# Quality Assurance Project Plan

**FOR**

# Solar Evaporation Pond Pilot Project
# Salton Sea, California

**Principal Investigator:**
**Institution: Salton Sea Authority with Agrarian Research**

## Section A: PROJECT MANAGEMENT

## A1 Project Title and Approval Sheet

- **Brine Evaporation Laboratory Study. Salton Sea brine will be evaporated with heating Lamps in a Laboratory to determine the chemistry of the brine and of the salt-quality deposited by fractional crystallization. Protocol is attached.**
- **Pilot Solar Evaporation Ponds. This experiment will verify and reconfirm the laboratory data in the field, and it will provide the parameters required for building a large solar salt operation for salt production.**

**Technical Project Manager** **Date**
**Carla Scheidlinger**

**QA Officer** **Date**
**Luis A. Coronel**

**Salton Sea Project Manager** **Date**
**John Ochs**

**Salton Sea QA Coordinator** **Date**
**Barry Gump**

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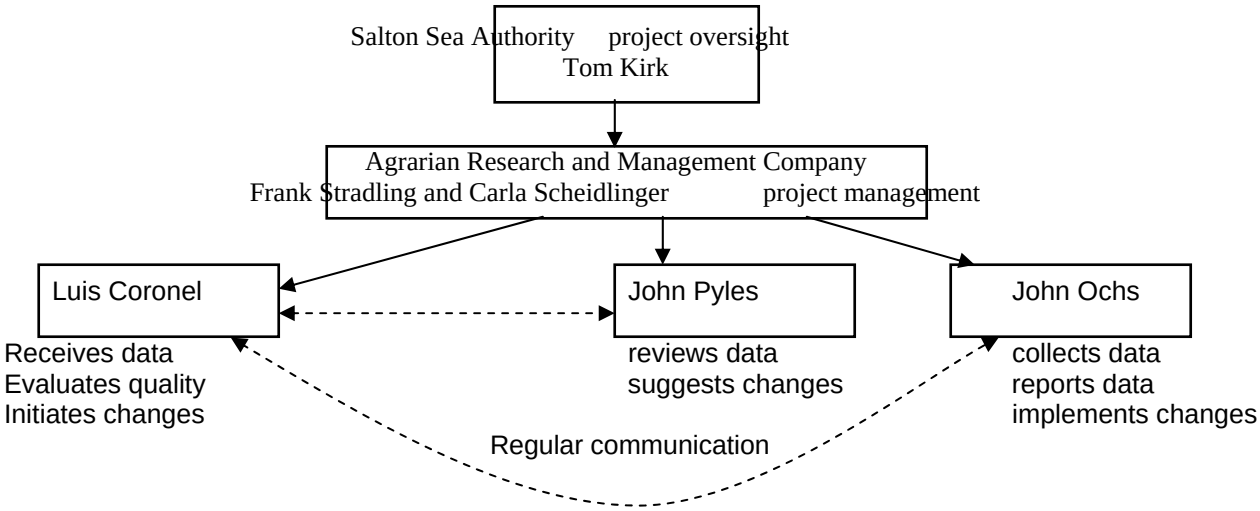
## A4 Project/Task Organization and Responsibilities (organizational chart)



## A5 Project Definition and Background:

Salt (Sodium Chloride) production by solar evaporation of sea water and salt brines is a process that has been implemented in several places around the world. Solar salt production is feasible in areas where enough flat land is available for pond construction with acceptably non-permeable soil and the appropriate weather conditions that result in high rates of evaporation. Evaporating the seawater or salty brine flowing continuously through a series of ponds produces saturated brine and then salt.

Because the water evaporates, the concentration of the salts in solution and density of the brine increases. Correct brine management is the key factor to the efficient production of good quality salt, and brine density is the parameter used for controlling a solar salt operation.

The process is divided into three stages or areas:

a) Concentration Area. This area is fed with seawater or brine that is concentrated by flowing through a series of solar ponds until it reaches its saturation point in sodium chloride. Carbonates and calcium sulfate crystallize in this area.
b) Crystallization Area. This area receives the saturated brine from the concentration area that flows through a series of ponds crystallizing sodium chloride salt. At the end of the series of ponds, the brine becomes weak in Sodium Chloride and becomes concentrated in sulfates. To avoid contamination of the sodium chloride salt produced, the brine is discarded and is called bittern.
c) Bittern Area. This area is use to store bittern for further evaluation. The chemistry of the bittern depends on the quality and origin of the seawater or the feeding brine. The bitterns produced from seawater have valuable compounds in solution, such as potassium sulfate, sodium sulfate, magnesium chloride and bromine.
d) The chemistry of the water in the Salton Sea is different from normal ocean water and contains more sulfates and lower magnesium in solution. The objective of this investigation is to determine the chemistry of the brine and the quality of the salts obtained by fractional crystallization as a function of the brine density.

## A6 Project/Task Description:

There are 2 components to the project. The first is the evaporation of Salton Sea brine which will be simulated at a laboratory scale in plastic trays using heating lamps. The second is the solar salt pond field project. In both projects, the analytic procedures are the same. Brine samples will be taken at different densities and chemical analyses for Ca, Mg, Cl and SO4 will be performed to create the respective curves. Crystallized salts between specific densities will be also sampled and analyzed.

Analyses of CO3, HCO3 will be performed in the initial brines until they become negligible in concentration. K analyses will be performed as soon as the element is found at a detectable level in the bittern phase.

**PROJECT TASK LIST AND TIMELINE**

The time line for the projects is the following:

| Task No. | Task | Responsibility | Start Date | Completion Date |
|---|---|---|---|---|
| 1 | Purchase of equipment and materials. Laboratory mplementation. | Carla Scheidlinger John Ochs | Feb 21 | Mar 10 |
| 2 | Lab procedures, experiment setup, training of personnel and start-up | Luis A. Coronel Carla Scheidlinger John Ochs | March 12 | March 16 |
| 3 | Brine concentration, salt crystallization, and bittern sampling and analyses. Data Collection. | Lab Technician | March 16 | May 4 |
| 4 | Solar pond construction | Construction crew | February 26 | May 1 |
| 5 | Solar pond operation, brine, salt and bittern salt crystallization. Brine, bittern and salt samples and analyses. Data collection. | John Ochs | May 1 2001 | May 1 2002 |
| 6 | Experiment Management, daily follow-up of events, data analyses, decision making, coordination and communication with personnel involved, data analyses and reportage. | Luis A. Coronel | March 7, 2001 | May 1, 2002 |

## A7 Quality Objectives and Criteria for Measurement Data

**Data to be collected:**

The following data will be collected from the laboratory study as well as the field study:

Experiment: Density in Baume, temperature (Deg. F), evaporation rate, weight of salt crystallized, brine or bittern volume, and mass balance

Brine & Bitterns: Density, temperature, analyses in percentages for K, Ca, Mg, CO3, HCO3, Cl, SO4

Salts: Analyses in percentages for moisture, insoluble, K, Ca Mg, Cl, SO4

**Conditions under which data are to be collected:**

For the Brine Evaporation Lab Study, the Lab Technician and an assistant if needed will collect data in the laboratory. There will be 4 evaporation pans initially in use to produce saturated brine. The number of pans will be reduced to two or one for the salt and bittern phase. During the day, the brine will be maintained at a maximum of 100 deg. F. At the end of the day, the lab technician will turn the lamps off and leave the brine /bitterns to cool during the night. In

the morning, density and temperature data will be taken, observations will be written, salts will be weighed if there is enough volume, and brine/bittern volume will be measured or calculated. Brine and salt samples collected will be analyzed. Data will be reported daily by email or Internet.

For the field study, brine samples will be collected at the designated Be levels as determined from daily Be monitoring. Solid salt and bittern samples will be collected monthly from the crystallizer and bittern ponds.

Measurement Performance Criteria

| Parameter | Detection Limit | Reporting Limit | Estimated Accuracy | Accuracy Protocol* | Estimated Precision | Precision Protocol** |
|---|---|---|---|---|---|---|
| Baume | 3 to 40 | | ASTM 0.001 divisions | | | |
| Temperature | 25 to 50 | | 2 deg. F | | | |
| Calcium | 0.01% to 1% | | 0.001 g | | | |
| Magnesium | 0 to 8.0% | | 0.001 g | | | |
| Potassium | 0 to 2.5% | | 0.001 g | | | |
| Sulfate | 0.3% to 20% | | 0.001 g | | | |
| Insoluble solids | 0 to 2% | | 0.001 g | | | |
| Moisture | 0 to 10% | | 0.001 g | | | |

**DATA COMPLETENESS (these to be collected from both lab and field projects)**

| | Number of Valid Sample Results | Number of Valid Samples Collected and Analyzed | Percent Complete |
|---|---|---|---|
| Brine/Bittern | 2 per each density point | 1 per each density point | 100 |
| Salt | 2 per each sample point | 1 per each sample point | 100 |
| | | | |

**Data Representativeness:**

Based on experience with ocean water chemistry, the following list of samples will be taken to define the changes of chemistry in Salton Sea brine with the respective adjustments made in the field. Brine samples will be taken at different densities as brine concentration progresses to determine the curve of the chemical ions, K, Ca, Mg, CO3, and SO4 as a function of density.

**Data Comparability:**

There are no historical data from Salton Sea that we can use for comparison. Ocean water data available will be used for guidance and reference. Salton Sea brine has more sulfates and more calcium than does ocean water.

## A8 Special Training Requirements/Certification

Sampling and standard laboratory procedures used in the salt industry are being adopted for the experiment. The chemical engineers, Luis A. Coronel and John Pyles, both salt experts

with many years of experience in salt operation and research, have selected the laboratory procedures. A field laboratory is being set up near to the Salton Sea field site. The standard laboratory procedures selected are basically volumetric-titration methods with standard solutions for calibration. Almost no instrumentation will be used. A field technician to conduct the experiments and analyses has been hired (John Ochs). Luis A. Coronel will train the technician to conduct the lab experiments, perform the analyses, and operate the pilot ponds. Luis A. Coronel will oversee, follow-up and make the decisions during the lab experiment.

| Position Title | Requirements | Date of Training/Certification |
|---|---|---|
| Luis A. Coronel | Chemical Engineer | Salt expert and consultant |
| John Ochs | Technical experience in chemistry | First week of March 2001 |

## A9 Documentation and Records

A spreadsheet is attached with the following documents

- Schedule of brine and salt samples to be taken
- Experimental data recording with a daily material balance
- Daily readings of density and temperatures
- Salt analyses record
- Brine analyses record

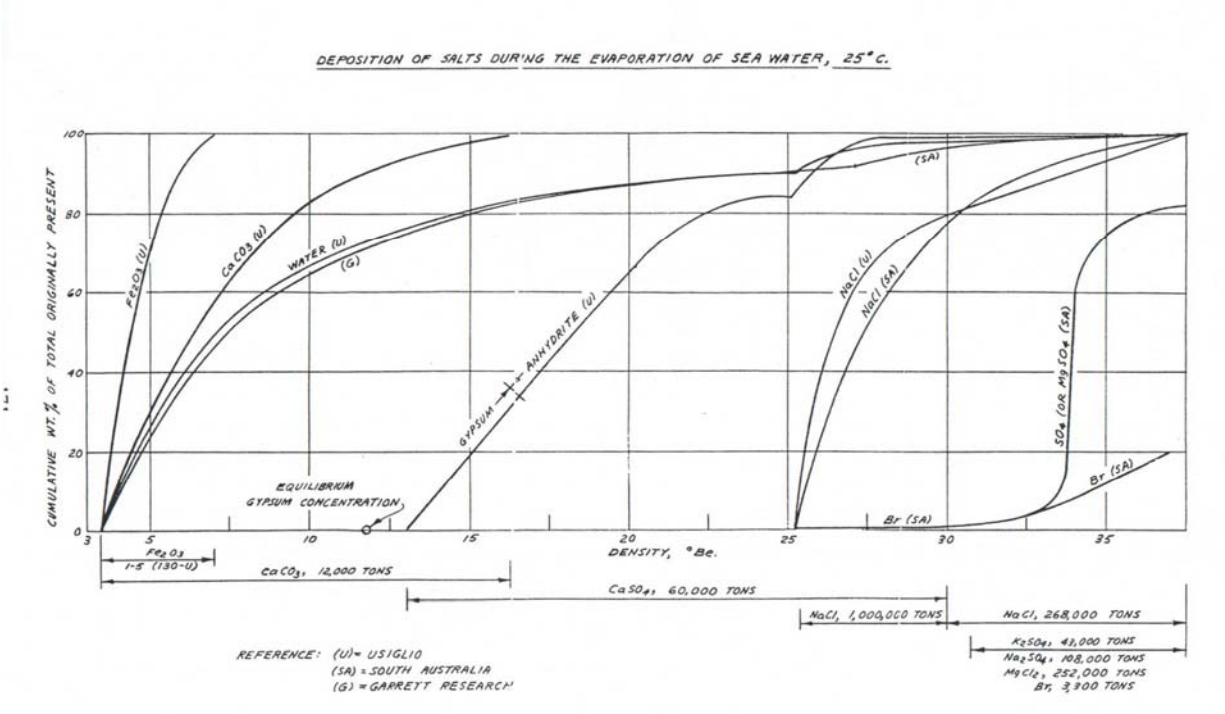
All the data and results will be stored in a local computer and reported daily by email or FTP to Luis A. Coronel for data analyses and decisions. Luis A. Coronel will issue a weekly progress report to the appropriate people involved in the project.

# Section B: MEASUREMENT/DATA ACQUISITION

## B1 Sampling Process Design (Experimental Design)

Sampling Design, Assumptions and Rationale:

The Salton Sea evaporation pond and lab experiment have been designed based on the vast experience in solar salt evaporation facilities and the very well documented knowledge of how to produce salt from seawater and brine from salty lakes. The following graphic shows how the chemistry of the brine varies based on the evaporation of seawater and the type of salts that crystallize as the concentration of the brine varies. The experiment with Salton Sea brine will give the required parameters for designing a large-scale solar salt operation as required for the restoration project.




**Procedures for Locating and Selecting Environmental Samples:**

See attached protocols

Brine Evaporation Lab Study. Brine and salt samples will be taken in the lab from the experimental pans as a function of the density as the concentration progresses.
Pilot Solar Evaporation Ponds. Brine and salt samples will be taken from the pilot pond systems consisting of 10 ponds as a function of density as the brine concentration progresses.

Salt Sample Preparation
The salt sample must first be drained of all free liquid. If the sample is in large lumps, gently break up the lumps. Then place the sample on filter paper or in a kitchen strainer, and cover the sample to minimize evaporation. The strainer may be lined with cheesecloth if necessary so as not to lose any sample. Drain the sample for several minutes until free liquid is removed. Mix the sample thoroughly on a paper. With a tablespoon, take small portions of the sample totaling about 200 grams by selecting from different locations of the mixed salt on the paper. Place the 200 grams in a mortar and grind to a fineness of about minus 10 mesh. Weigh 50 grams and transfer to a 500 ml volumetric flask. Dissolve the ground sample in distilled water, fill to the mark on the flask, and mix again.

Brine samples will be taken directly and will be allowed to settle well before analyses. If the original sample has precipitated out any solids, make sure they have gone back into solution by stirring and/or heating.

**Schedule for Project Sampling Activities: same schedule for lab and field**

| | | | Number of Samples | | | | | | Number of Samples | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Baume | | Sp.Gr. | Brine | Salt | Total | Baume | | Sp.Gr. | Brine | Salt | Total |
| 4.5 | (1) | 1.0320 | 3 | -- | 3 | 35.0 | | 1.3182 | 1 | 2 | 3 |
| 10.0 | | 1.0741 | 2 | -- | 2 | 36.0 | | 1.3303 | 2 | 1 | 3 |
| 15.0 | | 1.1154 | 1 | -- | 1 | 37.0 | | 1.3426 | 1 | 2 | 3 |
| 20.0 | | 1.1600 | 2 | -- | 2 | 38.0 | | 1.3551 | 2 | 1 | 3 |
| 25.0 | | 1.2083 | 1 | -- | 1 | 39.0 | | 1.3679 | 1 | 2 | 3 |
| 25.5 | | 1.2134 | 2 | -- | 2 | 40.0 | | 1.3810 | 2 | 1 | 3 |
| 25.8 | (2) | 1.2164 | 3 | -- | 3 | 41.0 | (3) | 1.3942 | 1 | 2 | 3 |
| 26.0 | | 1.2185 | 2 | 2 | 4 | 42.0 | | 1.4078 | 2 | 1 | 3 |
| 27.0 | | 1.2288 | 1 | 1 | 2 | 43.0 | | 1.4216 | 1 | 2 | 3 |
| 28.0 | | 1.2393 | 2 | 2 | 4 | 44.0 | | 1.4356 | 2 | 1 | 3 |
| 29.0 | | 1.2500 | 1 | 1 | 2 | 45.0 | | 1.4500 | 1 | 2 | 3 |
| 30.0 | | 1.2609 | 2 | 2 | 4 | 46.0 | | 1.4646 | 2 | 1 | 3 |
| 31.0 | | 1.2719 | 1 | 2 | 3 | 47.0 | | 1.4796 | 1 | 2 | 3 |
| 32.0 | | 1.2832 | 2 | 1 | 3 | 48.0 | | 1.4948 | 2 | 1 | 3 |
| 33.0 | | 1.2946 | 1 | 2 | 3 | 49.0 | | 1.5104 | 1 | 2 | 3 |
| 34.0 | | 1.3063 | 2 | 1 | 3 | | | Totals | 50 | 37 | 87 |

(1) Raw brine intake from Salton Sea
(2) Saturated brine
(3) The last set of samples depends on the weather conditions and the eutetic point. Field data from the site will define the last point.

Brines will be analyzed for K, Ca, Mg, Cl, SO4 and CO3 and the salt will be analyzed for moisture, K, Ca, Mg, Cl, SO4 and insolubles.

**Classification of Measurements as Critical or Noncritical**

All the data will be taken can be classified as Critical, except for Cl that is collected only as reference but will not be used for estimating the salts quality.

**Validation of Any Nonstandard Methods**

All the analytical methods to be used are standard procedures. We will use standard solutions for calibration. Analytical procedures and protocols are attached.

## B2 Sampling Method Requirements

Sampling Methods

Types of Samples to be Collected:

The brine samples will be grab samples according the recorded brine density; however the salt sample will be a composite sample.

Sampling Method's Requirements:

The brine and salt samples will be immediately analyzed, however no risk of contamination or decomposition is expected due to the fact that the samples are relatively stable. Brine and salt samples will be stored for any additional analyses if required.

Decontamination Procedures and Materials:

Not applicable

Sampling System Failure Response and Corrective Action Process:

No flaws are expected but in the hypothetical case that a data point looks like an outlier, an additional analysis will be ordered and/or a new sample will be taken.

## B3 Sample Handling and Custody Requirements

Samples will be taken and immediately analyzed in the laboratory. The samples will be taken, handled, kept in the custody of, and analyzed by the Lab Technician

PARAMETER TABLE

| Parameter | Number of Samples | Matrix | Sample Preservation | Holding Time |
|---|---|---|---|---|
| See above | | | | |

Custody Procedures

## B4 Analytical Methods Requirements

| Sample Parameter | Matrix | Analytical Method Reference* |
|---|---|---|
| | | |

*If any methods used are not EPA or State certified lab standard methods, then provide a descriptive paragraph describing each of those methods. Field analytical procedures can also be entered into this table.

Salt and Brine Protocols of the Analytical Procedures are attached.

## B5 Quality Control Requirements

QC Procedures:

Field QC checks

Standard solutions will be used for calibration.

Laboratory QC checks

Standard solutions will be used for calibration.

Corrective action:

A new analysis will be performed and/or a new sample will be taken.

## B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Analytical procedures and methods that will be used are volumetric. A standard weight will be acquired and used to calibrate the Precision Balance. Good quality and certified instruments such as hydrometers and thermometers will be acquired.

## B7 Instrument Calibration and Frequency

Analysis of the operation of the Precision Balance will be calibrated every two weeks.

## B8Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables will be acquired from recognized Suppliers such as Van Water & Rogers and Cole Parmer Instrument Co. The Lab Technician will request, inspect and receive the materials in compliance with the specifications. In general glassware will be properly washed with distilled water and dried before use. The chemicals required for analyses will be requested as reagents grade for analyses. All the material and chemicals will be logged in a database.

## B9 Data Acquisition Requirements (Non-direct Measurements)

This specific project does not require the use of non-measurement data.

## B10 Data Management

The Lab Technician will collect the data from the Lab and the field using pre-printed forms. The data will be entered in an Excel spreadsheet in a computer. Each analysis will generate a written form with the raw data and calculations. The results will be entered in a Excel

spreadsheet. At the end of day, the used forms will be filed in a binder and the spreadsheet will be zipped and emailed or FTP to Luis A. Coronel for its data analyses.

## Section C: ASSESSMENT/OVERSIGHT

### C1Assessments and Response Actions

A weekly progress report with the data collected, summarized, comments and recommendations will be submitted to the consultant-expert/auditor David Butts of the Salton Sea Authority for his review, assessment and response.

### C2 Reports to Management.

As has been stated, the lab and field data will be reported daily to Luis A. Coronel for review, data analyses, and immediate action. Luis Coronel will be assuring the quality of the data and reporting on time to the personal involved.

## Section D: DATA VALIDATION AND USABILITY

### D1 Data Review, Validation, and Verification Requirements

At the end of the project, a final report with all the data summarized, material balances, conclusions and recommendations will be delivered. All the data in digital form will be delivered in a data storage media such CD's

### D2 Validation and Verification Methods,

The Lab Technician John Ochs will be collecting and reporting data daily. The quality control, validation and verification process will start with Luis A. Coronel who will review and analyze the data. A corrective action, new analyses or new samples will be taken, if required. Data will be reported immediately to the working team integrated by Carla Scheidlinger, which includes John Pyles and the consultant representing the authorities, David Butts.

### D3Reconciliation with Data Quality Objectives

The Brine Evaporation Lab Study will provide the chemistry of the brine and salt quality production by fractional crystallization as a function of density. It will also provide the material balance of the effluents that will be used to estimate the parameters required for designing and building a solar salt operation. Such parameters include the area required for concentrating, salt production and salt bitterns production, amount and quality of salts expected to be crystallized, and brine volumes that would be handled by a large scale project. These data will be used to adjust the design of the Pilot Salt Evaporation Pond and also will be used in the design of the large Solar Salt Operation.

The Pilot Salt Evaporation Ponds will verify the data generated by the Brine Evaporation Lab Study in the field with added parameters investigated such as weather, seepage, and entrained soil brine. The pilot system will provide the additional parameters required from the field to design and build a large scale Solar Salt Operation.