MOUNTAIN VIEW
WWTP IMPROVEMENTS

PROJECT #: 20-018

DESIGN CALCULATIONS

CWB Engineers, Inc.
-Designing a Better Arkansas-

CERTIFICATE OF AUTHORIZATION
CWB ENGINEERS, INC.
No.1716
ARKANSAS

PROJECT NO. 20-018

MAY 2021

STATE OF ARKANSAS
REGISTERED PROFESSIONAL ENGINEER
No.13831
C. KYLE BRECKENRIDGE

5-12-21

Mt. View WWTP Final Clarifier Design Calculations

Existing Clarifier

Min. Flow	0.2	MGD	
Max. Flow	2.25	MGD	
Design MLSS in Oxidation Ditch =	3,500.00	mg/L	
Existing Clarifier Diameter =	55.00	ft	
Depth =	12.00	ft	
Volume =	213,254.45	gal	
Detention Time Min. =	25.59	hours	
Detention Time Max. =	2.27	hours	
Min. SOR =	84.18	gpd/sf	
Max. SOR =	947.04	gpd/sf	10 SS requires < 1,000 gpd/sf for Extended Aeration
Min. SLR =	2.46	ppd/sf	
Max. SLR =	27.64	ppd/sf	10 SS requires < 35 ppd/sf for Extended Aeration
Min. WLR =	1,157.49	gpd/lf	
Max. WLR =	13,021.77	gpd/lf	10 SS requires < 20,000 for WWTP ADF < 1 MGD

Proposed Clarifier

Min. Flow	0.2	MGD	
Max. Flow	1.25	MGD	
Proposed Clarifier Diameter =	40.00	ft	
Depth =	12.00	ft	
Volume =	112,795.74	gal	
Detention Time Min. =	13.54	hours	
Detention Time Max. =	2.17	hours	
Min. SOR =	159.15	gpd/sf	
Max. SOR =	994.72	gpd/sf	10 SS requires < 1,000 gpd/sf for Extended Aeration
Min. SLR =	4.65	ppd/sf	
Max. SLR =	29.04	ppd/sf	10 SS requires < 35 ppd/sf for Extended Aeration
Min. WLR =	1,591.55	gpd/lf	
Max. WLR =	9,947.18	gpd/lf	10 SS requires < 20,000 for WWTP ADF < 1 MGD

Total Combined Max. Clarifier Capacity = 3.5 MGD

Existing Effluent Box to Existing UV Channel

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4

DIAMETER: 14
C VALUE H 140
C VALUE L 100
LENGTH 110

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
2431	1.115	0.598	5.067	0.957	2.072

UV WL = 602.5
Eff Box WL = 604.57
Top of Effluent Box = 605 0.52 ft. of freeboard @ 3.5 MGD flow

Existing Effluent Box to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	1	1	0	0	0	0	0	0	4	4	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	3.12	4	0	0	0	0	0	0

TOTAL K 7.74

DIAMETER: 16
C VALUE H 140
C VALUE L 100
LENGTH 180

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
1042	0.199	0.107	1.663	0.332	0.531

Eff Box WL = 604.57
WL after FC weir = 605.10

Oxidation Ditch to Proposed Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0	0.39	0.21	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.38

DIAMETER: 12
C VALUE H 140
C VALUE L 100
LENGTH 80

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
1042	0.358	0.192	2.956	0.323	0.681

FC WL = 606.35
Weir 1 607.031121441411
WL in MLSS Splitter Box = 608.03 dist

Oxidation Ditch to Existing Final Clarifier

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0	0.39	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.17

DIAMETER: 14
C VALUE H 140
C VALUE L 100
LENGTH 55

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
1389	0.198	0.106	2.895	0.282	0.480

FC WL = 606.35
Weir 1 606.830386542951
WL in MLSS Splitter Box = 607.83

MLSB to Oxidation Ditch - Existing 16"

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0.23	0.39	0	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 2.4

DIAMETER: 16
C VALUE H 140
C VALUE L 100
LENGTH 100

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
2431	0.529	0.284	3.879	0.561	1.090

MLSB WL = 608.03
Ox Ditch Eff WL = 609.12

Scum Pump Discharge

PIPE SIZE	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
0.5	0.22	9.2	1.48	0.08	-	0.49	0.81	0.43	0.43	0.54	1.62	2.7	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
0.75	0.2	8.5	1.38	0.08	-	0.45	0.75	0.4	0.4	0.5	1.5	2.5	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1	0.18	7.8	1.27	0.07	-	0.41	0.69	0.37	0.37	0.46	1.38	2.3	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.25	0.18	7.5	1.21	0.07	-	0.4	0.66	0.35	0.35	0.44	1.32	2.2	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
1.5	0.15	7.1	1.16	0.06	-	0.38	0.63	0.34	0.34	0.42	1.26	2.1	-	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2	0.15	6.5	1.05	0.06	0.86	0.34	0.57	0.3	0.3	0.38	1.14	1.9	2.3	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
2.5	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
3	0.14	6.1	0.99	0.05	0.81	0.32	0.54	0.29	0.29	0.36	1.08	1.8	2.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
4	0.14	5.8	0.94	0.05	0.77	0.31	0.51	0.27	0.27	0.34	1.02	1.7	2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
6	0.12	5.1	0.83	0.05	0.68	0.27	0.45	0.24	0.24	0.3	0.9	1.5	1.8	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
8	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
10	0.11	4.8	0.77	0.04	0.63	0.25	0.42	0.22	0.22	0.28	0.84	1.4	1.7	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
12	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
14	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
16	0.1	4.4	0.72	0.04	0.35	0.23	0.39	0.21	0.21	0.26	0.78	1.3	1.2	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
18	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
20	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
24	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
30	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
36	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
42	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
48	0.1	4.1	0.66	0.04	0.3	0.22	0.36	0.19	0.19	0.24	0.72	1.2	0.72	0.78	1	0.05	0.065	0.08	0.03	0.08	0.13
	GATE VALVE	GLOBE VALVE	ANGLE VALVE	BALL VALVE	BUTTERFLY VALVE	PLUG VALVE	90° BEND	45° BEND	LR 90° BEND	TEE THROUGH	TEE BRANCH	SWING CHECK VALVE	TILTING DISK CHECK VALVE	PIPE ENTRANCE	PIPE EXIT	REDUCER D RATIO 0.8	REDUCER D RATIO 0.5	REDUCER D RATIO 0.2	ENLARGER D RATIO 0.8	ENLARGER D RATIO 0.5	ENLARGER D RATIO 0.2
QUANTITY	0	0	0	0	0	0	4	4	0	0	0	0	0	1	1	0	0	0	0	0	0
SUMMED K	0	0	0	0	0	0	2.16	1.16	0	0	0	0	0	0.78	1	0	0	0	0	0	0

TOTAL K 5.1

DIAMETER: 3
C VALUE H 140
C VALUE L 100
LENGTH 300

Q GPM	HLh FEET	HLl FEET	V FPS	ML FEET	Total Loss
50	4.144	2.224	2.270	0.408	4.552

Digester HWL = 630
Digester LWL = 620

Scum Beach HWL = 611
Scum Beach LWL = 609

LOW TDH = 11.63 ft
HIGH TDH = 23.63 ft

Mt. View Existing Oxidation Ditch

Flow	0.95	MGD
BOD	200.00	mg/L
TSS	200.00	mg/L
TP	6.00	mg/L
NH3	30.00	mg/L
TKN	40.00	mg/L
Total Basin Volume	430,705.00	gal
Mass Load		
BOD	1,584.60	ppd
Organic Loading	27.52	ppd/mcf
Hyd. Detention Time	10.88	hr
Ynet	0.90	
Design MLSS	3,500.00	mg/L
SRT @ design flow	8.82	days
Washout SRT @ 10°C	4.30	days
SF @0.95 MGD	2.05	

10 S.S. REQUIRES < 40 FOR CONVENTIONAL AERATION, SRT < 15 DAYS

from WERF Publication: Methods for Wastewater Characterization in Activated Sludge Modeling

THE FOLLOWING CALCULATIONS ARE THE ORIGINAL DESIGN CALCULATIONS FOR THE OXIDATION DITCH WHEN IT WAS INSTALLED - WITH DESIGN FLOW = 0.73 MGD.

USFilter
A Siemens Business
Envirex Products

ORBAL DESIGN OUTLINE

Project:	Mt View - AR Orbal	Prepared:	07/18/2006
Engineer:	McClelland consulting engineer	Designer:	Dennis Barnes

Influent Characteristics

Flow, MGD	0.73
BOD5, mg/L	200
TSS, mg/L	200
TP, mg/L	6
NH3-N, mg/L	40
TKN, mg/L	50

Effluent Requirements

BOD5, mg/L	10
TSS mg/L	15
TP, mg/L	1.5
NH3-N, mg/L	1.0
TN, mg/L	10.0

Orbal Design Parameters

Total Load, lb BOD5/day	1,216	MLSS, mg/L	3,470
Primary Clarifiers	NO	No. of Trains in Parallel	1
		Solids under Aeration, Lbs.	12,466
Organic Loading, lb/1000 cft/day	21.15	Sludge Yield	0.85
		WAS per train, lb/day	1,039
Total Hydraulic Detention Time, Hr	14.2	Sludge Age, days	12

Basin Dimensions

No. of Channels per Train	3	Wall Thickness, ft	1.00
Channel Depth, ft	12.00	Radius of Center Island, ft.	5.0
Channel Width, ft		Length of Short Axis Straight Section, ft.	0.0
Inner	10.00	Length of Long Axis Straight Section,ft.	14.0
Middle	10.00	Overall Width, ft.	76.0
Outer	10.00	Overall Length, ft.	90.0
		Volume per Train, cubic feet	57,581
		Volume per Train, gal	430,705

Pumping Requirements

RAS pumping rate at 150% of Q, (where Q is the average design flow rate)
Pump MLSS containing Nitrates from Aerobic Inner channel to Anoxic Outer channel at 400% of Q

Drives Recommendation

Location	Channels spanned	Discs per aerator	Design rpm	Max. rpm	Quantity per train	HP
Outer	1	18	29	45	(2)	10.0
Center Island	2	36	43	55	(2)	30.0
Wall Pumps for Nitrate Recycle to Anoxic Outer Channel				1		5.6

Based on max. disc immersion of	21 inches	Installed HP per Train	86 HP
Based on motor efficiency of	90%		
and design disc immersion of	14 inches	Operating electrical Hp per Train	38 HP

			Orbal Basin Cubic Yards		
Additional Costs	Concrete	Unit Price			
	Walls	$550	320		$176,000
	Floors	$500	156		$78,000
	Installation	Hourly Rate	Orbal	SmartBNR	
		$55	130 man-hrs	100 man-hrs	$13,000
				Total Additional Costs	$267,000

Influent Characteristics Ave. design flow, MGD 0.73

BOD5, mg/L	200	NH3-N, mg/L	40		
TSS, mg/L	200	TKN, mg/L	50	TP, mg/L	6

A) Determine Basin Volume

Basin volume is determined by minimum sludge age required to maintain a healthy population of nitrifying organisms at the minimum wastewater temperature. $\theta_{min}=1/(\mu_{max}*EXP(0.098*(T_{min}-15)))*TPF*SF$, where:

Minimum wastewater temperature, T_{min} =	53.6 degrees F
ΦΤ`xΙ¯Ι ε'ώ^´ϑ ¯Ι´Ω€ μ_{max} =	0.47 $days^{-1}$
Diurnal Peak Factor, DPF =	1.2
Monthly Peak Factor, MPF =	1.3
DPF x MPF = Total Process Peak Factor, TPF =	1.56
Safety Factor, SF =	2.5
Minimum Solids Residence Time, θ_{min} =	11.1 days
Selected Solids Residence Time, θx =	12.0 days

Use McCarty kinetic equations to calculate basin volume required:

1) Inert solids: $M_{o-IS} = (M_{o-TSS})(1 - f_{VSS_o})$ =

(1218 lb/day influent TSS)(100 - 80% VSS) / (100%) = 244 lb/day

2) Nonbiodegradable VSS: $M_{o-NS} = (M_{o-TSS})(f_{VSS_o})(f_{NS})$ =

(1218 lb/day influent TSS)(80% VSS),(40% NBVSS) / (100%) 390 lb/day

3) Heterotropic Kinetic Parameters

Growth Rate, $Y_{true,\,15}$ =	0.6 lb VSS/lb BOD5
Decay rate, b_{15} =	0.06 $days^{-1}$
BOD Half-saturation coefficient, K_{BOD} =	20 mg/l BOD
Adjusting for temperature, $b_T = b_{15}(1.04)^{(T-15)}$ =	0.073 $days^{-1}$
Maximum Growth Rate, $\mu_{MAX,h}$ =	6

Estimate Effluent BOD_5:

Soluble BOD, $S_e = [K_{BOD}(1+b_T\,\theta_x)]/[\theta_x(\mu_{MAX,h} - b_T) - 1]$ =	0.54 mg/l
Effluent VSS concentration, f =	40%
$BOD_{5,total} = S_e + (TSS \times f)$ =	
0.54 + (10mg/l effluent TSS)(40% VSS) / (100%)	4.54 mg/l

Observed yield of heterotrophs: $Y_{OBS\,H} = Y_{true}/(1 + b_T\theta_x)$ = 0.32

Heterotrophic Biomass Produced: $M_H = (M_{o-BOD} - M_{e-BOD})(Y_{OBS-H})$ = 381 lb/day

4) Autotrophic Kinetic Parameters

Growth Rate, $Y_{true,\,15}$ =	0.15 lb VSS/lb NH3-N
Decay Rate, b =	0.05 $days^{-1}$
Ammonia half-saturation coefficient, K_{an} =	0.5 mg NH_3-N/L
Oxygen half-saturation coefficient, Ko =	1 mg DO/L
ΦΤ`xΙ¯Ι ε'ώ^´ϑ ¯Ι´Ω€ μ_{max} =	0.47 $days^{-1}$
Adjusting for temperature: $\mu_{max\,T} = \mu_{max\,15}\theta^{0.098(T-15)}$ =	0.350 $days^{-1}$
$b_T = b_{15}(1.04)^{(T-15)}$ =	0.044 $days^{-1}$

Calculate observed yield of autotrophs: $Y_{OBS\,A} = Y_{true}/(1 + b_T\theta_c)$ = 0.098

Nitrogen assimilated by heterotrophic biomass:

Nitrogen content of biomass: N_{bm} =	12%
Nitrogen assimulated: $M_{NA-H} = (M_H)(N_{bm})$ =	46 lb/day

Nitrogen assimilated by autotrophic biomass (1st iteration):

TKN oxidized: $M_{TKN-o} = M_{o-TKN} - M_{NA-H}$ =	259 lb/day
Autotrophic Biomass Produced: $M_A = (M_{TKN-o})(Y_{OBS\,A})$ =	25 lb/day
Nitrogen assimilated by autotrophic biomass: $M_{NA-A} = (M_A)(N_{bm})$ =	3 lb/day

Nitrogen assimilated by autotrophic biomass (2nd iteration):

TKN oxidized: $M_{TKN-o} = M_{o-TKN} - M_{NA-H} - M_{NA-A}$ =	256 lb/day
Autotrophic Biomass Produced: $M_A = (M_{TKN-o})(Y_{OBS\,A})$ =	25 lb/day
Nitrogen assimilated by autotrophic biomass: $M_{NA-A} = (M_A)(N_{bm})$ =	3 lb/day
TKN oxidized: $M_{TKN-o} = M_{o-TKN} - M_{NA-H} - M_{NA-A}$ =	256 lb/day
Oxidized TKN Concentration = $(M_{TKN-o})(1000)/Q$ =	42 mg/l

5) **Total Solids Production Rate:**

$P_x = M_{O-IS} + M_{o-NS} + M_H + M_A$ =	1039 lb/day
Overall Yield: $Y_N = P_x/M_{o-BOD}$ =	0.85
MLVSS: (Mo-NS + MH + MA) / Px =	76.56%

6) **Orbal Basin Volume Calculations:**

Calculate required volume, based on MLSS concentration of	3500 mg/l
Required Volume, V = (θx)(Px)(1,000,000)/8.34/MLSS =	427048 gallons
Selected Orbal basin volume =	430705 gallons
Actual MLSS: X = (θx)(Px)(1,000,000)/V/8.34 =	3470 mg/l

7) **Waste Activated Sludge:**

WAS TSS: $X_W = (1 + F_R)(X)/(F_R)$ =	5784 mg/l
WAS Flow: QW = (Px)(1000000)/(XW)/8.34 =	21535 gal/day

B. Determine Actual Oxygen Transfer Rate (AOTR) to be satisfied in Orbal

1) **Carbonaceous O2 demand**

oxygen equivalent of cell mass, B =	1.42 lb O2/lb VSS
Influent BOD_{ULT}:BOD5 RATIO:	1.46
Effluent BOD_{ULT}:BOD5 RATIO:	1.2
Carbonaceous oxygen demand design factor, f_{c-o2}:	1.16

a) Mass of BOD_5 O_2 demand equivalents entering the system:

lb BOD5/d x Influent BODULT:BOD5 RATIO =	
(1218 lb/day influent BOD)(1.46) =	1778 lb/day

b) Mass of BOD_5 O_2 demand equivalents leaving the system:

lb BOD5/day x Effluent BODULT:BOD5 RATIO =	
(28 lb/day effluent BOD)(1.46) =	33 lb/day

c) Mass of O_2 equivalents leaving the system as biomass:

heterotrophic VSS/d + autotrophic VSS/d x lb O2/lb VSS =	
(381 + 25.01)(1.42) =	576 lb/day

d) Carbonaceous O_2 demand (calc.): $f_{c-o2}(a - b - c)$ = 1356 lb/day

e) Carbonaceous O_2 demand (selected): 1356 lb/day

2) Nitrification oxygen demand:

Nitrification oxygen equivalent:	4.6
Denitrification oxygen credit:	2.9

Nitrification oxygen demand: lb O2/kg NH3-N x lb TKN oxidized/day =
(256 lb/day TKN oxidized)(4.6) = 1176 lb/day

3) Denitrification oxygen credit:

As long as that the organic loading is high enough and the O2 supply is distributed to multiple locations, the outer channel(s) of Orbal systems can be maintained in an anoxic state by limiting the percentage of the overall system AOR satisfied in each anoxic channel to a value close to the percentage of the overall system volume in that channel, resulting in simultaneous nitrification and denitrification. Ammonia oxidation will occur at a rate proportional to the percentage of AOR satisfied in each Orbal channel. With a strong oxygen deficit (DO = near zero mg/l), 100% of the ammonia oxidized will be denitrified. With a mild oxygen deficit condition (DO = near 0.5 mg/l), 65% of ammonia oxidized will be denitrified. Based on the process split listed in the table below, we can calculate the rate of denitrification for the Orbal system:

	Channel 1	2	3	Total
Volume Split	47.7%	33.3%	18.9%	100.0%
AOR Split	19.4%	44.2%	36.4%	100.0%
DO, mg/l	0.0	0.5	2.0	
Denite Rate	100%	65%	0%	

Nitrogen Mass Balance

Nitrogen components in clarifier return activated sludge, with RAS flow at 150% of design flow

Ammonia-N: MR-NH3 = (Ce-NH3)(Q)(RAS%)(8.34) =	3 lb/day
Nitrate-N: MR-NOx = (Ce-NOx)(Q)(RAS%)(8.34) =	32 lb/day
Total-N: MR-TN = (Ce-TN)(Q)(RAS%)(8.34) =	52 lb/day

Nitrogen components in MLSS recycle stream, with internal recycle (IR) at 400% of design flow

Ammonia-N: MIR-NH3 = (Ce-NH3)(Q)(Recycle%)(8.34) =	7 lb/day
Nitrate-N: MIR-NOx = (Ce-NOx)(Q)(Recycle%)(8.34) =	86 lb/day
Total-N: MIR-TN = (Ce-TN)(Q)(Recycle%)(8.34) =	140 lb/day

Nitrogen components in channel 1 influent:

Ammonia-N: $M_{I\text{-}NH3} = M_{o\text{-}NH3} + M_{R\text{-}NH3} + M_{IR\text{-}NH3}$ =	266 lb/day
Nitrate-N: $M_{I\text{-}NOx} = M_{o\text{-}Nox} + M_{R\text{-}Nox} + M_{IR\text{-}NOx}$ =	118 lb/day

Nitrogen Components in Reactor 1 Effluent:

Ammonia-N: $M_{1\text{-}NH3} = M_{I\text{-}NH3} - (M_{o\text{-}NH3} - M_{e\text{-}NH3})(f_{N1})$ =	217 lb/day
Nitrate-N: $M_{1\text{-}Nox} = (M_{I\text{-}NH3} - M_{1\text{-}NH3} + M_{I\text{-}NOx})(1\text{-}f_{D1})$ =	0 lb/day

Nitrogen Components in Reactor 2 Effluent:

Ammonia-N: M2-NH3 = M1-NH3 - (Mo-NH3 - Me-NH3)(fN2) = 104 lb/day
Nitrate-N: M2-Nox = (M1-NH3 - M2-NH3 + N1-NOx)(1-fD2) = 39 lb/day

Nitrogen Components in Reactor 3 Effluent:

Ammonia-N: M3-NH3 = M2-NH3 - (Mo-NH3 - Me-NH3)(fN3) = 5 lb/day
Nitrate-N: M3-NOx = (M2-NH3 - M3-NH3 + N2-NOx)(1-fD3) = 53 lb/day

Nitrogen Components in Clarifier Effluent:

Ammonia-N: $M_{e\text{-}NH3} = M_{4\text{-}NH3} - M_{R\text{-}NH3}$ = 2 lb/day
Nitrate-N: $M_{e\text{-}NOx} = M_{4\text{-}NOx} - M_{R\text{-}NOx}$ = 21 lb/day
Effluent NH_3-N Concentration = $(M_{e\text{-}NH3})(1000)/Q$ = 0.3 mg/l
Effluent NO_3-N Concentration = (Me-Nox)(1000)/Q = 3.5 mg/l

Denitrification oxygen credit:
(lb O2/lb NO3-N)(lb TKN oxidized/d - lb effluent NO3-N/day) =
(2.9)(256 - 21) = 680 lb/day

4) **Net oxygen demand, AOR:**
lb Carbonaceous O2/d + lb Nitrogenous O2/d - lb Denitrification Credit/day = 1852 lb/day

C) **Determine Standard Oxygen Transfer Rate (SOTR) to be satisfied in Orbal**

SOTR = AOTR / FCF FCF = A x (B x ACF x C_s – DO) x TCF / 9.092

Alpha, A = 0.95 Beta, B = 0.98
Elevation = 770 feet Altitude Correction Factor (ACF) = 0.972
Design water temperature = 68F Temperature Correction Factor (TCF) = 1.000
Saturation Concentration of Oxygen at Design Water Temperature, Cs = 9.09 mg/l
DO = Dissolved oxygen concentration in each reactor, mg/l

	Channel 1	2	3	Total
AOR, lb/hr	15	34	28	77
DO, mg/l	0.0	0.5	2.0	
FCF	0.905	0.853	0.696	
SOR, lb/hr	17	40	40	97

1) Calculate disc quantity required per channel # of discs required = SOTR / SOTR/disc

	Channel 1	2	3	
Design disc immersion (in.)	14.0	14.0	14.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.48	1.18	1.18	Total
Disc Quantity	36	36	36	108

2) Disc aerator drive selection

(2)	10.0 Hp aerator(s) on periphery of basin, each turning	18 discs
(2)	30.0 Hp aerator(s) on periphery of basin, each turning	36 discs

3) Check for adequate oxygen reserve capacity

	Channel 1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

RESERVE SOTR CAPACITY

	All aerators in service	Largest aerator out
Maximum SOTR =	245 lb/hr	155 lb/hr
Reserve Over Design Load =	152%	60%

WITH LARGEST AERATOR OUT, CAPACITY = 0.73/0.6 = 1.2 MGD < 0.95 MGD PROPOSED DESIGN FLOW

1) **Calculate disc quantity required per channel** # of discs required = SOTR / SOTR/disc

	Channel 1	2	3	
Design disc immersion (in.)	16.0	16.0	16.0	
Design disc speed (rpm)	29	43	43	
Design SOTR/disc lb/hr/disc	0.54	1.32	1.32	Total
Disc Quantity	36	36	36	108

2) **Disc aerator drive selection**

(2)	10.0 Hp aerator(s) on periphery of basin, each turning	18 discs
(2)	30.0 Hp aerator(s) on periphery of basin, each turning	36 discs

80 Hp

3) **Check for adequate oxygen reserve capacity**

	Channel 1	2	3
Max. disc immersion (in.)	21.0	21.0	21.0
Max. disc speed (rpm)	45	55	55
Max. SOTR/disc lb/hr/disc	1.80	2.50	2.50

1.8 x 24 = 43.2 lb/d x 1 d/24 hr = 1.8 lb/hr
2.5 x 24 = 60. lb/hr
2.5 x 24 = 60. lb/hr

RESERVE SOTR CAPACITY

	All aerators in service	Largest aerator out
Maximum SOTR =	245 lb/hr	155 lb/hr
Reserve Over Design Load =	115%	36%

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transfer rate = 2 lbs O2 / 1 hp.hr

1 hp / 2 lbs O2 = x hp / 114 lb O2

x = 114 lb O2 x 1 hp / 2 lbs O2 = 57 hp

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HYDRAULIC CALCULATIONS FOR ORBAL SYSTEM

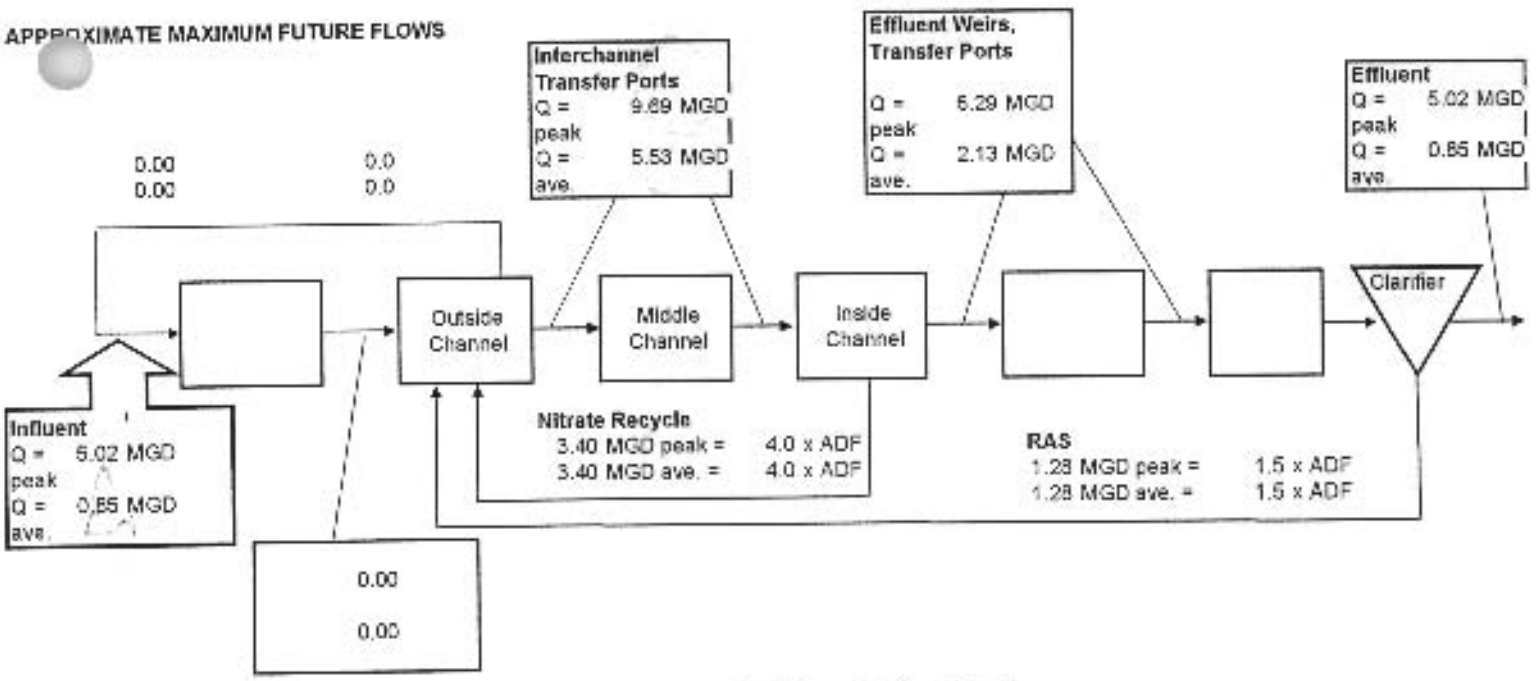
Date: 11/6/2005

Project: Mt View - AR Orbal
Engineer: McClelland consulting engineer

Designer: Dennis Barnes

Number of Channels in Orbal 3

APPROXIMATE MAXIMUM FUTURE FLOWS



SUGGESTED SIZING FOR INTERCHANNEL TRANSFER PORTS

(ports between outer, middle, and inner channels)

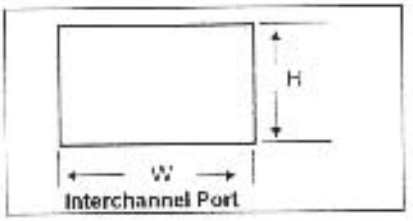
Maximum flow = 9.69 MGD = 5.02 MGD peak + 1.28 MGD RAS + 3.40 MGD SIM-PRE
Limit headloss to 0.50 inches at peak flow

Headloss Calculations: $h = 1.21 (Q/A)^2$

Where: h = headloss in inches
Q = flow in MGD
A = area in sq. ft

Solving for A, we have:

$A = (1.21Q^2/h)^{1/2}$ = 15.07 sq. ft.



Recommended port opening size = 16.00 sq. ft. = 48 inch x 48 inch

Actual hl at peak, inches =	0.444
Actual hl at peak, ft =	0.037
Actual hl at average, inches =	0.144
Actual hl at average, ft =	0.012

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HYDRAULIC CALCULATIONS FOR ORBAL SYSTEM

Date: 11/8/2005

Project: Mt View - AR Orbal
Engineer: McClelland consuting engineer

Designer: Dennis Barnes

SUGGESTED SIZING FOR EFFLUENT CONTROL STRUCTURE GATE

(gate between inner channel and effluent weirs)

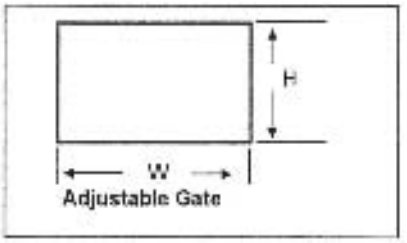
Maximum flow = 6.290 MGD = 5.015 MGD peak + 1.275 MGD RAS
Limit headloss to 1 inches at peak flow

Headloss Calculations: h = 1.21 (Q/A)^2

Where: h = headloss in inches
Q = flow in MGD
A = area in sq. ft.

Solving for A, we have:

A = (1.21Q^2/h)^1/2 = 6.919 sq. ft.



Recommended port opening size = 7.111 sq. ft. = 32 inch x 32 inch

Actual hl at peak, inches = 0.947
Actual hl at ave., ft = 0.079

Actual hl at average, inches = 0.1081
Actual hl at average, ft = 0.009

SUGGESTED SIZING FOR EFFLUENT WEIRS

Maximum flow = 6.290 MGD = 5.015 MGD peak + 1.275 MGD RAS
Limit headloss to 3 inches at peak flow with adjustable gate at 100% closed

Headloss Calculations: h = (18.96Q/L)^2/3

Where: h = headloss in inches
Q = flow in MGD
L = length of weir in feet

Solving for L, we have:

(18.96Q/h^3/2) = 23.0 feet

Recommended high weir length = 23 feet

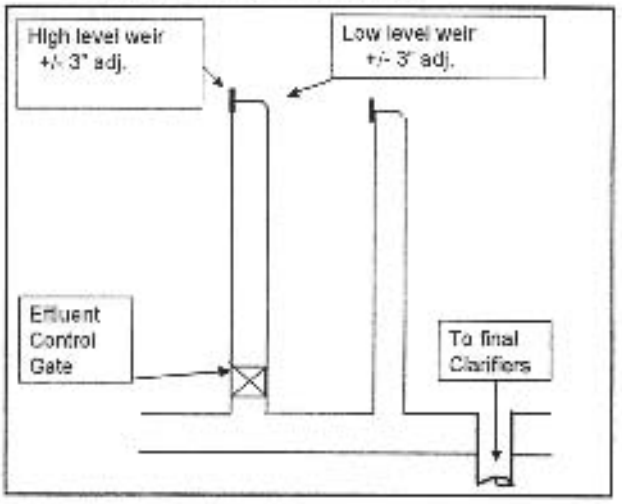
Actual hl at peak, inches = 2.996
Actual hl at peak, ft = 0.250

Minimum recommended low weir length = 5.157 feet

Actual low weir length, feet = 6 feet
Actual hl at peak, inches = 7.338 inches
Actual hl at peak, ft = 0.611 feet

Maximum disc immersion = 21"
Minimum disc immersion = 9"
disc radius = 27"

Section view of Center Island Weirs



- Top of high level weir plate should be placed 6" + (high weir hl) 2.996 " + (inter-channel calc h) 0.888 " = 9.88" below the centerline of the shaft. Top of concrete weir support should be placed 3" below the high weir plate.
= 0.824 feet

- Top of low level weir plate should be placed 18" below the center line of the shaft. Top of concrete weir support to be 21" below the centerline of the shaft.

With high level weir at 0.8236 feet below shaft centerline, max. disc immersion at average flow = 18.66 inches

If chamber between low weir and gate has a cross-sectional area= 2 sq. ft. average velocity = 0.655 fps
peak velocity = 3.68 fps