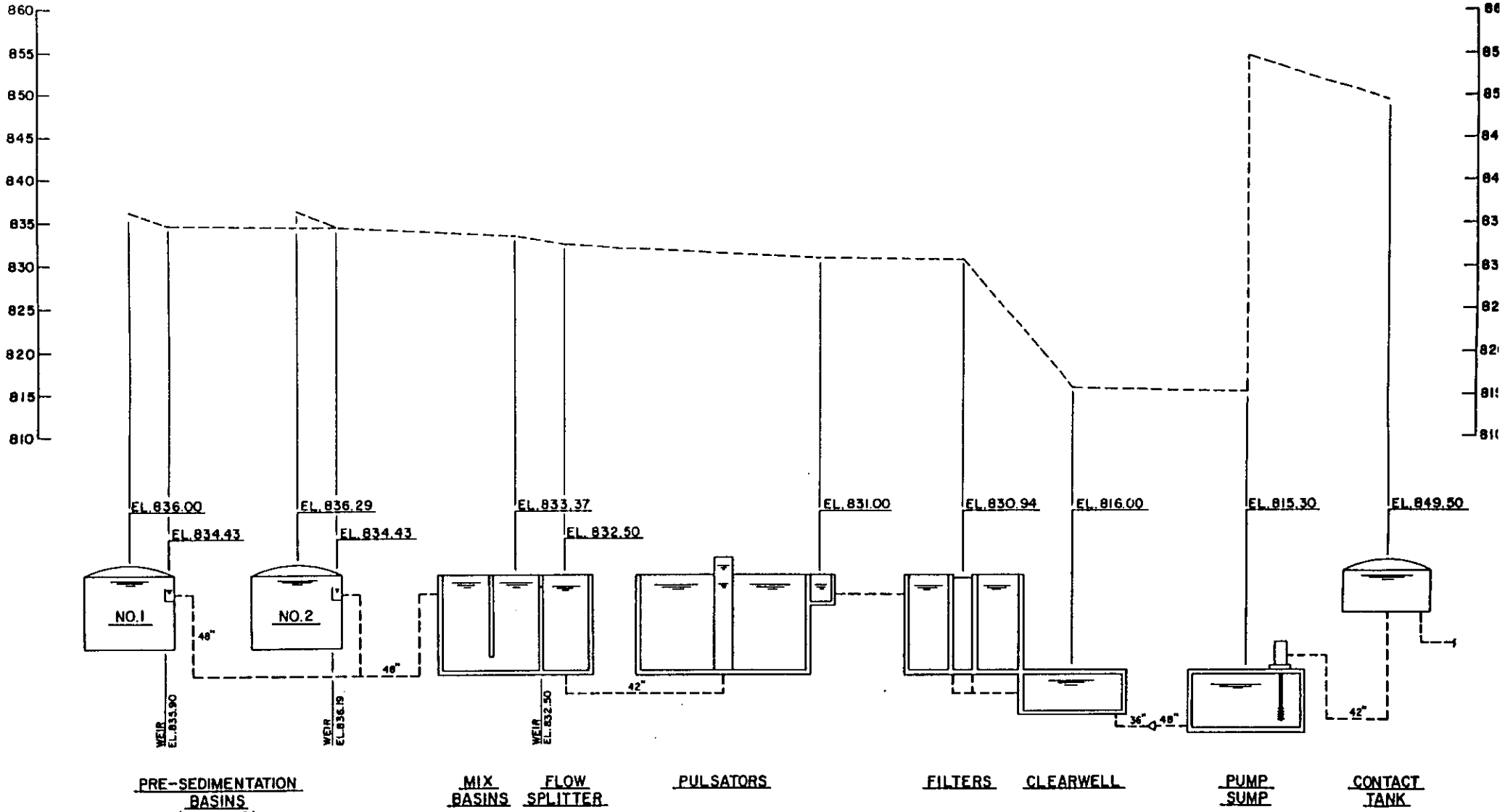

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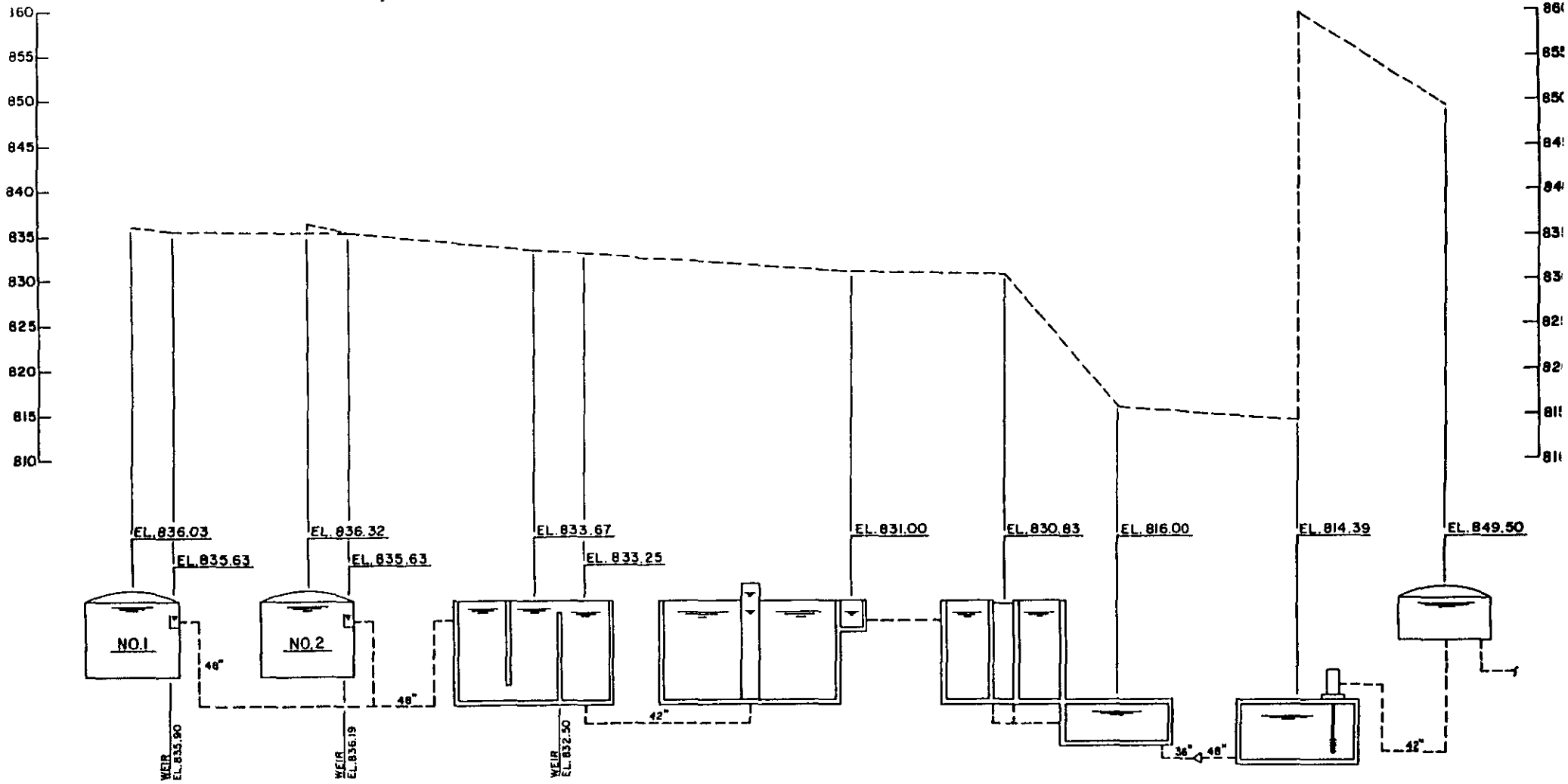
MISSOURI AMERICAN WATER CO.
ST. JOSEPH DISTRICT

HYDRAULIC PROFILE
PHASE 2 & 3

GANNETT FLEMING, INC. JULY, 19

EXHIBI



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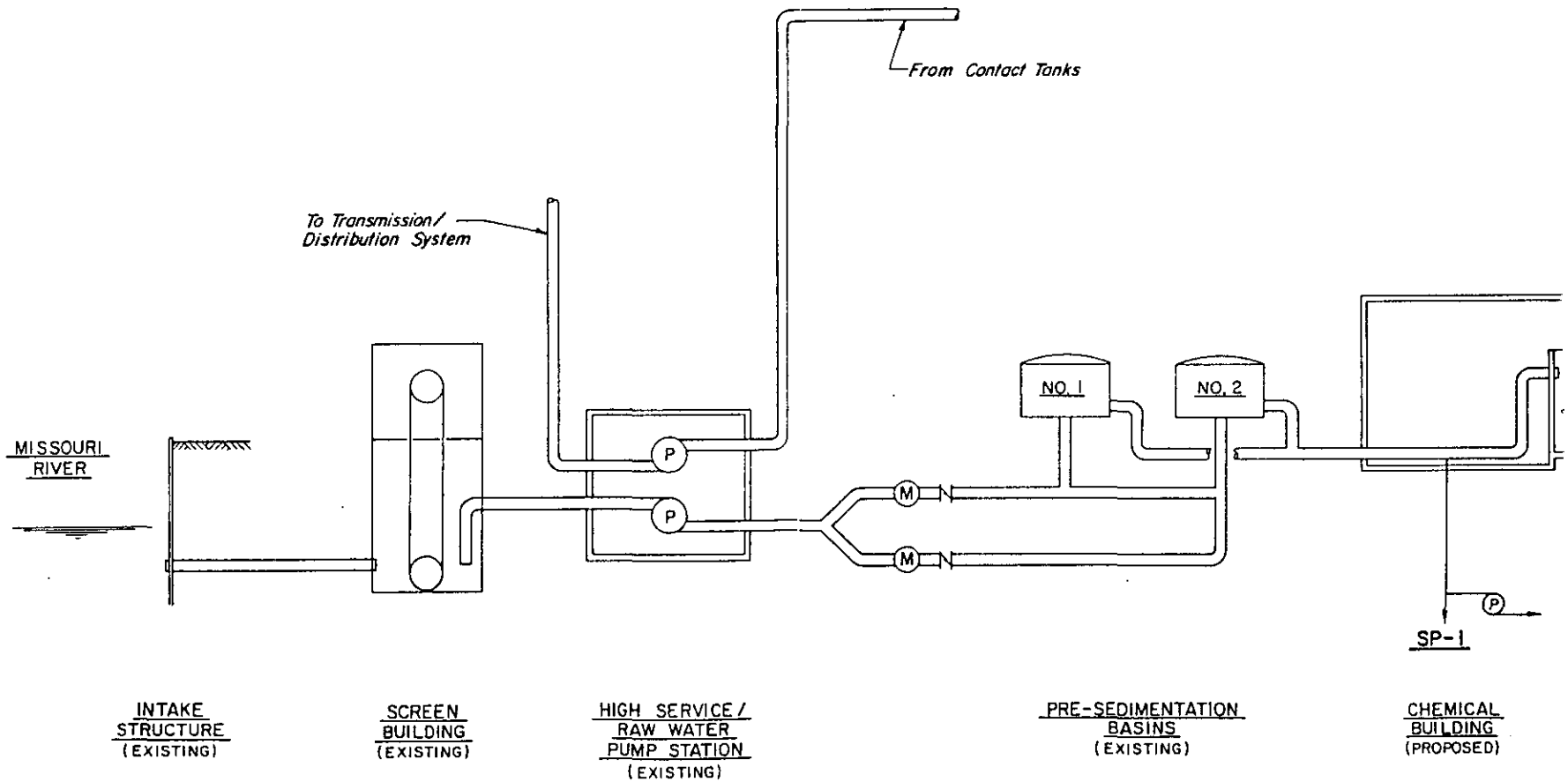
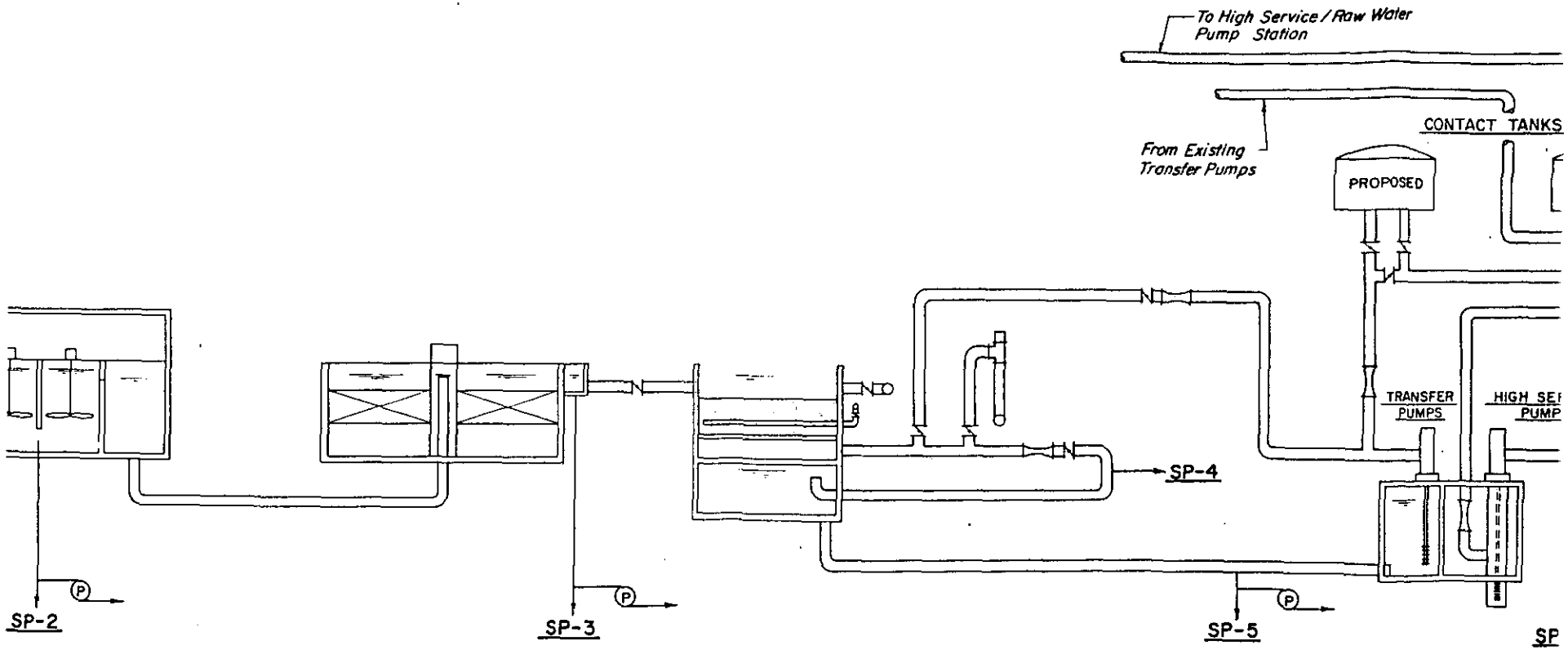
MISSOURI AMERICAN WATER CO.
ST. JOSEPH DISTRICT

HYDRAULIC PROFILE
PHASE 2&3

GANNETT FLEMING, INC. JULY, 19

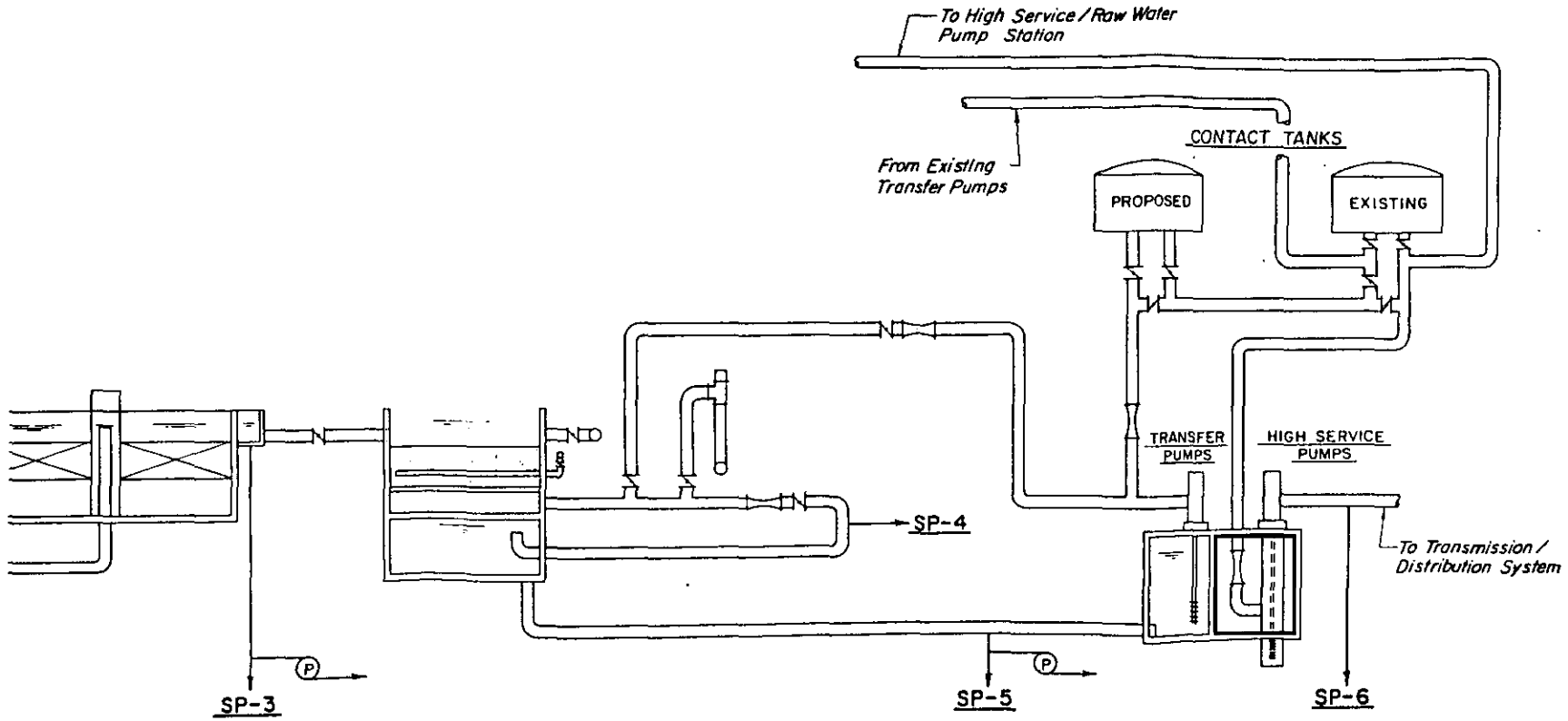
EXHIBI


From Contact Tanks
To Transmission/ Distribution System
NO. 1
NO. 2
P
P
M
M
P
MISSOURI RIVER
SP-1
INTAKE STRUCTURE (EXISTING)
SCREEN BUILDING (EXISTING)
HIGH SERVICE / RAW WATER PUMP STATION (EXISTING)
PRE-SEDIMENTATION BASINS (EXISTING)
CHEMICAL BUILDING (PROPOSED)



LEGEND

SP-1	PLANT INFLUENT (PIS)
SP-2	MIXED WATER (MWS)
SP-3	FILTER INFLUENT (FIS)
SP-4	COMBINED FILTER EFFLUENT (CFES)
SP-5	FINISHED WATER (FWS)
SP-6	PLANT EFFLUENT (PES)
(P)	SAMPLE PUMP TO LABORATORY



LEGEND

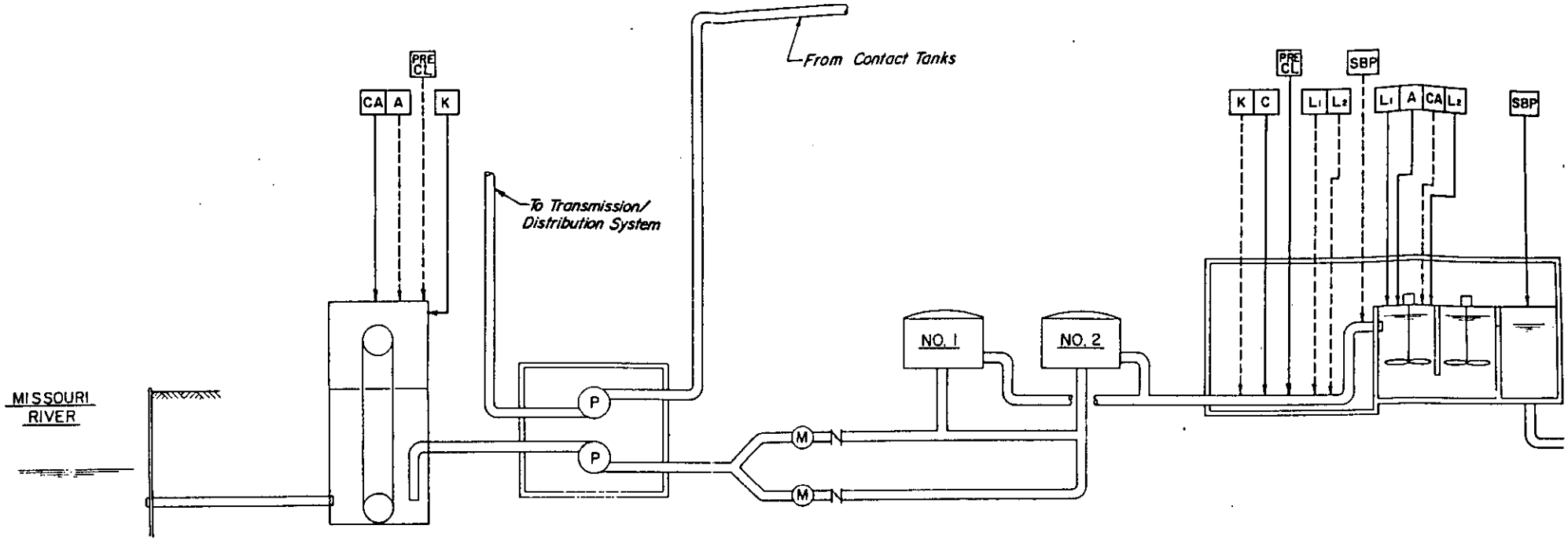
SP-1	PLANT INFLUENT (PIS)
SP-2	MIXED WATER (MWS)
SP-3	FILTER INFLUENT (FIS)
SP-4	COMBINED FILTER EFFLUENT (CFES)
SP-5	FINISHED WATER (FWS)
SP-6	PLANT EFFLUENT (PES)
(P)	SAMPLE PUMP TO LABORATORY

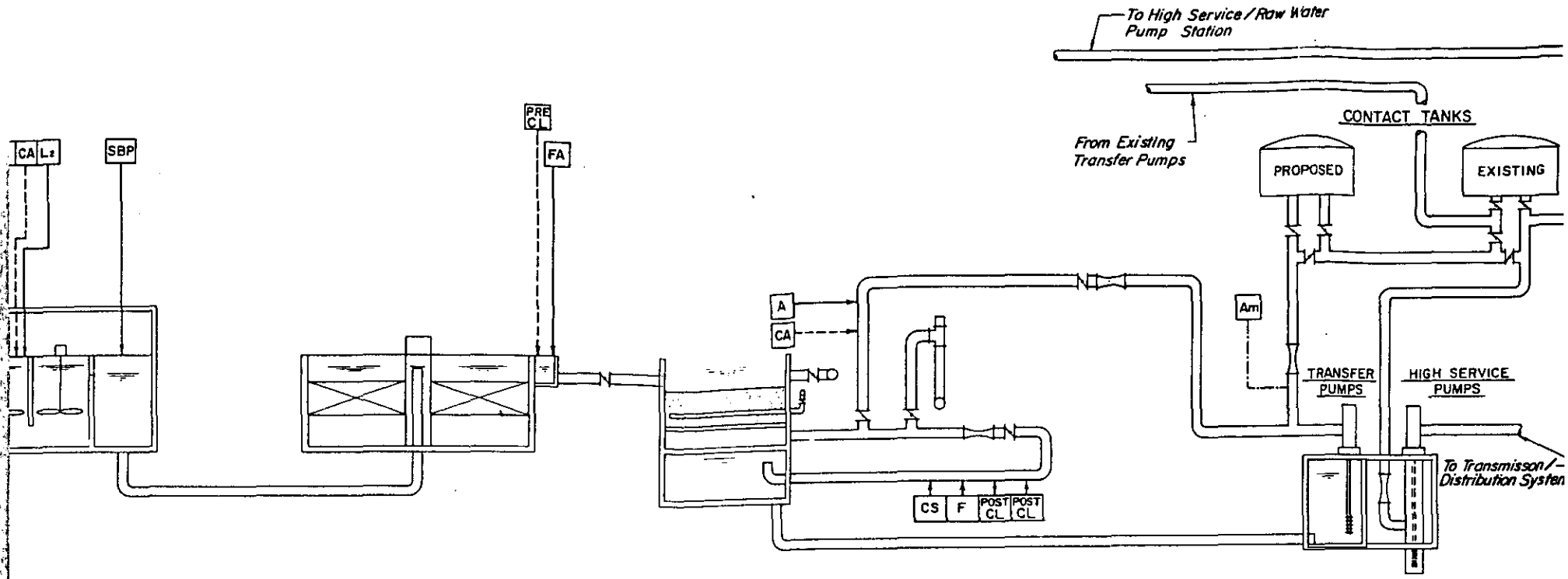
MISSOURI AMERICAN WATER CO.
ST. JOSEPH DISTRICT

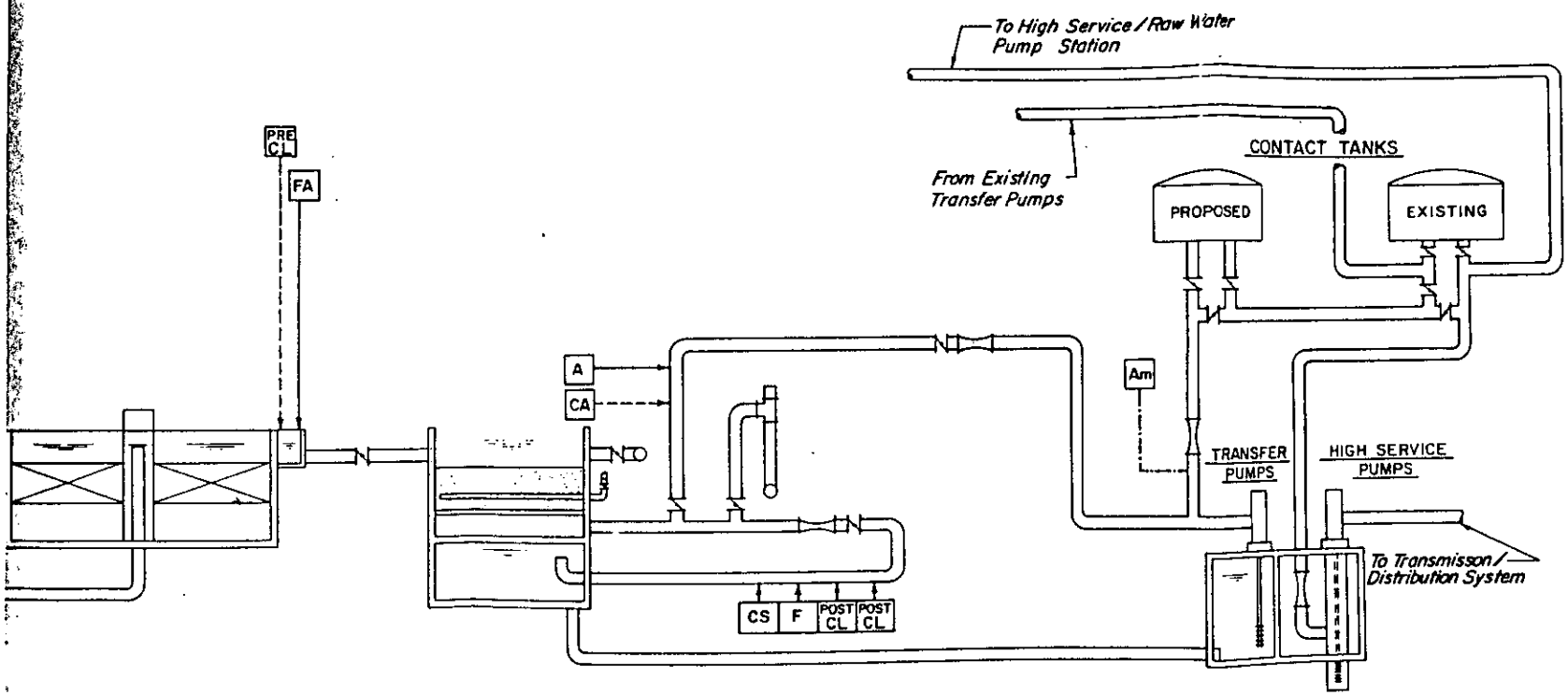
PROCESS SCHEMATIC
SAMPLE POINT LOCATIONS

GANNETT FLEMING, INC. JULY, 1993

EXHIBIT D


From Contact Tanks
To Transmission/
Distribution System
PRE CL
CA
A
K
PRE CL
SBP
K
C
L1
L2
L1
A
CA
L2
SBP
NO. 1
NO. 2
P
P
M
M
MISSOURI RIVER
INTAKE STRUCTURE (EXISTING)
SCREEN BUILDING (EXISTING)
HIGH SERVICE / RAW WATER PUMP STATION (EXISTING)
PRE-SEDIMENTATION BASINS (EXISTING)
CHEMICAL BUILDING (PROPOSED)
MIXER ROOM (PROPOSED)


To High Service / Raw Water Pump Station
From Existing Transfer Pumps
CONTACT TANKS
PROPOSED
EXISTING
CA
L₂
SBP
PRE CL
FA
A
CA
Am
TRANSFER PUMPS
HIGH SERVICE PUMPS
To Transmisson / Distribution System
CS
F
POST CL
POST CL
MIXER ROOM (PROPOSED)
PULSATORS (PROPOSED)
FILTERS / CLEARWELL (PROPOSED)
PUMP STATION (PROPOSED)



LEGEND

PRE-CHEMICALS

A	ALUM
C	CARBON
CA	COAGULANT AID POLYMER
FA	FILTER AID
L	LIME
Pre CL	Pre CHLORINE
K	POTASSIUM PERMANGANATE
SBP	SLUDGE BLANKET POLYMER

POST-CHEMICALS

Am	AMMONIA (FUTURE)
CS	CAUSTIC SODA
F	HYDROFLUOSILICIC ACID
Post CL	Post CHLORINE

FEED POINTS

——— PRIMARY

– – – – SECONDARY

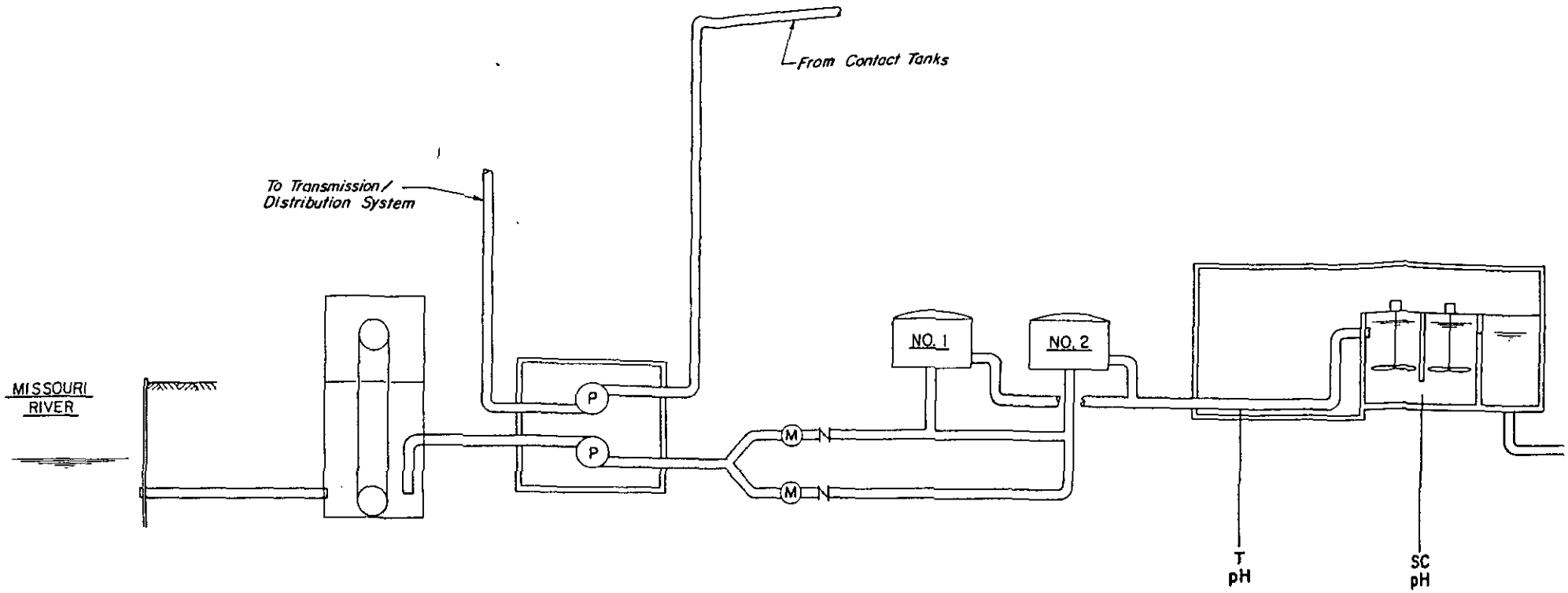
—·—·— FUTURE

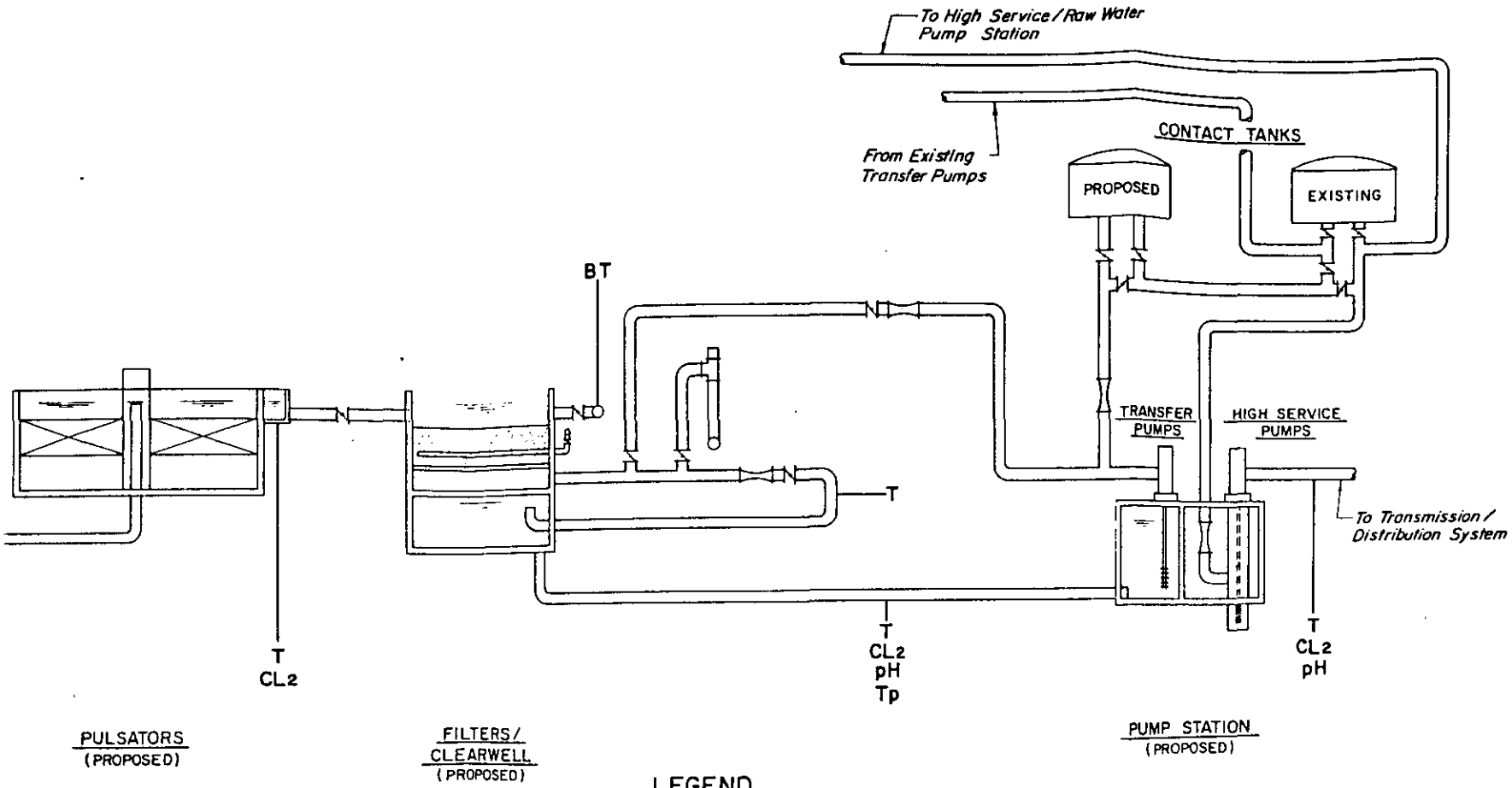
MISSOURI AMERICAN WATER CO
ST. JOSEPH DISTRICT

PROCESS SCHEMATIC
CHEMICAL FEED POINT LOCATIONS

GANNETT FLEMING, INC. JULY, 1993

EXHIBIT E


From Contact Tanks
To Transmission / Distribution System
MISSOURI RIVER
P
P
M
M
NO. 1
NO. 2
T
pH
SC
pH
INTAKE STRUCTURE (EXISTING)
SCREEN BUILDING (EXISTING)
HIGH SERVICE / RAW WATER PUMP STATION (EXISTING)
PRE-SEDIMENTATION BASINS (EXISTING)
CHEMICAL BUILDING (PROPOSED)
MIXER ROOM (PROPOSED)



LEGEND

T	TURBIDITY
pH	pH
CL2	CHLORINE RESIDUAL
SC	STREAMING CURRENT
Tp	TEMPERATURE
BT	BACKWASH TURBIDITY

MISSOURI AMERICAN WATER CO
ST. JOSEPH DISTRICT

PROCESS SCHEMATIC
ANALYTICAL INSTRUMENT
SAMPLE POINT LOCATIONS

GANNETT FLEMING, INC. JULY, 19

EXHIBI

APPENDIX A

CHEMICAL FEED SYSTEMS

MISSOURI-AMERICAN WATER COMPANY

ST. JOSEPH DISTRICT

ST. JOSEPH, MISSOURI

APPENDIX A
CHEMICAL FEED SYSTEMS

For

ST. JOSEPH

WATER TREATMENT PLANT

DESIGN MEMORANDUM

PRELIMINARY

AUGUST 1993

APPENDIX A

CHEMICAL FEED SYSTEMS

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PLANT FLOW & CHEMICAL FEED RANGES

Item	Min	Avg	Max
Flow, MGD	12	17	30
Liquid Alum - Normal Range, mg/l - High Range, mg/l	2.0 30.0	13.0	50.0 200.0
Chlorine - Pre, mg/l Chlorine - Post, mg/l Total	2.0 0.0 2.0	6.0 3.5 9.5	12.0 5.0 17.0
Hydrated Lime - Pre, mg/l	5.0	15.0	65.0
Cationic Polymer, mg/l	0.3	0.8	5.0
Blanket Polymer, mg/l	0.05	0.2	0.5
Filter Aid, mg/l	0.01	0.05	0.20
Hydrofluosilicic Acid (as F), mg/l	0.2	0.4	1.0
Powdered Activated Carbon, mg/l	5.0	10.0	30.0
Potassium Permanganate, mg/l	0.1	0.5	2.0
Caustic Soda, mg/l	2.0	6.0	15.0
Wastewater Conditioner Polymer (Future, drum), mg/l			
Ammonia (Future, outside tank), mg/l		2.4	4.5

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Primary Coagulant

a. Alum

Form - Bulk liquid
Weight - 5.48 lb/gal as alum
Feed Points - Primary: First stage mixer
- Secondary: Screen wet well

Feed Rate - ppm - Normal Range	2.0	13.0	13.0	50.0	50.0
lb/day	200	1,843	3,253	7,089	12,510
gpd	36.5	336	594	1,294	2,283
gph	1.5	14	25	54	95
Feed Rate - ppm - High Range	30.0	100.0	100.0	200.0	200.0
lb/day	3002	14,178	25,020	28,356	50,040
gpd	548	2,587	4,566	5,174	9,131
gph	22.8	108	190	216	380

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

b. Ferric Chloride (Alternate to Alum)

Form - Bulk liquid
3.37 lb/gal. active chemical
Weight - ____ lb/gal.
Feed Points - Primary: First stage mixer
- Secondary: Screen wet well

Feed Rate - ppm - Normal range	2.0	8.0	8.0	30.0	30.0
lb/day	200	1,134	2,002	4,253	7,506
gpd	59.4	337	594	1,262	2,227
gph	2.5	14	25	53	93

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

CHLORINE

a. Pre-Chlorine

Form - 99.8% liquid in ton cylinders
Weight - 91.7 lb/cu. ft. (liquefied gas under pressure)
Feed Points - Primary: First stage mixer
- Secondary: a. Screen wet well
b. Second stage mixer

Feed Rate - ppm	2.0	6.0	6.0	12.0	12.0
lb/day	200	851	1,501	1,701	3,002
lb/hr	8.3	35.4	62.5	71	125

b. Post-Chlorine

Form - 99.8% liquid in ton cylinders
Weight - 91.7 lb/cu.ft. (liquefied gas under pressure)
Feed Point - Clearwell influent

Feed Rate - ppm	0	3.5	3.5	5.0	5.0
lb/day	0	496	876	709	1,251
lb/hr	0	20.7	36.5	29.5	52

c. Total Chlorine

Feed Rate - ppm	2.0	9.5	9.5	17.0	17.0
lb/day	8.3	1,347	2,377	2,410	4,253
lb/hr	8.3	56	99	100	177

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Lime (Hydrated)

Form - Dry - bulk
Weight - 25 - 35 lb/cu.ft. (28 lb/cu.ft. for purposes of sizing silo and feeder).
Feed Point - First stage mixer

Feed Rate - ppm	5.0	15.0	15.0	65.0	65.0
lb/day	500	2,127	3,753	9,216	16,263
lb/hr	21	89	156	384	678
cf/hr	0.75	3.18	5.57	13.7	24.2

Cationic Polymer Coagulant Aid

Form - Liquid Bulk
- Design based on 0.1 lb/gal batch mix
Weight - 8-12 lb/gal. (varies with chemicals); (Use 8 lb/gal to size storage and max feed; 12 lb/gal to size min feed).
Feed Point - Screen wet well

Feed Rate - ppm	0.3	0.8	0.8	5.0	5.0
lb/day	30	113	200	709	1,251
gpd	300	1,134	2,002	7,089	12,510
gph	12.5	47	83	295	521
gpd neat	1.25	14.13	25	88.6	156
gph neat	0.05	0.59	1.04	3.69	6.5

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Blanket Polymer

Form - Liquid-drum
- Design based on 0.05 lb/gal batch mix

Weight - 8-12 lb/gal (varies with chemicals) (Use 8 lb/gal to size storage and max feed; 12 lb/gal to size min feed).

Feed Point - Pulsator influent

Feed Rate - ppm	0.05	0.2	0.2	0.5	0.5
lb/day	5.0	28.4	50	71	125
gpd	100	567	1,000	1,418	2,502
gph	4.2	23.6	41.7	59	104
gpd neat	0.42	3.55	6.25	8.875	15.6
gph neat	0.017	0.148	0.260	0.370	0.65

Filter Aid Polymer

Form - Liquid-drum
- Design based on 0.05 lb/gal batch mix

Weight - 8-12 lb/gal (varies with chemicals); (Use 8 lb/gal to size storage and max feed; 12 lb/gal to size min feed).

Feed Point - Filter influent

Feed Rate - ppm	0.01	.05	.05	0.2	0.2
lb/day	1.0	7.0	12.5	28	50
gpd	20	142	250	560	1,000
gph	0.83	5.9	10.4	24	42
gpd neat	0.08	0.88	1.56	3.5	6.25
gph neat	0.003	0.036	0.065	0.146	0.26

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Hydrofluosilicic Acid (as F)

Form - Bulk Liquid
- 1.76 lb/gal active chemical
Weight - 10.1 lb/gal @ 22% solution
Feed Points - Clearwell influent

Feed Rate - ppm	0.2	0.4	0.4	1.0	1.0
lb/day	20	56.7	100	142	250
gpd	11.4	32.2	57	81	142
gph	0.48	1.34	2.37	3.36	5.9

Powdered Activated Carbon

Form - Bulk slurry. Based on 1.0 lb/gal slurry.
Dry Weight - 12 lb/cu.ft.
Feed Point - First stage mixer.

Feed Rate - ppm	2.0	10.0	10.0	30.0	30.0
lb/day	200	1,418	2,502	4,253	7,506
gpd	200	1,418	2,502	4,253	7,506
gph	8.3	59	104	177	313

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Potassium Permanganate

Form - Dry crystalline
Weight - 90 lb/cu.ft
Dilution - 0.25 lb/gal
Feed Points - Primary: None
- Secondary: a. First stage mixer
b. Screen wet well

Feed Rate - ppm	0.1	0.5	0.5	2.0	2.0
lb/day	10	71	125	284	500
lb/hr	0.4	3.0	5.2	11.8	20.9
gph	1.6	12.0	20.8	47.2	83.6

Caustic Soda

Form - Bulk liquid, 50% solution, 50°F
- 6.39 lb/gal as NaOH
Weight - 12.78 lb/gal
Feed Point - Clearwell influent

Feed Rate - ppm	2.0	6.0	6.0	15.0	15.0
lb/day	200	850	1,501	2,127	3,753
gpd	31.5	133	235	333	588
gph	1.3	5.5	9.8	13.9	24.5

CHEMICAL FEED REQUIREMENTS

Chemical	Min Dose Min Flow	Avg Dose		Max Dose	
		Avg Flow	Max Flow	Avg Flow	Max Flow
WTP Production (MGD)	12	17	30	17	30

Wastewater Conditioner Polymer(s) (Future)

Form - Liquid-drum
- Design based on 0.05 lb/gal batch mix.

Feed Point - Sludge drying bed influent pipe

Feed Rate - ppm					
lb/day					
gpd					
gph					
gpd neat					
gph neat					

Ammonia (Future)

Form -
Weight -

Feed Rate - ppm					
lb/day					
gpd					
gph					

CHEMICAL STORAGE REQUIREMENTS

Chemical	Units	31 days @ Avg Dose Max Flow	31 days @ Max Dose Avg Flow	5 days @ Max Dose Max Flow	Minimum Delivery	Min. Storage[1] Required	Days Supply @ Avg. Dose Avg. Flow
Alum	lb-dry gal	100,831 18,400	879,036 160,408	500,400 91,314	21,600 4,000	171,720 31,394	93.3
Chlorine (ton containers)	lb	73,684	74,718	42,534	26,000[2]	40,000	29.7
Hydrated Lime (bulk)	lb	116,343	285,687	162,630	46,000	94,789	44.6
Cationic Polymer (bulk)	lb gal	6,205 744	21,976 2,635	12,510 1,500	46,000 5516	49,753 5,966	438.6
Blanket Polymer	lb	1,551	2,198	1,251	500	875	30.8
Filter Aid	lb	388	879	500	500	650	92.9
Hydrofluosilicic Acid (bulk)	gal	1,762	2,497	1,422	4,000	4,426	137.5
Powdered Carbon (bulk)	lb	77,562	131,843	75,060	46,000	68,518	48.3
Potassium Permanganate	lb	3,878	8,790	5,004	1,320[3]	2,821	39.8
Caustic Soda (bulk)	lb gal	46,537 7,283	65,928 10,317	37,530 5,873	20,000 3,100	31,259 4,862	36.7
Wastewater Polymer (future)	lb				500		
Ammonia (future)	lb						

(1) 3 days of maximum chemical dose at maximum flow plus minimum delivery, or minimum delivery plus 150%, whichever is greater.

(2) Truckload delivery is 13 cylinders chlorine.

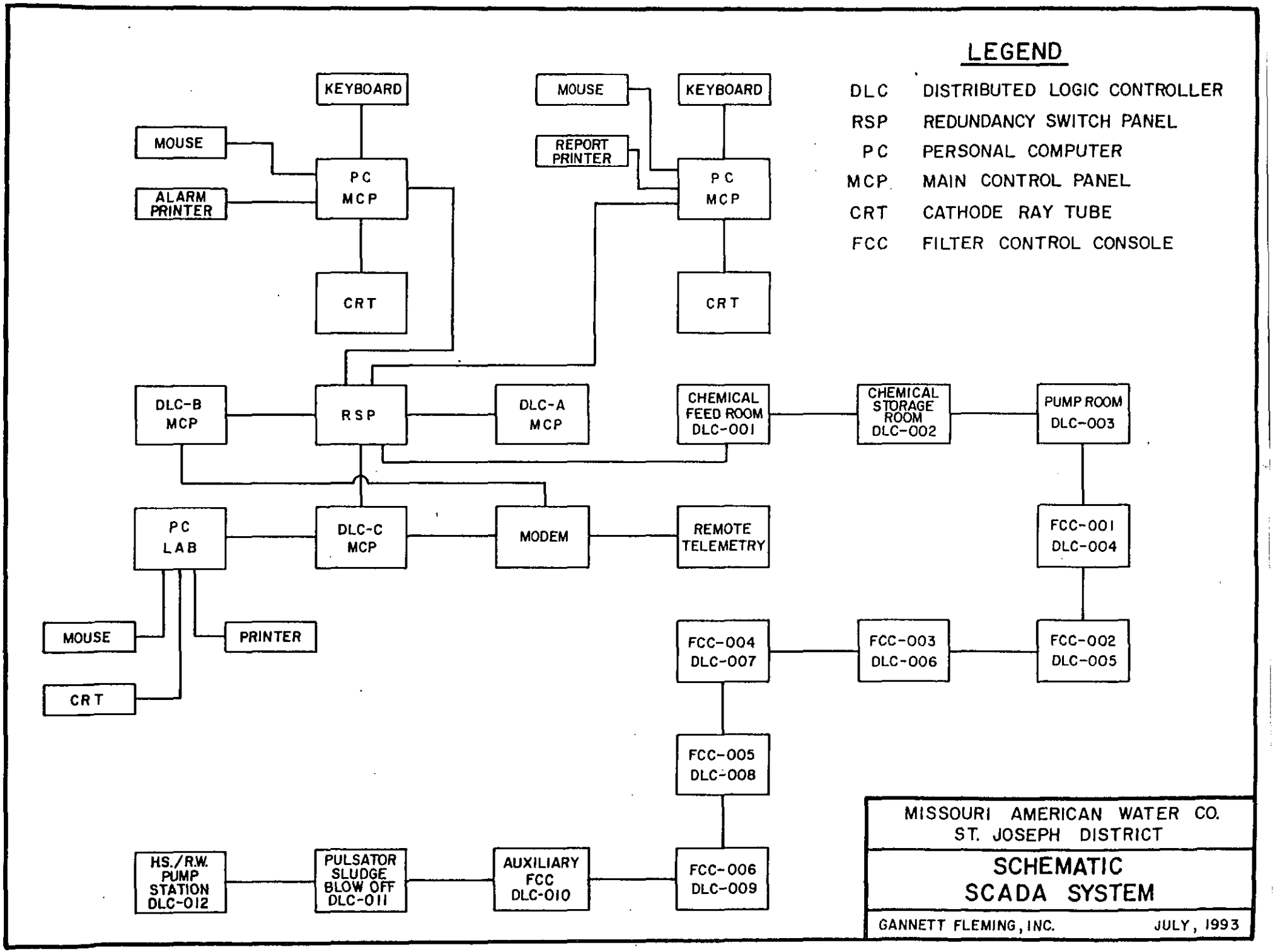
(3) Four barrels.

CHEMICAL TANK SIZING

Chemical	Day Tank	Storage
Alum		4 storage tanks @ 10,000 gal each
Chlorine	---	16 ton cylinders plus 4 on scales
Lime	Volumetric feeder ___ gal mix tank	Bulk silo 13' dia. x 42' H (25.5' SSH) (100,000 lbs @ 28#/ft^3)
Polymer		1 storage tank @ 6,400 gal
Blanket Polymer		Floor area for 1 pallet @ 4' x 4'
Filter Aid		Floor area for 1 pallet @ 4' x 4'
Hydrofluosilicic Acid		1 storage tank @ 6,400 gal
Powdered Carbon	---	Bulk silo 13' dia. x 52' H (38' SSH) (70,000 lbs @ 12#/ft^3)
Potassium Permanganate	Volumetric feeder ___ gal mix tank	Floor area for 2 pallets @ 4'x 4' (9 - 330 lb drums)
Caustic Soda		2 storage tanks @ 6,400 gal each
Spare Tank	___	1 storage tank @ 6,400 gal
Wastewater Polymer (Future)		
Ammonia (Future)		

APPENDIX B

INSTRUMENTATION


LEGEND
DLC DISTRIBUTED LOGIC CONTROLLER
RSP REDUNDANCY SWITCH PANEL
PC PERSONAL COMPUTER
MCP MAIN CONTROL PANEL
CRT CATHODE RAY TUBE
FCC FILTER CONTROL CONSOLE
KEYBOARD
MOUSE
ALARM PRINTER
PC MCP
CRT
MOUSE
KEYBOARD
REPORT PRINTER
PC MCP
CRT
DLC-B MCP
RSP
DLC-A MCP
CHEMICAL FEED ROOM DLC-001
CHEMICAL STORAGE ROOM DLC-002
PUMP ROOM DLC-003
PC LAB
DLC-C MCP
MODEM
REMOTE TELEMETRY
FCC-001 DLC-004
MOUSE
PRINTER
CRT
FCC-004 DLC-007
FCC-003 DLC-006
FCC-002 DLC-005
FCC-005 DLC-008
HS./R.W. PUMP STATION DLC-012
PULSATOR SLUDGE BLOW OFF DLC-011
AUXILIARY FCC DLC-010
FCC-006 DLC-009
MISSOURI AMERICAN WATER CO.
ST. JOSEPH DISTRICT
SCHEMATIC
SCADA SYSTEM
GANNETT FLEMING, INC.
JULY, 1993

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13610 - PROCESS CONTROL INSTRUMENTATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section covers the furnishing and installation of a complete instrumentation system for the St. Joseph Missouri Water Treatment Plant. Since the project is to be built in phases, items indicated in the following schedules shall be provided for the respective phase. In general Phase I consists of the construction of a new chemical and process building; Phase II consists of construction of a new clearwell, transfer pump station and two filters; and Phase III consists of construction of four new filters and installation of a new high service pump. Programming of the plant control system shall be reflective of instruments and control requirements for each phase.

Primary devices include pressure switches and cells, probes, magnetic flow meters and venturi tubes. Transmitters include electronic type for level, turbidity, and flow. Receivers include electronic indicators. Process indicators, controllers, control switches and status lights are included on the panels.

Controls for the plant shall be provided through a Supervisory Control and Data Acquisition System (SCADA). The control system shall be a distributed logic control (DLC) based system. Spare modules shall be provided for easy replacement of the Central Processing Unit (CPU) or processor modules and input/output (I/O) plug-in modules. All interconnections between modules in the same rack shall be via backplane wiring or a mother board. At least ten (10) per cent, but not less than four (4) analog and eight (8) digital, spare I/O shall be furnished at each DLC rack.

All analog, control, status and alarm signals required for alarm, display and report generation shall be transmitted to the DLC. The man-machine interface (CPU) computer system shall be a multi-tasking micro-computer (PC) based system, with 20-inch VGA monitor and dual printers.

B. The Specifications cover the hydraulic control systems for raw water rate of flow, filter level, filter rate of flow, filter backwash rate of flow, transfer and high service pumpage. Plant flow control shall be set from the CPU.

C. Electrical work, unless specifically noted to be included under this Section, is to be provided under Division 16000.

1.02 QUALITY ASSURANCE

A. The drawings and specifications are based on instrumentation equipment manufactured by Bristol Babcock. Any changes to the structure, piping,

electrical work, etc., required for other accepted substitute manufacturers shall be borne by the Contractor in accordance with Section 01630 of these Specifications. The Contractor shall submit drawings to the Engineer for approval, showing changes in the equipment, piping, structure and electrical work.

B. The instrumentation equipment and computer interface systems shall be the standard products of a manufacturer who has been regularly engaged in the successful production of high quality equipment and systems of the type specified for at least 10 years, has supplied such instrumentation equipment for at least five years of the ten year period, and has at least three installations in successful operation for at least five years.

C. All equipment included under this Section, regardless of manufacture, shall be supplied by:
- Bristol Babcock, Watertown, CT
- Industrial Controls System of Sandston, VA
The supplier shall assume complete system responsibility for the adequate and proper operation of all equipment furnished regardless of original source or manufacture.

In accordance with the Information for Bidders - Products Included in Base Bid, the Contractor shall indicate in the space provided on the Proposal form, the name of the supplier who will supply and be responsible for the instrumentation system. This supplier shall be the one the Contractor uses to perform work under this Section of the Contract Documents.

If a Contractor proposes to use a supplier other than the one named above, the supplier must be submitted as a substituted item in accordance with the requirements of Section 01630 - Substitutions and not used in the base bid. The supplier proposed under the substituted item of the Proposal shall submit a project management plan to the office of the Engineer as described under Paragraph 1.03 Submittals, F. of this section of the Specifications prior to bid opening.

D. The following codes and standards shall apply:
1. IEEE - Institute of Electrical and Electronic Engineers
2. ISA - Instrument Society of American Standards
3. ANSI - American National Standards Institute
4. AWWA - American Water Works Association Standards
5. JIC - Joint Industrial Council
6. OSHA - Occupational Safety and Health Act
7. NEC - National Electrical Code
8. NSF - National Sanitation Foundation

E. Any special standard or code requirements of the State, County or local regulatory body and other regulatory agency shall also apply herein. Where a conflict arises between codes, the one containing the more stringent requirements as determined by the Engineer shall apply.

F. Field test all equipment specified under this Section to the full satisfaction of the Engineer and so that each part and all components

together function in the manner intended by the functional descriptions specified herein.

G. The intent of the Specifications and Drawings covering the instrumentation is to outline the design concept and control mode of the instrumentation system. It also defines the various functions which are to be measured, monitored, and controlled. The various types of instruments and controls have been selected as best for the intended service and, where practical, the name and model number of a particular manufacturer has been given. The reason for mentioning a particular manufacturer's item is to establish a minimum standard of quality, as determined by the Engineer, below which the equipment will not be acceptable.

H. No attempt was made on the Drawings or in the Specifications to list all of the accessory hardware, such as power supplies, transformers, relays, current isolators, contact blocks, etc., which may be required to augment the instrumentation equipment. Nevertheless, furnish all these accessories, where required, to the degree that the connecting wiring between terminal blocks on the panels and transmitters is all that is required to complete the instrumentation system.

I. Store all equipment, instruments, and accessories specified in this Section, which are delivered to the project site prior to the time the Contractor is ready to install them, as specified in Section 01600. Verify from the instrumentation supplier the maximum and minimum temperature and maximum relative humidity for storing the equipment, and conform to the supplier's requirements. In any case, the minimum storage requirements will be those specified in Section 01600 and the minimum storage temperature shall not be less than 50 degrees F. Protect the equipment from humid conditions which might cause corrosion of the electrical and electronic parts of the equipment. Failure to store equipment in the specified or approved manner shall be sufficient reason for not accepting the equipment, regardless of the outside appearance or warranty of the manufacturer. Protect all electronic equipment from a dusty environment by sealing the equipment in plastic, etc.

J. All control and instrument panels shall be prewired and, where practical, the instruments shall be premounted before delivery to the job site. Where it is not practical to premount the instrument, the Contractor shall be responsible for the work of mounting and wiring the instrument at the job site. Any field modifications in equipment or in wiring required shall be the responsibility of the Contractor. All field work shall be performed under the prevailing labor conditions.

K. No form of energy shall be turned on to any part of the instrumentation system prior to receipt by the Engineer of a certified statement of approval of the installation from the Contractor, containing his supplier's authorization for turning on energy to the system.

L. Provide the supervisory service of a factory-trained serviceman, who is specifically trained on the types of equipment herein specified to assist the Contractor during construction in the location of sleeves, methods of installing conduit and special cable; mounting, piping, and

wiring of one of each type of device; and the methods of protecting all of the equipment prior to placing it into service.

M. Upon completion of the installation, provide the services of the above serviceman for adjustment, calibration, and start-up of the equipment. After acceptance of the Final Performance Test, provide the above serviceman for a minimum of five 8-hour days to instruct the plant operators in the operation and maintenance of the control systems. The Contractor shall provide sufficient service to place the complete instrumentation system in satisfactory operation, as determined by the Engineer, and maintain it that way for one year.

N. Provide Six (6) manweeks of training at the factory for maintenance and supervisory personnel. One week of on-site training shall be provided for operators.

1.03 SUBMITTALS

A. Submit in accordance with Section 01300 and the Special Conditions: manufacturers' literature, illustrations, shop drawings, specifications and engineering data including design performance, material, weights, dimensions and wiring diagrams.

B. Prepare and submit comprehensive as-built record drawings for the instrumentation work performed under this Section. Drawings shall include the following in addition to all requirements of Section 01300.
   1. Control wiring diagrams and loop drawings with terminal numbers and all control devices identified. Loop drawings shall be one per sheet. Sheets shall be 8½ x 11-inches or 11 x 17-inches in size.
   2. Drawings showing sizes and locations of all equipment and their control locations.
   3. Record drawings for the Panels shall contain internal and external ladder and point to point wiring schematics, with identified terminal numbers, relays and other control devices. Control electrical diagrams shall be drawn with circuitry arranged in functional sequence on ladder type diagrams. Each horizontal line on the ladder diagram shall be assigned a number which shall be written to the left or right of the ladder. Relay coils shall be drawn on the right side of the ladder. The line numbers on which the relay contacts appear shall be shown on the right of each coil. A normally closed contact shall be designated by drawing a diagonal line through the contact. Timed contacts shall be designated by letter "T" under the line number. Instrument logic diagrams and schematics shall be prepared using ISA 55.1, IEEE 315 and 315A, and NEMA standard symbols and identification letters.

C. Submit in accordance with Section 01730 an operation and maintenance manual for all equipment furnished under this section.
   1. The contractor shall provide a section in the O&M manual which assembles the individual maintenance and lubrication requirements for each instrumentation device or component into a single listing. A sample maintenance and lubrication schedule is contained in Appendix A.
   2. The contractor shall provide a section in the O&M manual which assembles all manufacturer recommended and contractor furnished

spare parts into a single listing. This listing will provide the names and phone numbers of supplier from which the owner can obtain replacement parts. A sample maintenance and lubrication schedule is contained in Appendix A.

3. Submit an operations manual for the micro processor based control and monitoring system describing in non-technical language the operation and software configuration for the keyboard, CRT display and printer. Functional flow diagrams shall also be provided describing pictorially each function. Diagrams shall be submitted on 8½ x 11 or 11 x 17 paper.

D. Submit in accordance with Section 01400, a manufacturer's installation certificate.

E. Submit a description of the control system for the raw water rate-of-flow control, filter level control, filter effluent rate-of-flow control, filter backwash and backwash rate-of-flow control, and the pacing of the chemical feed systems, blower control, high service and transfer pump control. Submit flow charts for the filter backwash control sequence including provisions for fault conditions and stop and reset conditions.

F. If the contractor offers a substituted item for using an instrumentation supplier other than one of the named suppliers, the substitute supplier shall submit a detailed project management plan to the office of the Engineer prior to bid opening.

1. The plan shall include staffing and resumes of the project management team assigned to this project. The supplier's project team shall include a project manager, who will be the key contact person. The team shall include a project site supervisor, who will provide on site assistance to the Contractor during installation, start-up and training. The project site supervisor shall be responsible for starting up the complete system and providing on site training of the Owner's supervisors, operators and service technicians.
2. The plan shall include a reference list of at least three of its water treatment plant control installations, including the name and location of the plant, the name and location of the Engineer, and the name and telephone number of at least one member of the plant supervisory personnel completely familiar with the installation and operation of the system.
3. The plan shall include a scope letter identifying the instrument manufacturers and series model number of each instrument and piece of equipment the supplier intends to use on the project.

G. A meeting shall be scheduled within thirty (30) days of the award of the Contract to coordinate all aspects of the design, fabrication, delivery, installation and start-up of the instrumentation system. In attendance shall be representatives of the Instrumentation manufacturer, Contractor and Owner. Subsequent meetings shall be scheduled, as required, to assure timely completion and start-up of this portion of the project. Meetings will be held at the office of Missouri-American Water Company, 1003 East Maartens Drive, St. Joseph, Missouri 64506.. The following items as a minimum will be discussed.

1. Equipment shop drawing submittal schedule

2. Wiring diagrams and loop drawing submittal schedule
3. Raw water rate of flow program submittal schedule
4. Filter Influent level/rate of flow program submittal schedule
5. Backwash program submittal schedule
6. SCADA screen and report submittal schedule
7. Pump Control program submittal schedule
8. Equipment delivery schedule, identifying long lead time, imbedded and in-line items
9. Factory test procedures
10. Calibration, field testing and start-up schedules

H. A factory performance test, witnessed by the Owner and the Engineer, shall be performed prior to shipment of the SCADA system. Test shall demonstrate that all I/O's are provided for at each DLC and termination panel and that communication of all data flows through system between DLC's and central processing unit. Test shall demonstrate backwash program and all computer control functions. Test shall also demonstrate graphic displays, report generation and alarm function of system.

1.04 JOB REQUIREMENTS

A. Instrumentation Requirements
1. All instruments and devices furnished under this item, except two-wire transmitters or as otherwise specified, shall be suitable for operation on nominal 120 volt, 60 Hz, single phase power sources.
2. The electronic signal referred to throughout these Specifications shall be 4 to 20 mAdc unless otherwise noted. Signal isolation shall be furnished for the input of each receiver where an analog signal is transmitted to more than one receiving device in an analog control loop or an alarm loop, in accordance with ISA Standard S50.1.
3. Signal alarm switches and meter relay switches shall be adjustable over the full range and shall be front set.
4. All instruments furnished for front panel mounting shall be suitable for flush mounting, vertical or angle mounted as required by panel design and shall have black satin finish cases.
5. All instruments shall return to normal operation upon restoration of power after a power failure.
6. An internal or an attached external "On-Off" disconnect switch shall be provided for each field located instrument or transmitter requiring 120-volt electric power connections. This shall be furnished so that each piece of field located equipment can be electrically isolated for repair and maintenance without shutting down the power at a power distribution panel.
7. All instruments shall be provided with transient voltage surge suppressors (TVSS) on both power and instrument signal lines. Panels shall be provided with TVSS on power and on each instrument signal line connected to external devices.
8. System shall be grounded in accordance with the manufacturers recommended grounding requirements, and in accordance with details shown on Drawings for Electrical Work. Contractor shall include all costs with his bid for grounding required by his equipment and not required under Division 16000.

B. System Requirements
   1. It shall be the system supplier's responsibility to furnish a complete and functional integrated process measurement and control system and all devices necessary to interface to the SCADA system.
   2. Systems integration responsibility shall include review of all appropriate drawings and specification sections for this entire project. This shall include review of specifications for all mechanical equipment including pumps, valves, blowers, analytical instruments, chemical storage and feed equipment, electrical contract drawings and specifications, and any other equipment interfacing to the instrumentation and computer systems, as required to provide necessary point-to-point wiring schematics and compliance with the functional requirements of these Specifications.
   3. All special cables, such as fiber optic cable, co-axial cable, or sensor/transmitter specialty interconnection wiring, shall be furnished by the system supplier for installation by the Electrical Contractor, under the direction of the system supplier.

C. Instrument and Valve Numbering Schedule
   1. A numbering system has been used in the Design Criteria Equipment Tables to identify individual equipment, valves, or systems. Each number is prefixed by letters denoting the type of equipment and function. Each number consists of three (or four) digits; the first digit indicates general location within the process; the second indicates the general function of the equipment; and third (or third and fourth) digit(s) denotes the number of individual process units.
   2. The standard numbering system for instruments is as follows:
      a. First digit-location
         0) Miscellaneous
         1) Raw Water
         2) Clarifiers
         3) Filters
         4) Air Wash
         5) Backwash
         6) Plant Support and Clearwell
         7) Finished Water and Distribution System
         8) Wastewater
         9) Chemical Storage and Containment
      b. Second digit-function
         0) Miscellaneous
         1) Flow
         2) Pressure
         3) Loss-of-Head
         4) Level
         5) Position
         6) Turbidity
         7) pH or other water quality
         8) Time
         9) Alarm/Status
      c. Third digit-unit
         0) Master or one of one
         1) Filter No. 1, Pump No. 1, etc.
         2) Filter No. 2, Pump No. 2, etc.

3) Filter No. 3, Pump No. 3, etc.
4) Filter No. 4, Pump No. 4, etc.

3. The standard numbering system for valves is as follows:
   a. First digit-location (same as instruments)
   b. Second digit-function
      0) Miscellaneous
      1) Flow Control
      2) Influent
      3) Effluent
      4) Air Wash
      5) Backwash
      6) Rinse
      7) Waste
      8) Pressure/Level Control
      9) Pump Control
   c. Third digit-unit (same as instruments)
4. Instrument tag identification
   a. The instrument tag identification letters shall follow the standard established by ISA - S5.1 Instrument Symbols and Identification, unless otherwise noted.

Letter	First		Second	Third	
Letter Designation	Variable	Modifier	Passive Function	Output Function	Modifier
A	Analysis		Alarm		
C				Control	
D		Differential			
E	Voltage (EMF)		Primary Element		
F	Flow Rate	Fraction (Ratio)			
H	Hand (Manual)				High
I	Current (Electrical)		Indicate		
J	Power				
K	Time			Control Station	
L	Level		Light		Low
N					Normal
P	Pressure (Head)				
Q	Quantity or Event	Integrate (TOTALIZE)			
R			Record (Print)		
S	Speed (Frequency)				
T	Temperature			Transmit	
V				Valve	
Y				Relay or Compute	
Z	Position			Drive or Actuate	

1.05 DESIGN CRITERIA

A. Treatment Plant Control Concept

1. Raw Water Flow control

a. Raw water for the plant will be obtained from the Missouri River using one of two intake/pump stations, or combination of these stations. The primary facilities (upstream station) consist of an intake, screen house and raw water pump station containing four (4) pumps rated at __, __, __, and __ mgd. The auxiliary facility (downstream station) consists of a submerged intake screen and single vertical turbine pump rated at __ mgd. The primary facilities (upstream station) will be used to supply raw water for the water treatment plant.

b. Determination of which to use will be established by the plant operator. The auxiliary facilities (downstream station) are used to supplement raw water flow during routine scheduled periods (to maintain reliability of facilities) or as an emergency supply.

c. The rate of flow into the plant will be established by the operator after consideration of clearwell levels, contact tank levels, distribution storage tank levels, and plant effluent flow rates. Clearwell level, contact tank levels, distribution storage tank levels and plant effluent flow rate will be available for indication, report and alarm generation at the central processing unit (CPU).

d. After reviewing system operating parameters, the operator may select any one or combination of four raw water pumps at the primary intake/pump station or pump at the auxiliary intake/pump station to supply the plant with raw water. The plant operator will be required to start and stop these pumps at their respective stations. However, the SCADA system shall have the ability to be modified in the future to start or stop, any or all of the raw water pumps or intake screen from the CPU and monitor pump and screen status and alarm points generated at these facilities.

e. A raw water turbidimeter (___) shall be located the raw water/high service pump station. Turbidity shall be transmitted to the CPU via the DLC located at this facility.

f. Raw water magnetic flow meters (__,___), flow transmitters (___,___), and control valves (___,___) with valve position transmitters, shall be located in underground meter vaults. Raw water flow, and valve position shall be transmitted to the CPU via the DLC located at the high service/raw water pump station. Raw water pressure will be monitored at the raw water pump station and shall be transmitted to the CPU via the DLC located at the high service/raw water pump station. The plant operator shall be capable of throttling the raw water control valves through the CPU via signals to the DLC, or locally via local control stations on the valve operators. By throttling these valves, the operator can regulate the amount of flow to the presedimentation basins.

g. The raw water flow control valves shall be capable of being operated via the SCADA system in any of three modes:

1) The operator positions either valve via the operator keyboard to a set position. The operator thereby may set

the flow through either line manually and flow will remain constant unless other hydraulic conditions change.

2) The DLC at the high service/raw water pump station shall have a controller function that may be selected via the operators keyboard to modulable either control valve to maintain a selected flow through each meter.

3) The DLC at the high service/raw water pump station shall have a controller function via the operators keyboard. To modulate total raw water flow to the presedimentation basin based upon a set point signal generated by the clearwell level transmitter.

4) When in mode three above, the controller shall split the flow through the two sets of meters to assure that detention time in either set of mains is equal.

h. Level probes (___,___) shall be located in each presedimentation tank. High level alarm shall be transmitted to the CPU for indication, alarm and report generation.

i. The band of operation of the master clearwell level rate controller should be set so that the water level in the clearwell does not vary more than one (1) foot above or below a selected center level during the changes in flow rate. The flows at the upper end of the band (low clearwell level) shall be programmed not to exceed 30 mgd. The flow at the low end of the band (high clearwell level) shall be programmed not to be less than 10 mgd. Flow at the center of the band shall be 20 mgd. This shall be at clearwell elevation _____. The band should be sufficiently wide so that small changes in level as would occur during a backwash would not cause large increases or decreases in flow through the plant. All changes in flow should be gradual from the initial rate to the final flow rate with no hunting actions. It shall be possible to adjust the selected center of the control band and all other parameters at the operators keyboard. The setpoint and clearwell level shall be available for indication at the CPU. Clearwell levels shall be monitored for levels out of range.

j. A presettled raw water turbidimeter and pH transmitter (___) shall be located at the water treatment plant. Turbidity and pH shall be transmitted to the CPU via the DLC located in the chemical storage room.

k. A presettled raw water sample (S.P.-1) shall be pumped to the laboratory for further analysis.

2. Pretreatment

a. The CPU shall utilize the totalized (total flow thru each magnetic meter) plant raw water flow signal to generate an output signal to the respective DLC for use in chemical feed pacing the appropriate chemical. A DLC will be located on each floor in the chemical feed building for this purpose. The output signal shall be proportional to flow and shall be retransmitted to each chemical feeder for use in pacing the chemical feed from the pacing panel.

b. Mixed water streaming current (____) shall be monitored from a sample point within the slow mixer chamber. Mixed water streaming current shall be transmitted to the CPU via the DLC for indication, report and alarm generation. Streaming current output shall be used to optimize coagulant dosage. A dosage

control function within the DLC shall be used for this purpose. The DLC shall output a corrective dosage signal to the alum feed pumps for this purpose. A mixed water sample (S.P.-2) shall transmit a sample to the streaming current detector and pH transmitter, and also pump a sample to the laboratory for further analysis.

c. Filter influent turbidity shall be monitored at the effluent of each process unit and a composite chlorine residual sample shall be monitored from the processing units effluent flume. Filter influent turbidity and process effluent chlorine residual shall be transmitted to the CPU via the pulsator control DLC for indication, report and alarm generation. Filter influent sample pump (S.P.-3) shall transmit a sample to the laboratory for further analysis. Solenoid valves shall be located on each process unit sample line. A four (4) position selector switch in the laboratory shall be used to select the process unit and energize the solenoid valve whose sample is to be analyzed for chlorine residual and transmitted to the laboratory for further analysis.

d. A level probe (_____) will be located in the rapid mix basin for indicating high mix basin level. This signal shall be transmitted to the CPU via the DLC for report and alarm generation.

e. A series of level probes will be located in the process units for indicating high process basin levels. These signals shall be transmitted to the CPU for report and alarm generation.

f. A raw water flow signal shall be transmitted to the sludge blowoff control panel for use in sequencing the blowoff cycle. The plant operator shall be capable of establishing the blow off cycle time and duration via the operators keyboard. The operator shall have the option to select whether a blow off sequence is generated by plant inflow, or time. He shall also have the option of manually initiating the operation of any blowoff valve and bypassing the cycle duration, flow controls.

3. Filtration:

a. Measurement of the level on top of the filters will be made by a level transmitter located over a stilling well connected to the process unit effluent flume. The level shall be transmitted to the CPU via the auxiliary filter control DLC for report and alarm generation, and display. A filter level controller function shall be provided at the DLC. This controller shall output a signal to the data highway for establishing a filter effluent rate set signal to DLC's located at the filter control consoles.

b. Flow through the 6 double filters will be controlled by individual filter rate of flow controllers and a master microprocessor based filter level control system located at the auxiliary filter control DLC. The master filter level control system will establish the setpoint for all individual filter rate control stations which are selected by the plant operator to accept this signal. All individual filter rate control stations selected to accept this signal by the operator, at the operators keyboard will be affected equally. Filters whose individual rate control station are not set to accept this signal will not be affected by the master filter level

controller. At the operators option, set point signals for each filter may be independently set manually via the operators keyboard at the CPU.

c. The band of operation of the master filter level rate controller should be set so that the water level in the filters does not vary more than 3 inches above a center selected level or 3 inches below a selected center level during changes in flow rates. The band should be sufficiently wide so that small changes in level such as would occur during the washing of a filter, would not cause large increases or decreases in the flow through the remaining filters. All changes in flow should be gradual from the initial rate to the final flow rate with no hunting action. It shall be possible to adjust the selected center of the control band via the operators keyboard. The setpoint and the filter influent level shall be indicated on the CRT. Filter influent levels shall be monitored for levels out of range.

d. The operator shall have the option to input a set point signal to the filter influent level controller at the CPU via the operators keyboard. The controller's output to the filters should be indicated on the CRT.

e. Individual filter effluent rate of flow controllers (_____) shall be located at the filter control consoles. These units shall serve as backup controllers to the filter effluent control function located at the DLC's in each FCC. A selector switch shall be located in each FCC for use in selecting DLC control of the filter effluent valve, or operation via these controllers. Normally these units will only be required to function while maintaining the DLC. Therefore filter effluent flow shall also be hardwired to this controller. Control signal to the valve operator shall be hardwired thru the selector switch. Effluent flow rate set point signal shall be established by the operator on the controller for each filter that is to operate in this mode.

f. Actual filter flow rate will be indicated on the individual filter rate control stations (_____). Filter flow setpoint will also be indicated on the station. The control stations output shall also be indicated on the individual filter rate control stations.

g. The filter flow rate control station located at each FCC should have the following operating functions:
   (1) "Auto" - the rate of flow through the filter rate of flow controller will be controlled automatically with the rate of flow being set locally on the flow rate control station.

h. The flow through each filter rate of flow controller (_____) shall be measured with a modified venturi section and transmitted (_____) to the FCC for indication and to the DLC at its respective FCC for control purposes and transmission via the data highway to the CPU for report, alarm generation, and display.

i. Head loss through each filter will be monitored with a differential head transmitter (_____) and transmitted to the DLC at its respective FCC for transmission via the data highway to the CPU for report, alarm generation, and display.

j. Effluent turbidity through each filter will be monitored (_____) and transmitted to the DLC at its respective FCC for transmission via the data highway to the CPU for report, alarm generation, and display.

k. The turbidity signal shall not activate a high alarm when the filter effluent valve is closed. This shall prevent a false alarm during the backwash and rinse cycles. The turbidity signal generated during backwash and rinse shall not be used to generate daily or monthly averages and ranges.

l. A backwash turbidimeter (_____) shall be located in the filter wastewater piping for the purpose of monitoring turbidity levels in the backwash wastewater. Turbidity shall be transmitted to the FCC for optional backwash control, and to the CPU via the data highway for report, alarm generation and display. (The plant supervisor shall determine whether backwash turbidity is to be integrated into the backwash program. If not selected this part of the backwash routine is to be bypassed. If selected the program shall integrate the function into the routine).

m. High level for each filter (_____) and low level (_____) for each filter cell shall be monitored to provide alarm for either extremely high or extremely low water level condition in each filter. Alarm signal shall be transmitted to the DLC at its respective FCC and the CPU via the data highway for report generation and display.

n. Level probes shall be provided in each filter half for use in indicating satisfactory levels for automatically starting and stopping the air wash system (_____). The probe level signal shall be transmitted to the FCC for this purpose.

o. Motor operated butterfly valves will be provided for the following functions:

    1) Influent - 1 per filter
    2) Effluent Rate of Flow Control - 1 per filter
    3) Drain - 1 per filter
    4) Isolation - 2 per filter
    5) Wash - 1 per filter
    6) Air Wash - 2 per filter
    7) Rinse Rate of Flow Control - 1 per filter.

All valves shall be capable of being automatically operated by the filter backwash program. All valves shall be capable of being manually operated through switches located at each FCC or at each valve. The filter influent, effluent rate of flow controller, air wash, wash and rinse rate of flow control valves shall have a hold position. Limit switches shall be provided so that fully closed, partially open, or fully open positions will be indicated for each valve at the FCC, and for report back to the filter backwash program and the SCADA system for graphic generations. Intermediate limit switches shall be provided for the filter influent and airwash valves for use during the backwash programs.

p. Rinse flow and turbidity will be transmitted to the CPU for rinse control, report, alarm generation and display.

q. An airwash meter (_____) and transmitter (_____) shall be located on the air blower supply line. The meter shall be for use in manually establishing and maintaining the air supply

from the blowers during an air wash cycle. Air wash flow shall be transmitted to the auxiliary filter control console DLC and CPU for report, alarm generation and display.

r. An air blower shall be provided for use during the air wash sequence of the filters. The blower will be capable of being automatically operated by the backwash program or by being manually operated from a switch on the auxiliary filter control console or the CPU. A pressure switch (_____) on the air blower discharge line shall serve to provide positive indication that the air blower is running. The signal shall be transmitted to the starter, and auxiliary filter control console. Contacts for the air blower motor starter shall be used to indicate that the blower is off and shall be wired to the auxiliary filter control console for this purpose.

4. Clearwell, High Service/Transfer Pumping Station:

a. After leaving the filters, water will flow into a combined filter effluent main prior to entering the clearwell.

b. After leaving the clearwell the water will flow into the finished water line. A finished water sample will be monitored for turbidity, (_____), pH, (_____) chlorine residual (_____) and temperature (_____) prior to entering the transfer pump sump. Finished water turbidity, pH and chlorine residual, and temperature shall be transmitted to the CPU via the DLC for indication, report and alarm generation. A finished water sample (SP-5) shall also be pumped to the laboratory for further analysis.

b. Measurement of the level in the transfer pump sump will be made by a level transmitter (_____) located over a stilling well in the sump. The level shall be transmitted to the high service/transfer pump station DLC and the CPU via the data highway for report and alarm generation, display,pump and raw water flow control.

c. Clearwell level shall be monitored by the CPU. Alarm outputs shall be provided from the CPU for low sump alarm levels, normal backwash sump levels, and high sump alarm.

1) The normal backwash sump level alarm shall be input into the backwash program and prevent a backwash from being initiated until adequate water is available to complete a backwash.

d. Level probes (_____) shall be provided to monitor the sumps for low level. Low level shall serve to shut down the transfer pumps. High clearwell level shall serve to shutdown the filter effluent valves.

e. Level probes shall be provided in the can pumps. Low can pump level shall serve to shut down the pump.

f. The pumping station will contain four (4) transfer pumps, one (1) high service variable speed drive pump plus space for three (3) future units. These pumps shall be capable of being operated by the plant operator from the CPU.

g. The variable speed high service pump shall be provided with a local off remote selector switch. In the local mode the operator can start the pump and set the flow rate at the variable speed pump controller. In the remote mode the operator shall be able to start the pump and set its effluent flow rate via the plant SCADA system. A controller function

shall be provided with the variable speed drive for use in modulating pump speed to maintain the established flow rate in either the local or remote mode.

h. A single stage pressure switch on the high service/transfer pump discharge (_____ thru ____) lines shall serve to provide positive indication that a high pressure condition exists. These signals shall be transmitted to the pump starter for control purposes and to the DLC for transmission to the CPU for indication, alarm and report generation.

i. A flow switch on the high service/transfer pump discharge lines (FSW-___ thru ___) shall serve to provide positive indication that the pumps are running and on line. These signals shall be transmitted to the pump starter for control purposes and to the DLC for transmission to the CPU for indication, alarm and report generation. Contacts in the motor starters shall be used to indicate that the pumps are off and shall be wired to the DLC for this purpose.

j. A turbine flow meter (_____) shall be located in the plant service line to meter plant water usage. Flow shall be transmitted to DLC for transmission to the CPU for report indication, report and alarm generation.

k. Flow meters (___ and ___) and transmitters (FIT-___ and ___) shall be located on the transfer and high service pump discharge and suction lines to meter plant transfer and effluent flows. These signals shall be transmitted to the CPU via the DLC for report, alarm generation and display.

l. Pressure transmitters (PIT-___ and ___) shall be located on the high service and transfer pump discharge lines to monitor pump discharge pressure. These signals shall be transmitted to the CPU via the DLC for report, alarm generation and display.

m. Backwash flow will be measured with a venturi meter (_____). This flow will be transmitted (_____) to the CPU for report generation, and display and to the backup washwater flow controller (_____) at the auxiliary filter control console for manual flow control and indication. Washwater flow will be regulated by a washwater rate of flow control valve and control function located at the DLC in the auxiliary filter control console. This control valve shall be operated by the backwash program via the controller function located in the DLC, or manually through the operation of the rate of flow controller (_____) at the auxiliary filter control console. A selector switch shall be located at the auxiliary filter control console for selecting the control signal to operate the valve. (DLC or _____)

n. Pump high service, transfer and air blower status shall be transmitted to the CPU for report generation.

o. An alum feed line shall be connected to the washwater supply line. A shutoff solenoid valve shall be located on the dilution water supply line for this feeder. The alum feed pump and solenoid (_____) valve shall be energized by the backwash program via the DLC to allow alum to be introduced into the washwater supply. The plant operator shall be capable of selecting whether this feed system is to be activated by the backwash program by inputing this information into the program via the operators keyboard at the CPU.

p. A coagulant aid feed line shall be connected to the washwater supply line. A shut-off solenoid valve shall be located on the dilution water supply line for this feeder. The coagulant aid feed pump and solenoid valve (_____) shall be energized by the backwash program via the DLC to allow coagulant aid to be introduced into the washwater supply. The plant operator shall be capable of selecting whether this feed system is to be activated by the backwash program by inputing this information into the program via the operators keyboard at the CPU.

q. A plant effluent sample will be monitored for turbidity (_____), pH (_____) and chlorine residual (_____). Plant effluent turbidity, pH and chlorine residual shall be transmitted to the CPU via the DLC for indication, report generation and alarm. Plant effluent sample will be obtained from the plant water service supply and piped to the laboratory for further analysis.

5. Distribution System Monitoring and Controls

a. Tank levels, pump status and controls are currently transmitted via time pulse or tone telemetry between the treatment plant and remote areas via lines leased from telephone companies. These facilities will remain in service, however the plant shall have spare I/O capacity to allow future integration of these facilities into the SCADA system as follows:

Analog Inputs - 20
Analog Outputs - 5
Digital Inputs - 50
Digital Outputs - 20

6. Chemical Feed Systems:

a. The rate of chemical feed in the water treatment plant will be established by manually setting the basic chemical feed rate in parts per million at the plant operators SCADA system keyboard and then pacing the chemical feeders from a raw water flow signal which is the summated value of flow through the two magnetic meters. Maximum pacing signal should be based on a maximum flow rate of 30 million gallons per day.

b. A 4-20 ma. d.c. pacing signal should be provided for pacing the feeders with variable speed drives. The pacing relays and accessory equipment shall be supplied by the instrumentation supplier and mounted in dust tight cabinets in each of two chemical feed areas.

c. A closed loop feed control signal shall be provided for feeding alum. Alum feed dosage control shall be based upon a signal originating at the streaming current detector (_____). This signal shall be transmitted to the DLC. A controller subroutine program within the chemical feed room DLC shall output a dosage control signal to the alum feed pumps for dosage control based upon the streaming current signal and raw water flow.

d. A closed loop feed control signal shall be provided for feeding post chlorine. Post chlorine feed dosage control shall be based upon a signal originating at the finished water chlorine residual analyzer (_____). This signal shall be transmitted to the chemical storage room DLC. A controller subroutine program within the DLC shall output a dosage control

signal to the post chlorinators for dosage control based upon the chlorine residual signal and summated filter effluent flow.

e. A closed loop feed control signal shall be provided for feeding post caustic. Post caustic feed dosage control shall be based upon a signal originating at the finished water pH analyzer (_____). This signal shall be transmitted to the chemical feed room DLC. A controller subroutine program within the DLC shall output a dosage control signal to the caustic feed pumps for dosage control based upon the pH signal and summated filter effluent flow.

f. The DLC's shall have the necessary power supplies isolators, relays, etc. to perform the necessary dosage control functions.

g. The following feeders shall be paced from the summated raw water flow signal:

Chemical	Control Signal
1) Alum Feed Pumps (4) -	4-20 ma. d.c.
2) Coagulant Aid (2) -	4-20 ma. d.c.
3) Sludge Blanket Polymer (2) -	4-20 ma. d.c.
4) Lime (2) -	4-20 ma. d.c.
5) Carbon (2) -	4-20 ma. d.c.
6) Chlorine (Pre & Spare) -	4-20 ma. d.c.
7) Filter Aid (2) -	4-20 ma. d.c.
8) Potassium Permanganate (2) -	4-20 ma. d.c.

h. The following feeders shall be paced from summated filter effluent flow signal:

Chemical	Control Signal
1) Chlorine (Post & Spare) -	4-20 ma. d.c.
2) Caustic Soda (2) -	4-20 ma. d.c.
3) Polyphosphate (2) -	4-20 ma. d.c.
4) Fluoride (2) -	4-20 ma. d.c.

i. Alum or coagulant aid feed for washwater flow shall be set manually at the feeder.

j. Low bin storage level alarms will be transmitted to the DLC for each of the following:
   1) Lime Silo
   2) Lime Feed Bin No. 1
   3) Lime Feed Bin No. 2
   4) Carbon Silo

   The alarms shall be transmitted to the CPU for report generation and display.

k. High lime and carbon silo level alarm shall be transmitted to the unloading alarm panel and the DLC for transmission to the CPU for report generation and display. Silo weight shall be transmitted to the DLC for transmission to the CPU for report generation and display.

l. High level alarm panels will be located at the unloading dock, and in the vicinity of the lime and carbon silo delivery area. These panels will have alarm lights and an audible bell that will be activated whenever a high level is reached in an alum, caustic soda, scrubber system caustic soda, phosphate or fluoride storage tanks or the lime and carbon silos. Provisions shall be made for two future chemicals. An alarm silence button shall be provided for each panel. The alarm light shall go out when the alarm clears.

Message	Occurrence
Extend Backwash	Backwash extended

c. The filter backwash mode of operation shall be either "SEMI-AUTOMATIC" or "MANUAL." A two-position "BACKWASH MODE" selector switch will be provided on each FCC. Pushbuttons shall be provided at each FCC to "START BACKWASH", "STOP BACKWASH", "RESET BACKWASH", "EXTEND BACKWASH" AND "EXTEND AIR WASH". Under the "SEMI-AUTOMATIC" mode of operation, washing of a filter will be achieved using the programmed backwash circuitry resident in the DLC. Under the "MANUAL MODE," the devices on each FCC will be required to be operated manually when placing a filter through a backwash cycle.
   1) Backwash Mode - shall be a maintained position switch used to select the semi-automatic or manual backwash mode.
   2) Start Backwash - shall initialize the semi-automatic backwash sequence.
   3) Stop Backwash - shall stop the backwash without resetting the program except for Program Timer T-1. All valves shall close and, if running, the air wash blower shall stop. Depending on when the sequence was stopped, on restart the backwash sequence shall resume in the following manner:
      a) Drawdown - The effluent valve shall open based on the signal from the filter effluent controller and drawdown shall continue until the filter level is below the start air wash level probe.
      b) Air Wash - Reset timer and restart from the beginning of the air wash cycle.
      c) Simultaneous Air/Water Wash - Open the drain valve, start the blower, open the filter air wash valve, open the filter backwash valve, set washwater flow rate to low rate and continue the simultaneous air/water wash without resetting the air wash timer.
      d) First Low Rate - Open the drain valve, and continue the first low wash rate from the beginning of the cycle by resetting the first low wash rate timer.
      e) High Rate - Open the drain valve, and go to the beginning of the first low wash rate timer and begin sequence from that point.
      f) Second Low Rate - Open the drain valve, go to the beginning of the second low wash rate timer and begin sequence from that point.
      g) Rinse - Restart the rinse sequence from the beginning of the rinse cycle.
   4) Reset Backwash - shall close all filter valves, turn off the blower, and reset the backwash program to start condition.

d. Each FCC shall contain the valve control stations with indicating lights for filter. The control stations shall be CMC type selector switches with open-close, open-hold-close or start-stop positions, as required. Valve control stations for each of the following valves shall be provided for each filter:
   1) Influent

2) Effluent rate-of-flow (Function of Rate of Flow Controller)
3) Wash Isolation Valve Cell A
4) Wash Isolation Valve Cell B
5) Wash Valve
6) Drain
7) Rinse

8) Air Wash Cell A
9) Air wash Cell B

e. The operation of the backwash sequence shall provide interlocks for levels, pressures, flows and valve positions, as required, so that each step is executed, completed and checked prior to advancing to the next step.

f. Valve operations shall provide limit switch report back to the DLC for program advance. Operator settable 'time out' timers shall be incorporated in the backwash sequence program for each valve sequence execution to prohibit program loop lockup due to a report back failure. Times shall be settable to allow for normal valve operation.

g. If any step in the sequence fails to check, no further progress in the sequence shall be allowed, an alarm message shall be generated for display at the CPU, and a filter backwash sequence fault message shall be printed.
The filter shall be shut down in an orderly manner, closing all valves and stopping the blower. If any step in the reverse sequence fails to check, no further progress in the sequence shall be allowed, an alarm message shall be generated for display at the CPU and a filter backwash fault shall be printed.

h. Indicating lights showing fully 'open' and 'close' positions shall be energized through relays by valve limit switches in both 'Auto' and 'Manual' backwash mode or in filter mode. Both open and close lights shall be lit when the valve is in an intermediate position.

i. Plug-in relays shall be furnished to connect to open and closed limit switches of each valve. Sufficient relay contacts shall be furnished to separate status indication from interlocks and any other relay logic needed for the programmed backwash.

j. Filter effluent and rinse rates-of-flow as metered by the filter effluent rate controller for each filter shall be indicated at the FCC on the Filter Rate Control Station. Loss-of-head and effluent turbidity for each filter shall be indicated at each FCC. Filter and rinse rates-of-flow, loss-of-head and effluent turbidity shall be transmitted to the DLC for indication, alarm and report generation. Rinse flow shall be distinguished from filter effluent flow.

k. The auxiliary FCC shall contain a washwater rate of flow controller with flow rate indicator reading directly in GPM. The wash water valve shall be controlled in the manual mode via this controller. Wash water flow shall be transmitted to the DLC for indication, alarm and report generation.

l. The auxiliary FCC shall contain a pressure controller that will modulate the pressure in the transfer pump discharge header via pressure control valve (_____) to assure that adequate pressure is available to backwash a filter.

m. The auxiliary FCC shall contain an air wash blower control switch with indicating lights. The blower switch shall be a two position selector switch with 'start' and 'stop' positions. The indicating lights in the start quadrant shall be energized through relays by pressure switches in the blower discharge pipe. The indicating light in the stop quadrant shall be energized through relays by contacts located in each blower motor starter.

n. The auxiliary FCC shall contain an air wash digital LED flow rate indicator reading directly in CFM.

o. The auxiliary FCC shall contain an alum feed and coagulant aid pump control switch with indicating lights. The feed pump switch shall be a two position selector switch with "start" and "stop" positions. The indicating lights in the start and stop quadrants shall be energized through relays in the feed pump control panel.

p. The Backwash Mode selector switch shall have these additional functions:
   1) In the Semi-Auto position the influent, effluent, drain, wash isolation valves, wash, rinse and air wash valves, chemical feed pumps and blower shall operate from the backwash program and the manual switches will not be operable.
   2) In the Manual position the valves, and blower may be operated by utilizing the switches on the respective filter FCC or on the auxiliary FCC.

q. Programming and circuitry shall be furnished in the backwash program to extend the air wash cycle for each filter. The extend air wash shall start at the completion of the air wash cycle. The circuitry shall only be operative when the Backwash Mode selector switch is placed in the Semi-Auto position. An "Extend Air Wash" backlighted pushbutton shall be provided on each FCC. The Extend Air Wash indicating light shall be lighted 30 seconds prior to the start of extend air wash timer timing cycle. By pushing the Extend Air Wash button while the button is lit, the extend air wash timer will be activated, extending the air wash time.

r. Programming and circuitry shall be incorporated in the backwash program to extend the wash cycle at the high rate for each filter. The extend wash shall start at the completion of the high wash rate. The circuitry shall only be operative when the Backwash Mode selector switch is placed in the Semi-Auto position. An "Extend Wash" backlighted pushbutton shall be provided on each FCC. The Extend Wash indicating light shall be lighted 30 seconds prior to the start of extend wash timer timing cycle. By pushing the Extend Wash button while the button is lit, the extend wash timer will be activated, extending the high wash rate time. Provisions shall be incorporated in the backwash program to terminate the high wash cycle based on time or satisfactory backwash turbidity quality. Inclusion of backwash turbidity for this cycle shall be provided as a selectable supervisory function from the CPU. If the backwash turbidity quality option is selected and the extend backwash option has <u>not</u> been selected and backwash turbidity quality is not achieved during the high wash cycle,

the backwash shall be stopped and an alarm shall be generated. If the backwash turbidity quality option is selected and the extend backwash option has been selected and backwash turbidity quality is not achieved during the first extend wash cycle, the backwash shall be terminated and an alarm shall be generated. The Operator shall have the option to continue or abort the backwash cycle.

s. Programming and circuitry shall be incorporated in the backwash program which will automatically transfer the filter from a rinse sequence to a filtering sequence without interrupting flow through the filter. A ramping function will slowly close the filter rinse valve while simultaneously opening the filter effluent valve to its normal mode of operation to accomplish this function. The ramping function will be uniform and will take place over the time interval input into the backwash program. The time interval will close the rinse valve in this set time period regardless of the valve starting position.

t. The semi-automatic backwash sequence control required for the filters when initiating the programmed "Start Backwash" from the FCC shall be as follows:
   1) The operator will manually select the filter to be backwashed based on head loss, turbidity, or time since the last wash. The program will not initiate the wash process automatically.
   2) The operator must place the backwash mode selector switch in the "SEMI-AUTO" position.
   3) Depressing the "START BACKWASH" selector pushbutton for the selected filter will start the programmed backwash sequence for the selected filter. The DLC will poll other filter DLC's to prevent more than one filter from being backwashed semi-automatically or manually. The operator shall also have the option of initiating the backwash from the control room via key commands at the CPU.
   4) Upon initiation of the backwash cycle, the backwash program will automatically close the influent valve causing the water level to draw down in the filter. When the influent valve is fully closed, display the "Filter Drawdown" message.
   5) When the filter draws down to the desired level, as determined by the start air wash level probe, the backwash program will automatically close the filter effluent rate-of-flow control valve by dumping the setpoint signal to the filter effluent valve controller. Once the filter effluent rate-of-flow control valve is closed, a limit switch on the valve shall stop the backwash program until the operator depresses the "Start Backwash" pushbutton on the FCC.
   6) The following pre-checks will be performed by the computer program and must be satisfied before resuming with the semi-automatic Backwash Program:
      a) The backwash mode selector switch set on Semi-Auto.
      b) No other filter backwash is in progress, either manual or automatic.
      c) Filter level has drawn down to the start air wash level.

d) All filter valves including the wash valve at the filter are closed.
e) Both high and low wash rates are set.
f) Low rinse rate is set.
g) All timers are set (T-1 through T-16). See timer description table included at the beginning of this section.
h) The clearwell is at normal level.
i) The operator has selected which chemical feed pump to operate - alum, coagulant aid, none.
j) Transfer pump capacity necessary to wash a filter are on-line.
k) If any of the above conditions do not check out, the program will not continue and a filter fault alarm message, "FILTER BACKWASH FAULT", shall be displayed.

7) If all pre-checks are satisfied, the "CLEAR FOR WASH" message will be displayed. If all pre-checks are not satisfied, the appropriate fault statement will be displayed on the CPU monitor and a printed report generated in addition to the FCC fault message.
8) Once cleared for wash, the operator shall depress the "START BACKWASH" pushbutton. This will:
   a) Display "FILTER BACKWASHING" message.
   b) Start backwash program timer (T-1). Should program timer T-1 time out during the wash, the program will shutdown and the backwash fault alarm message, "BACKWASH FAULT", will be displayed on the FCC and the backwash fault alarm will be indicated on the CPU monitor and printer.
   c) Lock out all other filters from backwashing on semi-auto or manual.
   d) Begin to open filter drain valve.
9) After the drain valve is fully open, the program will start the air blower. The DLC shall not allow the blower to start unless all filter air wash valves are closed.
10) When air blower is on, as determined by a pressure switch on air blower discharge line:
   a) Open Cell A filter air wash valve to its intermediate position as determined by intermediate valve position limit switch.
   b) Start hold air wash timer T-3B.
   c) Display the "AIR WASH" message
11) After timer T-3B times out, open the filter air wash valve.
12) After the air wash valve is open the program will:
   a) Start air wash timer T-3A.
   b) Start wash delay timer T-4.
13) If the wash delay timer times out prior to the air wash timer (simultaneous air/water wash sequence), initiate the first low wash cycle by opening the filter wash valve and modulating the pressure control valve to assure adequate back pressure in the transfer pump header to perform a backwash (the DLC shall not allow the wash to start unless all filter wash valves are closed) and start first low wash timer T-6. If not, go to Step 17.
14) After the wash valve has opened:

a) Open the filter Cell A wash isolation valve.
b) Modulate the washwater rate-of-flow control valve to low wash rate.

15) After the filter level rises to the level of the "STOP AIR WASH" level probe:
a) Close filter Cell A air wash valve.
NOTE- The 'stop air wash' level probe shall function to close the air wash valve and shutdown the blower whenever the filter level rises to probe level. The air wash sequence shall be locked out in all modes for each individual filter until filter level drops below the level of the "START AIR WASH" level probe.

16) After the filter Cell A air wash valve is closed:
a) Stop the blower.

17) After air wash timer T-3A times out, the program will activate internal timer (a) in the program controller that will light the "EXTEND AIR WASH" pushbutton on the FCC for 30 seconds.

18) As the 30 second internal timer times out:
a) If the extend air wash pushbutton has been depressed during the 30 seconds, the program will:
(1) Place timer T-4 in a hold mode during which period it will not continue to time.
(2) Extinguish the "EXTEND AIR WASH" light.
(3) Extend the air wash.
(4) Activate the extend air wash timer T-5.
(5) Display the "EXTEND AIR WASH" message.
(6) After the extend air wash timer T-5 times out, go to step 18) b) (3).
b) If the extend air wash pushbutton has not been depressed during the 30 seconds after T-3 times out, the program will:
(1) Allow timer T-4 to continue to time if it has not been stopped, or restart timer T-4 if it has been stopped.
(2) Extinguish the "EXTEND AIR WASH" light.
(3) Close Cell A air wash valve.

19) After Cell A air wash control valve is closed, the air blower will shutdown.

20) After the wash delay timer T-4 times out, initiate the first low wash cycle by opening the filter wash valve and modulate the pressure control valve to assure adequate back pressure in the transfer pump header to perform a backwash. NOTE: The DLC shall not allow the wash to start unless all filter wash valves are closed.

21) After the wash valve has opened, open the washwater control valve and if a simultaneous air/water wash has not occurred, open the filter Cell A wash isolation valve.

22) When Cell A wash valve is fully open, the program will:
a) Modulate the washwater rate-of-flow control valve to first low wash rate. NOTE: A washwater flow controller shall be configured in the DLC to control washwater flow rates. All controller variables and tuning parameters shall be accessible via the CPU.
b) Start first low wash timer T-6.

c) Display "FIRST LOW WASH MESSAGE".

23) After first low wash timer T-6 times out, the program will:
   a) Modulate the washwater rate-of-flow control valve to the high wash rate.
   b) Start high wash timer T-7.
   c) Display "HIGH WASH" message.

24) a) If the backwash turbidity quality option has been selected and backwash turbidity quality is achieved at any time during the high wash cycle go to step 26) b) (2) (a).
   b) If the backwash turbidity quality option has been selected and backwash turbidity quality is not achieved during the high wash cycle go to step 26) a) (1).
   c) If the backwash turbidity quality option has not been selected, go to step 25)

25) After the high wash timer T-7 times out, the program will:
   a) Activate internal timer (b) in the program controller that will light the "EXTEND WASH" pushbutton on the FCC for 30 seconds.
   b) Light the "EXTEND WASH" indicator on the FCC.

26) As the 30 second timer times:
   a) If the "EXTEND WASH" button has been pushed during the 30 second time interval:
      (1) Activate extend wash timer T-8.
      (2) Extinguish the "EXTEND WASH" light.
      (3) Extend the high rate wash time.
      (4) Display the "EXTEND BACKWASH" message.
      (5) As the extend wash timer times out:
         (a) If the backwash turbidity quality option has been selected and backwash turbidity quality is achieved at any time during the extend wash period, go to step 26 b) (2) (a).
         (b) If the backwash turbidity quality option has been selected and backwash turbidity quality is not achieved by the end of the first extend wash period, stop the backwash sequence and generate an alarm. The operator shall have the capability to continue to step 25) a) by pressing the "START BACKWASH" pushbutton or aborting the backwash by pressing the "RESET" pushbutton. If the "START BACKWASH" pushbutton is depressed, an alarm shall be printed indicating a backwash turbidity override together with the value of the backwash turbidity when the backwash was stopped.
         (c) If the backwash turbidity quality option has not been selected, go to step 25) a).
   b) If the 'Extend Wash' button has not been pushed during the 30 second time interval, extinguish the "EXTEND WASH" light:
      (1) If the backwash turbidity quality option has been selected and backwash turbidity quality has not been achieved during the high wash cycle, stop the backwash sequence and generate an alarm. The