placed on the proposed aquifer, this source will be considered under the direct influence of the Missouri River. Disinfection by product issues could emerge as significant issues. This would particularly impact the company's plans to use chlorine as primary chemical to oxidize iron and manganese in that there could be an enhancement of THM formation. The company does not foresee this as a problem; but, only long-term pumping of the aquifer at the design flow rates will adequately dispel this concern. If this does become a significant issue, the company could be forced to consider several costly options:

    a. Reduce the aquifer draw, thereby reducing the river's influence on water quality, thus reducing the capacity of the new facility.

    b. Convert to aeration as the primary means of oxidizing iron and eliminate the use of chlorine expected in residual disinfection efforts.

This would result in a capital investment of approximately $1,131,000.

2. The proposed finished water quality of the new facility will be "harder" than the existing finished water. Currently, finished water hardness is 267 mg/L as $CaCo_3$. No softening is anticipated at the existing plant. It would appear that the cost of providing softening should have been included in the

economic analysis when comparing alternatives. This is particularly true when assuming that current customers are likely to expect, if not demand, the same finished water quality.

3. The company proposes to hydraulically load the new filters at 6 gpm/sq ft; the MoDNR guidelines stipulate a maximum loading or 4 gpm/sq ft. The MoDNR has indicated that they would accept this higher loading if the new facility demonstrates that it can consistently meet water quality goals. The acceptance of this loading rate by MoDNR will not be certain until after an appropriate demonstration period.

4. The company proposes to automate the new plant such that it can be operated as an unmanned facility. Again, total acceptance of this operating mode by MoDNR is uncertain. MoDNR is proposing an extensive demonstration period and testing scheme prior to rendering their final judgment.

Q. YOU HAVE PRESENTED THE CONCEPT OF PHASED CONSTRUCTION. IN YOUR OPINION WHY WOULD PHASING OF THIS PROJECT BE JUSTIFIED?

A. The option chosen by the company is the construction of a new ground water treatment plant located at a remote site. Phasing of the improvements whereby the existing plant would remain in service for at least an interim period appears to have merit given the uncertainties surrounding key design aspects of the existing facilities.

There is a brief mention of the phasing consideration on page 2-5 of MAWC Engineer's Report, Ground Water Supply and Treatment Project for St. Joseph, dated May 1996.

> There is some limited potential for phasing this project. This would involve building 15 MGD capacity of ground water intake, treatment, and transmission facilities in one phase, and keeping the existing treatment plant in service. At a later date, the additional groundwater supply, treatment and transmission capacity would be added, and the existing surface water plant would be retired at that time. This approach, while technically feasible, is not a favored approach because it would be more costly in the long run and would cause a reduced level of reliability in the interim.

When considering phasing of this endeavor, it would seem reasonable to size a new water source upon the basis of meeting the projected hydraulic capacity required by the average daily demand. Based upon this premise, the first phase of a new treatment facility could be sized at 17 MGD. When considering the company's alternative, sizing of the well field and transmission mains should remain at the 2009 maximum day requirement of 30 MGD.

The use of phasing allows consideration of the following project impacts:

Impacts to the company's selected alternative.

1. Reduced initial construction costs.
2. Ability to demonstrate effectiveness of automated operations over a longer period.
3. Ability to demonstrate effectiveness of the higher (6 gpm/sq. ft.) filter hydraulic loading rate.

4. Less reliability is inherent in this option than constructing a new 30 MGD sized facility. It should be noted, however, that the primary disruption to service associated with the existing plant is the result of flooding. Generally, floods occur at a time when water demands are closer to the average day requirements.

5. Leaving the existing plant in service would require that certain process improvements previously noted would need to be added to the project capital plan.

6. Ability to measure over an extended period the exact resulting water quality of the raw ground water when river flow is induced to the aquifer.

Q. HOW WOULD THE PROJECT'S ECONOMICS BE AFFECTED BY A PHASED APPROACHED TO THIS WATERWORKS IMPROVEMENTS PROJECT?

A. It is estimated that phasing of this project in the manner previously described would result in initial capital cost of $52,210,000. Approximately $20,000,000 less than the company's plan. Estimated annual operation and maintenance expenses would be $255,000. Approximately $200,000 higher than the company's proposed plan. The justification for phasing this project is not solely justified on the basis of economic analysis, rather this recommendation should be considered as a means to begin decommissioning the existing facilities while resolving significant project uncertainties. The risks associated with project uncertainties could result in the following increases in project costs:

		Construction Cost	Annual O&M Costs
1.	Increased filter area capacity	$ 3,308,000	$ 170,000 increase
2.	Increased lime storage and feed facilities for softening	$ 2,659,000	$ 200,000 increase
3.	Increased labor requirements due to failure to successfully automate plant, costs per year	$ N/A	$ 400,000

While the exact value of these risks may be debated, it is most likely that the order of magnitude of these costs cannot. Phasing of this project would allow for a new evaluation of expanded plant capacity at the new remote site versus continuation of utilizing the existing facility at a reduced production level.

Q. PLEASE DESCRIBE ANY DIFFERENCES YOU MAY HAVE WITH THE TECHNICAL APPROACH INCLUDING EQUIPMENT AND PROCESS SELECTION PROPOSED BY THE COMPANY IN THE CONSTRUCTION OF A NEW TREATMENT FACILITY.

A. There has obviously been a great deal of consideration and study provided by the company in the selection of its processes and equipment. There is one general observation, however, regarding process selection which leads to certain specific recommendations. In general, the company has relied on the induced flow from the Missouri River through the aquifer to enhance water quality, particularly with regard to total hardness and, to some extent, total iron and manganese concentration. Simultaneously the company is relying on the filtration of the aquifer's sand and gravel to buffer the raw water supply from being categorized as under the direct influence of the Missouri River. The company assumes that the potential disinfection by-products, most specifically THM's, will not be elevated as a result of induced river flow. The process treatment scheme relies heavily upon this assumption in order to produce a finished water quality similar to that produced by the existing treatment plant.

I would specifically recommend that consideration be given to the use of aeration as the primary oxidizer of iron in lieu of chlorine. This would at least preclude the risk of THM formation as the result of induced river flow. This is the only specific recommendation with regard to process or equipment selection.

The cost of providing aeration equipment in lieu of chlorination would be $1,131,000.

Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY IN THIS CASE?

A. Yes it does.

Gary M. Lee, P.E.

Exhibit A

Expertise:
Project Management
Water Utility Management
Capital Financing
Rate Analysis

Education:
B.S. Civil Engineering, University of Missouri-Rolla, 1971
M.S. Civil Engineering, University of Missouri-Rolla, 1974

Organizations:
National Society of Professional Engineers
Missouri Society of Professional Engineers
Professional Engineers in Private Practice
American Public Works Assoc.
Water Pollution Control Fed.
American Water Works Assoc.
American Soc. of Civil Engineers

Registration:
Professional Engineer - Missouri, Colorado, Oklahoma, North Dakota, South Dakota, Arkansas, Nebraska, Montana, Iowa

Uniformed Service:
Reserve commissioned officer U.S. Public Health Service

Mr. Lee currently serves as President and Chief Executive Officer for Archer Engineers. His experience includes the planning, financing and implementation of public works projects.

He possesses liaison experience in developing grant and loan relationships between local and state/federal programs. He is knowledgeable in municipal and governmental financing alternatives including municipal bonding and privatization.

Mr. Lee is experienced in a wide range of civil-environmental projects that include feasibility studies, plans, specifications, construction supervision, expert testimony, project management and project development.

He has experience in providing civil/environmental consulting services outside the U.S., including environmental projects in Panama, Guatemala, Mexico City, Honduras and Brazil. This experience has included feasibility studies, design and project management of water and wastewater facilities.

Mr. Lee was project manager for the Tri-County Regional Water Authority project which consisted of the development of a groundwater resource along the Missouri River in Jackson County, Missouri. Three 600 gpm wells were designed. The project also included construction of a 1,100 gpm two-stage (lime-soda) water treatment plant with dual media filter and 80 miles of PVC 12" and 20" diameter transmission main to serve 8 wholesale customers in Jackson, Lafayette and Cass Counties in Missouri. Mr. Lee assisted in the difficult development of this project, coordinating the individual needs and desires of 8 separate entities and molding a consensus for a single joint project.

He served as project manager for the development of master plans water facilities, which included planning for additional capital improvements, analysis of water rates and implementation of initial construction for the following communities: Clinton, Missouri, Beloit, Kansas, Great Bend, Kansas and Maryville, Missouri.

Mr. Lee was design engineer for the development of rural water districts including: Cass County PWSD #12, Cass County PWSD #7 and Jackson County PWSD #16. He was also involved in improvements to water districts for Jackson County PWSD #13 and Cass County PWSD #9.

He has provided engineering services pertaining to municipal water works improvements for the cities of Cameron, Holden, Peculiar, Belton and Clinton, Missouri.

Mr. Lee was principal engineer for the development of tariff analysis and restructuring of management systems for the water utilities in Guatemala City, Guatemala, S.A. and Panama City, Panama, C.A. The projects included development of new management systems and analysis of water rates and tariffs.

Gary M. Lee, P.E.

Mr. Lee was project coordinator for the U.S. State Department Office of Foreign Disaster Assistance during the aftermath of the Mexico City earthquake. The project involved damage assessment to the City's water system and development and management of emergency response to the disruption of water service to over 9 million Mexico City residents.

Mr. Lee served as engineer in the development of an integrated rural-potable water system for remote areas along the Amazon River in the State of Para, Brazil, S.A. The project included development of the organizational structure for management of the utility, system design and on-site training in both construction and operation techniques.

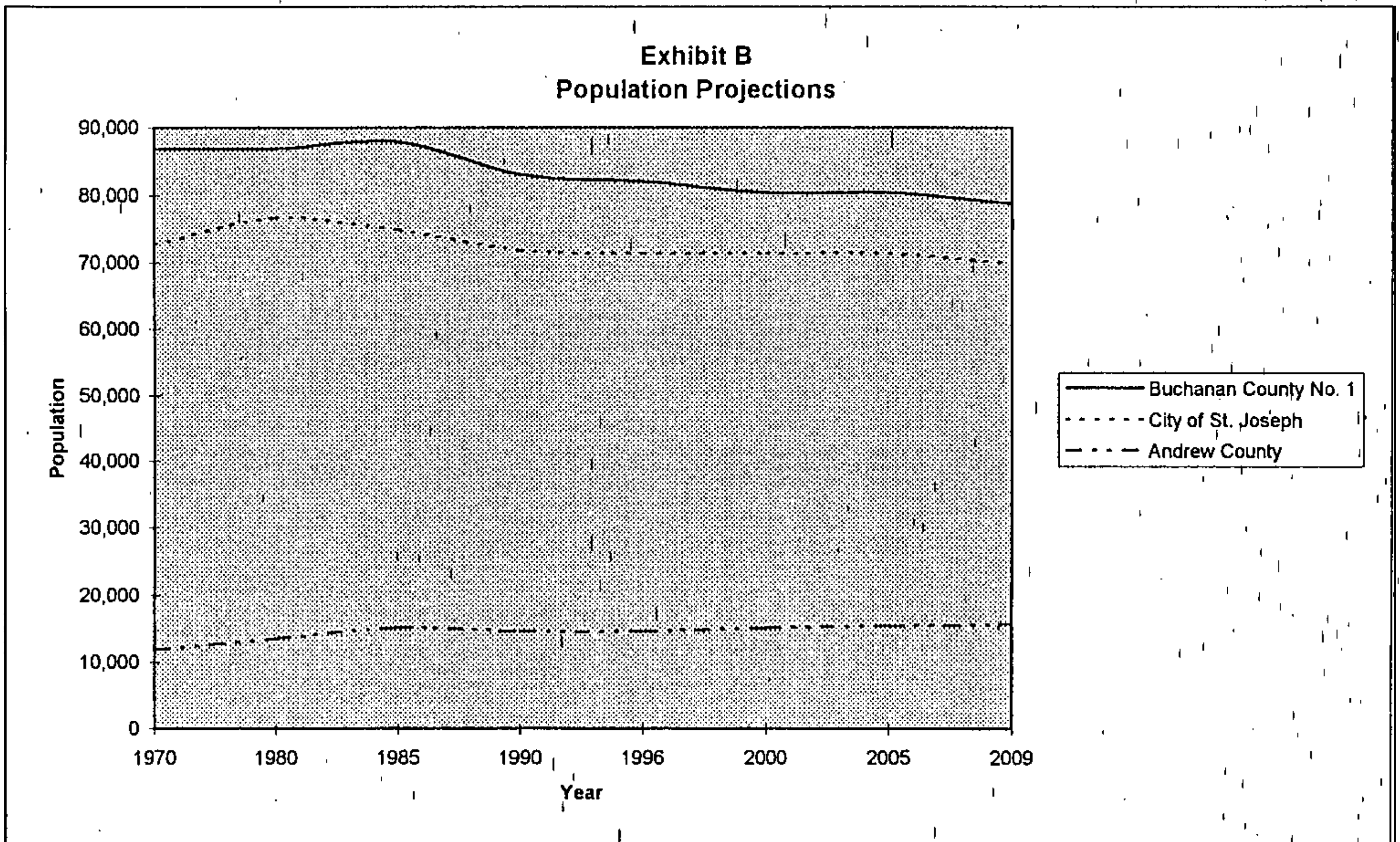


Exhibit B
Population Projections
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Population
1970
1980
1985
1990
1996
2000
2005
2009
Year
Buchanan County No. 1
City of St. Joseph
Andrew County

Exhibit C
Average Daily Demand

Historic Customers and Demand (MGD)	
Year	Average Day
1977	15.25
1978	15.71
1979	15.47
1980	15.18
1981	14.92
1982	15.56
1983	14.85
1984	14.45
1985	14.03
1986	13.93
1987	14.58
1988	16.35
1989	16.12
1990	16.54
1991	16.39
1992	15.89
1993	15.35
Projected Customers and Demand (MGD)	
1999	16.13
2004	16.59
2009	17.34

Exhibit D

	Maximum/Average Day Demand Ratio
Kansas City, MO	1.48
Springfield, MO	1.42
Cape Girardeau, MO	1.54
Kansas City, KS	1.54
St. Joseph, MO	1.60
Columbia, MO	1.60

EXHIBIT E
ST. JOSEPH FILTER PLANT

FINISHED WATER QUALITY DATA FOR 1992

MONTH	TURBIDITY (NTU)			ALKALINITY (mg/L)			pH			HARDNESS (mg/L)			CHLORIDE			FLUORIDE (mg/L)			CHLORINE (mg/L)			
	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	PRE* AVG	POST MIN	POST MAX	AVG
JAN	0.13	0.43	0.26	162	182	169	7.4	7.6	7.5	240	260	252	26	30	27	1.05	1.27	1.15	2.90	2.40	3.20	2.70
FEB	0.17	0.44	0.25	154	178	166	7.4	7.8	7.5	238	264	250	29	30	30	0.98	1.24	1.13	2.90	2.30	2.90	2.70
MAR	0.19	0.47	0.26	148	168	158	7.3	7.7	7.5	224	266	247	26	30	28	1.00	1.24	1.14	2.90	2.10	2.90	2.60
APR	0.15	0.28	0.20	128	168	154	7.2	7.9	7.6	208	266	244	22	27	25	1.02	1.33	1.16	3.00	2.40	3.10	2.70
MAY	0.11	0.37	0.21	156	174	164	7.3	7.7	7.5	242	276	256	26	29	27	1.03	1.25	1.17	2.90	2.20	2.80	2.50
JUN	0.11	0.27	0.17	150	172	160	7.4	7.6	7.5	232	262	244	23	30	26	1.07	1.29	1.20	2.90	2.40	2.80	2.50
JUL	0.13	0.31	0.19	94	164	144	7.2	7.6	7.4	180	254	231	21	31	26	0.91	1.19	1.10	3.00	2.40	2.90	2.70
AUG	0.13	0.22	0.18	122	172	158	7.4	7.8	7.5	198	264	246	24	27	25	0.99	1.21	1.11	3.20	2.70	3.20	2.80
SEP	0.14	0.28	0.19	142	176	159	7.3	7.6	7.5	226	268	248	22	28	25	0.99	1.33	1.12	3.30	2.70	3.20	3.00
OCT	0.13	0.28	0.19	148	214	178	7.4	7.7	7.6	244	316	277	22	27	26	0.80	1.20	1.01	3.40	3.00	3.60	3.20
NOV	0.14	0.43	0.21	186	218	202	7.4	7.6	7.5	278	320	303	25	28	27	0.90	1.24	1.03	3.20	2.80	3.30	3.00
DEC	0.11	0.34	0.17	148	218	193	7.4	7.8	7.5	224	328	288	23	25	25	1.02	1.26	1.14	3.00	2.60	3.00	2.80
ANNUAL	0.11	0.47	0.21	94	218	167	7.2	7.9	7.6	180	328	257	21	31	26	0.80	1.33	1.12	3.05	2.10	3.60	2.77

* CHLORINE MEASURED AFTER CLARIFICATION PRIOR TO FILTRATION.

NOTE: 1) NO ODOR DETECTED IN FINISHED WATER THROUGHOUT 1992

Exhibit F

Preliminary Capital Cost Estimating
Associated with Rebuttal Testimony

I. Addition of Forced Draft Aeration Equipment

	Item			Cost
1.	Equipment	5 units	@$70,000 /unit	$350,000
2.	Installation	1 LS	@$200,000 /LS	$200,000
3.	Structural	5 units	@$50,000 /unit	$250,000
4.	Piping and Valves	1 LS	@$45,000 /LS	$45,000
5.	Electrical	1 LS	@$15,000 /LS	$15,000
6.	Miscellaneous	1 LS	@$10,000 /LS	$10,000
	Sub-Total Construction Cost			$870,000
	Engineering, Contract Administration	20%		$174,000
	Contingency & Miscellaneous Cost	10%		$87,000
	PROJECT TOTAL			$1,131,000

II. Additional Filters to Meet MDNR 4 gpm/sq ft Loading Rule

1.	Controls	2 units	@$50,000 /unit	$100,000
2.	Media	3600 sq ft	@$150 /SF	$540,000
3.	Underdrains	3600 sq ft	@$50 /SF	$180,000
4.	Structural	1 LS	@$150,000 /LS	$150,000
5.	Mechanical	1 LS	@$125,000 /LS	$125,000
6.	Piping and Valves	1 LS	@$250,000 /LS	$250,000
7.	Building Systems	10000 sq ft	@100 /SF	$1,000,000
8.	Installation	1 LS	@$200,000 /LS	$200,000
	Sub-Total Construction Cost			$2,545,000
	Engineering, Contract Administration	20%		$509,000
	Contingency & Miscellaneous Cost	10%		$254,500
	PROJECT TOTAL			$3,308,500

Item			Cost
III. 17 MGD Iron Removal Plant with Lime Softening			
1. Wells			$5,000,000
2. Low Service Pumping			$3,000,000
3. Aerators			$500,000
4. Bulk Lime Storage with Feeders			$1,000,000
5. Miscellaneous Chemical Feeders and Storage			$1,000,000
6. Miscellaneous Controls			$1,000,000
7. Upflow Clarifiers			$3,000,000
8. Filters			$5,000,000
9. Clearwell Storage			$1,000,000
10. Building			$1,000,000
11. Site Improvements			$500,000
12. High Service Pumping			$2,000,000
13. Piping and Valves			$3,000,000
14. Electrical			$1,500,000
15. Mechanical			$2,000,000
16. Laboratory			$500,000
17. Furniture and Fixtures			$250,000
18. Transmission Pipelines			$8,000,000
Sub-Total Construction			$39,250,000
Engineering and Construction Administration		15%	$5,890,000
Contingencies and Miscellaneous Cost		5%	$1,960,000
PROJECT TOTAL			$47,100,000

IV. Addition of Bulk Lime Storage and Slakers

1. Equipment	6 units	@$140,000 /unit	$840,000
2. Structure	6 units	@$50,000 /unit	$300,000
3. Installation	6 units	@$30,000 /unit	$180,000
4. Mechanical	1 LS	@$100,000 /LS	$100,000
5. Electrical	1 LS	@$150,000 /LS	$150,000
6. Piping and Valves	1 LS	@$350,000 /LS	$350,000
7. Controls	1 LS	@$125,000 /LS	$125,000
Sub-Total Construction Cost			$2,045,000

Item		Cost
Engineering, Contract Administration	20%	$409,000
Contingency & Miscellaneous Cost	10%	$204,500
PROJECT TOTAL		$2,658,500

V. Cost to Rehabilitate Existing Plant at a Plant Rating of 12 MGD

1.	Additional Chemical Feeders, i.e., Ammonia, P.A.C.		$1,000,000
2.	Control Modifications		$500,000
3.	Ozone Equipment		$1,500,000
4.	Residual Handling Facilities		$1,000,000
	Sub-Total Construction		$4,000,000
	Engineering and Construction Administration	20%	$800,000
	Contingencies and Miscellaneous Cost	10%	$400,000
	PROJECT TOTAL		$5,200,000

Exhibit G

Preliminary Operation and Maintenance Cost Estimate Associated with Rebuttal Testimony

I. Addition of Forced Draft Aeration

Item	Annual Cost: Forced Draft Aeration	Annual Cost: Chlorination
1. Chemicals	$100,000	$300,000
2. Labor	$50,000	$100,000
3. Power	$75,000	$50,000
4. Repairs and Replacement Short Life Equipment	$30,000	$15,000
Total	$255,000	$465,000

II. Additional Filters

Item	Annual Cost: Six Filters	Annual Cost: Eight Filters
1. Labor	$300,000	$400,000
2. Power	$150,000	$200,000
3. Repairs and Replacement Short Life Equipment	$60,000	$80,000
Total	$510,000	$680,000

III. 17 MGD Iron Removal with Lime Softening Plant

Item	Cost
1. Labor	$1,000,000
2. Power	$1,800,000
3. Utilities	$1,000,000
4. Chemicals Short Life Equipment	$1,000,000
Total	$4,800,000

IV. Addition of Bulk Lime Storage and Feeders

Item	Annual Cost
1. Labor	$200,000
2. Chemicals	$500,000
3. Repair and Replacement	
Short Life Equipment	$50,000
4. Utilities	$30,000
Total	$780,000

V. Operation of Existing Treatment Plant to Meet Peak Demand Above 17 MGD

Item	Cost
1. Labor	$500,000
2. Chemicals	$300,000
3. Repair and Replacement	
of Short Life Equipment	$200,000
4. Utilities	$300,000
Total	$1,300,000

MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH DISTRICT
ST. JOSEPH, MISSOURI

WATER TREATMENT PLANT IMPROVEMENTS

SEPTEMBER, 1992

GANNETT FLEMING, INC.
WATER RESOURCES AND GEOTECHNICAL DIVISION

HARRISBURG, PENNSYLVANIA

SCHEDULE
JSY-2

MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH, MISSOURI
WATER TREATMENT PLANT

TABLE 1
MISSOURI DEPARTMENT OF NATURAL RESOURCES
DESIGN STANDARDS

A.	Detention Times		
	1.	Rapid Mixing Basin	≤30 seconds (1)
	2.	Flocculation Basin	≥30 minutes (2)
	3.	Sedimentation Basin	≥240 minutes (2)
B.	Flow Through Velocities		
	1.	Flocculator Basin	0.5 fpm to 1.5 fpm (2)
	2.	Sedimentation Basin	< 0.5 fpm (2)
C.	Launder Weir Loading Rate		≤ 20,000 gpd/ft

NOTE:
(1) Suggested Guidelines
(2) Mandatory Standards

TABLE 2

LIST OF ALTERNATIVES

ALTERNATIVE	DESCRIPTION
Existing	One Sedimentation Basin/One Rapid Mixing Basin/One Flocculator-Sedimentation Basin/One Sedimentation Basin
A1	One Rapid Mixing Basin/One Flocculator-Sedimentation Basin/One Sedimentation Basin
A1	One Rapid Mixing Basin/Split Box/Two Parallel Flocculator-Sedimentation Basins/One Sedimentation Basin
A3	One Rapid Mixing Basin/Split Box/Four Parallel Flocculator-Sedimentation Basins/One Sedimentation Basin
B1	One Rapid Mixing Basin/Two Parallel Flocculator-Sedimentation Basins/One Sedimentation Basin
C1	Two Parallel Rapid Mixing Basins/Split Boxes/Two Parallel Flocculator-Sedimentation Basins Each With Two Compartments
C2	One Rapid Mixing Basin/Split Box/Two Parallel Flocculator-Sedimentation Basins Each With Two Compartments
D1	One Rapid Mixing Basin/Superpulsator/Clarifier

TABLE 3
ITEMS LIST FOR PROCESS FACILITIES AND ALUM STORAGE

		ALTERNATIVES						
	ITEM	A1	A2	A3	B1	C1	C2	D1
1.	Rapid Mixing Basin	X(1)	X(1)	X(1)	X(1)*	X(2)	X(1)	X
2.	Split Box		X(1)	X(1)		X(2)	X(1)	
3.	Flocculator Baffle Walls a. Basin No. 1	X(4)	X(4)	X(4)		X(4)	X(4)	
	b. Basin No. 2	X(1)**	X(1)**	X(1)**	X(4)	X(4)	X(4)	
4.	Three-Staged, Tapered Flocculators a. Basin No. 1	X	X	X		X	X	
	b. Basin No. 2				X	X	X	
5.	Sludge Collector System a. Basin No. 1	X	X	X	X	X	X	
	b. Basin No. 2 (partial)	X	X	X				
6.	Dividing Wall a. Basin No. 1		X(1)	X(3)		X(1)	X(1)	
	b. Basin No. 2				X(1)	X(1)	X(1)	
7.	Effluent Collection Launders a. Basin No. 1	X	X	X	X	X	X	
	b. Basin No. 2 (Add one Launder)	X	X	X	X	X	X	
8.	Rehabilitation of Basin No. 1 Bottom	X	X	X	X	X	X	
9.	Flumes Connecting Basin No. 1 and No. 2	X	X	X				
10.	Removal of the Existing Flocculator and Rapid Mixer	X	X	X	***X	X	X	X
11.	Influent Piping & Connections	X	X	X	X	X	X	X
12.	Effluent Piping & Connections				X	X	X	X
13.	100,000 Gallons Alum Storage Tank	X	X	X	X	X	X	X
14.	Roof a. Basin No. 1	X	X	X	X	X	X	
	b. Basin No. 2	X	X	X	X	X	X	
15.	Super Pulsator/Clarifier Building							X

NOTES:
- X - Required
- (2) - Number of units
- * - Add Second Stage
- ** - In Sedimentation Basin for Flow Redistribution
- *** - Flocculator Only

TABLE 4-1
ALTERNATIVE EXISTING
ONE SEDIMENTATION BASIN/ONE RAPID MIXING BASIN/ ONE FLOCCULATOR SEDIMENTATION BASIN/ONE SEDIMENTATION BASIN DETENTION TIME AND FLOW THROUGH VELOCITY
(Design Flow Rate 30 MGD)

	Treatment Unit	Basin Dimension (LxWxD) (ft x ft x ft)	Basin Volume (gallons)	Detention Time (Minutes	Flow Through Velocity (fpm)
I.	Basin No. 1	203 x 209 x 15.75	4,998,325		
	A. Sedimentation Basin	203 x 209 x 15.75	4,998,325	236	0.85
II.	Basin No. 2	175 x 209 x 13.91	3,805,511		
	A. Flocculator	50 x 209 x 13.91	1,087,289	52	0.96
	B. Sedimentation Basin	125 x 209 x 13.91	2,718,222	130	0.96
III.	Basin No. 3	172 x 207 x 12	3,195,815	153	1.12
	TOTAL DETENTION TIME				
	A. Flocculator			52	
	B. Sedimentation Basin				
	1. Basin No. 1			236	
	2. Basin No. 2			130	
	3. Basin No. 1 → Basin No. 2			366	
	4. Basin No. 1 → Basin No. 3			389	
	5. Basin No. 2 → Basin No. 3			283	
	6. Basin No. 1 → Basin No. 2 → Basin No. 3			519	

TABLE 4-2
GENERAL DESCRIPTION AND EVALUATION OF EXISTING FACILITY

A. GENERAL DESIGN

1. One single-staged rapid mixing basin.

2. Basin No. 1 sedimentation basin with wooden baffle wall and sludge collecting gutters.

3. Basin No. 2 divided by a wooden baffle wall into two sections. The influent end serves as a flocculation basin with four single-stage vertical reel flocculators. The effluent end serves as a sedimentation basin.

4. Basin No. 3, serves as a sedimentation basin.

5. Bypass flumes/and pipes allow water to bypass any Basin.

B. COMPLIANCE (With respect to DNR Standards)

1. Flocculation Basin

a.	Detention time	52 min. (complies)
b.	Flow-through velocity	0.96 fpm (complies)

2. Sedimentation Basin

a.	Detention Time	
	(1) Basin No. 1	236 min. (requires variance)
	(2) Basin No. 2	130 min. (requires variance)
	(3) Basin No. 1 → Basin No. 2	366 min. (complies)
	(4) Basin No. 1 → Basin No. 3	389 min. (complies)
	(5) Basin No. 2 → Basin No. 3	283 min. (complies)
	(6) Basin No. 1 → Basin No. 2 → Basin No. 3	519 min. (complies)
b.	Flow-through Velocity	
	(1) Basin No. 1	0.85 fpm (requires variance)
	(2) Basin No. 2	0.96 fpm (requires variance)
	(3) Basin No. 3	1.12 fpm (requires variance)
c.	Outlet Weir Loading Rate	
	(1) Basin No. 1	(Lack of outlet Launders) (requires variance)
	(2) Basin No. 2	25,400 gpd/ft (requires variance)
	(3) Basin No. 3	25,400 gpd/ft (requires variance)

C. ADVANTAGES

1. Flocculator size meets the DNR standards.

2. Can meet DNR sedimentation detention time standard under dual basin modes of operation.

D. DISADVANTAGES

1. Flow-through velocities exceed the DNR standards established for settling basins.

2. Launder weir loading rate from sedimentation basins requires variance from the DNR standard.

3. Lack of influent baffle walls for flocculation and settling basin results in poor influent flow distribution and causes short-circuiting problems.

4. Single stage rapid mixing has less operational flexibility.

5. Single stage flocculation has less operational flexibility.

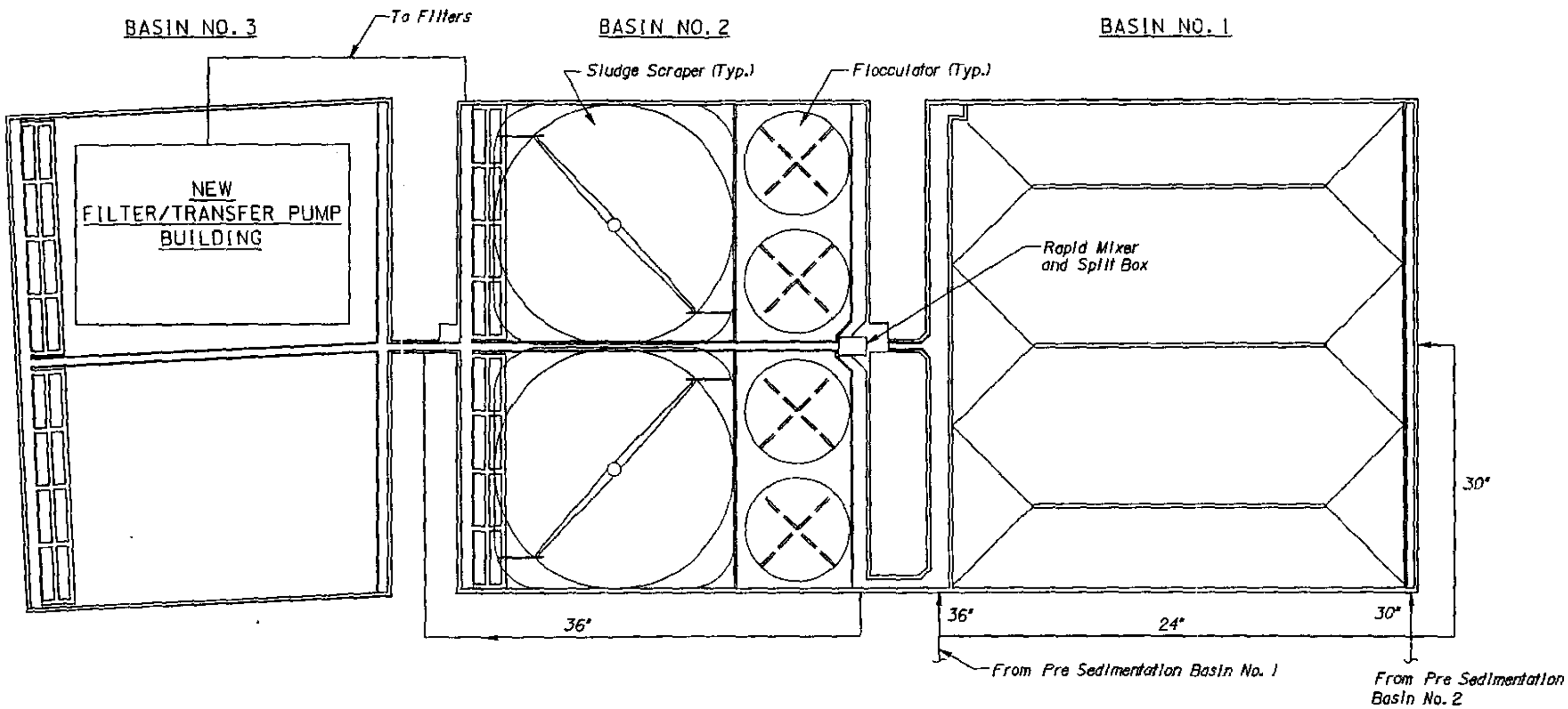
6. Single flocculation compartment has no standby in the event that maintenance is required in basin. System must operate without rapid mix and flocculation facilities.

7. Lack of sludge collection equipment requires Basin No. 1 to be shutdown for periodic manual cleaning.

8. Rapid mixing and flocculation take place further in process and do not take advantage of potential total post flocculation detention time in system.

9. Uncovered basins presents icing problems in winter.

10. Lack of sludge removal facilities may result in settled material turning septic.



EXISTING FLOCCULATOR/SEDIMENTATION BASINS

MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH, MISSOURI

ST. JOSEPH
WATER TREATMENT PLANT
IMPROVEMENT PROJECT
EXISTING FACILITIES

GANNETT FLEMING INC. SEPTEMBER 1992

DFWR\EXHIBITS\AMERICAN\28512EX1.DGN

EXHIBIT AX

TABLE 5-1
ALTERNATIVE A1
ONE RAPID MIXING BASIN/ONE FLOCCULATOR-SEDIMENTATION BASIN/ ONE SEDIMENTATION BASIN
DETENTION TIME AND FLOW-THROUGH VELOCITY
(Design Flow Rate 30 MGD)

	Treatment Unit	Basin Dimension (LxWxD) (ft x ft x ft)	Basin Volume (gallons)	Detention Time (Minutes)	Flow-Through Velocity (fpm)
I.	**Basin No. 1**	203 x 209 x 15.75	4,998,325		
	A. Flocculator	40 x 209 x 15.75	984,892	47	0.85
	B. Sedimentation Basin	160 x 209 x 15.75	3,939,566	189	0.85
II.	**Basin No. 2**	175 x 209 x 13.91	3,805,511		
	A. Sedimentation Basin	175 x 209 x 13.91	3,805,511	183	0.96
	TOTAL DETENTION TIME				
	A. Flocculator			47	
	B. Sedimentation Basin				
	1. Basin No. 1			189	
	2. Basin No. 1 → Basin No. 2			372	
	3. Basin No. 2			183	

TABLE 5-2
GENERAL DESCRIPTION AND EVALUATION OF ALTERNATIVE A1

A. GENERAL DESIGN

1. Install new two-stage rapid mixing basin adjacent to the Basin No. 1 and remove the existing rapid mixing basin at Basin No. 2.

2. Retrofit Basin No. 1 with three-staged tapered flocculator with variable input energy and provide the flocculator influent baffle wall, baffle walls between staged flocculators and diffuser wall between flocculator and clarifier.

3. Modify Basin No. 1 bottom for installation of sludge collecting system.

4. Install effluent collecting launders in Basin No. 1.

5. Install four flumes to connect Basin No. 1 effluent flume and Basin No. 2 influent flume.

6. Remove the existing flocculators in Basin No. 2 and install chain and flight sludge collectors.

7. Install influent baffle wall.

8. Add new launder to Basin No. 2 existing effluent collecting system.

9. Basin No. 3 abandoned. Filters and possibly residual waste facilities to be constructed in this area.

B. COMPLIANCE (With Respect to DNR Standard)

1. Flocculation Basin

   a. Detention Time — 47 minutes (complies)
   b. Flow-through velocity — 0.85 fpm (complies)

2. Sedimentation Basin

   a. Detention Time
      (1) Basin No. 1 — 189 min. (requires variance)
      (2) Basins No. 1 and No. 2 — 372 min. (complies)
      (3) Basin No. 2 — 183 min. (requires variance)

   b. Flow through velocity
      (1) Basin No. 1 — 0.85 fpm (requires variance)
      (2) Basin No. 2 — 0.96 fpm (requires variance)

c. Outlet weir loading rate
   (1) Basin No. 1 — 18,300 gpd/ft (complies)
   (2) Basin No. 2 — 18,300 gpd/ft (complies)

C. ADVANTAGES

1. One influent pipe connection required.

2. Two-stage rapid mixing provides additional flexibility for chemical feed.

3. Three-stage, tapered flocculation provides additional flexibility in the process system.

4. Both detention time and horizontal velocity through the flocculators comply with the Missouri Department of Natural Resources (DNR) Standards.

5. Flocculator influent and outlet baffle walls provide uniform distribution of flow and velocity through the flocculator and clarifier area in Basin No. 1. Flow short-circuiting in flocculator can be minimized.

6. Additional settling time is provided after flocculation under normal operation.

7. Continuous sludge removal will reduce operating maintenance and prevent settled sludge from impairing clarified water quality and turning septic.

8. New and additional effluent launders will serve to comply with DNR standards for both Basin No. 1 and No. 2 outlet weir loading rates.

9. Roofed enclosure over basin would eliminate icing problem.

D. DISADVANTAGES

1. Flow through velocities exceed DNR standards for settling basins.

2. Single flocculation compartment has no standby in the event maintenance is required in Basin No. 1. System must operate without rapid mixing and flocculation facilities.

3. With either basin out of service, the system cannot meet the required DNR detention time for sedimentation.

4. Loss of rapid mix basin will require bypassing system with loss in treatment efficiency.

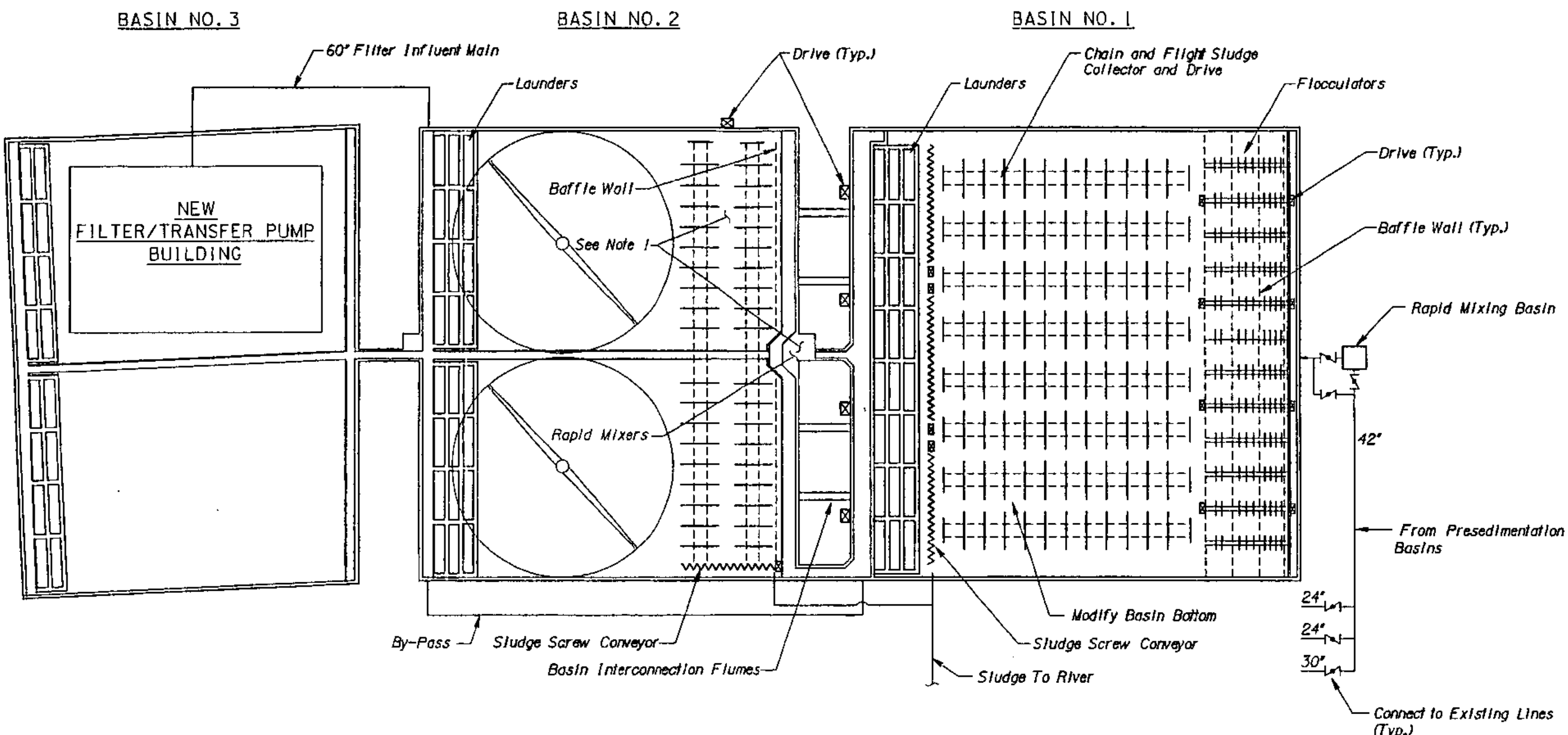
5. Flow through velocities will increase significantly as flow passes through flumes from Basin No. 1 to Basin No. 2.

6. Winter ice problem will remain if costly roof enclosure system is not constructed.

TABLE 5-3
BASIN WORK AND ADDITIONAL ALUM STORAGE
ADDITIONAL COST ESTIMATE
ALTERNATIVE A1

No.	ITEM	COST
	Base Construction Cost*	$8,810,000
1.	Rapid Mixing Basin	215,000
2.	Split Box	- - -
3.	Flocculator Baffle Walls a. Basin No. 1	175,000
	b. Basin No. 2	43,000
4.	Three-Staged, Tapered Flocculators a. Basin No. 1	430,000
	b. Basin No. 2	- - -
5.	Sludge Collector System a. Basin No. 1	900,000
	b. Basin No. 2 (partial)	170,000
6.	Dividing Wall a. Basin No. 1	- - -
	b. Basin No. 2	- - -
7.	Effluent Collection Launders a. Basin No. 1	225,000
	b. Basin No. 2	40,000
8.	Rehabilitation of Basin No. 1 Bottom	300,000
9.	Flumes Connecting Basin No. 1 and No. 2	75,000
10.	Removal of the Existing Flocculator and Rapid Mixer	20,000
11.	Influent Piping & Connections	300,000
12.	Effluent Piping & Connections	80,000
13.	100,000 Gallon Alum Storage Tank	200,000
	SUBTOTAL	$11,983,000
14.	Roof a. Basin No. 1	1,520,000
	b. Basin No. 2	1,520,000
15.	Superpulsator/Clarifier Building	- - -
	TOTAL	$15,023,000

* Previously estimated 3A construction cost less basin construction cost (Items 1, 3a, 4a, 5a and 8)



FLOCCULATOR/SEDIMENTATION BASINS

NOTE:

1. *Remove existing flocculators, rapid mixer and wooden baffle wall.*

MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH, MISSOURI

ST. JOSEPH
WATER TREATMENT PLANT
IMPROVEMENT PROJECT
ALTERNATIVE A1

GANNETT FLEMING INC. SEPTEMBER 1992

GFWR\EXHIBITS\AMERICAN\28512EX1.DGN

EXHIBIT A1

TABLE 6-1
ALTERNATIVE A2
ONE RAPID MIXING BASIN/SPLIT BOX/TWO PARALLEL FLOCCULATOR-SEDIMENTATION BASINS/ONE SEDIMENTATION BASIN DETENTION TIME AND FLOW-THROUGH VELOCITY
(Design Flow Rate - 30 MGD)

	Treatment Unit	Basin Dimension (LxWxD) (ft x ft x ft)	Basin Volume (gallons)	Detention Time (Minutes)	Flow-Through Velocity (fpm)
I.	**Basin No. 1** (with one dividing wall)	203 x 209 x 15.75	4,998,325		
	A. Flocculator (FL) - All in use	40 x 208 x 15.75	980,179	47	0.85
	1. FL No. 1A - one unit off-line	40 x 104 x 15.75	490,090	23	1.70
	2. FL No. 1B - one unit off-line	40 x 104 x 15.75	490,090	23	1.70
	B. Sedimentation Basin (SB) - All in use	160 x 208 x 15.75	3,920,717	188	0.85
	1. SB No. 1A - one unit off-line	160 x 104 x 15.75	1,960,258	94	1.70
	2. SB No. 1B - one unit off-line	160 x 104 x 15.75	1,960,358	94	1.70
II.	**Basin No. 2**	175 x 209 x 13.91	3,805,511		
	A. Sedimentation Basin (SB)	175 x 209 x 13.91	3,805,511	183	0.96
	TOTAL DETENTION TIME				
	A. Flocculator				
	1. Both units in use			47	
	2. One unit off-line			23	
	B. Sedimentation Basin				
	1. Basin No. 1 (all units in use)			188	
	2. Basin No. 1 (one unit off-line)			94	
	3. Basin No. 1 (all units in use) → Basin No. 2			371	
	4. Basin No. 1 (one unit off-line) → Basin No. 2			277	

TABLE 6-2
GENERAL DESCRIPTION AND EVALUATION OF ALTERNATIVE A2

A. GENERAL DESIGN

The arrangement of process units for Alternative A2 is similar to Alternate A1 except for the following:

1. A split box is provided adjacent to the rapid mixer basin for Basin No. 1.

2. A dividing wall divides Basin No. 1 into two compartments. Each compartment contains one flocculation basin and one sedimentation basin.

B. COMPLIANCE (With Respect to DNR Standard)

1. Flocculation Basin

   a. Detention time
      - (1) Both units in use — 47 min. (complies)
      - (2) One unit off-line — 23 min. (requires variance)

   b. Flow-through velocity
      - (1) Both units in use — 0.85 fpm (complies)
      - (2) One unit off-line — 1.70 fpm (requires variance)

2. Sedimentation Basin

   a. Detention time
      - (1) Both units in Basin No. 1 in service — 188 min. (requires variance)
      - (2) One unit in Basin No. 1 in service — 94 min. (requires variance)
      - (3) Both units in Basin No. 1 in service along with Basin No. 2 — 371 min. (complies)
      - (4) One unit in Basin No. 1 in service along with Basin No. 2 — 277 min. (complies)

   b. Flow-through velocity
      - (1) Two units in Basin No. 1 and Basin No. 2 in use
        - (a) Basin No. 1 — 0.85 fpm (requires variance)
        - (b) Basin No. 2 — 0.96 fpm (requires variance)
      - (2) One train off-line
        - (a) Basin No. 1 — 1.7 fpm (requires variance)
        - (b) Basin No. 2 — 0.96 fpm (requires variance)

c. Outlet weir loading rate
(1) Two units in Basin No. 1 and Basin No. 2 in use
(a) Basin No. 1 — 18,900 gpd/ft (complies)
(b) Basin No. 2 — 18,900 gpd/ft (complies)
(2) One train off-line
(a) Basin No. 1 — 37,800 gpd/ft (requires variance)
(b) Basin No. 2 — 18,900 gpd/ft (complies)

C. ADVANTAGES

Besides advantages listed for Alternative A1, Alternative A2 offers the following additional advantages.

1. The additional split box and influent piping provide more uniform flow distribution for Basin No. 1.

2. The dividing wall will provide additional operational flexibility allowing the operator to take one series of process units off-line for repairs or maintenance while keeping the other in service.

3. With one flocculator - sedimentation basin off-line Alternative A2 is capable of providing in excess of 240 min. (4 hours) sedimentation time.

D. DISADVANTAGES

1. With one flocculator off-line, the flocculator detention time of 23 minutes is less than 30 minutes required by DNR standard under normal operation. There is no criteria with one unit out of service. DNR has indicated that system could be overloaded when one unit is out of service for maintenance.

2. The velocity through the sedimentation basins is greater than the DNR standard.

3. Loss of rapid mix basin will require bypassing system with loss in treatment efficiency.

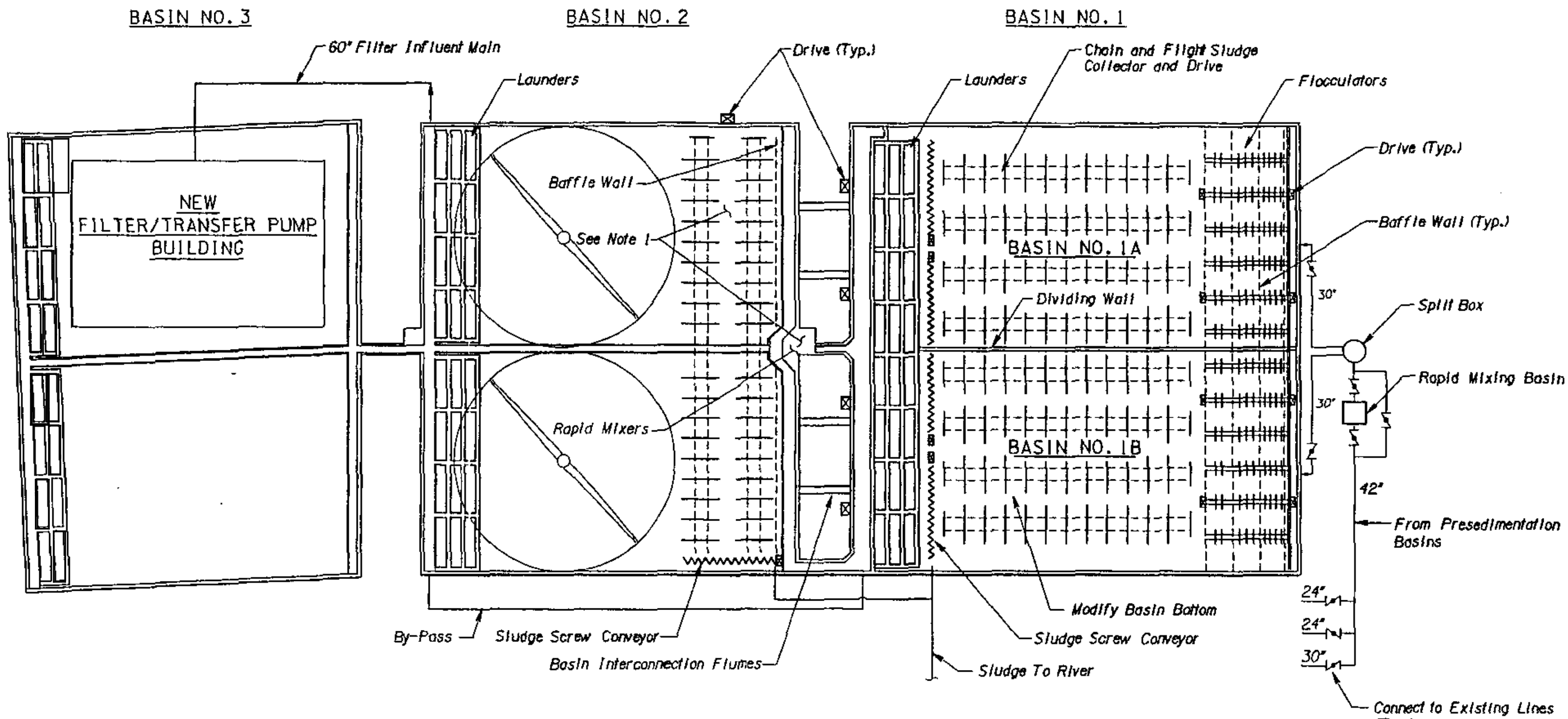
4. Launder loading in sedimentation basin will be over DNR standard with one one-half of Basin No. 1 out of service.

5. Flow through velocities will increase significantly as flow passes through flumes from Basin No. 1 to Basin No. 2.

6. Winter ice problems will remain if costly roofed enclosure system is not constructed.

TABLE 6-3
BASIN WORK AND ADDITIONAL ALUM STORAGE
ADDITIONAL COST ESTIMATE
ALTERNATIVE A2

No.	ITEM	COST
	Base Construction Cost*	$8,810,000
1.	Rapid Mixing Basin	215,000
2.	Split Box	50,000
3.	Flocculator Baffle Walls a. Basin No. 1	175,000
	b. Basin No. 2	43,000
4.	Three-Staged, Tapered Flocculators a. Basin No. 1	430,000
	b. Basin No. 2	- - -
5.	Sludge Collector System a. Basin No. 1	900,000
	b. Basin No. 2 (partial)	170,000
6.	Dividing Wall a. Basin No. 1	330,000
	b. Basin No. 2	- - -
7.	Effluent Collection Launders a. Basin No. 1	225,000
	b. Basin No. 2	40,000
8.	Rehabilitation of Basin No. 1 Bottom	300,000
9.	Flumes Connecting Basin No. 1 and No. 2	75,000
10.	Removal of the Existing Flocculator and Rapid Mixer	20,000
11.	Influent Piping & Connections	400,000
12.	Effluent Piping & Connections	170,000
13.	100,000 Gallon Alum Storage Tank	200,000
	SUBTOTAL	$12,553,000
14.	Roof a. Basin No. 1	1,520,000
	b. Basin No. 2	1,520,000
15.	Superpulsator/Clarifier Building	- - -
	TOTAL	$15,593,000



FLOCCULATOR/SEDIMENTATION BASINS

NOTE:

1. Remove existing flocculators, rapid mixer and wooden baffle wall.

MISSOURI-AMERICAN WATER COMPANY
ST. JOSEPH, MISSOURI

ST. JOSEPH
WATER TREATMENT PLANT
IMPROVEMENT PROJECT
ALTERNATIVE A2

GANNETT FLEMING INC. SEPTEMBER 1992

GFWR\EXHIBITS\AMERICAN\28512EX1.DGN

EXHIBIT A2

TABLE 7-1
ALTERNATIVE A3
ONE RAPID MIXING BASIN/SPLIT BOX/FOUR PARALLEL FLOCCULATOR-SEDIMENTATION BASINS/ONE SEDIMENTATION BASIN DETENTION TIME AND FLOW-THROUGH VELOCITY

(Design Flow Rate - 30 MGD)

	Treatment Unit	Basin Dimension (LxWxD) (ft x ft x ft)	Basin Volume (gallons)	Detention Time (Minutes)	Flow-Through Velocity (fpm)
I.	Basin No. 1 (with three dividing walls)	203 x 209 x 15.75	4,998,325		
	A. Flocculator (FL) - All units in use	40 x 206 x 15.75	970,754	46	0.86
	1. FL No. 1A - one unit off-line	40 x 51.5 x 15.75	242,689	35	1.15
	2. FL No. 1B - one unit off-line	40 x 51.5 x 15.75	242,689	35	1.15
	3. FL No. 1C - one unit off-line	40 x 51.5 x 15.75	242,689	35	1.15
	4. FL No. 1D - one unit off-line	40 x 51.5 x 15.75	242,689	35	1.15
	B. Sedimentation Basin (SB) - All units in use	160 x 206 x 15.75	3,883,018	186	0.86
	1. SB No. 1A - one unit off-line	160 x 51.5 x 15.75	970,754	140	1.15
	2. SB No. 1B - one unit off-line	160 x 51.5 x 15.75	970,754	140	1.15
	3. SB No. 1C - one unit off-line	160 x 51.5 x 15.75	970,754	140	1.15
	4. SB No. 1D - one unit off-line	160 x 51.5 x 15.75	970,754	140	1.15
II.	Basin No. 2	175 x 209 x 13.91	3,805,511		
	A. Sedimentation Basin (SB)	175 x 209 x 13.91	3,805,511	183	0.96
	TOTAL DETENTION TIME				
	A. Flocculator				
	1. Both units in use			46	
	2. One unit off-line			35	
	B. Sedimentation Basin				
	1. Basin No. 1 (all units in use)			186	
	2. Basin No. 1 (one unit off-line)			140	
	3. Basin No. 1 (all units in use) → Basin No. 2			369	
	4. Basin No. 1 (one unit off-line) → Basin No. 2			323	