CITRUS COUNTY
DEPARTMENT OF TECHNICAL SERVICES
P.O. BOX 440 LECANTO, FL. 32661

LEACHATE TREATMENT FACILITY OPERATION MANUAL for CITRUS COUNTY, FLORIDA OPERATIONAL PERMIT #SO09-187229

BY

DIVISION OF AQUATICS AND SOLID WASTE MANAGEMENT

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CITRUS COUNTY
CENTRAL SANITARY LANDFILL EXPANSION
Citrus County, Florida

Batch PACT[R] Leachate Treatment System

OPERATION MANUAL

March 1990

ZIMPRO PASSAVANT

INNOVATIVE WASTE TREATMENT TECHNOLOGY
301 W. Military Rd.
Rothschild, WI 54474
Telephone (715) 359-7211
FAX: (715) 355-3219

Shop Dwg. No. CC-47
Our Job No. 22-081.91

Date 4/4/90

☐ ~~Approved.~~
☐ Approved Subject to Notations and Corrections as Indicated.
☒ Disapproved. Revise as Indicated by Notations and Corrections and Resubmit.

Checking of shop drawing is limited to general design and general arrangement only, and is not intended to be a verification of the items or total material required. Approval shall not relieve the Contractor from the responsibility of details of design, correct dimensions for proper fitting, capacity, performance, construction or any other requirement of the Contract.

POST, BUCKLEY, SCHUH & JERNINGAN, INC.
Consulting Engineers and Planners

By [signature]

REVIEWED AND APPROVED FOR SUBMITTAL

TO THE ENGINEER

CONE CONSTRUCTORS, INC.

[signature] DATE 3/30/90

BEFORE ATTEMPTING TO START OR OPERATE THE ZIMPRO UNIT OR ANY OF THE EQUIPMENT OR SYSTEMS COMPRISING THE UNIT, A THOROUGH UNDERSTANDING OF ITS USE AND OPERATION IS MANDATORY. ALL OPERATORS ARE REQUIRED TO THOROUGHLY READ AND UNDERSTAND THIS MANUAL AND ALL MANUALS FURNISHED WITH THE UNIT RELATIVE TO THE EQUIPMENT TO BE OPERATED.

TABLE OF CONTENTS

Section No. 1

INTRODUCTION

1.0 Introduction

Understanding the operation of a Zimpro/Passavant PACT[R] Wastewater Treatment System requires an appreciation for the dual nature of the system. It is both biological and physicochemical. The equipment used to operate and control the process has been designed to allow controlled variation in the influence of either of these dual facets to accommodate a wide range of load conditions while maintaining a given level of superior performance. The process is able to provide this level of superior performance because of a synergistic* interaction between Powdered Activated Carbon (PAC) and the microorganisms or biomass which constitute the physicochemical and biological components of the system, respectively.

All activated sludge systems function by converting suspended, colloidal and dissolved solids into settleable biological floc. The mechanism for this conversion is generally described as occurring in two steps:

1. "Sorption" - Whether adsorption, absorption, chemisorption, electrostatic interaction, or some similarly-named phenomenon, the term refers to the mechanism by which molecules and larger sorbate particles are initially removed from the wastewater stream in which they are suspended or dissolved.

* The combined action of the two together is greater than the sum of the action of the two occurring separately.

2. Stabilization - Incorporation of sorbed materials into the floc. Those materials, largely organic contaminants, which can be decomposed or directly assimilated are said to be biodegradable and are used by the microorganisms for new cell material and to obtain energy. These materials are converted to suspended biomass and harmless carbon dioxide and water when wastewater is properly seeded and aerated in the PACT[R] process. Nondegradable materials - largely grit, plastics, etc. - also accumulate in the floc and form a part of the matrix upon which biological growth occurs.

Similar to activated sludge, the biophysical PACT[R] process also converts these same suspended, colloidal and dissolved solids into a settleable PAC/biological floc. The conversion mechanism may be considered to be the same: i.e., as occurring in two steps-sorption and stabilization. The differences between PACT[R] and activated sludge processes can be viewed as being differences in degree rather than as being entirely different phenomena. Accordingly, whatever one would do to properly operate/control the activated sludge process applies to PACT[R] in the same way, and for the same reasons. However, PACT[R] has additional characteristics which favor its use when compared with the activated sludge.

1. The synergism referred to earlier allows PACT[R] to "sorb" a greater variety of types and sizes of molecules and particles than can be achieved by either carbon (whether powdered or granular) or activated sludge acting alone. This synergistic sorption also occurs much more quickly. This "more and faster" removal allows greater volumetric loadings - whether hydraulic, organic, or both - than are possible with activated sludge. Equivalent loadings produce an effluent of higher quality from PACT[R] than would result from activated sludge.

2. Present of the PAC buffers the effect of toxic and shock loads on the biomass. The environment seen by the microorganisms is thus more constant, and "steady state" becomes a more realistic concept than when applied to the typical activated sludge ecosystem.

3. Presence of PAC improves the oxygen environment seen by the biomass organisms. Activated carbon exhibits a rather strong affinity for gaseous oxygen, which may help to account for a greater transfer efficiency of aeration devices when PAC is present in the PACT^{R} system.

From the operating point of view, this means that higher D.O. levels are possible, that demand can be more readily satisfied, and most important, that the micro-environment in and around the individual floc particles can be more easily maintained as truly aerobic, rather than fluctuating between aerobic, micro-aerophilic, and anaerobic - as occurs in activated sludge systems.

2.0 Basis of Design

Table 1-1
Basis of Design
Citrus County, Florida
Leachate Treatment System

	Influent	PACT[R] Effluent
Flow Rate, GPD	30,000	30,000
pH	6.5-8.5	6.5-8.5
COD, mg/l	6,000	
BOD_5, mg/l	2,000	20
TSS, mg/l	400	20
NH_3, mg/l	400	-
NO_3, mg/l	-	12
SRT, days	15	
HDT, days	4.5	
Carbon Dose, mg/l	650	

Refer to page 1-6 for definition of abbreviated terms.

3.0 Abbreviations

COD	Chemical Oxygen Demand
BOD	Biochemical Oxygen Demand
DO	Dissolved Oxygen
F/M	Food to Microorganism Ratio (Biomass)
HDT	Hydraulic Detention Time Days
MG	Million Gallons
MGD	Million Gallons Per Day
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MLVCS	Mixed Liquor Volatile Carbon Solids
PAC	Powdered Activated Carbon
Q	Rate of Flow
TCS	Thickened Carbon Sludge Concentration
SRT	Solids Residence Time, Days
Va	Volume of Aeration Basin
W	Waste Flow, MGD
WCS	Waste Rate, lbs/day
P	Phosphorous
TKN	Total Kjeldahl Nitrogen
DOC	Dissolved Organic Carbon
NH_3-N	Ammonia Nitrogen
TSS	Total Suspended Solids
PO_4	Phosphate
NH_3	Ammonia
NO_3	Nitrate

4.0 Drawings

1. Piping Symbols & Identification, 30.1-2343-D-1001
2. P&ID Symbols & Identification, 30.1-2343-D-1002
3. Engineering Flow Diagram, 30.1-2343-D-1003, Sheet 1-4
4. General Arrangement Dwgs, 30.1-2343-D-7302, -7303, & -7304

GRAPHIC SYMBOLS FOR VALVES

- GATE VALVE
- GLOBE VALVE
- BALL VALVE
- BUTTERFLY VALVE
- PLUG VALVE
- LUBRICATED PLUG VALVE
- CHECK VALVE
- DIAPHRAGM VALVE
- HOSE BIB
- NEEDLE VALVE
- ANGLE VALVE
- RELIEF VALVE
- THREE WAY VALVE
- FOUR WAY VALVE
- DIAPHRAGM OPERATED VALVE
- PRESSURE REGULATOR
- SOLENOID OPERATED VALVE
- MOTOR OPERATED VALVE
- PISTON OPERATED VALVE
- LOUVERED DAMPER
- DAMPER
- VALVE SUPPLIED BY ZIMPRO (ZP)
- METERING ORIFICE VALVE

LC – INDICATES THAT A VALVE IS NORMALLY LOCKED IN THE CLOSED POSITION
LO – INDICATES THAT A VALVE IS NORMALLY LOCKED IN THE OPEN POSITION

PIPING SYMBOLS

- PROCESS LINE
- SECONDARY LINE
- CAPILLARY TUBING
- PNEUMATIC TUBING
- ELECTRICAL SIGNAL
- HYDRAULIC SIGNAL
- INSULATED PIPE
- ELECTRICALLY TRACED LINE
- STEAM JACKETED LINE
- ① THREADED CONNECTIONS
- ① FLANGED CONNECTIONS
- ① BUTT WELD CONNECTIONS
- ① SOCKET WELD CONNECTIONS
- ① CONCENTRIC REDUCER
- ① ECCENTRIC REDUCER
- CAPPED PIPE
- HOSE CONNECTION
- BLIND FLANGE
- ① REDUCING FLANGE
- ORIFICE
- SPECTACLE BLIND (CLOSED / OPEN)
- ① UNION

- RUPTURE DISK
- DIAPHRAGM SEAL
- Y STRAINER
- OPEN FLOOR DRAIN
- CLOSED FLOOR DRAIN
- FLOOR TRENCH
- SENSING BULB
- SIGHT FLOW INDICATOR
- SIGHT GLASS
- CONDENSATE TRAP
- SPRAY NOZZLE
- EXPANSION JOINT
- FLEXIBLE CONNECTOR
- PIGTAIL SYPHON
- EXPANSION CHAMBER
- EDUCTOR
- PILOT GAS MIXER
- IN LINE AIR FILTER
- AIR INTAKE FILTER
- SURGE CHAMBER
- VENT WITH WEATHER HOOD

- EXPANSION JOINT (BELLOWS TYPE)
- FILTER
- SILENCER
- SLIDE GATE
- ROTARY FEEDER
- ① PIPE SUPPORT LOCATION
- ① PIPE SUPPORT DESIGNATION

MISC IDENTIFICATION

ABBREVIATIONS – SERVICE DESIGNATIONS

AIR	A	OXIDIZED LIQUOR	OL
AIR SUPPLY	AS	OXIDIZED LIQUOR & VAPORS	OLV
AMBIENT AIR INLET	AA	OXIDIZED SLUDGE	OS
		OXIDIZED SLUDGE & VAPORS	OSV
BACKWASH	BKH	OXIDIZED WASTE	OW
BOILER BLOWDOWN	BBD	OXIDIZED WASTE & VAPORS	OWV
BOILER FEED WATER	BFW		
BRINE	B	PLANT WATER	PLW
BURNER COMBUSTION AIR	BCA	POTABLE WATER	PW
		PILOT GAS	PG
CARBON SLURRY	CS	PROCESS WATER	PRW
CHEMICAL FEED	CHF	PHOSPHORIC ACID	PA
CHEMICAL RECYCLE	CR	REACTOR SPRAY WATER	RSW
CHEMICAL RECYCLE BLEED	CRB	REGENERATED CARBON	RC
CLARIFIER EFFLUENT	CE	RAW LIQUOR	RL
CONDENSATE	C	RAW LIQUOR & AIR	RLA
		RAW WASTE	RW
DIGESTOR GAS	DG	RAW SLUDGE & AIR	RSA
DIGESTOR OVERFLOW	DO	RECYCLE SLUDGE	RS
DRAIN	D	RAW WASTE & AIR	RWA
EFFLUENT	EFF	REACTOR BLOWDOWN	RBD
EFFLUENT WATER	EW	RECOVERED LIQUOR	RCL
		RELIEF VENT	RV
FEED WATER	FW		
FILTER PRESS EFFLUENT	FPE	SEAL WATER	SW
FILTRATE	F	SLUDGE	S
FLASH STEAM	FS	SOFTENED FEED WATER	SFW
FLUSHING WATER	FW	SOFTENED FEED WATER RETURN	SFR
FUEL OIL	FO	SOLVENT	SOL
FUEL OIL SUPPLY	FOS	STEAM	ST
FUEL OIL RETURN	FOR	SPENT CARBON	SC
FLUIDIZING AIR	FA	SHAFT COOLING AIR	SCA
		SLUDGE COMBUSTION AIR	CA
HOT OIL	HO	SCUM	SCM
HOT WATER	HW	SCRUBBER EFFLUENT	SE
		SODA ASH	SA
INSTRUMENT AIR	IA	VACUUM	VAC
LEACHATE	LTE	VAPORS	V
LIQUID PROPANE GAS	LPG	VENT	VT
LIME SLUDGE	LS	VIRGIN CARBON	VC
LIME	L		
NITRIC ACID	NA	WASTE SLUDGE	WS

ABBREVIATIONS – MATERIALS

BRASS	BS	HASTELLOY	HST
BRONZE	BR	INCONEL	INC
CARBON STEEL	CS	INCOLOY	INL
CAST IRON	CI	KYNAR	KY
CHLORINATED POLYVINYL CHLORIDE	CPVC	MALLEABLE IRON	MI
COPPER	CU	POLYPROPYLENE	PP
DUCTILE IRON	DI	POLYVINYL CHLORIDE	PVC
FIBERGLASS REINFORCED PLASTIC	FRP	REINFORCED THERMOSETTING RESIN	RTR
FORGED STEEL	FS	SEMI STEEL	SIS
GALVANIZED IRON	GI	STAINLESS STEEL	SS
GALVANIZED STEEL	GS	TANTALUM	TA
		TITANIUM	TI

LINE CONTINUATIONS

- INDICATES A LINE GOING TO OR COMING FROM ANOTHER SYSTEM.
- (5 A/2) INDICATES CONTINUATION OF LINE IS ON SHEET NUMBER 5, SAME DRAWING NUMBER, IN ZONE A – 2.
- (501) INDICATES A FLOW STREAM NUMBER AND/OR DIRECTION.

NOTES:
① NORMALLY APPLIES TO PIPING LAYOUTS ONLY

REV	DATE	BY	DESCRIPTION	CHKED	APPR'D

PREFABRICATED MODEL B140 BATCH PACT[R]
LEACHATE TREATMENT SYSTEM FOR
CITRUS COUNTY, FLORIDA

PIPING SYMBOLS & IDENTIFICATION

DRAWN Larry J. Doepke
CHECKED
APPROVED
DATE 2-13-90 SCALE NONE
NEXT ASSEMBLY CC-PSYM SHEET 1 OF 1

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474
DRAWING NUMBER REV

INSTRUMENT SYMBOLS

- FIELD MOUNTED INSTRUMENT
- PANEL MOUNTED INSTRUMENT (PANEL FACE)
- PANEL MOUNTED INSTRUMENT (PANEL REAR)
- FIELD PANEL MOUNTED INSTRUMENT (PANEL FACE)
- FIELD PANEL MOUNTED INSTRUMENT (PANEL REAR)
- CONTROL INTERLOCK NOT CONNECTED TO COMPUTER
- CONTROL INPUT INTERLOCK ALSO CONNECTED TO COMPUTER
- CONTROL OUTPUT INTERLOCK ALSO CONNECTED TO COMPUTER
- INTERLOCK BRANCH
- TURBINE METER

INSTRUMENT LETTER DESIGNATIONS

	FIRST LETTER		SUCCEEDING LETTER		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER FLAME		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY (ELECTRICAL)			CONTROL	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW RATE	RATIO			
G	GAGING (DIMENSIONAL)		GLASS		
H	HAND (MANUALLY INITIATED)				HIGH (OPEN)
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME OR TIME-SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW (CLOSED)
M	MOISTURE OR HUMIDITY				MIDDLE OR INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE (RESTRICTION)		
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY OR EVENT	INTEGRATE OR TOTALIZE			
R	RADIOACTIVITY		RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VISCOSITY			VALVE, DAMPER, OR LOUVER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED		UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	USER'S CHOICE			RELAY OR COMPUTE	
Z	POSITION			DRIVE, ACTUATE, UNCLASSIFIED FINAL CONTROL ELEMENT	

RELAYS INCLUDE ALL COMPUTATION, SELECTION, AND TRANSMISSION DEVICES.
FUNCTIONAL SYMBOLS GIVEN BELOW DESIGNATE THE EXACT FUNCTIONS OF THE RELAY.

[Σ] – ADD	[REV] – REVERSE
[Δ] – SUBTRACT	[1:3] – RATIO
[×] – MULTIPLY	[>] – HIGH SELECT
[÷] – DIVIDE	[<] – LOW SELECT
[√] – SQUARE ROOT	[∼] – INTEGRATE
[AVG] – AVERAGE	[D] – DERIVATIVE

[I/P] – INPUT/OUTPUT CONVERSION

E – VOLTAGE	O – ELECTROMAGNETIC OR SONIC
I – CURRENT	A – ANALOG
P – PNEUMATIC	D – DIGITAL
H – HYDRAULIC	
R – RESISTANCE	

ABBREVIATIONS

CO	CONTROLLER OUTPUT
PV	PROCESS VARIABLE
SP	SET POINT
L.O.R.	LOCAL/OUT OF SERVICE/REMOTE
S/S	START/STOP
F.C.	FAIL CLOSED
F.O.	FAIL OPEN
E	ENERGIZED STATE
DE	DE-ENERGIZED STATE

REV	DATE	BY	DESCRIPTION	CH'KED	APPR'D

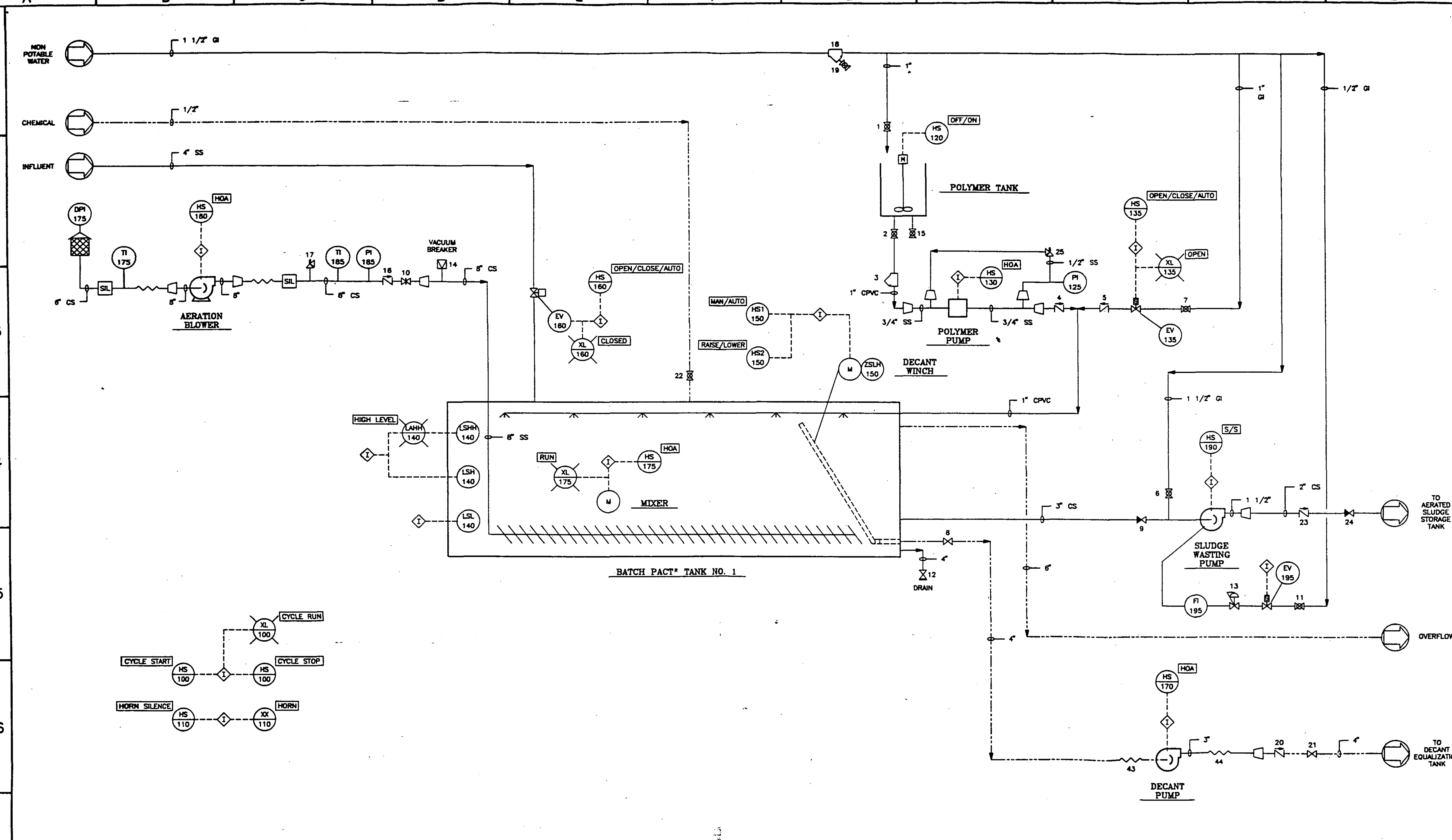
PREFABRICATED MODEL B140 BATCH PACT[R]
LEACHATE TREATMENT SYSTEM FOR
CITRUS COUNTY, FLORIDA

P&ID SYMBOLS AND IDENTIFICATION

DRAWN: Larry J. Doepke
CHECKED: KJD
APPROVED: RAH
DATE: 2-12-90 | SCALE: NONE
NEXT ASSEMBLY: CC-PIDS | SHEET 1 OF 1

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474

DRAWING NUMBER: 30.1-2343-D-1002 | REV: 0



REV	DATE	BY	DESCRIPTION	CH'KED	APPR'D
1	11/2		Mill Revisions	[illegible]	[illegible]

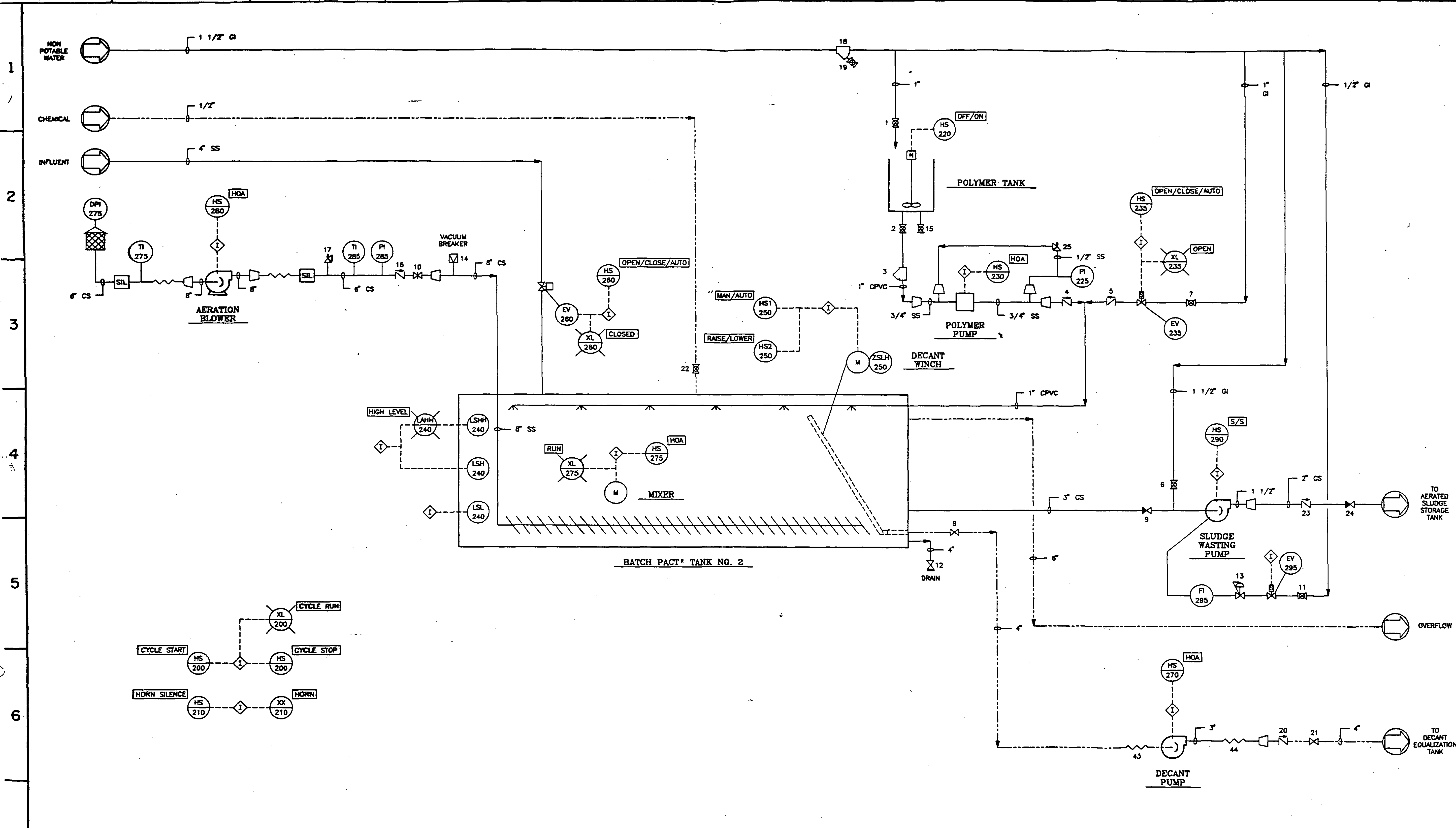
PREFABRICATED MODEL B140 BATCH PACT®
LEACHATE TREATMENT SYSTEM FOR
CITRUS COUNTY, FLORIDA

ENGINEERING FLOW DIAGRAM

DRAWN Larry J. Doepke
CHECKED [illegible]
APPROVED [illegible]
DATE 10-12-89 SCALE NONE
NEXT ASSEMBLY CC-EFD1
SHEET 1 OF 4

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474

DRAWING NUMBER 30 1-2343-D-1003 REV. 1



REV.	DATE	BY	DESCRIPTION	CH'KED	APPR'D
1	1/93	LJD	MISC REVISIONS	DAA	[illegible]

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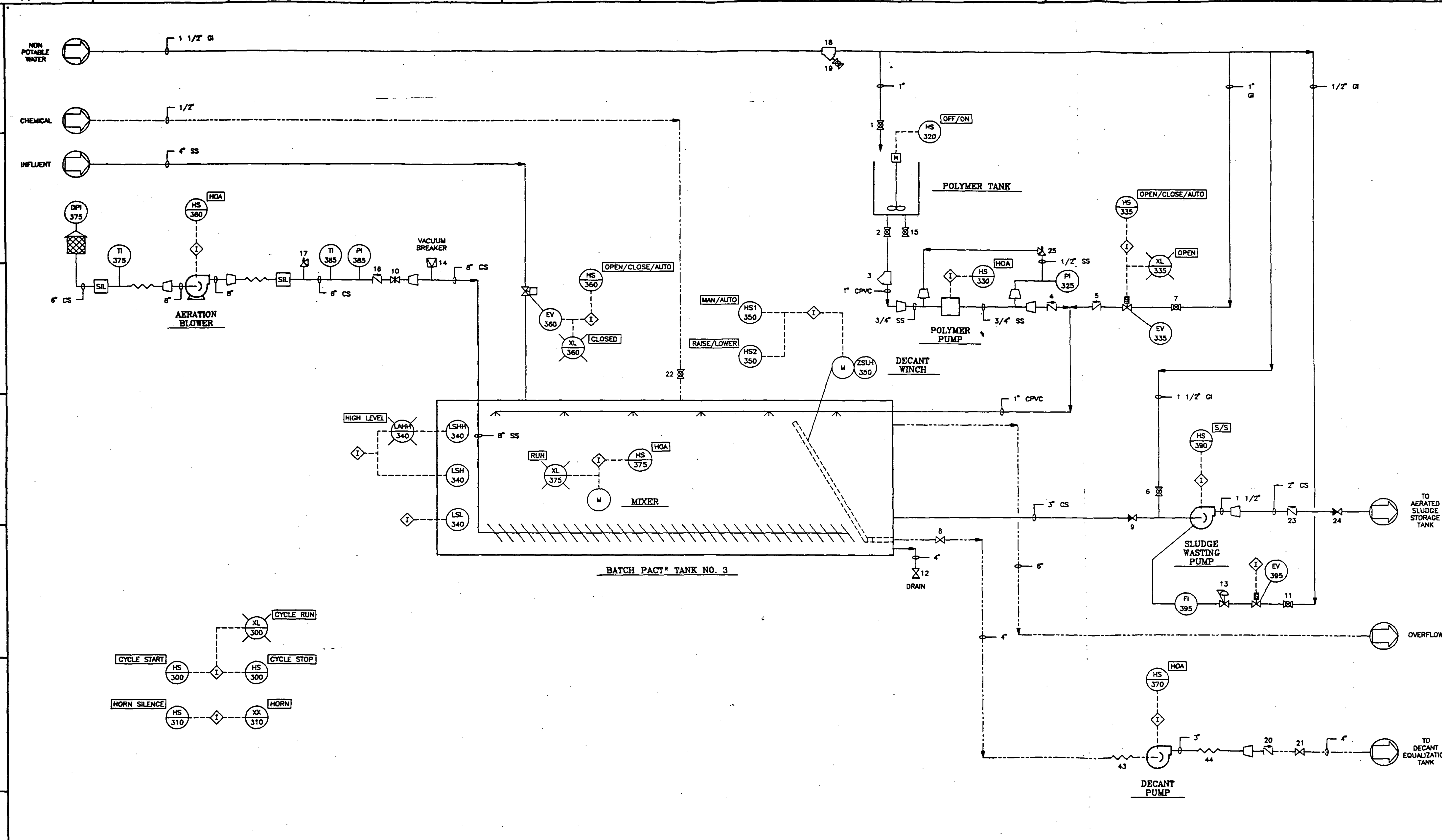
PREFABRICATED MODEL B140 BATCH PACT[R]
LEACHATE TREATMENT SYSTEM FOR
CITRUS COUNTY, FLORIDA

ENGINEERING FLOW DIAGRAM

DRAWN	Larry J. Doepke
CHECKED	[illegible] DAA
APPROVED	[illegible]
DATE	10-12-89
SCALE	NONE
NEXT ASSEMBLY	CC-EFD2
SHEET	2 OF 4

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474

DRAWING NUMBER 30.1-2343-D-1003 REV. 1



2-2	WD	MISC REVISIONS			

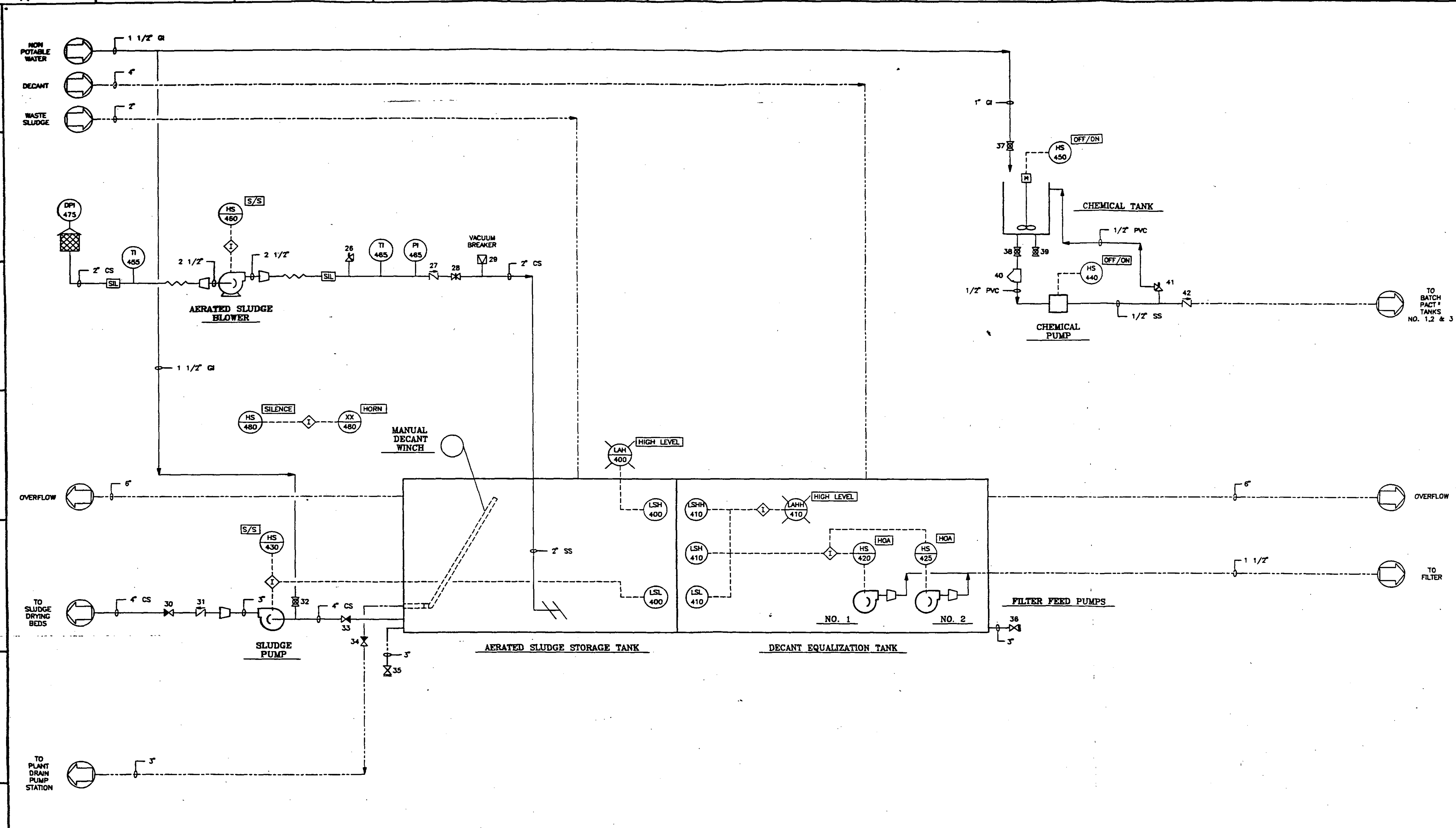
PREFABRICATED MODEL B140 BATCH PACT R
LEACHATE TREATMENT SYSTEM FOR
CITRUS COUNTY, FLORIDA

ENGINEERING FLOW DIAGRAM

DRAWN	Larry J. Doepke
CHECKED	BJD DAH
APPROVED	
DATE	10-12-89
SCALE	NONE
NEXT ASSEMBLY	
SHEET	3 OF 4

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474

DRAWING NUMBER
REV



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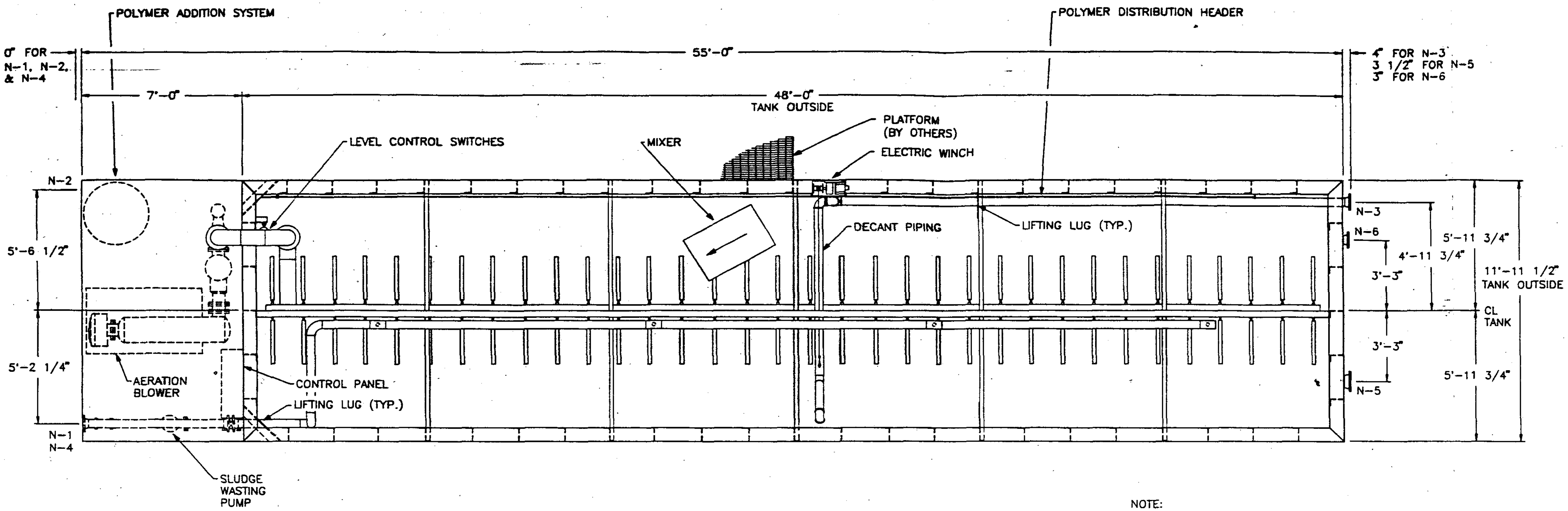
PREFABRICATED MODEL B140 BATCH PACT[R] LEACHATE TREATMENT SYSTEM FOR CITRUS COUNTY, FLORIDA

ENGINEERING FLOW DIAGRAM

DRAWN Larry J. Doepke
CHECKED
APPROVED
DATE 10-12-89 SCALE NONE
NEXT ASSEMBLY CC-EFD4 SHEET 4 OF 4

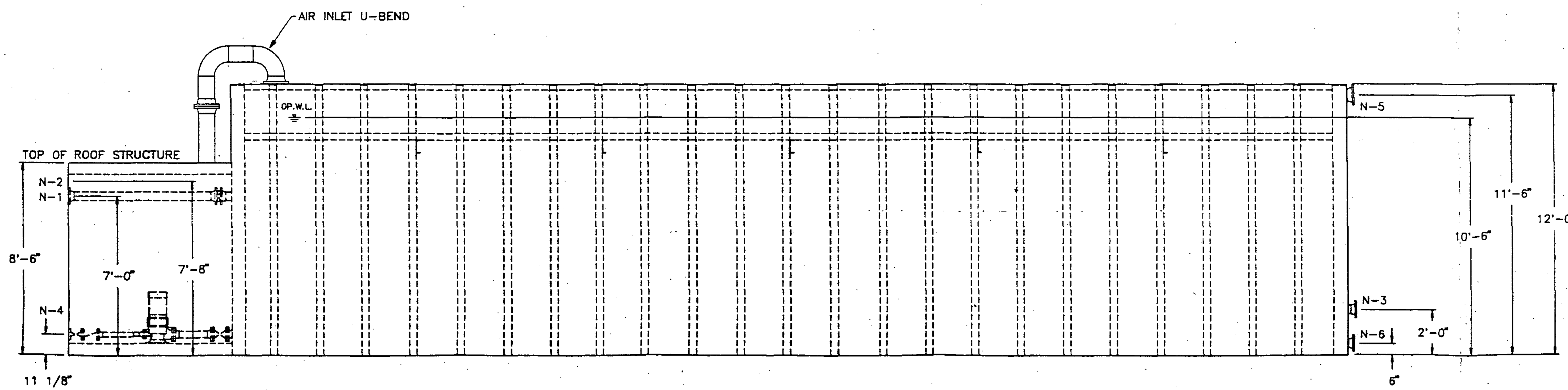
ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474
DRAWING NUMBER



PLAN VIEW

NOTE:

CHEMICAL INLET PIPING (N-7) SHALL BE ROUTED BY CUSTOMER OVER THE TOP OF THE TANK AT ANY LOCATION IN ORDER TO OPTIMIZE THE FIELD PIPING ARRANGEMENT.



ELEVATION VIEW

GENERAL NOTES

1. GENERAL MATERIALS OF FABRICATION:
   - C.S. – PLATE – ASTM A36
     - STRUCTURAL SHAPES – ASTM A36
     - PIPING – ASTM A120
     - BOLTS – ASTM A307
   - S.S. – PLATE – ASTM A240-304L
     - PIPING
       - WELDED – ASTM A312-TP304L
       - THREADED – ASTM A312-TP304
     - BOLTS – 18-8
2. FINISHING:
   - C.S. – EXTERIOR – SURFACE PREP. – SSPC-SP6
     - PRIMER – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT – TNEMEC 71-BLACK ENDURA-SHIELD ONE COAT @ 1.5 MIL D.F.T.
   - INTERIOR – SURFACE PREP. – SSPC-SP10
     - PRIMER – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
   - UNDERSIDE – SURFACE PREP. – SSPC-SP10
     - PAINT – TNEMEC 46H-413 HI-BUILD TNEME-TAR ONE COAT @ 16.0 MIL D.F.T.
3. APPROXIMATE WEIGHTS:
   - EMPTY – 40,000 LBS.
   - OPERATING – 415,000 LBS.
   - FLOODED – 470,000 LBS.

NOZZLE SCHEDULE

MARK	SIZE	TYPE	DESCRIPTION
N-1	4"	150 LB. FLANGE	TANK INLET
N-2	1 1/2"	NPT UNION	NON-POTABLE WATER INLET
N-3	4"	150 LB. FLANGE	DECANT OUTLET
N-4	2"	150 LB. FLANGE	SLUDGE WASTING OUTLET
N-5	6"	150 LB. FLANGE	TANK OVERFLOW
N-6	4"	150 LB. FLANGE	TANK DRAIN
N-7	BY CUSTOMER	BY CUSTOMER	CHEMICAL INLET

ALL FLANGE BOLT HOLES STRADDLE CENTER LINES, U.O.N.

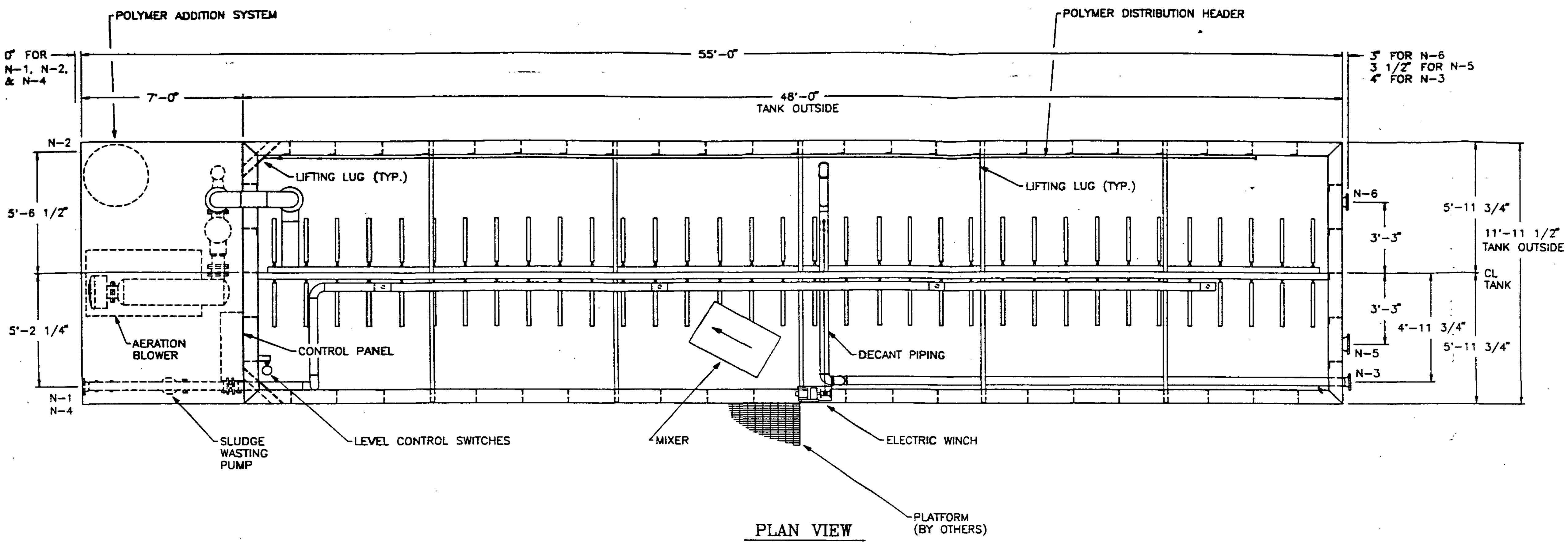
REV.	DATE	BY	DESCRIPTION	CHK'D	APPR'D
3	5-14-90	LJD	MILL REVISIONS	DAA	RMK

PREFABRICATED MODEL B140 BATCH PACT® LEACHATE TREATMENT SYSTEM FOR CITRUS COUNTY, FLORIDA

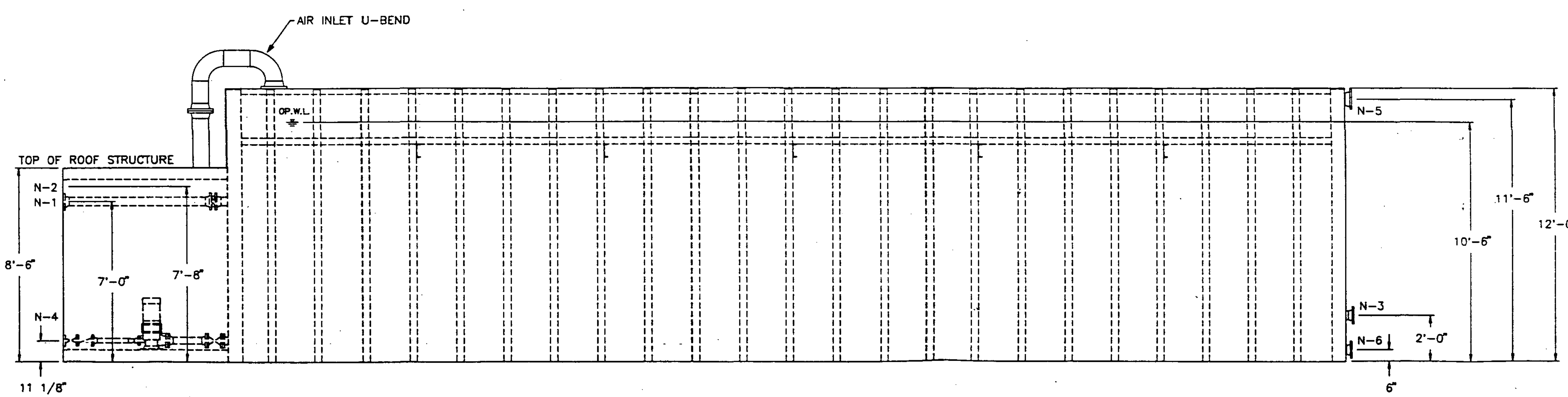
BATCH PACT® TANK NO. 1 GENERAL ARRANGEMENT

DRAWN	Larry J. Doepke
CHECKED	DAA
APPROVED	RMK
DATE	10-24-89
SCALE	3/8" = 1'-0"
NEXT ASSEMBLY	CC-7302
SHEET	1 OF 1
DRAWING NUMBER	30 1-2343-D-7302
REV.	3

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474



PLAN VIEW



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     - PIPING
       - WELDED - ASTM A312-TP304L
       - THREADED - ASTM A312-TP304
     - BOLTS - 18-8

2. FINISHING:
   - C.S. - EXTERIOR - SURFACE PREP. - SSPC-SP6
     - PRIMER - TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT - TNEMEC 71-BLACK ENDURA-SHIELD ONE COAT @ 1.5 MIL D.F.T.
   - INTERIOR - SURFACE PREP. - SSPC-SP10
     - PRIMER - TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT - TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
   - UNDERSIDE - SURFACE PREP. - SSPC-SP10
     - PAINT - TNEMEC 46H-413 HI-BUILD TNEME-TAR ONE COAT @ 16.0 MIL D.F.T.

3. APPROXIMATE WEIGHTS:
   - EMPTY - 40,000 LBS.
   - OPERATING - 415,000 LBS.
   - FLOODED - 470,000 LBS.

NOZZLE SCHEDULE

MARK	SIZE	TYPE	DESCRIPTION
N-1	4"	150 LB. FLANGE	TANK INLET
N-2	1 1/2"	NPT UNION	NON-POTABLE WATER INLET
N-3	4"	150 LB. FLANGE	DECANT OUTLET
N-4	2"	150 LB. FLANGE	SLUDGE WASTING OUTLET
N-5	6"	150 LB. FLANGE	TANK OVERFLOW
N-6	4"	150 LB. FLANGE	TANK DRAIN

ALL FLANGE BOLT HOLES STRADDLE CENTER LINES, U.O.N.

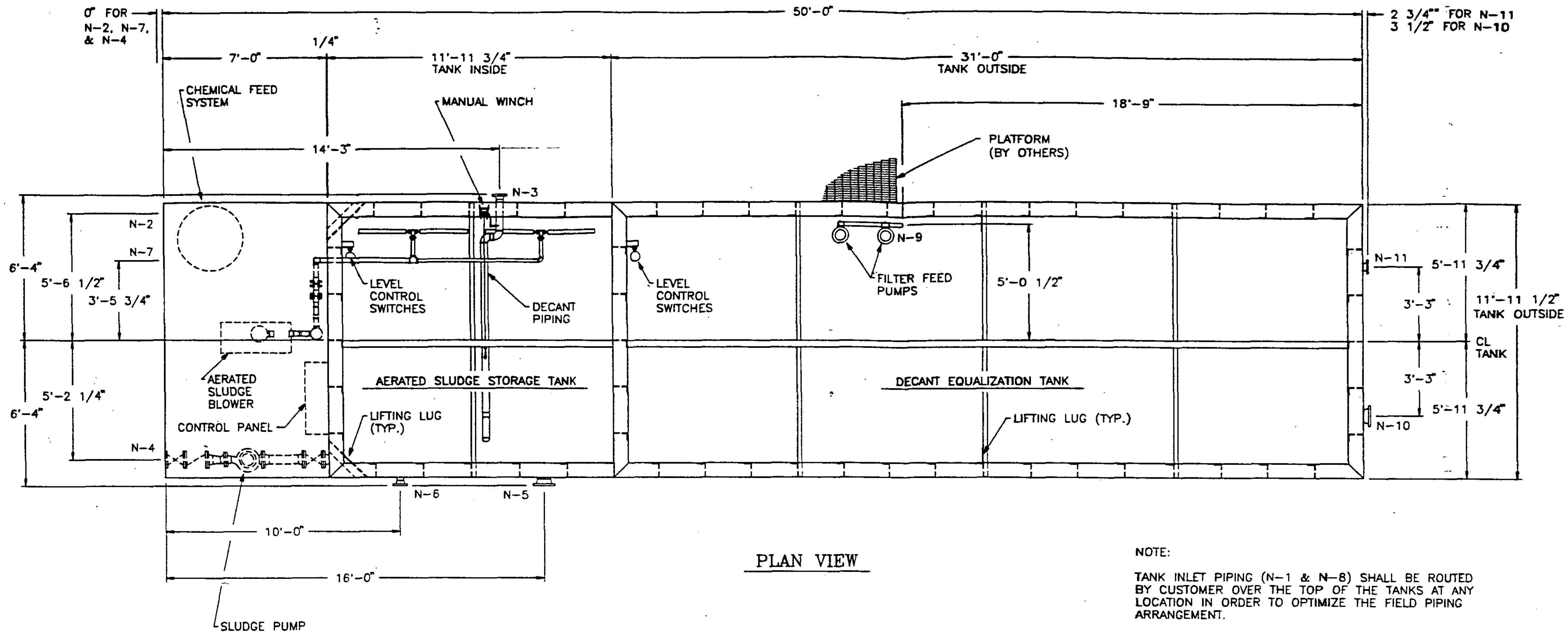
REV.	DATE	BY	DESCRIPTION	CH'KED	APPR'D
3	[illegible]	[illegible]	MISC REVISIONS	DAK	R-H

PREFABRICATED MODEL B140 BATCH PACT® LEACHATE TREATMENT SYSTEM FOR CITRUS COUNTY, FLORIDA

BATCH PACT® TANKS NO. 2 & 3 GENERAL ARRANGEMENT

DRAWN	Larry J. Doepke
CHECKED	DAK
APPROVED	R-H
DATE	10-24-89
SCALE	3/8" = 1'-0"
NEXT ASSEMBLY	CC-7303
SHEET	1 OF 1
DRAWING NUMBER	30.1-2343-D-7303
REV.	3

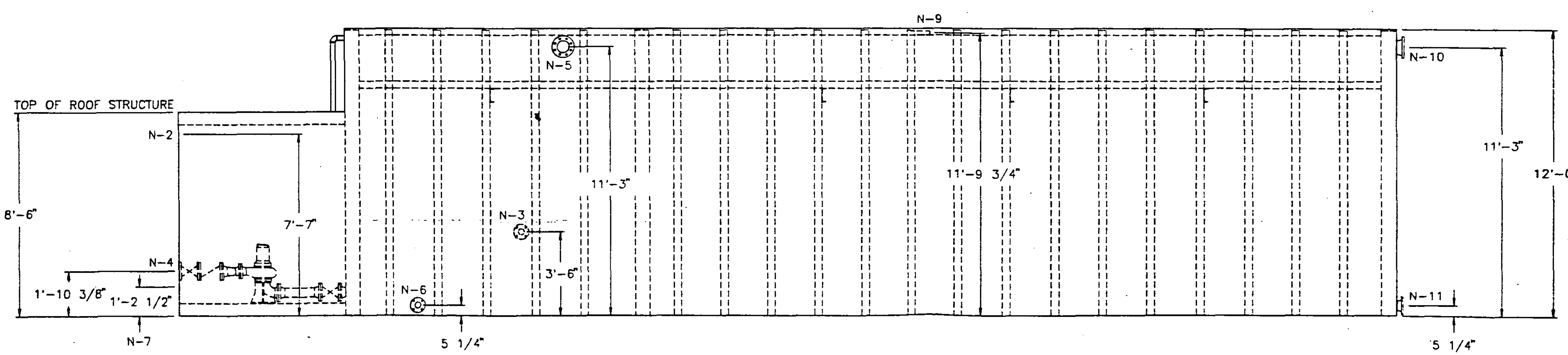
ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474



PLAN VIEW

NOTE:

TANK INLET PIPING (N-1 & N-8) SHALL BE ROUTED BY CUSTOMER OVER THE TOP OF THE TANKS AT ANY LOCATION IN ORDER TO OPTIMIZE THE FIELD PIPING ARRANGEMENT.



ELEVATION VIEW

GENERAL NOTES

1. GENERAL MATERIALS OF FABRICATION:
   - C.S. – PLATE – ASTM A36
     - STRUCTURAL SHAPES – ASTM A36
     - PIPING – ASTM A120
     - BOLTS – ASTM A307
   - S.S. – PLATE – ASTM A240-304L
     - PIPING
       - WELDED – ASTM A312-TP304L
       - THREADED – ASTM A312-TP304
     - BOLTS – 18-8

2. FINISHING:
   - C.S. – EXTERIOR
     - SURFACE PREP. – SSPC-SP6
     - PRIMER – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT – TNEMEC 71-BLACK ENDURA-SHIELD ONE COAT @ 1.5 MIL D.F.T.
   - INTERIOR
     - SURFACE PREP. – SSPC-SP10
     - PRIMER – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
     - PAINT – TNEMEC 66-BLACK HI-BUILD EPOXOLINE ONE COAT @ 4.0 MIL D.F.T.
   - UNDERSIDE
     - SURFACE PREP. – SSPC-SP10
     - PAINT – TNEMEC 46H-413 HI-BUILD TNEME-TAR ONE COAT @ 16.0 MIL D.F.T.

3. APPROXIMATE WEIGHTS:
   - EMPTY – 36,000 LBS.
   - OPERATING – 372,000 LBS.
   - FLOODED – 421,000 LBS.

NOZZLE SCHEDULE

MARK	SIZE	TYPE	DESCRIPTION
N-1	BY CUSTOMER	BY CUSTOMER	AERATED SLUDGE STORAGE TANK INLET
N-2	1 1/2"	NPT UNION	NON-POTABLE WATER INLET
N-3	3"	150 LB. FLANGE	DECANT OUTLET
N-4	4"	150 LB. FLANGE	SLUDGE OUTLET
N-5	6"	150 LB. FLANGE	AERATED SLUDGE STORAGE TANK OVERFLOW
N-6	3"	150 LB. FLANGE	AERATED SLUDGE STORAGE TANK DRAIN
N-7	1/2"	NPT UNION	CHEMICAL OUTLET
N-8	BY CUSTOMER	BY CUSTOMER	DECANT EQUALIZATION TANK INLET
N-9	1 1/2"	MALE NPT	DECANT EQUALIZATION TANK EFFLUENT OUTLET
N-10	6"	150 LB. FLANGE	DECANT EQUALIZATION TANK OVERFLOW
N-11	3"	150 LB. FLANGE	DECANT EQUALIZATION TANK DRAIN

ALL FLANGE BOLT HOLES STRADDLE CENTER LINES, U.O.N.

REV.	DATE	BY	DESCRIPTION	CH'KED	APPR'D
2	12-27-93	LJD	MISC REVISIONS	LJH	EAH

PREFABRICATED MODEL B140 BATCH PACT[R] LEACHATE TREATMENT SYSTEM FOR CITRUS COUNTY, FLORIDA

A.S.S.T. / DECANT EQUALIZATION TANK GENERAL ARRANGEMENT

DRAWN Larry J. Doepke
CHECKED DH
APPROVED EAH
DATE 10-24-89 SCALE 3/8"=1'-0"
NEXT ASSEMBLY CC-7304 SHEET 1 OF 1

ZIMPRO PASSAVANT
ROTHSCHILD, WISCONSIN 54474

DRAWING NUMBER 30.1-2343-D-7304 REV 2

Section No. 2
PROCESS DESCRIPTION

1.0 Narrative

The Citrus County Central Sanitary Landfill Leachate Treatment System consists of three (3) Model B140 Batch PACT[R] structures, one (1) Sludge Storage/Decant Equalization Structure, and three (3) decant pumps. Each Model B140 structure includes aeration tank, diffusers, aeration blower, submersible mixer, electric decant winch, waste sludge pump, polymer feed system, level sensors, and control panel. The sludge storage/decant equalization structure includes sludge storage tank, diffusers, aerated sludge blower, manual decant winch, sludge pump, chemical feed system, decant equalization tank, filter feed pumps, level sensors, and control panel.

The Engineering Flow Diagrams, found in Section 1, depict the process flow scheme for the batch PACT[R] Leachate Treatment System.

The PACT[R] Leachate Treatment System is a biological treatment and physical adsorption process combined into a single unit process. Powdered activated carbon is added to the conventional activated sludge process to adsorb non-biodegradable compounds and provide improved removal of biodegradable materials.

The Citrus County Central Sanitary Landfill Batch PACT[R] system is designed to treat leachate generated at the site. The leachate is pumped to one of three aeration tanks where the required nutrient (phosphorous) and carbon are added to maintain optimum treatment. When the aeration tank is filled with leachate, treatment proceeds in the following sequence:

Aerobic treatment - One positive displacement blower provides air to the coarse bubble diffusers for dispersion throughout the aeration tank. In this step, carbonaceous BOD is removed and nitrification takes place via biological assimilation. Also, nondegradable, adsorbable material is adsorbed on the powdered carbon.

Anoxic treatment - With the aeration blower off, a submerged mixer provides mechanical agitation. In this step, denitrification takes place in an anoxic (without air) environment.

Clarification - The aeration tank also acts as a clarifier. After aerobic and anoxic treatment steps, the aeration blower is restarted and the polymer pump provides polymer from a 100 gallon tank. The polymer is added to the aeration tank and allowed to mix for 10-15 minutes. The blower is then shut off and the entire tank is allowed to settle.

Decantation - After a settling time of approximately 30-60 minutes, the clear liquid is decanted off the top of the tank and pumped to the decant equalization tank.

Sludge Removal - Solids concentrations are controlled in the aeration tank by periodic wasting of the sludge to the aerated sludge storage tank via the sludge wasting pump. Sludge is normally wasted from the aeration tank after decanting. Virgin carbon must be added to the aeration tank to replace carbon removed from the tank during sludge wasting. Virgin carbon is added directly to the aeration tank daily via 50 pound water soluble bags.

2.0 Flow To The Aeration Tank

A. Leachate:

Three pumping stations supply leachate through force mains to the three batch PACT[R] aeration tanks for treatment.

B. Plant Drains:

One plant drain pump station supplies wastewater through force mains to the batch PACT[R] aeration tanks for treatment.

C. Carbon Addition:

Make-up powdered activated carbon is added to the aeration tank using 50 pound water soluble bags as needed. The 50 pound bags are placed directly in the aeration tank after first removing the outer paper bag. Aeration blower or submerged mixer should be operating to provide mixing.

D. Nutrient Addition:

Nutrient (phosphorous) requirements are provided by adding phosphoric acid as needed via the chemical feed system.

3.0 Aerobic/Anoxic Treatment

Aerobic Reaction (Carbonaceous Oxidation and Nitrification):

In the aeration tank, the wastewater will aerate in the presence of powdered activated carbon, bio-mass and non-volatile material (ash) to remove BOD and COD and convert ammonia to nitrate (nitrification).

The bacteria in the aeration tank remove the organic compounds that are measured by the BOD analysis by consuming it as food. This is called metabolism. Metabolism consists of two separate on-going processes; respiration and synthesis. The desired bacteria are aerobic. That is, they require free oxygen dissolved in the mixed liquor for respiration. In the respiration process the bacteria consume organic compounds and oxygen dissolved in the wastewater and convert (oxidize) it to carbon dioxide and water. The bacteria also reproduce, using a portion of the food for synthesis or new cell growth. The required oxygen is made available to the bacteria by bubbling air into the water (mixed liquor) in the aeration tank. Some of the oxygen is dissolved in the water and in this dissolved form becomes available to the bacteria. The available oxygen is measured as D.O. (dissolved oxygen) and should be at least 2 PPM to maintain adequate biological activity and promote the predomination of the proper species of aerobic bacteria. Low D.O. levels (less than 1.0) as well as other factors, promote the reproduction of filamentous, poorly settling bacteria.

The oxygen requirement for biological uptake is provided by one positive displacement aeration blower. The blower will provide compressed air through coarse bubble diffusers located throughout the aeration tank.

Anoxic Reaction (Denitrification):

In the anoxic step, the wastewater in the aeration tank is subjected to anoxic (no oxygen) conditions. The aeration blower is shut off and a 10 HP submerged mixer provides the required mixing of the wastewater. Under these conditions, nitrate in the wastewater is removed by converting nitrate to nitrogen gas (denitrification).

Sludge Wasting:

It is in the aeration tank that the substrate in the wastewater is consumed as food by the biomass or absorbed on the carbon. The substrate represents food, and air is added to supply oxygen needed for respiration. The micro-organisms will multiply (increase in population) as long as there is flow (substrate) to the aeration tank, oxygen and the appropriate environmental conditions such as temperature, pH, etc., exist. The solids resident time (SRT) is determined by the mass of solids removed from the aeration tank each day. The SRT must be controlled at some desirable value. In this case 15 days is the target SRT so the biological solids retain good settling characteristics. This means that every day one-fifteenth of the solids in the aeration tank must be removed from the system.

The required solids removal is accomplished by pumping sludge to the aerated sludge storage tank. The biomass fraction will be replaced by new cell growth and the carbon fraction will be replaced by adding virgin carbon.

Clarification:

In the Batch PACT® system the aeration tank also acts as the clarifier. This is accomplished by shutting off the aeration blower after polymer addition and allowing the solids to settle. The treated effluent from the system is decanted from the top of the aeration tank and pumped to the decant equalization tank via the decant pump.

4.0 Polymer Addition

Polymer is fed to the aeration tank using a constant speed gear pump for injection of a dilute polymer solution from a mixed tank.

The pump flow is constant at 7 gpm, therefore polymer addition is controlled by regulating the amount of time that the pump is operating. The polymer injection pump can be operated either manually or automatically. In the automatic mode the polymer pump run time is set in register C03 of the controller located in the batch PACT[R] control panel.

A 100 gallon tank is supplied to hold a minimum of one day's usage of polymer solution at a polymer concentration of ½%. The polymer dose required is estimated to be 2 mg/l which represents approximately 3 minutes of polymer injection pump operation per cycle.

5.0 Carbon Addition

The addition of make-up powdered activated carbon (PAC) is done intermittently (one per day for example) to replace PAC losses and PAC wasted from the system. Make-up carbon is added directly to the aeration tank from 50 pound water soluble bags.

Carbon addition is manually carried out each day with the aeration blower operating to insure good mixing. A dust mask should be used when working with the powdered activated carbon.

6.0 Nutrient Addition

A nutrient solution of phosphoric acid supplies the required phosphorous to the aeration tank. The chemical feed system is required to supply the nutrient concentration required to maintain optimum biomass growth. Note that nutrient nitrogen is available in the leachate influent as ammonia (NH_3).

Calculation of the amount of nutrient required is detailed in Section 3.

7.0 Aerated Sludge Storage Tank

The aerated sludge storage tank is used to hold wasted mixed liquor solids under aerobic conditions until they can be pumped to sludge drying beds. Diffusers are used to aerate and mix the contents of the aerated sludge holding tank and may decrease the volatile solids content by up to one third. To maximize the solids storage capacity of the holding tank a decant pipe is used to decant off clear supernatant. Decanting is accomplished manually. In the decanting cycle, the aerated sludge blower is shut off and the tank contents are then allowed to settle. If the tank level is sufficient to warrant decanting, the swing-pipe suction line is positioned so the open end is just above the sludge blanket level, the decant discharge valve (No. 34) is opened, and the tank is decanted to the plant drain pump station. When the supernatant level falls to near the sludge blanket or when solids are carried out of the tank, the decant discharge valve (No. 34) is closed and the aerated sludge blower is restarted.

8.0 Decant Equalization Tank

The decant equalization tank is used to store the treated leachate from each of the three aeration tanks. The leachate is then pumped at a steady flow rate to a tertiary filter (supplied by others) by one of two filter feed pumps. After filtration, the treated leachate is discharged to the landfill percolation pond site.

9.0 Equipment List

Aeration Tank	Capacity	45,000 gallons
	Dimensions	12'Wx12'Hx48'L
	HDT (Nominal)	108 hrs (4.5 days)
	Quantity	3
Decant Equalization Tank	Capacity	29,000 gallons
	Dimensions	12'Wx12'Hx31'L
	HDT (Nominal)	23 hrs (0.97 days)
	Quantity	1
Aerated Sludge Storage Tank	Capacity	11,200 gallons
	Dimensions	12'Wx12'Hx12'L
	Quantity	1
Aeration Blowers	Capacity	1000 SCFM
	Disch. Press.	6.0 PSI
	Motor	40 HP / 460 V
	Quantity	3
Aerated Sludge Blower	Capacity	60 SCFM
	Disch. Press.	6.0 PSI
	Motor	5 HP / 460 V
	Quantity	1
Electric Decant Winches	Capacity	700 lbs
	Motor	½ HP / 115 V
	Quantity	3
Submersible Mixers	Capacity	9400 GPM
	Motor	10 HP / 460 V
	Quantity	3

Waste Sludge Pumps	Capacity	70 GPM @ 30' TDH
	Motor	1½ HP / 460 V
	Quantity	3
Decant Pumps	Capacity	200 GPM @ 12' TDH
	Motor	2.1 HP / 460 V
	Quantity	3
Filter Feed Pumps	Capacity	30 GPM @ 23' TDH
	Motor	½ HP / 460 V
	Quantity	2
Sludge Pump	Capacity	180 GPM @ 12' TDH
	Motor	2.1 HP / 460 V
	Quantity	1
Polymer Systems	Quantity	3
	Pump	7 GPM/1 HP/460 V
	Tank	100 Gallons
	Mixer	1/3 HP/115 V
Chemical Feed System	Quantity	1
	Pump	11 GPH/1/3 HP/115 V
	Tank	100 Gallons
	Mixer	¼ HP/115 V
Control Panels	Quantity	4
	Size	(3) @ 48"Hx37"Wx12"D
		(1) @ 36"Hx31"Wx8"D
	Features	(3) w/Modicon PC-0085 Programmable Controllers

Section No. 3

PROCESS CONTROL

1.0 Narrative

A. A control scheme - whether for activated sludge or PACT[R] - should maintain a balance between sorption and stabilization. Such schemes will also be based on sludge wasting (and addition of virgin carbon in the required amounts).

B. While PAC affects both sorption and stabilization, its major contribution is to the sorptive capacity of the system. PAC concentration or dosage levels will thus be primarily determined by the pollutant removals required, which may be measured by effluent color or COD, for example.

C. Control of the PACT[R] system thus involves two different but related elements: Addition of virgin PAC; and wasting of excess Mixed Liquor Suspended Solids (MLSS) to solids disposal.

In PACT[R] systems where the PAC is not regenerated and returned to the system, sufficient virgin powdered activated carbon (PAC) must be added either continuously or incrementally to replace whatever PAC has been intentionally wasted or lost in the effluent. This amount is termed the Carbon Dose and is defined as:

$$\text{Carbon Dose (mg/l)} = \frac{\text{(MLVCS mg/l) HDT}}{\text{SRT}}$$

Where MLVCS = Mixed liquor volatile carbon solids, mg/l
HDT = Hydraulic detention time, days
SRT = Solids residence time, days

HDT may be further defined as the time required for a unit volume influent to the aeration tank to pass through the tank, expressed in days:

$$\text{HDT, days} = \frac{\text{Va (volume of aeration tank, gallons}}{\text{Q (rate of flow into tank, gallons/day)}}$$

For this example: Va = 45,000 gallons

Q = 10,000 gallons/day

HDT = 4.5 days

SRT is defined as:

$$\text{SRT, days} = \frac{\text{Total solids in PACT}^{R}\text{ system, lbs.}}{\text{Waste rate, lb./day}} = \frac{\text{MLSS}}{\text{WCS}}$$

The weight of total solids is calculated as follows:

MLSS lbs. = Va (volume of aeration tank, MG) x 8.34 x MLSS, mg/l

(8.34 is the well known factor which converts concentrations in mg/l and flows in MGD into lbs/day.)

Solids wasting is directly from the aeration tank. The waste rate is calculated as follows (neglecting solids lost to the effluent):

WCS, Waste Rate; lb. solids to be wasted per day =

$$\frac{\text{MLSS, mg/l x 8.34 x Va, MG}}{\text{SRT (desired)}}$$

Since the aeration tank is well mixed, there is a direct relationship between solids and volume in the mixed liquor.

If wasting is to be accomplished directly from the aeration tank:

$$\text{W, waste flow rate; GPD} = \frac{\text{Va, Gal.}}{\text{SRT}}$$

NOTE: If decant effluent suspended solids <u>are</u> significant, they must be considered or over wasting will result and the actual SRT will be lower than desired. In this case:

$$WCS = \frac{MLSS \times 8.34 \times Va}{SRT} - Q, MGD \times 8.34 \times Effl.\ SS, mg/l$$

Wasting is accomplished by pumping solids to the aerated sludge storage tank. This requires that the thickened carbon solids concentration (TCS) be known. So:

$$W, GPD = \frac{WCS,\ lb/day \times 10^6}{8.34 \times TCS,\ mg/l}$$

Wasting can also be done directly from the aeration tank during aeration. In that case, the MLSS, mg/l concentration is substituted for TCS in the above equation.

Once the sludge waste pump flow rate is known, the time required for wasting can be calculated.

$$\frac{W\ GPD}{70\ GPM\ (for\ example)} = \frac{Min.}{Day}$$ Total time solids must be pumped

Volatile carbon must be added each day to replace carbon wasted and that lost in the effluent.

Carbon in the mixed liquor is measured as carbon by the PAC/BIO test procedure.

$$Carbon\ Wasted, = W, GPD \times MLVCS \times 8.34 \times 10^{-6}$$

Carbon lost in the effluent is estimated as follows:

$$Lb/day = Q, MGD \times 8.34 \times Eff.\ SS, mg/l \times \frac{MLVCS, mg/l}{MLSS, mg/l}$$

Make-up volatile carbon must replace carbon lost to these two areas.

Powdered activated carbon can vary in inert (ash) content from 5% to 35%. Therefore;

$$PAC\ added = \frac{Lbs.\ volatile\ carbon\ added/day}{1 - \frac{\%\ ash}{100}}$$

Once the appropriate "initial charge" of PAC has been added to the system, only makeup carbon need be added. Makeup is necessary to compensate for effluent PAC losses and the amount of spent PAC wasted from the system.

Wasting of sludge from the system is done to maintain a biological Sludge Age which will permit growth of desired flora, such as nitrifying bacteria, including Nitrobacter but not so great as to provide conditions suitable for the excess growth of scum-foam producing organisms such as Nocardia. In this respect - control by solids wasting - PACT^R is exactly the same as activated sludge, as one would expect based on the inherently biological nature of PACT^R. Sludge Age is defined as the age, in days, which results when the system total solids mass is divided by the daily rate at which solids are removed from the system. This parameter is thus seen to be the same as Solids Residence Time (SRT) or Mean Cell Residence Time (MCRT) often seen in wastewater treatment reference literature. The initial goal for this application will be a Sludge Age of 15 days. This figure may change as more information and operating data become available, and as loadings to the plant change. Seasonal changes in the Sludge Age or SRT may also be required to achieve the effluent quality desired.

D. In addition to the control of the system as just discussed, the following operational parameters should be monitored closely:

1. **Dissolved Oxygen (D.O.)** - It is recommended that D.O. levels be kept at a minimum of 2 mg/l at all sample locations in the aeration tank, and should not be allowed to drop to less than 1.0 mg/l for any reason. Levels below 1.0 mg/l may result in poor effluent quality which may persist well beyond restoration of proper D.O. levels.

2. **Polymer Dosage** - It will be necessary to determine an approximate range of polymer dosage based on bench-scale testing (which can and should be done on-site by prospective polymer suppliers). The polymer is added to increase capture of fine solids which would otherwise be lost in the effluent, and to improve sludge settleability overall. When scaling up to plant requirements, calculations should be based on the aeration tank volume.

Polymer required (lbs/day) = (Volume MG) (8.34) (mg/l)*

Normally 2 mg/l of Cationic polymer is required to produce an acceptable effluent suspended solids concentration.

*mg/l = dosage determined from bench jar tests.

3. **Nutrient Addition** - The supplemental addition of nutrient phosphorous may be required to supply this key element to the biomass. The addition of nutrient nitrogen is not required since it is supplied in the leachate influent as ammonia (NH_3).

Bacteria require a source of soluble nitrogen and phosphorous for cell growth and reproduction. If there are insufficient nutrients in the incoming wastewater, two problems can result:

a. Filamentous bacteria (fungi) will predominate resulting in poor settleability of the mixed liquor (bulking sludge).
b. Biological activity will be capable of assimilating only a fraction of the organic loading (food) to the PACT[R] system. BOD/COD reductions will be hindered.

If excess nutrients are fed to the PACT[R] system to overcompensate for a nutrient deficiency, a large fraction of these nutrients may not be incorporated into the mixed liquor solids and will pass from the PACT[R] system in the effluent. It is important to monitor the effluent for excess nutrients, and then make adjustments to the amount of nutrients added. A change of no more than 5 percent (5%) per week is advised to avoid adverse effects on the biomass.

Operational experience with BOD removal at the lowest possible nutrient dosage rates will allow the operator to properly control the addition rate. Soluble ammonia-nitrogen (NH_3-N) and soluble phosphorous as measured in the PACT[R] system effluent need not exceed 1-2 mg/l. Many systems have demonstrated adequate treatment at 25-50 percent of these values.

Nutrient requirements are based on BOD_5 loading to the PACT[R] system. For every 100 parts of BOD_5 in the incoming wastewater, 5 parts of soluble nitrogen and 1 part of phosphorous need to be available to the biomass. Nitrogen in the incoming wastewater should be determined by a TKN (Total Kjeldahl Nitrogen) analysis in the laboratory. Phosphorous in the incoming wastewater should be determined as total phosphorous.

To determine the amount of commercial chemical nutrients to be added to correct a nutrient deficiency, the following information is required:

a. PACT[R] influent BOD_5, mg/l
b. PACT[R] influent TKN, mg/l
c. PACT[R] influent P, mg/l (as total phosphorous)
d. Average daily wastewater flow, mg/d
e. Suggested weight ratio, $BOD_5/N = 100/5 = 20$
f. Suggested weight ratio, $BOD_5/P = 100/1 = 100$

g. Atomic weight ratio for commercial nutrient chemicals used (given in Table 3-1)

h. Density ratios for liquid chemicals (given in Table 3-1)

Examples of nutrient dosage calculations are given in Section 3-2, F.

E. Operation and control of the PACT[R] system have been discussed in terms of the following parameters:

1. Wasting (proper SRT)
2. Carbon addition (Carbon Dose)
3. D.O. control (minimum of 2 mg/l D.O.)
4. Polymer or coagulant dosage (proper feed rate for actual plant flows).
5. Maintaining proper nutrient (Nitrogen and Phosphorous) levels.

Any problems which arise during operation of a PACT[R] Wastewater Treatment System will be found to have its cause in one or more of these five parameters.

2.0 Sample Calculations

A. Biomass Level

The influent stream contains pollutants (suspended, colloidal, and dissolved solids) which the PACT[R] system must remove to meet the required plant effluent limitations. The portion of the waste measured as COD will be adsorbed by the PAC in the aeration system. The portion of the waste measured as BOD will have to be stabilized (converted to CO_2, water and cell structure material) biologically.

The question arises: How much biomass is needed to stabilize a given amount of BOD loading? A commonly used parameter which relates influent loadings and the biomass which results from those loadings is the F/M ratio. F = food or BOD loading, M = microorganism mass.

F/M may be applied to PACT[R] much in the same way it is used in activated sludge systems. The normal activated sludge F/M is in the range of 0.2 - 0.5.

To calculate a target MLVSS the F/M ratio chosen should be within this range. Example:

1. Let's assume that the BOD loading to the plant is projected at 2,000 mg/l.

2. The average plant flow is projected at 30,000 gal/day (GPD) or 0.030 million gallons/day (MGD). For each of the three aeration tanks, the average flow is then 10,000 GPD or 0.010 MGD.

3. The volume of each of the three aeration tanks is 0.045 million gallons (MG).

4. Convert BOD loading in mg/l to lbs/day.
   F = 2,000 mg/l x 8.34 lbs/gal x 0.10 MGD = 1668 lbs/day

5. For an F/M of 0.35 (midway between 0.2 and 0.5).

$$M = \frac{1668 \text{ lbs/day BOD}}{0.35} = 4766 \text{ lbs MLVSS will be required (per tank)}$$

6. To avoid problems associated with relatively higher values of F/M (analogous to low SRT) such as turbid effluent containing significant solids and BOD due to the dispersed bacterial growth which characterizes operation at high F/M (short SRT), it is recommended that M (pounds of MLVSS in the system) be increased. This may be accomplished by decreasing wasting rates (raising SRT). In the next section we will consider the constraints on values of F/M which can actually be attained in any given plant. To illustrate the point here, however, assume we choose a biomass which will make F/M = 0.24 (M=6950 lb). This allows BOD excursions up to 3,475 lbs/day without exceeding F/M = 0.50, but we assume that the average BOD remains at about 1668 lbs/day. This is saying that with an F/M of 0.24 we can double the short term loading on the plant without causing bleed through of BOD or change the biology to an extent that would hamper treatment assuming ample oxygen, nutrients, hydraulic capacity and a readily degradable wastewater are provided.

B. Carbon (PAC) Level

The solids carried in the aeration tank of course are not just MLVSS. Associated with the living portion of the biological floc are many inert, inorganic materials like grit. A portion of each living organism is also inorganic. We commonly differentiate these fractions by burning or ashing a MLSS sample in a muffle furnace at 550° or 660° in the laboratory. In a PACT[R] system, about 5-35% of the virgin PAC added as initial charge or make-up PAC is ash. When a sample of MLSS is analyzed for its various components - PAC, biomass and ash - there is no distinction made regarding where the ash in the sample came from. Therefore, the following applies equally whether there is PAC in the system or not.

We choose, for example, to operate the system with a mixed liquor volatile carbon concentration at say 2,100 mg/l because experience has shown acceptable treatment results with this level.

1. Given an aeration tank volume of 45,000 gallons then:
   Vol. Carbon = 0.045 MG x 8.34 x 2,100 mg/l = 788 lbs./tank

2. Virgin carbon, as delivered, may be approximately 15% ash, 85% PAC. To get 788 lbs. of volatile carbon will require:

   $$\text{lbs. virgin carbon} = \frac{788}{0.85} = 927 \text{ lbs./tank}$$

C. Wasting

Again, this is the means by which the process is controlled. PAC levels in the PACT[R] system are determined by operating experience. Based on this information, PAC addition to the system is essentially an independent variable, which can be maintained at as high or low a level as required (or desired). Biomass level, on the other hand, is not an independent variable because the amount of biomass which can be developed in any system depends upon the amount of food available to that biomass.

Therefore, the concept of control of PACT[R] by wasting reflects the fact that what is really being controlled is the biomass. We can add as much PAC as we want, but we will only get as much biomass as the influent loading will support.

Empirically, it has been determined that the biomass which results from a wasting level based on a 5-15 day SRT performs well, and development of nuisance biogrowths are minimized. As dictated by actual operation the SRT may change to provide optimum treatment.

The calculation of the daily waste quantity (W) is quite simple, no matter what SRT is chosen:

W lbs/day = M (MLSS) lbs/SRT days

1. The MLSS concentration is measured at 15,000 mg/l, for example. Then:

   M (MLSS) lbs = 15,000 mg/l MLSS x 8.34 x 0.045 MG = 5,630 lbs.

2. Choose SRT = 15 days (design value), then:

3. $W = \frac{M - \text{Effluent S.S.}}{SRT}$, if effluent S.S. concentration is low, we can neglect this term.

   $$\frac{M}{SRT} = \frac{5{,}630 \text{ lbs}}{15 \text{ days}} = 375 \text{ lbs/day}$$

   This amount can be wasted as mixed liquor, whose concentration has been measured at 15,000 mg/l.

4. $W\ (MGD) = \frac{375\ lbs/\ day}{MLSS\ mg/l \times 8.34}$

5. $W\ (MGD) = \frac{375\ lbs/day}{8.34 \times 15{,}000\ mg/l} = 0.003\ MGD/tank$

   (Also calculated as one fifteenth of the aeration tank volume.)

6. W = 3,000 gallons/day/tank of mixed liquor at 15,000 mg/l SS

7. Let the waste flow rate = 70 gpm (for this example).

   Then the total time in minutes to waste (during aeration sequence) for the day is:

   $\frac{3{,}000\ gal.}{70\ gpm} = 43\ minutes/tank$

8. Wasting can be done at the end of the settling sequence or during the aeration sequence. Note that wasting time will be less if done at the end of settling sequence (higher solids concentration).

D. Carbon Addition Rate

1. Carbon addition = Carbon wasted (given negligible effluent losses).

2. The amount of volatile PAC wasted is based on the amount of volatile PAC in the MLSS.

   From B.1.: The mixed liquor contains 788 lbs. of volatile carbon (per tank). Since we are wasting one fifteenth (1/SRT) of the total mass of MLSS every day, we will remove:

1/SRT x MLVC = 1/15 X 788 lbs. = 53 lbs of volatile carbon/day

3. To get an equivalent amount of virgin PAC (15% ash):

$$\frac{53 \text{ lbs. vol.}}{0.85 \frac{\text{lb. vol. PAC}}{\text{lb. PAC}}} = 61 \text{ lbs. virgin PAC}$$

4. The carbon makeup required can be added at the start of the cycle. The carbon concentration in the mixed liquor should be routinely analyzed and the carbon feed adjusted accordingly.

E. Polymer Addition

1. A cationic polyelectrolyte (polymer) of high molecular weight, applied at the correct dosage, can significantly reduce the amount of suspended solids in the effluent and enhance settling.

   Dosage requirements can be (roughly) determined by a bench jar test. Your polymer supplier will usually be glad to demonstrate his/her product and suggest dosage rates.

   A wide range of brands and types of polymer should be tested initially keeping in mind the economics involved. One supplier's "cheap" polymer may work just as well as another supplier's "expensive" brand or even exceed the high priced polymer's performance. Polymer dosage is usually expressed in terms of parts per million.

2. Example

   Let's say that the polymer chosen demonstrates good particulate capture at 2 ppm, as demonstrated by the jar test.

The polymer will be applied to the entire tank contents of 45,000 gallons. The pounds of polymer can be calculated as follows:

0.045 MG x 8.34 lb/gal x 2 ppm = 0.75 lbs/day

Convert 0.75 lbs. of polymer to gallons of polymer:

$$\text{Total days dosage} = \frac{0.75 \text{ lbs/day}}{9.0 \text{ lbs/gal}} = 0.083 \text{ gallons of polymer per day as supplied}$$

3. Polymer Dilution:

The concentrated polymer must be diluted prior to blending into the wastewater stream. This occurs in the mix tank supplied as part of the polymer addition system. The neat polymer solution is pumped into the mix tank containing the proper quantity of dilution water to yield a solution of about 0.5% wt. polymer.

At an injection rate of 7 gpm, approximately 2 to 3 minutes are required to inject 2 mg/l of polymer respectively. Experience will dictate what dilution and dosage are most effective.

F. Nutrient Addition

The following example shows how to determine whether there is a nutrient deficiency in the PACT[R] system influent, and how to calculate the quantity of additional nutrients required to correct the deficiency. Once the nutrient chemical feed rate (lb/day) is determined, the chemical feed equipment must be set to feed the calculated amount of nutrient based on a 24-hour period. (In continuous flow PACT[R] systems the nutrients should be fed, preferably, in proportion to flow. In batch

$PACT^R$ systems the nutrients should be added during the wastewater feed step of the process cycle.)

Example: Calculate the required amount of additional nutrients to correct a nutrient deficiency.

Given: (for this example only)

a. $PACT^R$ influent BOD_5 = 2000 mg/l

b. $PACT^R$ influent TKN = 250 mg/l

c. $PACT^R$ influent P = 2 mg/l

d. $PACT^R$ average daily influent flow = 0.028 mgd (27,600 gallons/day)

e. Suggested weight ratio, BOD_5/N = 100/5 = 20

f. Suggested weight ratio, BOD_5/P = 100/1 = 100

g. Nutrient Nitrogen = Commercial liquid ammonium hydroxide (NH_4OH) 29% by weight. Atomic weight ratio from (Table 3-1) = 2.5

Nutrient Phosphorous = Commercial liquid phosphoric acid (H_3PO_4) 75% by weight. Atomic weight ratio (from Table 3-1) = 3.2

h. Density of 29% aqueous NH_4OH = 0.95 (from Table 3-1)

Density of 75% H_3PO_4 solution = 1.58 (from Table 3-1)

1.0 Calculate nutrient needed to achieve the suggested BOD/N/P ratios.

$$\text{Nutrient Needed} = \frac{PACT^R \text{ influent BOD, mg/l}}{\text{suggested ratio, } BOD_5/\text{nutrient}}$$

$$\text{N needed, mg/l} = \frac{2000}{20} = 100 \text{ mg/l}$$

$$\text{P needed, mg/l} = \frac{2000}{100} = 20 \text{ mg/l}$$

2.0 Calculate the nutrient addition. If the answer is zero or a negative number, no nutrient need be added.

Nutrient Addition =

(Nutrient needed, mg/l) - (Nutrient in $PACT^R$ influent, mg/l)

N addition, mg/l = 100-250 (TKN) = -150 mg/l

P addition, mg/l = 20-2 (Total P) = 18 mg/l

3.0 Calculate the weight of nutrients that need to be added.

Nutrient to add, lb/day =
(Added Nutrient, mg/l)(Q, mgd)(8.34 lb/gal)

P to add, lb/day = (18)(.020)(8.34) = 1.5 lb/day/tank

4.0 Calculate weight of commercial chemical to be added per day

Nutrient chemical, lb/day =

$$\frac{\text{(nutrient to add, lb/day)(Atomic weight ratio)(100\%)}}{\text{concentration of chemical \%}}$$

75% H_3PO_4 gal/day = $\frac{(1.5)(3.2)(100)}{75}$ = 6.4 lbs/day, solution/tank

5.0 Convert lbs/day solution to gallons per day

Nutrient chemical, gal/day = $\frac{\text{Solution lbs/day}}{\text{(Density)(8.34 lbs/gal)}}$

75% H_3PO_4 gal/day = $\frac{6.4}{(1.58)(8.34)}$ = 0.5 gal/day/tank

Note: If dry chemicals are to be used, the weight of the chemical is determined directly; Step 5.0 is omitted.

TABLE 3-1

PACT[R] Nutrient Atomic Weight Ratios
for Commonly Used Commercial Chemicals

Source	Formula	Atomic Wt	Calc.	Atomic Wt. Ratio	Density
Nitrogen					
Elemental Nitrogen	N	14	14/14 =	1.0	-
Ammonia	NH_3	17	17/14 =	1.2	-
Ammonium Hydroxide	NH_4OH	35	35/14 =	2.5	-
10% solution		-	-	-	.98
18% solution		-	-	-	.96
29% solution		-	-	-	.95
Ammonium Chloride	NH_4Cl	53.5	43.5/14 =	3.8	-
Ammonium Sulfate	$(NH_4)_2SO_4$	132	132/(2)(14) =	4.7	-
Phosphorus					
Elemental Phosphorus	P	31	31/31 =	1.0	-
Phosphoric Acid	H_3PO_4	98	98/31 =	3.2	-
50% solution		-	-	-	1.34
75% solution		-	-	-	1.58
Trisodium Phosphate	Na_3PO_4	164	164/31 =	5.3	-
Combination N-P					
Mono-basic Ammonium Phosphate	$(NH_4)H_2PO_4$	115	115/14 =	8.2 (nitrogen)	
			115/31 =	3.7 (phosphorus)	
Di-basic Ammonium Phosphate	$(NH_4)_2H_2PO_4$	132	132/(2)(14) =	4.7 (nitrogen)	
			132/31 =	4.3 (phosphorus)	

6.0 Nutrient addition using estimated BOD and nitrogen values.

As stated previously, a desirable BOD:N:P weight ratio based on influent BOD is 100:5:1. For practical purposes an estimate of organic loading to the PACT[R] system can be used especially if nutrient addition rates have to be adjusted on a daily basis. Therefore, analysis such as chemical oxygen demand (COD) is necessary to provide quick analytical results. COD analyses can be run within several hours and an estimated BOD value can be calculated once a BOD:COD ratio has been established. To establish a BOD/COD ratio, parallel COD and BOD analyses of the PACT[R] influent should be conducted over a period of 90 days or longer. Once the BOD:COD ratio is known, a BOD can be estimated based on a measured COD.

Estimated BOD, mg/l = (COD, mg/l)(Ratio BOD/COD)

As an estimate for nitrogen content in the PACT[R] influent, ammonia-nitrogen (NH_3-N) can be used since it is easier to run in the lab than the Total Kjeldahl Nitrogen (TKN) analysis. However, a correlation between NH_3-N and TKN must be developed also. Again, this ratio of TKN/NH_3-N should be established over a period of 90 days or longer using parallel TKN and NH_3-N analyses of the PACT[R] influent.

Estimated N, mg/l = (NH_3-N, mg/l)(Ration TKN/NH_3-N)

a. Example: Estimate the BOD loading based on a COD analysis.

For this example, let's say that over a 3-month period of time, the influent BOD/COD ratio is consistently 0.33. In other words, the organic loading to the PACT[R] system can be expressed as: BOD = (COD)(.33)

Given:

COD = 6,000 mg/l

Estimated BOD, mg/l = (COD, mg/l) ratio $\frac{BOD}{COD}$

Estimated BOD, mg/l = (6,000)(.33) = 1980 mg/l

Use the estimated BOD in the nutrient calculation in place of actual BOD_5.

b. Example: Estimate N available in the PACT[R] influent based on the TKN/NH_3-N ratio.

For this example, let's say that over a 3-month period of time the TKN/NH_3-N ratio is consistently 10.0.

Given:

NH_3-N = 25 mg/l

Estimated N, mg/l = (NH_3-N, mg/l) ratio $\frac{TKN}{NH_3\text{-}N}$

Estimated N, mg/l = (25)(10) = 250 mg/l

Use the estimated N in the nutrient calculation in place of the actual TKN.

Note: TKN measures organic nitrogen plus ammonia-nitrogen in the sample. This analysis better quantifies total nitrogen available to the biomass.

Section No. 4

PLANT COMPONENT DESCRIPTION AND OPERATION

Important - This section explains in detail the description, function and operation instructions for every major piece of equipment in the plant. It is not a sequential listing of start-up and shut-down instructions for the plant. Sequential start-up and shut-down instructions are found in Sections 5 and 8 respectively of this manual. This section should be referenced in conjunction with sequential plant start-up and shut-down instructions. Further information for each piece of equipment is found in the Equipment section of the Equipment/Control/Instrument/Valve Manual.

1.0 Operating Sequence

Batch PACT®* Units No. 1, 2, and 3 can be operated in either manual or automatic mode. In the manual mode, all pieces of equipment will operate independently. In the automatic mode most of the equipment will operate automatically once the operator starts the cycle. In the automatic mode the equipment operation is controlled by a series of adjustable timers in the PC0085 programmable controller. The registers are preset and times are adjusted by using a TC0085 keypad located on the front face of the Batch PACT® control panel.

The A.S.S.T./Decant equalization tank is operated in the manual mode only. That is, each piece of equipment operates independently.

Automatic Mode

The operating sequence for the automatic operating mode is controlled using a PC0085 programmable controller located in each control panel. Additional information, including the Gould PC0085 programmable control system users manual, the Quartech TCR085 Data

Access Panel Products Manual, and a Zimpro/Passavant software ladder diagram of the automatic operating mode as outlined below, is given in the Control Section of the Equipment/Control/Instrument/Valve Manual. Operators should become familiar with the Control/Instrumentation sections of this manual before attempting to operate the Batch PACT^R unit. Operation of the Batch PACT^R unit in the manual mode would be similar to the operator having the responsibility to turn-on or shut-off equipment at the appropriate time.

Sequence of Operation
Batch PACT[R] Unit 1, 2, or 3

1. When power is applied to panel, unit is off-line and influent valve is closed. Place all selection switches in the "auto" position.

2. Operator presses START, CYCLE RUN lamps lights, unit enters IDLE mode.

3. Unit waits for both other Batch PACT[R] influent valves to close. If this unit must wait longer than the Anoxic Idle Timer, the blower will start and run for the duration of the Aerobic Idle Timer. This cycle will continue until both other influent valves close. Influent valve opens. Tank begins to fill.
   a. In Aerobic Fill mode (normal operation), blower starts (if not already running).
   b. In Anoxic Fill mode (operator selectable), blower stops (if running) and mixer starts.

4. Blower or mixer continues to run until tank fills (level control mode) or Fill Timer expires, if enabled (timed control mode). Operator can disable Fill Timer.

5. Mixer stops (if running) and blower starts (if not already running). Aerobic React Timer starts.

6. Aerobic React Timer expires. Blower stops, Anoxic React Timer starts. Mixer starts.

7. Anoxic React Timer expires. Mixer stops. Polymer addition Timer starts. Polymer pump starts. Blower starts.

8. Polymer Addition Timer expires. Polymer pump stops. Flush Timer starts. Flush Valve opens.

9. Flush Timer expires. Flush Valve closes. Polymer Mix Timer starts.

10. Polymer Mix Timer expires. Blower stops. Settling Timer starts.

11. Settling Timer expires. Decant pipe lowers.

12. Decant pump starts. Tank is pumped to LOW level. Decant pump stops. Decant pipe rises.

13. Go to Step 3.

Modicon 0085 Programmable Controller
PACT[R] Registers

	Name	Register	Preset (One cycle/day)
1.	Fill Timer	C00	480
2.	Aerobic React Timer	C01	600
3.	Anoxic React Timer	C02	240
4.	Polymer Addition Timer	C03	3
5.	Polymer Line Flush Timer	C04	3
6.	Polymer Mix Timer	C05	5
7.	Settling Timer	C06	60
8.	Horn Blow Timer	C07	5
9.	Anoxic Idle Timer	C10	120
10.	Aerobic Idle Timer	C11	30

All register values are in minutes.

Enable Fill Timer by setting register].40 to 1. If the Fill timer is disabled, the Influent Valve will close when the tank fills to the High Level Sensor. If the Fill Timer is enabled, the Influent Valve will close when the Fill Timer expires or the tank fills to the High Level Sensor, whichever comes first.

If register].41 is set to 0 (default setting), the unit will run the Aeration Blower during filling (Aerobic Fill). If register].41 is set to 1 (by using the register access module), the unit will run the Mixer during filling (Anoxic Fill).

The Aeration Blower will always run during steps 2, 4, 5 and 6. The Mixer will always run during Step 3.

In Idle mode, if this unit is waiting for influent for longer than the Anoxic Idle Timer, due to low flows, the Aeration Blower will run for the time set in the Aerobic Idle Timer. This cycle will continue until the unit is needed to process influent or the unit is taken off line.

Operation of Batch PACT[R]
Unit 1, 2 and 3

Start-up

Apply power to all three units (120 VAC 1ϕ and 480 VAC 3ϕ). Press Cycle Stop button twice to ensure each unit is off line.

Press Cycle Start on unit to be filled first. Wait for influent valve to open. Press Cycle Start on other tanks to be used.

Operation

Press Cycle Stop once to pause a unit. While the unit is paused, the Cycle Run lamp will flash, all motors and pumps will stop, and the influent valve will close.

Press Cycle Stop again to take unit off line and reset PACT[R] cycle position to beginning.

NOTE: No motors or pumps will be automatically started if the unit is off line. If aeration of the tank is required when the unit is off line, place the Aeration Blower control selector in the Hand position.

To continue a paused cycle, press the Cycle Start button. The Cycle Run lamp will go to a steady-on state, and the PACT[R] cycle will continue from the paused point.

NOTE: If the unit is paused during a timed event (such as the aeration step), the total time spend in that step may vary by as much as one minute per each time the cycle is paused. Pressing Cycle Stop while the polymer line contains polymer is strongly discouraged.

Shutdown

To take an individual unit off line, press Cycle Stop twice. No pumps or motors will be automatically started, although the Hand Off Auto and Open Close Auto switches can still be used to manually operate the pumps, motors and valves.

NOTE:

1. Chemical feed (nutrient phosphorous) to the aeration tank is done manually by running the chemical pump for a predetermined length of time.

2. Sludge wasting from the aeration tank is done manually by running the sludge waste pump for a predetermined length of time. Sludge is pumped to the sludge storage tank.

3. Carbon addition is done manually by placing 50 lb. bags of PAC, as required, in aeration tank.

2.0 Non-Potable Water Supply System

Description: Non-potable (clean) water is supplied to the following users via a network of piping and valves:

Equipment	Use
Polymer System	Polymer dilution, line flushing
Waste Sludge Pump	Seal Water, line flushing
Chemical Tank	Chemical mixing

Start-Up: Before charging the non-potable water system, make sure the following valves are closed:

No. 1, 7 (Polymer System)
No. 6, 11 (Waste Sludge Pump)
No. 37 (Chemical Tank)
No. 32 (Sludge Pump)
No. 19 (Non-Potable Water Strainer)

3.0 Controls/Instrumentation

Description: The controls/instrumentation consists of four field control panels and miscellaneous instruments for local control of Zimpro/Passavant furnished equipment.

A. Batch PACT[R] Unit 1, 2, & 3 Control Panels - One panel is located in the equipment area of each unit. Each panel houses the programmable controller, electrical equipment, and manual operating controls for:

- Aeration Blower
- Tank Mixer
- Influent Valves
- Polymer System
- Waste Sludge Pump
- Decant Pump & Winch
- Alarms

B. A.S.S.T./Decant Equalization Control Panel - Located in the equipment area of the unit. This panel houses the electrical equipment and manual operating controls for:

- Aerated sludge blower
- Sludge pump
- Chemical feed system
- Filter feed pumps
- Alarms

C. Miscellaneous field instruments and electrical controls including:

- All hand switches (HS) for 120 volt, 1ϕ, Zimpro/Passavant supplied motors
- Pressure Indicators (PI)
- Temperature Indicators (TI)
- Level Switches (LS)
- Limit Switches (ZS)
- Electrically actuated valves (EV)
- And other miscellaneous instruments as shown on the engineering flow diagrams.

Start-Up

It should be noted here that once the plant instrumentation is energized, it should remain energized unless the plant is shut down for an extended period of time.

Shut-Down

De-energize all power supplies.

4.0 Polymer System (Unit #1)

Description: Polymer is mixed in a tank and fed to the system by a constant speed gear pump rated at 7 gpm. Add neat polymer to the polymer tank containing dilution water to form a ½% (wt) polymer solution. The mixer should be on as the polymer is added and allowed to mix for 30 minutes after polymer addition. Mixing is not required during operation. Polymer quantities should be limited to what can be used in a 24-hour period.

Polymer addition to the aeration tank per cycle:

Polymer Dose, mg/l	Volume at ½%, gal	Pump Run Time, min.
2	14	2
3	21	3
5	35	5

Start-Up:

Prerequisites:

— Non-potable water available.

— Power supply energized.

To prepare the polymer system for use: Close valve No. 15, open valve No. 1, and add the desired quantity of water to the polymer tank.

Open valve No. 19 and flush strainer (No. 18) until clean water is observed. Operate polymer pump momentarily (HS-130 to HAND position) to insure water flow through the pump. Turn on the polymer tank mixer (HS-120) and add neat polymer to the mix tank. Allow to mix for 30 minutes and then turn off mixer (HS-120).

Open valve No. 2 & 7. Turn on the polymer pump (HS-130) and run the pump for the time required to provide the polymer dosage. In the automatic mode the run time is set on register C03 of the PC0085 programmable controller.

Shut-Down: Turn off the polymer pump (HS-130), and flush the lines with dilution water by opening valve EV-135 with hand switch HS-135. In the automatic mode the pump will stop and lines will be flushed in accordance with the Operating Sequence.

Note: If the system is shut down for a long period of time, it should be thoroughly flushed with water and drained.

5.0 Aeration Blower (Unit #1)

Description: Air to the aeration tank diffusers is supplied from one aeration blower. The blower is a Roots Type RAI-U, Size 718, rotary positive displacement blower rated at 1000 cfm. The blower is equipped with inlet filter, inlet and discharge silencers, inlet and discharge temperature gauges, inlet and discharge expansion joints, discharge relief valve, discharge check valve, and discharge pressure gauge.

Start-Up:

Prerequisites:

-- Blower pre-startup maintenance, including lubrication, must be completed (see Equipment Manual for details).

-- Electric power supply energized.

Before starting the blower, open Valve No. 10. Turn on the blower (HS-180 to HAND position). In the automatic mode, the blower will start in accordance with the Operating Sequence.

Shut-Down: Turn off the blower (HS-180 to OFF position). In the automatic mode, the blower will stop in accordance with the Operating Sequence.

6.0 Waste Sludge Pump (Unit #1)

Description: PACT^{R} sludge is drawn from the bottom of the aeration tank and pumped to the aerated sludge storage tank by the waste sludge pump. The pump is Dean Bros. Model DL201, in-line vertical, centrifugal pump rated at 70 gpm.

Start-Up:

Prerequisites:

— Waste sludge available.

— Power supply energized.

Before starting the waste sludge pump, open the following valves:

No. 9, pump suction.

No. 11, seal water. Establish seal water flow at 5-10 GPH. Readjust once the pump is running.

No. 24, pump discharge.

Turn on the waste sludge pump (HS-190) and run until the required volume of sludge has been pumped.

Shut-Down: Turn off the waste sludge pump (HS-190). If the shutdown is to be an extended one, close valve No. 9 and flush the pump suction and discharge lines with non-potable water by opening valve No. 6.

7.0 Submersible Mixer (Unit #1)

Description: Contents of the aeration tank are kept mixed during the anoxic cycle by the submersible mixer. The mixer is a Flygt Model 4451 submersible, motor driven mixer rated at 9400 gpm.

Start-Up:

Prerequisites:

— Wastewater available.

— Power supply energized.

— Mixer pre-startup maintenance, including lubrication, is completed (see Equipment Manual for details).

Turn on the mixer (HS-175 to HAND position). In the automatic mode, the mixer will start in accordance with the Operating Sequence.

Shut-Down: Turn off the mixer (HS-175). In the automatic mode, the mixer will stop in accordance with the Operating Sequence.

8.0 Decant Pump (Unit #1)

Description: Decant supernatant is drawn from the top of the aeration tank and pumped to the decant equalization tank by the decant pump. The pump is a Flygt Model CT3085/82, dry pit vertical mount, centrifugal pump rated for 200 gpm.

Start-Up:

Prerequisites:

- Wastewater available for decanting.
- Decant pipe lowered below wastewater to decant level.
- Power supply energized.

Before starting the decant pump, open the following valves:

No. 8, pump suction

No. 21, pump discharge

Turn on the decant pump (HS-170) to HAND position and run until aeration tank is decanted to the desired level. In the automatic mode, the decant pump will start in accordance with the Operating Sequence.

Shut-Down: Turn off the decant pump (HS-170). In the automatic mode, the decant pump will stop in accordance with the Operating Sequence.

9.0 Decant Winch (Unit #1)

Description: The decant pipe is lowered into the aeration tank for draw-off of the decant supernatant and raised out of the liquid after decanting is completed by the decant winch. The winch is a Thern Model 473A 1/2 B electric power winch (worm gear type).

Start-Up:

Prerequisites:

-- Power supply energized.

Turn local operating station hand switch (HS1-150) to manual position and raise or lower decant pipe by turning hand switch (HS2-150). In the automatic mode, the decant winch will be raised and lowered in accordance with Operating Sequence.

NOTE: For automatic operation the limit switches furnished with decant winch must be adjusted to the required lowered position and raised position.

Initial Start-Up Raised Position -

Set end of pipe @ 0'-6" from top of aeration tank.

Initial Start-Up Lowered Position -

Set end of pipe @ 4'-0" from top of aeration tank.

10.0 Carbon Addition

Description: Virgin powdered activated carbon (PAC) is added directly to the aeration tank on a daily basis as required to meet leachate treatment performance levels. PAC is furnished in 50 lb. water soluble bags with an over-pack made of paper. These bags are to be stored indoors in a dry area.

To Add Carbon: PAC bag(s) are transported from storage to the Batch PACT[R] tank platform. At this time the outer paper bag can be cut at one end, allowing inside water soluble bag to be carefully removed and slipped into the aeration tank.
Safety: Note that some dusting of carbon will occur and that a dust mask is recommended while handling PAC. See Activated Carbon Material Safety Data Sheet found in Section 9 of this manual for additional information regarding activated carbon.

11.0 Chemical Feed System

Description: Phosphoric acid (nutrient) is fed from a tank to one of three (3) aeration tanks by a Neptune Chemical proportioning pump, Model No. 532-A-N3, diaphragm type, rated at 0-11 GPH. Add 50% or 75% commercially available solution of phosphoric acid to the chemical tank. (A mixer is supplied for the mixing of dry chemicals, if required.)

> **NOTE:** Be sure that Valve No. 39 (Chemical Tank Drain) is closed before filling tank.

Safety: A phosphoric acid Material Safety Data Sheet must be obtained from the supplier of phosphoric acid. This safety data sheet will provide detailed information on the phosphoric acid used at your facility. For reference, a "sample" phosphoric acid Material Safety Data Sheet can be found in Section 9 of this manual.

CAUTION: Eye protection and special clothing are required when handling phosphoric acid. See Section 9 on working safely with chemicals.

Start-Up:

Prerequisites:

-- Non-potable water available.

-- Power supply energized.

-- Solution in chemical tank.

-- Wastewater in aeration tank.

Open pump suction valve No. 38 and discharge valve No. 22 to the selected aeration tank. Turn on the chemical pump (HS-440) and run the pump at the required stroke rate and length of time to provide the needed phosphoric acid dosage.

Shut-Down: Turn off the chemical pump (HS-440) and close valve No. 38 and 22.

12.0 Aerated Sludge Blower

Description: Air to the aerated sludge storage tank diffusers is supplied from one aerated sludge blower. The blower is a Roots Type RAI-U, Size 36, rotary positive displacement blower rated at 60 cfm. The blower is equipped with inlet filter, inlet and discharge silencers, inlet and discharge temperature gauges, inlet and discharge expansion joints, discharge relief valve, discharge check valve, and discharge pressure gauge.

Start-Up:

Prerequisites:

-- Blower pre-startup maintenance, including lubrication, must be completed (see Equipment Manual for details).

-- Electric power supply energized.

Before starting blower, open valve No. 28. Turn on blower (HS-460).

Shut-Down: Turn off blower (HS-460) and close Valve No. 28.

13.0 Sludge Pump

Description: Solids from the bottom of aerated sludge storage tank are pumped to the sludge drying beds adjacent to the leachate treatment system. The pump is a Flygt Model CT3085/82, dry pit vertical mount, centrifugal pump rated for 180 gpm at 12' head or 220 gpm at 7.5' head.

Before pumping sludge to drying beds, the aerated sludge blower should be turned off (HS-460) and the sludge allowed to settle. At this time the liquid near the top of the tank can be decanted to the pump drain station. This is done by using the manual decant winch to position the decant pipe just above the sludge level and opening valve No. 34.

Before the sludge pump, open the pump suction and discharge valve, No. 33 and 30 respectively.

Turn on the sludge pump (HS-430) and run until the required amount of sludge has been pumped or pump automatically shuts off at low level.

Shut-Down: Turn off the sludge pump (HS-430) and close pump suction valve No. 33. If shutdown is to be an extended one, flush the pump suction and discharge lines with non-potable water by opening Valve No. 32.

Restart aerated sludge blower (HS-460).

14.0 Filter Feed Pumps

Description: Treated leachate from the decant equalization tank is pumped to a tertiary sand filter by the two filter feed pumps. These pumps are Goulds Model GL887 submersible sewage pumps rated for 30 GPM at 23' TDH. In the automatic mode these pumps are cycled on and off by level controls as follows:

- lead pump ON @ High Level
- lag pump ON @ High High Level
- lead and lag pump OFF @ Low Level

Note: Lead and Lag pumps are alternated.

In the manual mode the filter feed pumps can be operated by turning HS-420 and/or HS-425 to HAND position.

Start-Up:

Prerequisites:

-- Wastewater available.

-- Power supply energized.

-- Tertiary filter on-line.

Turn pump(s) ON (HS-420 and/or HS-425).

Shut-Down:

Turn pump(s) OFF (HS-420 and/or HS-425).

Section No. 5
PLANT START-UP

1.0 Narrative

This section contains a sequential, step-by-step procedure to start-up the PACT[R] Wastewater Treatment Plant. This procedure should be followed anytime the plant is put on line, such as after an extended shut-down.

A. Due to initial slow biomass growth, the plant should be started, if possible, at a decreased influent loading rate.

B. An initial charge of 800 lbs. (16 bags) of virgin PAC is to be added to each aeration tank. This amount is placed directly in aeration tank.

C. It will be very important to control wastewater flows into the plant during start-up. In no case should the full flow/load be applied before PAC and biomass levels have reached at least the lower design limit concentrations and the polymer used has been proven to be effective. Premature introduction of the full hydraulic load may result in biomass die off and the possible loss of weeks of effort in developing an acclimated biomass.

D. Biomass can be introduced into the system in two ways- either by developing naturally in the system from inoculating organisms carried in with the waste stream or by seeding the system with sludge from an operating biological treatment plant. Seeding with a large inoculum of either activated sludge or trickling filter humus will allow development of the biomass much more quickly than will starting from "scratch".

If sludge can be trucked in from a neighboring plant, add enough sludge to bring the biomass level to about 500 mg/l, after which it can develop on its own to whatever level the influent feed can support.

The recommended start-up schedule is outlined below. Percentages listed represent percent of the total daily flow (30,000 GPD).

% Waste	Duration, Days
25	2
50	4
75	4

The schedule may be shortened or waste flow percentages increased as dictated by the performance results.

E. Polyelectrolyte or "polymer" should also be added from the beginning of plant operation in the proper dosage for the flows/loadings existing during the start-up period. It may be necessary to perform jar tests and change feed rates accordingly, even day-to-day, as flows and loads change and the system approaches design or "steady state" operation. This will be especially important when the plant is started from "scratch" or with very low levels of biomass.

F. It will not be necessary to waste sludge immediately, especially when the biomass is difficult to establish, but wasting and PAC addition to maintain SRT and the desired carbon dose should begin as soon as biomass is detectable microscopically, and not later than one SRT after beginning operation of waste (i.e., if the design SRT is 15 days, the wasting of 1/15 of the solids in the system daily should begin within 15 days after the introduction of waste - in whatever quantity or flow - to the PACT® system).

G. As biomass levels increase, the system oxygen demand will also increase. D.O. checks at various points and depths in the aeration tank should be made 2-3 times per day, and additional aeration provided if D.O. concentrations are seen to fall consistently between 1-2 mg/l D.O.

H. It will be necessary to sample and test the system daily during start-up. Table 5-1 shows the recommended sample points and analyses. While many plants may be run without all recommended analyses, baseline data and periodic samples are invaluable in solving problems which may arise even long after start-up. Analytical procedures for the recommended analyses will be found in Section 10 of this manual.

2.0 Initial Start-Up Instructions

A. **Pre-Start-Up Checks & Procedures**

These checks should be made at initial start-up and also by all new operating personnel (or whenever the system has been idle or mothballed for an extended period).

1. Locate and trace all flow streams in the system. Use the equipment drawings supplied with the system equipment manual. These streams include:
   a. Plant influent stream
   b. Air flow
   c. Waste sludge flow
   d. Polymer feed lines
   e. Non-potable water
   f. Nutrient system
   g. Waste sludge transport and storage

   Inspect all connections and fittings to be sure they are correct and tight.

2. Inspect the equipment, piping and valves associated with each stream to ensure free operation, no obstructions or broken lines, and in the case of rotating equipment, jog to confirm the proper direction of rotation. Repair or adjust as necessary.

3. Check all lubricant levels and grease fittings, determine whether fresh lubricant is needed or has recently been added.

4. Check packings, seals and seal water flows to ensure proper installation and operation. Packings and seal water flows will have to be readjusted after operation on process flows.

5. Check all timers for proper initial setting (see equipment manual for initial setpoints). Visually confirm that contacts and electrical connections are secure and clean (not burned or corroded).

6. Visually check the entire system for loose or broken gratings, braces, belt guards, etc. Insure that all protective coatings and paint are intact, cover the area completely as required, and are free from wrinkles, bubbles, and flaking or peeling especially on submerged surfaces.

7. Read and become thoroughly familiar with all manufacturers' manuals and instructions in the system equipment section.

B. **Check-Out on Water**

Fill all the tanks with water, then run all equipment and instrumentation for a minimum of 8 hours following manufacturers' instructions and instructions found in Section 4 of this manual. Monitor all equipment closely and note the following:

1. Current draw on each leg of 3 phase equipment.
2. Any unusual noise or vibration.
3. Overheating.
4. Make operational adjustments to equipment and instrumentation per instructions given in manufacturers' manual.

C. **Detailed Plant Start-Up**

Once the equipment and instrumentation has performed satisfactorily on water, prepare the plant to go on-line as follows:

NOTE: Reference sections in parenthesis ().

1. Drain the test water from all tanks except the aeration tank. The aeration tank should be drained to about two thirds full to accommodate the initial charge of carbon slurry and seed biomass.

2. Energize the instrumentation system (Section 4-3).

3. Charge the non-potable water system (Section 4-2).

Important

It should be noted here that the operator should take all prescribed safety precautions for handling powdered activated carbon, acid, nutrients, and polymer before proceeding. See Section 9 on Personnel Safety.

4. Prepare the polymer addition system (Section 4-4).

5. Start the aeration blower at minimum flow (Section 4-5).

6. Charge the aeration tank with PAC (Section 4-10).

7. Add seed sludge to aeration tank. The aeration tank should now be nearly full. (If not, add water.)

8. Add wastewater to the aeration tank at 25% of normal flow.

9. Add nutrients (Section 4-11).

10. Begin wasting sludge to the aerated sludge storage tank after 10-15 days of sustained biological growth.

Monitor all plant functions. Maintain the following operating parameters during the start-up phase:

MLSS D.O.	2.0 mg/l (ppm) minimum
MLSS pH	6.5 - 7.5

Effluent ammonia nitrogen and phosphorous at 1-3 ppm.

Influent flow - increase gradually as biological activity increases (no more than 25% increase per day).

Tabe 5-1

Suggested Analytical Schedule

	BOD	COD	SS	PAC/ BIO	pH	NH_3-N	Total P	Settleability
1. PACT Feed	D	D	D	N	D	D	D	N
2. Mixed Liquor	N	N	D	Th	D	N	N	D
3. Effluent	D	D	D	N	D	D	D	N

D = Daily (week days)

Th = 2-3 times per week

W = Once per week

N = Not required

NOTE: Analytical work required by the Discharge Permit is not considered in this manual.

Use TOC or COD to monitor treatment level.

Use microscopic exam to monitor biology.

Use NH_3 and total P to regulate nutrient addition.

Section No. 6

ROUTINE OPERATION

1.0 Routine Operation

Maintain the following process control parameters during normal operation of the plant.

Influent flow range - minimal to 10,000 GPD per aeration tank at 6000 mg/l COD.

Mixed liquor D.O. - 2 ppm minimum

Mixed liquor pH - 6.5 to 7.5 is optimal

Nutrient addition - maintain effluent phosphorous (P) in the range of 1-3 ppm.

Polymer feed rate - maintain minimal "suspended solids" in effluent.

SRT - 15 days (10 day SRT recommended to start with. SRT may be increased slowly if nuisance biogrowths do not cause effluent quality to deteriorate.)

The operator should perform the following recommended duties in developing an operations routine for the plant:

A. Collect samples and perform analyses as recommended (see Section 5) to monitor plant operation and meet any applicable Federal, State or local regulatory agency requirements.

B. Perform maintenance as recommended by equipment manufacturers. (See Equipment Manual.)

C. Check air flow and distribution to ensure proper D.O. and mixing.

D. Fill out log sheets as required.

E. Check that required chemical additives are available in storage tanks. Check and record all feed rates. Ensure delivery at feed point. Recalibrate system as required.

F. Check the pump flow of waste sludge to ensure that proper waste rates are achieved.

G. Add carbon daily to the aeration tank to replace carbon wasted.

NOTE: It is strongly recommended that a preventative maintenance program, for all plant equipment, be developed and implemented. Such a preventative maintenance program should contain a schedule for cleaning, lubrication, inspections, adjustments, calibrations and maintaining protective coatings for plant equipment. With proper maintenance, the equipment can be expected to last its full anticipated service life.

OPERATING RECORDS

1. Waste Processed

    a. Influent or effluent flow data
    b. pH to the PACT^R unit
    c. Temperature to the PACT^R unit

2. Carbon Added

    a. Carbon added to system

3. Polymer Dose Rate

    a. Polymer pump operating time
    b. Change in polymer tank level
    c. Polymer usage per day (neat polymer)

4. Wasting Rate

    a. Pump flow rate and operating duration
    b. Sludge storage tank levels

5. Nutrient Feed Rate

    a. Nutrient pump operating time
    b. Change in nutrient tank level
    c. Nutrient usage per day

6. Records of equipment operation should be kept also.

2.0 Lubrication Schedules

Points of Lubrication	Mfr's Recommended Lubr.	Amount	Freq.
Aeration Blower, Aerated Sludge Blower (Roots)			
a) Bearing Lubrication	a) Chevron SRI No. 2 Grease	As Req'd	5 weeks
b) Gear Housing	b) Oil - SAE40 (Winter) SAE50 (Summer)	Full	See Manual
c) Motor, 40HP, 5HP	c) Baldor Motor Chevron SRI No. 2	As Req'd	3 months
Polymer Pump (Liquiflo)			
a) Motor, 1HP	a) U.S. Motor Chevron SRI No. 2	As Req'd	Yearly
Polymer Mixer (Neptune)			
a) Gear Housing	a) Lithium #2 Grease	16 oz.	Yearly
b) Motor, 1/3HP	b) Prelubricated for life of motor	———	———
Waste Sludge Pump (Dean Brothers)			
a) Motor, 1½HP	a) Lithium #2 Grease	3/4 Full	Yearly
Submersible Mixer (Flygt)			
a) Oil Casing	a) Mobil SHC630	2.65 qt.	After 1st 200 hrs of operation
b) Bearing Casing	b) Mobil SHC630	0.5 qt	After 1st 200 hrs of operation

Points of Lubrication	Mfr's Recommended Lubr.	Amount	Freq.
Decant Pump, Sludge Pump (Flygt)			
a) Oil Casing	a) SAE10W30 Motor Oil Mobil Whiterex 309 or equivalent paraffin oil	1.1 qt.	Inspect Monthly
Decant Winch (Thern)			
a) Gear Case	a) AGMA #8 Oil	Fill to middle oil plug	Inspect Monthly
b) Open Gears	b) NLGI #2 EP Grease	2.0 oz.	Monthly
c) All other points of friction	c) medium wt. oil	As Req'd	Monthly
Chemical Pump (Neptune)			
a) Gear Box	a) SAE90 or AGMA No. 5EP	As Req'd	Yearly
b) Motor, 1/3HP	b) Prelubricated for life of motor	-----	-----
Chemical Mixer (Neptune)			
a) Motor, ¼ HP	b) Prelubricated for life of motor	-----	-----
Filter Feed Pumps (Goulds, G&L)			
a) Submersible pump/motor	a) Oil - filled w/no further lubrication required	-----	-----

TABLE 7-1

PACT[R] TROUBLESHOOTING GUIDE

OBSERVATIONS	PROBABLE CAUSE	REQUIRED CHECK	REMEDY
1. Sludge floating to surface.	1. Denitrification occuring; nitrogen gas bubbles attaching to sludge particles; sludge rises in clumps. 2. Filamentous growth causing floating solids.	1a. Nitrate concentration; if no measurable NO_3, then 1 (1a) is not the cause. 1b. Check SRT, do a microscopic examination.	1a. Increase DO in aeration tank. 1b. Reduce SRT. 1c. See 3a below.
2. Straggler floc in effluent settling is good, but effluent is turbid.	2a. Excessive turbulence in aeration tanks. 2b. Carbon fines not flocculating. 2c. Toxic shock load. 2d. Large increase in loading, causing predominance of flagellates.	2a. DO in aeration tank. 2b. Polymer addition. 2c. Microspocically examine sludge for inactive protozoa. 2d. Plant influent loading.	2a. Reduce aeration agitation. 2b. Assure proper delivery and dose. 2c. Re-seed sludge with sludge from another plant if possible. 2d. Increase PACT addition.

OBSERVATIONS	PROBABLE CAUSE	REQUIRED CHECK	REMEDY
3. Very stable foam on aeration tank which sprays cannot break up.	3a. SRT is too long, filamentous organisms predominating.	3a. Check SRT, also microscopic examination can be used to determine presence of filamentous organisms.	3a. (1) Increase sludge wasting so as to reduce SRT. (2) Increase DO in aeration tank if less than 1 mg/l. (3) Increase pH to 7. (4) Supplement deficiency of nutrients so that BOD to nutrient ratio is no more than 100 mg/l BOD to 5 mg/l total nitrogen; to 1 mg/l phosphorus.
4. Thick billows of sudsy foam on aeration tank.	4a. MLSS too low.	4a. MLSS	4a. (1) Decrease sludge wasting so as to increase MLSS. (2) Increase daily carbon addition.

OBSERVATIONS	PROBABLE CAUSE	REQUIRED CHECK	REMEDY
5. pH of mixed liquor decreases to 6.5 or lower. Sludge becomes less dense.	5a. Nitrification occurring and wastewater alkalinity is low.	5a. Effluent NH_3 & NO_3.	5a. (1) Add source of alkalinity such as lime or sodium bicarbonate.
	5b. Improper pH adjustment.	5b. Influent pH records.	5b. Add caustic.
6. Pin floc in effluent - SVI is good, effluent is clear, but some floating material. Floc is granular in appearance.	6a. Long SRT.	6a. MLSS	6a. Increase sludge wasting to decrease SRT.
	6b. Anaerobic side streams recycled.		6b. Identify and correct sources of anaerobic conditions.

Section No. 8

PLANT SHUTDOWN

1.0 Plant Shutdown

A. Short intermittent disruptions (several hours) of influent should not affect plant performance.

B. If a flow disruption is to be a day or two in length, continue to add carbon and waste sludge to the sludge storage tank, and continue aeration.

C. For a feed flow interruption of more than two days up to about a week, the instructions in Item B above should be followed for the first two days. Thereafter carbon addition and sludge wasting should be discontinued.

The bacteria in the aeration tankage will be deprived of soluble food and will then consume any available food stored inside their cell walls. The bacteria will begin to die off and the more hearty bacteria will live off of the dead cell matter. During this period the bacteria will decrease in number. The longer the unit is held in this mode, the slower it will have to be restarted to minimize bleed-through of soluble BOD. For restarting, seed sludge will speed up the restart.

D. For a shutdown of a month or two, the plant can be left filled with water if there is no danger of freezing. Water should be added to flush all of the MLSS from the tank. The other plant feeds should also be discontinued, i.e., polymer, nutrients, and carbon. The feed pumps should be shut down and discharge lines flushed with water.

E. If the shutdown is to be long term or if freezing will be a problem, remove solids from the system as described in Item D, above. Then drain all tankage.