A DIGITAL CONTROL SYSTEM FOR OPTIMAL OXYGEN TRANSFER EFFICIENCY

Arnold Schwarzenegger

APPENDIX D: PRELIMINARY MARKET ASSESSMENT OF AN OFF-GAS ANALYZER FOR OXYGEN TRANSFER EFFICIENCY MONITORING OF WASTEWATER AERATION

PIER FINAL PROJECT REPORT

Prepared For:
California Energy Commission
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Prepared By:
Southern California Edison
University of California, Los Angeles
Utility Technology Associates

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Prepared By:
Southern California Edison
Lory Larson
Los Angeles, California 95616

Prepared For:
Public Interest Energy Research (PIER) Program
California Energy Commission

Paul Roggensack
Contract Manager

Michael Lozano
Program Area Lead
Industrial/Agricultural/Water End-Use Energy Efficiency

Virginia Lew
Office Manager
Energy Efficiency Research Office

Thom Kelly, Ph.D.
Deputy Director
ENERGY RESEARCH & DEVELOPMENT DIVISION

Melissa Jones
Executive Director

Appendix D

Preliminary Market Assessment of an Off-Gas Analyzer for Oxygen Transfer Efficiency Monitoring of Wastewater Aeration

Final Report

Prepared by:

Design and Engineering Services
Southern California Edison

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Disclaimer

Preface

Market assessment is an integral part of any new technology rollout program. Information developed through market assessment provides market intelligence on customers' interest to adopt the new technology.

The original intent of this study was to have SCE energy service representatives conduct the market survey internally. This plan was changed when we found out that BacGen, a very reputable wastewater consultant, was under contract at the time to SCE on a different technology deployment program for the same wastewater industry we plan to survey. By having BacGen conduct the survey/assessment concurrent with their on-going activities, we were able to reduce the time required for the survey as well as cost for training of SCE personnel prior to the survey. Consequently, the survey was performed more cost-effectively, without utility bias, and by skilled professionals in this field.

Study results showed that the majority of the wastewater treatment plant operators have little interest in the off-gas technology. The most common reasons given by operators were: lack of time, no interest to learn, and lack of understanding/too complex to be useful. Off-gas testing consultants and diffuser suppliers also shared similar negative comments.

We can understand why consultants are against this technology development because of obvious conflict of interest. They (the consultants) as well as diffuser manufacturers would rather have the tests performed only by experts and not operators. Most treatment plant operators, unfortunately, have little or no exposure to the off-gas monitoring technology since they rarely have seen or performed the tests themselves. The tests were historically performed by off-gas testing consultants. The few that thought they understood or knew the technology have exposure to only the old off-gas measurement techniques where monitoring was extremely cumbersome, too costly, and excessively time consuming.

UCLA researchers, through research and innovation, were able to mitigate these concerns. They developed a prototype off-gas monitoring device that is low-cost, modular, automated, easy to use, and can provide instantaneous readings of oxygen transfer efficiency. Because of its low cost and simplicity, we believe that most if not all of the operators would find this device useful and helpful when it is commercially deployed. Most importantly, it will help them determine when cleaning of diffusers is needed and how much energy they can save monthly and annually.

To overcome ignorance and preconceived notion about this technology, we need to provide informative education and training of the technology to most if not all of the treatment plant operators at pre-scheduled workshops and seminars. Technology transfer is vital to the success of implementing this technology.

ABBREVIATIONS AND ACRONYMS

AL	**Aerated Lagoon – Facility type whereby the secondary treatment is conducted in earthen basins (lined or non-lined), containing a mixture of suspended bacteria and wastewater. Aerated lagoons are typically loaded at a lower rate (per volume of basin) than activated sludge basins. Aerated lagoons are traditionally aerated by mechanical aerators, however diffused aeration systems are now also available in the market place.**
ASP	**Activated Sludge Plant – Facility type whereby the secondary treatment is conducted in constructed basins (typically concrete or metal), containing a mixture of suspended bacteria and wastewater. The process is mainly aerobic, whereby process air is provided by diffused aeration or mechanical aerators.**
BOD	**Biochemical Oxygen Demand**
CBOD	**Carbonaceous Biochemical Oxygen Demand**
DO	**Dissolved Oxygen**
DOC	**Department of Corrections**
DR	**Demand Response**
F/M	**Food to Microorganism**
HCl	**Hydrogen Chloride**
hp	**Horsepower**
LACSD	**Los Angeles County Sanitation District**
MCRT	**Mean Cell Residence Time**
Mgd	**Million gallons per day**
MLSS	**Mixed Liquor Suspended Solids**
OCSD	**Orange County Sanitation District**
OTE	**Oxygen Transfer Efficiency**
PLC	**Programmable Logic Controller**
RAS	**Returned Activated Sludge**

SCADA	**Supervisory Control and Data Acquisition**
SBR	**Sequential Batch Reactor**
TF	**Trickling Filter – Facility type with fixed film bacteria. Wastewater is typically pumped up to and distributed at the top of the media column. Air to supply oxygen to the bacteria passes through the media column through natural convective ventilation or through forced air (supplied by fans at the bottom of the column).**
VFD	**Variable Frequency Drive**
WAS	**Waste Activated Sludge**
WwTF	**Wastewater Treatment Facility**

TABLES

CONTENTS

EXECUTIVE SUMMARY

The majority of wastewater facilities with activated sludge basin designs have diffused aeration systems to provide oxygen to the bacteria for destruction of organic material. Because aeration systems are very energy intensive, it is important to address their efficiency. The most effective method for measuring diffuser efficiency 'in situ' is the off-gas technique, which is based on measuring the partial pressure of oxygen in the off-gas of a diffused aeration system. *The* expert researcher in this field is Prof Stenstrom of UCLA. A portable, low cost off-gas measuring device was recently developed by Prof Stenstrom and his team. The subject of this study is to find out whether this new device is likely to be widely adopted by wastewater operators if brought to market. The project deliverables are as follows:

- Development of an Audit Survey Form to form the basis of wastewater operator interviews
- Conduct a phone survey and analyze the data
- Conduct further investigations through site visits
- Identify potential wastewater facilities that can model as demonstration sites
- Identify barriers for broad market adoption of the device

Conclusions of the study are as follows:

- Of the thirteen wastewater treatment respondents (mainly operators) surveyed, either by telephone interview or on-site visits, nine were skeptical, one showed some interest and three were interested to get more information about the device and its merits.
- 'Operator' respondents with a skeptical response usually claimed that they had little time for taking off-gas measurements. An often heard response was that measurement to quantify the inefficiencies would not help them in any way. They were mostly aware of the diffuser performance deterioration over time, but that they had no means of cleaning or replacing these diffusers easily.
- A number of off-gas measurement experts in the field and diffusers suppliers were also surveyed. Out of four useable responses, the general consensus was that off-gas testing should be left to experts. All 'expert' respondents expressed doubt that there would be a viable place for an off-gas device in the market place. These responses were understandably reflective of their professions which are primarily to market their services or products.

INTRODUCTION

Approximately 80% of all wastewater treatment facilities in the SCE territory use activated sludge treatment as the main type of secondary treatment. The majority of these activated sludge designs have diffused aeration systems for providing oxygen to the bacteria that convert organic load into benign substances (carbon dioxide and water). According to data collected by BacGen for wastewater facilities in California, the typical energy usage in the activated sludge system is 50% or more of the total energy consumed by the wastewater facility. Hence it is very important to optimize energy use in the secondary treatment system.

The efficiency of oxygen transfer of diffused aeration systems in activated sludge basins has long been the subject of research by UCLA (see References and Bibliography at the end of this document). Professor Stenstrom is an authority in off-gas techniques and measurement of the efficiency for diffused aeration systems.

Recently, Prof. Stenstrom and his team have developed a monitoring device, through a grant from the CEC and managed by SCE, to make off-gas measurement techniques more user-friendly and accessible to facility operators. The main advantages of the new device are:

- The use of a fuel cell to measure oxygen partial pressure
- Removal of humidity and CO_2 to simplify the procedure
- Calibration with ambient air
- Automatic calculation of the mass balance equations
- Real time measurements involving no lag time
- Good precision and accuracy compared to other methods

Loss in efficiency in activated sludge plant diffused aeration systems was quoted to be up to 50% (in SCE literature) as a result of diffuser fouling and aging. Nevertheless, further market research is required to find out whether wastewater operators would make use of the off-gas technology to optimize energy efficiency at their facility, provided that the technology for such optimization would be more easily accessible.

Unlike the current off-gas monitoring technology, which is bulky, costly, and difficult to use, this newly developed device by Prof. Stenstrom is portable, automated, low cost, and user friendly. It is intended to be commercialized and made available to operators for use as a monitoring instrument on a daily basis. The objective of this study is to find out whether wastewater operators would have the time, interest and ability to use this new instrument. The project deliverables are as follows:

- Development of an audit survey form
- Conduct a phone survey and analyze the data
- Conduct further investigations through site visits
- Identify potential wastewater facilities that can model as demonstration sites
- Identify barriers for broad market adoption of the device

RESULTS

BacGen did not have available a comprehensive database containing information like population served, flow rates and power consumption pertaining to all wastewater treatment facilities served by SCE.

BacGen conducted database research for small and medium size facilities in 2002-03. This database contains 68 facilities is SCE territory varying in size between 0.02 and 16 Mgd.

SCE recently made available to BacGen a database of water and wastewater customer accounts with demand charges of 300 kW and greater. In the 'SCE database', there are approximately 60 wastewater accounts, with power consumption between about 50,000 and 26,737,000 kWh/yr.

There was some overlap between the 'BacGen' and the 'SCE' databases, therefore, the approximate number of wastewater customer accounts can reasonably assumed to be around 120.

To obtain a statistically justifiable result, the target was to conduct survey of at least twelve (10%) of the SCE wastewater customer facilities with questions pertinent to the off-gas measurement device.

AUDIT SURVEY FORMS

An audit form was developed, which is attached in **Appendix A**. This survey was the basis for interviewing the selected facilities.

RESULTS OF THE PHONE SURVEY AND DATA ANALYSIS

The results of the phone survey can be found in **Table 1** below.

TABLE 1. PHONE SURVEY RESULTS

	FACILITY (WWTF)	CONTACT PERSON	CONTACT #	CONTACT DATE	INITIAL RESPONSE TO OFF-GAS ANALYZER	INTEREST IN ANALYZER
1	Tulare	Richard Bono	559-685-2360	1/17/2007	Skeptical	none
2	Rialto	Dave	909-877-2752	1/18/2007	Skeptical	none
3	Ventura	Don Burke	805-677-4131	1/18/2007	Skeptical	none
4	Yucaipa Valley	Kevin Lee, Kevin King	909-795-2491	1/18/2007	Skeptical	none
5	Tehachapi DOC	Jim Bwintempo	661-822-4402	1/18/2007	Skeptical	none
6	Summerland	Mike Sullivan	805-969 4344	1/18/2007	slightly interested	more information
7	Montecito	Jim McManus	805-969-4200	1/18/2007	Skeptical	none
8	Blythe	Mark Edwards	760-922 6611	1/23/2007	interested	wants demo
9	Carpinteria	Mark Bennett	805-684-7214 ext 18	10/18/2006	Skeptical	none
10	San Jose Creek	Mike Creel	562-699-7411 ext 2448	10/17/2006	interested	more information
11	Michelson Drive	Tom Bonkowski	949-453-5392	10/19/2006	interested	demo trial
12	San Bernardino	Andy Coady	909- 384-5507	10/16/2006	Skeptical	none
13	Las Virgenes	Carlos Reyes	818-251-2330	10/18/2006	Skeptical	none
14	City of Hanford	Gary Misenhimer	559-586-2567			wrong number
15	City of Visalia	Jeff Misenhimer	559-713-4176			1/18/06 called no answer
16	City of Porterville	Richard Bartlett	559-782-7518			wouldn't take my call
17	City of Palm Desert	Tina Donahue	760-398-2651			1/18/07 went to voicemail
18	Moorpark	Satya Karra	805-584 -4884			No return call
19	Beaver Equipment	Nik Quesnell	425.398.8082	1/31/2007		Sanitaire rep in Seattle, WA: referred to Sanitaire directly
20	Sanitaire	Tyler Kunz	414.365.2255	12/08/06		may be
21	Environmental Dynamics	Chuck Tharp	573.474.9456	2/09/07	Skeptical	may be
22	Aeration Technologies	Gary Gilbert	978.475.6385	2/9/2007	Very skeptical	none
23	City of LA	Salvica Hammond		2/9/2007	Skeptical	none
24	Parkson Corp	Dave Gibson	954.974.6610	1/31/2007		Left message – no reply
25	Aerostrip Corp	Ingolf Janerus	860.388.6686	1/31/2007		Left message – no reply
26	OCSD	YJ Shao		1/31/2007		sent email - no reply

Table 1 shows that there were thirteen wastewater facility operator respondents with information that can be analyzed for the purposes of this report. Additionally, a number of diffuser manufacturers were contacted, as well as two consultants with experience in the field of off-gas analysis. From these contacts, there were four useable responses. The main conclusions were as follows:

- Of the thirteen wastewater treatment respondents (mainly operators) surveyed, nine were skeptical, one showed some interest and three were interested to get more information about the device and its merits.
- Respondents with a skeptical response usually claimed that they had little time for taking off-gas measurements. An often heard response was also that they were aware of diffuser performance deterioration over time, but measurement to quantify the inefficiencies would not help them to solve their problem, which is cleaning or replacing diffusers easily.
- The respondents that showed interest in the device were as follows:
    - Summerland WwTF, Summerland – this is a very small facility (0.2 Mgd). The practicalities of diffuser cleaning or replacement were not addressed due to the limited scope of the phone survey.
    - Blythe WwTF, Blythe – This is a 1.3 Mgd lagoon type activated sludge facility with Biolac diffusers. This facility has a basin redundancy for diffuser cleaning purposes.
    - San Jose Creek WwTF, Whittier, LACSD (Los Angeles County Sanitation District) – This is a 57 Mgd facility that was later interviewed in more depth (see next section).
    - Michelson Drive WwTF, Irvine, IRWD (Irvine Ranch Water District) - This is a 14 Mgd facility and was also interviewed in more depth (see next section).
    - Sanitaire, wastewater equipment supplier (see below)
    - Environmental Dynamics, wastewater equipment supplier (see below)
- Ms Hammond, who was involved in off-gas testing for the City of LA wastewater treatment facilities had the following response. “Presently we use prof Stenstrom’s expertise and equipment. He performs all our testing since year 2000. In the past there was an interest to perform off gas testing in-house (ed: engineering consultant from Montgomery Watson). The in-house Group along with the off-gas equipment was dissolved after a few trials over a couple of years. I am skeptical about broad market adoption of an off-gas analyzer”.
- Tyler Kuntz with Sanitaire responded that there is an in-situ cleaning system is available for ceramic diffusers only. Sanitaire does not provide a cleaning system for membrane diffusers. Technical Grade

Anhydrous HCl gas is used for cleaning. The process is patented and requires a $6 one time license fee per diffuser associated for use of the cleaning system. The system can be retrofitted to existing diffusers. His response implies that an off-gas testing device would be a useful instrument in association with the cleaning system.

- Environmental Dynamics, Inc. claim to be the second largest supplier of diffuser, after Sanitaire (trade names: EDI™, FlexAir™). They said that off-gas testing is sometimes used during the initial design and set-up phase of their diffusers but that their Teflon diffusers did not deteriorate over time through fouling or loss of elasticity.
- Gary Gilbert at Aeration Technologies had a very skeptical response. Being only one of 3 or 4 experts in the country, his opinion was that off-gas testing requires a lot of experience, not just to handle the testing device but also with respect to data interpretation, sampling frequency, sample location, etc. He said that wastewater operators would not have the expertise, nor the inclination or the need for an off-gas testing device.

RESULTS OF FURTHER INVESTIGATION

Because interpretation of the phone survey results is somewhat limited, BacGen visited five of the facilities mentioned in **Table 1** in order to obtain additional information. The results are presented below.

MICHELSON DRIVE WWTF, IRVINE

This facility, managed by the Irvine Ranch Water District, has 6 parallel fine bubble diffused aeration lanes, with Turblex blowers and Sanitaire 9" flexible dome diffusers. The flow to the aeration basins is relatively constant at 12.5-13 Mgd through the use of an equalization basin. **Appendix B** shows the results of survey questions.

Turblex blowers are regarded as the most efficient units in the market. The aeration tanks are relatively deep (26 ft), promoting a high Oxygen Transfer Efficiency. Typically, Sanitaire Inc assume a 2% transfer efficiency per foot diffuser submergence for (new) fine bubble diffusers in their design documents. The theoretical air flow consumption was modeled to be 8,444 cfm, where the air flow meter at time of the visit indicated 11,652 cfm. The source of this potential inefficiency is unknown.

The facility tested the efficiency of the diffusers shortly after they were first installed through off-gas methodology (an external consultant was involved). BacGen was not able to obtain the results of the tests. Site staff indicated they would be interested in repeating the OTE testing.

The control system is state-of-the-art most-open-valve double loop PID control. In the first or second pocket of each aeration lane, a HACH sc100 DO sensor is used for control purposes. These are modern solids state, luminescent DO probes that have much greater reliability than the older style galvanic cell DO sensors. The Turblex blowers have very good flexibility through their size range (two 250 hp and one 500 hp) and also have very good turn-down ability through dual variable diffuser vane control, maintaining high efficiencies even at lower airflow rates. Inspection of the historical trends on the SCADA system indicate that the DO setpoint is maintained well and that the air flow does not vary much throughout the day as a result of constant basin influent flow rates. For those reasons, an improvement in OTE would directly result in power savings. The facility already has an annual cleaning program for the membrane disks. A repeat of the original OTE test would indicate whether efficiency losses have taken place over the years.

Municipal Water Department WwTF, San Bernardino

This is a 23 Mgd facility with full nitrification/denitrification. The aeration basins are 15 ft deep circular units with the primary tanks in the middle and the aeration part around the perimeter. The facility has two 750 Roots dual vane blowers and two engine driven blowers with the same capacity (878 rpm, ~ 14,000 cfm). Typically, two blowers are in operation.

There are HACH sc100 luminescence DO sensors in each basin and the electrical blowers have recently been fitted with variable frequency drives. However automatic DO control has not yet been implemented. Inspection of the historical trending shows DO levels of up to 8 ppm during the night. The first priority would be to implement automatic DO control. Then it would be logical to evaluate the use of off-gas monitoring and the possibilities for diffuser cleaning along with other improvements to the OTE. **Appendix B** contains the survey results.

San Jose Creek WwTF, Whittier

This facility, which belongs to the Los Angeles County Sanitation District, has two identical treatment facilities, one on the East side of Highway 605, one on the West side. Survey results for both facilities are attached in **Appendix B**.

The East Side facility (57 Mgd) has covered primary sedimentation tanks and aeration basins with ceramic fine pore diffusers (Sanitaire). There are 5 parallel, 4 pass serpentine aeration lanes (20 lanes total). There are three 1750 hp Roots dual vane blowers and two 900 hp Roots dual vane blowers (4160V). There are three DO sensors per four pass aeration unit (HACH sc100) and there is automatic DO control through a PLC/SCADA system. The West side was built with identical design features as the East side.

Observations during the site visit showed that the DO setpoint is not very well maintained. Blowers can not be started or stopped in 'remote'. The control strategy is complex because of the high number of distribution air headers.

Visual inspection of the aeration basins showed a 'boiling' effect in all of the first pass lanes, due to over-aeration. The air demand in these lanes is so great, that the resulting air flow far exceeds the recommended air flow per diffuser. As a result, fine bubbles coalesce into much larger bubbles, resulting in a loss of transfer efficiency.

The low efficiency is reflected in the low yield of oxygen per kWh (1.0 kg O_2/kWh) and a relatively high energy use per million gallons treated (1,093 kWh/Mg). The West side facility has much higher efficiencies of 1.6 kg O_2/kWh and 440 kWh/Mg respectively. Through modeling, it has been calculated that the OTE of the diffusers on the East side is no greater than 1.2% per ft of submergence. The OTE testing equipment would be able to quantify this efficiency on a routine basis.

The operator informed us that the basins are emptied and the diffusers are pressure washed every year. An improvement in efficiency (not quantified), through blower air flow, is observed for a period of about a month as a result of the cleaning. After that, the efficiency returns back to the 'old' levels.

LAS VIRGENES WWTF, CALABASAS

This 9 Mgd facility (see **Appendix B** for survey results) has serpentine (three pass) aeration lanes with coarse/medium diffusers which are suspended at the end of a retractable 'arm' on the side of the basin. Compared to dome diffuser systems, the diffuser (surface area) density is far less in these systems, therefore, the average air flow that passes through a unit of diffuser surface area (square inch) is much greater than with FBDA (Fine Bubble Diffused Aeration) systems. This causes greater bubble coalescence and lower efficiency.

This facility has three Roots dual vane blowers and three Hoffman 5 stage centrifugal blowers. These are connected to a SCADA/PLC automatic DO control system. The system maintains setpoint relatively well.

The effective OTE of the diffuser system was calculated to be 1% per foot of submergence. There are plans to replace the diffusers with fine pore diffusers but the operator remarked that he would lose the accessibility and ease of cleaning of the current system.

CARPINTERIA WWTF, CARPINTERIA

This is a 1.6 Mgd facility with a dual pass aeration basin and fine pore diffusers. There are two 150 hp centrifugal blowers, one is typically in operation. There is a basic SCADA/PLC system. Blower output is proportional to the influent flow.

Model calculations show that the predicted air flow demand should be in the order of 935 cfm, where the average air flow is about 1,500 cfm (an OTE of 1.5% per ft submergence was used). This indicates that efficiency gains may be possible through improvement of the OTE. However, the blowers have turn-down restrictions. Control of the blower system needs to be evaluated before OTE improvements can be realized at this site.

POTENTIAL SITES FOR A DEMONSTRATION STUDY

The following facilities may have an interest in conducting a feasibility study pertinent to the device:

- Michelson Drive WwTF, IRWD (Irvine)
- San Jose Creek WwTF, Whittier, LACSD
- Summerland WwTF, Summerland
- Blythe WwTF, Blythe

BARRIERS FOR MARKET IMPLEMENTATION

The following barriers for the market implementation of the off-gas device have been identified as a result of the phone and site visit surveys:

- Lack of understanding of the off-gas device capabilities (i.e. light weight, portable, low cost, simple to operate, and automatic, etc,)
- Lack of interest and time to investigate the capabilities of the device.
- Lack of interest and time for taking measurements with the device
- The device being perceived as for use only by specialist, despite recent advances and innovations.
- A lack of belief that the device can be automated and used for on-line control purposes (or is better than regular DO analyzers for control purposes)
- Inability to improve diffuser efficiency even with the knowledge that deterioration in efficiency is being experienced, e.g. as a result of limitation with respect to diffuser cleaning ability, turn down range on the blowers, unrelated control issues, etc.

SUMMARY AND CONCLUSIONS

- None of the sites interviewed had recently carried out OTE off-gas measurements. Some sites showed signs that OTE improvements were possible and that testing would be relevant, provided that the available control system was capable of materializing on the energy saving.
- Most operations staff had moderate to severe reservations regarding the ability to clean the diffusers more frequently to improve OTE in practice.
- There are diffuser systems on the market that provide in situ acid gas cleaning, i.e. without the need for basin emptying. None of these systems were found at the interviewed sites.
- One site (San Jose Creek- Whittier) cleans the fine bubble diffusers (ceramic) every year and claims efficiency improvements for up to a month, and then a rapid decline to the 'old' efficiency thereafter. Plant operators measure this through air flow consumption. Cleaning is very labor intensive but they continue this activity out of fear that things could deteriorate badly over time, if they did not clean. They have never performed OTE tests.
- Only one site (Michelson Drive WwTF) carried out OTE tests when they first installed their diffusers 5 years ago and they would be interested in a trial to retest.
- Generally, the concern about the OTE measurement is that, even if one has the knowledge about deterioration in efficiency, there are still limitations and barriers to making improvements (emptying basins, turn-down limitation on blower, good control systems etc).
- The opinion that an off-gas measuring device is meant for expert consultants in the first instance. Only after the ability to save energy is shown, might operations staff be convinced to take on the responsibility of regular measurements themselves. The quantification of potential energy savings will be essential for wide acceptance.
- Education and training of wastewater management and operations personnel that have an interest in reducing energy consumption and related cost will also be necessary. Results from initial pilot testing at several wastewater facilities need to be publicized to demonstrate the simplicity and ease of the off-

gas monitoring operation as well as the benefits of routine OTE measurements.

- The responses of the wastewater operators and off-gas measurement practitioners imply that not only do they need to be convinced of the benefits of the monitoring device, but they also need information about how to capitalize on the potential energy savings. To realize the energy saving, the following are all essential elements of the energy saving measure:
    1. An automatic diffuser cleaning system, or basin redundancy to carry out manual diffuser cleaning and/or diffuser replacement, and the available manpower and capital for such investments.
    2. A good reliable control system (i.e. reliable control instruments, a sufficiently wide blower air flow range and a well written PLC/SCADA program for control)
    3. Off-gas testing to detect changes in diffuser efficiency.
    4. A team of experts to help initiate the above outlined system.

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SUB APPENDIX A

OTE Off-gas Measurement Device Feasibility Study
Survey Form for Activated Sludge Facilities

SCE Customer Name:

Site Name (if different)

Site Street Address, City, State, Zip

Primary Contact and Title

Primary Contact Phone #

Fax #

Email

Loading information

Average daily flow (Mgd):_____

Seasonal variation Y/N (please describe)_____

Facility Design Capacity (Mgd):_____

Facility influent type: Municipal ☐ Industrial ☐ Agricultural ☐ Mixed ☐

	influent **mg/l or lbs/d***	***effluent*** **mg/l or lbs/d***	***permit*** **mg/l or lbs/d***
BOD or CBOD*			
TSS			
nitrification Y/N*			
ammonia			

*please delete

Treatment Overview

Grit Removal Y/N

Primary Sedimentation Y/N # tanks_____Volume/ea:_____(g or cu ft)*

Secondary clarifiers Y/N # tanks_____Volume/ea:_____(g or cu ft)*

'Extended aeration' Y/N

ASP Configuration complete mix basin(s) ☐ Plug flow ☐ Oxidation ditch ☐

SBR ☐ Pure Oxygen ☐ Other _____

Basins:_____

System configuration (Series, parallel. Please provide sketch if possible):_____

basin #	surface area	depth	Volume

MLSS: mg/l_____

RAS: Flow rate (gpm/gpd)_____ concentration:_____ mg/l

WAS: volume (gpm/gpd)_____concentration: _____ mg/l

MCRT (sludge age)_____

F/M_____

DO: avg_____mg/l min_____mg/l
max_____mg/l

Nitrification/nutrient removal requirement?_____

Aeration type

Mechanical Surface aerators (vertical shaft) ☐ # _____ rating_____hp

Rotor (horizontal shaft) ☐ # _____ rating_____ hp

Other_____ # _____rating_____ hp

Diffused Fine/medium bubble ☐ Supplier (Sanitaire, EDI, etc..)_____

Coarse bubble ☐ Supplier (Sanitaire, EDI, etc..)_____

Blower type Centrifugal ☐ # _____ rating_____ hp

Positive Displacement ☐ # _____ rating_____ hp

Typical operating air flow (cfm)_____

Discharge pressure (psi)_____

Aeration Control

Blowers: Timers ☐ Manual ☐

Inlet vane ☐ SCADA/plc present Y/N_____

Variable speed control ☐ Dynamic DO control Y/N_____

Mechanical Timers ☐ Manual ☐ Variable Speed ☐

Oxygen Transfer Efficiency Testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

If YES, provide details (method used, date, consultant used? Results etc)

_____

_____

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

If YES would do this in-house if reasonable priced equipment was available? Y/N

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD)

_____

_____

Remarks:_____

SUB APPENDIX B

SCE Customer Name	**Irvine Ranch Water District**
Site Name	Michelson WwTF
Address, City, Zip	3512 Michelson Drive, Irvine, CA 92612
Primary Contact, title	tom Bonkowski
Phone #	949-453-5392
fax#	949-476-2854
email	bonkowsl@irwd.com

System Configuration

grit removal	Y
primary sedimentation	Y
Secondary clarifiers	Y
Extended aeration	N
Aeration basins	6 parallel plugflow lanes 5 pockets per lane (1/2 size pocket anoxic)
blowers	Turblex (dual vane) 1-500 hp; 3- 250 hp
diffusers	Sanitaire, membrane disks

OTE testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

Yes, after they were installed (5 years ago) but not thereafter.

If YES, provide details (method used, date, consultant used? Results etc)

No results were obtained but they are possibly available upon request.

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

No.

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

Would be interested in re-testing and participating in a trial.

If YES would do this in-house if reasonable priced equipment was available? Y/N

Not sure

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

Yes, the disks are cleaned every year.

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD))

The blowers have a wide air flow range. There is a state-of-the art SCADA system and there are reliable DO sensors in each aeration lane. An improvement in diffuser efficiency would directly result in an efficiency saving.

SCE Customer Name	**LACSD**
Site Name	San Jose Creek, Whittier
Address, City, Zip	1965 Workman Mill Road, Whittier, CA 90601
Primary Contact, title	Michael Creel
Phone #	562-699-7411
fax#	562-699-3368
email	mcreel@lacsd.org
ADF	57 Mgd

System Configuration

	East	West
grit removal	Y	Y
primary sedimentation	Y	Y
Secondary clarifiers	Y	Y
Extended aeration	N	N
Aeration basins	5 basins, 4 lane serpentine	3- basins, 4 lane serpentine
blowers	Roots dual vane 3-1750 hp 2-900 hp	Roots dual vane 3- 1750 hp
diffusers	Sanitaire, ceramic disks	Sanitaire, ceramic disks

OTE testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

Yes

If YES, provide details (method used, date, consultant used? Results etc)

Every year after cleaning, through air flow measurement (not off-gas testing).

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

Yes

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

That would be a lot of work.

If YES would do this in-house if reasonable priced equipment was available? Y/N

Not sure

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

Yes

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD))

An OTE efficiency gain would directly result in lower energy use and possibly even treatment improvement.

SCE Customer Name	**Las Virgenes Municipal Water District**
Site Name	Las Virgenes
Address, City, Zip	4232 Las Virgenes Road, Calabasas, CA 91302
Primary Contact, title	Carlos Reyes, Ops Manager
Phone #	818-251-2330
fax#	818-251-2309
email	creyes@lvmwd.com

System Configuration

grit removal	Y	
primary sedimentation	Y	
Secondary clarifiers	Y	
Extended aeration	N	
Aeration basins	2# basins, 3 pass serpentine	
blowers	Roots dual vane 3# 900 hp	Hoffman 5 stage centrifugal 2# 250 hp
diffusers	Coarse/medium bubble, side arm configuration	

OTE testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

No

If YES, provide details (method used, date, consultant used? Results etc)

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

Diffusers can be cleaned, the 'arms' can be lifted above water without emptying the basin.

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

Retrofit of FBDA may reduce cleaning flexibility.

If YES would do this in-house if reasonable priced equipment was available? Y/N

Not sure

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

Not sure

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD))

A DO control system is available with wide range flexibility of air flow through different blower sizes. OTE improvement would result in direct energy savings.

SCE Customer Name	**City of San Bernardino Water Dept**
Site Name	San Bernardino WwTF
Address, City, Zip	399 Chandler Place, San Bernardino, CA 92408
Primary Contact, title	Andy Coady, Env Control Officer
Phone #	909-384-5507
fax#	909-384-5268
email	coady_an@ sbcitywater.org

System Configuration

grit removal	Y
primary sedimentation	Y
Secondary clarifiers	Y
Extended aeration	N
Aeration basins	3 circular units with PST in middle
blowers	Roots dual vane, 2- 750 hp
diffusers	FBDA

OTE testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

No

If YES, provide details (method used, date, consultant used? Results etc)

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

No

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

Not sure

If YES would do this in-house if reasonable priced equipment was available? Y/N

Not sure

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

No

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD))

Implementation of automatic DO control is the first priority.

SCE Customer Name	**Carpinteria Sanitary District**
Site Name	Carpinteria WwTF
Address, City, Zip	5300 6th St, Carpinteria, CA 93013
Primary Contact, title	Mark Bennett, Treatment Supervisor
Phone #	805-684-7214
fax#	805-566-6599
email	markb@carpsan.com

System Configuration

grit removal	Y
primary sedimentation	Y
Secondary clarifiers	Y
Extended aeration	N
Aeration basins	2 basins, dual pass
blowers	GD Lamson centrifugal 2-150 hp
diffusers	FBDA

OTE testing

Has the efficiency of the diffusers ever been tested in-situ? Y/N

No

If YES, provide details (method used, date, consultant used? Results etc)

Are you aware of loss of efficiency due to fouling, membrane hardening? Y/N

No

Would you consider testing regularly (twice per year) to detect losses in efficiency? Y/N

Not sure

If YES would do this in-house if reasonable priced equipment was available? Y/N

Not sure

Do you have spare capacity to enable basin emptying for membrane cleaning or replacement purposes? Y/N

Not really

What about blower control (surge problems? Blower over-sized? Operating point on the curve? Control abilities (SCADA, PLC, reliable DO monitoring, inlet vanes, VFD))

The blowers have restrictions in turn-down. OTE improvement would not result in power savings unless the blower operation and control system are improved.