

# Irvine Ranch Water District

## Research Business Plan



December 2009



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## Mission Statement

“To conduct research and participate in research programs and organizations that identify new technologies and other opportunities to ensure IRWD’s water, wastewater, recycled water and urban runoff treatment systems are operated cost effectively and efficiently, and to implement new opportunities to improve the final product quality and environmental benefits of the systems as a result of applied research.”

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**Appendix “A” – Research Proposal Work-Flow Diagram**

## Executive Summary

The following provides a brief narrative summary of action elements of the Research Business Plan. There are six “elements” of the Plan:

1. Emerging Technologies Evaluation

Provide District facilities for the evaluation and testing by public and private entities of emerging technologies that are considered applicable to the District’s operations.

2. Utilization of an IRWD Emerging Technologies Review Committee

The IRWD Emerging Technologies Review Committee will be utilized to review all requests for District support/participation (financial, in-kind, use of District facilities) of applied research projects to ensure that the data/information expected to be obtained from the research projects will have a direct and proportional benefit to IRWD.

3. Financial Support of “Basic Research” Organizations

Continue to support water, wastewater, recycled water, and urban runoff “basic research” efforts through the District’s memberships in established industry organizations that have the expertise and resources to conduct basic research projects.

4. Promotion of Collaborative Research Efforts

Pursue research partners/organizations for applied research projects that will be willing to share in the funding of research projects for which the partner organizations stand to realize direct benefits.

5. Support of Educational Outreach Initiatives

Support educational research activities with colleges and universities in the District’s service territory.

6. Comprehensive Validation of Research Needs

Ensure that the District does not expend resources, including staff time or capital, on research projects that are being conducted, or have been completed, by other utilities and/or research organizations or on emerging technologies that are not applicable to the District.

## 1.0 Background

### 1.1 Importance of Research

Research is an integral part of the District's overall strategy to achieve its short-term and long-term goals. The water and wastewater industries are constantly changing in order to meet the increasing demands for a high-quality, reliable supply of water against a backdrop of increasing supply restrictions and more stringent regulatory requirements. The District provides a comprehensive suite of services to its customers including enhanced water supply reliability through its groundwater and recycled water programs, wastewater collection and treatment systems, and watershed management through the operation of wetlands. As it delivers these services to its customers, IRWD focuses on the following objectives:

- Provide an ample supply of potable water that consistently meets all applicable drinking water standards;
- Collect, treat, and discharge wastewater, all in compliance with applicable regulations and at a reasonable cost;
- Provide urban runoff treatment opportunities, in a cost effective, environmentally sound manner, for dry weather runoff and small storm events; and
- Promote the most efficient use of water through the use of best management practices and the implementation of conservation measures.

While pursuing these objectives, IRWD faces ongoing challenges including:

- Changing regulatory requirements;
- Expansion of the District's wastewater treatment facilities;
- Future biosolids handling, dewatering and treatment at the MWRP;
- Changing operational needs of the production and treatment facilities;
- Construction of additional groundwater production facilities;
- New applications for the use of recycled water throughout the service area; and
- Customer sensitivity to increases in rates and changes.

These challenges are being driven by:

- Changing regulatory requirements;
- Limitations on existing and future water supplies;
- Facilities that are approaching the end of their useful lives;
- New technology developments;
- Rate increases by external agencies (i.e., imported water, OCSD sewage treatment, and power costs); and
- Concerns of customers and environmental organizations regarding environmental impacts (i.e. carbon footprint) related to District operations.

IRWD has a reputation for being at the forefront of new and innovative approaches to meeting the needs of its customers. IRWD has been successful in applying innovative

solutions by recognizing opportunities, particularly those presented by emerging technologies, and evaluating these opportunities based on an appropriate level of research on technical, economic, and other merits. The success of future projects and initiatives to be implemented by IRWD will rely on the District's continued commitment to research.

## 1.2 Need for Research Projects

*Internal.* Internal research projects are directed at specific challenges presented during the normal course of IRWD's business. Alternatively, they may address a specific regulatory concern in response to proposed or promulgated changes in regulatory criteria. This type of research typically occurs as part of the regular operation of the District. But some research projects will have broader application and interest and are candidates for a broader distribution of results.

*External.* External factors will occasionally create the need for other types of research projects. These factors include in regulations, requests for participation from regulatory agencies, requests to provide assistance from public agencies with common interests and from other sources. Regardless of the external factor, any research project undertaken must show the potential to provide a benefit to the District.

## 1.3 Differentiation of Basic Research, Applied Research, and Pilot Studies

*Basic Research.* Basic research is performed to increase understanding of fundamental principles. Many times the end results have no direct or immediate commercial benefits. In the long term, it is the basis for understanding and the foundation for applied research. Basic research is mainly carried out by universities.

While IRWD does not typically perform basic research projects, the District does support basic research efforts through its memberships in industry organizations which have resources and expertise in basic research projects. In the past the District has maintained memberships in the following research organizations:

- The Water Research Foundation (WRF), formerly American Water Works Association Research Foundation (AwwaRF), which specializes in potable water research issues;
- The Water Environment Research Foundation (WERF), which specializes in wastewater issues;
- The WateReuse Foundation, which specializes in recycled water issues;
- The National Water Research Institute (NWRI), which performs research on water supply and quality issues and the development of technologies to protect the freshwater and marine environments; and
- The UCI Urban Water Research Center (UWRC), which addresses a wide range of topics including water supply, demand and distribution, water quality issues for drinking and recreational use, wetlands performance and how the distribution of water and wastewater affect urban ecosystems, urban water reuse and public policy.

*Applied Research.* Applied research accesses and builds on the accumulated theories, knowledge, methods, and techniques as derived from basic research and then applied this information for a specific purpose. Applied research is often contrasted with basic research in discussions about research ideals, programs and projects.

The District has a history of involvement predominantly with applied research projects. Past and current applied research projects include:

- Evaluation of Membrane Characterization Methods;
- Energy Reduction in Membrane Filtration Processes through Optimization of Biogenic Nanosuspended Particle Removal;
- Selecting Treatment Trains for Seasonal Storage of Reclaimed Water: Treatment to and Withdrawals from Storage;
- Optimizing Nitrification with Molecular Monitoring of Ammonia Oxidation Bacteria at MWRP; and
- Selenium Removal Project – Mesocosm-Level Testing.

In many cases the results of this research were presented at seminars and conferences or published in trade and technical publications.

*Pilot Studies.* Pilot studies are a form of research not included in the District's basic or applied research programs. Pilot studies are conducted on emerging technologies to prove vendor claims of operating efficiencies or effectiveness in specific applications. (Large-scale pilot studies are often referred to as Demonstration Tests.) The District may also perform pilot studies of its operations in order to evaluate process control changes that may be necessary in order to improve operating efficiencies. Pilot studies can include short-term investigations of specific problems, as performed by schools and universities over a quarter or semester evaluating a specific process, pollutant or monitoring method. Examples of past and current pilot include:

- Cienega Selenium Removal Demonstration Project;
- San Diego Creek Trash Boom Pilot Project; and
- Baker Treatment Plant Microfilter Effectiveness Testing

## **2.0 Direction of Future Regulatory Requirements**

One of the most significant drivers for applied research is the need to meet changing regulatory criteria. The following is a summary of potential regulatory requirements and the impacts they may have on District operations.

### **2.1 Water**

The statutory foundations of modern water quality regulations are the Safe Drinking Water Act (for drinking water) and the Federal Water Pollution Control Act also known as the Clean Water Act (for surface waters). Some regulatory programs, such as the Office of Environmental Health Hazard Assessment (OEHHA), contain mandates to regulate new chemicals and to revise existing limitations on a prescribed schedule. As a



result, there are an increasing number of regulated compounds that will be regulated more stringently in the future, based on past performance. The regulatory environment has expanded from the regulation of chemicals that are known to cause problems to emerging chemicals of concern which have not been shown to cause any problems. The evolving trend in the water quality regulation is that if a chemical of concern can be controlled, it must be controlled. For example, NDMA is a byproduct of wastewater treatment and cooking bacon. The regulation of NDMA is based on wastewater treatment which can be controlled rather than on cooking bacon, which cannot be controlled. The regulatory process will endeavor to control contaminant levels when possible, regardless of the overall effect of the control measures. From the microbiological perspective, there is a significant effort to develop methods that give analytical results in a matter of hours, rather than days, and are more specific to organisms associated with human use. There have been significant advances in identifying food borne illness and how those causes relate to the quality of the water.

## 2.2 Wastewater

The wastewater industry is faced with many challenges. First and foremost, the gains in water quality resulting from the national requirement to upgrade to secondary treatment standards have been eroding due to an increase in the volume of wastewater being treated and an increase in the number of emerging contaminants of concern. As a result, future treatment standards more restrictive than current secondary treatment standards are being developed. In addition, wastewater treatment plants are reaching the end of their intended life spans and will require replacement. New facilities constructed to replace outdated facilities are now being designed to employ new technologies that produce treated water that is cleaner than required, in anticipation of increasingly stringent future regulations.

The wastewater industry is impacted by advances in sampling and analysis technology. Chemical constituents that were undetectable a few years ago are easily measured today, and this has resulted in increased public concern, especially with pharmaceuticals and other constituents of emerging concern. Wastewater treatment plants are not designed to ensure complete removal of pharmaceutical products, especially at extremely low concentrations. Because of improvements in the ability to measure pollutants at increasingly low levels, the number of pollutants of concern is increasing dramatically.

One new industry impacting the wastewater industry is nanotechnology. Nanomaterials behave differently from other materials and while they present a substantial opportunity for advancement in water and wastewater treatment technologies, other applications using nanomaterials could result in their discharge to municipal wastewater systems. In addition, emerging wastewater treatment technology using membranes are known to be impacted by nanomaterials. Significant future research in the wastewater industry is warranted to address the concerns described above.

## 2.3 Water Recycling

The recycled water industry continues to expand as more communities accept this effective method to expanding their water supplies. Though municipalities have been recycling wastewater for multiple uses since the 1960s in many areas, public concerns linger. As other communities become more accepting of recycled water, new applications of recycled water are being implemented beyond the traditional uses for irrigation and certain industries. Nowhere is this more evident than with indirect potable reuse. As the water industry expands the use of recycled water, the requirements for treating and analyzing this water will continue to become more stringent.

## 2.4 Energy Use

Accounting for the energy used in the water and wastewater industry is an emerging science. Many studies are now underway at both the basic research and the applied research levels. As the understanding of energy use becomes a higher priority, more opportunities for applied research project will develop. Wastewater treatment biosolids are a source of energy, and this energy can be extracted in many forms including methane, ethane (and other gasses, alcohols and other liquids), and elemental hydrogen which is a zero carbon footprint fuel. With the tools currently available, there is a need for research into the development of high efficiency low carbon footprint fuels. Advances are also being made in the area of energy generation from diverse sources such as solar, hydro, and heat recycling.

## 2.5 Biosolids Handling

Water and wastewater treatment processes generate residual solids. Solids that are high in carbon and nutrient content (typically produced in a wastewater treatment process) are called biosolids. Biosolids typically have value as a soil amendment and fertilizer. Unless treated thoroughly, biosolids may also contain bacteria, viruses, manmade chemicals, and potentially harmful concentrations of substances (such as metals) that could limit its reuse or disposal. Many communities are learning that exporting biosolids, even when treated to the most stringent standards, to other communities is becoming increasingly problematic. Communities will need to be more creative in how they dispose of or reuse biosolids closer to home. Determining cost effective methods for efficiently dewatering, disinfecting, and reusing biosolids will require years of further research.

## 2.6 Air Quality

Water and wastewater treatment have the potential to affect air quality. Energy typically generated by fossil fuels is required to treat and convey water. Water and wastewater can also contain substances such as chlorine and volatile organic compounds that require regulation to meet air quality standards. Water and wastewater can contain objectionable compounds such as hydrogen sulfide. The South Coast Air Quality Management District currently requires control of hydrogen sulfide to the limit of detection in the urban environment as well as requiring management of volatile organic compounds from water and wastewater operations. Communities require control of objectionable compounds to levels that remove the nuisance potential or reduce the level of concern for some

pollutants to a level of non-detection. As analytical methods improve, there will be continued public and regulatory pressure to reduce emissions into the air. As the number of chemical compounds found in the air increases and research into their effects become known, additional restrictions on the sources, such as water or wastewater, are likely to be implemented.

## 2.7 Urban Runoff Control and Treatment

Many communities have begun to prioritize the importance of protecting the quality of water on a watershed-wide basis. The primary threat to water quality in most watersheds is from urban runoff. The major concerns with urban runoff are pathogens, nutrients, and pollutants of emerging concern. Optimizing programs, such as irrigation management and natural treatment systems, can provide a high degree of pollutant reduction. Additional research of these types of programs is needed to better define the pollutant reduction benefits.

## 3.0 Research Program Objectives

It is the District's intention to engage in applied research and pilot studies to advance the mission of the District – "To ensure that IRWD's water, wastewater, recycled water and urban runoff production and treatment systems are operated in the most efficient manners and identify future opportunities to improve the environmental benefits of the systems." A business plan requires a set of objectives on which the success of the program implementation can be measured. The following is a description of the objectives of the IRWD Research Business Plan:

### 3.1 Research Projects Must Have Recognizable Benefits Applicable to IRWD Operations

Research is an integral part of the District's overall strategy to achieve its short-term and long-term goals. The water and wastewater industries are constantly changing in order to meet the needs of their customers. It is IRWD's intent to support and/or conduct applied research and pilot studies that will have direct and recognizable benefits to the District. Part of the District's research needs (i.e., basic research) will be met through participation in organizations dedicated to basic research such as the Water Research Foundation and the National Water Research Institute, and through partnerships with universities (University of California Irvine, Chapman University, etc.). The remaining research needs (i.e. applied and pilot studies) will be met through participation in specific research projects and studies which should have a recognizable benefit to the District. Examples of such research are projects designed to address specific IRWD regulatory compliance needs or projects which will improve the efficiency of IRWD treatment processes.

### 3.2 Research Projects Must Comply with Specific Timeframes and Milestones

Projects that meet a timely research need, specific to and funded by the District, should be completed within a one-year period from issuance of the purchase order. The duration of projects can be significantly less than one year if they are research-directed to answer a specific need or fill a specific gap in the record. It is also likely that grant-funded

research projects will take greater than one year to complete. Grant-funded projects can involve several agencies and a funding agency. Such research projects address issues of common interest to the participating and funding agencies and should be undertaken on a case-by-case basis.

In addition, all requests for IRWD participation in applied research projects or pilot studies must include a comprehensive project definition in addition to a defined scope of work and defined timelines.

### 3.3 Research Projects Should Involve Educational Partnerships

The District is committed to supporting educational research activities with colleges and universities, particularly those located within the District's service area. Examples of research activities include internships and research projects for undergraduate students in science majors; collaborative research projects between IRWD staff and students to undertake pilot projects in areas of joint emerging interest; access of students to research and field sites; and giving presentations at seminars for students on campus on research and career issues.

## 4.0 Potential IRWD Applied Research Areas

The environmental agenda is formulated at the Federal and State levels and expressed in the form of specific requirements. It is the responsibility of the District to satisfy both the State and Federal agendas. Based on the current and future regulatory agendas, the District should focus its applied research efforts in the following areas:

- The Newport Bay watershed is subject to natural sources of selenium at levels which can be toxic to wildlife. Research into selenium sequestration and removal from the watershed has progressed sufficiently to warrant construction of treatment facilities to remove selenium to levels considered environmentally safe. The District continues to research an effective selenium removal process to reduce this hazard to the environment. The Cienega Selenium Removal Demonstration Project is currently being operated as a component of IRWD's Natural Treatment Systems program.
- There will be a continued effort to reduce byproducts resulting from the disinfection of water for potable use. Regulations that have reduced disinfection byproducts have also reduced the efficiency of disinfection. There is a considerable effort being placed on the development of rapid analytical methods which identify biological organisms that cause or represent the potential for compromised water quality. The techniques currently under development need to be applied and rigorously evaluated for their effectiveness in maintaining high quality domestic water.
- Wastewater treatment begins with the removal of large solids, progresses through activated sludge and other forms of biological removal processes and on to biological nutrient removal. The next level of treatment is fine and ultra-fine solids removal using membrane technology. However, the ultra-fine or nanoparticles which are effectively removed have a tendency to adhere, imbed

and clog the membranes, which greatly impacts their efficiency and throughput. Because nanoparticles do not behave like larger solids, new evaluation techniques and process technologies need to be developed to achieve the potential offered by membrane treatment systems.

- To achieve public acceptance of indirect potable reuse of recycled water, analytical and physical processes common to domestic water use will need to be applied to recycled water sources. It will take considerable analytical effort to evaluation show that indirect potable reuse is a wholesome use of recycled water.
- Currently, there are a limited number of wastewater treatment plants that are totally energy self-sufficient. With the energy potential available in wastewater treatment, application of current technologies and modified technologies could substantially reduce energy use. In addition, biological processes are being developed to produce high energy low carbon fuels, which have a substantially lower carbon footprint. It is likely that a combination of solar energy and enhanced fuel stocks will be required to achieve acceptable levels of energy self-sufficiency and these energy sources must work in tandem. Currently, carbon dioxide reduction is the focus of greenhouse gas reduction.
- In addition to carbon dioxide, nitrous oxide (a much more potent greenhouse gas) is produced by biological nutrient removal processes. Research applied to minimize nitrous oxide production has produced process modifications, and these processes could be modified to apply at the District's treatment facilities.

## **5.0 IRWD Emerging Technologies Evaluation Process**

### **5.1 IRWD Emerging Technologies Evaluation Process**

One of the elements of this Plan is the establishment of an IRWD Emerging Technologies Review Committee that will coordinate an internal evaluation of requests for District funding and/or participation of research projects. This multi-department / multi-disciplinary Committee will:

- Evaluate proposed projects for applicability and cost benefits to the District;
- Ensure that similar research projects have not been completed or initiated;
- Ensure that outside multi-agency participation and outside funding is explored and, if possible, procured;
- Monitor project funding, project milestones and completion dates;
- Provide periodic research updates to the IRWD Engineering and Operations Committee and any special research Ad Hoc Committees and/or the Board of Directors, as appropriate
- Identify the need for applied research projects at District facilities and coordinate a Request for Proposals process to solicit applied research project proposals that address a specific opportunity for improvement of District operations or a technology evaluation at District facilities.

All requests for IRWD participation and/or funding of research projects will be evaluated by the Emerging Technologies Review Committee which is comprised of the Directors of

Departments 30, 40, 50, 60, 70 and the General Manager and/or the Assistant General Manager. This committee will meet quarterly, or more frequently if needed.

The Emerging Technologies Review Committee will assemble an interdisciplinary workgroup comprised of District staff and consultant resources, if necessary, with relevant knowledge and experience related to specific proposed research projects. The workgroup will perform a comprehensive review of research projects submitted and provide a recommendation to the Emerging Technologies Review Committee as to the District's participation (financial or operational) in the project. In addition, the Emerging Technologies Review Committee will also interface, as necessary with any Board established Ad Hoc Committees which have been established to provide review and input on specific research projects or technologies. A work-flow diagram is attached to the Research Business Plan as Appendix "A".

After completing its review of a research project, the Emerging Technologies Review Committee will make one of the following recommendations to the Engineering and Operations Committee:

- to implement and/or fund the research technology;
- to fund additional research to determine the applicability and direct benefits to the District, or
- to discontinue further research.

Funding for proposed research projects that have been evaluated by the Committee and identified as providing significant value to the District will be proposed for inclusion in the District's Capital Budget. For "mid-year" research projects that were not included in the capital budget, a recommendation for funding will be made to the IRWD Board of Directors.

## 5.2 Proposal Format

For outside requests that IRWD participate in a research project, the requesting entity must submit a written and/or verbal presentation of the proposed project to the Emerging Technologies Review Committee, including a description of the research to be performed, a summary of the direct benefits the project will provide to IRWD, the timeframes of the project, other participants in the project, and the project budget and funding source(s).

## 5.3 Evaluation Format

The Emerging Technologies Review Committee will evaluate the project based on its understanding of the project scope, the qualifications of the entity requesting IRWD's support, the direct benefits the project will provide to IRWD, the amount of funding requested and project timeframes.

## 5.4 NWRI Review

In order to ensure that IRWD staff time and resources are being effectively utilized, the Emerging Technologies Review Committee may request that NWRI provide third-party review the project scope to ensure that the research project has not already been completed, or in the process of being completed, by another research organization.

## **6.0 Research Program Funding**

### **6.1 Program Funding**

*Financial Support of Basic Research:* IRWD will provide funding in support of basic research organizations such as the Water Research Foundation and the Water Environment Research Foundation. On an annual basis, the effectiveness of the basic research organizations supported by the District and the annual membership dues will be reviewed to determine the benefits provided by the organizations to the District and the related costs.

*Financial Support of Applied Research Projects:* In order to ensure that financial resources are available to carry out the applied research projects approved for implementation by the Emerging Technologies Review Committee, funds will be included in the District's annual operating budget.

If additional funding is needed, staff will obtain approval for project funding from the Engineering and Operations Committee and the Board.

*Financial Support of Pilot Studies:* The District allocates staff, consultant and vendor resources as needed to effectively administer pilot studies. These studies are typically undertaken to improve operating efficiencies or provide performance data for new technologies that, if effective, result in capital improvements. Funding for these activities are specific research projects required implemented and adequate funding for these projects will be included in the District's Operating and Capital budgets.

## **7.0 Research Program Reports**

The goal of all scientific research is to advance the body of knowledge following sound scientific principles. This goal can only be achieved if new knowledge is disseminated to those who could benefit from the information or archived in a form where it is easily accessible for future reference. The Research Program data and information will be disseminated in the following ways:

### **7.1 White Paper Reports**

White paper reports are short reports usually five pages or less, which describe the research performed and the results of the research. The report is the recognition that the research was performed and completed, and is now available for use.

### **7.2 Formal Written Reports**

Significant District-funded research projects and all grant-funded projects require formal written reports of the research performed. For grant-funded research projects, the final report is the culmination of the completion of the tasks to be performed under the grant, and is the vehicle to disseminate the results of the research. Results of all research projects in which the District participates should be available to IRWD. Confidentiality statements may be required in some cases

### 7.3 Quarterly Standing Committee Updates

Research is an important element of the operations of the District and is a portal through which the District can engage the future. Notwithstanding the research reports, District staff will prepare a summary of District research activities for review by the Engineering and Operations Committee.



Research Proposal Work-Flow Diagram

