Attachment 1, Part I – Application Cover Sheet

Application for a grant under § 78645 of the Safe, Clean, Reliable Water Supply Act of 1996

Dennis Falaschi – General Manager
Panoche Drainage District
52027 W. Althea Avenue
Firebaugh, California 93622

Of the County of Fresno, State of California, does hereby apply to the California Department of Water Resources for a grant in the amount of $298,240.

For the following project under the Drainage Reuse Grant Program of the Safe, Clean, Reliable Water Supply Act of 1996:

Commercialization of Reticle Electrostatic Deionization (ESD) Process for Producing Reduced Salinity Agricultural Waters in the San Joaquin Valley

By ______________________________________ Date: January 6, 2015

Dennis Falaschi, Panoche Drainage District General Manager

Telephone: (209)364-6136 Email: dfalaschi@aol.com

Brief Proposal Description:

The California-based company, Reticle Inc., has developed an electrostatic deionization (ESD) process, which has been proven on a bench scale to be able to remove the ions from any water effectively and efficiently. The technology relies on a unique carbon material that has immense available surface areas (>1800 m^2/gram). The carbon is porous, electrically conductive and is produced in large blocks which can be cut into tiles that are attached to metal plates. These Reticle Carbon electrodes are the fundamental underpinning of the ESD technology. By simply charging alternate Reticle Carbon plates positively and negatively with a 1.5-V DC power supply, the charged Reticle Carbon plates are able to attract ions from the water as it passes. Once full coated with ions, those ions are removed by removing the electrical charge, ejecting them into the then resident fluid and creating a concentrated brine. That concentrated brine is flushed from the cells, which can now begin cleaning water again. The process has been shown to desalinate water using as little as 1.5 kWhr per 1000 gallons (~$0.15 of electricity per 1000 gallons). With amortization costs included, we believe this technology could easily produce water with less than 250 ppm TDS for less than $120 per acre-ft.

The project to test Reticle ESD technology will be conducted in two phases. The first phase will focus on constructing and testing an intermediate-scale ESD cell that can be modified to treat a variety of Panoche Drainage District (PDD) well water (2000-3000 ppm TDS) and farm drainage (that can exceed 8000 ppm TDS). This cell will be mounted onto a trailer and transported to a variety of locations that have a variety of brackish waters. The trailer will have the DC power supply for the cell, requisite plumbing, a head tank for feeding the cell and storage tanks for the brine and clean water, which will be given to the owner of the water that is being tested. Every test will be conducted to determine the ion removal rate (i.e., mg/minute) and the energy efficiency (Wh/gal) of the unit in various configurations. The cell will be fed waters with different degrees of salinity and will be operated at a variety of inlet flow rates and spacings between the electrodes. This cell should be able to clean at a rate of 1 gallon per minute (1400 gallons per day). Approximately 150-200 gallons of concentrated brine will be produced and analyzed to determine if there are any valuable commodities dissolved in the brine, and to determine overall efficiency of the process.

The results from Phase I will be used to finalize the design of two commercial-scale cells that will be constructed for testing on various waters in Phase II of this project. (This project consists of two phases. Phase II does not mean a second project not proposed here. It is the second main step of this project.) The optimum electrode spacing and optimal flow rate for a given feed TDS as determined in Phase I will be used to design these units. The commercial cells will be constructed to fit within the same trailer for transportation to wellheads, drainage sites, etc. The cells will operate in parallel, and will likely be able to produce up to 30,000 gallons of clean water and about 3000 gallons of brine each day. As in Phase I, the cells will be tested to determine the ion removal rates and energy efficiencies for a variety of feedwater salinities (ranging from 2000 to 8000 ppm TDS.) All of the data from all of the sites will be compiled in a final report to PDD, CWR and for publication.

A cursory treatment process will be available to dispose of the brine produced each day from the tests, including precipitation and evaporation or other methods to minimize the volume and toxicity of the brine. However, under a separate proposal, Reticle Inc. is prepared to construct a small-scale, portable brine treatment facility designed to clean the brines derived from all of the tests, recover any valuable constituents for resale or reuse, and render the final product amenable to disposal.

Attachment 1, Part II – Applicant's Representatives

Project Name: ***Commercialization of Reticle Electrostatic Deionization (ESD) Process for Producing Reduced Salinity Agricultural Waters in the San Joaquin Valley***

Primary Project Contact

Name: Mr. Dennis Falaschi Title: General Manager

Address: Panoche Drainage District
52027 W. Althea Avenue
Firebaugh, California 93622

Telephone: (209) 364-6136 FAX: (209) 364-6122
Email: dfalaschi@aol.com

Alternate Project Contact

Name Dr. Carl C. Nesbitt Title: Chief Technical Officer/Vice President

Address: Reticle Inc.
27121 Adonna Court
Los Altos Hills, California 94022

Telephone: (906) 231-7203 FAX: (775) 784-1833
Email: Carl.Nesbitt@ReticleCarbon.com

Alternate Project Contact

Name Mr. Jack Mastbrook Title: Chief Operating Officer

Address: Reticle Inc.
27121 Adonna Court
Los Altos Hills, California 94022

Telephone: (310) 347-6888 FAX: (650) 948-8830
Email: Jack.Mastbrook@ReticleCarbon.com

Type of Organization: Panoche Drainage District; Firebaugh, California
Reticle Inc. California-Based Small Business

Attachment I, Part III – Summary of Project Costs

		% of Total Cost
Total Cost of Project:	$ 298,240	
Amount Requested:	$ 298,240	100%
Amount of Cost Share:	$ -	0%
Amount of Federal Contribution	$ -	0%
In-Kind Contributions:	$ -	0%
Amount to Funded by Other Sources	$ -	0%

Additional explanation:
No in-kind, federal or private cost share will be used to complete the project.

Attachment I, Part IV – Authorizing Resolution

(Panoche Drainage District will adopt the authorizing resolution at the January Board Meeting. A copy will be transmitted to DWR shortly thereafter.)

Attachment II – Project Proposal and Task Breakdown

Commercialization of Reticle Electrostatic Deionization (ESD) Process for Producing Reduced Salinity Agricultural Waters in the San Joaquin Valley

Contents

1 TITLE OF THE PROJECT

Commercialization of Reticle Electrostatic Deionization (ESD) Process for Producing Reduced Salinity Agricultural Waters in the San Joaquin Valley

Presented By: Reticle Inc.
27121 Adonna Ct
Los Altos Hills, CA 94022

2 PROJECT PERSONNEL

Project Director: Mr. Dennis Falaschi, General Manager Panoche Drainage District
dfalaschi@aol.com

Reticle Project Director: Dr. Dale M. Nesbitt, CEO Reticle Inc.
Dale.Nesbitt@ReticleCarbon.com

Co-Principal Investigator: Dr. Carl C. Nesbitt, CTO Reticle Inc.
Carl.Nesbitt@ReticleCarbon.com

Co-Principal Investigator: Mr. Jack Mastbrook, COO Reticle Inc.
Jack.Mastbrook@ReticleCarbon.com

Reticle Inc. is a California-based company owned and operated by Drs. Carl Nesbitt and Dale Nesbitt. Dr. Carl. Nesbitt, CTO and co-founder, is the inventor of Reticle Carbon and the processes to manufacture it. He is the Goldcorp Chair of Mineral Engineering in the Mining and Metallurgical Engineering Department at the University of Nevada, Reno since 2008. From 1990-2008, he was a tenured professor of metallurgical and chemical engineering at Michigan Technological University. He has nearly 25 years of experience managing research studies in materials processing, hydrometallurgy, and hydrochemistry. Dr. Nesbitt was educated at the University of Nevada, Reno (UNR) and the University of Michigan (U of M). He has two advanced degrees in metallurgical engineering (an M.S. in 1985 and a Ph.D. in 1990) and two degrees in chemical engineering (a B.S. from UNR in 1980 and an M.S.E. from U of M in 1989.) He began his academic career in 1990 at Michigan Technological University; he has generated numerous publications and a number of patents worldwide, including the Reticle patents. His combination of industrial and academic experience gives Dr. Nesbitt the skill set to manage Reticle Carbon technology.

Dr. Dale Nesbitt, CEO and co-founder, is a well-known consultant in the oil and gas, electricity, high technology, infrastructure, resource, and transportation fields. Dr. Nesbitt has co-founded and built two successful companies (consulting and software development). He cofounded Decision Focus Incorporated (DFI), where he remained as a principal until 1995, and Altos Management Partners whose products, branded MarketPoint^{TM}, are world class forward market and decision support models used by major companies worldwide. Dr. Nesbitt was educated at Stanford University, earning a Ph. D. degree in 1975 in Engineering-Economic Systems (Ph.D. thesis defense with honors), an M.S. degree in 1972, in Engineering-Economic Systems, an M.S. degree in 1970, in Mechanical Engineering with an emphasis in Nuclear and

Mechanical Engineering, and, before Stanford, at the University of Nevada, with a B.S. in 1969, in Engineering Science with high honors.

Mr. Jack Mastbrook, who directs Reticle Carbon production, assembly and field testing, completed his studies at Vanderbilt Electrical Engineering School and moved to the West Coast to work in the aerospace industry for Consolidated Systems Corporation of Monrovia CA. At CSC, he was a field engineer responsible for system support and redesign at numerous missile sites including Atlas ICBM, Minute Man Test and at NASA's Huntsville facility. When CSC was acquired by Scientific Data Systems, he was promoted to National Tech Support Manager for the SDS 940, the first Internet server, and conceived a method for remotely diagnosing system failures. When Xerox acquired SDS he was promoted as the Midwest Regional Tech Support Manager. Later, he was transferred to their El Segundo, California facility as a Senior Member of the Technical Staff to design and implement Xerox's Long Range Field Support Strategy and was ultimately promoted to Research & Development Manager. After Xerox, Jack started a computer support company (which he sold to GE) and an environmental remediation and safety company. Since 2008, he has been with Reticle Inc., where he has the responsibility of marketing and development of the manufacturing and logistics plan for the company. He will be managing the production and delivery of the pilot systems for this grant.

Reticle Inc. is a California company that manages the patents for Reticle Carbon. We rely on vendors to manufacture the carbon, and to assemble the ESD cells. Virtually all of the vendors are California based. The labor will occur in California. The demonstrations will occur in California. It is a local value added project in the State of California. Follow-on Reticle business will be centered in California.

Project Plan:

Reticle and its principals have implemented many research and development projects over the past decade. Inasmuch, we have developed a thorough plan for completing the project timely and within the budget. The project will be conducted in two sequential phases—Phase I is to create an intermediate-scaled ESD cell testing on various waters in the Panoche Drainage District, resulting in the development of two commercial models in Phase II. Dr. Dale Nesbitt will perform the necessary duties of Project Director for Reticle. He will be responsible for ensuring the invoices are passed to Panoche Drainage District (PDD) for payment to vendors who will assemble the cells. Dr. Carl Nesbitt provides expertise in the manufacture and application of the cells, and will spend many hours overseeing the project in the field once the cells are delivered to PDD for testing. Mr. Jack Mastbrook is integral in overseeing the manufacture and assembly of the cells from the purchase of the carbon to final delivery. All of our equipment and component vendors are located in southern California, where Jack will personally oversee the progress of the manufacture. Carl and Jack will directly oversee the operation of the Reticle ESD cells in PDD and will help to relocate the units to new sites as recommended by PDD. Together all three will work in consort with PDD to ensure the deliverables and tasks are completed on-schedule and on-budget. Email memorandums will serve as the primary form of communication; however, frequent conference calls will be scheduled to inform PDD management of progress on the project throughout the duration of the project.

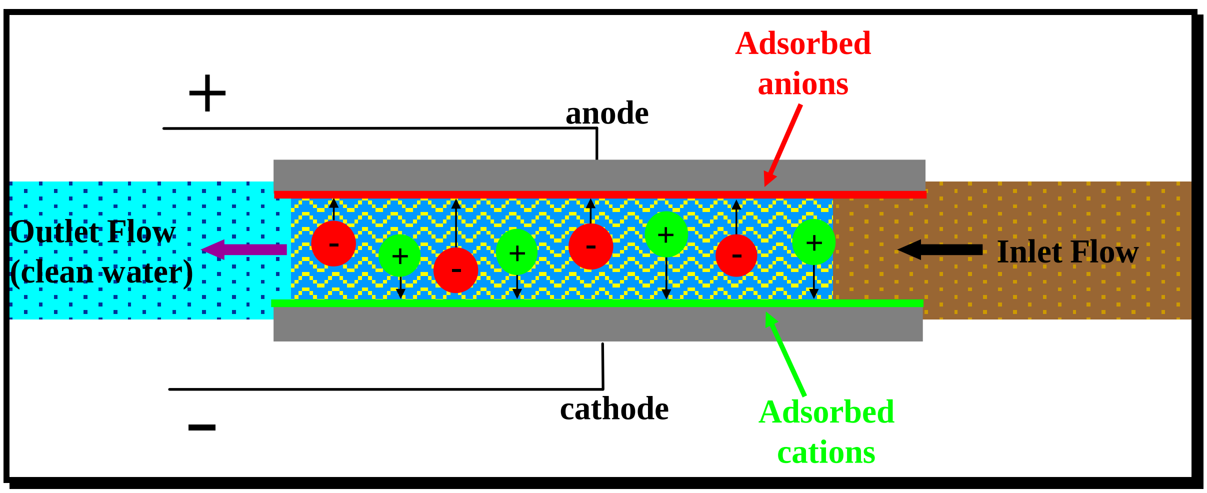
3 SCOPE OF WORK

3.1 Technology Description

Reticle Inc. (a California-based small business) has developed a solid, conductive carbon material that has the largest available surface area in a conductive mass ever verified (over 1900 m^2/g has been demonstrated and measured). The material can be machined to any shape, meaning it can be incorporated as electrodes into electrostatic deionization (ESD) cells, which we shall diagram shortly. The electrostatically attractive surface area is so large that it can economically clean the waters in the Panoche Drainage District (PDD), bringing them up to agricultural, drinking, or even higher standard. We propose to demonstrate the cells commercially so that California can get on with the task of deionizing-desalinating-decontaminating its various waters (wellwater, surface water, drainage water, reservoir water, etc.)

The functioning of Reticle deionization cells is simple. Two plates with Reticle carbon tiles attached are placed a small distance apart—one is charged positively, and one is charged negatively. If ion-bearing water is passed between the two charged electrodes, the charged carbon will arrest the ions but allow the water to flow through, thereby reducing the ion concentration of the water, as illustrated in Figure 1. More and more ions are adsorbed as the charge in the electrode is offset by the charge in the attached ion mass.

Figure 1: Ions Attach Against an Oppositely Charged Electrode, Allowing Desalinated Water to Flow Through



A low voltage (less than 1.5-V DC) is all that is needed to remove ions from water. It is important to note that the voltages used in Reticle Carbon ESD cells must be less than the oxidation potential of water, i.e., less than 2 volts. At voltages above the oxidation potential of water, the cell would produce oxygen (and likely CO_2 from the degradation of the carbon) at the anode and hydrogen at the cathode, which would result in a huge loss of electrical energy to electrolysis instead of simply arresting ions. Reticle Carbon ESD cells operate in the range of 2 volts, making it a low voltage, high amperage DC device. Interestingly, 2 volts is the voltage produced by a state of the art solar photovoltaic device, rendering the Reticle Carbon ESD cell ideally suited to be coupled with solar photovoltaic panels for remote (off the power grid) ion removal.

The key to efficient ion removal, of course, is to have as massively large a charged surface as you can possibly have on the charged plates. The more surface area there is, the more ions are arrested on the charged plates. That is what Reticle carbon allows—an unprecedentedly large, charged surface area doing the work. Our highest surface area carbon to date had nearly 1900 m^2/g of specific surface area. That means that one mere pound (0.5 kg) of the Reticle Carbon material has the surface area of Hoover Dam. Think of it; one pound of electrode (a small electrode indeed) presents charged surface area to the surrounding fluid equal in magnitude to the face of Hoover Dam. Additional carbon mass can be applied by simply adding more plates (alternately charged) in the path of the water. In fact, our cells will likely have between 20 and 30 electrode pairs full of high surface area carbon to arrest huge quantities of ions from water. The surface area presented to the ionized fluid becomes almost incomprehensible.

Sooner or later, the surface area is going to become loaded with ions that have been pulled out of the water and held electrostatically. By simply removing the charge accumulated on the plates at that time, all the arrested ions are instantly released from the charged plates back into whatever waste fluid is resident between the formerly charged plates at the time. When a large volume of water has been deionized for a long period, the discharge step results in all the arrested ions being transferred to a smaller volume of water, creating a high concentration wastewater brine in the cell, which can be flushed out to carry the ions away. We have shown that for every 6 to 10 gallons of ion-laden water passing between the plates until they are loaded, we can discharge all of the arrested ions into 1 gallon of wastewater then resident between the plates, thereby achieving up to 90 percent recovery of the inlet water. The concentrated brine can be sent to a separate tank and either disposed of or further treated (e.g., precipitated). Brine treatment strategies are addressed in a separate proposal. Once the ions have been discharged, the electrodes are ready for action again. Just pass more water through it and arrest more ions from the water.

Reticle Carbon has been manufactured with the properties listed in Figure 2. The table not only puts forth the Reticle Carbon properties (which has been manufactured and demonstrated in actual tests) and compares with Lawrence Livermore National Laboratory Aerogel Carbon and carbon nanotubes (both used in modern CDI cells). It is not clear whether Lawrence Livermore properties shown here have ever been demonstrated in practice but rather are merely advocated without proof.

Figure 2: Reticle Carbon Properties

Specific Attribute	Reticle Carbon Properties	Aerogel Carbon Properties	Carbon Nanotube Properties
Specific Surface Area	1250 – 1900 m^2/g	424 – 800 m^2/g	125 – 250 m^2/g
Bulk Density	0.75 – 1.0 g/cm^3	0.78 g/cm^3	1.3 – 1.4 g/cm^3
Est. Manufacturing Cost	$50/kg	$250/kg	>$10,000/kg

Reticle Carbon is manufactured by a simple, one-step consolidation process beginning with "off-the-shelf" commercially available granular activated carbon. We select the precursor carbon on the basis of its surface area and particle size. Heat and pressure consolidate the precursor carbon into the porous, monolithic mass known as Reticle Carbon. The resulting block (such as the one shown in Figure 3) can be sliced into tiles of any size or shape for direct incorporation into desalination units. (Simple wire wafer saws work spectacularly, the same types of saws used to cut silicon chips in the electronic industry.)

Once we have sliced the carbon block in Figure 3 into thin wafers to be used as electrodes (quite like semiconductor chip cutting into wafers), we create a Reticle Carbon cell by arranging the electrodes into a serpentine path. That serpentine path directs the water through the cell, attracting ions all along the way as it flows through. The actual serpentine configuration in our demonstration machine is an up-down-up pattern as in Figure 4. The ion-laden (dirty) feedwater enters from the upper right in the diagram. It flows through the "inflow conductivity meter" on the inlet which measures the ion concentration in the inlet water. The inlet water enters the cell and flows up-down-up-down as shown in the lower right in vertical serpentine pattern. As it does so, there is a slight amount of turbulence and mixing to facilitate attaching of the ions in the feedwater to the colossal charged surface area of the Reticle Carbon electrodes. (That is why we chose a vertical flow pattern—a small amount of turbulence and mixing.) The final water exits at the front of the diagram where it passes through the outflow conductivity meter. We know that pure water is not very conductive, and deionized water is not very conductive. Thus, if the cell is arresting ions, the conductivy meter at the output will register much lower conductivity than the input, meaning most or all of the ions have been stripped from the water and arrested inside the cell. The exiting water is ion free!

Figure 3: Manufactured Block of Reticle Carbon (Block Shown Has 1400 m^2/g)

When the conductivity of the outflow water rises toward the conductivity of the inflow water, we know that ions are no longer being absorbed within the unit. The electrodes in the unit are fully coated with previously adsorbed ions. There is no more "room" to adsorb. At that point, we remove the power supply and electrically connect the anodes and cathodes. That immediately removes all charge on the anodes and cathodes, rendering them all electrically neutral. They cannot attract ions any more; they can only release ions. The water then resident in the cell takes all those released ions into a (highly concentrated) solution which leaves the cell, i.e. that brine water is flushed out as in Figure 5 to the brine storage tank.

Figure 4: Reticle ESD Demonstration Cell Flow and Charge Pattern

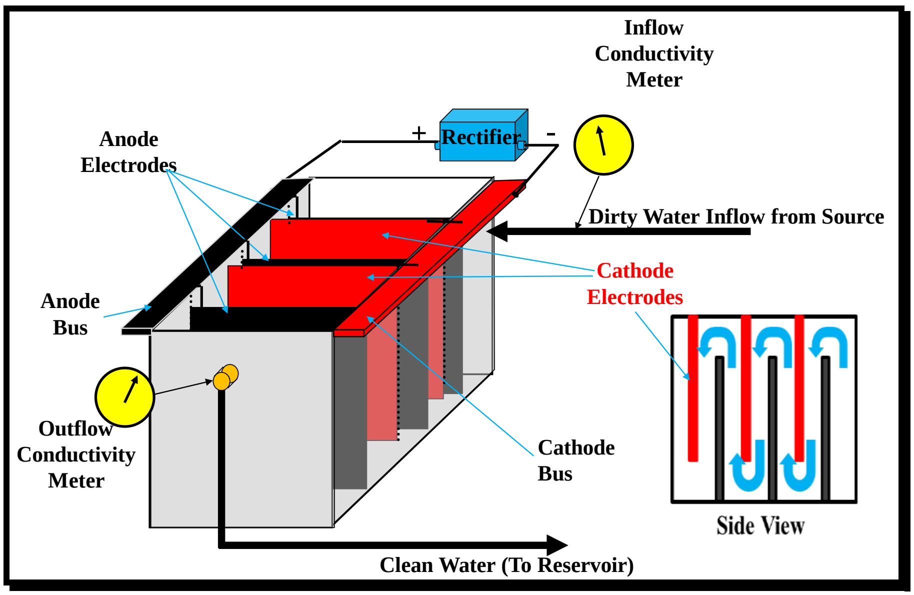
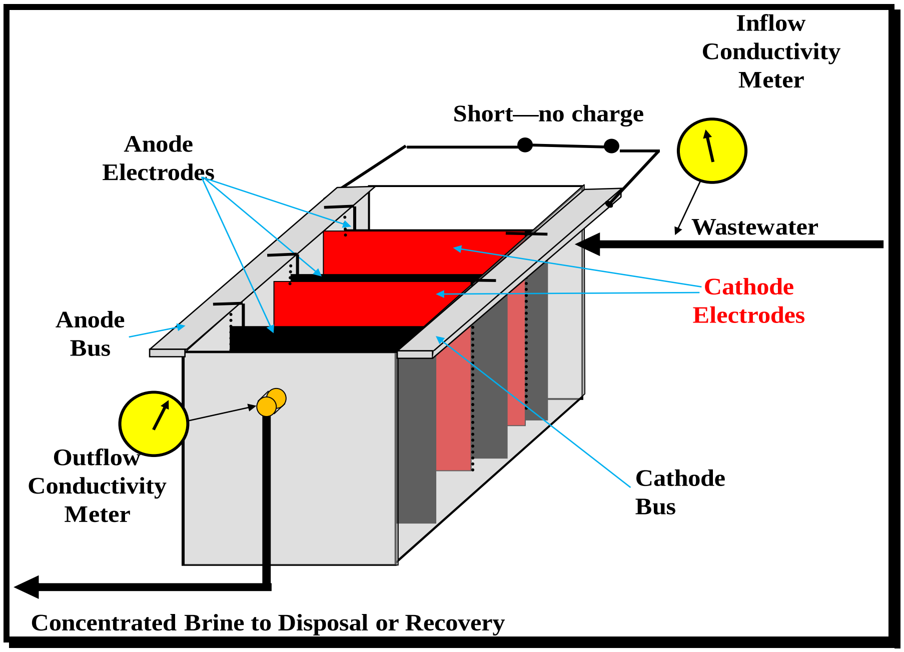


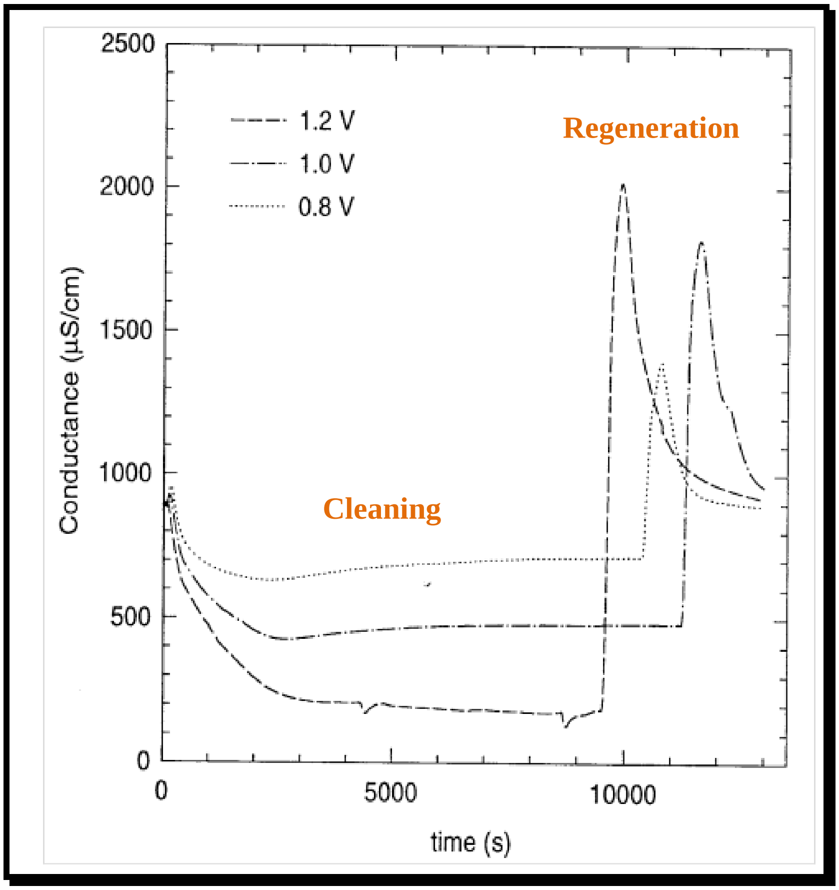
Figure 5: Regeneration of the Cell and Disposal of the Concentrated Wastewater Brine



The product water is passed through the conductivity probe to monitor the cell performance. In a laboratory experiment designed to remove NaCl from a salt water solution, the outlet water conductivity was measured as a function of the applied voltage. The results are shown in Figure 6. If we refer to the middle line in Figure 6, which corresponds to 1 volt of potential applied during the ion attraction and arresting cycle, we note that the conductivity of the outbound stream of water decreases and remains on a low but increasing plateau. This means that the outbound stream has low conductivity and is, in fact, relatively ion free, the ions having been arrested inside the unit. As we move further to the right, we see that the conductivity of the outbound water slowly increases, meaning that an increasing number of the ions are getting through to the output stream. This indicates that the unit is becoming fuller and fuller of arrested ions and more and more in need of discharge and purging. The time of discharge corresponds to the high spike in conductivity of the output stream. This occurs when the electrodes are shorted; all the ions are released into the fluid then resident within the cell; and the conductivity in the outbound fluid carrying all the released ions into the brine tank skyrockets. As the ions are carried away, the conductivity of the outbound stream decreases. The cell is ready again.

To summarize, water is cleaned by applying a voltage, and then regenerated by removing the voltage. The spikes in concentration (at 10,000 seconds in Figure 6) correspond to the resulting brine solutions produced during regeneration when the electrodes are shorted. Notice that the time for regeneration is shorter than the time for loading, which is significant in that two redundant units could continuously generate clean water. One unit can be cleaning while the second is regenerating. Most of the time, both units will be simultaneously cleaning and producing clean water. In practice, we anticipate producing a standard sized unit, and simply adding more to meet the volume demand for cleaned water.

Figure 6: Conductivity of Effluent Water from the Prototype Reticle Carbon ESD Cell at Various Potentials



The diagram in Figure 6 shows three different voltages applied. As expected, higher voltages result in faster adsorption of the NaCl at the same inlet flow rate. However, higher voltages begin to decompose the water into hydrogen and oxygen, and that scavenges and wastes a huge amount of energy from the process. We do not want that to occur, so we operate at the highest possible voltage just under the decomposition voltage for water. In practice, that is 1.5 volts.

To summarize the Reticle ESD technology:

- Reticle ESD uses hydraulic water pressure to pass water between oppositely charged electrodes—ambient temperature and pressure—and does not require or use any membranes. ESD is non-selective (even H^+ and OH^- are removed), thus producing water at a neutral pH. There are no “pesky” ions like boron that sneak right through the process and render the deionization ineffectual. And because it collects positive ions in a different place (the negatively charged cathode) than it collects negative ions (the positively charged anode), scale precipitation, clogging, and plugging problems (as from calcium carbonate, metal hydroxides, etc.) that literally kill other methods are avoided.

- Reticle ESD has been shown to have extremely long cycle life—over 500,000 charge/regeneration cycles have be completed without having to replace electrodes. As long as the applied voltage never exceeds 1.5-V, the carbon should have even longer cycle life.

- Reticle ESD is simple and safe to operate. There are no high-pressure hoses or high-temperature pipes involved. With the maximum potential at just 1.5-V DC, there is no danger of shock, electrocution, water decomposition, or fire. No special personal protective equipment (PPE) or safety precautions need to be incorporated during operation of the cells. The low voltage application means that solar and wind power could be easily used for "off-the-grid" desalination.

- At 1.5 volts, the energy consumption is miniscule compared to other desalination technologies (1.4 kWh/1000 gallons verses 4-6 kWh/1000 gallon for RO.) Our estimated "all in" cost (including operating, energy, amortization, etc.) is desalinated water for less than $120 per acre foot. Other techniques are considerably higher cost processes. The ESD cells can be fully automated by using the different conductivities (inlet and outlet) to determine when to regenerate the cell.

- The lower the TDS of the incoming stream, the easier, more complete, and more efficient the desalination is. Reticle ESD arrests and removes ions. The fewer ions in the incoming water, the fewer it has to arrest, the more feedwater it can process and clean, the more highly concentrated the final product, and the greater the fraction of incoming water that will be rendered clean and economic. This is a huge advantage, indeed a "sweet spot," for Reticle ESD. RO and thermal methods are precisely the opposite—they are singularly uneconomic/inefficient for low concentration feedwaters such as those in PDD. When you think about it, low concentration feedwaters should be the easiest, not the hardest, to clean, and they should leave the least residue behind. That is precisely true with Reticle ESD.

The proposed project will be conducted in two phases. Phase I is intended to construct a "mid-size" ESD cell that can be modified to fit the salinity of the test water. The cell and ancillary holding tanks, pumps, instruments, etc. will be assembled in a trailer to make it easy to transport the unit to any site. PDD has indicated that wellwater, agricultural drainage or other sites may become candidates for Reticle testing. The tests will be conducted with the intent of determining the optimum desalination results for a variety of saline waters (ranging from 1000 to 6000 ppm TDS). The tests will provide insight into the optimum spacing between the electrodes to maximize the rate and efficiency that any water can be deionized using Reticle ESD. Results will be reported for well water (low salinity) and agricultural drainage (high salinity). The results of Phase I testing will be the precise design for cells that will be manufactured for Phase II. Also, this represents a natural "go/no go" opportunity to stop the project if any of the expected results are not met. An economic analysis will be used to help determine if the results are good enough to go forward in the project.

Phase II involves the assembly of two "commercial scale" ESD cells that can be operated in parallel using any feedwater in the PDD. The goal of this phase of the project is to demonstrate the final commercial design, to determine the parameters of operation for the cells so that they can be manufactured for any agricultural application, and to demonstrate removal of any inorganic in the feedwater.

Phase I is anticipated to take approximately 15 weeks to complete. This includes approximately 8 weeks to order and manufacture the carbon, assemble the small cell, and assemble the trailer that will take the ESD cell to various locations to test a variety of waters. Each site will be tested for approximately 3 days to determine the optimum parameters for the specific TDS of the feedwater. As the results are analyzed, the Phase II will commence with the ordering of carbon for two full-scale ESD cells. The assembly of the ESD cells and building the trailer will commence immediately thereafter. The total duration of Phase II is estimated to be 24 weeks, culminating in a final report and two commercial-scale Reticle ESD cells in a trailer that can be moved to any location for testing of the system. Total duration of the project is expected to be approximately 10 months.

4 PROJECT OBJECTIVES AND PROGRAM PRIORITIES

We have successfully tested ESD in a number of previous applications (deionization, electroplating, concentration, capacitance), and we have perfected the process to manufacture Reticle Carbon efficiently. We have partnered with quality third party vendors to manufacture the carbon material, the cells, the electrodes, etc. to create bench, demonstration, and commercial size units. We know we can manufacture and engineer demonstration size facilities and verify their proper, effective, economic operation.

The objective of this proposal is to assemble three working Reticle ESD cells: one that is portable (in a small trailer container) for demonstration testing on a number of waters in the Panoche Drainage District, and two commercial-scale cells that will be operated in parallel to determine the maximum throughput for the commercial cell on waters with a variety of salinities.

We emphasize that Reticle ESD provides a viable solution to all of the issues specified in the solicitation from California DWR pertaining to the treatment of Irrigation Drain Water under Prop. 204, released on October 30, 2014:

1. **Source control of salinity and toxins**

2. **Desalination of agricultural drainage water**

3. **Detoxification of the brine produced to protect wildlife and the environment.**[1]

4. **Treatment of the brine constituents to produce marketable products such as potash.** [1]

5. **Acceptable capital and operating costs**

6. **Environmentally responsible**

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[1] Reticle is providing a separate proposal to specifically handle these areas. However, it is important to note that Reticle ESD would provide a perfect brine for the complete testing of processing strategies to clean and recovery valuable salts from the deionization processes.

This section addresses the applicability of the demonstration project to each of these six required areas.

4.1 Source Control of Salinity and Toxins

The Reticle ESD cell will remove EVERY ion from the feedwater—toxic and nontoxic alike. Reticle ESD removes all ions at energy consumption levels as low as 1.5 kWh/1000 gallons (1.5 W/gph). It concentrates 100 percent of the dissolved ions into as little as 10 percent of the original water volume, rendering 90 percent of the water fully ion-free and rendering it useful for economic use—agriculture, human and livestock consumption, wetlands, etc. The purpose of the demonstration project will be to show this definitively in an objective setting across a number of waters tested using the mobile Reticle ESD cell. If we concentrate 100 percent of the toxicity (and non-toxicity) of the feedwater into 10 percent of the original volume, we will have effectively controlled all the salinity and toxins in the original feedwater into a much smaller, more manageable volume. The tenfold increase in the salt concentration renders it far easier to treat to remove (by precipitation) all of the toxic substances that make it a hazardous substance.

Panoche is unique in California. Privately owned wellwater in the District has relatively low salinity (1000-2500 ppm TDS), but even that water is still too saline for prolonged application to crops in the area. However, such water is a uniquely valuable and easily treatable asset using Reticle ESD. It is not very saline, and it can be purified, i.e., deionized, using Reticle ESD very economically and simply. It is in the “sweet spot” for Reticle ESD., which easily reduces the salinity to safe levels (e.g., 250 ppm TDS). All of the salt ions are sequestered into a highly concentrated brine, and the water from which the ions were taken is now clean. This releases large quantities of clean water for use and sequesters all the salt in a small volume of brine. Chemical treatment of the brine removes substances by precipitation, and such brine can be input to plants designed to recover valuable constituents.

As an added advantage, boron, which is not eliminated by reverse osmosis (RO)—it sneaks right through the membrane because the molecules are the same size as water molecules—is easily eliminated from the water by Reticle’s technology. Boron is just another charged ion removed in exactly the way as all other charge ions.

The advantage of Reticle ESD is multi-level. No other desalination process can operate as inexpensively. Reticle has substantially lower operating cost and minuscule energy consumption. All other processes are substantially more expensive to purchase, i.e., higher capital cost. Reticle has far lower capital cost. Reticle sequesters all salts indiscriminately, in sharp contrast with RO, which cannot remove pernicious borates from the water and therefore has limited value even if it works.

4.2 Desalination of Agricultural Drainage, As Well As Source Water

Agricultural drainage water has a rather high ion concentration, in the range of 2000-8000 ppm TDS. There are too many ions in it to be useful, especially when many of the ions are pernicious to agriculture, human, or wetlands. Reticle plans to access the drainage water of several ranches and farms in the PDD to demonstrate our mobile unit built for this project. The information we will gather from the tests will be important to design a full-size unit capable of effectively operating on any range of salinity. We will demonstrate in each case that we have pulled all the ions out of the drainage water and rendered it entirely suitable for reuse. This would be an immense act of water conservation, essentially creating the prospect of a "zero discharge" system. Drainage water can be recycled and put back into commercial use, or discharged to the wetlands safely.

Reticle ESD is the only "sure-fire" way to safely, inexpensively, and reliably remove such elements as boron and selenium effectively without additives, antiscalants, or any other chemicals. Our system is "once through" meaning sequential processing is not necessary. Instead, we simply add parallel units to treat more water.

4.3 Detoxification of the Brine Produced to Protect Wildlife and the Environment

Dr. Carl Nesbitt is an internationally renowned inorganic chemist. He knows the chemistry of wildlife-threatening toxins such as selenium, arsenic, and others. He knows Reticle ESD and its ability to maximally concentrate the pernicious toxic ions into brines. He knows how to isolate, precipitate, and render them inert, keeping them out of the water life cycle. Protection of wildlife is a wonderful byproduct of the proposed Reticle ESD demonstration. By assay, this project will demonstrate that in fact Reticle ESD will fully remove all the wildlife-threatening ions. We know how important this has become in California, politically as well as palpably.

Reticle has the expertise to selectively remove the "bad actors" from the brines. However, we have opted to put the brine treatment into a separate (but related) proposal. In that separate proposal, a series of processing steps that remove specific species of chemicals will be constructed to bring to each site. As the assays of the brines vary, the process be tailored to only remove ions that need to be removed, leaving a benign brine at the end. The information gathered from this pilot-scale testing will be used to engineer full-scale, permanent operations tailored to the specific contents of the salts contained in the water in that area. As everyone knows, different waters contain different ions, and brine treatment is customized to the specific brine content.

4.4 Treatment of the Brine Constituents to Produce Marketable Products Such as Potash

Some salts present in some feedwaters can have economic value, and our brine treatment process is designed to capture that value. Such constituents as copper, potassium, calcium, magnesium, etc. all have economic value, either as the metals or as salts of the metals. For instance, any significant amount of copper in the solution could recoup up to $3 per pound of copper when and if collected properly. All of the K^+ in solution could be collected and sold as potash (K_2O), which is a component of fertilizer. The key will be to recover the valuable ions or salts selectively. Dr. Nesbitt knows from his mining and chemistry experience that this can and is done more efficiently based on the more highly concentrated brines, such as the Reticle ESD discharge brines. Using the more concentrated brines is exactly the scope of the brine treatment proposal ancillary to this proposal. Base metals (such as copper and zinc) are easily removed selectively from concentrated brines. Metalloids (such as selenium, arsenic, alumina, silica) are more easily removed after the metals have been extracted. The remaining alkali (Na^+ and K^+)

and alkaline metals (Ca^{+2}, Mg^{+2}) can be selectively removed, or they can be recycled to the clean water to replace some of the lost "good salt" value of the water. Sodium and potassium can be removed using "salt legs," but the value for the expense to do so will have to be evaluated on a brine-by-brine basis. These are precisely the expertise and experience areas that the Reticle engineers bring to the table. A more detailed proposal is being submitted in this area.

Notwithstanding issues related to brine treatment, recovery, and disposal, concentrating the ions present at rather dilute levels in 1000-1500 TDS wellwater into 10 or less percent of the incoming water and thereby freeing up 90 percent or more of the water for human, agriculture, and/or industrial use is where the payoff lies and where the objective of this demonstration lies. Turning an otherwise "dry hole" at 1000-1500 TDS into a valuable asset, freeing at least 90 percent of that water for economic use, has tremendous value and is the objective of this demonstration. One can but imagine how economically valuable a technique that can do so will be.

4.5 Acceptable Capital and Operating Costs

The cost of producing Reticle Carbon and the Reticle ESD cells is rather modest. During the proposed demonstration project, Reticle is going to access our full production chain and demonstrate that it is extremely reasonable and cost effective to manufacture the demonstration cell. The performance/cost ratio of the cell will be demonstrated to be far, far higher than processes such as RO. Realistically, there is going to be "no contest." The operating costs are considerably cheaper than RO or CDI as well, and that emanates from the fact that there is literally no "equipment" within Reticle ESD. Our low voltage systems use precious little electrical energy to arrest the ions and create the concentrated brine for the feedwater, meaning less electrical equipment. Ambient temperatures and pressures, no antiscalants, no water pretreatment, and process control automation means that our operating costs are significantly lower than RO or CDI. And we will not scale because we do not force the + and – charged ions into proximity as RO does. Quite the contrary, we pull them apart to different locations, de facto eliminating the possibility of scaling.

It should be noted that as we make the first demonstration cell, we will bear the "first of a kind" or FOAK cost. That is inevitable. The "one-at-a-time" cost for the carbon will be higher for these first cells than it would be for the subsequent fifty cells when scale economies can be applied. However, we will be able to predict "full-production" costs for Reticle Carbon and the ESD cell components for future cells based on the FOAK cost during this project.

4.6 **Environmentally Responsible**

Reticle uses just 1.42 kWh per 1000 gallons of purified water. RO uses 4.00 kWh/1000 gallons (even higher energy consumptions have been reported) to achieve the same purification level and water specification. If one needed to make 24 million gallons per day (a modest size municipal plant), that means that the Reticle ESD cell would have the following power consumption

$$\frac{1.42\text{ kWh}}{1000\text{ gal}}\times\left(24\times10^{6}\right)\frac{\text{gal}}{\text{day}}\times\frac{365\text{ days}}{\text{yr}}\times\frac{1\text{MWh}}{1000\text{ kWh}}=12{,}493\ \frac{\text{MWh}}{\text{yr}}$$

If one were condemned to use RO, the

$$\frac{4.0\text{ kWh}}{1000\text{ gal}}\times\left(24\times10^{6}\right)\frac{\text{gal}}{\text{day}}\times\frac{365\text{ days}}{\text{yr}}\times\frac{1\text{MWh}}{1000\text{ kWh}}=35{,}040\ \frac{\text{MWh}}{\text{yr}}$$

The difference in electricity consumption in moving from RO to Reticle ESD is the difference of 22,550 MWh/yr, a substantial quantity of electrical energy. We know that a coal plant emits about 2000 lb CO_2/MWh (1 ton CO_2/MWh), and a gas plant emits about 1000 lb CO_2/MWh (0.5 tons CO_2/MWh). That means that for every 24 million GPD plant that uses Reticle ESD rather than RO, the CO_2 output will be reduced between 12,000 and 22,000 tons per year. This is a huge reduction in CO_2 output and thereby a huge contribution to greenhouse gas reduction. It may under California law be possible to secure CO_2 credits for such emission reduction, but we have not considered that during this demonstration project. If that happens, the value of those CO_2 credits will directly offset and reduce the cost of Reticle ESD desalination, and it will be even less expensive.

Reticle ESD cells use sequestered carbon in our electrodes. (The carbon in our electrodes is not carbon floating around in the atmosphere or ecosystem.) We create monolithic carbon and leave it as monolithic carbon. There is no way such sequestered carbon can ever enter the atmosphere. That is an important point; our carbon is and remains sequestered from the atmosphere. Carbon resident within our machines will never enter the atmosphere.

Because Reticle ESD uses such small voltages to effectively deionize water, Reticle ESD is ideally suited, in fact perfectly suited, for renewable generation sources such as solar panels or wind generators. The 1.5 volts DC required by Reticle ESD can be easily matched to an array of solar photovoltaic panels (which generate at precisely such voltages), rendering the most use of this portable energy source. When grid power is limited (or unavailable) solar and/or wind could be used to generate clean water during peak solar or wind activity.

The stored energy in the ESD cells (prior to regeneration) is also a potential source of energy for loading batteries or resale to the electricity grid. In particular, one could use the Reticle ESD unit to deionize during the night when power price is low, taking advantage of low power price and thereby low operating cost. One could then regenerate during the early afternoon (time of electricity peak) when power price is very high, discharging and selling all the power in the cell into the electrical grid during time of peak. The economics of off peak charging/on peak discharging are highly compelling. (That is precisely how the California Aqueduct works at Castaic. They pump the water up at night and generate on the Los Angeles side on the way down during the day.) Such a strategy would eliminate power cost altogether for Reticle ESD units because the peak-off peak price differential in California is so high. We have not factored this into our demonstration project quite yet.

4.7 Testing and Demonstration Prior to the Proposed Tests

The very first Reticle ESD cell was based on Reticle Carbon with only 1250 m^2/g available area, yet we were able to remove 95 percent of the salt from a NaCl solution using just 1.4 watts per gallon per hour of flow rate. In other demonstrations, we have successfully used laboratory ESD cells to produce deionized-distilled quality water from a municipal drinking water, deionized and softened the water from a Canadian municipality in Saskatchewan, desalinated water from highly saline sources in the Middle East, and removed dissolved selenium from natural streams. The technology has proven to be sound and robust. A full-scale demonstration on real waters, the objective of this proposal, is the logical next step.

During our significant development history, it has been necessary to turn our attention (more than we anticipated) to making Reticle Carbon with better properties and ensuring the ability to mass-produce large quantities of the carbon. This was a more challenging task than we anticipated, but we have mastered the carbon manufacturing and fabrication process and controlled the Reticle Carbon to have the properties we want. In particular, we have created the next generation Reticle Carbon (with as much as 1900 m^2/g) that will easily exceed the performance of the early carbon for desalinating brackish water.

It is well known that water becomes more electrically conductive with higher TDS. The conductivity of the feedwater directly affects the recovery and operating efficiency of a Reticle ESD cell. Because there are few species able to react in reduction/oxidation reactions, electrical current applied to the cell can only do one of two things at the solid/liquid interface: (1.) attract and hold an ion against the surface, or (2.) flow directly throught the ionized (electrolyte) water from the cathode to the anode. The latter option is a "short," meaning less current will be able to absorb ions. The simplest means of decreasing the possibility of a "short" is to widen the space between the cathodes and anodes when more highly conductive water is present. In other words, a wider inter-electrode spacing is required for waters with higher than 5,000 ppm TDS than the spacing for a 1,000 ppm TDS water treatment. The first phase of the project will be using a "mid-size" cell (e.g., 1'x1'x3') with several electrode spacing position options available to test a variety of electrode spacings for a variety of waters. This cell (which will be portable and will fit in a small portable mobile "container") will require small vessels to store feedwater and brine, so the entire process (including brine treatment) can be contained on a trailer or truck for easy transportation to the wellhead or farm. The cell will be tested on a variety of saline waters to show the relative ion removal rate and the electrical efficiency of the cell. At each location, the cell will be tested under a number of configurations to ensure the optimal efficiency (with maximum ion removal rate) is determined. The ultimate answers obtained will be used to determine the optimum spacing for the permanent electrodes in the larger (Phase II) cells that will be constructed subsequent to the Phase I testing. This spacing will help us design the optimum configuration for the range and content of water typically seen in the San Joaquin area.

5 WORKPLAN AND TASKS

Reticle proposes to execute the following workplan to meet the requirements for desalination of a variety of water sources in the PDD watershed. From our discussions, we are aware that we may be asked to treat a range of brackish waters from 2,000-6,000 ppm TDS. While these are within the range of the Reticle ESD technology (and in fact in the "sweet spot"), we know that the higher the inbound salinity, the lower the efficiency of the cell. That is just plain simple logic. The more ions that are in the feedwater, the more ions the cell has to take out. It takes more "arresting" to take more out, meaning the capacity of the cell will be proportionately lower.

We also know there will be an erosion in current efficiency for higher saline waters, so we intend first to build a small prototype unit in Phase I of the workplan. The small cell (anticipated to be 1'x1' in cross-section and about 3' long) will be designed to be portable so it can be taken to any site to test any water. Furthermore, it is designed so that we can change the spacing between the electrode pairs (anodes and cathodes) as the salinity of the water tested changes. The goal of this first phase is to see how significantly the efficiency can be improved by placing the electrodes closer or farther apart. We anticipate that the ion removal rate might decrease as the spacing is increased, so we anticipate a maximum spacing that will limit how far apart the electrodes can be and still "communicate" together with the solution. The goal of Phase I will be to determine the optimum spacing for the full-scale prototype cells as a function of efficiency and ion removal rate. We have done this type of thing in the past, and we do not anticipate difficulties. However, we know it will be necessary to engineer the test cell to the specific waters being processed, not only for the demonstration but for all subsequent commercial applications and systems.

To accomplish this, we will need to test the cell at different sites with different degrees of salinity. A portable plant will include the small ESD cell, a feed tank, a brine storage tank, and a clean water storage tank along with all of the conductivity meters, controllers, valving, and plumbing. Because of the small scale of the ESD and tanks, we anticipate that all of this will fit on a trailer or truck bed. As part of Phase I, the portable plant will be taken to sites determined by PDD as potential test sites and feedwaters.

Once the spacing parameter is finalized, two full-scale ESD cells will be constructing using this optimum spacing. Two full-scale cells (anticipated to be 2'x2'x4') will be constructed and brought to sites to run in tandem. Both units will be operated as independent units (cleaning and regenerating as required) to determine the ability to clean the water. Different sites will be chosen for different salinity testing. Those two commercial cells will be portable and vehicle mounted as well.

The following sections provide detailed procedures and motivation for the workplan, as well as deliverables and anticipated schedules and budget estimates.

5.1 Phase I Prototype Tasks

There are four major tasks that will be accomplished in Phase I:

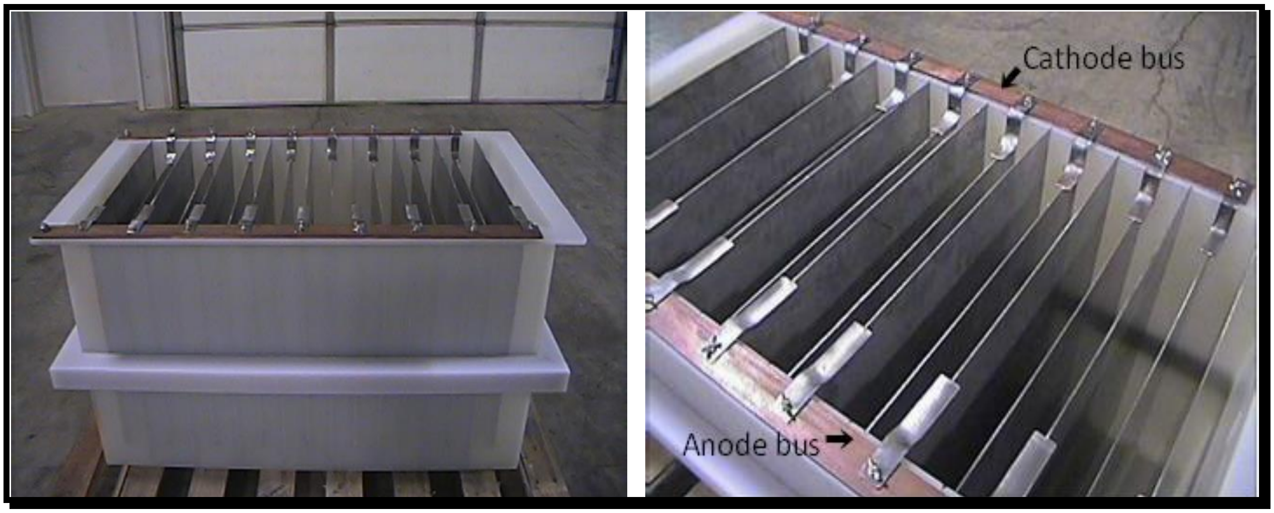
1) Produce Reticle Carbon
2) Assemble the Reticle ESD cell in the trailer
3) Desalination tests at the site
4) Complete formal report of results

Upon initiation of Phase I, we will need to order the Reticle Carbon from our manufacturing partners. We are not a high-volume client, meaning we need to allow plenty of lead time for delivery. This workplan anticipates and accounts for that. Procurement of the Reticle Carbon will be the critical lead-item and will be ordered immediately. In the meantime, other partners will be sent the specs for constructing the balance of the ESD cell components. In addition to the carbon, our manufacturing partners include cell designers who make the reinforced polyethylene shells, cut the metal plates for the electrodes, make DC power supplies, precision cut the blocks of Reticle Carbon, and the final assemblers who will attach the Reticle Carbon tiles (anticipated to be 4" x 8" x ¼" each) to the metal plates. Fabrication of the cell requires a number of serial tasks, but they are all straightforward.

The final trailer unit (assembled in Southern California) will be shipped to the PDD area for testing. Small tanks for holding the feedwater, the clean water, and the concentrated brine during testing will be required. Smaller carboys (i.e., 55-gallon drums) can be used for the head tank and collection tanks. Thus, the overall footprint of the Phase 1 plant will be quite small, capable of fitting on a truck bed or small trailer for easy transportation to various sites. The container will be fitted with hose barbs and electrical hookups for quick hookup at any site.

Our Reticle Carbon ESD cell design utilizes passive water flow to propel the water between the series of electrodes, as the one in Figure 7 indicates. As seen in the photograph, the electrodes are connected to metal strips along either side; these strips are directly attached to the power supply to charge the plates. Slots cut into the side panels will hold the plates in place, and each plate has tabs that connect to the metal strips on either side. Tabs on the electrodes allow us to place the plates into two locations—anodes are placed level with the top leaving a gap at the bottom, while the cathodes are pushed all the way to the bottom, leaving a gap for water flow on top. With this "over-under" configuration, the water entering the cell will flow over and under the electrodes by hydraulic pressure toward the exit (the slots prevent water from going around the electrodes). Reticle Carbon tiles are affixed to the charged plates and will arrest ions as the water passes between the electrode pairs. The preliminary cell for this project will be 1'x1'x3'; however, different spacing of the slots will be prepared by our plastic manufacturing partner. For instance, if the cells have $^1/_8$" slot spacing, we will be able to put ¼", $^3/_8$", ½", etc. spacing between electrode pairs.

Figure 7: Example of an ESD Cell Assembly Proposed for This Project



To operate the cell, all that is required is to monitor the existing water conductivity compared with the entering water conductivity. Two flow-through conductivity meters on the inlet and outlet pipes will provide the requisite conductivity measurements. Throughout the operation of the cell, the feedwater conductivity will remain constant (the TDS of the feedwater is constant), but the exit water conductivity will change as the cell becomes more or less full of arrested ions. This is precisely what we saw in the context of Figure 6.

To begin, water will be fed continuously into the Reticle ESD unit at a given flow rate (i.e., 1 gallon/min). Once the unit is full of water, and the outflow matches the inlet flow rate, the power supply will be turned on. The effluent conductivity will drop as the ions are removed. After a period, the conductivity of the effluent will begin to rise, signaling that the cell is ready for regeneration. Without altering the flow of water, the power supply will be turned off, and the cathode and anode bus bars will be shorted to remove the charge built up in the cell. The outflow water (with an extremely high conductivity as the excess ions are flushed) will be diverted to a brine collection drum until the effluent conductivity matches the influent cell conductivity. Then the power supply will be turned back on, the effluent diverted to the clean water drum, and the process continued. It is critical to understand that the water flow rate to the unit will not change whether the cell is in “clean mode” or “regeneration mode.” However, if it is determined that a slower or higher flow rate can be tolerated, the rate may be changed during the operation.

Most of the work outlined can be accomplished concurrently, and we have scheduled a review point after three months for a “Go/No Go” evaluation of Phase I project objectives. The longest lead item, as always, will be the manufacture of Reticle Carbon. The delivery could take as much as 8 weeks, with the cutting taking an additional 2 weeks to complete. However, if all of the various shorter lead-time items (the metal electrodes, adhesives, shells, power supplies, conductivity probes/meters, etc.) have been delivered, the final assembly will be just a few days after the electrodes have been delivered and assembled. We consider this to be a rather short lead time for one-at-a-time orders from vendors, but we will plan, schedule, and execute carefully.

The small-scale ESD cell will allow us to ascertain the optimal operating strategy for the unit as a function of the initial TDS of the water to be treated. The information we will garner from each test is how efficiently the unit runs, both measured by energy consumption and by ion removal rate. The effectiveness of how well deleterious elements are removed will be determined for each test by sending samples of clean water, brine and feedwater to analytical laboratories. We will be reporting that to the sponsors as the operation and efficiency data are assembled.

For Phase II, we will need to take what we learn from the portfolio of tests and the test ESD cell and design an optimized, scaled-up version. With optimal design, the completion of Phase II will take a similar path as Phase I, and should be accomplished by the same schedule.

5.2 Schedule of Work for Phase I

This section enumerates the specific tasks and durations to complete the Phase I project:

Step 1: Produce Reticle Carbon for Prototype ESD Cells (8 Weeks). Vendor and in-house consultation will be used to fabricate the Reticle Carbon. This task includes the purchase of carbon, the consolidation of the carbon into blocks, the cutting of the blocks into tiles and the delivery of the tiles to the assembly site.

Step 2: Manufacture The Small-Scale Prototype ESD Cell With Reticle Carbon (8-Weeks). We will procure and assemble the equipment (tanks, cells, electrodes, controllers, and power supply) for the ESD mobile plant. Equipment will be ordered and assembled as received, the Reticle Carbon tiles will be adhered to the metal electrodes; the cell container will be manufactured; and the final assembly will be tested for leaks and operability. Specifically, the tasks are as follows:

Task 2-1. Procure the equipment and power supplies for the larger Phase II ESD tests.

Task 2-2. Cut the Reticle Carbon tiles and affix them to the metal plate.

Task 2-3. Assemble the unit, and perform preliminary tests to ensure proper operation.

Step 3: Transport the mobile plant to test at various locations throughout the PDD (4-weeks).

Task 3-1. **Subject the ESD cell to a battery of tests** at various locations with a variety of TDS levels to evaluate the performance of the unit (and electrode spacing) on brackish water. The specific testing protocol will be as follows:

a. The ESD cell will be configured for the conductivity of the water to be tested (larger spacing for higher salinity)
b. The feedwater tank will be filled with water from the site, and the cell will be continuously fed the water and operated to determine the following:

   i. Energy efficiency (in watt-hours/gallon, W/gph or watt-hours/liter, etc.)
   ii. Deionization rate (in mg/min, etc.)
   iii. Time between regenerations (i.e., hours of operating the cell is in clean mode)
   iv. Time of regeneration (i.e., hours to completely remove adsorbed ions)
   v. Completeness of regeneration
   vi. Percent water cleaning (i.e., percent of feedwater that is clean water, and percent that is brine)

c. Under a separate proposal, accumulated concentrated brines from regeneration will be analyzed and treated using Reticle engineering solutions to remove and isolate deleterious elements, such as:
   i. Heavy metals, such as lead, mercury, cadmium, etc.
   ii. Toxic metals, such as cadmium, selenium, arsenic
   iii. Base metals, such as iron, copper, zinc, etc.

Task 3-2. **Summarize the results** for interim Go/No Go evaluation of results. We will brief the sponsor in detail on the operation, efficiency, and all data gathered on all the tests.

5.3 Specific Manufacturing Steps for the ESD Cells and Container

The specific steps to make the carbon, the ESD cells and trailer are the same for both Phase I and Phase II. The primary difference is only the sizes and masses of carbon required. The overall process is summarized as follows:

1. **Order Precursor Carbon:** The supplier for our granulated activated carbon has a distribution warehouse located in Southern California. The product will be shipped directly to our carbon consolidation contractor, who is also in Southern California.

2. **Reticle Carbon Processing Cans:** These are specially fabricated steel cans that contain the carbon for the consolidation process. These cans require special treatment (evacuation and heating) to properly process the activated carbon in subsequent steps. This is presently the most lengthy and most costly element in the process and is scheduled carefully. This process is accomplished by a Southern California vendor.

3. **Consolidation:** In this procedure the carbon, now in the evacuated, heated cans, is subjected to heat and pressure (Hot Isostatic Pressing or HIP). After the consolidation, the cans are cut open, and the carbon block contained within is ready to be cut into tiles and fabricated into Reticle Carbon electrodes. This process is accomplished by a Southern California vendor.

4. **Carbon tile production:** The carbon blocks are sent to Lake Havasu, Arizona for cutting into tiles. This contractor is the foremost graphite and carbon machining company in the United States. The cost of such cutting is modest. The cut tiles are subsequently shipped to our system fabrication contractor.

5. **Electrode and Cell Fabrication:** The electrode and cell fabrication contractor is a premier fabrication and model maker for many aerospace companies in the United States. At this facility, cell fabrication occurs in five steps:

   a. **Fabricating the electrode plates**

      i. Steel plates are cut to size
      ii. They are sandblasted to improve adhesion
      iii. An electrical connection tab is welded to one corner
      iv. A conductive epoxy is sprayed on the plate edges for waterproofing
      v. The plates are laid flat and sprayed with conductive epoxy
      vi. Carbon tiles are affixed to the plate faces.
      vii. The plates are then placed in an oven to cure the epoxy
      viii. The plate is then turned over to repeat the process for the opposite side
      ix. A small bead of adhesive epoxy is applied each side of each tile for mechanical adhesion and then cured

   b. **Fabricating the tub (the cell)**

      i. A polypropylene tub will be fabricated with precision machined slots on the inside bottoms and sides to accommodate the electrodes
      ii. Water input and output holes will be also drilled into each end.
      iii. Reinforcing ribs will then be attached to the sides and ends of the tub
      iv. Copper busbars will be attached to the sides of the tub
      v. The electrodes will then be inserted into the slots, and the electrical connectors will be screwed to the busbar
      vi. Conductivity sensors will be attached to the tub in an appropriate place.

   c. **Cell Assembly**

      i. A wood or aluminum table will be fabricated to accommodate the cell.
      ii. The cell will be attached to the table with eye bolts through the reinforcing skirt.
      iii. The table will also contain an equipment shelf to mount the power supply, system controller and other necessary peripheral devices.

   d. **System Test**

      i. Tests will be conducted to assure that all system elements are operational. Tests will consist of running salt solutions of several different salt concentrations in order to emulate field operations.
      ii. A plastic cover will also be fabricated to keep debris out of the cell.

6. Trailer Modification

a. **Installation:** A 16 ft. long x 8 ft. wide enclosed equipment trailer will be purchased and modified as follows

i. Install appropriate garden hose quick disconnects on one side of the trailer
ii. Install a 5000 Btu roof mounted RV type air conditioner on the trailer
iii. Install the appropriate plumbing for inside water distribution
iv. Install the appropriate electrical system.
v. Install all necessary pumps and valves
vi. Install the ESD cell w/table on shock mounts to protect system elements when towed over rough terrain.

b. **System Tests:** The system will be tested again to assure that all equipment operates both individually and as an integrated system.

c. **System, Transportation:** The system will be professionally towed to the designated test site, safely parked, and secured for operation.

5.4 Phase II Deliverables and Timetable

In Phase II, we will scale up the ESD cell based on the results from Phase I—the most important piece of information being the spacing of the electrodes. However, the carbon for the larger unit can be ordered well in advance of the initiation of Phase II so that there will be no unanticipated delays. We anticipate learning fairly early in the testing of Phase I the best spacing and will finalize the design of the Phase II commercial unit before the end of Phase I. Armed with this information, we can have the bulk of the equipment for the large unit ready for the electrode tiles of Reticle Carbon to be cut and delivered for assembly upon approval and initiation of Phase II.

The difference in mass of Reticle Carbon from Phase I to Phase II will be significant. The initial Phase I cell will likely require only about 40 pounds (20 kilograms) of Reticle Carbon to be installed within it. The larger unit will require in excess of 150-pounds (70 kilograms) of Reticle Carbon installed within it. The ordering of precursor carbon for Phase II will begin early during Phase I to ensure that we have enough carbon on hand to make the number of blocks required for Phase II (about 30 cans that will be required for the consolidation process).

5.5 Statement of Work for Phase II

We have identified the specific tasks to complete the Phase II project, each step by step. They are summarized below with the estimated duration for each task:

Step 1: Produce Reticle Carbon for prototype ESD cells (13-weeks). There are two tasks required here:

Task 1-1. Procure sufficient activated carbon to ensure we have enough activated carbon for the Phase II cell. This has been discussed previously.

Task 1-2. Produce Reticle Carbon using vendor and in-house consultation. The process will be the same as during Phase I, simple scaled to a larger size.

Step 2: Manufacture two full-scale prototype ESD cells with Reticle Carbon (16-weeks). There are three tasks required here:

Task 2-1. Procure the equipment and power supplies for the larger Phase II ESD tests.

Task 2-2. Cut the Reticle Carbon tiles and affix them to the metal plate. The process is the same as Phase I, but upsized.

Task 2-3. Assemble the unit, and perform preliminary tests to ensure proper operation. The process is the same as Phase I, but upsized.

Step 3) Assemble a mobile plant to mount the two ESD units, and transport them to various locations throughout the PDD (6-weeks). There are several steps required, but they are virtually identical with the Phase I steps, just upsized.

Task 3-1. Subject the ESD cell to a battery of tests at the testing location. The tests will be substantially the same as the Phase I tests.

Task 3-2. Summarize the results for the project in a final report to the California DWR

Analogous to the smaller Reticle ESD unit from Phase I, the larger Phase II cells will be tested in the following manner:

a. Temporary tanks will be brought to the site to provide water that can be tested without affecting the water needs of the location

b. The feedwater tank will be filled with water from the site, and the cell will be tested to determine the following:

   i. Energy efficiency (in watt-hours/gallon, watts/gph or watt-hours/L, etc.)
   ii. Deionization rate (in mg/min, etc.)
   iii. Time between regenerations (i.e., hours of operating the cell in clean mode)
   iv. Time of regeneration (i.e., hours to completely remove adsorbed ions)
   v. Completeness of regeneration
   vi. Percent water cleaning (i.e., percent of feedwater that is clean water, and percent that is brine)

c. Collected regeneration brines and clean water will be assayed and analyzed. It is important to know precisely what is in them in light of the range of waters in the San Joaquin. Brines will be used to test Reticle processes to remove deleterious elements, such as heavy metals (including lead, mercury, cadmium, etc.), toxic metals (including cadmium, selenium, arsenic, etc.), base metals (iron, copper, zinc, etc.), and alkaline earth metals (calcium, magnesium, etc.).

6 MATERIALS, METHODS, AND SCIENTIFIC MERIT

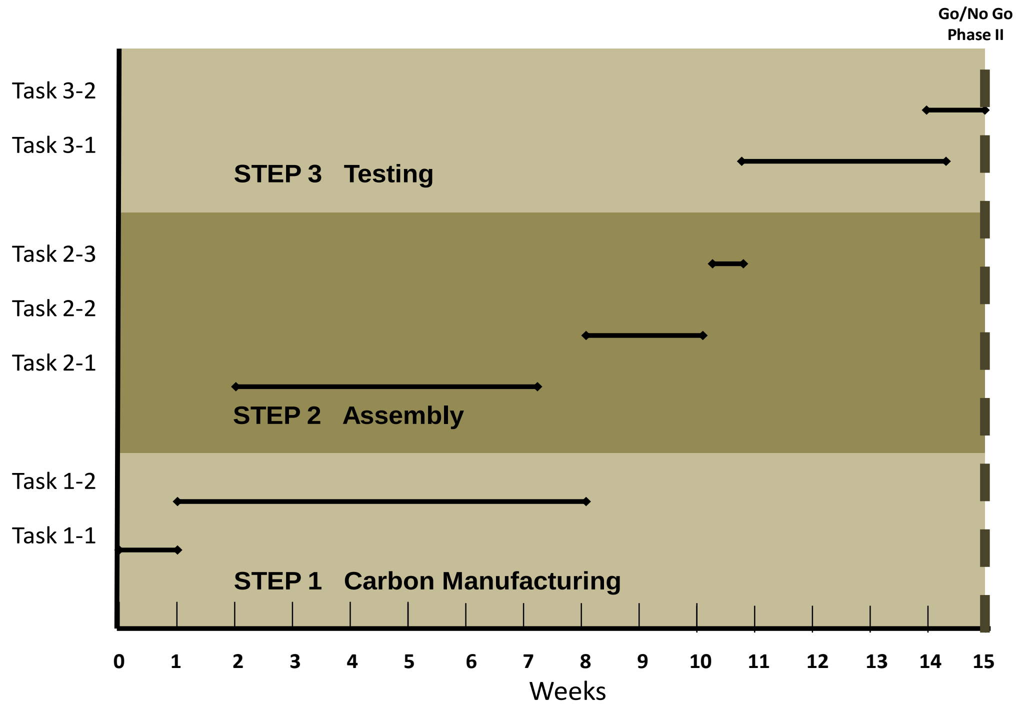
The concept of deionizing water using carbon-based electrode materials is not magic, arcane, misunderstood, or really novel. Electrostatic attraction for purposes of arresting and concentration has been known for many years. The "secret sauce" is the Reticle Carbon. Reticle Carbon is a unique material that is at the heart of the success of Reticle ESD. It is made from pure, unblended activated carbon (which can even be pharmaceutical grade carbon) that has been selected for its specific surface areas. Tiles of the consolidated activated carbon are adhered to the surface of metal electrodes, which are directly connected to a power supply that charges the plates to begin to arrest ions from passing water. Because Reticle Carbon has such colossal, almost unbelievably so, interfacial surface areas, is electrically conductive, and is comprised only of pure activated carbon, it has allowed Reticle to create a unique cell design that does not need membranes, pumps or other additions to make it work. We simply pass the water across pairs of oppositely charged electrodes, arrest the ions, and allow the clean water to flow through. Periodically the cell will have to be regenerated, which places the collected ions into a concentrated brine that can be processed to recover any valuable minerals or salts, or disposed.

The Reticle ESD process is a disarmingly simple, low-cost, low-energy alternative to reverse osmosis, distillation (solar or fossil fuel), flashing, or dialysis, which are horrifically expensive to operate and construct. The research will be unique in that no one has ever had Reticle Carbon to replace the thin film electrodes that have been tried (unsuccessfully) in the past.

7 SCHEDULE

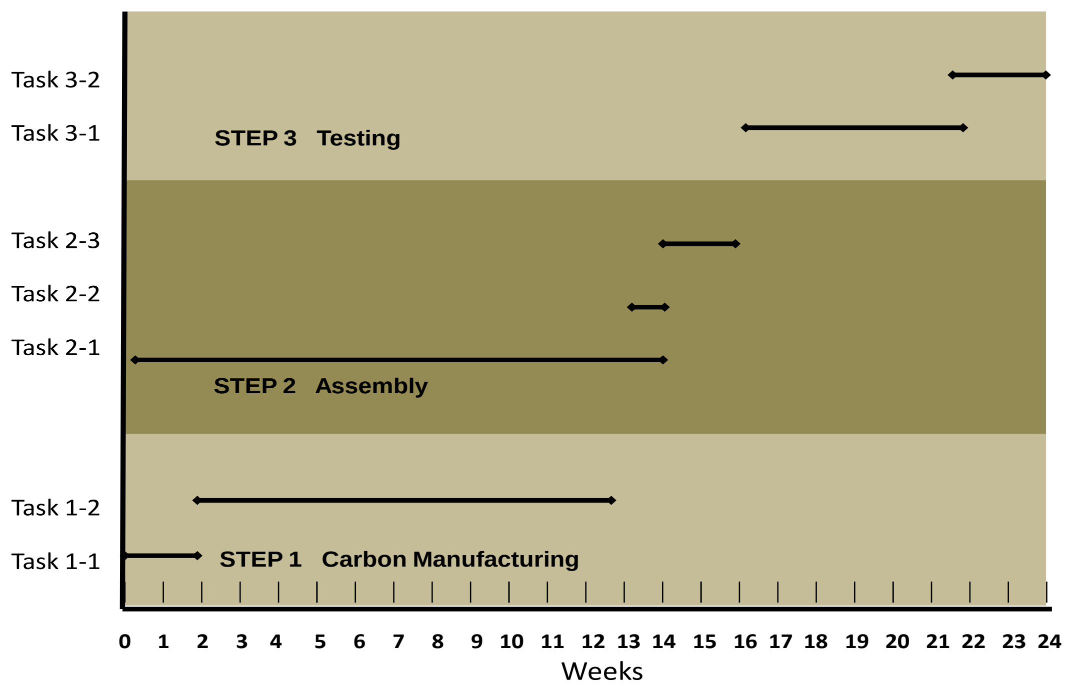
Phase I will follow the schedule in Figure 8. The longest lead time item is shown to be the preparation of the Reticle Carbon tiles to attach to the electrodes prior to assembling the cell in the mobile plant. Several of the tasks (namely the manufacture of the carbon (Task 1-2) and the construction of the trailer (Task 2-1) can and will occur concurrently. Each of the tasks will be started immediately upon approval of the project.

Figure 8: Phase I Schedule



The schedule and timetable for Phase II appears in Figure 9.

Figure 9: Phase II Schedule



8 BUDGET

8.1 Budgeted Cost to Complete Phase I

The following table summarizes the cost to complete Phase I of this proposal:

Reticle ESD Phase I Cost Chart		
ITEM	RATE	TOTALS
Administrative Expenses for PDD	Panoche Admin	$ 22,000
Granulated Activated Carbon	110 lbs @ $35/lb	$ 3,850
Reticle Electrode Can Fab.	5 Cans @$1,122/can	$ 5,610
Project Mgmt & Eng. (PM&E)	80 Hours @ $75/hr.	$ 6,000
Hot Isostatic Press Process		$ 1,800
PM&E	20 hrs	$ 1,500
Carbon Tile Cutting Service	320 tiles @ $4.00 ea.	$ 1,280
PM&E	40 hrs.	$ 3,000
Electrode Fabrication		$ 6,400
PM&E	80 hrs.	$ 6,000
Cell Assembly		$ 4,500
PM&E	80 hrs.	$ 6,000
Peripheral (pwr., valves, etc.)		$ 4,750
Contingency		$ 2,500
Plumbing		$ 500
PM&E	40 hrs.	$ 3,000
Mobile Van plus modification	16 ft. x 8 ft.	$ 9,500
PM&E	80 hrs	$ 6,000
Analytical Laboratory Costs		$ 4,000
Testing PM&E	40 Hours	$ 3,000
Travel and Per Diem		$ 5,000
Technical mods.(Carl Nesbitt)	80 Hours	$ 6,000
	Total Costs for Phase I	***$ 112,190***

The "Administrative Expenses for PDD" are intended to cover the costs for the Program Manager to follow the progress of the project, and to oversee the paying of all invoices expended in the completion of the project (both Phase I and Phase II). Reticle's vendors for making the carbon, cells and electrodes have supplied quotes which are totaled in the table. They have not been included in this proposal, but are available upon request. All project management and engineering (PM&E) costs are for Reticle personnel to oversee the manufacturing processes and ensure the completion of all assembly of the Phase I cell.

8.2 Budgeted Cost to Complete Phase II

The following table summarizes the estimated costs to complete Phase II:

Reticle ESD Phase II Cost Chart		
ITEM	RATE	TOTALS
Granulated Activated Carbon	1100 lbs @ $32/lb	$ 35,200
Reticle Electrode Can Fab.	50 Cans @$600/can	$ 56,100
PM&E	80 Hours	$ 6,000
Hot Isostatic Press Process		$ 4,500
PM&E	20 hrs	$ 1,500
Carbon Tile Cutting Service	3600 tiles/ $3.00 ea.	$ 11,800
PM&E	20 hrs	$ 1,500
Electrode Fabrication		$ 4,900
PM&E	80hours	$ 6,000
Cell Assembly		$ 4,750
PM&E	80 hours	$ 6,000
Support Equipment. (Pwr., valves, etc.)		$ 4,900
Conductive Adhesive		$ 2,400
Misc.		$ 1,500
Contingency Vendor costs only		$ 6,000
PM&E (Logistics/follow up)	80 hours	$ 6,000
Plumbing		$ 1,500
Mobile Van modifications	.	$ 500
PM&E	80 hours	$ 6,000
Testing PM&E	40 Hours	$ 4,000
Analytical Laboratory Costs		$ 4,000
PM&E Dr. Carl Nesbitt	80 hours	$ 6,000
Travel and Per Diem		$ 5,000
	Costs for Phase I	**$186,050**

As in Phase I, we have quotes from our vendors that have been incorporated in this budget estimate. The quotes were not included in this document, but are available upon request.

The total estimated cost to complete both Phase I and Phase II is approximately $298,240.

9 DELIVERABLES

This section summarizes the physical and informational deliverables from the demonstration project

9.1 Phase I Deliverables

The Phase I portion of the project will develop the following deliverables:

- A fully contained, mobile facility complete with a Reticle ESD cell that can be tailored for testing any brackish water in the San Joaquin Valley (well, drainage or discharge waters). The unit will be capable of cleaning 1000-2000 gallons of water daily and will produce about 200 gallons of concentrated brine daily.

- Engineering design for a full-scale Reticle ESD unit that will result during Phase II in two full-scale Reticle ESD cells.

- A final report of the results of the testing of the unit on several well waters and drainage water in the Panoche Drainage District

9.2 Phase II Deliverables

The Phase II portion of the project will develop the following deliverables:

- A fully contained facility complete with two commercial-scale Reticle ESD cells that can be used for testing any brackish water in the San Joaquin Valley (well, drainage or discharge waters). The unit will be capable of deionizing up to 15,000 gallons of water daily and will produce about 2000 gallons of brine daily. A treatment strategy will be suggested for each application and feedwater.

- Engineering design for full-scale, commercial Reticle ESD units that have to potential to clean a wide range of wellwaters and drainage waters in the PDD region (and certainly by extrapolation in other regions).

- A final report of the results of the testing of the unit on several wellwaters and drainage water in the Panoche Drainage District

10 CONCLUSION

The need for desalination is not new. It has been prevalent for many years. It has become crucially so in venues like California, which are not blessed with huge supplies of fresh water and which are prone to changes in precipitation. The need is no longer a luxury; the population of California and contiguous states continues to burgeon and pressure for fresh water burgeons right along with it.

The hyperbole has exceeded the reality for proposed desalination techniques—RO, ion exchange, flash, capacitive deionization (CDI), and others. They either have not worked or have not been anywhere approaching economic. Reticle ESD has the potential to truly advance the state of desalination in the state. It uses known technology to electrostatically purify water; there is nothing arcane or complex about the technology. The “secret sauce” is the Reticle Carbon itself, a conductive material that puts colossally high surface areas to work attracting and arresting dissolved salts and allowing fresh water to flow right on through to economic uses. It has the potential to deionize/desalinate drainage water and wellwater, rendering agriculture effectively a “zero discharge” industry if desired. It has the potential to remove pernicious ions such as selenium that would otherwise harm wildlife, thereby protecting the environment. It does not make the egregious sin of overlooking boron like RO does. Reticle ESD is nonselective; it removes all ions. That is a huge advantage; nothing in the water is missed. It has the potential to render otherwise brackish wells fully economic, creating and asset from what otherwise would be a “dry hole.” Reticle ESD promises to be a low capital cost technique—all standard “order out of the catalog” components

De facto, this proposed program is a low cost demonstration and test of the material Reticle Carbon that holds so much promise in finally cracking the desalination nut for California—arresting ions and removing them from otherwise ion-laden water streams and thereby saving the water for economic use. When one ponders how much impact that could have on the state, one is overwhelmed. Freshwater sources can continue to support people, agriculture, and wildlife. Formerly polluted sources can be recovered to support people, agriculture, and wildlife. The water supply of California is stretched to heretofore unachievable levels.

Reticle is eager to begin the demonstration in concert with its partner Panoche Drainage District.

Attachment 3 – Eligibility Requirements

Eligibility Checklist		
Applicable?		**Eligibility Criteria**
Yes	**No**	
		Local Agency Certification
X		1) Local Agency: The applicant must provide a written statement (and additional information if noted) containing the appropriate information outlined below: ↳ Is the applicant a local agency as defined in CA Water Code §78640(b)? ↳ What is the statutory or other legal authority under which the applicant was formed and is authorized to operate? ↳ Does the applicant have legal authority to enter into a grant agreement with the State of California? ↳ Describe any legal agreements among partner agencies and/or organizations that ensure performance of the proposal and tracking of funds.
	X	2) Basin Plan: Is each project consistent with a Regional Water Quality Control Plan (Basin Plan)?
		Urban Water Suppliers
	X	3) Urban Water Suppliers: List the urban water suppliers that will receive funding from the proposed grant. Please provide the agency name, a contact phone number and an e-mail address. Those listed must submit self-certification of compliance with CWC §525 *et seq*. and AB 1420 (links to appropriate forms in Appendix A).
	X	4) Urban Water Suppliers: Have all of the urban water suppliers listed in #3 above submitted complete Urban Water Management Plans (UWMPs) to DWR? Have those plans been verified as complete by DWR? If not, explain and provide the anticipated date for having a complete UWMP.
		Groundwater Projects/Users
	X	5) Groundwater Projects: Does the proposal include any groundwater projects or other projects that directly affect groundwater levels or quality? If so, provide the name(s) of the project(s) and list the agency(ies) that will implement the project(s).
	X	6) Groundwater Projects: For the agency(ies) listed in #5 above, how has the agency complied with CWC §10753 regarding Groundwater Management Plans (GWMPs)?
	X	7) Groundwater Users: List the groundwater users that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number, and an e-mail address. If there are none, please indicate so and skip to #9.
	X	8) Groundwater Users: Have all of the groundwater users, listed in #7 above met the requirements of DWR's CASGEM Program? http://www.water.ca.gov/groundwater/casgem/ If not, explain and provide the anticipated date for meeting the requirements.
		Agricultural Water Suppliers
X		9) Agricultural Water Suppliers: List the agricultural water suppliers that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number and e-mail address. If there are none, please indicate so and go to #11.
X		10) Agricultural Water Suppliers: Have all of the agricultural water suppliers, listed in #9 abov, submitted complete Agricultural Water Management Plans (AWMPs) to DWR? Have those plans been verified as complete by DWR? If the plans have not been submitted, please indicate the anticipated submittal date.
		Surface Water Diverters
	X	11) Surface Water Diverters: List the surface water diverters that will receive funding from the proposed grant. Please provide the agency/organization name, a contact phone number, and an e-mail address. If there are none, please indicate so.
	X	12) Surface Water Diverters: Have all of the surface water diverters, listed in #11 above, submitted surface water diversion reports to the State Water Resources Control Board in compliance with requirements outlined in Part 5.1 (commencing with §5100) of Division 2 of the CWC? If not, explain and provide the anticipated date for meeting the requirements.

Attachment 3 – Eligibility Requirements

Local Agency Certification: Panoche Drainage District.

Panoche Drainage District (PDD) is a California local agency formed under the Drainage District Act of 1903, set out in Appendix 8 of the California Water Code. PDD has legal authority and authorization from its Board of Directors to enter into funding assistance agreements with Federal and State agencies as well as with private parties.

Grant fund performance and reporting requirements will be included in the agreement(s) between PDD and the private party(ies) carrying out the specified work. These agreements will spell out the all relevant requirements of the State grant agreement, including invoicing procedure, project performance measures, schedule, and reporting requirements.