Orange County Sanitation District

Research Report 2010

2010
OCSD Research Report

Compiled by

Technical Services Administration and Research

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Acknowledgments

Oversight of the research program is provided by the Research Technical Advisory Group (TAG), a staff technical committee charged with evaluating proposals for new research projects, monitoring the progress of existing projects, and disseminating the results of projects to interested parties inside and outside OCSD. The TAG membership provides scientific and engineering expertise and reflects the wide-ranging occurrence of research activities throughout the agency.

The TAG members in 2009-10 were:

Operations and Maintenance

- Carla Dillon
- Michelle Hetherington
- Y. J. Shao

Engineering

- Jim Burror

Technical Services

- Jeff Armstrong
- Jeff Brown
- Charles McGee
- Tom Meregillano

Part 1

Introduction and Overview

Part 1

Introduction and Overview

This document is a report of OCSD research activities for fiscal year 2009-10. While it was compiled by the Technical Services Department, the various activities it describes were done in Technical Services, Engineering, and Operations and Maintenance.

This document brings together in one place summaries of research-related expenditures (Part 2), information about specific project accomplishments (Parts 3 and 4), and plans for relevant activities in the upcoming year (Part 5). It also presents for reference the research project schedule that was developed in 2008-09 for the agency's Research Program Strategic Plan (Part 6).

The activities during this year addressed a range of topics, with notable efforts in air quality management, environmental improvement, odor and corrosion control, treatment process improvements, and emerging (trace) contaminants detection and removal. These included several cooperative projects with wastewater industry research organizations and with universities, arrangements which provided substantial leveraging of OCSD's funds.

Environmental stewardship figures prominently in the current research projects. The fuel cell demonstration at Plant 1, a project with high public visibility and interest, is finishing construction and will start operating early in 2010-11. The installation will use a renewable energy source and is expected to produce virtually no regulated air emissions. This public/private collaboration will use anaerobic digester gas in a fuel cell to produce electricity (for on-site use) and hydrogen (for fueling vehicles at a nearby publicly-accessible fueling station). A continuing climate change initiative aims to determine and reduce the environmental footprint of OCSD's activities and to identify effective responses if climate changes affect our operations. Applying superoxygenation for odor and corrosion control in the collection system, thereby reducing or eliminating the use of additional chemicals, continues to be evaluated as a means for reducing operating costs and environmental impacts. The need to comply with upcoming stricter air emissions regulations affecting the Central Generation engines has driven a large test of catalytic emissions control systems at both treatment plants.

New research projects will be undertaken consistent with the research strategic plan's recommendations and in response to any changes in OCSD's needs. Work is continuing on an evaluation of processed food waste as an additional digester feed source and on a process to increase the digestion efficiency of waste activated sludge, for example. The research program will continue to be proactive in identifying and evaluating opportunities for OCSD's activities to reduce costs, improve efficiency, and promote environmental protection.

Part 2

Research Financial Summary

Part 2

Research Financial Summary

During 2009-10, the budget for research totaled $5.68 million, including $1 million as an annual allocation for operational research projects. (See Figure 2-1a.) This could be divided into three distinct types of expenditures: CIP Research, CIP Other, and Operating.

"CIP Research" includes projects that typically have been funded as individual line items in the CIP budget and in the future usually will be funded from the annual allocation (project SP-125) that became part of the CIP budget in 2007-08. These projects include studies, pilot tests, and full-scale demonstrations of innovative products and processes related to collections system and treatment plant operations. This category was 27% of the total research budget.

"CIP Other" includes capital (CIP budget) projects that are essentially research in nature but are funded from other parts of the CIP budget. In 2009-10, only two projects were in this category: air emissions control of Central Generation engines (project J-79) and the fuel cell demonstration (projects SP-132 and SP-134). This category was 62% of the total research budget due to the high cost of project J-79.

"Operating" includes expenditures that are research in nature but will not lead directly to facility improvements or modifications and thus are not included in the CIP budget. The majority of these expenditures is for memberships in various research-related organizations; the remainder is for projects (often cooperative projects through the research organizations) that are funded from specific division budgets. Most often, these are projects involving Division 630 (Environmental Lab and Ocean Monitoring). This category was 12% of the total research budget.

Figure 2-1b shows the distribution of actual expenditures for 2009-10. While the budget was $5.68 million, the expenditures totaled only $4.53 million. This is primarily due to two factors. First, the annual allocation ($1 million) appears in the budget as a level amount over several years, whereas the expenditure schedule in the Research Strategic Plan is a typical S-curve with lower than average expenditures near the beginning as new projects are started and higher expenditures in later years. Second, the contract for a major project (OpenCEL process evaluation) was not approved until July 2010, so it does not appear in the 2009-10 fiscal year. The actual expenditures for CIP Research are primarily (95%) for ongoing projects that are funded as CIP line items and so did not draw on the general allocation funds.

The actual expenditures for the other groups (CIP Other and Operating) essentially equaled their budgeted amounts for the year.

Figure 2-2 shows the actual expenditures broken down by focus category. The largest fraction (66%) is for projects related to air quality (J-79), with organization memberships forming the next largest fraction (13%). Progressively smaller fractions are devoted to

categories such as environmental improvement, odor and corrosion control, and emerging contaminants. Details about the projects in each category are presented in Parts 3 and 4 of this report.

Through its participation in cooperative projects with research institutions and other agencies, OCSD leverages funds to receive substantial benefits without funding the entire cost of a project. Figure 2-3 illustrates the leveraging achieved for these projects, separating the fuel cell demonstration project from other projects due to its notably larger budget. The fuel cell project shows 14:1 leveraging of its total $8.0 million cost, and the other projects as a group show 13:1 leveraging of their total $2.9 million cost. Overall, for a total cost of $0.8 million, OCSD benefits from projects budgeted at $10.9 million.

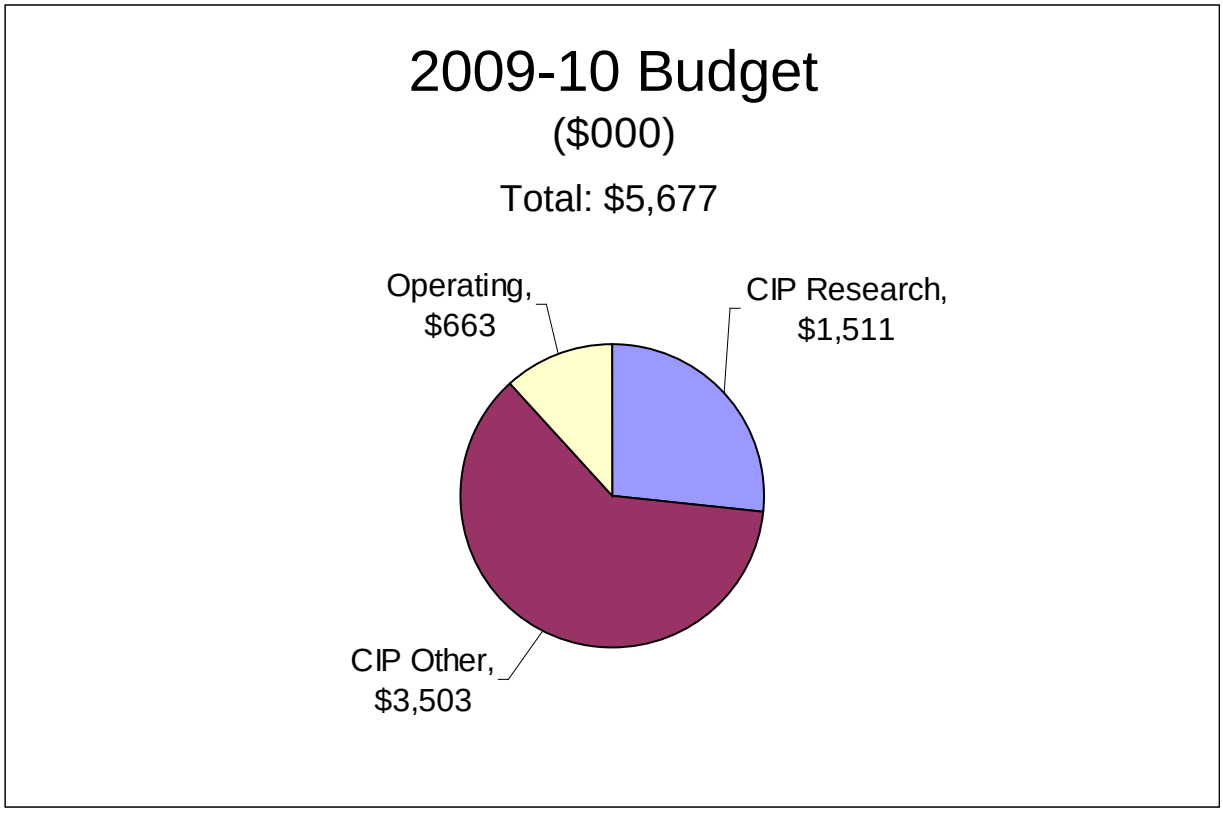


Figure 2-1a. Research Budget by Expenditure Type

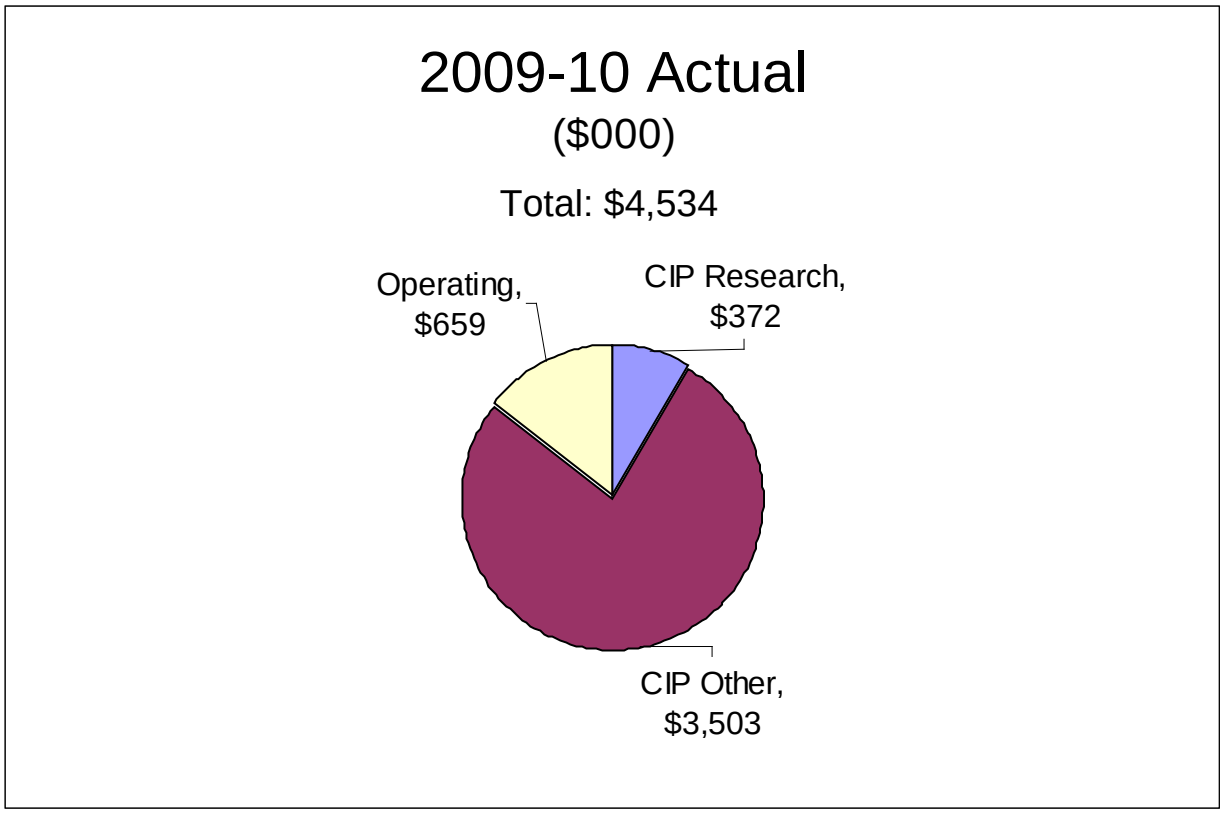


Figure 2-1b. Distribution of Research Expenditures by Expenditure Type

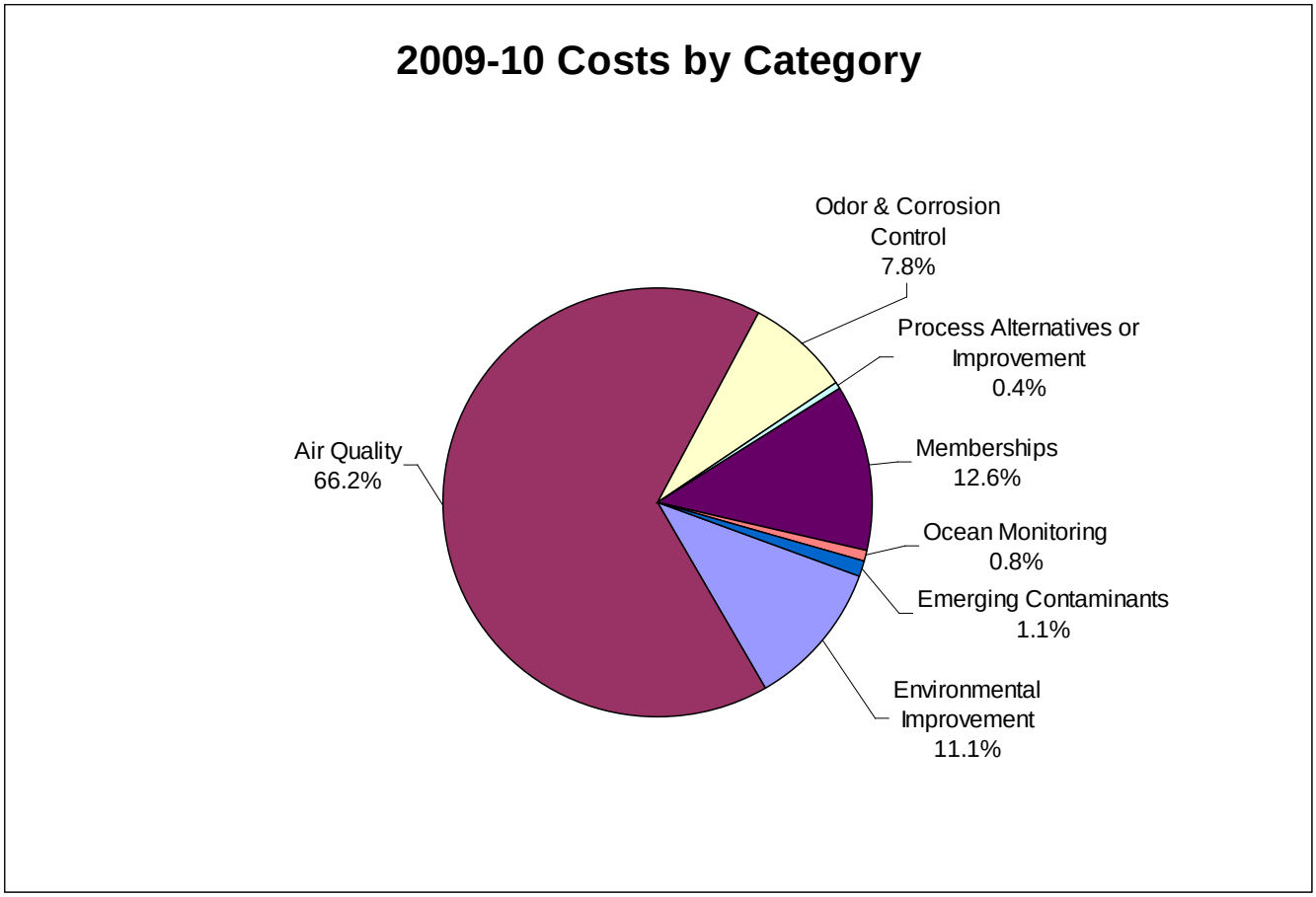


Figure 2-2. Actual Research Expenditures by Focus Category

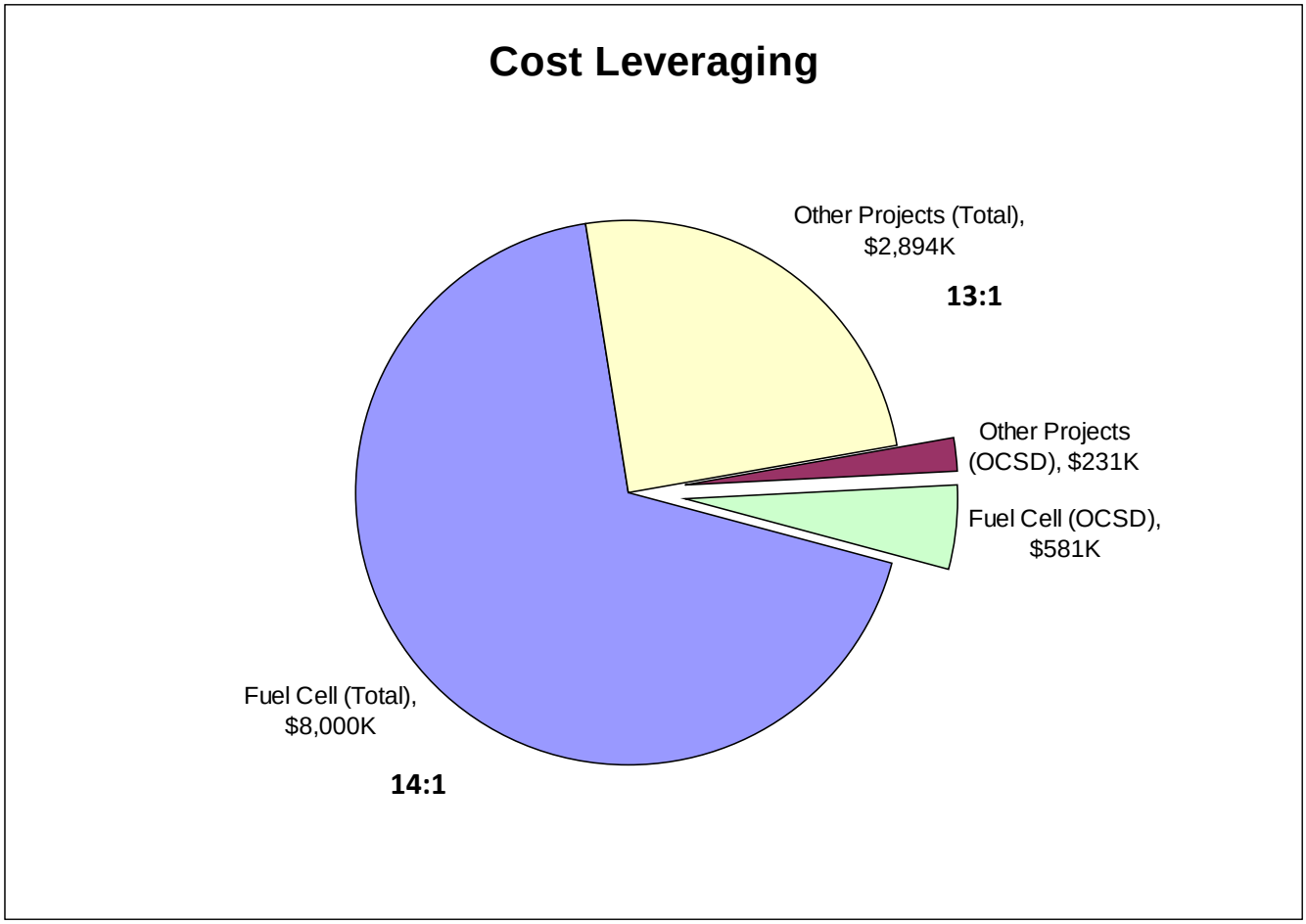


Figure 2-3. Cost Leveraging Achieved in Research Projects

Part 3

Summary of Projects and Memberships

OCSD Research Summary 2009-10: Projects

Category	Project Description	Total OCSD Project Cost or Budget	OCSD Cost 2009-10	Total Project Cost or Budget (if cost-shared)	Other Participating or Funding Organizations	Goals / Scope	Accomplishments / Benefits	Upcoming Work (2010-11)
Environmental Improvement	Greenhouse gases (GHG) emissions model	To be determined	$35,000 (through UCI's Urban Water Research Center)	---	UC Irvine (in 2009-10)	Develop model for predicting GHG emissions for various process configurations	UCI and OCSD developed a model that can be used to evaluate the methane-equivalent emissions from various parts of OCSD's activities. This can be used to evaluate environmental impacts of current and proposed process options.	Activities might include refining parts of the OCSD model and starting to integrate the OCSD model with a related model UCI might develop for OCWD.
Environmental Improvement	Fuel cell demonstration	$500,000 for installation; $81,400 for operation	~$500,000 + $3,200	$8.0 million	Air Products & Chemicals, Fuel Cell Energy, SCAQMD, US DOE, UC Irvine, CARB	Demonstrate fuel cell operating with digester gas fuel to produce electricity and hydrogen	Use renewable resource (digester gas) to produce environmentally "clean" electricity and hydrogen for fuel.	Finish installation at Plant 1 (Q1 2010-11); start fuel cell and hydrogen fueling station operation (Q2)
Air Quality	J-79 Central Generation engine emissions control	$9.1 million	$3.0 million	---	---	Identify methods to comply with stricter air emissions regulations affecting the Central Generation engines	Improved exhaust emissions controls will allow Central Generation engines to operate without violating air emissions regulations. An oxidative catalyst system to reduce CO and air toxics emissions passed a long-term test at P2. Full scale installation of a dual oxidative / reductive catalyst system and a digester gas cleaning system was completed in February 2010. Testing activities began in March 2010.	Testing activities will continue through March 2011. A final results report will be complete by June 2011.

OCSD Research Summary 2009-10: Projects

Category	Project Description	Total OCSD Project Cost or Budget	OCSD Cost 2009-10	Total Project Cost or Budget (if cost-shared)	Other Participating or Funding Organizations	Goals / Scope	Accomplishments / Benefits	Upcoming Work (2010-11)
Odor & Corrosion Control	Superoxygenation for odor control	$850,000	$353,600	---	---	Investigate using dissolved oxygen rather than chemicals for controlling odors and corrosion in sewers and treatment plants.	Promising opportunities at collections system pump stations were identified. Intensive onsite sampling programs were conducted at both sites to provide accurate information about the wastewater characteristics. These data, together with computer models of the collections system served by these pump stations, were used to predict the effectiveness of superoxygenation treatment and to prepare preliminary designs of superoxygenation systems for both sites.	Engineering analyses for specific pump stations will be completed and reported, possibly with recommendations for proceeding with full-scale installations. In addition, combining superoxygenation with chemicals to treat force mains followed by gravity sewers may be studied.
Process Alternatives or Improvement	OpenCEL process for digestion improvement	To be determined; est. $450,000 through pilot testing	$10,300	---	---	Investigate improved anaerobic digestion efficiency with OpenCEL predigestion sludge treatment	Effective sludge treatment would increase digester gas production and reduce residual biosolids amounts, leading to reduced O&M costs of several million dollars per year	Full-scale onsite test of the OpenCEL process will begin in Q3 2010.
Process Alternatives or Improvement	Deep well biosolids injection	$63,000 to date; ultimate cost undetermined	$0	---	---	Investigate biosolids management through underground conversion of biosolids to methane.	The City of Los Angeles has a five-year experimental demonstration project to inject biosolids deep underground, where it will be converted to methane and later recovered. OCSD had a feasibility study done for similar activity at both treatment plants; both locations are feasible, but Plant 1 would be geologically preferable. A full-scale system would cost $8 million to engineer and construct.	The Los Angeles results will continue to be monitored; further evaluation at OCSD will be done as appropriate.

OCSD Research Summary 2009-10: Projects

Category	Project Description	Total OCSD Project Cost or Budget	OCSD Cost 2009-10	Total Project Cost or Budget (if cost-shared)	Other Participating or Funding Organizations	Goals / Scope	Accomplishments / Benefits	Upcoming Work (2010-11)
Process Alternatives or Improvement	Process modeling	$252,250	$7,600	---	---	Develop biological and hydraulic computer models to help optimize plant performance.	Biological modeling: a commercial program (Biowin) has been used by OCSD consultants on past capital improvement projects. OCSD now has this program in-house. After calibration, it will be a tool for optimizing plant processes. Hydraulic modeling: EPA and custom models were used in evaluating OOBS and EPSA design and performance at Plant 2.	Staff will continue to build and refine the models. Two other secondary plants are operating that can be modeled and two additional plants will be coming on-line for future modeling. For hydraulic modeling, staff will assess the timing and appropriate resources for further model development.
Emerging Contaminants	Trace organic chemical removal during wastewater treatment	$20,000 + $20,000 (in-kind over 3 years)	$23,200	$500,000	WERF (Water Environment Research Foundation)	Determine the effects of wastewater treatment processes on various trace chemicals (pharmaceuticals, EDCs, PCPs)	Leverage OCSD contribution to $500,000 project. Expected benefits: more detailed knowledge of the fate of chemicals and greater ability to model their removal in wastewater treatment processes. One testing cycle at OCSD has been completed.	OCSD will provide technical expertise and review data, and a second cycle of testing at OCSD secondary treatment facilities is likely.
Emerging Contaminants	Evaluating analytical methods for certain trace contaminants in water	$36,000 (in-kind for lab analyses)	$12,000 (in-kind for lab analyses)	$784,000	WRF (Water Research Foundation)	Evaluate lab analysis methods for endocrine disrupting compounds (EDCs) and personal care products (PCPs)	Three sets of samples were analyzed through round-robin testing with other laboratories. This effort aims to help establish the best test methods for EDCs and PCPs and may improve current in-house methods	None; OCSD's direct contribution to this project is complete.

OCSD Research Summary 2009-10: Projects

Category	Project Description	Total OCSD Project Cost or Budget	OCSD Cost 2009-10	Total Project Cost or Budget (if cost-shared)	Other Participating or Funding Organizations	Goals / Scope	Accomplishments / Benefits	Upcoming Work (2010-11)
Emerging Contaminants	Impacts of nanoparticles on water reclamation and sewage treatment	$15,000 (in-kind for lab analyses)	$15,000	$215,000	WateReuse Research Foundation; UC Irvine; Kennedy/Jenks	Evaluate effects of zinc and silver nanoparticles on specific water reclamation and sewage treatment processes, leading to better understanding of the importance of nanomaterial pollutants on activated sludge and media filtration processes.	OCSD analyzed over 200 samples for zinc and silver concentrations during this study.	None; OCSD's work on this project is complete.
Ocean Monitoring	Southern California Bight Regional Study 2008	$125,000 (in-kind services only)	---	$1,095,000 plus in-kind services from various agencies	SCCWRP (So. Cal. Coastal Water Research Project) with 60 participating organizations	Collect regional information on contaminant effects and other stresses on ocean ecology	2008 study expands on 2003 survey to expand knowledge of such areas as coastal ecology, shoreline microbiology, and water quality	Continuing sample collection and analysis through 2010; reports issued over next three years
Ocean Monitoring	Online tools for organism identification	$15,000	$7,500	$300,000	SCAMIT (Southern California Association of Marine Invertebrate Taxonomists)	Participate in project to develop a database of ocean species relevant to OCSD's marine monitoring program	Completed development of the database listing of species called *A Taxonomic Listing of Soft Bottom Macro- and Megainvertebrates from Infauna & Epibenthic Monitoring Programs in the Southern California Bight, Edition 5,* previously available in hard copy only. Overhauled the SCAMIT webpage taxonomic tool box. Digitizing prior information, such as species voucher sheets and identification aids that SCAMIT members have produced since 1982.	Release of a beta version of the taxonomic database. The future activities will include finalizing the protocols and procedures for updating the names, testing and building upon the beta version of the taxonomic database by adding links to other websites of interest and value, and adding taxonomic tools.
Ocean Monitoring	Spatial Variability of Ocean Sediments (Phase I)	$30,000 (Phase I)	$30,000	---	SCCWRP (So. Cal. Coastal Water Research Project)	Determine the optimal sediment station array for accurate map generation of OCSD's outfall footprint for sediment geochemistry analytes and benthic infaunal community metrics.	Improved maps will provide better data for determining NPDES permit compliance and information on trends of sediment impacts from wastewater discharge. Phase 1 developed a list of 60 additional sites for sampling in addition to the 49 existing sites.	Phase II will involve field testing and analyses of the recommended sampling sites from Phase 1, ultimately leading to an optimized cost-efficient mapping design and annual monitoring program. Phase II will run from June 2010 through June 2013.

OCSD Research Summary 2009-10: Memberships

Organization	OCSD Funding	Benefits of Membership	Key Projects & Accomplishments
University of Arizona Water and Environmental Technology (WET) Center	$10,000	The WET consists of an interdisciplinary group of research scientists working together to resolve water quality-related problems. The funding is supplied by the State of Arizona, the National Science Foundation, and a variety of companies and agencies. As a member, OCSD gets access to the Center's research results and, as a voting member of the Industrial Membership Board, can influence the direction of the research program. The Center's annual budget is approximately $750,000.	Previous work related to OCSD's operations has focused on biosolids applications options and pathogen occurrence and transport. During 2009-10, there also has been an increased emphasis on endocrine disrupting chemicals in wastewater.
Southern California Coastal Water Research Project (SCCWRP)	$400,000	SCCWRP's purpose is "to increase the scientific knowledge of how treated wastewater discharges, storm-water discharges, and other human activities interact to affect coastal aquatic ecological systems, and thereby to ensure protection of these resources." Association with SCCWRP provides opportunities for OCSD to participate in regional research and development that facilitates a better understanding of the results of the individual wastewater dischargers by placing them in a regional context, engage in regional discussions related to the interpretation of observations made by participating agencies, and participate in staff training and development activities related to ocean monitoring that might not otherwise be available. SCCWRP's budget for projects related to marine receiving waters is over $1.1 million.	SCCWRP is active in public health research including bacterial epidemiology studies and methods for the rapid detection of bacteria in recreational water. Through a 2007 joint use agreement, much of the SCCWRP microbiology research is performed at OCSD. This has provided OCSD the opportunity to participate in cutting edge research related to public health concerns about water quality. OCSD is currently participating in a demonstration project for rapid detection of microbial indicators of fecal contamination. SCCWRP manages and maintains a data base of all data collected as part of the regional monitoring programs which can be accessed for comparison to existing data from OCSD's monitoring program. OCSD staff meet regularly with SCCWRP staff to discuss questions of statistical analysis, sample design, program implementation, etc. Two recent examples include: 1) SCCWRP staff met with OCSD staff on multiple occasions to help develop a proposal for mapping the sediments surrounding the OCSD discharge in order to discern the footprint of any discharge-related change to the environment. 2) SCCWRP and OCSD staff have worked together to facilitate meetings with the four major POTWs and State Water Quality Control Board staff to analyze data and review determinations of water quality compliance with California Ocean Plan standards. These data have been used to distinguish receiving waters impacted by wastewater dischargers from "natural" conditions, a critical component to determining compliance with California Ocean Plan standards.
Water Environment Research Foundation (WERF)	$87,630	WERF is recognized as the country's leading independent scientific research organization dedicated to wastewater and stormwater issues. Over the past 20 years, it has produced 300 research reports valued at over $62 million. It is a nonprofit organization that operates with funding from subscribers and the federal government; the subscribers include wastewater treatment plants, stormwater utilities, regulatory agencies, consultants, and industrial companies. WERF's approach to research stresses collaboration among teams of subscribers, environmental professionals, scientists, and staff. All research is peer reviewed. As a WERF member, OCSD has access to all research results at no additional cost and also is able to become actively involved in steering the direction of WERF research projects through individual staff members' participation on Issue Area Teams.	WERF is a source of information about every major area of water and wastewater planning and treatment. Its "knowledge areas" include biosolids, climate change, conveyance systems, decentralized systems, nutrients, operations optimization, pathogens & human health, security & emergency response, stormwater, strategic asset management, trace organics, use attainability analysis, and water reuse. WERF has a "Program-Directed Research" initiative designed to focus on high-priority issues identified in consultation with WERF members. For example, in 2009-10 OCSD participated in a WERF collaborative project to determine the effects of wastewater treatment processes on various trace chemicals (such as pharmaceuticals and endocrine disrupting compounds). OCSD also has participated for several years in a collaborative project to reduce odors and corrosion in collection systems through identifying effective odor control approaches and improving the accuracy of odor control computer models.

OCSD Research Summary 2008-09: Memberships

Organization	OCSD Funding	Benefits of Membership	Key Projects & Accomplishments
WateReuse Research Foundation	$25,000	The mission of the Foundation is to conduct and promote applied research on the reclamation, recycling, reuse, and desalination of water. The Foundation's research advances the science of water reuse and supports efforts to create new sources of high quality water while protecting public health and the environment. As a member, OCSD has access to the research results and can influence the choice of projects to be undertaken. The Foundation's work is particularly applicable to OCSD's participation in the Groundwater Replenishment System (GWRS).	The Foundation currently funds or co-funds several projects related to the following topics that are relevant for OCSD: 1) Analytical method development for TOrCs (trace organic chemicals). 2) Identification of surrogate or indicator TOrCs. 3) Risk analysis for public health and environmental health issues related to TOrCs. 4) Analysis of removal processes & mechanisms for selected TOrCs in wastewater (including membrane bioreactors) and water reclamation. 5) Analysis of mechanism of TOrCs removal using high energy free radical chemistry. 6) Psychology of public acceptance of reclaimed water for potable or indirect potable use. 7) New membranes and separation processes in water reclamation including desalination. 8) Legislative advocacy for water reclamation and desalination.
University of California, Irvine: Urban Water Research Center (UWRC)	$35,000	The Urban Water Research Center's (UWRC) mission is to advance the understanding of the urban water environment to assist efforts to promote health, enhance the efficient use of water resources, and protect environmental values. It includes over 70 faculty members and a variety of UCI departments and takes a multidisciplinary approach to research. The Center's work addresses topics such as water supply, demand and distribution; water quality issues for drinking and recreational use; and using wetlands to reduce water pollution from urban runoff. When OCSD's membership fee is used to support specific research, the overhead charges normally assessed by the university for sponsored research are reduced substantially.	In 2009-10, OCSD's membership fee was applied to a project to determine the environmental (carbon-equivalent) footprint of our treatment processes. This involved source testing of the greenhouse gas (GHG) air emissions from individual processes and modeling of the carbon-equivalent impacts of the treatment activities. The resulting computer model will allow OCSD staff to evaluate the GHG effects of possible operational changes.
National Water Research Institute (NWRI)	$50,000	NWRI sponsors projects and programs focused on ensuring safe, reliable sources of water. Their interests include encouraging public support of conservation and higher water use efficiency, implementing strategies to allocate and sustain water resources on regional and national levels, protecting existing water supplies from impacts on quality and quantity, developing technologies that identify and remove contaminants from water supplies, identifying treatment technologies that are cost- and energy-efficient, and educating youth on water issues and future water needs. To leverage funding, NWRI arranges strategic partnerships with organizations in the water and wastewater industries. Its major activities include funding and guiding scientific research projects, supporting graduate fellowships and other water-related educational programs, developing outreach material such as reports and videos, holding workshops and conferences to promote new issues and technologies, providing peer-review panel services for local and state water agencies, managing projects or programs for water agencies and others, and awarding scholarly and practical achievements in water research with a national prize.	NWRI currently funds exploratory research projects in the following areas that could be of interest to OCSD in future years: 1) Recovery of metal ions from membrane concentrates by dendrimer enhanced filtration: This project examines the feasibility of using a specific process to remove toxic metals from membrane filtration waste streams that complicate the disposal of those streams. 2) Source, fate, and transport of endocrine disruptors, pharmaceuticals, and personal care products: This project documents the occurrence of various trace contaminants on three California drinking water sources to assess the impact of wastewater on drinking water supplies. 3) High-efficiency hydrogen gas production using a microbial electrolysis cell: This project focuses on generating hydrogen gas from wastewater; if successful, this could be a cost-effective route to produce hydrogen and treat wastewater simultaneously. 4) Enzyme-enhanced membrane bioreactors to upgrade wastewater treatment for reuse: This project examines using membrane bioreactors and enzymes to enhance the removal of various trace compounds during wastewater treatment. 5) Development of rapid detection method of somatic coliphage as viral indicator of source water: This project is attempting to develop a test to detect water contamination by bacteria in four hours as an alternative to current tests that can take four days to provide results.

Part 4

Detailed Project Information

Project Category:

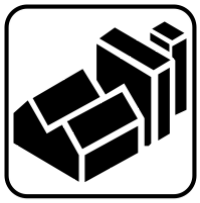
Environmental Improvement

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Greenhouse Gases (GHG) Emissions Model



Contact: Jeff Brown, Technical Services

Purpose: Develop a computer model of GHG emissions from OCSD activities to use in evaluating the environmental impacts of current practices and possible future process choices.

Description:

Various parts of OCSD's activities result in emissions of gases that have been identified as "greenhouse gases" (GHG) because of their role in trapping heat in the earth's atmosphere. Other than carbon dioxide (CO_2), which is produced by bacteria and through combustion processes, the two most common GHG associated with wastewater treatment are methane (CH_4) and nitrous oxide (N_2O).

California Assembly Bill 32 (AB 32) requires that GHG emissions be monitored and inventoried. In addition, as the understanding of these emissions and their importance grows, they become integral parts of the decision-making process for selecting process options and practices. Thus it is increasingly important to quantify the GHG emissions from wastewater treatment activities and evaluate their relative contributions to an agency's carbon footprint (CFP).

OCSD and UCI's Urban Water Research Center developed a CFP model with detailed consideration of OCSD's biosolids transportation activities, aerated biological (secondary) treatment processes, and sludge digestion and dewatering processes. Other unit operations (such as the headworks and clarifiers) and fugitive emissions, all of which were believed to be less important sources of GHG emissions, were included in the model but were treated in less detail.

2009-10 Project Description

Results:

The CFP calculations and analyses for the current operating scenarios showed that biosolids operations, methane (biogas) combustion in flares, CO_2 from bacterial respiration and combustion, and electricity generation were the major contributors to each treatment plant's CFP. The analyses of energy consumption showed that secondary treatment, influent and effluent pumping, and anaerobic digesters were the largest energy users.

The model includes flexibility to evaluate a variety of process conditions, including secondary treatment in either nitrifying or non-nitrifying operation.

Status:

Work in the upcoming year might include:

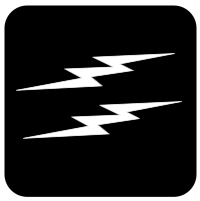
- Improving the model's treatment of GHG emissions from such sources as DAFs, sludge dewatering, and general fugitive sources.
- Longer-term dynamic modeling of N_2O and CH_4 emissions.
- Starting to integrate OCSD's model with a comparable model UCI might develop for the Orange County Water District (OCWD).

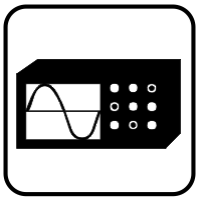
Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Fuel Cell Demonstration for Energy and Hydrogen Production





Contact: John Linder, Engineering
Jeff Brown, Technical Services

Purpose: Demonstrate a fuel cell power plant using digester gas as fuel and producing hydrogen for vehicle fuel and electricity for onsite use

Description:

A fuel cell is an electrochemical device to generate electricity. Its fuel is a carbon source, such as digester gas, and its operation produces only water, waste heat, and trace gaseous emissions as byproducts. The electrochemical process occurring in a fuel cell is a direct form of fuel conversion that is much more efficient than conventional combustion-based electricity generation. Compared to combustion processes, fuel cell operation results in dramatically reduced emissions of such pollutants as nitrogen oxides (NO_x), sulfur oxides (SO_x), and carbon dioxide (CO_2).

OCSD has agreed to be the host site for a public / private collaborative demonstration with the University of California, Irvine (UCI), U.S. Department of Energy, California Air Resources Board (CARB), South Coast Air Quality Management District, Air Products and Chemicals (APCI), and FuelCell Energy (FCE). A 300 kW fuel cell will be installed at Plant No. 1 to use a portion of the treatment plant's digester gas to generate electricity for on-site use. In addition, hydrogen gas will be produced and compressed for fueling vehicles at a publicly accessible fueling station as part of the California "Hydrogen Highway."

The specific fuel cell technology selected for this project has qualified for several environmental certifications, such as the Leadership in Energy and Environmental Design (LEED) program and the Renewable Energy Standards (RES). It also qualifies as an "ultra-clean" technology by exceeding all CARB emission standards.

2009-10 Project Description

APCI and FCE will design, install, operate, and maintain the fuel cell system, and UCI's National Fuel Cell Research Center will operate the fueling station. The entire installation is expected to operate for three years.

The elements of this project that are included under the general goal of "demonstrating the fuel cell power plant operation" include determining the amount of digester gas cleaning that is needed to make it a suitable fuel, documenting the operating efficiency of the power plant and its component processes, determining the maintenance requirements for the system, and verifying the expected lack of air pollutant emissions. Appropriate samples will be collected throughout the test program by the participating organizations, and all test results and operating records will be reviewed by OCSD and the other participants.

Since digester gas is considered a renewable energy source, this project has received significant financial incentives, including $2.7 million from CARB. Air Products and FuelCell Energy will operate and maintain the fuel cell and its ancillary equipment, and UCI will operate the hydrogen fueling station. OCSD is responsible for preparing the site and installing the utilities the equipment will need. OCSD's share of this $8 million project is $500,000 plus project oversight costs during the test period.

Results: None; the system was not yet operational as of the end of 2009-10.

Status:

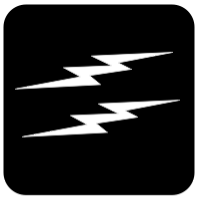
Installation of the fuel cell and ancillary equipment is expected to be completed during Q2 2010, with startup of the fuel cell and the hydrogen vehicle fueling station occurring during Q3 2010.

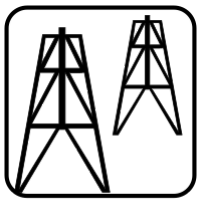
Project Type: ☒ New ☐ Continuing

2009-10 Project Description

Project Title:

Fuel Cell Feasibility Study, Project No. SP-132





Contact: Jacob Dalgoff, Engineering

Purpose: Develop and evaluate alternatives for fuel cell use at OCSD

Description:

OCSD is investigating the use of stationary fuel cells for generating electricity and process heat within the treatment plants. These could be replacements for, or supplements to, the existing Central Generation engines, and would be expected to be fueled primarily with digester gas.

This project will provide design, performance, and cost information for large fuel cell facilities. The performance requirements for base load generation and load following capability will be defined, and the ability of fuel cells in various configurations to meet these requirements will be investigated. The project also will develop lifecycle costs for selected equipment configurations, evaluate increased generating efficiency impacts to OCSD facilities, and identify grant funding opportunities for fuel cell projects. Several scenarios are expected to be developed that consider phased equipment replacements and options for complying with current and future air emissions regulations affecting the existing biogas-fueled engines**.**

Results: No results are available yet.

Status:

The scope of work has been developed and the Request for Proposal is expected to be released in August 2010.

Project Category:

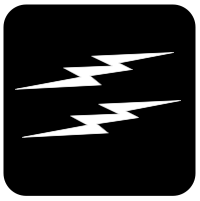
Air Quality

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Central Generation System (CGS) Engines Air Emissions Compliance (Project J-79)



Contact: Dave MacDonald, Engineering (CIP Project Manager)
Jeff Brown, Technical Services

Description:

CGS engines are the largest sources of air pollution at OCSD. They emit both criteria pollutants (NO_x, CO, VOC, particulates, SO_x) and substances identified as air toxics.

The goal of the J-79 project is to evaluate and test technologies to reduce emissions from the CGS engines to address AQMD Rules 1110.2, 1401, and 1402. Several identified technologies that reduce NOx, CO, and VOC emissions were evaluated in detail based on technical and economic factors such as proven performance, availability, long-term performance, commercial application, site specific constraints, and cost. Based on the results of this evaluation, a pilot test of a Selective Catalytic Reduction (SCR)/Catalytic Oxidizer System is being conducted on one CGS engine at Plant 1. This selected post-combustion technology has been proven effective for controlling NOx, CO, and VOC emissions from combustion units using natural gas. However, the CGS engines run on digester gas, which can lead to fouling or rapid performance degradation of catalytic oxidizers. Therefore, a digester gas cleaning system is also included as part of the pilot testing program.

The design of the pilot testing program includes one full-scale platform-mounted SCR/catalytic oxidizer system that has been installed on Engine #1. Based on pilot testing previously performed at Plant 2, the digester gas cleaning system has proven successful in removing contaminants such as siloxane and hydrogen sulfide from the digester gas, making the catalyst life comparable to an IC engine installation operating on natural gas. The pilot testing will use one layer of catalyst in the catalytic oxidizer housing and two layers of

catalyst in the SCR housing to collect data for compliance with upcoming (year 2012) emission limits. The digester gas cleaning system will use carbon adsorption to clean all digester gas produced at Plant 1.

Results:

The pilot testing program will assess the performance of NO_x, CO and VOC removal by the SCR/catalytic oxidizer system and provide information for use in full-scale design. The monitoring requirements for the program include the following:

- Test the catalytic oxidizers while running the engines on 90 to 100 percent digester gas.
- Perform source testing once during the initial start-up of the system using CARB approved sampling methods for NO_x, CO, and total VOCs and using CARB Method 430 for formaldehyde.
- Perform periodic monitoring of NO_x and CO performance at the inlet and two outlets of the two catalytic oxidizers using hand-held analyzers.
- Perform quarterly source testing of VOCs using SCAQMD Method 25.1 and formaldehyde CARB Method 430 at the inlet and outlet of the catalytic oxidizer.
- Perform bi-weekly source testing of specified organics (air toxics) and sulfur compounds at the inlet and outlet of the fuel gas cleaning system and the inlet and outlet of the catalyst system utilizing EPA Method TO-15 and SCAQMD Method 307-91.
- Perform quarterly testing of siloxane removal using MS/FID.

The catalytic oxidizer reduces carbon monoxide and air toxics (e.g., formaldehyde, acrolein) emissions from the engine exhaust. Urea is injected into the engine exhaust ductwork between the catalytic oxidizer and the SCR catalyst to reduce NO_x emissions. The digester gas cleaning system is filled with activated carbon media to remove siloxane compounds that could potentially foul the oxidative and SCR catalysts.

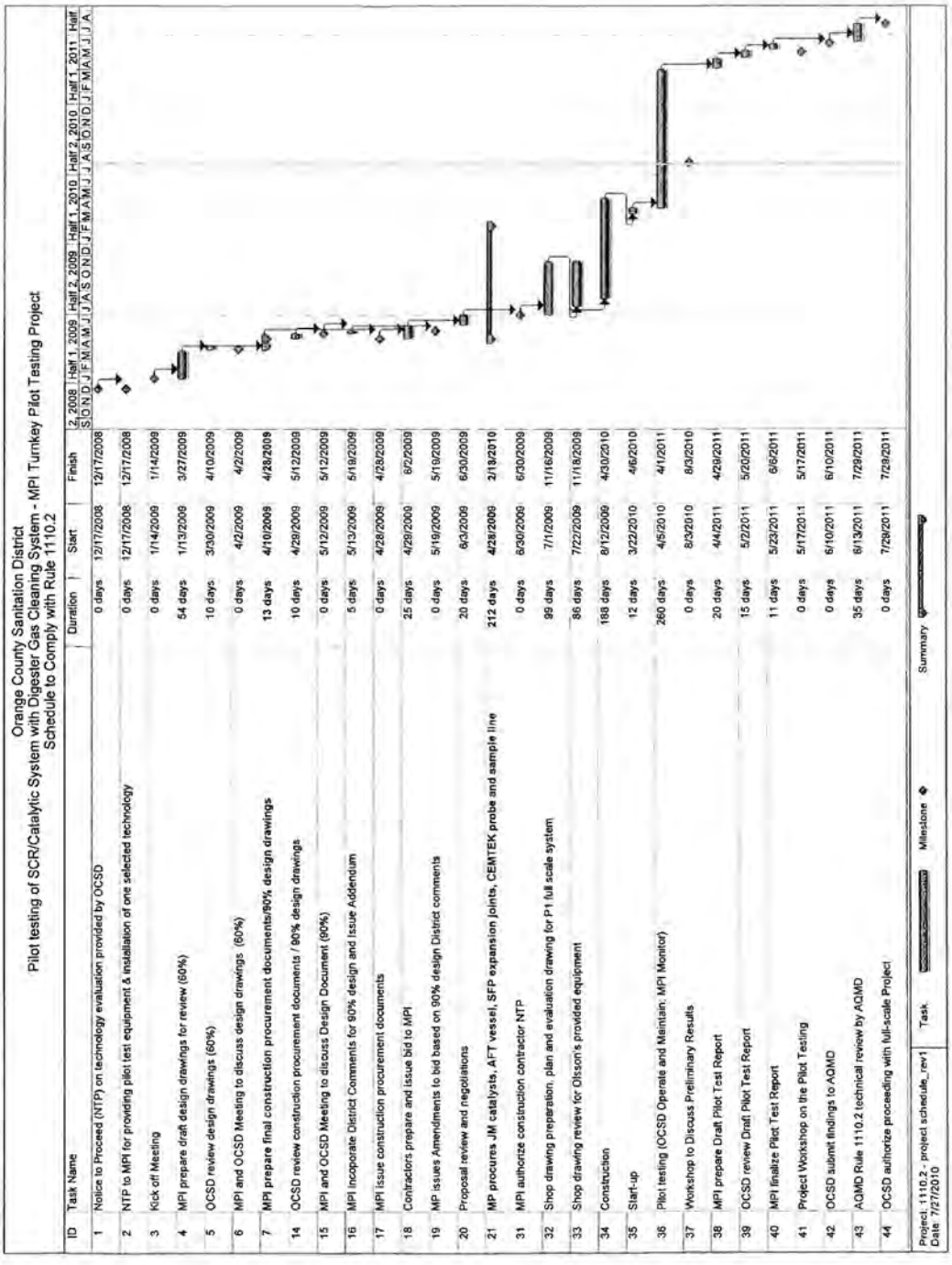
The projected cost for the pilot testing is $530,000 for the SCR/catalytic oxidizer and digester gas cleaning system and $2.4 million for construction and related expenses during the test. Equipment for full-scale installations on the remaining seven CGS engines would cost $31 million.

Status:

Engineering services for the J-79 Project are being provided by Malcolm Pirnie, Inc. (MPI). The design and construction of the pilot testing facilities has been completed. Olsson Construction provided installation services for the earlier catalytic oxidizer pilot test at Plant

2 and installed the pilot testing equipment at Plant 1. The construction began October 2009 and was completed in February 2010. Testing activities began in March 2010 and will continue through March 2011. Final reports will be prepared by Malcolm-Pirnie, with final reports submitted by June 2011.

2009-10 Project Description



Project Category:

Odor and Corrosion Control

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Superoxygenation Process Evaluation

Contact: Jeff Brown, Technical Services

Purpose: Evaluate an oxygen-based process for odor and corrosion control

Description:

Hydrogen sulfide (H_2S) is the principal cause of odors and corrosion in our sewers and treatment plants. H_2S is formed only when there is a deficiency of oxygen. Maintaining dissolved oxygen levels is a challenge in normal treatment situations because bacteria consume much of the oxygen, and some dissolved oxygen is released from water into the atmosphere when the water is turbulent.

A process for dissolving large amounts of pure oxygen in water (superoxygenation) using a device called a "Speece cone" was tested successfully at the Seal Beach pump station in 2005 as part of our efforts to evaluate cost-effective odor control technologies. Subsequently, three parts of OCSD's treatment system were identified as potentially benefitting from superoxygenation: the collections system, headworks / primary treatment, and secondary treatment (activated sludge). The goals in the first two areas would be to provide oxygen to reduce odors and corrosion. In secondary treatment, the goal would be to provide the required process oxygen less expensively than is done now using air blowers or oxygen diffusers.

Results:

In 2008-09 a comprehensive engineering evaluation of the technical feasibility and cost implications of using superoxygenation at OCSD found that superoxygenation would not be technically feasible for the headworks / primary clarifiers because there would not be enough contact time available for the added oxygen to react. For the activated sludge processes, using superoxygenation was found to be technically feasible but not cost effective.

2009-10 Project Description

For odor control at certain pump stations, superoxygenation was found to be technically feasible and potentially less expensive than alternative chemical treatments. These locations could be candidates for superoxygenation with relatively minor modifications to the existing sites.

The Crystal Cove and Main Street pump stations were selected for additional study. Intensive onsite sampling programs were conducted at both sites to provide accurate information about concentrations and variations of sulfides, dissolved oxygen, and orthophosphate, as well as various physical and chemical characteristics of the wastewater (pH, temperature, oxygen uptake rate, and oxidation reduction potential). These data, together with computer models of the collections system served by these pump stations, were used to predict the effectiveness of superoxygenation treatment and to prepare preliminary designs of superoxygenation systems for both sites.

Status:

The technical and economic analyses are being completed, which will allow superoxygenation to be compared to various chemical-based odor control options at the two pump stations. In addition, the simultaneous addition of oxygen and chemicals to treat force mains (with oxygen) followed by gravity sewers (with chemicals) might be investigated further, as such a combination system might address superoxygenation's limitation of not exceeding saturated oxygen levels in gravity sewers to prevent oxygen accumulations in head spaces.

Project Category:

Process Alternatives or Improvement

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

OpenCEL Process Evaluation

Contact: Jeff Brown, Technical Services

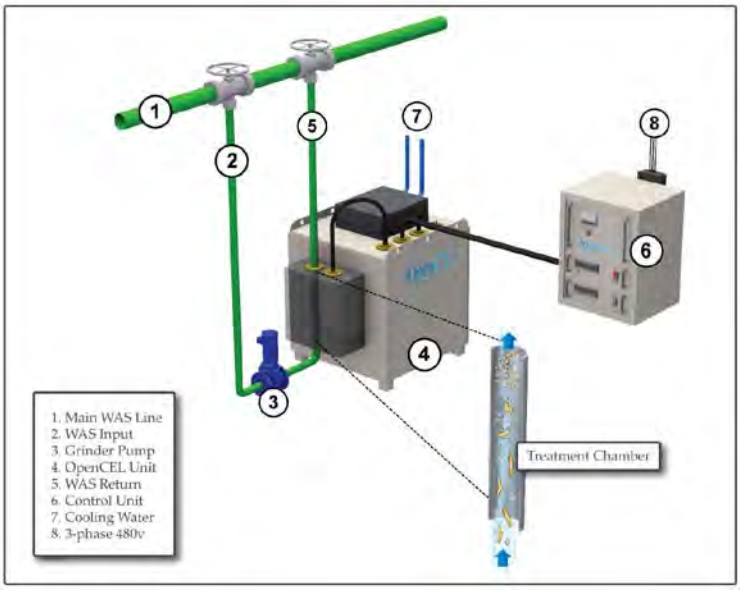
Purpose: Evaluate a process to improve digester efficiency and minimize residual solids

Description:

Anaerobic digesters convert volatile solids to methane gas, but their conversion efficiency is not 100%. Solids from secondary treatment (such as waste activated sludge or WAS) are particularly difficult to convert; a typical digestion cycle might convert only one-third of the available secondary volatile material.

Breaching the cellular membrane is the rate-limiting step for anaerobic digestion of WAS. Various methods of digestion pretreatment have been shown effective at laboratory scale since the late 1970's, but scalability problems, excessive power requirements, and other factors generally have kept them from achieving full-scale practical use.

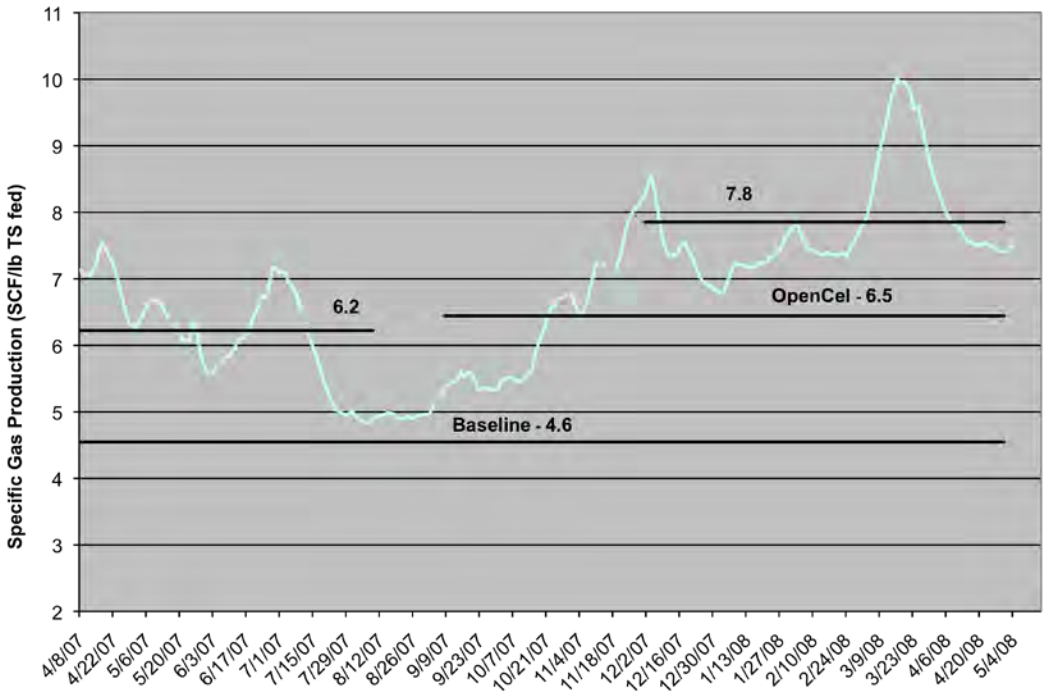
The OpenCEL process is a proprietary Focused Pulsed (FP) treatment that creates reversible disruptive conditions within cellular membranes. These forces are generated by a rapid, pulsed electric field using high voltage, high frequency, microbursts of conditioned electricity. Applying enough electrical energy to the WAS results in irreversible opening and breaching of the cell membrane. This releases the intracellular material, making it readily available for further reaction and conversion to methane in the digester. The net result would be increased digester gas production and reduced amounts of residual biosolids.



2009-10 Project Description

Results:

OpenCEL has been used in a full-scale commercial installation at the wastewater treatment plant in Mesa, AZ, since 2007 to treat a mixture of thickened primary solids and WAS. The results have been impressive: the WAS volatile solids reduction (VSR) has increased from ~30% VSR to ~70% VSR, and the biogas production has increased ~60%. Analyses of the digester microbial population showed increases in the relative abundance of acetate-utilizing methanogens, indicating the cell lysis caused by the treatment increased the availability of simple volatile acids.



Status:

Biological Methane Potential (BMP) tests in 2009 on OCSD's WAS by Arizona State University showed BMP increases after treatment that supported OpenCEL's expectations for successful performance. Preliminary cost analyses suggested that using OpenCEL could save OCSD on the order of $2-4 million/year at each plant (depending on the specifics of each plant's operation and the value placed on WAS heating). The equipment cost for full WAS treatment at each plant would be ~$4 million.

A test program for an OpenCEL installation on one digester at Plant 1 has been developed for 2010-11. This program will compare the digester's performance (e.g., biogas production

and VSR) with and without OpenCEL treatment. In addition, a second digester without OpenCEL will be used as an experimental control so any changes in the test digester's performance can be correctly attributed to OpenCEL or other factors.

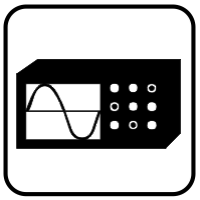
After installing the OpenCEL equipment and necessary auxiliary equipment, the test is expected to begin in Q3 2010 and continue for about nine months.

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Deep Well Injection of Biosolids



Contact: Michelle Hetherington, Operations & Maintenance

Purpose: Consider underground disposal as a biosolids management practice

Description:

Managing the biosolids produced by wastewater treatment is a continuing concern for OCSD. Beneficial land application to provide soil nutrients, composting, and processing into industrial fuel are among the options that the agency has pursued. Another future possibility involves putting biosolids far underground.

The City of Los Angeles is pioneering the nation's first project to produce green energy from a renewable bioresource using deep well injection with its experimental Terminal Island Renewable Energy (TIRE) project. Using techniques that are similar to enhanced oil recovery operations, the TIRE project will inject biosolids in depleted oil and gas reservoirs more than a mile underground. The earth's high internal temperatures and pressures will convert the biosolids to methane gas and carbon dioxide, but the carbon dioxide will remain trapped (sequestered) in the deep subsurface layers. The project's permit allows a five-year period to evaluate the potential for high temperature treatment of the biosolids, biodegradation and conversion to methane and carbon dioxide, permanent sequestration of the majority of the carbon dioxide, and recovery of the methane from the sandstone formation for energy use in surface facilities.

Results:

The TIRE injection process is being operated and maintained by Terralog Technologies, a company specializing in this type of work. Since OCSD is interested in the deep well injection option, Terralog previously was contracted to complete a technical feasibility and design

2009-10 Project Description

report for deep well injection at OCSD facilities. The report included a detailed geologic review of the areas around both treatment plants and a preliminary design concept of a deep well injection facility to inject up to 400 wet tons per day of biosolids or 200,000 gallons per day of dilute sludge or brine.

Terralog's report concluded that the areas around both OCSD plants have the appropriate geology for biosolids injection with containment and confinement zones at depths of 4,000 – 6,000 feet. Plant 1 would be preferred for an injection operation because the geology is less complex and has fewer existing oil wells nearby; Plant 2 also has more seismic risks due to the Newport-Inglewood fault zones.

Concerns about earthquakes and ground movement were addressed by Terralog. The target injection zones are relatively shallow (5,000 feet depth) compared to natural seismic zones in the area (30,000 feet depth). There are more than 24,000 deep production and injection wells in Los Angeles County and Orange County, including more than 1000 wells within a few miles of Plant 1. These existing wells have experienced decades of seismic activity with no dangerous releases of gas to the surface during earthquakes because metal casings on wells merely deform slightly under seismic strains rather than breaking. Higher standards of design and construction would be used for biosolids injection wells, and more stringent monitoring and operational safeguards would be applied.

Fresh water aquifers are generally protected from deep well injection based on the difference in subsurface depth of the groundwater aquifers (200 - 1,200 feet) compared to the injection zone (5,000 feet). There also is natural geological protection to prevent the injected biosolids from migrating because multiple sealing shale layers would inhibit any fluid migration.

A deep well injection test at OCSD would require a Class V (experimental) permit from the EPA. Public and technical workshops would be necessary before applying for the permit.

2009-10 Project Description

Status:

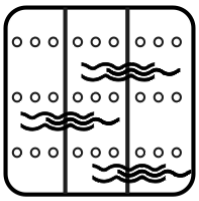
The TIRE project began full production in 2008, and OCSD continues to observe their operation. Staff have visited Los Angeles' application at Terminal Island and have been tracking the performance under varying densities and combinations of injected materials and the associated costs. The deep well injection system cost approximately $8 million to engineer and construct. OCSD will further evaluate options and potential applications in the next year.

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Process Modeling



Contact: Carla Dillon, Operations & Maintenance

Purpose: Establish biological and hydraulic models to optimize plant performance

Description:

Two types of computer models are involved in this project. For biological modeling, the Biowin program is being used. In addition to extensive sampling, calibration is required to ensure that modeled results are close to actual sample results. For hydraulic modeling, the EPA SWMM 5 model is being used together with custom-made Excel spreadsheet models.

Results:

OCSD owns a license for the Biowin program, and five employees have been trained on using the program. This model was used by OCSD consultants on several capital improvement projects in the past and is now used in-house.

In 2008-09, staff worked with a hydraulic consultant to evaluate the Plant 2 Ocean Outfall Booster Station (OOBS) and Effluent Pump Station Annex (EPSA), which pump treated effluent into the ocean, and the associated pipe/channel system. No further work was completed on the hydraulic model in 2009-10.

Status:

In coordination with the design consultant, a test in nitrification mode was completed for the Plant 1 activated sludge facility 1 (AS-1) after its recent upgrades. Data obtained during this test aided in calibrating the Biowin model for this mode of operation. Although construction is not yet completed, OCSD obtained model data from consultants for the Plant 1 activated sludge facility 2 (AS-2). In addition, OCSD staff began to model the Plant 1 trickling filters.

2009-10 Project Description

Part of the effort in 2010-11 will include completing the model and calibration for the Plant 1 trickling filters, calibrating the model for Plant 1 AS-2, and beginning to model Plant 2 secondary treatment facilities. The model will also be used as an on-going optimization tool by OCSD staff.

Also in 2010-11, staff will reassess the resources available for expanded hydraulic modeling.

Project Category:

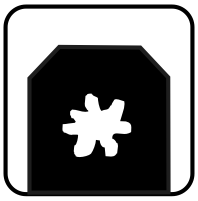
Emerging Contaminants, Ocean Monitoring, and General Topics

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

University of Arizona Water and Environmental Technology (WET) Center



Contact: Tom Meregillano, Technical Services

Purpose: Benefit from membership in a National Science Foundation-sponsored research center devoted to water quality-related research.

Description:

OCSD supports and benefits from the research performed at the National Science Foundation Water & Environmental Technology (WET) Center administered through The University of Arizona. Although OCSD joined for their expertise in research related to land application of biosolids, the WET Center also researches water quality issues, reclaimed water, emerging contaminants, water and wastewater treatment technologies, new laboratory methods, climate change, and other cross-media issues related to OCSD's business activities.

Approximately 70% of the WET Center's funding is furnished by the State of Arizona through grants and public education funding. The remainder comes from annual contributions by individual members such as OCSD. For our annual contribution of $10,000, OCSD gets access to research costing approximately $1 million annually (over $11 million cumulatively 1999-2009) into the most pertinent issues in our industry today. OCSD also has direct input to the program and voting rights as a member of the Industrial Membership Board. The Center is also critical because their research is done in the same arid desert region where our biosolids are land applied, making their field studies more directly pertinent to the OCSD Biosolids Program than studies done in other regions.

Results:

During 2009-10, research programs and results from the WET that were relevant to OCSD included the following.

2009-10 Project Description

Publications

2010	Pepper, I.L., J.P. Brooks, R.G. Sinclair, P.L. Gurian, and C.P. Gerba. 2010. Pathogens and Indicators in United States Class B Biosolids: National and Historic Distributions. *J. Environ. Quality*. In Press.	In general, both bacterial indicator loads and pathogen loads (bacterial and viral) decreased from the 1980s to present. Presumably this is due to better and more consistent treatment of sewage, illustrating that the Part 503 Rule has been effective in reducing public exposure to pathogens relative to 25 years ago. The percent reduction of both indicators and pathogens during anaerobic mesophilic digestion was between 94 and 99% for all organisms illustrating that such treatment is effective in reducing pathogen loads.
2010	Zerzghi, H., J.P. Brooks, C.P. Gerba, and I.L. Pepper. Influence of long-term land application of Class B biosolids on soil bacterial diversity. *J. Appl. Microbiol*. 109:698-706.	**Conclusion:** Bacterial diversity was either enhanced or was not negatively impacted following 20 years of land application of Class B biosolids.
2010	Zerzghi, H., C.P. Gerba, and I.L. Pepper. Long-term Effects of Land Application of Class B Biosolids on Soil Chemical Properties. *J. Res. Sci. Technol.* 7:51-61.	The study showed that land application of Class B biosolids had no significant long-term effect on soil pH and $CaCO_3$. However, land application significantly increased soil macronutrients (C, N, and P). Total metal concentrations attenuated rapidly with increasing soil depth and were generally similar to values found in control soils at a depth of 150 cm. Application of biosolids for nonfood agricultural crop production at this arid southwest site seems to be sustainable with respect to soil chemical entities.
2010	Zerzghi, H., Gerba, C.P., Brooks, J.P., and Pepper, I.L. Long-term Effects of Land Application of Class B Biosolids on the Soil Microbial Populations, Pathogens and Activity. *J. Environ. Qual.* 39:402-408.	This study evaluated the influence of 20 annual land applications of Class B biosolids on the soil microbial community. Overall, the applications showed no long-term adverse effects, and therefore, this study documents that land application of biosolids at this particular site was sustainable throughout the 20-yr period with respect to soil microbial properties.
2009	Walker, D.B., N.V. Paretti, G. Cordy, T.S. Gross, S.D. Zaugg, E.T. Furlong, D.W. Kolpin, W.J. Matter, J. Gwinn, and D. McIntosh. Changes in Reproductive Biomarkers in an Endangered Fish Species (bonytail chub, *Gila*	In arid regions of the southwestern United States, municipal wastewater treatment plants commonly discharge treated effluent directly into streams that would otherwise be dry most of the year. A better understanding is needed of how effluent-dependent waters differ from more natural aquatic ecosystems and the ecological effect of low levels of environmentally persistent organic wastewater compounds with distance

	elegans) Exposed to Low Levels of Organic Wastewater Compounds in a Controlled Experiment. *Aquatic Toxicology*. 95:133-143.	from the pollutant source. Measures of fish condition showed no significant differences between male or female fish housed in effluent or clean water. The population-level impacts of these findings are uncertain. Studies examining the long-term, generational and behavioral effects to aquatic organisms chronically exposed to low levels of organic wastewater compound mixtures are needed.
2009	Gundy, P.M., C.P. Gerba, and I.L. Pepper. Survival of Coronaviruses in Water and Wastewater. *Food Environ. Virol.* 1:10-14.	The advent of severe acute respiratory syndrome and its potential environmental transmission indicates the need for more information on the survival of coronavirus in water and wastewater. Coronaviruses die off rapidly in wastewater (between 2 and 4 days).
2009	Rodriguez, R.A., I.L. Pepper, and C.P. Gerba. Application of PCR-Based Methods to Assess the Infectivity of Enteric Viruses in Environmental Samples. *Appl. Environ. Microbiol.* 75:297-307	The advent of the PCR has greatly enhanced our ability to detect human enteric viral pathogens in the environment, including water, municipal wastes, sewage, food, and air. The ability of PCR to assess infectivity would greatly enhance its application for the monitoring of water and food quality and for treatment processes (e.g., disinfection). This review focuses on approaches to overcome these limitations.

Final Reports

2009	*Ian Pepper .* Survival of Prions in Class B Biosolids	This was the first study of the survival of infectious prions in biosolids. To accomplish this, a method was developed for extracting prions from biosolids that was compatible with the assay of the samples using cell culture. A method has been developed that will allow for additional detailed studies on the survival of prions in biosolids. This method was then used to study the persistence of prion infectivity in Class B biosolids incubated at mesophilic (37°C) and thermophilic (60°C) anaerobic digester temperatures. A 2.43-$\log_{10}$ reduction in prion infectivity was observed under a mesophilic (37°C) temperature after 15 days and 3.41-$\log_{10}$ reduction was observed after 10 days at a thermophilic temperature (60°C).
2009	John Brooks, Charles Gerba, Ian Pepper. Risk Assessment of Land Application of Biosolids vs. Animal Manures	The transmission of pathogens by land application of untreated human and animal wastes has been known for more than 100 years. In the United States there are more than 450,000 animal feeding operations producing more than 100 times as much manure as sewage sludge produced by municipal wastewater treatment plants. In addition, grazing animals also deposit large quantities of

2009-10 Project Description

		manure on range land. This study looks at the relative risks of pathogens in biosolids vs. animal manure applied to land using a quantitative microbial risk assessment approach. Assuming USDA-AMS and USEPA recommended guidelines and regulations are followed for crops grown on waste-applied land, risks associated with manure or biosolids land application are well below the 1:10,000 per year risk of infection standard. This analysis provides insight on the relative risks of animal waste and biosolid land application that allows for a better understanding of the risks to the general public and the industry.
2009	Charles Sanchez. Preliminary Evaluation of Antibiotic and Illicit Drug Contaminants in the Colorado River and Their Potential for Food Chain Transfer	A number of pharmaceuticals have been detected in surface waters across the United States. The objective of this study was to evaluate the presence of selected pharmaceuticals (macrolidic antibiotics and pseudoephedrine) and illicit drugs (methamphetamine, Ecstasy) in surface waters in the southwestern U.S. and evaluate the potential for food chain transfer when pharmaceutical containing waters are used for irrigation. One or more of the pharmaceuticals and/or illicit drugs evaluated were found in urban waste streams at concentrations sometimes exceeding 500 ng/L. However, amounts found in the main surface water channels were always below 10 ng/L and most frequently below detection. The results of the greenhouse and field studies indicate the uptake of one or more of the pharmaceuticals evaluated, albeit at very low-levels, into several of the crops species.

Projects in Progress:

- Sustainability of Land Application of Biosolids for Mine Tailing Reclamation
  - *Ian Pepper*

- Incidence of Pathogens and Indicators in Biosolids: A National Study of Wastewater Treatment Plants
  - *Ian Pepper*

- Fate of Endocrine Disruptors Following Long-Term Application of Class B Biosolids
  - *David Quanrud*

2009-10 Project Description

- Survival of Infectious Prions During Wastewater Treatment and Land Application of Biosolids
  - *Syreeta Miles*

- Microbial Risk Assessment of Pathogens within Biosolids
  - *Chuck Gerba, Ryan Sinclair, Ian Pepper*

  questioned. The objective of this study was to evaluate the sustainability of biosolids land application. To do this, the WQC evaluated (1) the fate and transport of potential biological and chemical hazards within biosolids, and (2) the influence of long-term land application on the microbial and chemical properties of the soil. Direct risks to human health posed by pathogens in biosolids have been shown to be low. Risks from indirect exposure such as aerosolized pathogens or microbially contaminated ground water are also low. A long-term land application study showed enhanced microbial activity and no adverse toxicity effects on the soil microbial community. Long-term land application also increased soil macronutrients including carbon, nitrogen, and in particular, phosphorus. Available soil metal concentrations remained low over the 20-year land application period due to the low metal content of the biosolids and a high soil pH.

Status:

As a continuing member, OCSD maintains access to the Center's considerable research results and, as a voting member of the Industrial Membership Board, continues to participate in and provide input to the direction of the research program.

Project Type: ☐ New ☒ Continuing

2009-10 Project Description

Project Title:

Marine Impacts and Trace Pollutants Studies

Studies
Research

Misc. &
Support Projects

Description:

OCSD participates in a number of projects related to marine life, ocean conditions, and trace pollutants. Often these are cooperative projects with industry organizations (e.g., WERF) or universities (e.g., UC Riverside). OCSD's role can range from minor (serving on project oversight committees) to more substantial. The analytical capabilities of the environmental sciences laboratory often are useful for researchers and provide opportunities for collaboration through in-kind contributions of sample analyses by OCSD.

Significant projects during 2009-10 related to marine topics and trace pollutants included the following.

- Southern California Bight Regional Monitoring Program 2008 (SCCWRP Cooperative Project)

  Contacts: George Robertson and Charles McGee, Technical Services

  This project collects regional information to assess cumulative impacts of contaminant inputs and to evaluate relative risk among different types of stresses. It is conducted through SCCWRP and involves about 60 participating organizations.

  The Bight'08 Survey is organized into six technical components: (1) Coastal Ecology, (2) Shoreline Microbiology, (3) Water Quality, (4) Hard Bottom, (5) Areas of Special Biological Significance, and (6) Nutrient Overenrichment in Wetlands. OCSD is directly involved in the first three components.

  Bight'08 builds on the information from previous Bight Studies and expands on the 2003 survey by including new participants, answering additional questions, and measuring more parameters or using novel methods. Sixty organizations, including international

and volunteer organizations, have agreed to participate. The inclusion of multiple participants, many of them new to regional monitoring, provides several benefits. Cooperative interactions among many organizations with different perspectives and interests, including a combination of regulators and dischargers, ensure that an appropriate set of regional-scale questions will be addressed by the study.

All field sampling work has been completed for the Coastal Ecology and Water Quality components. Shoreline microbiology activities were suspended due to State budgetary issues. Future activities will include completing the sample analyses by late fall 2010 or early winter 2011 and completing and issuing reports over the next three years.

The total SCCWRP budget for the three components involving OCSD will be $500,000 to $750,000, and the total SCCWRP budget in Bight'08 for activities related to marine receiving waters is $1,095,000 plus in-kind services from various agencies. OCSD will provide $125,000 for taxonomic and nutrient analysis, plus in-kind services (e.g., vessel and staff time for field surveys).

- Ocean Current Measurement Program

  Contact: George Robertson, Technical Services

  The purpose of this study is to measure ocean currents in the vicinity of the OCSD ocean outfall. This is an on-going study that provides data used in determining compliance with our ocean discharge permit.

  The ocean current measurement program has several objectives, including providing data to determine compliance with discharge permit conditions and advancing the understanding of physical processes that affect dispersion of the District's wastewater plume. These studies have contributed significantly to our understanding of mixing and transport processes on the San Pedro shelf near the District's outfall. In particular, the District studies have increased the knowledge of three key processes – subtidal flows, internal tides, and sea breeze currents – that are important for understanding the behavior and fate of the District's wastewater discharge and for evaluating the contributions to near shore bacterial contamination.

2009-10 Project Description

- Online Tools for Taxonomic Analysis: Access Database for 5th Edition of SCAMIT Taxonomic Species Listing

  Contact: Dean Pasko, Technical Services

  This project supports the efforts of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) to develop the a database listing of species called *A Taxonomic Listing of Soft Bottom Macro- and Megainvertebrates from Infauna & Epibenthic Monitoring Programs in the Southern California Bight, Edition 5*. The database will become the framework through which taxonomic tools (such as images and taxonomic keys) and ecological resources (such as distribution data and sediment preferences) will be linked. This will facilitate the consistent application of species identifications throughout the Southern California marine monitoring community.

  Since June 2009, SCAMIT has been working towards a 2010 release of a beta version of the taxonomic database. The 5th edition of the species listing forms the backbone of this database. A process for updating the names has been developed and final protocols and procedures are being finalized. The data base will include a Species Presentation page for each species on the list, which will highlight information for the proper identification of the organism. The beta version contains species distribution information pulled from the regional monitoring programs, and an effort is underway to include distributional data from each of the large monitoring agencies' programs. Morphbank images have been included where they exist. Demonstration pages of the final product have been produced and are undergoing final tests to fix glitches of data loading.

  Another ongoing project supported by this effort has been digitizing prior information, such as species voucher sheets and identification aids that SCAMIT members have produced since 1982. These digitized files are being posted at the website in the completely overhauled taxonomic tool box.

  SCAMIT also partnered with Dr. Karen Stocks of the San Diego Supercomputer Center to create a large, searchable database of taxonomic literature with keywords for ease of use. Three separate data bases, including over 30,000 references, were combined by a class from San Diego State University's graduate program on building web-based databases to create a web-accessible database that will link to SCAMIT's Taxonomic Database.

  This concludes OCSD's two year financial support of the project, which can be considered a major success. The future activities will include testing and building upon the beta version of the taxonomic database by adding links to other websites of interest and value, and adding taxonomic tools.

2009-10 Project Description

- Final Effluent Ammonia Toxicity Study

  Contact: Robert Gamber, Technical Services

  This study was conducted to address concerns over increases in effluent ammonia concentrations associated with the projected GWRS expansion and the possible effect on OCSD's NPDES permit compliance for whole effluent toxicity (WET).

  Acute toxicity tests were performed using the topsmelt silverside fish, *Atherinops affinis*. This test was chosen to provide a conservative result because using topsmelt is the most sensitive test to ammonia required in the NPDES permit. Three testing regimes were performed: (1) final effluent, (2) ammonia reference toxicant (ammonia + clean seawater), and (3) final effluent spiked with ammonia. The purpose was to assess the toxicity caused by ammonia alone (ammonia + seawater), final effluent alone (since other constituents in the effluent will cause some degree of toxicity), and toxicity produced by increasing ammonia concentrations in the effluent.

  The results indicate that final effluent total ammonia concentrations as high as 113 mg/L will likely not result in acute WET test exceedances. These results represent a one-time testing only, performed in accordance with the current permit-required testing program. Any changes to toxicity testing requirements in the next permit (e.g., changes in test species or dilution) would require retesting. Changes and variability in final effluent characteristics and constituents also could affect the outcomes of future tests. However, the projected increases in final effluent ammonia levels should not be an issue for the District. The final effluent ammonia concentration will continue to be monitored as the District transitions to full secondary treatment in 2012.

- Interlaboratory Comparison of Analytical Methods for Endocrine Disrupting Compounds (EDCs) and Pharmaceuticals and Personal Care Products (PPCPs) (Water Research Foundation Cooperative Project)

  Contact: Kim Christensen, Technical Services

  This project evaluates analytical methods for EDCs and PPCPs using a round robin design involving multiple laboratories.

  OCSD's role is to analyze nine samples during three round robin events over 12 to 15 months using its existing in-house methods for EDCs and PPCPs. Other laboratories will do the same. The project will compare the strengths and weaknesses of each method. It also will help to establish performance-based QA/QC criteria and guidelines to aid utilities in assessing the most appropriate methods to use.

2009-10 Project Description

During 2009-10, the three interlaboratory round robin sample sets were analyzed and the results submitted. Two sets of results were evaluated with other laboratories, and the third set of results was still being evaluated. All laboratories submitted their written procedures used for sample analysis. All results will be reviewed and outlier data points will be identified, after which performance-based QA/QC criteria and guidelines will be proposed and tested.

- Impacts of Nanoparticle Pollutants on Water Reclamation and Sewage Treatment (WateReuse Research Foundation Cooperative Project)

  Contact: Kim Christensen, Technical Services

  This is a WateReuse-funded cooperative project with UC Irvine and Kennedy/Jenks Consultants to (1) evaluate the impact of zinc and silver nanomaterials in two key water reclamation treatment processes, activated sludge and media filtration, through bench scale studies, and (2) determine if these nanoparticles have an impact on the treatability of sewage.

  The total project budget was $200,000 from WateReuse plus $15,000 from OCSD in in-kind support through sample analyses. Over a one-year period, the laboratory analyzed over 200 samples from secondary process streams for nanomaterials (as total metals concentrations of zinc and silver) using the ICPMS method. This project is complete.

- Trace Organic Chemical (TOrC) Removal during Wastewater Treatment (WERF Cooperative Project)

  Contact: Jeff Brown, Technical Services

  The goals of this large project is to determine the fate and transport of a suite of trace organic chemicals (TOrCs) during conventional wastewater treatment and to determine quantitative structure/activity relationships (QSARs) so that removal of any chemical can be modeled. Common TOrCs include pharmaceuticals, personal care products, hormones, and industrial endocrine disrupting chemicals. The results of this project will improve understanding of the occurrence and fate of TOrCs in municipal wastewater systems, assist in identifying a short list of TOrCs that can be used in monitoring efforts to assess process performance, and allow a utility to determine the most cost-effective method for TOrC reduction.

  This study is being conducted in four phases. Phase 1 includes the selection of viable indicator TOrCs that represent a wide range of physicochemical properties followed by a comprehensive and critical review of currently available TOrC fate models. This

comprehensive review provides the foundation for the second and third phases of the project.

During Phase 2, aqueous and biosolid samples from full-scale treatment processes of participating utilities are being analyzed to determine and quantify select TOrC present in raw sewage, in treated wastewater effluents, and accumulated in biosolids. Treatment processes being evaluated include non- or partly- nitrifying activated sludge systems, nitrifying/denitrifying activated sludge systems, and biological phosphorus removal processes. These efforts are being augmented by controlled experiments at the laboratory- and pilot-scales to enable the further development and evaluation of observed relationships between operational parameters and TOrC removal. Additional laboratory-scale experiments will derive biotransformation rate constants that will be used in fate model calibration.

During Phases 3 and 4, the most viable fate model will be validated at full-scale during various process modifications, and the economic value of the project to WERF subscribers will be assessed. The performance and costs of modifying and operating a secondary process for a given target TOrC reduction will be compared with the known performance and costs of removing TOrC with tertiary and advanced processes, such as membrane filtration, ozonation, and chlorination.

OCSD currently is a minor participant in the larger WERF study, sharing data from previous internal studies, allowing samples to be taken from the Plant 1 activated sludge system operating in nitrifying mode, and contributing about $40,000 in cash and in-kind expenses to the total $500,000 project cost.

In the future, it is likely that a second set of samples will be collected at OCSD, particularly if the activated sludge system is returned to non-nitrifying operation. OCSD also could become a test site for validating the fate model in Phase 3.

Project Type: ☒ New ☐ Continuing

2009-10 Project Description

Project Title:

Orange County Spatial Variability of Ocean Sediments – Phase I

Contact: Dr. Jeffrey Armstrong, Technical Services

Purpose: The goal of this two-phased study is to strengthen OCSD's ability to detect changes in sediment quality in its receiving waters monitoring area and insure the accuracy of NPDES permit compliance assessments.

Description:

Problem Statement:

Maps are an extremely effective data summary tool used to demonstrate spatial extent and magnitude of environmental conditions. Maps help put information about contaminant gradients relative to sources into context over the entire area of interest. Maps of environmental conditions in the area of interest across multiple years will help identify changes in spatial extent (i.e., is the outfall footprint expanding or shrinking over time?). However, the ability to create maps with scientific rigor is difficult and rarely accomplished as sampling grids are often too sparse to capture the necessary spatial variability for reliable predictions at unsampled locations. In addition, many tools used in map creation do not describe confidence in the mapping contours. The District publishes contour maps of pollutants and sediment physical parameters in the Marine Monitoring Annual Report. These maps are based on the placement of existing sediment sampling stations prescribed in the NPDES discharge permit. This sampling scheme is likely not optimal for accurately assessing the outfall footprint for contaminants discharged with the treated wastewater effluent.

Study Objective:

The objective of this study is to review the District's historical benthic sediment data to determine the optimal sediment station array for accurate map generation of the District's outfall footprint for sediment geochemistry analytes and benthic infaunal

community metrics. Improved maps will ultimately provide better data for the determination of NPDES permit compliance and provide managers, regulators, and other stakeholders with the best available information on spatial and temporal trends of sediment impacts from wastewater discharge. As a result of this study, we will be able to answer the following questions: (1) How representative is our existing station grid of the outfall area? (2) Are we undersampling some areas and/or oversampling others? (3) What is the most cost-efficient grid spacing to provide accurate mapping contours? (4) How many additional stations are necessary to characterize spatial variance in the area around the discharge, and/or other areas of influence (e.g., Santa Ana River); and (5) What analyses (e.g., chemical parameters, biological indices) will provide the best resolution for mapping the area?

This study will be conducted in three discrete tasks conducted serially, each with associated products (see Study Outline below). Specific products will include estimates of sample spacing and resulting spatial variability estimates from the current monitoring grid. In addition, an enhanced sample design will be created that will ensure quantifiable spatial variability estimates (also known as a "variogram"). A map of station locations and a table of latitude/longitude will be created for a sediment mapping sampling and analysis. The project will also include the transfer of mapping technology from SCCWRP to dedicated OCSD staff. Implementation of the sediment mapping study design will be evaluated at the conclusion of this study based upon a review of the results, the study value, and the fiscal constraints.

The study was scheduled to run from July 2009 through June 2010 as an OCSD self-funded project with an estimated cost of $30,000.

Study Collaborators:

Dr. Kerry Ritter, Southern California Coastal Water Research Project (SCCWRP), supported the study with assistance in modeling the spatial variability (i.e., variograms), spatial statistics, and spatial designs. She currently is completing a comparable sediment mapping project with the City of San Diego.

Dr. Jeff Armstrong, the project leader, worked with Dr. Ritter to provide data and assist with statistical analyses as needed.

The study outline for this project (phase 1 of 2) was as follows:

TASK 1: Determine mapping domain

The goal of this task was to determine exactly what locations needed to be mapped. There might be different regions that should be mapped with differing levels of

confidence. In addition to spatial domain, the specific indicators to be mapped were defined.

Products (January 2010):
- delineated map with areas of concern
- list of indicators to be mapped

TASK 2: Investigate historical data

The goal of this task was to evaluate the mapping capacity of the existing monitoring design and data. This included evaluating lag distances between sites, initial assessments of spatial variability (i.e., variograms), and comparisons of these spatial variance models to previous models from other locations.

Products (February 2010):
- computed initial lag distributions
- provided initial variogram models
- compared initial variogram models at OCSD to models from other locations (e.g., San Diego)

TASK 3: Optimal sampling design for estimating spatial variability

Based on results from Task 2, the goal of this task was to design a sampling program to quantify estimates of spatial variability. This sampling design was to improve the distribution of lag distances between sites. Distance gaps based on existing monitoring grids were targeted.

Products (March 2010):
- map/table with sampling stations and latitudes and longitudes

Results:

Dr. Ritter completed her statistical analyses and developed a list of 60 additional sites for sampling in addition to the 49 existing sites. She identified data gaps near the outfall, on the shelf area inshore of the outfall, and several locations on the slope and San Gabriel Submarine Canyon.

Status:

The Phase I project is complete. Field sampling for Phase II is currently in progress.

2009-10 Project Description

Phase II is scheduled to run from July 2010 to June 2013. It is an OCSD self-funded project. There is no estimated budget for this phase due to the unknown number of samples required. The number of additional sampling sites for Tasks 1 is 60, while the sampling sites for Task 4 are yet to be determined.

The study outline for Phase II is as follows.

TASK 1: Sample and analysis for variability assessment (to be completed by OCSD)

The goal of this task is implementation of the optimal sampling design created in Phase 1, Task 3. Implementation will include field sampling and laboratory analysis. At a minimum, indicators to be measured include sediment grain size, chemistry, and benthic infauna.

Products:

- Sampling to be completed by July 2010
- Chemistry analysis to be completed by Aug. 2010
- Benthic infaunal analysis completed by Dec 2010

TASK 2: Spatial variability assessment

This task will focus on analyzing the data collected during Task 1. Data analysis will include variogram modeling, spatial regression models for trends in spatial and temporal gradients, and the effects of unique spatial heterogeneity (i.e., outliers). Finally, an initial contour map, based on the results from Task 1, will be prepared. Based on kriging models, the contour map will focus on representative indicators and include estimates of confidence.

Products:

- Preliminary variogram modeling
- Initial contoured image maps of kriged values with estimates of kriging errors

TASK 3: Design cost-efficient mapping study / annual monitoring program

Based on the spatial variance calculated during Task 2, a cost efficiency curve will be generated that weighs prediction errors versus sample density. This cost efficiency curve

will be used to create an optimal sample design for mapping that maximizes contour resolution and confidence for the minimum amount of resources. Several designs will be explored including uneven sample allocation and nested sample designs.

Products:

- Cost efficiency curve
- Written description of optimized sample design
- Map of station locations and table of latitudes and longitudes

TASK 4: Sample and analysis for final map (to be completed by OCSD)

The goal of this task is implementation of the cost-efficient sampling design created in Task 3. Implementation shall include field sampling and laboratory analysis. Indicators should be focused on monitored parameters currently collected by OCSD including sediment grain size, chemistry, and benthic infauna.

Products:

- Sampling to be completed by July 2011
- Chemistry analysis to be completed by Aug. 2011
- Benthic infaunal analysis completed by Dec 2011

TASK 5: Production of final map

The goal of this task is to prepare the final maps for OCSD's Annual Report. A complete set of indicators can be evaluated. The contour maps shall include kriged predictions and estimates of confidence. In addition, the capability of map production and assessment shall be transferred to OCSD for making future maps.

Products:

- Final contoured image maps of kriged values with estimates of kriging errors by June 2012
- Technical transfer of kriging techniques to dedicated OCSD staff by June 2012

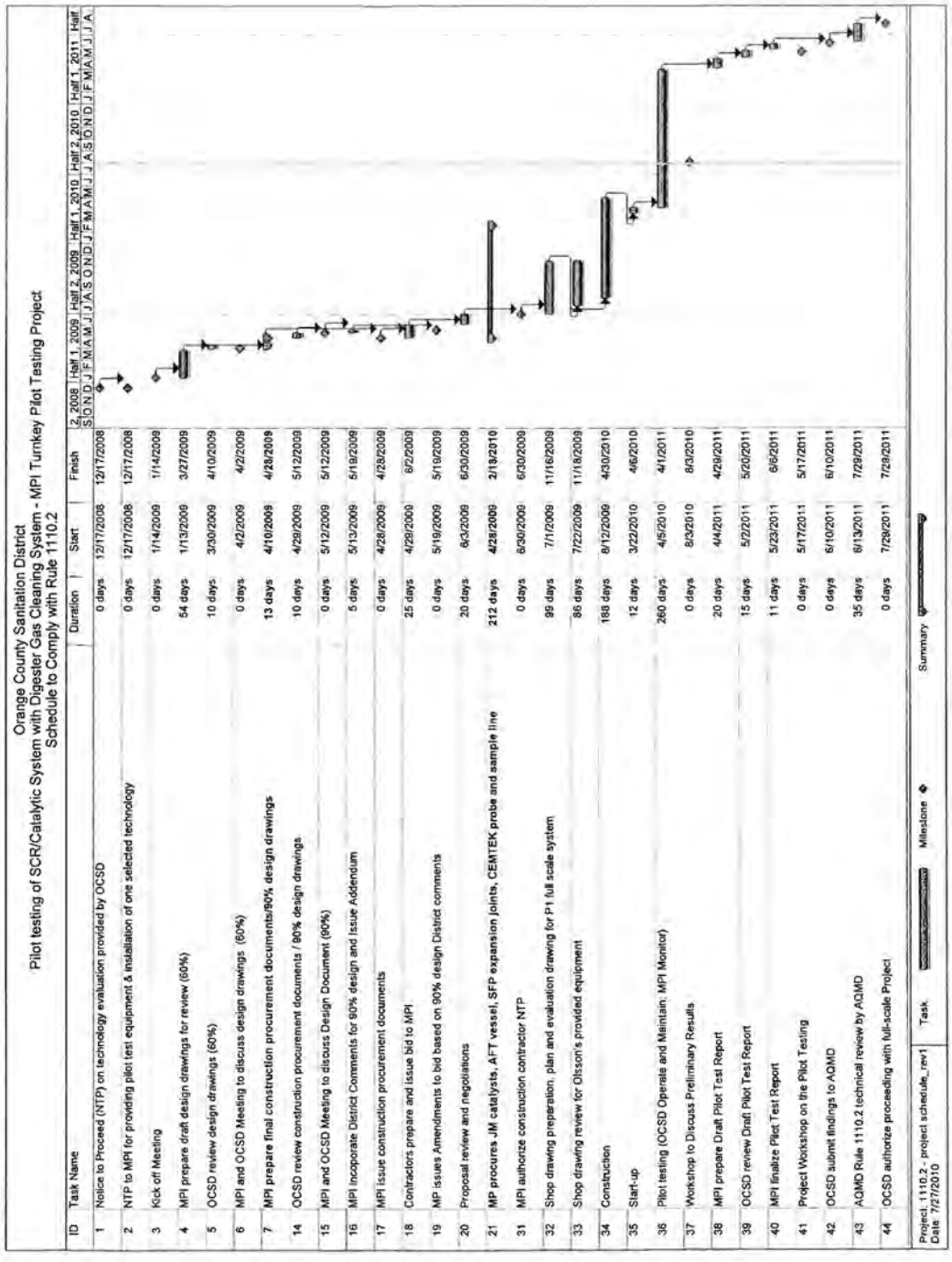
Phase II Schedule

TASK 1: Sample and analysis for variability assessment (OCSD) -Sampling (July – September 2010) -Laboratory analysis	7/10 – 12/10

2009-10 Project Description

TASK 2: Spatial variability assessment - Preliminary variogram modeling - Initial contoured image maps of kriged values with estimates of kriging errors	3/11
TASK 3: Design cost-efficient mapping study/ annual monitoring program - Cost efficiency curve - Written description of optimized sample design - Map of stations locations and table of lat and longs	7/11
TASK 4: Sample and Analysis (OCSD) -Sampling -Laboratory analysis	7/11 – 12/11
TASK 5: Production of final map - Final contoured image maps of kriged values with estimates of kriging errors - Technical transfer of kriging techniques to dedicated OCSD staff	6/13

2009-10 Project Description



Part 5

2010-11 Research Plan

Part 5

2010-11 Research Plan

Several major project milestones are planned during 2010-11 and are described below. These will reflect substantial progress on efforts relating to air emissions control, environmentally responsible energy production and operating practices, and increased treatment process efficiency, among others. (A general description of the upcoming work on these and other continuing projects is found in the project summary table in Part 3 of this report.)

Continuing Projects:

J-79 Central Generation engine emissions control: Several years of study and preliminary testing have led to a full-scale installation and validation testing of a gas cleaning system and a Selective Catalytic Reduction / catalytic oxidizer system on a Plant 1 engine to reduce the emissions of NO_x, CO, and volatile organic compounds as required by upcoming regulations. The testing will continue through the first three quarters of the year.

Fuel cell demonstration at Plant 1: Fuel cells provide perhaps the most environmentally benign method of generating electricity. The 300 kW OCSD installation will start with a renewable resource (digester gas), generate electricity for plant use and hydrogen for vehicle use, and emit only water, trace amounts of gases, and heat. This project involves a number of organizations, including the U.S. Department of Energy, the California Air Resources Board, the South Coast AQMD, and the University of California. Once the equipment is installed and operating early this year, a three-year test is planned.

Greenhouse gases (GHG) emissions model: This project has produced a computer model for predicting GHG emissions from various parts of OCSD's treatment activities, with some aspects being modeled in more detail than others. The model might continue to be refined if it seems the effort would be worthwhile. Another possible activity is to cooperate with UCI and OCWD to integrate the OCSD model with a similar model UCI will develop for OCWD.

Alternative technologies: Improving the efficiency of core wastewater treatment activities is an on-going effort. One way to improve efficiency is to adopt new technologies that provide cost or efficiency advantages over existing practices.

- The OpenCEL process for digester improvement appears promising based on laboratory evaluations of the digestibility of OCSD's waste activated sludge, engineering economic projections of its benefits and costs, and several years of full-scale operating experience at an Arizona treatment plant. In 2010-11 a test will be conducted to demonstrate OpenCEL's performance in full-scale use on an OCSD digester.

- Superoxygenation for odor control in the collection system continues to be of interest. Onsite sampling and preliminary design efforts were completed for selected pump stations in 2010-11 that could lead to full-scale installations, and additional evaluations may be undertaken for other locations.

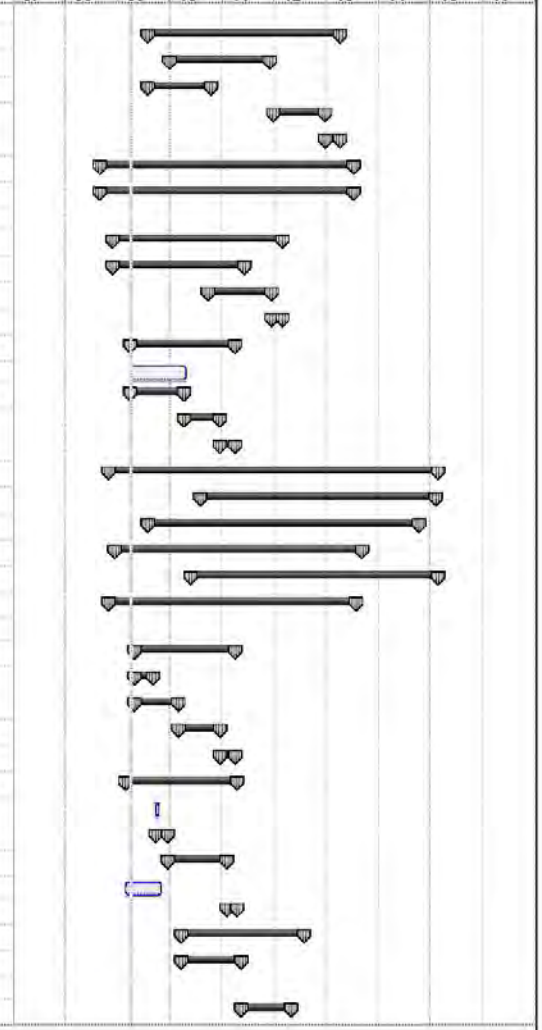
- Processed food waste as an additional digester feed source will be investigated at laboratory scale and full scale. Food waste is highly digestible itself, but research also suggests that its presence in a mixed-feed digester may alter the conditions in ways that improve the digestibility of the entire digester contents.

Part 6

Research Strategic Plan Schedule

OCSD Strategic Research Plan
5-year Project Scheduling

ID	Rank	Task Name
1		
2	1	Power Generation Project
3		Task 1: FOG Handling Study
10		Task 2: Fuel Cell Testing and Marketing
14		Task 3: Strategy for OCSD Vehicle Fleet and Renewable/Alternative Energy Sources
16		
21	2	Sludge Disposal (Deep Well Injection) Project
22		Task 1: Sludge Disposal via Deep Well Injection
28		
29	3	Enhanced Gas Production and Solids Treatment Project
30		Task 1: Evaluation of Sludge Conditioning Technologies & Dewatering Improvements
37		Task 2: Digester Mixing
43		
48	4	Environmental Footprint Project
49		Task 1: Investigate Green Technologies Applicable to OCSD
50		Task 2: Ecological and Carbon Equivalent Footprint
54		Task 3: Impacts of Climate Change on Plant Operations and Compliance Monitoring
60		
65	5	Organizational Cooperation and Outreach Project
66		Task 1: Website and Outreach Materials Development for the Board and Public
72		Task 2: Establish Regional Technology and Information Sharing Group
76		Task 3: Placeholder for Urgent Regulatory Analysis
78		Task 4: Develop Formal Program of Cooperation with Universities
82		Task 5 - Participate in Multi-agency Technology Review Group
84		
85	6	Process Modeling Project
86		Task 1: Develop Biowin Models for OCSD Plants
90		Task 2: Develop Hydraulic Modeling of Plants
94		Task 3: Liquid Stream Optimization
99		
104	7	Chemical Mixing Systems and Collection System Chemicals Evaluation Project
105		Task 1: Select Mixing Site
106		Task 2: Evaluate Mixing Alternatives
110		Task 3: Testing of Selected Mixing Technology
116		Task 4: Collection System Chemicals Evaluation
117		
122	8	Odor Analysis Project
123		Task 1: Identify Specific Odor Problems by Odor Panels and Chemical Analysis
127		Task 2: (moved to end)
128		Task 3: Determine non-H2S Compounds in Collection System



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Project Summary
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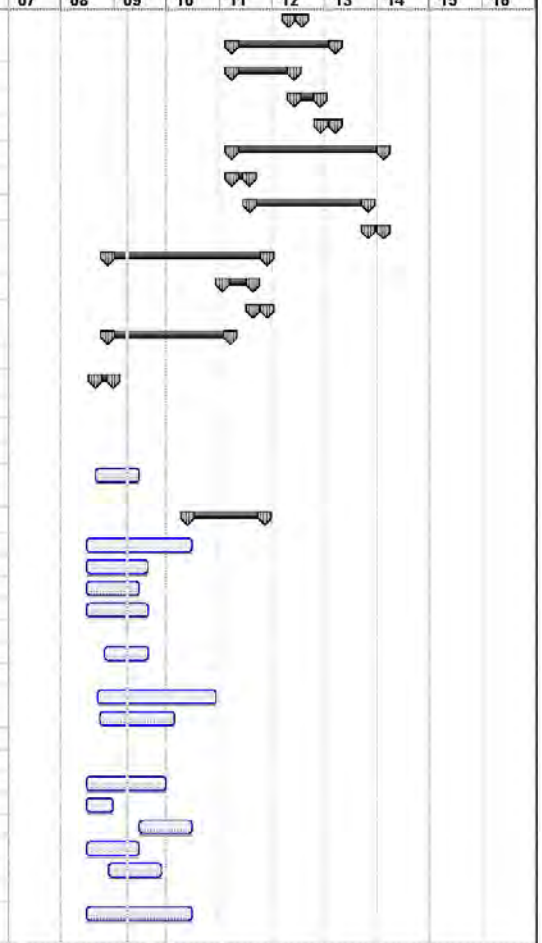
OCSD Strategic Research Plan
5-year Project Scheduling

ID	Rank	Task Name
132		
137	9	Odor Control Improvement Project
138		Task 1: Modifications of Biological/Chemical Scrubbers
146		Task 2: Optimization of Chemical Scrubbers
151		
156	10	WASAC Process Feasibility Study Project
157		Task 1: WASAC Process Evaluation
160		Task 2: Demonstration Testing
166		
171	11	Air Regulations (Combustion Sources) Project
172		Task 1: Evaluation of Regulated and Unregulated Particulate and Odorous Emissions from Combustion Sources
178		Task 2: Project Report
183		Task 3: J-79 Engine Emissions Control Catalyst Test (MPI)
188		
189		Superoxygenation Applications
191		
192		Cooperative Projects Not Included in Other Projects Above:
193		University of Arizona Water Quality Center (WQC)
194		WQC Biosolids Safety Studies
195		Water Environment Research Foundation (WERF) Support
196		WERF Cooperative Project: Model Development Linking Collection System Odor Generation and Corrosion
200		WERF Targeted Research (TCR): Pathogen Risk Assessment
201		WERF Targeted Research (TCR): Incident Response
202		WERF Targeted Research (TCR): Centrifuges & Pathogen Regrowth
203		WERF Epidemiological Study Advisory Committee
204		UC Irvine Urban Water Research Center (UWRC)
205		UWRC Projects TBD
206		So. Cal. Coastal Water Research Project (SCCWRP)
207		SCCWRP Endocrine Disruptor Study
208		SCCWRP So. Cal Bight Regional Study
209		American Water Works Assn. Research Foundation
210		WateReuse Foundation (WRF)
211		WRF: Identifying Health Effects Concerns of Water Reuse
212		WRF: Study of Advanced Oxidation Processes
213		WRF: Impacts of Nanoparticle Pollutants
214		WRF: Project Advisory Committee on UV Disinfection
215		WRF: Methods for Measuring Chemicals of Emerging Concern (CECs)
216		So. Cal. Assn. of Marine Invertebrate Taxonomist (SCAMIT)
217		SCAMIT: Developing On-line Tools for Ocean Organism Identification



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Project Summary
External Tasks
External MileTask
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OCSD 9/10