Irvine Ranch Water District

ECOSYSTEM PLUS® TREATMENT

Report of Results

The following is a report of the results of a treatment program at the wastewater treatment facility owned and operated by the Irvine Ranch Water District (IRWD) in Irvine, California utilizing the EcoSystem Plus® (ESP) product manufactured by Neozyme International, Inc. The objective of this short-term treatment program was to demonstrate the efficacy of the product in reducing aeration energy through the formation of microbubbles that increase oxygen diffusion. The air flow in one aeration tank (Tank 1) treated with the ESP product was compared to an untreated tank (Tank 4), and with a baseline before treatment. The ESP treatment was successful in demonstrating reduced air requirements both as compared to air flow in the untreated tank (21.4% average reduction), and as compared to the baseline before treatment (19% average reduction). Single day reductions of as much as 58% were observed. In addition, although only one of six tanks was treated, total plant aeration efficiency (cubic feet per lb of COD) was reduced by about 6% during the treatment, due to product carry-over in the return activated sludge. No adverse effects on sludge settling or denitrification were observed.

Facility Description

The facility receives an average of about 13 MGD of residential and commercial/industrial wastewater. The facility design is of the advanced activated sludge treatment type utilizing primary clarifiers, flow equalization, and an activated sludge nitrification/denitrification secondary treatment system. The plant also includes dual media gravity filtration, and chlorine contact tanks before discharge to reservoirs for wetlands discharge and reuse as irrigation water. Primary and secondary sludge is pumped to the Orange County Sanitation District for digestion and disposal (see Drawing SK-01a).

After passing through a comminutor and grit separators, solids are separated in five primary clarifiers. Primary effluent is then pumped to flow equalization basins and to six diffused air aeration basins, followed by ten secondary clarifiers. The aeration basins incorporate anaerobic and mixed anoxic sections at the entrance to the basins for denitrification. The aeration basins incorporate fine-bubble diffused air aeration supplied by variable vane type blowers driven by electric motors that are automatically controlled. Air flow to each aeration basin is individually controlled by monitoring the dissolved oxygen (DO) in each basin. It is assumed that the COD load to each basin is maintained at approximately equivalent levels.

Baseline Conditions

Based upon data supplied by the IRWD for November and December 2001, a seven-day baseline period was established between November 29 and December 5: 2001. This period was selected because the air diffusers had been cleaned in both Tank 1 (the tank to be treated) and Tank 4 (the comparison tank) during November, and this period was after the diffusers had been back in operation for one week. In this baseline period, the COD averages about 546 mg/L in the influent and about 28 mg/L in the plant effluent, a reduction of about 95%. Primary effluent COD averages about 232 mg/L (25,069 lb/day COD based upon the average flow of 12.96 MGD). During this period, the average total air flow to the aeration basins was 11.029 million cubic feet (d) per day. This is equivalent to 440 cf of air per pound of COD (1,100 cf per pound of BOD at a 2.5:1 COD to BOD conversion ratio). This air consumption is within a reasonable design range for diffused air aeration in a nitrification/denitrification process. The aeration tanks were operated at an average MLSS of 2,638 mg/L during the baseline period. Table 1 lists the daily data for the baseline period obtained from the plant operators. During the baseline period, air flow to Tank 1 (the tank to be treated) averaged 1.956 million cf/day. This flow is equivalent to 468 cf of air per pound of COD (assuming equal distribution of primary effluent flow to each aeration tank).

In other applications, Neozyme's bio-organic catalyst technology has demonstrated the ability to increase DO concentrations in similar aeration basins through the formation of microbubbles, resulting in increased aeration efficiency. In this application, the treatment was expected to allow the automatically controlled levels of dissolved oxygen to be maintained in the treated aeration tank while decreasing the airflow requirements of the aeration devices, and therefore decreasing the energy requirements.

Treatment Set-up

The mixing and metering device was set up on December 6, 2001 at a location near Aeration Tank 1. Plant wash water (effluent) was used as dilution water for the treatment at about 2.0 gallons per minute. A diaphragm-type metering pump was used to inject ESP into the dilution water stream at a dosage rate of 6 gallons per day (based upon the average influent BOD_5). A starting dose of 15 gallons of ESP was injected on December 6 to treat the existing volume of water in the basin. Continuous ESP injection was started at about 11:30 AM on December 6.

The treatment continued through December 24, 2001 at which time the continuous injection was stopped and a final dose of20 gallons of ESP was added. Due to an average solids retention time of about 6 days, the effects of the treatment continued until December 30, 2001.

Results of Treatment

All data were collected by the plant operators as normal practice during the treatment period. Tank 1 was selected to be the treated tank, and Tank 4 was selected to be the untreated control tank for comparison. These two tanks had historically similar air flow requirements. Operators not only monitored air flow into the treated and untreated tanks, but also MLSS, DO and the DO levels in the anoxic sections of the basins. Operators were concerned about any adverse impact on the denitrification process. Operators also monitored secondary clarifier supernatant clarity to detect any adverse impacts on sludge settling.

Table 2 lists the daily primary effluent flow, primary effluent COD, and air flow data for the treatment period for all of the aeration tanks. During the treatment period, the primary effluent averaged 26,487 Ib/day of COD, about 6% higher than in the baseline period. In addition, the aeration basins were operated at an average MLSS of 3,005 mg/L, about 14 % higher than the baseline period. Despite these changes that should require greater amounts of air, the air flow to the ESP treated Tank 1 dropped to an average of 1.584 million cf/day (19% lower than the baseline). On December 11, the air flow dropped to 0.817 million cf, a reduction of 58% from the baseline and a 50% reduction from the air flow to Tank 4 on the same day. The average DO in Tanks 1 and 4 were nearly the same on this day. It is believed that this large drop in air flow is evidence that the system was responding to the high initial dose of ESP several days after injection.

Compared to the untreated Tank 4, the average air flow to Tank 1 was 21.4% lower (1.584 versus 2.016 million cf/day) during the treatment period. Calculated per pound of COD, the air flow dropped in Tank 1 ITom468 cf/1b COD before treatment to 359 cf/lb COD during treatment (23% lower than the baseline). DO levels in each tank were automatically controlled to a set concentration, which remained relatively unchanged during the treatment period.

Despite the higher COD load and MLSS concentration in the aeration tanks, the total plant air requirement actually dropped from an average of 11.029 million cf/day to 10.905 million cf/day (about 1% lower). Calculated per pound of COD, the total plant air requirement was reduced from 440 cf/1b COD to 412 cf/1b COD (about 6% lower). It is believed that the treatment in Tank 1 has affected the operation of all of the aeration basins through the carry-over of ESP product in the return activated sludge (RAS). The ESP bio-organic catalyst tends to attach to bacterial flocs and therefore is carried into the sludge that is returned to all of the aeration tanks. This phenomenon may also explain why the air requirements in both Tanks 4 and 5 were reduced during the treatment period while the air flow increased in both Tanks 3 and 6. The RAS return line empties into the primary effluent flow between Tanks 4 and 5, and may cause more RAS to flow into these tanks. It is believed that greater reductions would be observed if the entire plant flow was treated. It should be noted that air flow in Tanks 3 and 6 were lower in the baseline period than Tank 1, but during the treatment period, the air flow to Tank 1 was the lowest of all aeration tanks.

Conclusions
The following are the conclusions that can be drawn from the data.

1. **Aeration air flow was reduced by over 21% in the treated Tank**. The average air flow required by Tank 1 (treated) was 21.4% lower than the average air flow required by Tank 4 (untreated) during the treatment period. Compared with the average air flow during the baseline period before treatment, the air flow to Tank 1 was reduced by 19%, despite higher COD load and MLSS concentrations. During the treatment, DO was automatically controlled at equivalent levels.

2. **Air Flow decreases are greater at higher doses of ESP**. Five days after the injection of a large starting dose of ESP, a dramatic decline in air flow was observed in the treated Tank 1. Also, the effects of the final large dose were evident for six days after ESP injection stopped.

3. **Total Plant air flow was reduced by 6%**. Calculated per pound of COD, the plant required about 6% less air during the treatment period as compared to the baseline period before treatment. This effect was observed even though only one of six aeration tanks was treated.

4. **No adverse effects were observed**. No adverse effects of the treatment on denitrification or sludge settling were observed.

TABLE 1
Aeration Tank Data
Before Treatment with Neozyme ESP
Irvine Ranch Water District

Date 2001	Prim Eff MGD	Prim Eff COD mg/L	Prim Eff COD lb/day	Air Flow (million cubic feet) Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6	MLSS mg/L
11/29	14.55	204	24,755	2.196	1.962	1.599	1.984	3.541	1.626	2,612
11/30	11.77	214	21,007	2.165	3.424	1.753	2.310	4.814	1.752	2,447
12/1	12.16	227	23,021	2.165	3.424	1.753	2.300	4.814	1.752	2,663
12/2	12.46	251	26,083	2.165	3.424	1.753	2.313	4.814	1.752	2,676
12/3	14.25	234	27,810	1.978	4.420	2.143	2.507	5.177	2.001	2,752
12/4	12.82	231	24,698	1.505	4.494	1.718	1.995	4.829	1.62	2,702
12/5	12.72	2,965	28,112	1.516	4.201	1.831	2.047	5.013	1.656	2,612
Totals	**90.73**	**1,626**	**175,486**	**13.69**	**25.349**	**12.55**	**15.456**	**33.002**	**12.159**	**18,464**
Averages	12.96	232	25,069	1.956	3.621	1.793	2.208	4.715	1.737	2,638
cf/lb COD	-	-	-	468	-	-	528	-	-	-

Source: IRWD Data reports

TABLE 2
Aeration Tank Data
During Treatment with Neozyme ESP
Irvine Ranch Water District

Date	Prim Eff	Prim Eff COD		Air Flow (million cubic feet)						MLSS
2001	MGD	mg/L	lb/day	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6	mg/L
12/6	13.03	284	30,862	1.283	3.779	1.700	1.792	4.388	1.646	2,775
12/7	12.00	219	21,918	1.640	3.854	1.814	1.960	3.325	1.737	2,764
12/8	11.80	217	21,355	1.640	3.854	1.814	1.960	3.325	1.737	2,585
12/9	12.20	307	31,237	1.640	3.854	1.814	1.960	3.325	1.737	2,662
12/10	12.89	171	18,383	2.113	4.428	1.818	1.979	3.436	1.863	2,850
12/11	12.57	196	20,547	0.817	4.083	1.805	1.868	4.209	1.643	2,683
12/12	12.89	231	24,833	1.442	4.573	1.884	1.912	4.712	2.262	2,893
12/13	12.81	211	22,542	1.553	5.911	1.898	1.957	4.591	1.795	2,914
12/14	12.04	231	23,196	1.680	5.209	2.123	2.050	4.177	2.003	2,932
12/15	12.48	284	29,560	1.380	5.209	2.123	2.050	4.177	2.003	2,837
12/16	13.39	271	30,263	1.680	5.209	2.123	2.050	4.177	2.003	2,774
12/17	13.78	257	29,536	1.914	5.912	2.102	2.187	4.154	2.059	2,897
12/18	13.69	284	32,426	1.758	6.214	1.877	2.052	4.354	1.896	2,949
12/19	12.12	271	27,393	1.764	5.013	1.8893	2.112	5.815	1.923	3,181
12/20	12.96	194	20,969	1.789	3.577	1.947	2.178	4.039	1.976	3,173
12/21	11.89	246	24,394	1.774	3.613	2.086	2.192	3.153	1.530	2,157
12/22	12.04	273	27,413	1.767	3.04	2.034	2.182	4.48	1.968	3,088
12/23	11.00	277	25,412	1.731	3.914	1.955	2.133	4.81	1.918	3,104
12/24	12.22	272	27,721	1.931	3.972	2.188	2.339	5.958	2.063	3,180
12/25	11.32	284	26,812	1.892	3.08	2.165	2.445	5.486	2.060	3,156
12/26	11.58	383	36,989	1.467	1.933	1.717	1.995	3.572	1.748	3,172
12/27	11.13	307	28,497	1.212	2.175	1.595	1.846	2.584	1.630	3,379
12/28	12.12	278	28,100	1.141	1.563	1.518	1.737	1.867	1.576	3,489
12/29	11.20	302	28,209	1.141	1.563	1.518	1.737	1.867	1.576	36,369
12/30	11.79	240	23,599	1.141	1.563	1.518	1.737	1.867	1.576	3,166

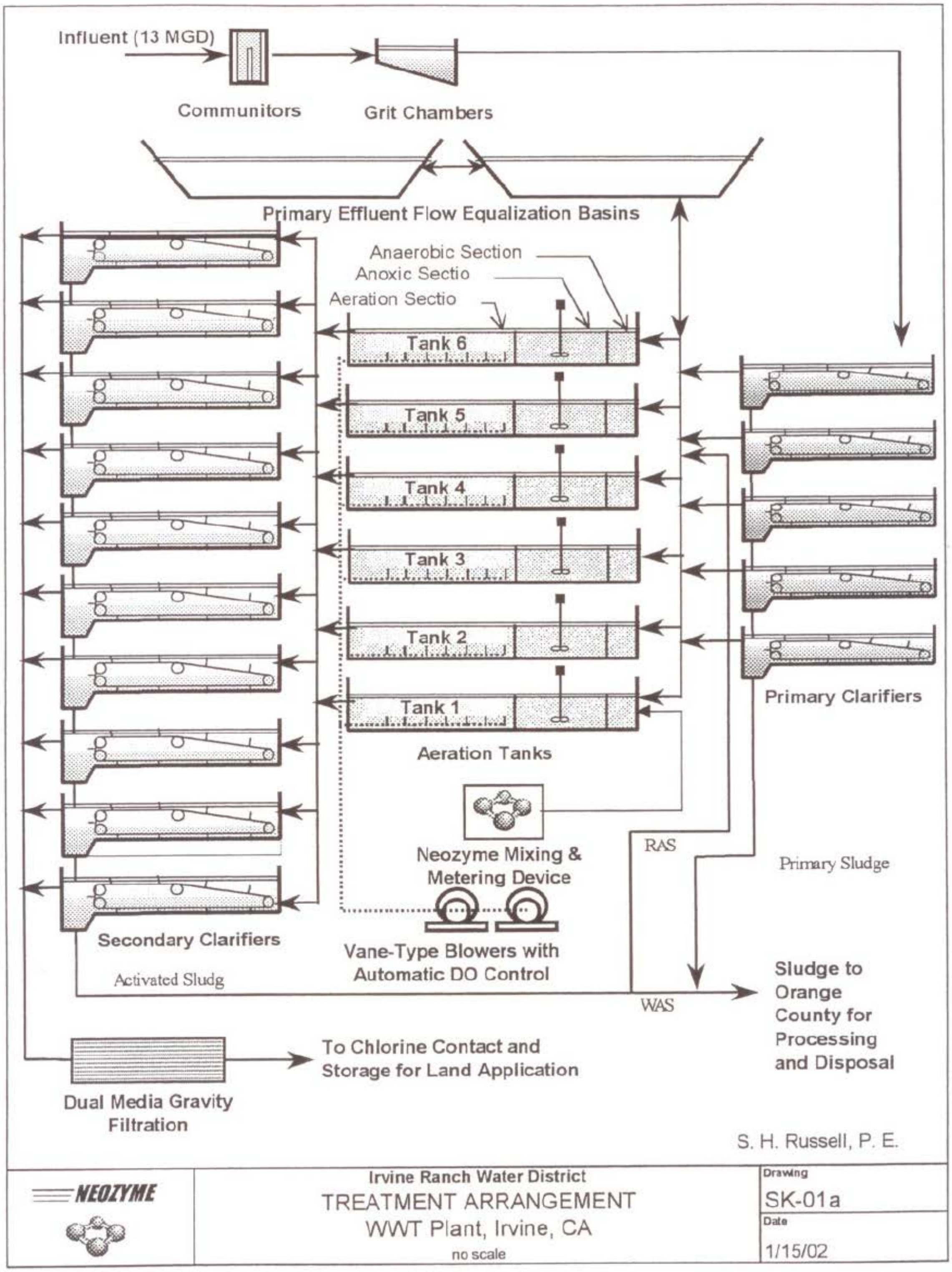
Totals	**306.94**	**6,490**	**662,166**	**39.590**	**97.095**	**47.029**	**50.41**	**97.848**	**46.351**	**75,129**
Averages	12.28	260	26,487	1.584	3.884	1.881	2.016	3.914	1.854	3,005
cf/lb COD	-	-	-	359	-	-	457	-	-	-

Treated Tank

Source: IRWD Data Reports

Notes:

1. Treatment started on Tank 1 at 11.30am on 12/6/001
2. Final ESP Injection: 20 gallons on 12/24/01


Influent (13 MGD)
Communitors
Grit Chambers
Primary Effluent Flow Equalization Basins
Anaerobic Section
Anoxic Sectio
Aeration Sectio
Tank 6
Tank 5
Tank 4
Tank 3
Tank 2
Tank 1
Aeration Tanks
Primary Clarifiers
Neozyme Mixing & Metering Device
RAS
Primary Sludge
Secondary Clarifiers
Vane-Type Blowers with Automatic DO Control
Activated Sludg
WAS
Sludge to Orange County for Processing and Disposal
Dual Media Gravity Filtration
To Chlorine Contact and Storage for Land Application
S. H. Russell, P. E.
NEOZYME
Irvine Ranch Water District
TREATMENT ARRANGEMENT
WWT Plant, Irvine, CA
no scale
Drawing
SK-01a
Date
1/15/02