NAVAJO GALLUP WATER SUPPLY PROJECT

APPRAISAL LEVEL DESIGNS AND COST ESTIMATES

APPENDIX C

WATER TREATMENT

WATER TREATMENT APPENDIX C

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Modified by Glenn Howard
For Enhanced Coagulation

ZeeWeed® Water Treatment System

BUDGET PROPOSAL for a ZeeWeed® Membrane Filtration Drinking Water Treatment System For the Navajo Gallup Water Supply Project Proposal Number 820-01

Submitted to:

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1.0 ZeeWeed® Water Treatment System Design

1.1 Design Parameters

The table below summarizes the main design parameters on which the proposed ZeeWeed® Water Treatment System for the Navajo Gallup Water Supply Project has been designed. The column titled "treated water" is the anticipated treated water quality.

Two options have been proposed; both to produce a combined treated maximum daily flow capacity of 40.5 MGD. The source water will be from either the future Moncisco Reservoir or from a blend of San Juan River and Cutter Reservoir. The first option is to use ZW500 series membranes in contact with coagulated water for an enhanced coagulation ultrafiltration system. The second option is to use the ZW1000 membranes to filter settled water. This option does not include the flocculation and settling equipment.

Moncisco Reservoir – Source Water, Navajo Dam via Navajo Indian Irrigation Project (NIIP)

Design Flow	Raw Water		Treated Water*	
Design Flow				
Maximum Daily Flow year 2020	26.25	MGD	26.25	MGD
Maximum Daily flow year 2040	42.24	MGD	42.24	MGD

* 90 percent recovery is included in maximum daily flow demand estimate

Cutter Reservoir – Source Water Navajo Dam

Design Flow	Raw Water		Treated Water*	
Design Flow				
Maximum Daily Flow year 2020	2.35	MGD	2.35	MGD
Maximum Daily flow year 2040	4.0	MGD	4.0	MGD

* 90 percent recovery is included in maximum daily flow demand estimate

Physical Parameters - NIIP Water

	Raw Water		Treated Water	
Temperature	45.3-49.1	°F		°F
Turbidity	1.47-3.16	NTU	≤ 0.1	NTU
TOC	2.29-8	Mg/L	35%	reduction
DOC	N/A	Mg/L		Mg/L
Color	N/A	TCU		TCU
Alkalinity	N/A	Mg/L (as $CaCO_3$)		Mg/L (as $CaCO_3$)
Hardness	N/A	Mg/L (as $CaCO_3$)		Mg/L (as $CaCO_3$)

TTHM's	N/A	µg/L	µg/L
Iron	N/A	Mg/L	Mg/L
Manganese	N/A	Mg/L	Mg/L
PH	7.7		

San Juan River

Design Flow	Raw Water		Treated Water*	
Design Flow				
Maximum Daily Flow year 2020	23.89	MGD	23.89	MGD
Maximum Daily flow year 2040	38.25	MGD	38.25	MGD

* 90 percent recovery is included in maximum daily flow demand estimate

Physical Parameters, San Juan River without runoff

	Raw Water		Treated Water	
Temperature	45 - 74	°F		°F
Turbidity	1.47-3.16	NTU	≤ 0.1	NTU
TOC	2.29-8	mg/L	35%	reduction (Option 1 only)
DOC		mg/L		mg/L
Color		TCU		TCU
P Alkalinity		mg/L (as $CaCO_3$)		mg/L (as $CaCO_3$)
M Alkalinity		mg/L (as $CaCO_3$)		mg/L (as $CaCO_3$)
Hardness		mg/L (as $CaCO_3$)		mg/L (as $CaCO_3$)
TTHM's		µg/L		µg/L
Iron		mg/L		mg/L
Manganese		mg/L		mg/L
PH				

Microbiological Parameters for all source water being considered.

	Raw Water		Treated Water	
Giardia	Not Stated	units/L	≥ 6	log removal Note 1
Cryptosporidium	Not Stated	units/L	≥ 6	log removal Note 1
Viruses	Not Stated	units/L	≥ 2	log removal Note 2
Total Coliforms			≤ 1	cfu/100 mL
Faecal Coliforms			≤ 1	cfu/100 mL

Note 1: The ZeeWeed® Membrane is guaranteed to achieve ≥ 6 log removal of *Giardia* and *Cryptosporidium* to the limits of detection, however it must be realized that 6 log removal can only be achieved if > 10^6 cysts/oocysts are present in the raw water.

Note 2: Viruses are usually less than 0.1 microns, however they are typically associated with host bacteria or attached to particulates larger than 0.1 microns and can therefore be removed by the ZeeWeed® Membrane. ZENON has received a minimum of 2.0 log virus rejection certification by the DHS based on the results of the California DHS Certification Testing which showed a minimum virus rejection of 2.5 log for the ZeeWeed® Immersed Ultrafiltration Membrane.

1.2 Design Philosophy and Equipment Selection

System Configuration – ZW 500 Series Enhanced Coagulation

The design configuration proposed by ZENON for the Moncisco Reservoir and the San Juan River will have seven (7) individual membrane treatment trains. The system for the Cutter Reservoir will have four (4) individual membrane trains. Future plant expansion, if and when required, can be achieved by adding additional treatment units to the spare compartment provided.

The use of multiple process trains enables the plant to be operated at full capacity for short periods with one (1) membrane treatment stream off-line for cleaning (or maintenance) by increasing the flow (and hence flux) through the remaining operational membrane trains. The system proposed by ZENON is capable of producing the maximum daily demands of treated water with one train of membranes temporarily removed from service.

The system is designed for installation within adjacent rectangular concrete membrane tanks that will use common wall construction to reduce costs and minimize plant footprint. Each membrane treatment stream will be equipped with its own permeate pump. The flow will be split into the individual tanks from a common inlet feed channel that will run along the feed end of the membrane tanks. Tank characteristics for the Moncisco and San Juan treatment plants are as follows:

Tank Dimensions (Approximate)	85.5 ft	long x	18.0 ft	wide x	10.0 ft	high
Side Water Depth (SWD)	9	Ft				
Number of Tanks	7					
Flocculation Tank(s)	5-7 minutes detention time					

Process tanks may be of concrete construction or fabricated steel tanks, whichever suits the Customer's preferences and are not included in ZENON's scope of supply. Tank dimensions are preliminary only and may change slightly once final detail design commences.

Overview of Equipment Provided

The ZeeWeed® Membrane Water Treatment System is designed with major process equipment supplied loose for installation on concrete pads. The ZeeWeed® membranes are supplied for installation in concrete tanks (by others) within ZENON supplied membrane support frames.

The permeate from each membrane train will be pumped via a single permeate pump. Permeate pumps are supplied loose for mounting on concrete pads with the interconnecting piping and local isolators for supply by others. ZENON will supply the valves for the permeate system to ensure compatibility with the control system provided.

Backpulsing of the membranes will be by dedicated backpulse pumps/, using water from concrete backpulse water storage tanks that are not included within ZENON's scope of supply. ZENON will supply the size requirements for the backpulse tanks. The backpulse tank will be filled from the common permeate discharge header pipe (piping by others).

The membrane air scour blowers are supplied loose either for installation adjacent to the membrane system tanks or if preferred, within a separate blower room to minimize the noise within the plant building. The interconnecting piping from the blowers to the air headers in the membrane tanks will be for supply and installation by others (not by ZENON).

The design proposed uses one (1) air blower to provide the air to two (2) trains of membranes. For this system to operate correctly it is important to ensure that the water levels in the two adjacent tanks are the same to ensure and even flow of air to each train of membranes. This is achieved by installing a balance pipe between adjacent tanks to permit equalization of the water level. The balance pipe includes an isolation valve to permit adjacent tanks to be isolated from each other when drained down for maintenance or membrane cleaning operations. Alternatively, a common feed channel with inlets to each train below the operating water level can be utilized to provide a common water level.

Reject water will flow via an overflow by gravity to the disposal point.

A control valve and flowmeter will regulate reject water.

The plant control panel will be supplied loose so that it can be either wall mounted adjacent to the plant or located in a separate control room depending on the Owner's preference.

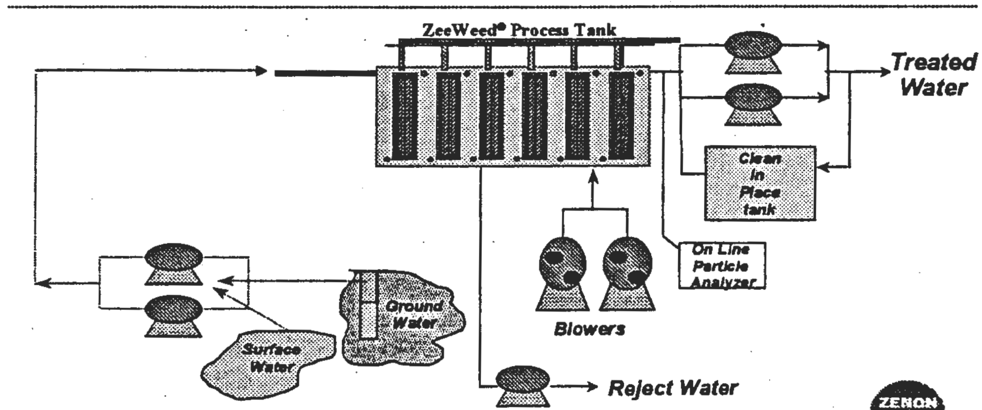
2.0 Summary of the ZeeWeed® Water Treatment Process

Enhanced Coagulation

ZeeWeed® water treatment is a ZENON process technology that produces high quality treated water by drawing raw water through immersed ZeeWeed® membrane modules. ZeeWeed® "Outside-In", hollow-fiber membranes have nominal and absolute pore sizes of 0.035 and 0.1 microns respectively. This ensures that particulate matter greater than 1 micron in size, including *Giardia* cysts and *Cryptosporidium* oocysts, cannot enter the treated (drinking) water stream. The ZeeWeed® ultrafiltration membrane ensures removal of a large percentage of impurities due to its small pore size. This includes some viruses, which are removed by a combination of adsorption onto the solids in the process tank and by direct membrane filtration. The ZeeWeed® UF membranes can achieve ≥ 6 log removal of *Giardia* cysts and *Cryptosporidium* oocysts and 2.0-4.5 log removal of viruses.

The membranes operate under a slight vacuum created within the hollow membrane fibers by a permeate pump. Treated water is drawn through the membranes, enters the hollow fibers and is pumped out to the treated water storage tank (or distribution system). Air flow is introduced at the bottom of the membrane modules to create turbulence which scrubs and cleans the outside of the membrane fibers, allowing them to operate at a high flux. The aeration also oxidizes iron and organic compounds, resulting in a treated water quality that is better than that provided by ultrafiltration or microfiltration alone.

ZeeWeed® Schematic



With a ZeeWeed® membrane direct filtration water treatment system, removal of turbidity, *Giardia* & *Cryptosporidium* requires no process chemicals. Since treatment is a single stage process, there is no need for coagulants and the ZeeWeed® membranes effectively replace both the clarifier and granular media type filters found in conventional water treatment plants. There is no need to create large flocculated particles for settling in clarifiers or for capture by granular media filters. This results in significantly easier control for plant operators. Also, as the membranes are immersed directly in the process tank and are under only a low vacuum, high suspended solids concentrations do not foul the membranes or cause excessive backpulsing frequency and therefore, avoid the loss of productivity that can be experienced with positive pressure membranes in vessels.

ZeeWeed® membranes have the additional benefit of being chlorine resistant up to concentrations greater than 500 mg/L. Therefore, influent water can be pre-chlorinated for zebra mussel control.

The ZeeWeed® membrane technology process consistently produces high quality water, as the membranes are not subjected to stress, pressurization or rapid pressure fluctuations. Membrane cleaning by backpulsing is achieved by reversing the permeate flow and backwashing the fibers' lumen with permeate at low pressure (due to the high permeability of the ZeeWeed® membrane, the backpressure during backpulsing is low). The small variations in operating pressure occur smoothly over relatively long periods so that at no time is the membrane stressed. This, in turn, results in a membrane filtered permeate with the lowest sustainable particle count on the market.

3.0 Enhanced Coagulation Process

The ZeeWeed® water treatment systems are highly effective at removing color, Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) from water - more effective than conventional treatments. Color, TOC and DOC removal is achieved using an enhanced coagulation process.

The ultrafiltration enhanced coagulation process consists of the integration of immersed membrane technology with the conventional coagulation/filtration steps traditionally used in municipal filtration plants. However, in this process, a three-stage process comprised of rapid-mix–coagulation–ultrafiltration replaces the conventional coagulation-flocculation-sedimentation-filtration steps. This is accomplished in a single process tank, which contains the membranes in a compartment. Coagulant is injected into the water to allow the formation of floc particles, which need only be larger than the membrane pore size to be removed by the membranes. The success of the enhanced coagulation process is based on the presence of a high concentration of pin sized iron or aluminum based flocs in the process tank.

There are numerous advantages associated with the enhanced coagulation process, some of which are:

1. High floc concentration in the process tank increases the surface area available for adsorption of NOM and thus increases the TOC removal efficiency.
2. Increasing the solid concentration increases the floc retention time in the process tank. When standard ultrafiltration membranes are combined with coagulation, it is very likely that some impurities do not have sufficient time to get adsorbed on to floc surface and thus escape treatment. Increasing floc retention time enhances the removal of these particles.

3. Higher solid concentration also translates into improved membrane performance as most of the impurities that would normally adsorb on the membrane surface and cause fouling will have more floc surface area and time available for adsorption, thereby eliminating their availability as a foulant.
4. Since settling is not an issue for membrane based separation, there is only the need to form micro-flocs of 0.1 microns and larger for the membrane to effectively separate the coagulated organic and colloidal particles. This is achieved by providing enough mixing to maintain G values greater than 80-100 sec^{-1} range in the process tank. The small size of flocs further increases the surface area available for adsorption and thus improves the overall process efficiency.
5. Compared to conventional treatment, enhanced coagulation process requires a smaller building footprint area and thus reduces capital cost.
6. Based on the process efficiencies discussed above, lower coagulant dosages are required to achieve similar results which further decreases chemical and sludge disposal costs.

TOC removal can also be achieved and/or enhanced by the addition of PAC to the rapid mix stage of the enhanced coagulation process. Aeration in the solids contact zone and membrane tank maintains the PAC in suspension. Similar to the immersed enhanced coagulation process, a high solids concentration is maintained in the process tank to enhance the adsorption of dissolved organic carbon, particularly low molecular weight organics.

4.0 Features & Benefits of the ZeeWeed® System

Advantages of an "Outside-In" Immersed Membrane

a) Single Step Treatment

The ZeeWeed® membrane is an outside-in membrane, where the flow of water is from the outside of the membrane to the inside of the hollow fiber. The result is that the inside of the membrane only comes in contact with clean, filtered water. The solids to be removed remain outside of the membrane, where they do not cause fouling and plugging.

b) Low Energy Requirement

Being immersed allows ZENON's ZeeWeed® Membranes to operate under a slight vacuum instead of under a high positive pressure, as do other membranes on the market. The ZeeWeed® Membrane operates under a differential pressure of 5"Hg to 18"Hg (5-20 ft H_2O) vacuum. The operational energy to maintain this vacuum is very low; to ZENON's knowledge it is the lowest in the membrane market.

c) Ability to Operate in a High Solids Environment

The ZeeWeed® membranes are immersed within the process tank, where suspended solids can exist without interfering with membrane operation. The operating flux rates of ZeeWeed® membrane modules are, for all practical purposes, independent of the solids content and turbidity of the raw water supply. This may not be the case for positive pressure membrane systems in vessels using high coagulant dosages.

d) *Stable and Low Particle Counts in the Effluent*

The low energy backpulse of the ZeeWeed® membrane does not produce significant expansion of the membrane pores. Expansion of the membrane pores, which results from high energy air backpulsing of the membranes as utilized in some types of membrane systems, can result in high particle counts immediately following backpulsing. This expansion of the membrane pores may potentially permit the passage of particles of larger sizes through the membranes until the membrane fiber is fully relaxed from the expansion induced by the backpulsing process. Such systems cannot reliably use particle counters to verify the membrane integrity.

The ZeeWeed® process consistently produces high quality treated water, which remains stable at all phases of plant operation.

Simplicity of Operation

The ZeeWeed® process is an easy and inexpensive system to operate both in terms of maintenance costs and personnel requirements. Since treatment is a single stage process, there is no need for coagulants (except for color and organics removal), clarifiers or sand filters as with some other membrane systems. Instead the plant operators are only required to ensure they maintain proper membrane permeating conditions by maintaining the permeate pumps and blowers in operation.

Ruggedness of Operation / Operational Flexibility

The ZeeWeed® Treatment Process consistently produces high quality treated water irrespective of seasonal and weather related variations in the source raw water quality, since the membranes can operate equally well in low or high solids concentrations and at varying temperatures:

- without clogging
- without the need for pressurized air backpulsing cycles which consistently stress the membranes and lead to premature failure
- without any detrimental effects on the membrane flux since the ZeeWeed® membrane was developed for environments of high solids concentrations
- without breaking since the hollow fiber membrane is a composite developed to be both highly durable structurally as well as chemically resistant to outside elements

Reduced Consumption of Process Chemicals

With a ZeeWeed® Membrane Water Treatment System, removal of turbidity, *Giardia* & *Cryptosporidium* requires no process chemicals. For these types of applications it may be permitted to pump the reject (overflow) water back to the water source (lake or river) reducing the waste sludge disposal/treatment costs associated with chemical coagulants. This, in turn, may eliminate chemical laden sludges, which must be taken to a waste treatment plant for disposal. The particular local regulations pertaining to reject return should be investigated, as significant savings in capital equipment costs and the cost of constructing facilities to store the waste sludge may be realized.

For removal of organic color, TOC or DOC, coagulant addition is required and the waste stream may need to be directed to a waste treatment facility for disposal. The ratio of waste water generated to treated water produced is, however, comparable to or better than conventional water treatment plants. Recovery, the percentage of feed water that is delivered treated to the distribution system, is typically in the range of 95 - 99%.

In lieu of direct discharge of the waste stream to a municipal sewer, settling facilities can be incorporated into the treatment plant design to separate settleable solids from the supernatant which can be returned to the ZeeWeed® process tank without impairing the treated water quality. Cyst concentration is not a concern as the membranes provide an absolute barrier to pathogenic organisms larger than the membrane pore size. Alternatively, the supernatant may be returned to the raw water source, where permitted. The relatively low volume of settled solids (sludge) that remains after decanting the supernatant can be pumped to the wastewater treatment plant.

Periodically, cleaning chemicals may need disposal by either being pumped into the sewer line or hauled away by truck, depending on local site conditions. Cleaning the membranes by slowly backpulsing cleaning chemicals into an empty tank can minimize the volume of wastewater of which to be disposed. Cleaning chemicals are typically neutralized prior to discharge to a sanitary sewer system.

Modular Expandability

Since the membrane equipment used with the ZeeWeed® Membrane System is modular in nature, plant capacity expansion can be undertaken in stages by progressively adding more ZeeWeed® Treatment Units (and treated water pumping capacity) as the need for increased plant operating capacity occurs. This feature provides the option of inventorying membranes at ZENON for future installation and significantly reducing O&M costs.

Compact Plant

The ZeeWeed® Water Treatment Unit requires only a compact reactor vessel to accomplish that which would conventionally require a rapid mix tank, flocculation tank, sedimentation basin and sand filters. This enables large savings in physical plant size and hence construction costs.

Treated Water Disinfection & Disinfection By-Products

The treatment system proposed by ZENON does not include a chlorine dosing system to add residual chlorine to the treated water for disinfection, neither is any type of chamber provided for chlorine contact time. Treated water is to be chlorinated by others prior to being pumped to the distribution system in accordance with the applicable local standards for municipal water plant design.

NOM Removal

Natural Organic Matter larger than the 0.035 micron pore size will be rejected by the ZeeWeed® membrane. This will reduce the NOM available to react with free chlorine during disinfection. Additionally, NOM can be removed with the use of a coagulant prior to being fed to the ZeeWeed® system.

Disinfection Contact Time/Virus Rejection

ZENON has received a minimum of 2.0 log virus rejection certification by the DHS based on the results of the California DHS Certification Testing which showed a minimum virus rejection of 2.5 log for the ZeeWeed® Immersed Ultrafiltration Membrane.

Based on the assured 2 log virus removal with the membrane technology, there is only a need for 2 log virus inactivation by disinfection.

Based on the greater than 6 log removal capability of the membrane for *Giardia* and *Cryptosporidium* and the 2 log removal for the viruses, the ZENON membrane approach will require considerably less disinfectant dosages than other approaches. This will not only substantially reduce the annual disinfection chemical costs, it will also reduce the potential for the formation of disinfection by-products, including TTHMs.

Geosmin Removal

Taste and odor complaints associated with Geosmin, a secondary metabolite of blue green algae *Actinomycetes* are a common concern for most water utilities using surface water. Recent Research completed by Dr. James Taylor et. al, University of Central Florida, 1998 has shown that the

ZeeWeed® Ultrafiltration system can remove between 25.9 to 44.9 % of Geosmin without pretreatment. While this ability is not unique to the ZeeWeed Ultrafiltration System, higher rejections of Geosmin are anticipated by ZeeWeed® and other ultrafilters compared to microfiltration systems.

Membrane Certifications

The ZeeWeed® Ultrafiltration Membrane System is certified to NSF-61 as an ultrafiltration membrane. A copy of our notice of Official Listing can be supplied upon request.

Membrane Chemical Tolerance

The ZeeWeed® membrane is resistant to chlorine and other typical water treatment plant oxidants (such as chlorine dioxide and potassium permanganate). This means that it is possible to pre-chlorinate the water for zebra mussel control as required without having to add a de-chlorination step such as Granular Activated Carbon (GAC) or bisulfite injection, which not only requires periodic chemical filling and maintenance, but also adds an unnecessary compound into the drinking water. Where prechlorination is desired, chemical resistance also provides protection against dechlorination equipment failure, which could lead to severe damage of a chlorine sensitive membrane. Finally, chlorine resistance also allows for easy disinfection of the membrane and the plant should this be required.

ZENON's ZeeWeed® Membrane is resistant to those chemicals that are commonly encountered in water treatment applications. The membranes will likely not be exposed to the majority of the chemicals listed below. However, should the need arise in the future to add any of these chemicals to the water, the ZeeWeed® Membrane is able to operate with concentrations up to the levels indicated:

Chemical	Maximum Concentration
Chlorine	1,000 mg/L
Sodium Hypochlorite	1,000 mg/L
Chloramines	1,000 mg/L
Sodium Hydroxide	100 mg/L or pH < 10.5 @ 40°C
Powdered Activated Carbon	Unlimited
Alum (Aluminum Sulfate)	Unlimited @ pH 4.5 – 8.5
Ferric Chloride	Unlimited @ pH 3.5 – 9.0
Potassium Permanganate	< 100 mg/L
Polyaluminum Chloride	Unlimited @ pH 4.5 – 8.5

5.0 Major Equipment

The list below summarizes the major equipment and the quantities of items included for the ZeeWeed® Water Treatment System design.

ZENON Scope of Supply

ZW 500 Series with Enhanced Coagulation

ZeeWeed® Membranes and Tankage Including:
- Aluminum Membrane Cassette Support Frames to permit membrane installation in concrete tanks
- 224 ZeeWeed® Membrane Cassettes
- Eight (8) Permeate Collection Header Pipes
- Eight (8) Air Scour Distribution Header Pipes
- Eight (8) Process Tank Level Transmitters – one (1) per process train
- 32 Process Tank Level Switches, four per tank

Permeate Pumping System Including:
- Eight (8) Permeate Pumps, duty
  supplied loose, complete with required manual and automatic valves associated with the permeate pumping system
- Eight (8) Air Separation Columns
- Four (4) Vacuum Pumps, one duty and one stand-by
- Eight (8) Trans-Membrane Pressure Transmitters
- Eight (8) Permeate Pump Pressure Gauges
- Eight (8) Permeate Flowmeters
- Eight (8) Particle Counters
- Eight (8) Turbidimeters

Membrane Air Scour System Including:
- Five (5) Membrane Air Scour Blowers, four duty and one stand-by, supplied loose
- Five (5) Discharge Isolation Valves
- Five (5) Membrane Air Scour Blower Flow Switches
- Five (5) Membrane Air Scour Blower Pressure Gauges

Reject Water Flow Control Equipment
- Eight (8) Reject Water Discharge Flow Control Valves
- Eight (8) Reject Water Flowmeters

Backpulse System Including:
- Two (2) Backpulse Pumps, one duty and one stand-by
- Two (2) Backpulse Water Storage Tank Level Transmitters, one per tank

- Eight (8) Backpulse Tank Level Float Switches, four per tank
- Two (2) Backpulse Tank Inlet Fill Valves
- Two (2) Backpulse Tanks Discharge Isolation Valves
- One (1) Backpulse Tank Crossover Valve
- One (1) Backpulse Flowmeter
- One (1) Backpulse Sodium Hypochlorite Chemical Feed System, including
  Two (2) Chemical Metering Pumps, one duty and one stand-by
  One (1) Sodium Hypochlorite Chemical Storage Tank

Membrane Cleaning Systems
- One (1) Sodium Hypochlorite CIP Chemical Feed System including:
  Two (2) Chemical Feed Pumps, one duty and one stand-by
  One (1) Sodium Hypochlorite Chemical Storage Tank
- One (1) Sodium Bisulfite Chemical Neutralization System including
  Two (2) Chemical Feed Pumps, one duty and one stand-by
  One (1) Sodium Bisulfite Chemical Storage Tank
- One (1) MC1 CIP Chemical Feed System including
  Two (2) Chemical Feed Pumps, one duty and one stand-by
  One (1) MC1 Chemical Storage Tank
- One (1) Sodium Hydroxide Chemical Neutralization System including
  Two (2) Chemical Feed Pumps, one duty and one stand-by
  One (1) Sodium Hydroxide Chemical Storage Tank

Chemical Feed Systems
- One (1) Coagulant Chemical Feed System
  Two (2) Chemical Feed Pumps, one duty and one stand-by
  One (1) Chemical Storage Tank
- One(1) pH Sensor and Transmitter

Electrical and Control Equipment
- One (1) PLC based Control Panel with Panelview 900 Touchscreen HMI for ZENON supplied equipment

Miscellaneous
- Two (2) Air Compressors for Membrane Integrity Pressure Hold Test, dual operation for pneumatic valve operation

General
- Equipment General Arrangement and Layout Drawings
- Operator Training
- Operating & Maintenance Manuals
- Field Service and Process Start-up Assistance
- Equipment Delivery FOB Gallup WTP, NM

6.0 Commercial Information

6.1 Pricing Summary

The budget pricing to supply equipment and services as described in this proposal is as follows:

ZeeWeed® Membrane Water Treatment System including membranes, pumps, blowers, instruments and control system & equipment F.O.B. Gallup WTP, NM

Process equipment

Other miscellaneous instrumentation integral to the ZeeWeed® Membrane Filtration System	Lot
Air Compressors for Membrane Integrity Pressure Hold Test, dual operation for pneumatic valves supplied with the ZeeWeed® System	2

General

- Equipment General Arrangement and Layout Drawings
- Operating & Maintenance Manuals
- Field Service and Process Start-Up Assistance
- Equipment delivery FOB Gallup WTP, NM

will be supplied loose, i.e. not on skids, for installation by others.

ZW500 Series with Enhanced Coagulation
Capital Cost Estimate

Budgetary System Price

Flow rates between 42 MGD and 26 MGD - $0.42/GPD

Flow rates between 4 MGD and 2 MGD - $0.60/PPD

6.2 Equipment Shipment and Delivery

Typical Drawing Submission and Equipment Shipment Schedule

	Number of Weeks					
		8 - 10	2 - 3	16 - 20		2
Acceptance of PO	u					
Submission of Drawings		vvvvvvvv				
Drawing Approval			vvv			
Equipment Manufacturing				vvvvvvvvvvvvvvvvv		
Equipment Shipment					u	
Plant Operation Manuals						vv

Operator training will occur when preferred by the Customer, but no later than 2 weeks prior to the scheduled plant start-up.

6.3 Standard Terms and Conditions

ZENON's Standard Terms and Conditions apply.

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AQUIONICS INC.

21 KENTON LANDS ROAD ERLANGER, KY 41018
PHONE: 859-341-0710 FAX: 859-341-0350

Date: February 1, 2001
Quote No. DW01-02-01B

Quotation For: Art Clemens

Attention: Art Clemens

From: Tina L. Masters, P.E. JM.

Project: Navajo Indian Irrigation Project, CO

Parameters:

Water Evaluation: Assume __85___% transmission in a 1cm light path at 253.7nm

Flow Rate: 2.0 mgd per unit

Minimum UV Dose: 40 mJ/ cm2 (end of lamp life)

Inactivation of: Cryptosporidium parvum: 2 to 4 $\log_{10}$ reduction based on animal infectivity
Giardia: 0.5 log reduction

Equipment Selection: two (2) Inline 1250 Units

Design: Install 1 ea. Model Inline 1250 medium pressure UV disinfection unit in parallel pipes. Each unit will disinfect up to 2.0 mgd of wastewater to the requirements stated above. Two units will be used for peak flows. Each unit consists of a stainless steel chamber containing one bank of 6 x 2020W medium pressure UV lamps mounted horizontal and perpendicular to flow. The unit comes complete with an automatic quartz sleeve cleaning system, manual lamp power level control, UV monitor, and access hatch. Standard controls and the power supply will be housed in two wall mounted epoxy coated steel cabinets (NEMA 12) per unit.

Electrical: 480V, 3-phase, 30kW maximum connected load (two units operating at high power level)

Connections: 8" ASA flanges

O&M costs: See attached

Budget Price. $ 104,900

Price Includes: Freight to jobsite, 10% spares and factory start-up assistance included.

Terms: Net 30, FOB factory, freight allowed to jobsite
Delivery approx. __12-16 weeks after approval of submittals.

Navajo Indian Irr., CO	unit	qty	unit cost	subtotal	Total
Capital cost:					
Inline 1250	each	2	$52,450.00		$104,900
O&M cost:					
electricity	kwh	11.4	$0.06	$5,992	
lamps	each	6	$575.00	$3,450	
wiper rings	each	6	$25.00	$150	
quartz sleeves	each	2.00	$150.00	$300	
sleeve seals	each	2.00	$10.00	$20	
labor	hr	108	$20.00	$2,160	
Annual O&M Total				$12,072	
O&M cost (50 years)	%	50	0.05	$12,072	$220,432
Total cost (50 years)					$325,332

Assumptions:

1. Electricity costs are based on operation of one unit to treat a flow of 2.0 mgd at T10=85% and UV dose = 40 mj/cm2. Operate 6 lamps at 1.9 kw per lamp on average for one year.
2. Based on 1. Above replace 6 lamps per year on average.
3. Replace quartz sleeves every 3 years or two (2) per year.
4. Replace wiper rings every 10,000 cycles or once per year.
5. Replace quartz sleeve seals with each quartz sleeve change.
6. Labor cost assumes four (4) hour per week for UV system maintenance.
7. 50 year cost of money @ 5% (18.26 multiplication factor).

AQUIONICS INC.

21 KENTON LANDS ROAD ERLANGER, KY 41018
PHONE: 859-341-0710 FAX: 859-341-0350

Date: February 1, 2001
Quote No. DW01-02-01A

Quotation For: Art Clemens

Attention: Art Clemens

From: Tina L. Masters, P.E. TLM

Project: Navajo Indian Irrigation Project, CO

Parameters:

Water Evaluation: Assume __85___% transmission in a 1cm light path at 253.7nm

Flow Rate: 7.0 mgd per unit

Minimum UV Dose: 40 mJ/ cm2 (end of lamp life)

Inactivation of: Cryptosporidium parvum: 2 to 4 $\log_{10}$ reduction based on animal infectivity
Giardia: 0.5 log reduction

Equipment Selection: Inline 5000 Units

Design: Install 1ea. Model Inline 5000 medium pressure UV disinfection unit on the downstream side of each 7.0 mgd segment of the Xenon unit. Each unit will disinfect up to 7.0 mgd as described to the required discharge level. Each unit consists of a stainless steel chamber containing one bank of 8 x 3535W medium pressure UV lamps mounted horizontal and perpendicular to flow. The unit comes complete with an automatic quartz sleeve cleaning system, manual lamp power level control, UV monitor, and access hatch. Standard controls will be housed in one freestanding epoxy coated steel cabinet per unit. Cabinets are rated NEMA 12, suitable for indoor installation.

Electrical: 480V, 3-phase, 36kW maximum connected load.

Connections: 14" ASA flanges

O&M costs: See attached

Budget Price: $ 88,200.00 per unit

Options: Freight to jobsite, 10% spares and factory start-up assistance included.

Terms: Net 30, FOB factory, freight allowed to jobsite
Delivery approx. __12-16___weeks after approval of submittals.

Navajo Indian Irr., CO	unit	qty	unit cost	subtotal	Total
Capital cost:					
Inline 5000	each	1	$74,900.00		$74,900
O&M cost:					
electricity	kwh	28	$0.06	$14,717	
lamps	each	8	$575.00	$4,600	
wiper rings	each	8	$25.00	$200	
quartz sleeves	each	2.67	$250.00	$667	
sleeve seals	each	2.67	$10.00	$27	
labor	hr	108	$20.00	$2,160	
Annual O&M Total				$22,370	
O&M cost (50 years)	%	50	0.05	$22,370	$408,479
Total cost (50 years)					$483,379

Assumptions:

1. Electricity costs are based on operation of 1unit to treat a flow of 7.0 mgd at T10=85% and UV dose = 40 mj/cm2. Operate 8 lamps at 3.5kw per lamp on average for one year.
2. Based on 1. Above replace 8 lamps per year on average.
3. Replace quartz sleeves every 3 years or 2.67 per year.
4. Replace wiper rings every 10,000 cycles or once per year.
5. Replace quartz sleeve seals with each quartz sleeve change.
6. Labor cost assumes four (4) hour per week for UV system maintenance.
7. 50 year cost of money @ 5% (18.26 multiplication factor).

AQUIONICS

Specialist Manufacturers of Water, Air and Surface Disinfection Systems

SPECIFICATIONS... INLINE 1250

TREATMENT CHAMBER

Model		: Inline 1250
Drawing		: INLN08HA
Number per system		: 1
Material		: 316L stainless steel
Dimensions:	- length	: 500mm (19.68 in.) with access hatch
	- diameter	: 273mm (10.7 in.)
Weight	- dry	: 70kg (154 lbs.)
	- wet	: 95kg (209 lbs.)
Degree of Protection		: IP54 (Nema 12)
Pressure rating	- test	: 10 bar (150 psi)
	- operational	: 7 bar (100 psi)
Operational water temperature		: 0 – 45° C (32 – 113° F)
Storage temperature		: 0 – 70° C (32 – 158° F)
UV lamp type		: B2020
Lamp life		: 8000 hrs
Lamp voltage (max.)		: 235 Vac
Lamp current (max.)		: 11 A
Number lamps per chamber		: 6
Inlet/Outlet connections		: 8 in. ASA
Cleaning mechanism		: auto-wipe
Access Hatch		: yes
UV sensor		: yes
Temperature detector		: yes

POWER MODULE

Model		: 2020HSC4
Drawing		: CLIN1250
Number per system		: 1
Material		: 316 Stainless Steel
Dimensions	- height	: 700mm (28 in.)
	- width	: 820mm (32.5 in.)
	- depth	: 340mm (13.5 in.)
Weight		: 140kg (308 lbs.)

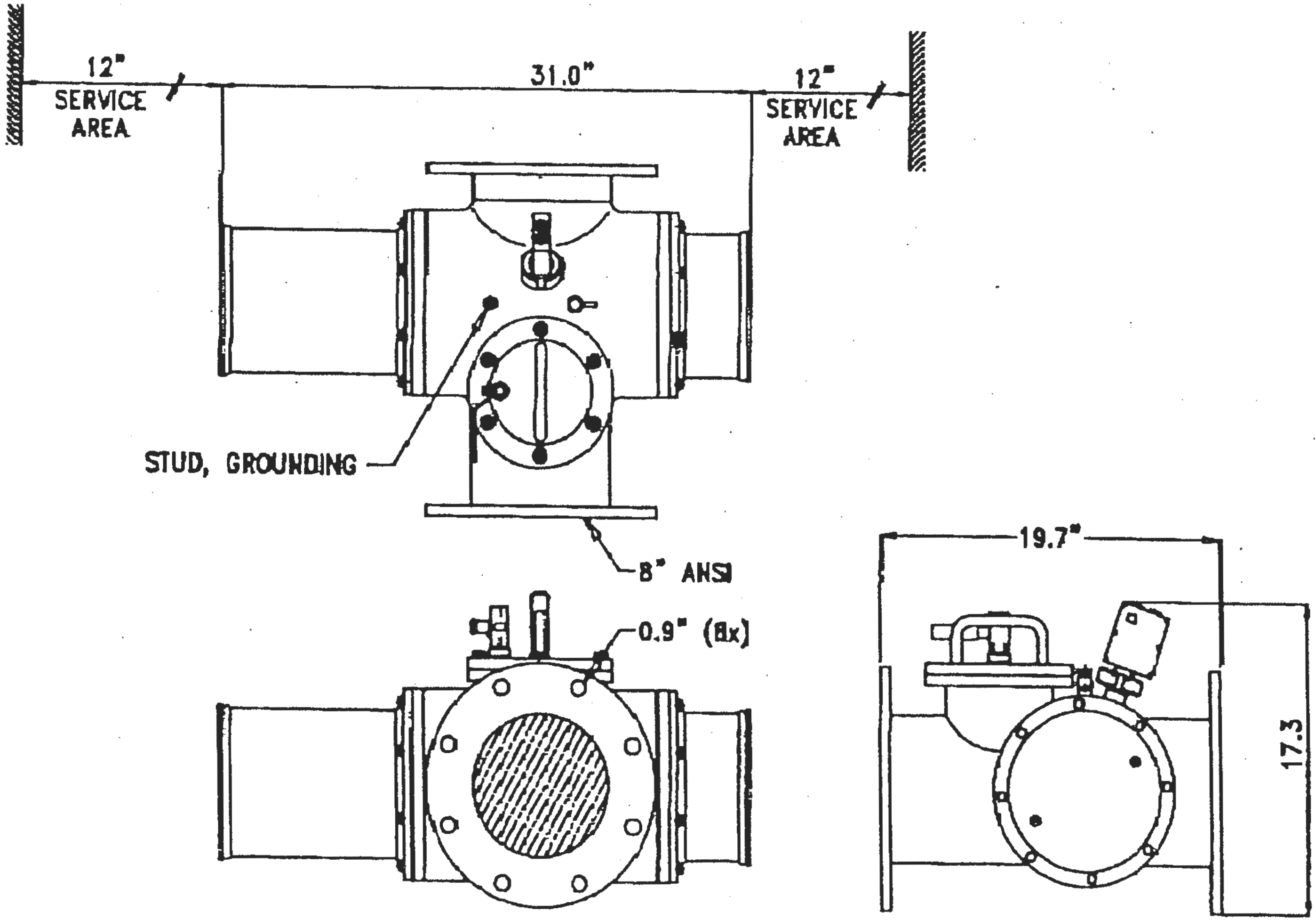
Aquionics, Inc.
P.O. Box 18395, Erlanger, KY 41018
Tel: (606) 341-0710 Fax: (606) 341-0350

HALMA GROUP COMPANY

Degree of Protection		: IP54 (NEMA 12)
Operational temperature		: 0 – 35° C (32 – 95° F)
Storage temperature		: 0 – 70° C (32 – 158° F)
Lamp power	- level 1	: 1500 W
	- level 2	: 1880 W
	- level 3	: 2240 W

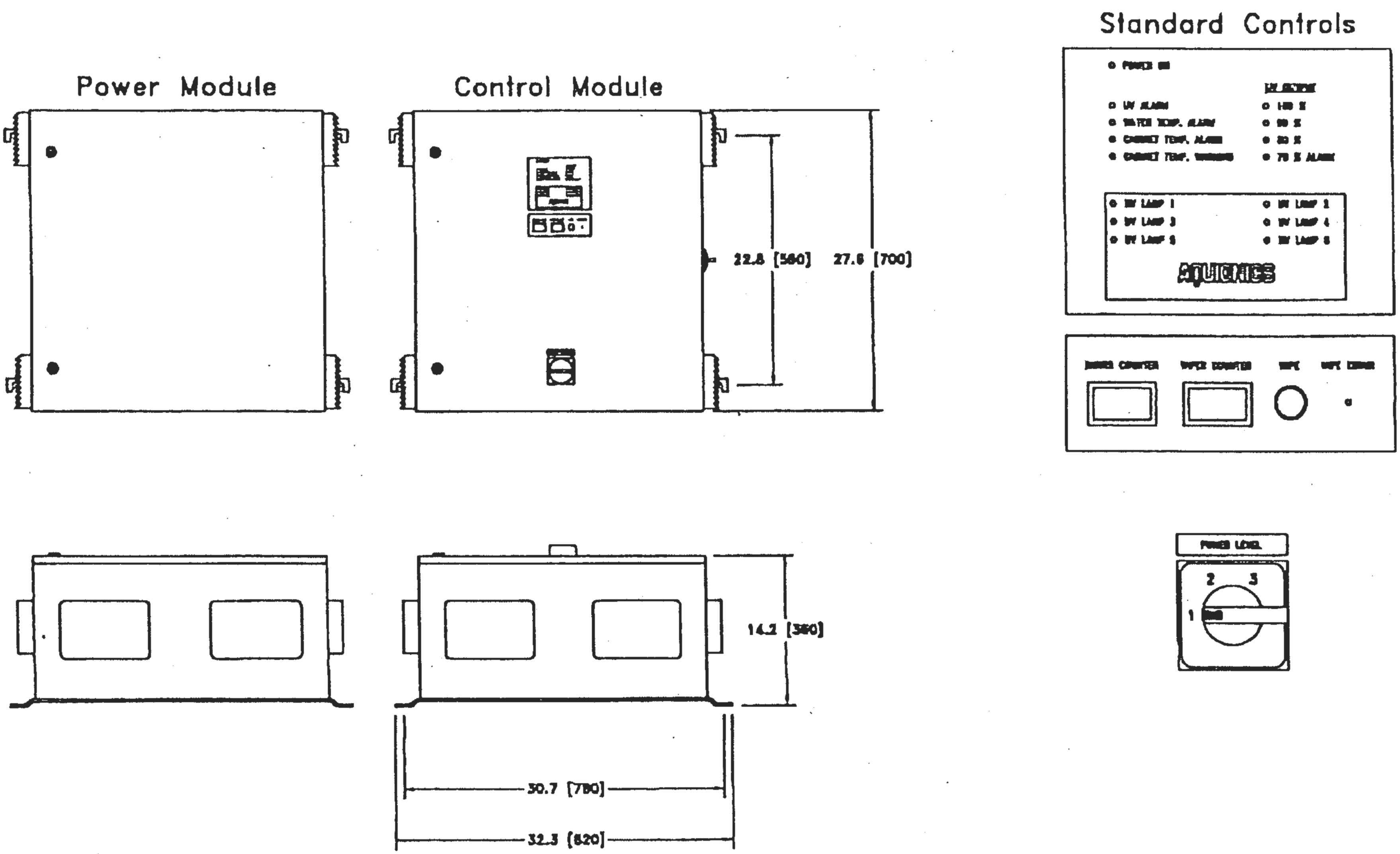
POWER/CONTROL MODULE

Model		: 2020HSC2 - ECUA1(G)
Drawing		: CLIN1250
Number per system		: 1
Material		: 316 Stainless Steel
Dimensions	- height	: 700mm (27.6 in.)
	- width	: 820mm (32.5 in.)
	- depth	: 340mm (13.4 in.)
Weight		: 80kg (176 lbs.)
Degree of Protection		: IP54 (NEMA 12)
Operational temperature		: 0 – 35 ° C (32 – 95° F)
Storage temperature		: 0 – 70° C (32 – 158° F)
Power level control		: manual
Controls		: Basic
Displays	- UV% output	: yes
	- Power ON	: yes
	- Lamp ON	: yes, per lamp
	- UV alarm	: yes
	- Water temp alarm	: yes
	- Cabinet temp warning	: yes
	- Cabinet temp alarm	: yes
	- Hours run counter	: yes
	- Wiper cycles counter	: yes
Inputs	- Remote ON/OFF	: yes
	- Lamp power level	: yes, 3 level manual
	- Immediate clean	: yes, pushbutton
Outputs	- Alarm	: yes
	- Warning	: yes
	- Ground Fault	: yes
	- UV monitor	: yes, 4-20mA
Electrical Supply	- voltage	: 240V, 277V, or 480V
	- phase	: 3
	- frequency	: 60Hz
Power Consumption (max.)		: 15 kW



NOTE:
1. DO NOT SCALE DRAWING
2. CLEARANCE REQUIRED FOR SERVICE AND MAINTENANCE OF SYSTEM
3. DIMENSIONS SUBJECT TO CHANGE

Title: INLINE 200, 300, 450, 600, 750		Scale: NTS
1000, 1250 HATCH & AUTOMATIC WIPER		Page 1 of 1
8" ASA FLANGES	Drawn: TDS	Date: 12/4/97
AQUIONICS	Appd:	Date:
	Mat. 316L SS	Rev. A

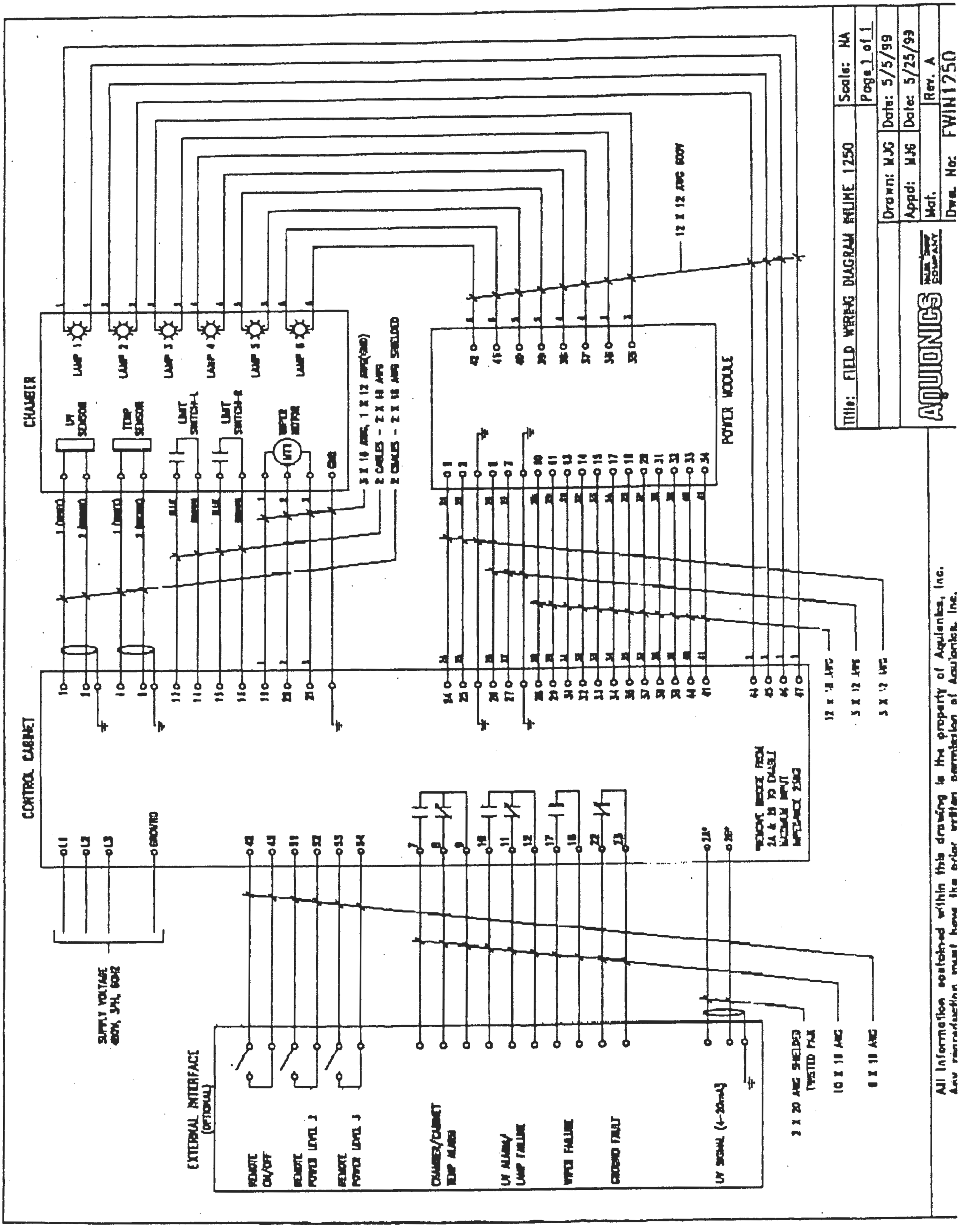


NOTES:
1. DIMENSIONS ARE IN INCHES [MILLIMETERS]
2. 30" FRONT CLEARANCE REQUIRED FOR SERVICE.
3. 12" SIDE CLEARANCE RECOMMENDED FOR AIR FLOW.
4. REMOVABLE PLATES ON BOTTOM FOR CABLE ENTRY.

Title: POWER AND CONTROL CABINET LAYOUT
INLINE 1250

Scale: NA
Page 1 of 1
Drawn: MJG | Date: 6/4/99
Appd: MJG | Date: 6/4/99
Mat. | Rev. A
Dwg. No: CLIN1250

AQUIONICS


CHAMBER
LAMP 1
LAMP 2
LAMP 3
LAMP 4
LAMP 5
LAMP 6
UV SENSOR
TEMP SENSOR
LIMIT SWITCH-L
LIMIT SWITCH-R
WIPER MOTOR
POWER MODULE
12 X 12 AWG BODY
CONTROL CABINET
SUPPLY VOLTAGE 480V, 3PH, 60HZ
EXTERNAL INTERFACE (OPTIONAL)
REMOTE ON/OFF
REMOTE POWER LEVEL 2
REMOTE POWER LEVEL 3
CHAMBER/CABINET TEMP ALARM
UV ALARM/ LAMP FAILURE
WIPER FAILURE
GROUND FAULT
UV SIGNAL (4-20mA)
2 X 20 AWG SHIELDED TWISTED PAIR
10 X 18 AWG
8 X 18 AWG
Title: FIELD WIRING DIAGRAM
Scale: NA
Page 1 of 1
Drawn: MJG Date: 5/5/99
Appd: MJG Date: 5/25/99
Rev. A
Dwg. No: FWIN1250
AQUIONICS
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AQUIONICS

Specialist Manufacturers of Water, Air and Surface Disinfection Systems

SPECIFICATIONS... INLINE 5000

TREATMENT CHAMBER

Model		: Inline 5000
Drawing		: INLN14HA
Number per system		: 1
Material		: 316L stainless steel
Dimensions:	- length	: 755mm (29.72 in.) with access hatch
Weight	- dry	: 120kg (264 lbs.)
	- wet	: 190kg (418 lbs.)
Degree of Protection		: IP54 (Nema 12)
Pressure rating	- test	: 10 bar (150 psi)
	- operational	: 7 bar (100 psi)
Operational water temperature		: 0 – 45° C (32 – 113° F)
Storage temperature		: 0 – 70° C (32 – 158° F)
UV lamp type		: B3535
Lamp life		: 8000 hrs
Lamp voltage (max.)		: 525 Vac
Lamp current (max.)		: 8.2 A
Number lamps per chamber		: 8
Inlet/Outlet connections		: 14 in. ASA
Cleaning mechanism		: auto-wipe
Access Hatch		: yes
UV sensor		: yes
Temperature detector		: yes

POWER/CONTROL MODULE

Model		: 3535HSC8
Drawing		: CLIN5000
Number per system		: 1
Material		: Epoxy coated steel
Dimensions	- height	: 2100mm (82.7 in.)
	- width	: 800mm (31.5 in.)
	- depth	: 800mm (31.5 in.)
Weight		: 450kg (990 lbs.)
Degree of Protection		: IP54 (NEMA 12)
Operational temperature		: 0 – 35° C (32 – 95° F)

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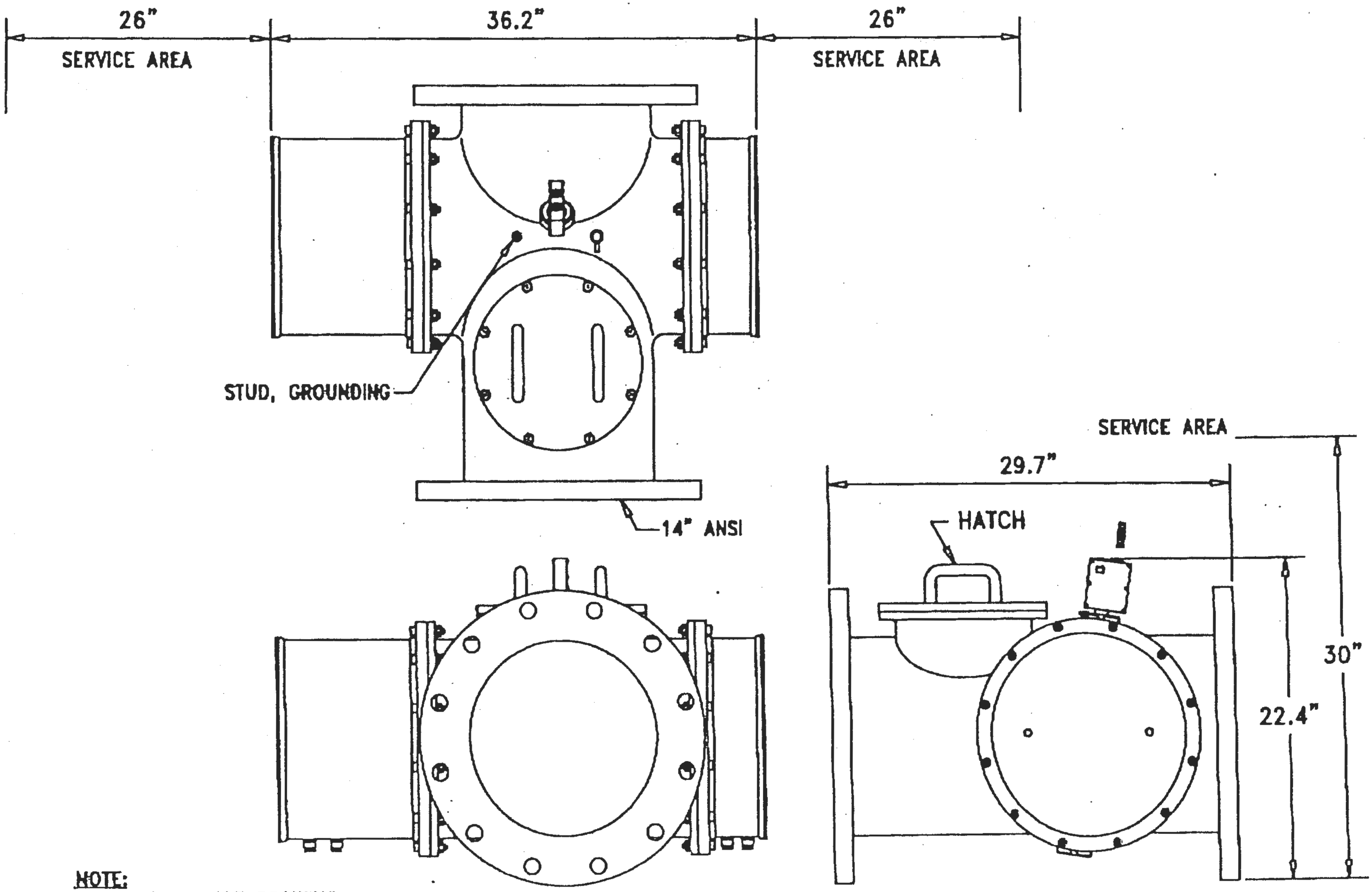
Tel: (606) 341-0710 Fax: (606) 341-0350

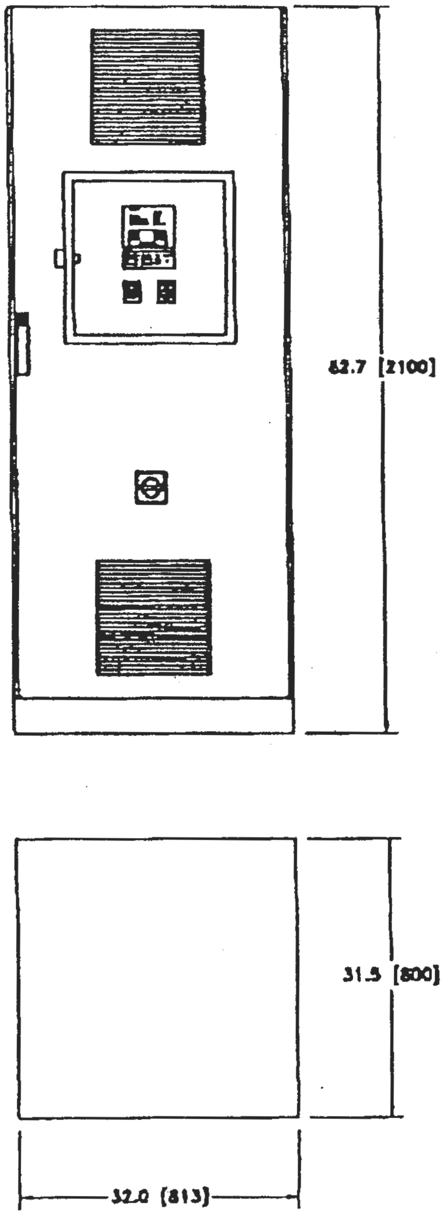
HALMA GROUP COMPANY



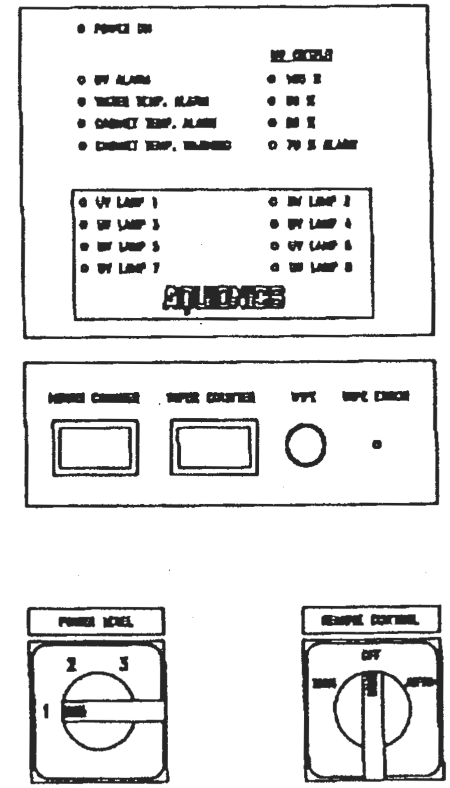
NOTE:
1. DO NOT SCALE DRAWING
2. CLEARANCE REQUIRED FOR SERVICE AND MAINTENANCE OF SYSTEM
3. DIMENSIONS SUBJECT TO CHANGE

INLINE 3500, 4000, 4250, 4500, 5000, 7500		Scale: NTS
WITH HATCH & AUTOMATIC WIPER		Page 1 of 1
14" ASA FLANGES	Drawn: TDS	Date: 03/18/98
AQUIONICS	Appd:	Date:
	Mat. 316L SS	Rev. A

Storage temperature		: 0 – 70° C (32 – 158° F)
Lamp power	- level 1	: 2650W
	- level 2	: 3100W
	- level 3	: 3750W
Power level control		: manual
Controls		: Basic
Displays	- UV% output	: yes
	- Power ON	: yes
	- Lamp ON	: yes, per lamp
	- UV alarm	: yes
	- Water temp alarm	: yes
	- Cabinet temp warning	: yes
	- Cabinet temp alarm	: yes
	- Hours run counter	: yes
	- Wiper cycles counter	: yes
Inputs	- Remote ON/OFF	: yes
	- Lamp power level	: yes, 3 level manual
	- Immediate clean	: yes, pushbutton
Outputs	- Alarm	: yes
	- Warning	: yes
	- Ground Fault	: yes
	- UV monitor	: yes, 4-20mA
Electrical Supply	- voltage	: 480V
	- phase	: 3
	- frequency	: 60Hz
Power Consumption (max.)		: 36kW

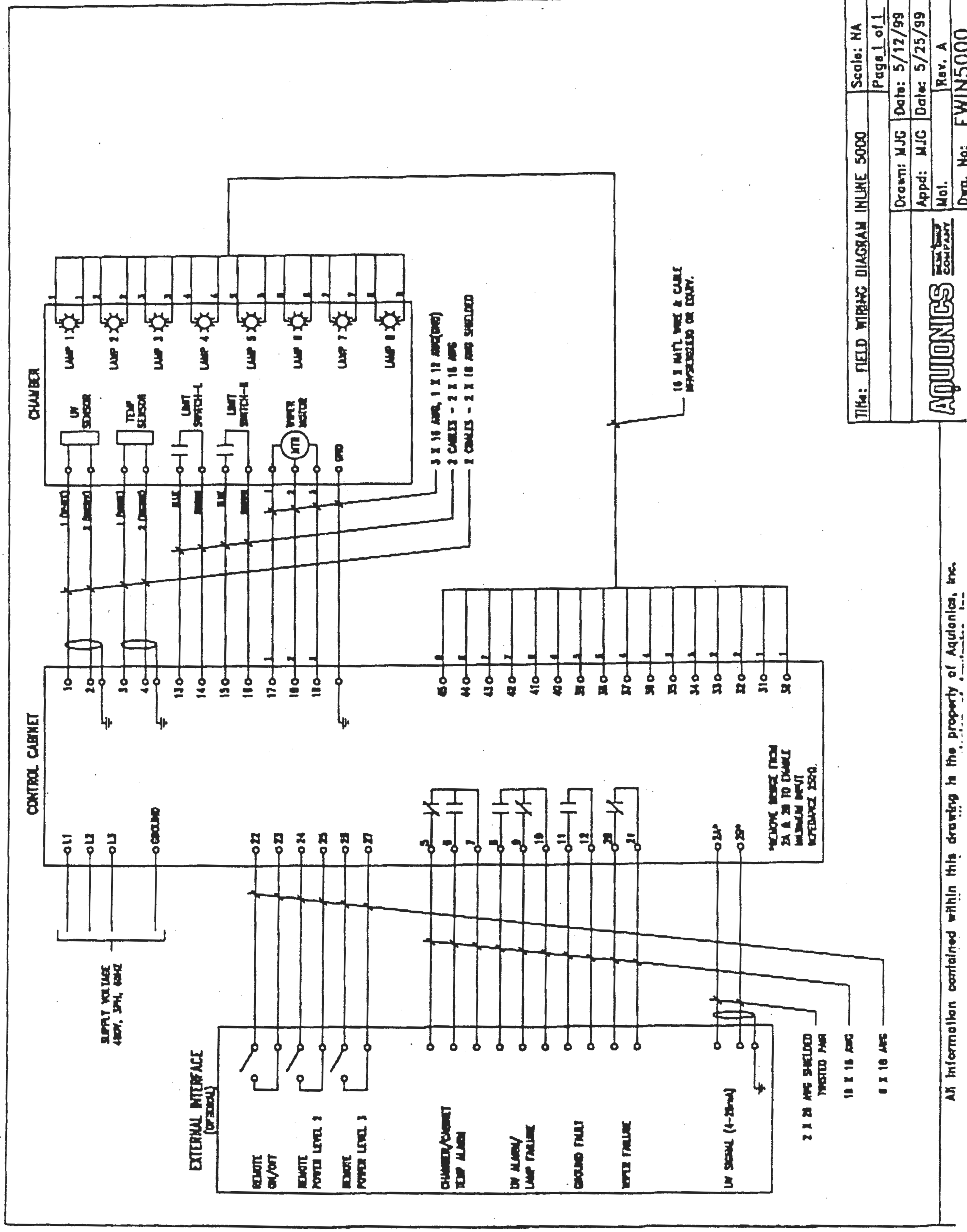


Standard Controls



NOTES:
1. DIMENSIONS ARE IN INCHES (MILLIMETERS)
2. 34" FRONT CLEARANCE REQUIRED FOR SERVICE.
3. REMOVABLE PLATE ON BOTTOM FOR CABLE ENTRY.

Title: POWER AND CONTROL CABINET LAYOUT			Scale: NA
INLINE 5000			Page 1 of 1
	Drawn: MJG	Date: 6/4/99	
	Appd: MJG	Date: 6/4/99	
AQUIONICS	Mat.		Rev. A


Title: FIELD WIRING DIAGRAM INLINE 5000
Scale: NA
Page 1 of 1
Drawn: MJG
Date: 5/12/99
Appd: MJG
Date: 5/25/99
Mat.
Rev. A
Dwg. No: FWIN5000
AQUIONICS
CHAMBER
LAMP 1
LAMP 2
LAMP 3
LAMP 4
LAMP 5
LAMP 6
LAMP 7
LAMP 8
UV SENSOR
TEMP SENSOR
LIMIT SWITCH-1
LIMIT SWITCH-2
WIPER MOTOR
MTR
GND
3 X 16 AWG, 1 X 12 AWG(GND)
2 CABLES - 2 X 16 AWG
2 CABLES - 2 X 18 AWG SHIELDED
16 X MAT'L WIRE & CABLE
CONTROL CABINET
L1
L2
L3
GROUND
SUPPLY VOLTAGE
480V, 3PH, 60HZ
EXTERNAL INTERFACE
(OPTIONAL)
REMOTE ON/OFF
REMOTE POWER LEVEL 2
REMOTE POWER LEVEL 3
CHAMBER/CABINET TEMP ALARM
UV ALARM/ LAMP FAILURE
GROUND FAULT
WIPER FAILURE
UV SIGNAL (4-20mA)
2 X 20 AWG SHIELDED TWISTED PAIR
10 X 16 AWG
8 X 18 AWG
All information contained within this drawing is the property of Aquionics, Inc.

SUPPORTING DOCUMENTATION FOR CAPITAL COSTS ESTIMATES

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 12-Oct-2001	PROJECT:
NIIP Alternatives Moncisco Dam, Coury Lateral & Cutter Dam 2020 Demand (26.25 MGD) Quantities for tanks, building and process pons for 2040 demand. All other quantities for 2020 demand Includes Jicarilla Apache Nation Demand	Navajo Gallup WSP DIVISION: FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\NIP-ESTA.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		Prefabricated Building with 20 foot high exterior wall	D8230	27,200	SF	$75.00	$2,040,000.00
		includes 2,700 square foot mezzanine.					
2		Hollow Fiber UF Water Treatment System		27,640,000	GPD	$0.46	$12,714,400.00
3		Concrete Reinforced tanks for UF System		1047	CY	$400.00	$418,800.00
4		Concrete for Flocculation tank		310	CY	$400.00	$124,000.00
5		Concrete for splitter box		50	CY	$400.00	$20,000.00
6		Concrete for rapid mix tank		50	CY	$400.00	$20,000.00
7		Ultraviolet Disinfection Units		5	EA	$100,000.00	$500,000.00
8		Excavation of Clearwell		10800	CY	$10.00	$108,000.00
9		Reinforced Concrete for Clearwell		1162	CY	$400.00	$464,800.00
10		Backfill after Clearwell Construction		6327	CY	$15.00	$94,905.00
11		Excavation for wastewater polishing ponds		8850	CY	$8.00	$70,800.00
12		Mixers for Clearwell		6	EA	$15,000.00	$90,000.00
13		Sediment Drying beds					
		Sand for Wastewater Polishing Ponds		125	CY	$20.00	$2,500.00
14		Regional Operations and Maintenance Bldg		2,500.00	SF	$110.00	$275,000.00
		Prefab, slab on grade with 14 feet eves					
15		45 mil Polypropylene Liner for Wastewater Ponds		35,500.00	SF	$0.50	$17,750
		Installation		35,500.00	SF	$0.20	$7,100
		Unlisted 30% (mixer for rapid mix tank, chlorinators, ammoniators, misc piping, blending studies, etc.)					$5,100,000.00 ✓
		Subtotal					$22,068,055.00 ✓
		Unlisted 10% (for DBP Treatment Systems at service points)					$2,210,000.00
		Construct and operate Pilot sytem for 12 consecutive months					$200,000.00
		TOTAL					$24,478,055.00 ✓

QUANTITIES		PRICES	
BY Glenn Howard	CHECKED	BY K. Copeland	CHECKED KP 10-12-01
DATE PREPARED October 9, 2001	APPROVED BY	DATE 12-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 11-Oct-2001	PROJECT:
NIIP Alternatives Moncisco Dam, Coury Lateral & Cutter Dam Additional treatment units to to upgrade the plant by 15.99 MGD for a total Production Rate of 43.63 MGD Includes Jicarilla Apache Nation Demand	DIVISION: FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\NIP-ESTA.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		ZeeWeed Water Treatment System		15,990,000	MGD	$0.46	$7,355,400
2		Ultraviolet Disinfection Units		2	EA	$100,000	$200,000
		Unlisted 5%					$378,000.00
		TOTAL					$7,933,400.00

QUANTITIES		PRICES	
BY Glenn Howard		BY K. Copeland	CHECKED LP 10/11/01
DATE PREPARED October 9, 2001	APPROVED BY	DATE 11-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 12-Oct-2001

SJR PNM Alternative
2020 Demand (23.89 MGD)
Quantities for tanks, buildings, and process ponds for 2040 demand. All other quantities for 2020 demand

PROJECT: Navajo Gallup WSP

DIVISION:

FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\PMN-ESTF.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		Prefabricated Building with 20 foot high exterior wall	D8230	27,200	SF	$75.00	$2,040,000.00
		includes 2.700 SF of Mezzanine					
2		ZeeWeed Water Treatment System		23,890,000.00	GPD	$0.42	$10,033,800
3		Concrete Reinforced tanks for ZeeWeed Systems		1047	CY	$400.00	$418,800
4		Concrete Flocculation tank		198	CY	$400.00	$79,200
5		Concrete for Splitter Tank		50	CY	$400.00	$20,000
6		Concrete for rapid mix tank		50	CY	$400.00	$20,000
7		Ultraviolet Disinfection Units		5	EA	$88,200.00	$441,000
8		Excavation of Clearwell		7700	CY	$10.00	$77,000
9		Backfill around clearwell after construction		2900	CY	$15.00	$43,500
10		Construction of Clearwell		1053	CY	$400.00	$421,200
11		Excavation for wastewater treatment ponds		8570	CY	$8.00	$68,560
12		Excavation for settling ponds		53,000	CY	$6.00	$318,000
13		Clear Well Mixers		6	Ea	$15,000.00	$90,000
14		Sediment Drying Beds					
		Gravel		20,400	CY	$20.00	$408,000
		Sand for Settling Pond Sediment		10,200	CY	$15.00	$153,000
		Concrete for sides		84	CY	$400.00	$33,600
		4-inch PVC perforated pipe		25,000	LF	$6.00	$150,000
15		Regional Operations and Maintenance Bldg		2,500.00	SF	$110.00	$275,000.00
		Prefab, slab on grade with 14 feet eves					
16		45 mil Polypropylene Liner for Wastewater Ponds		34,500.00	SF	$0.50	$17,250
		Installation		34,500.00	SF	$0.20	$6,900
17		6-inch thick reinforced concrete liner for settling ponds		4100	CY	$150.00	$615,000
		Unlisted 30% (mixer for rapid mix tank, chlorinators,					$4,720,000.00
		ammoniators, misc piping, blending studies, etc.)					
		Subtotal					$20,449,810.00
		Unlisted 10% (for DBP Treatment Systems at service points)					$2,040,000.00
		Construct and operate Pilot sytem for 12 consecutive months					$200,000.00
		TOTAL					$22,689,810.00

QUANTITIES		PRICES	
BY Glenn Howard	CHECKED BY	BY K. Copeland	CHECKED 10-12-01
DATE PREPARED October 9, 2001	APPROVED	DATE 12-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

FEATURE: 11-Oct-2001

SJR PNM Alternative
Additional treatment units to upgrade the plant by 14.36 MGD with a total capacity of 38.25 MGD

PROJECT:

DIVISION:

FILE:
H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\PMN-ESTF.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		ZeeWeed Water Treatment System		14,360,000		$0.46	$6,605,600
2		Ultraviolet Disinfection Units		2		$100,000	$200,000
		Unlisted 5%					$340,000
		TOTAL					$7,145,600.00

QUANTITIES		PRICES	
BY Glenn Howard	Checked BY	BY K. Copeland	CHECKED LP 10/11/01
DATE PREPARED October 9, 2001	APPROVED	DATE 11-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 12-Oct-2001

San Juan Alternative Cutter Diversion
Quantities for tanks, building and process ponds for 2040 demand. All other quantities for 2020 demand
Includes Jicarilla Apache Nation Demand

PROJECT: Navajo Gallup WSP

DIVISION:

FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\CUT-ESTA.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		Prefabricated Building	D8230	4,600	SF	$90.00	$414,000
2		ZeeWeed Water Treatment System		3,740,000	GPD	$0.70	$2,618,000
3		Concrete Reinforced tanks for ZeeWeed Systems		110	CY	$500	$55,000
4		Concrete Flocculation tank		61	CY	$500	$30,500
5		Reinforced Concrete for Splitter Tank		20	CY	$500	$10,000
6		Reinforced Concrete for Rapid mix tank		20	CY	$500	$10,000
7		Ultraviolet Disinfection Units Model 1250		3	Ea	$120,000	$360,000
8		Excavation of Clearwell		1,820	CY	$10	$18,200
9		Backfill around clearwell after construction		1,270	CY	$15	$19,050
10		Reinforced concrete for clearwell		213	CY	$500	$106,500
11		Excavation of Wastewater Polishing Ponds		2,100	CY	$9	$18,900
12		Mixers for ClearWell		6	Ea	$15,000	$90,000
13		Sediment Drying Beds					
		Sand for Wastewater Polishing Ponds		25	CY	$20	$500
14		Regional Operations and Maintenance Bldg		2,500.00	SF	$110.00	$275,000.00
		Prefab, slab on grade with 14 feet eves					
15		45 mil Polypropylene Liner for Wastewater Ponds		11,500.00	SF	$0.50	$5,750
		Installation		11,500.00	SF	$0.20	$2,300
		Unlisted 30% (mixer for rapid mix tank, chlorinators, ammoniators, misc piping, blending studies, etc.)					$1,210,000.00 ✓
		Subtotal					$5,243,700.00 ✓
		Unlisted 10% (for DBP Treatment Systems at service points)					$520,000.00
		Construct and operate Pilot sytem for 12 consecutive months					$200,000.00
		TOTAL					$5,963,700.00 ✓

QUANTITIES		PRICES	
BY Glenn Howard	CHECKED	BY K. Copeland	CHECKED LP 10-12-01
DATE PREPARED October 9, 2001	APPROVED BY	DATE 12-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 11-Oct-2001

San Juan Alternative Cutter Diversion
Additional treatment units to upgrade the treatment plant by 1.65 MGD to a total capacity of 5.39 MGD
Includes Jicarilla Apache Nation Demand

PROJECT:

DIVISION:

FILE:
H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\CUT-ESTA.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		ZeeWeed Water Treatment System		1,650,000.00	GPD	$0.70	$1,155,000.00
		Unlisted 5%					$58,000.00
		TOTAL					**$1,213,000.00**

QUANTITIES		PRICES	
BY Glenn Howard		BY K. Copeland	CHECKED *[initials]* 10/11/01
DATE PREPARED October 9, 2001	APPROVED BY	DATE 11-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 12-Oct-2001

SJR Infiltration Alternative
2020 Demand (23.89 MGD)
Quantities for tanks, building and process ponds for 2040 demand. All other quantities for 2020 demand

PROJECT: Navajo Gallup WSP

DIVISION:

FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\SJR-ESTF.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		Prefabricated Building with 20 foot high exterior wall	D8230	27,200	SF	$75.00	$2,040,000.00
		includes 2.700 SF of Mezzanine					
2		ZeeWeed Water Treatment System		23,890,000.00	GPD	$0.46	$10,989,400.00
3		Concrete Reinforced tanks for ZeeWeed Systems		1047	CY	$400.00	$418,800.00
4		Concrete Flocculation tank		198	CY	$400.00	$79,200.00
5		Concrete for Splitter Tank		50	CY	$400.00	$20,000.00
6		Concrete for rapid mix tank		50	CY	$400.00	$20,000.00
7		Ultraviolet Disinfection Units		5	EA	$100,000.00	$500,000.00
8		Excavation of Clearwell		7700	CY	$10.00	$77,000.00
9		Backfill around clearwell after construction		2900	CY	$15.00	$43,500.00
10		Construction of Clearwell		1053	CY	$400.00	$421,200.00
11		Excavation for wastewater treatment ponds		8570	CY	$8.00	$68,560.00
12		Clear Well Mixers		6	Ea	$15,000.00	$90,000.00
13		Sediment Drying Beds					
		Sand for Wastewater Polishing Ponds Sediment		125	CY	$15.00	$1,875.00
14		Regional Operations and Maintenance Bldg		2,500.00	SF	$110.00	$275,000.00
		Prefab, slab on grade with 14 feet eves					
15		45 mil Polypropylene Liner for Wastewater Ponds		34,500.00	SF	$0.50	$17,250
		Installation		34,500.00	SF	$0.20	$6,900
		Unlisted 30% (mixer for rapid mix tank, chlorinators, ammoniators, misc piping, blending studies, etc.)					$4,520,000.00 ✓
		Subtotal					$19,588,685.00 ✓
		Unlisted 10% (for DBP Treatment Systems at service points)					$1,960,000.00
		Construct and operate Pilot sytem for 12 consecutive months					$200,000.00
		TOTAL					**$21,748,685.00** ✓

QUANTITIES		PRICES	
BY Glenn Howard	CHECKED BY	BY K. Copeland	CHECKED KP 10-12-01
DATE PREPARED October 9, 2001	APPROVED	DATE 12-Oct-2001	PRICE LEVEL

CODE:D-8230

ESTIMATE WORKSHEET

SHEET 1 OF 1

FEATURE: 11-Oct-2001	PROJECT:
SJR Infiltration Alternative Additional treatment units to upgrade the plant by 14.36 MGD with a total capacity of 38.25 MGD	DIVISION:
	FILE: H:\D8170\EST\SPREADSH\COPELAND\NAVAJO~1\SJR-ESTF.WK4

PLANT ACCT.	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1		ZeeWeed Water Treatment System		14,360,000		$0.46	$6,605,600.00
2		Ultraviolet Disinfection Units		2		$100,000	$200,000.00
		Unlisted 5%					$340,000.00
		TOTAL					$7,145,600.00

QUANTITIES		PRICES	
BY Glenn Howard	CHECKED BY	BY K. Copeland	CHECKED 10/11/01
DATE PREPARED October 9, 2001	APPROVED	DATE 11-Oct-2001	PRICE LEVEL

SUPPORTING DOCUMENTATION ON ESTIMATED CAPITAL COST QUANTITIES

Treatment Process Calculations
UF units and Clearwell

Navajo- Gallup Water Supply Project
Treatment Process Calculations with J. Apache Demands
11-Oct-01

Assumptions

1. Production rate per cassette is approximately 200,000 GPD with 4 cassettes per module for NIIP and San Jaun Plants
2. Production rate per cassette is approximately 200,000 GPD for the Cutter treatment plant.
3. 6 hours of detention in settling pond will be adequate for Jan Juan River after the PMN diversion structure.
4. Clear well detention time is 30 minutes with a depth of 10 ' deep

Options

	NIIP Alternatives - Moncisco, Coury Lateral & Cutter							
	Water Quality Constant Turbidity, TOC higher than source water							
	Treatment Scheme - Enhanced coagulation Ultrafiltration - NH2Cl							
						CW S.A	CW Length	Volume
Year	Demand MGD	Size SP	number of cassestts	Groups of 4	Clear Well size -acres	SF	width of L 60'	Gallons
2040	43.63	NR	218.15	54.54	0.28	12152	203	908,958
2020	27.64	NR	138.20	34.55	0.18			

	San Juan Alternative *							
Year								
	Source 1 San Juan River							
	Water Quality - Periods of High Turbidity. High TOC, Potential for Crypto							
	Treatment - Enhanced Coagulation - Ultrfiltration - NH2Cl							
						CW S.A.	CW Length	Volume
	Demand MGD	Size SP (MG)	number of cassettes	Groups of 4	Clear Well size-acres	SF	width if L 60'	Gallons
2040	38.25	9.56	191.25	47.81	0.24	10653.41	178	796,875
2020	23.89	5.97	119.45	29.86	0.15			
	Source 2 Cutter Reservoir in San Juan Alternative							
	Water Quality - Constant turbidity - Low turbidity							
						CW SA	CW Length	Volume
	Demand MGD	Size SP (MG)	number of cassettes		Clear Well size-acres	SF	width of L 60'	Gallons
2040	5.39	NR	26.95		0.03	1501.225	25	112,292
2020	3.74	NR	18.70		0.02			

* San Juan alternative includes treatment plants at PNM and the San Juan treatment plant with a infiltration intake.
** Demand by Jicarilla Apache from Moncisco and Cutter is 1.39 MGD for 2020 and 2040
CW Clearwell

(file: designfowsr3.xls)

Concrete Volumes

Navajo-Gallup WSP
Calculations- Concrete Quantities Reinforced concrete
9/23/2001 Incl J. Apache demands

Assumptions
1. Tanks for hollow fiber membranes will be constructed for final build-out
2. Equalization tanks will be constructed for final build-out
3. Hollow Fiber tanks height 10 feet with includes 1 feet of freeboard
   All other tanks have height of 12 feet with 2 feet of freeboard
4. Thickness of all concrete 1 foot
5. All quantities for PNM are the same for the San Juan WTP with infiltration intakes

Tanks for hollow fiber treatment trains			
	NIIP Alternatives	PNM	Cutter *
Length (ft)	91	91	25
Width (ft)	20	20	10
Height (ft)	10	10	10
CY per tank	150	150	35
# tanks	7	7	3
Total CY	1,047	1,047	106

Floccualton Tanks			
	NIIP Alternatives	PNM	Cutter *
Length(ft)	45	33	14
Width(ft)	45	33	13
Height(ft)	12	12	12
CY per tank	155	99	31
# tanks	2	2	2
Total CY	310	198	61

Building slab -minus the tanks			
NIIP Alternatives	piping area	tank area	2nd floor
Length	185	122	122
Width	30	24	24
CY	206	108	108
CY total	422		
PNM	piping area	tank area	2nd floor
Length	185	122	122
Width	30	24	24
CY	206	108	108
CY total	422		

Clearwell			
	NIIP Alternatives	PNM	Cutter *
Length(ft)	202	182	100
Width(ft)	62	62	15
Height(ft)	12	12	12
CY per tank	1162	1053	213
# tanks	1	1	1
Total Concrete	1,162	1,053	213

Rapid Mix Tank and Splitter Box			
	NIIP Alternatives	PNM	Cutter *
Length(ft)	20	20	8
Width(ft)	20	20	8
Height(ft)	12	12	12
CY per tank	50	50	17
# tanks	1	1	1
Total CY	50	50	17

* Cutter Diversion in San Juan River Alternatives

(file:concrete calcsr3.xls)

Flocculation Tank Calculations

Design of Flocculation tanks - GH - 10/11/01 w J Apache Demand

Design Criteria
1 Flocculation basin split into with 5 minutes detention time each
2. Water depth 10 ft
3.Rapid mix detention time 40 seconds

		Floc tank				Rapid Mix		
NIIP *	Demand	volume (gal)	area (sf)	L	W	Vol (gal)	area (sf)	LxW
2040	43.63	302,986	4067	90	45	20,981	282	17
2020	27.64	191,944	2576	72	36	16,700	224	15

		Floc tank				Rapid Mix		
PNM **	Demand	volume (gal)	area (sf)	L	W	Vol (gal)	area (sf)	LxW
2040	38.25	265,625	3565	84	42	19,645	264	16
2020	23.89	165,903	2227	67	33	15,526	208	14

		Floc tank				Rapid Mix		
Cutter ***	Demand	volume (gal)	area (sf)	L	W	Vol (gal)	area (sf)	LxW
2040	5.39	26,201	352	27	13	6,170	83	9
2020	3.74	18,181	244	22	11	5,140	69	8

* For all NIIP alternatives, Moncisco, Coury Lateral and Cutter
** For both San Juan alternatives, PNM and Infiltration Intake
*** Cutter Diversion in San Juan alternatives
(flocc basinr3.xls)

NIIP Chemical Disinfection Caclulatons

Design Calculations -10/11/01 GLHJ
Chlorimination System - With J. Apache Demands
Navajo Gallup Water Supply Project
NIPP alternatives - Moncisco, Coury Lateral and Cutter

Assumptions
Chlorine injection rate of 1 ppm (demand of .5 ppm residual of .5 ppm)
Ammonia Demand .33 ppm (chlorine to ammonia ration 3:1)
pH of treated water 7.0 to 7.5
No ammonia in water after filtration
All disenfection CT requirements provided by UV units

Requirements
Determine chlorine and ammonia usage rates
size chorine and ammonia storage and injection system.

Calcs

NH3 and CL2 usage rates

Year	Demand (MGD)	NH3 dosage Rate	NH3 Daily Use	NH3 Monthly Use	Cl2 dosage rate	Cl2 daily Use	Cl2 Monthly use
		(ppm)	ppd	Tons	(ppm)	PPD	Tons
2020	27.64	0.33	76.07	1.14	1	230.52	3.46
2040	43.63	0.33	120.08	1.80	1	363.87	5.46

Room size

Assumptions Store 2 months supply of chlorine and ammonia canisters
Use 2 parallel parallel trains, 8 feet in width, 3' centers, empty set of trunions provided.

Ammonia - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	1.5	1.5	3	144	6
2040	2	2	4	192	8

Chlorine - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	4	4	8	384	16
2040	6	6	12	576	24

(file:NIIP disenf calcsr3.xls)

References
Handbook of Chlorination

San Juan Alternatives

Chemical Disinfection Calculations

Design Calculations -9/24/01 GLHJ
Chloramination System with J Apache Demands
Navajo Gallup Water Supply Project
San Juan Alternatives, PNM and Infiltration Intakes

Assumptions
Chlorine injection rate of 1 ppm (demand of .5 ppm residual of .5 ppm)
Ammonia Demand .33 ppm (chlorine to ammonia ration 3:1)
pH of treated water 7.0 to 7.5
No ammonia in water after filtration
All disinfection CT requirements provided by UV units

Requirements
Determine chlorine and ammonia usage rates
size chorine and ammonia storage and injection system.

Calcs

NH3 and CL2 usage rates

Year	Demand (MGD)	NH3 dosage Rate	NH3 Daily Use	NH3 Monthly Use	Cl2 dosage rate	Cl2 daily Use	Cl2 Monthly use
		(ppm)	ppd	Tons	(ppm)	PPD	Tons
2020	23.89	0.33	65.75	0.99	1	199.24	2.99
2040	38.25	0.33	105.27	1.58	1	319.01	4.79

Room size

Assumptions Store 2 months supply of chlorine and ammonia canisters
Use 2 parallel parallel trains, 8 feet in width, 3' centers, empty set of trunions provided.

Ammonia - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	1.5	1.5	3	144	6
2040	2	2	4	192	8

Chlorine - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	4	4	8	384	16
2040	6	6	12	576	24

(file:SJ disenf calcs r3.xls)

References
Handbook of Chlorination

Cuttter Diversion
Chemical Disinfection Calculations

Design Calculations -9/24/01 GLHJ
Chlorimination System - Witth J. Apache Demands
Navajo Gallup Water Supply Project
Cutter diversion in San Juan Alternative

Assumptions
Chlorine injection rate of 1 ppm (demand of .5 ppm residual of .5 ppm)
Ammonia Demand .33 ppm (chlorine to ammonia ration 3:1)
pH of treated water 7.0 to 7.5
No ammonia in water after filtration
All disenfection CT requirements provided by UV units

Requirements
Determine chlorine and ammonia usage rates
size chorine and ammonia storage and injection system.

Calcs

NH3 and CL2 usage rates

Year	Demand (MGD)	NH3 dosage Rate	NH3 Daily Use	NH3 Monthly Use	Cl2 dosage rate	Cl2 daily Use	Cl2 Monthly use
		(ppm)	ppd	tons/month	(ppm)	PPD	Tons
2020	3.74	0.33	10.29	0.15	1	31.19	0.47
2040	5.39	0.33	14.83	0.22	1	44.95	0.67

Room size

Assumptions Store 2 months supply of chlorine and ammonia canisters
Use 2 parallel parallel trains, 8 feet in width, 3' centers, empty set of trunions provided.

Ammonia - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	0.47	1	1.47	70.46	2.94
2040	0.67	1	1.67	80.37	3.35

Chlorine - Design

Year	Used/mo	Stand by	Total	Space Require	Total# of trunions
2020	0.47	1	1.47	70.46	2.94
2040	0.67	1	1.67	80.37	3.35

(file:cut disenf calcsr3.xls)

References
Handbook of Chlorination

Liner Quantities
Water Treatment Plants
Process Ponds

Navajo Gallup WSS
WTP Pond Liner Requirements
11-Oct-01

Assumptions
Quantities for liner will be determined
Costs will include the cost of the liner and installation cost
Cost for liner subgrade will be included in unlisted items
Liner will be exposed - Actual design may include some form of liner protection from damage due to ice formation

						Single Pond	Both Ponds
Alternative	Type of Pond	Bot Length	Bot Width	Depth	Slope	S.F. Liner	S.F. liner
NIIP Moncisco	Wastewater	160	60	10	1to 1	17,625	35,250
NIIP Cory Lateral	Wastewater	160	60	10	1to 1	17,625	35,250
NIIP Cutter	Wastewater	160	60	10	1to 1	17,625	35,250
PNM	Wastewater	155	60	10	1to 1	17,139	34,278
PNM	Settling	360	180	12	1to 1	see note	see note
SJ Infiltration	Wastewater	155	60	10	1to 1	17,139	34,278
SJ Alt Cutter	Wastewater	80	25	10	1to 1	5,687	11,374

Note: Liner for PNM settling ponds will be six inch reinforced concrete with a surface area of approximately 92,000 square feet per pond.

Navajo- Gallup Water Supply Project
Wastewater Flows Includes J. Apache Demands
5-Oct-01

Assumptions

1. Total of 6 hours detention time, 2 ponds polishing ponds or wastewater treatment ponds in series each with 3 hours of detention time
2. Length to width ratio 2:1
3. Side slopes 1:1
4. Wastewater Estimate = BW production which is estimate which is 10 percent of incoming flow

Options

	NIIP Alternatives - Moncisco Dam, Coury Lateral and Cutter								
	Water Quality - Water Constant Turbidity, TOC higher than source water								
	Treatment Scheme - Enhanced coagulation - MF - UF - NH3- chlorine								
					Per pond	per pond	per pond	per pond	SA (acres)
Year	**Demand MGD**	BW Water MGD	Flow rate gpm	Total volume gals	Volume PP	area	width	length	each
2040	**43.63**	4.36	3,030	1,090,750	545,375	7,291	80	181	0.33
2020	**27.64**	2.76	1,919	691,000	345,500	4,619	68	156	0.24

	San Juan Alternatives								
	Source 1 San Jauan River PNM and Infiltration								
	Water Quality - Periods of High Turbidity. High TOC, Potential for Crypto								
	Treatment - Enhanced Coagulation - MF - UF - NH3- Chlorine								
									SA (acres)
	Demand MGD	BW Water MGD	Flow rate gpm	Pond size for DT 6	Volume PP*	area	width	length	each
2040	**38.25**	3.83	2656.25	956,250	478,125	6392	77	173	0.30
2020	**23.89**	2.39	1659.03	597,250	298,625	3992	65	149	0.22
	Source 2 Cutter Reservoir								
	Water Quality - Constant turbidity - Low turbidity								
									SA (acres)
	Demand MGD	BW Water MGD	Flow rate gpm	Pond size for DT 6	Volume PP*	area	width	length	each
2040	**5.39**	0.54	374.31	134,750	67,375	901	41	102	0.097
2020	**3.74**	0.37	259.72	93,500	46,750	625	38	95	0.082

* PP - Polishing or wastewater treatment ponds (gallons)

Wastewater Polishing Ponds and Polishing Pond Drying Beds

Volume Calculations
Polishing Pond Excavation and Sediment Drying Bed Size and Sand Requirements
10/11/2001 Includes j. Apache

Assumptions and Notes
A. Polishing Ponds to treat backwash water and other wastes before being recycled
to the treatment system.
B. Sediment taken from the PNM polishing pond will be conveyed to the drying beds
for the sediment removed from the settling ponds.

1. Wastewater Settling Ponds Excavation Quantities

Site	Top Width	Top Length	Depth	Slope	Bottom W	Bottom L	Vol CY ea	total Vol
NIIP *	180	80	10	1 to 1	160	60	4415	8829
San Juan **	175	80	10		155	60	4285	8570
Cutter ***	100	42	10		80	22	1071	2143

2.. Sediment Excavation Quantities

Site	Top Width	Top Length	Depth	Slope	Bottom W	Bottom L	Volume CY	
NIIP *	164	64	2	1 to 1	160	60	744	1488
SJ Alt **	159	64	2		155	60	721	1442
Cutter ***	84	24	2		80	20	134	267
Design criteria - Dewater, Drain and excavate solids when the depth of solids is approximately 2 feet deep,								

3. Drying bed Quantities

Drying Bed	L	W	Sand Volume (CY)
NIIP *	167	40	124
SJ Infiltration	162	40	120
Cutter ***	60	20	22
Design assumes 4 inches of sediment will be spread across drying bed			
6 inches of sand used for drying will be replaced after unloading bed			

Notes:
* NIIP Alternatives including Moncisco, Coury Lateral and Cutter
** San Juan Alternatives including PNM and San Jaun with Infiltration Intake
*** Cutter Diversion in San Juan Alternatives
No separate drying beds for PNM Alternative as drying beds for Settling
ponds will also be used for sediment from polishing ponds

(file: PP and PP drying bedsr3.xls)

PNM Settling Pond
Size, Excavation, Sediment

Navajo- Gallup Water Supply Project
Settling Pond Calculations
15-Aug-01

Assumptions

1. Total of 6 hours detention time, 2 ponds in series each with 3 hour detention time
2. Length to width ratio 2:1
3. Side slopes 1:1 with a finished depth of 10 feet with 2 feet freeboard
4. Ponds sized for 2040 demand

	Demand	Pond Q	Flow rate	Pond size DT 6hrs	area (SF)	width	length	Acres	Acres
	(MGD)	(MGD)	(gpm)	(Gallons)	each	(feet)	(feet)	Each	Total
2040	38.25	38.25	26562.50	9,562,500	63,920	199	378	1.72	3.4

Excavation Quantities per pond							
	Bottom width	Bottom Length	Top Width	Top Length	Depth	One pond	Both
Year	(feet)	(feet)	(feet)	(feet)	(feet)	Volume CY	CY
2040	179	358	203	382	12	31,388	62,777

Volume of solids in each pond when sediment depth is 2 feet.					
Bottom W	Bottom L	Sediment W	Sediment L	depth of sediment	Volume
					CY
179	358	183	362	2	4,815

Drying Bed Requirement

Bed size based on a length to width ratio of 2:!
Bed will consist of 12 inches of gravel with underdrain piping system followed by 6 inches of sand. It will be assumed that 2 inches of sand will be removed with the dry sediment. Approximately 6-inches of excavated sediment will be spread on top of the bed for drying. Primary and secondary pond will be switched after cleaning.

Sed Vol	Surface area	Width	Length	Sand Requirement	Gravel
(cubic feet)	(square feet)	(feet)	(feet)	(cubic yards)	CY
129,996	259,992	361	721	4,815	9,629

Two drying beds will be provided each with a drying area of approximately 260,000 square feet (5.97acres). The sediment generated during the cleaning of one pond will produce a layer from 5 to 6 inches thick. A combination of draining and evaporation will produce a dried sediment layer between 2.5 and 3.0 inches that will be removed and disposed of along with any sand that is excavated with the dried sediment.
One drying bed will be used, with one on standby.

file: pnm SP calcs revised.xls

SUPPORTING DOCUMENTATION ON ANNUAL OPERATION COST ESTIMATES.

ANNUAL POWER COSTS
NTUA

Navajo Gallup Water Supply Project - October 11, 2001
Operation and Maintenance Calculations -Revised to Include J Apache

Power Consumption Calculations usintg NTUA Power

Assumptions

1 Power Consumption provided by Zenon for the ultrafiltration system and Aquionics for ultraviolet disinfection units. These costs will be prorated for each demand and each treatment plant.

2 KW usage for influent pumps and recycle pumps will be calculated based on flow and head

3 Miscellaneous power will be included in a safety factor of 1% of the total of 1 and 2 above

4 Electrical Supply requirement 480V 3 phase

5 Power costs are based on operating at an average daily flow (design flow / 1.3) for 24 hours a day.

Power usage per MGD								
	Rated Flow (MGD)	Head	KW-hr/day	kw-h/day/ MGD	KW		KW/MGD	Source
	1. Ultrafiltration systems							
	20.2		7475	370	638		31.6	Zenon
	2 Ultraviolet Disinfection units							
	7		672	96.0	28		4.0	Aquionics
	(UV unit consumes 28 KW/hour)							
	3. Intake Diversion pumps							
	1	30	147	147	6.1		6.1	Calc
	4. Pumps from PNM Settling Pond							
	1	30	147	147	6.1		6.1	Calc
	4 Recycle pumps from WW ponds							
	1	30	147	147	6.1		6.1	Calc

Estimated cost of power NTUA	KWH	$0.0185
Demand Charge (Annual)	KW	$184.80

	Annual Estimated Consumption Per Alternative	Design	Average				Energy	Demand	Demand	Total
Year	Plant	Flow (MGD)	Flow (MGD)	KW-hr/day	Annual KW-hr	Misc	Costs	KW	Costs	
2020	NIIP Moncisco and Cutter	27.64	21.26	13,038	4,758,831	47,588	$88,919	887	$163,908	$252,827
2040		43.63	33.56	20,580	7,511,860	75,119	$140,359	1,400	$258,730	$399,089
2020	NIIP Coury Lateral	27.64	21.26	16,167	5,900,903	59,009	$110,258	887	$163,908	$274,166
2040		43.63	33.56	25,520	9,314,631	93,146	$174,044	1,400	$258,730	$432,774
2020	SJR PNM	23.89	18.38	16,678	6,087,434	60,874	$113,744	992	$183,319	$297,062
2040		38.25	29.42	26,703	9,746,519	97,465	$182,114	1,588	$293,509	$475,623
	Cutter Diversion									
2020		3.74	2.88	1,764	643,923	6,439	$12,032	120	$22,179	$34,210
2040		5.39	4.15	2,542	928,007	9,280	$17,340	224	$41,360	$58,700
	SRJ Infiltration*									
2020		23.89	18.38	11,269	4,113,187	41,132	$76,855	767	$141,670	$218,525
2040		38.25	29.42	18,043	6,585,575	65,856	$123,051	1,227	$226,826	$349,878
* Does include power consumption by the Ranney intake system.										

ADF - Average daily flow

Backup generators are required at each WTP plant to supply power at the average daily flow.

Electrical usage and costs are based on average water demands

ANNUAL POWER COSTS
CRSP

Navajo Gallup Water Supply Project - October 11, 2001
Operation and Maintenance Calculations -Revised to include J Apache

Power Consumption Calculations usintg CRSP Power

Assumptions

1. Power Consumption provided by Zenon for the ultrafiltration system and Aquionics for ultraviolet disinfection units. These costs will be prorated for each demand and each treatment plant.
2. KW usage for influent pumps and recycle pumps will be calculated based on flow and head
3. Miscellaneous power will be included in a safety factor of 1% of the total of 1 and 2 above
4. Electrical Supply requirement 480V 3 phase
5. Power costs are based on operating at an average daily flow (design flow / 1.3) for 24 hours a day.

Power usage per MGD								
	Rated Flow (MGD)							
	1. Ultrafiltration systems	Head	KW-hr/day	kw-h/day/ MGD	KW		KW/MGD	Source
	20.2		7475	370	638		31.6	Zenon
	2 Ultraviolet Disinfection units							
	7		672	96	28		4.0	Aquionics
	(UV unit consumes 24 KW/hour)							
	3. Intake Diversion pumps							
	1	30	147	147			6.1	Calc
	4. Pumps from PNM Settling Pond							
	1	30	147	147			6.1	Calc
	4 Recycle pumps from WW ponds							
	1	30	147	147			6.1	Calc

Estimated cost of power from CRSP	KWH	$0.0081
Demand Charge (annual)	KW	$41.28

	Annual Estimated Consumption Per Alternative	Design	Average				Energy	Demand	Demand	Total
Year	Plant	Flow (MGD)	Flow (MGD)	KW-hr/day	Annual KW-hr	Misc	Costs	KW	Costs	
2020	NIIP Moncisco and Cutter	27.64	21.26	13,038	4,758,831	47,588	$38,932	887	$36,613	$75,545
2040		43.63	33.56	20,580	7,511,860	75,119	$61,455	1,400	$57,794	$119,249
2020	NIIP Coury Lateral	27.64	21.26	16,167	5,900,903	59,009	$48,275	887	$36,613	$84,888
2040		43.63	33.56	25,520	9,314,631	93,146	$76,203	1,400	$57,794	$133,997
2020	SJR PNM	23.89	18.38	16,678	6,087,434	60,874	$49,801	992	$40,949	$90,750
2040		38.25	29.42	26,703	9,746,519	97,465	$79,736	1,588	$65,563	$145,299
	Cutter Diversion									
2020		3.74	2.88	1,764	643,923	6,439	$5,268	120	$4,954	$10,222
2040		5.39	4.15	2,542	928,007	9,280	$7,592	224	$9,239	$16,831
	SRJ Infiltration*									
2020		23.89	18.38	11,269	4,113,187	41,132	$33,650	767	$31,646	$65,296
2040		38.25	29.42	18,043	6,585,575	65,856	$53,877	1,227	$50,668	$104,544
* Does include power consumption by the Ranney intake system.										

Notes

ADF - Average daily flow

Backup generators are required at each WTP plant to supply power at the average daily flow.

Electrical usage and costs are based on average demands (30% of Peak flows).

ANNUAL OPERATOR COSTS

Navajo-Gallup Water Supply Project
Appraisal Study - Operator Costs
25-Sep-01

Assumptions

1. Technical operators have a total cost of $40 dollars a hour. Two operators are required 8 hours a day. between 0900 to 1700 hrs with one operator required the rest of the time.
2. Maintenance personnel have a total cost of $50.00 an hour and with one in the plant an average of 8 hrs a day.
3. Plant manager has a total cost of $60.00 per hour at the plant an average of 8 hours a day. plant manager will also be used to fill in for an operator when one of the operators are sick or on vacation or on vacation.
4. Operator requirements for all plants and demands will be the same.

Annual Operations Cost Estimate

Title	Shift	hourly cost	Hrs day	Days / week	Annual Cost
Operator	0700-1500	$40	8	7	$116,480
Operator	0700-1500	$40	8	7	$116,480
Operator	1500-2300	$40	8	7	$116,480
Operator	2300-0700	$40	8	7	$116,480
Maintenance	0900-1700	$50	8	5	$104,000
Manager	0900-1700	$60	8	5	$124,800
Total					$694,720

Notes

Total costs are "loaded" costs and includes hourly wage, insurance, retirement etc.

ANNUAL CHEMICAL COSTS

Chemical Costs include demand by J Apache
10/11/01
Assumptions

Cleaning Chemicals hollow fiber membranes will be prorated from Zenon Cost Data

Aluminum sulfate costs will be based on a dosage of 30 ppm for all plants except the San Juan River for the SJ infiltration intake alternative which will be at 10 PPM. The estimated cost of Alum is $.25.

Chloramine demand is estimated at 1mg/L with a dosage ratio of 3 parts chlorine to one part of ammonia.
Cost of chorine is $.25 per pound delivered in ton containers while cost of ammonia gas is estimated to be $1.00 per pound.

Chemical usage is based on operation at average flow (design demand divided by 1.3) for 24 hours a day.

Cleaning chemicals - Information from Zenon				
Chemical	Cost/yr		base flow	$/ MGD
MC-1	$47,237		20.2	$6.41
Sodium Hypochlorite	$11,678			$1.58
Sodium Hydroxide	$4,834			$0.66
Sodium Bisulfate	$2,651			$0.36
Total				$9.01

Aluminum sulfate					
Plant	Dosage mg/L		# used/ MG	$/ pound	$/ MGD
All except II	30		250	$0.25	$62.50
Infiltration Intake(II)	10		83	$0.25	$20.75

Chlorine Gas	Dosage mg/L		# used/ MG	$/ pound	$/ MGD
All Plants	1		8.34	$0.25	$2.09

Anhydrous Ammonia	Dosage mg/L		# used/ MG	$/ pound	$/ MGD
All Plants	0.33		2.75	$1.00	$2.75

Annual Chemical costs		Design	Average						
Year	Plant	Flow Rate	Flow rate	$/day CC	$/ day Alum	$/day Cl2	$/day NH3	$/day total	$/year
2020	NIIP Alternatives	27.64	21.26	$191.48	$1,329	$44	$58	$1,623.12	$592,440
2040	NIIP Alternatives	43.63	33.56	$302.25	$2,098	$70	$92	$2,562.12	$935,172
2020	PNM	23.89	18.38	$165.50	$1,149	$38	$51	$1,402.91	$512,062
2040	PNM	38.25	29.42	$264.98	$1,839	$61	$81	$2,246.18	$819,856
2020	Cutter Diversion	3.74	2.88	$25.91	$180	$6	$8	$219.63	$80,164
2040	Cutter Diversion	5.39	4.15	$37.34	$259	$9	$11	$316.52	$115,530
2020	San Juan w II	23.89	18.38	$165.50	$381	$38	$51	$635.67	$232,021
2040		38.25	29.42	$264.98	$611	$61	$81	$1,017.77	$371,486
CC - Hollow fiber Cleaning Chemicals									

Notes
1. NIIP alternatives include Moncisco Dam, Coury Lateral and Cutter
2. San Juan II - San Jaun alternative with infiltration intake.

(file: power-chem-eq calcsr5.xls sheet 2)

ANNUAL EQUIPMENT REPLACEMENT COSTS

Equipment Replacement incl J. Apache demand
11-Oct-01

Assumptions

1. Replacement of Hollow Fiber membrane cassettes. Cost/MGD
(Data from manufacturer information)

Flow MGD	$/year	$/year-MGD	Source
22.5	$354,475	$15,754	Zenon

2. Annual replacement of tubes etc in Ultraviolet Disinfection Units. Cost/MGD
(Data from manufacturer information)

Flow MGD	$/year	$/year-MGD	Source
7	$4,000	$571	Aquionics

3. Replacement of mechanical equipment. Cost/MGD
(Estimate based on 10% of UF filter cost)

Flow MGD	$/year	$/year-MGD	Source
22.5	$35,000	$1,556	Estimated

4 Sum of annual cost for replacement of equipment per MGD $17,881

Annual cost for equipment replacement				
Year	Plant	Design	Average	cost
		Flow rate (MGD)	Flow rate (MGD)	
2020	NIIP Alternatives	27.64	21.26	$380,187
2040	NIIP Alternatives	43.63	33.56	$600,128
2020	PNM	23.89	18.38	$328,606
2040	PNM	38.25	29.42	$526,127
2020	Cutter Diversion	3.74	2.88	$51,443
2040	Cutter Diversion	5.39	4.15	$74,139
2020	San Juan w II	23.89	18.38	$328,606
2040	San Juan w II	38.25	29.42	$526,127

Notes
1. Costs area based on operating at average daily flow (design/1.3) 24 hours a day.
2. NIIP Alternatives include Moncisco, Coury Lateral and Cutter
3. San Juan w II = San Juan Alternative with infiltration intake.
4. Costs are based on annual replacement although it is expected that the hollow fiber membrane cassettes will need to be replaced every 10 years, the tubes in the UV disinfection units every year and the mechanical equipment (pumps, blowers etc) every 15 years.

(file: power-chem-eq calcsr5.xls sheet 3)

ANNUAL SEDIMENT DISPOSAL COST
WASTEWATER POLISHING PONDS

Excavation and disposal of sediment contained in the Wastewater polishing ponds.
Navajo Gallup WSP
10/11/01

Assumptions

1. Distance between each plant and disposal site 10 miles round trip.
3. Ponds cleaned every 15 years no matter what demand.
4. Annual cost based on a interest rate of 8 percent
5. Dewater, Drain and excavate solids when the depth of solids is approximately 2 feet deep.

1. Wastewater Settling Ponds Excavation Quantities

							Per pond	Both
Site	Top Width	Top Length	Depth	Slope	Bottom W	Bottom L	Vol CY	
NIIP Alternatives	180	80	10	1 to 1	160	60	4415	8829
San Juan Alternatives	175	80	10		155	60	4285	8570
Cutter Diversion	100	40	10		80	20	1004	2007

2. Volume of solids to be removed, dewatered and hauled for disposal.

							Sediment	
Site	Top Width	Top Length	Depth	Slope	Bottom W	Bottom L	CY each	CY total
NIIP Alternatives	164	64	2	1 to 1	160	60	744	1488
San Juan Alternatives	159	64	2		155	60	721	1442
Cutter Diversion	84	24	2		80	20	134	267

Excavation			
		Dragline	total Cost
Site	CY	$/CY	
NIIP Alternatives	1488	$4.00	$5,952
PNM	1442	$4.00	$5,769
Cutter	267	$4.00	$1,069
San Juan with II	1442	$4.00	$5,769

Source for cost RS Means Site work, 3/4 CY removing light clay

Loading and Transport			
Site	CY	Cost/YD	Total Cost
NIIP Alternatives	1637	$14.84	$24,292
PNM	1586	$14.84	$23,542
Cutter	294	$14.84	$4,363
San Juan with II	1586	$14.84	$23,542

CY includes a 10% increase for sand removed during loading
Source cost for Loading RS Means, using a front end loader at 70 CY per hour
Source for cost RS Means Site Work, 12 CY dump truck with PR of 0.6 loads per hour.

Total Costs Every 15 years		F/P	A/F factor	Annual cost
Site		factor		
NIIP Alternatives	$30,244	3.1722	0.03682	$3,533
PNM	$29,311	3.1722	0.03682	$3,424
Cutter Diversion	$5,432	3.1722	0.03682	$634
San Juan with II	$29,311	3.1722	0.03682	$3,424

Notes

1. NIIP alternatives include Moncisco, Coury Lateral and Cutter
2. San Juan with II = San Juan River alternative with infiltration intakes.

(file: wwpp cleaning costsr3.xls)

San Juan River PNM Alt
Sediment Handling Costs

Navajo Gallup Water Supply Project
Sediment Production and Disposal Costs
San Juan River PNM Alternative

15-Aug-01

Sediment Production Rates

Criteria and Assumptions
- Solids loading will be based on peak solids loading 14 days a year at a Suspended solids concentration of 20,000 mg/L.
- Sediment production rates and costs will be based on year 2040 flow rate
- density of fully dried material 70 pounds per cubic feet
- sediment in pond at cleanout is 2 percent solids
- sludge after drying beds have solids content of 50 percent solids

Site	Flow - MGD	TSS	#/year per day(1)	CY/day (1)	Volume @ 2 % solids (2)
PNM	38.25	15,000	398,756	211	418

1. Pounds if totally dry
2. Volume taken up in pond

Notes:
Volume of sediment in pond when excavation is required 4,815 CY
90% of solids retained in lead pond with a solids accumulation rate of (557 x .9) or 501 CY per day
Days of high sediment loading before lead pond needs to be cleaned (4815/418) = 11.5 days of TSS loading of 15,000 mg/L.

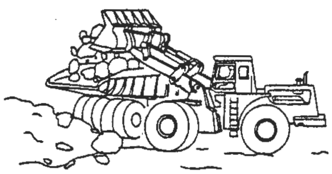
Costs for Sediment Handling

Criteria and Assumptions
- Excavation, drying and disposal of sludge will need to be done twice a year
- Excavated sediment is placed on the bed will have a depth of approximately 6 inches.
- Dried sludge will have a depth of 3.0 inches over 5.96 acres or a volume of 2404 cubic yards.
- It is estimated that 2 inches of sand will be removed with the dried sediment or a volume of 1603 CY.

Activity	CY	$ per CY	Cost per Cleaning Cycle	Annual Cost
1 Excavate sediment and load beds	4815	$4.64	$22,342	$44,683
2. Load and haul dried sludge	4,007	$8.03	$32,176	$64,352
3. Sand Replacement	1,603	$20.00	$32,060	$64,120
Total			$86,578	$173,156

Notes
Volume of loaded sludge includes 2404 CY of dried sediment and 1603 CY of Sand with a total of 4007 CY.
Excavation costs are from means using 1 1/2 power shovel, 6-12 CY dump trucks
Load and haul costs form means using 1-1/2 CY loader, 4-16 CY dump trailers with a 4 mile round trip.
(file sp pnm costs.xls)

A12.1-614 Load & Haul Common Earth



The Loading and Hauling of Common Earth System balances the productivity of loading equipment to hauling equipment. It is assumed that the hauling equipment will encounter light traffic and will move up no considerable grades on the haul route.

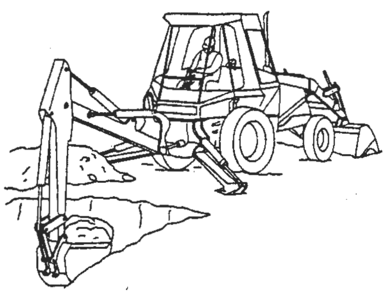
The Expanded System Listing shows Loading and Hauling systems that use either a track or wheel front–end loader. Track loaders indicated range from 1-1/2 Cubic Yards capacity to 4-1/2 Cubic Yards capacity. Wheel loaders range from 1-1/2 Cubic Yards to 5 Cubic Yards. Trucks for hauling range from 6 Cubic Yards capacity to 20 Cubic Yards capacity. Each system lists the number of trucks involved and the distance (round trip) that each must travel.

System Components	QUANTITY	UNIT	COST PER C.Y. EQUIP.	COST PER C.Y. LABOR	COST PER C.Y. TOTAL
SYSTEM 12.1-614-1000					
LOAD & HAUL COMMON EARTH, 1-1/2 CY LOADER, SIX 6 CY TRUCKS, 1 MRT					
Excavating bulk, F.E. loader track mtd., 1.5 C.Y.	1.000	C.Y.	.48	.65	1.13
Haul earth, 6 C.Y. dump truck, 1 mile round trip, 3.3 loads/hr	1.000	C.Y.	3.86	2.69	6.55
Spotter at earth fill dump or in cut	.010	Hr.		.35	.35
Total			4.34	3.69	8.03

12.1-614	Load & Haul Common Earth	COST PER C.Y. EQUIP.	COST PER C.Y. LABOR	COST PER C.Y. TOTAL
1000	Load&haul common earth,1-1/2 C.Y. tr. loader,six 6C.Y. trucks,1MRT	4.34	3.69	8.03
1200	Four 12 C.Y. dump trucks, 2 mile round trip	3.95	2.88	6.83
1400	Three 16 C.Y. dump trailers, 2 mile round trip	3.98	2.50	6.48
1600	Four 16 C.Y. dump trailers, 4 mile round trip	5.05	2.98	8.03
2000	2-1/2 C.Y. track loader, six 12 C.Y. dump trucks, 3 mile round trip	4.17	2.93	7.10
2200	Four 16 C.Y. dump trailers, 2 mile round trip	3.99	2.29	6.28
2400	Five 16 C.Y. dump trailers, 4 mile round trip	5.10	2.80	7.90
2600	Three 20 C.Y. dump trailers, 1 mile round trip	2.90	1.73	4.63
3000	3-1/2 C.Y. track loader, six 12 C.Y. dump trucks, 1 mile round trip	3.05	1.94	4.99
3200	Seven 16 C.Y. dump trailers, 4 mile round trip	5.20	2.69	7.89
3400	Four 20 C.Y. dump trailers, 1 mile round trip	3.06	1.57	4.63
3600	Six 20 C.Y. dump trailers, 4 mile round trip	4.73	2.46	7.19
4000	4-1/2 C.Y. track loader, eight 12 C.Y. dump trucks, 1 mile round trip	3.05	1.81	4.86
4200	Six 16 C.Y. dump trailers, 1 mile round trip	3.44	1.73	5.17
4400	Six 20 C.Y. dump trailers, 2 mile round trip	3.72	1.84	5.56
4600	Eight 20 C.Y. dump trailers, 4 mile round trip	4.72	2.29	7.01
5000	1-1/2 C.Y. wheel loader, eight 6 C.Y. dump trucks, 2 mile round trip	5.45	4.46	9.91
5200	Four 12 C.Y. dump trucks, 1 mile round trip	2.76	2.12	4.88
5400	Six 12 C.Y. dump trucks, 3 mile round trip	3.99	2.93	6.92
5600	Five 16 C.Y. dump trailers, 4 mile round trip	4.88	2.79	7.67
6000	3 C.Y. wheel loader, eight 12 C.Y. dump trucks, 2 mile round trip	3.64	2.41	6.05
6200	Five 16 C.Y. dump trailers, 1 mile round trip	2.98	1.62	4.60
6400	Eight 16 C.Y. dump trailers, 3 mile round trip	4.21	2.22	6.43
6600	Six 20 C.Y. dump trailers, 2 mile round trip	3.18	1.75	4.93
7000	5 C.Y. wheel loader, eight 16 C.Y. dump trailers, 1 mile round trip	3.18	1.61	4.79
7200	Twelve 16 C.Y. dump trailers, 3 mile round trip	4.42	2.16	6.58
7400	Nine 20 C.Y. dump trailers, 2 mile round trip	3.39	1.66	5.05
7600	Twelve 20 C.Y. dump trailers, 4 mile round trip	4.39	2.11	6.50

MNM Settling Ponds
Sediment HANDLING

A12.1-414 Excavate Common Earth



The Excavation of Common Earth System balances the productivity of the excavating equipment to the hauling equipment. It is assumed that the hauling equipment will encounter light traffic and will move up no considerable grades on the haul route. No mobilization cost is included. All costs given in these systems include a swell factor of 25% for hauling.

The Expanded System Listing shows Excavation systems using backhoes ranging from 1/2 Cubic Yard capacity to 3-1/2 Cubic Yards. Power shovels indicated range from 1/2 Cubic Yard to 3 Cubic Yards. Dragline bucket rigs range from 1/2 Cubic Yard to 3 Cubic Yards. Truck capacities range from 6 Cubic Yards to 20 Cubic Yards. Each system lists the number of trucks involved and the distance (round trip) that each must travel.

System Components	QUANTITY	UNIT	COST PER C.Y. EQUIP.	LABOR	TOTAL
SYSTEM 12.1-414-1000					
EXCAVATE COMMON EARTH, 1/2 CY BACKHOE, TWO 6 CY DUMP TRUCKS, 1 MRT					
Excavating, bulk hyd. backhoe wheel mtd., 1/2 C.Y.	1.000	C.Y.	.99	1.74	2.73
Haul earth, 6 C.Y. dump truck, 1 mile round trip, 3.3 loads/hr	1.000	C.Y.	2.09	1.45	3.54
Spotter at earth fill dump or in cut	.020	Hr.		.56	.56
Total			3.08	3.75	6.83

12.1-414	Excavate Common Earth	COST PER C.Y. EQUIP.	LABOR	TOTAL
1000	Excavate common earth, 1/2 C.Y. backhoe,two 6 C.Y. dump trucks, 1MRT	3.08	3.75	6.83
1200	Three 6 C.Y. dump trucks, 3 mile round trip	7.30	6.80	14.10
1400	Two 12 C.Y. dump trucks, 4 mile round trip	5.95	5.15	11.10
1600	3/4 C.Y. backhoe, three C.Y. dump trucks, 1 mile round trip	2.97	3	5.97
1700	Five 6 C.Y. dump trucks, 3 mile round trip	7.10	6.15	13.25
1800	Two 12 C.Y. dump trucks, 2 mile round trip	4.40	3.67	8.07
1900	Two 16 C.Y. dump trailers, 3 mile round trip	4.75	3.13	7.88
2000	Two 20 C.Y. dump trailers, 4 mile round trip	4.85	3.29	8.14
2200	1-1/2 C.Y. backhoe, eight 6 C.Y. dump trucks, 3 mile round trip	6.95	5.40	12.35
2300	Four 12 C.Y. dump trucks, 2 mile round trip	4.10	2.95	7.05
2400	Six 12 C.Y. dump trucks, 4 mile round trip	5.55	3.72	9.27
2500	Three 16 C.Y. dump trailers, 2 mile round trip	4.14	2.36	6.50
2600	Two 20 C.Y. dump trailers, 1 mile round trip	3.13	1.91	5.04
2700	Three 20 C.Y. dump trailer, 3 mile round trip	4.23	2.40	6.63
2800	2-1/2 C.Y. backhoe, six 12 C.Y. dump trucks, 1 mile round trip	2.88	1.86	4.74
2900	Eight 12 C.Y. dump trucks, 3 mile round trip	4.17	2.63	6.80
3000	Four 16 C.Y. dump trailers, 1 mile round trip	3.34	1.74	5.08
3100	Six 16 C.Y. dump trailers, 3 mile round trip	4.57	2.40	6.97
3200	Six 20 C.Y. dump trailers, 4 mile round trip	4.54	2.37	6.91
3400	3-1/2 C.Y. backhoe, six 16 C.Y. dump trailers, 1 mile round trip	4.08	1.81	5.89
3600	Ten 16 C.Y. dump trailers, 4 mile round trip	5.80	2.58	8.38
3800	Eight 20 C.Y. dump trailers, 3 mile round trip	4.77	2.12	6.89
4000	1/2 C.Y. pwr. shovel, four 6 C.Y. dump trucks, 2 mile round trip	5.85	4.75	10.60
4100	Two 12 C.Y. dump trucks, 1 mile round trip	3.13	2.56	5.69
4200	Four 12 C.Y. dump trucks, 4 mile round trip	5.60	3.81	9.41
4300	Two 16 C.Y. dump trailers, 2 mile round trip	4.15	2.69	6.84
4400	Two 20 C.Y. dump trailers, 4 mile round trip	4.82	3.13	7.95
4800	3/4 C.Y. pwr. shovel, six 6 C.Y. dump trucks, 2 mile round trip	5.65	4.60	10.25
4900	Three 12 C.Y. dump trucks, 1 mile round trip	2.98	2.18	5.16
5000	Five 12 C.Y. dump trucks, 4 mile round trip	5.55	3.67	9.22
5100	Three 16 C.Y. dump trailers, 3 mile round trip	4.67	2.74	7.41
5200	Three 20 C.Y. dump trailers, 4 mile round trip	4.65	2.72	7.37
5400	1-1/2 C.Y. pwr. shovel, six 12 C.Y. dump trucks, 1 mile round trip *	2.79	1.85	4.64
5500	Ten 12 C.Y. dump trucks, 4 mile round trip	5.35	3.34	8.69

PNM Settling Ponds - Sediment Hauling

Important: See the Reference Section for critical supporting data - Reference Nos., Crews, & City Cost Indexes

ESTIMATES ON LOG REDUCTION CREDIT DURING TREATED WATER CONVEYANCE TO SERVICE.

MONCISCO TREATMENT PLANT TO SERVICE AREAS
Navajo Gallup Water Supply Project
Appraisal Study
Contact Times/Log Reduction in Distribution System-Southwest Leg

						Section	Section	Total CT	Total CT	Log	Log
		Pipe Size	Pipe Size	Q(cfs)	Q(cfs)	CT (min)	CT(min)	(min)	(min)	Reduction	Reduction
Withdrawal Point	Distance From WTP*	2020	2040	2020	2040	2020	2040	2020	2040	2020	2040
Burnham	61,340	48	48	36.12	57.94	355	222	355	222	0.48	0.30
Lake VJ	133,468	48	48	35.75	57.33	422	263	778	485	1.06	0.66
Burnham Junction	244,475	48	48	34.24	59.49	679	391	1457	876	1.99	1.19
Tohachi	282,446	42	48	31.51	44.84	193	177	1650	1053	2.25	1.44
Coyote CJ	315,099	42	48	30.35	42.85	172	160	1822	1212	2.48	1.65
Twin Lakes	330,693	30	48	27.78	38.41	46	85	1868	1297	2.55	1.77
Ya-To-hey J	361,859	30	48	26.67	36.53	96	179	1964	1476	2.68	2.01
Gallup Junction	382,455	30	48	18.47	21.83	91	198	2055	1673	2.80	2.28
Naschitti	51,693	18	36	4.24	12.49	359	487	2414	2161	3.29	2.95
Sheepspring	97,272	18	36	3.35	10.94	401	491	2814	2651	3.84	3.62
Newcomb	142,073	18	36	2.04	8.72	646	605	3461	3256	4.72	4.44
Sanostee	193,131	18	36	8.2	14.71	183	409	3644	3665	4.97	5.00
Shiprock J	287,472	18	36	0.86	6.72	3229	1653	6832	5318	9.32	7.25
Coyote Canyon	35,907	18	24	2.58	4.44	410	423	2232	1636	3.04	2.23
Standing Rock	117,215	18	24	1.83	3.2	1308	1330	3540	2965	4.83	4.04
Dalton Pass	155,234	18	24	1.76	3.06	636	650	4176	3616	5.69	4.93

Contact Times/Log Reduction in Distribution System - Southeast Leg

						Section	Section	Total CT	Total CT	Log	Log
		Pipe Size	Pipe Size	Q(cfs)	Q(cfs)	CT (min)	CT(min)	(min)	(min)	Reduction	Reduction
Withdrawal Point	Distance From WTP	2020	2040	2020	2040	2020	2040	2020	2040	2020	2040
Huerfano	111,544	20	20	3.63	6.19	1117	655	1117	655	1.52	0.89
Nageezi	172,811	20	24	3.37	5.68	661	564	1777	1219	2.42	1.66
Counselor	278,791	20	20	2.75	4.63	1401	832	3178	2051	4.33	2.80
Torreon	364,240	14	18	1.14	2.01	1335	1251	4513	3303	6.15	4.50

Notes

1. Blank line within table indicates a branch off of main line
2. CT requirement of 2,200 minutes to provide a 99.9 percent deactivation (3 log) with a residual of .5 total chloramines and a temperature of 5 degrees C
3. 1 log is 90 percent removal of Girardia
   2 log is 99 percent removal of Girardia
   3 log is 99.9 percent removal of Girardia
   4 log is 99.99 percent removal of Girardia

PNM TREATMENT PLANT TO SERVICE AREAS
Navajo Gallup Water Supply Project
Appraisal Study
Contact Times/Log Reduction in Distribution System

						Section	Section	Total CT	Toal CT	Log	Log
		Pipe Size	Pipe Size	Q(cfs)	Q(cfs)	CT (min)	CT(min)	(min)	(min)	Reduction	Reduction
Withdrawal Point	Distance From WTP*	2020	2040	2020	2040	2020	2040	2020	2040	2020	2040
Ship Rock Junction	99,075	42	48	36.28	58.21	438	356	438	356	0.60	0.49
Sanostee	193,415	42	48	35.42	51.49	427	384	865	740	1.18	1.01
Burnham Junction	244,475	48	48	34.24	59.49	312	180	1177	920	1.60	1.25
Newcomb	254,017	48	48	34.08	49.22	59	41	1235	960	1.68	1.31
Sheepsprings	305,216	45	45	33.19	47.7	284	197	1519	1158	2.07	1.58
Naschitte	334,853	45	45	32.77	47	166	116	1686	1274	2.30	1.74
Tohachi	405,274	42	42	31.88	45.46	354	248	2040	1522	2.78	2.08
Coyote Canyon	457,713	42	42	30.72	43.47	274	193	2313	1715	3.15	2.34
Twin Lakes	473,307	39	42	27.28	38.41	79	65	2392	1780	3.26	2.43
Ya-To-hey Junction	520,067	30	39	26.67	36.53	143	177	2536	1957	3.46	2.67
Gallup Junction	587,424	28	30	18.47	21.83	260	252	2795	2209	3.81	3.01
Rock Springs	29,441	21	30	8.2	14.71	144	164	2679	2121	3.65	2.89
Window Rock	88,415	21	24	6.27	11.51	565	402	3244	2523	4.42	3.44

Notes
1. * Rock Springs and Window Rock distances is from the Yo-to-Hey junction
2. CT requirement of 2,200 minutes to provide a 99.9 percent deactivation (3 log) with a residual of .5 total chloramines and a temperature of 5 degrees C
3. 1 log is 90 percent removal of Girardia
   2 log is 99 percent removal of Girardia
   3 log is 99.9 percent removal of Girardia
   4 log is 99.99 percent removal of Girardia

CUTTER TREATMENT PLANT TO SERVICE AREAS
Navajo Gallup Water Supply Project
Appraisal Study
Contact Times/Log Reduction in Distribution System

						Section	Section	Total CT	Total CT	Log	Log
		Pipe Size	Pipe Size	Q(cfs)	Q(cfs)	CT (min)	CT(min)	(min)	(min)	Reduction	Reduction
Withdrawal Point	Distance From WTP	2020	2040	2020	2040	2020	2040	2020	2040	2020	2040
Huerfano	136,524	14	16	3.63	6.19	670	513	670	513	0.91	0.70
Nageez1	197,791	16	21	3.37	5.68	423	432	1093	945	1.49	1.29
Counselor	303,772	12	14	2.75	4.63	504	408	1597	1353	2.18	1.84
Torreon	389,220	8	12	1.14	2.01	436	556	2033	1909	2.77	2.60

Notes
1. CT requirement of 2,200 minutes to provide a 99.9 percent deactivation (3 log) with a residual of .5 total chloramines and a temperature of 5 degrees C
2. 1 log is 90 percent removal of Girardia
   2 log is 99 percent removal of Girardia
   3 log is 99.9 percent removal of Girardia
   4 log is 99.99 percent removal of Girardia

WATER QUALITY DATA

Design Water Quality
Navajo Gallup Water Supply Project

Water Analysis													
Navajo Gallup Water Supply Project													
PNM Diversion - River Quality - 1999													
Design Water Quality San Juan Diversion													
Source : Weekly sampling/analysis by													
San Juan Generating Station													
Parameters	1/5/99	1/12/99	1/19/99	1/26/99	2/2/99	2/9/99	16-Feb	23-Feb	3/2/99	3/9/99	3/16/99	3/23/99	3/30/99
Temp deg C													
EC	584.0	589.0	587.0	539.0	553.0	549.0	547.0	512.0	510.0	498.0	504.0	503.0	488.0
pH	8.1	8.1	8.1	8.1	8.6	8.1	8.2	8.1	8.1	7.9	8.0	8.0	7.9
Turbidity	57.0	54.0	27.0	41.0	30.0	30.0	40.0	24.0	32.0	31.0	25.0	33.0	34.0
TSS mg/L	100.0	139.0	101.0	103.0	78.0	108.0	111.0	67.0	53.0	91.0	104.0	113.0	83.0
TDS mg/L													
T SO4 mg/L	160.0	155.0	170.0	185.0	150.0	153.0	160.0	147.0	130.0	148.0	140.0	158.0	160.0
T. Hardness mg/L	204.0	214.0	216.0	200.0	194.0	210.0	193.0	180.0	176.0	174.0	188.0	180.0	196.0
Calcium +2	66.0	66.0	63.0	59.3	78.0	59.3	59.0	56.0	55.0	55.3	60.0	56.0	40.9
Magnesium +2	10.0	12.0	14.0	12.7	7.8	15.1	11.0	9.7	9.7	8.8	9.3	9.7	22.3
P Alkalinity	0.0	0.0	0.0	0.0	0.0		0.0			0.0	2.0	0.0	0.0
M Alkalinity	114.0	116.0	110.0	112.0	110.0	108.0	120.0	104.0	102.0	108.0	118.0	110.0	100.0
SiO2	8.8	9.4	8.8	8.4	8.3	8.3	8.5	6.6	7.9	8.3	8.0	6.8	6.9
PNM Diversion After Settling Pond.													
Turbidity NTU													
TSS mg/L													
TDS mg/L													
percent reduction in NTU due to settling													
percent reduction in suspended solids due to settling													

Design Water Quality
Navajo Gallup Water Supply Project

Water Analysis													
Navajo Gallup Water Supply Project													
PNM Diversion - River Quality - 1999													
Design Water Quality San Juan Diversion													
Source : Weekly sampling/analysis by													
San Juan Generating Station													
Parameters	4/6/99	4/13/99	4/19/99	4/25/99	5/3/00	5/10/99	5/18/99	5/24/99	6/1/99	6/7/99	6/13/99	6/20/99	6/28/99
Temp deg C					16.1								
EC	538.0	513.0	518.0	479.0	468.0	451.0	333.0	263.0	254.0	265.0	234.0	245.0	214.0
pH	7.7	8.0	8.1	8.2	8.3	8.2	8.1	8.0	7.6	8.0	7.9	7.9	8.2
Turbidity	58.0	75.0	49.0	**180.0**	**212.0**	**109.0**	88.0	**244.0**	64.0	50.0	56.0	***660.0***	69.0
TSS mg/L	132.0	143.0	108.0	**718.0**	**451.0**	**327.0**	320.0	**733.0**	262.0	128.0	206.0	***937.0***	130.0
TDS mg/L				32.0							24.0	***160.0***	110.0
T SO4 mg/L	165.0	152.0	125.0	128.0	165.0	148.0	122.0	70.0	52.3	52.0	57.2	45.0	38.0
T. Hardness mg/L	186.0	174.0	188.0	186.0	184.0	204.0	138.0	96.0	90.0	110.0	90.0	88.0	84.0
Calcium +2	42.4	55.7	58.9	58.0	59.0	61.7	46.0	34.4	32.8	33.6	29.2	23.9	28.1
Magnesium +2	4.0	8.5	9.9	10.2	9.0	12.1	54.0	24.0	1.9	6.3	4.1	3.9	3.4
P Alkalinity	0.0	0.0	0.0	0.0	4.0	4.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
M Alkalinity	124.0	108.0	122.0	108.0	128.0	125.0	88.0	66.0	78.0	72.0	66.0	58.0	50.0
SIO2	7.2	7.3	7.3	6.8	8.0	7.6	6.9	5.7	9.0	9.8	7.5	5.7	5.8
PNM Diversion After Settling Pond.													
Turbidity NTU				7	17	16		16				14	
TSS mg/L				14	40	41		62				13	
TDS mg/L				34								270	
percent reduction in NTU due to settling				96.1	92.0	85.3		93.4				97.9	
percent reduction in suspended solids due to s				98.1	91.1	87.5		91.5				98.6	

Design Water Quality
Navajo Gallup Water Supply Project

Water Analysis											
Navajo Gallup Water Supply Project											
PNM Diversion - River Quality - 1999											
Design Water Quality San Juan Diversion											
Source : Weekly sampling/analysis by											
San Juan Generating Station											
Parameters	7/4/99	7/11/99	7/19/99	7/26/99	8/2/99	8/8/99	8/16/99	8/23/99	8/29/99	9/5/99	9/14/99
Temp deg C											
EC	274.0	455.0	500.0	347.0	476.0	302.0	334.0	278.0	297.0	260.0	308.0
pH	7.8	8.0	7.8	8.4	8.0	8.1	7.9	7.7	8.1	8.3	8.3
Turbidity	17.0	**5100.0**	**6150.0**	**1140.0**	**6700.0**	**780.0**	**1400.0**	**186.0**	**940.0**	**150.0**	60.0
TSS mg/L	60.0	**6116.0**	**10810.0**	**1674.0**	**10326.0**	**1736.0**	**3520.0**	**654.0**	**1757.0**	**561.0**	245.0
TDS mg/L	150.0	**300.0**	**340.0**			**190.0**	**220.0**				
T SO4 mg/L	75.0	95.0	150.0	68.0	108.0	51.6	92.0	76.0	68.0	49.0	51.6
T. Hardness mg/L	104.0	118.0	154.0	128.0	123.0	115.0	113.0	148.0	108.0	106.0	116.0
Calcium +2	35.0	40.9	41.6	45.7	42.4	38.5	38.9	40.1	34.4	34.4	36.8
Magnesium +2	4.0	4.4	12.2	3.4	4.1	4.6	3.9	11.7	5.4	4.9	5.8
P Alkalinity	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	0.0
M Alkalinity	80.0	82.0	4.8	90.0	92.0	94.0	92.0	85.0	86.0	78.0	82.0
SiO2	6.0	6.4	7.8	7.0	4.9	6.5	9.4	9.0	13.2	8.9	11.5
PNM Diversion After Settling Pond.											
Turbidity NTU		22	23	16	27	32	22	17	19	23	
TSS mg/L		24	26	15	25	27	25	37	22	55	
TDS mg/L		230	260			270	300				
percent reduction in NTU due to settling		99.6	99.6	98.6	99.6	95.9	98.4	90.9	98.0	84.7	
percent reduction in suspended solids due to s		99.6	99.8	99.1	99.8	98.4	99.3	94.3	98.7	90.2	

Design Water Quality
Navajo Gallup Water Supply Project

Water Analysis												
Navajo Gallup Water Supply Project												
PNM Diversion - River Quality - 1999												
Design Water Quality San Juan Diversion												
Source : Weekly sampling/analysis by												
San Juan Generating Station												
Parameters	9/21/99	9/27/99	10/3/99	10/10/99	10/18/99	10/24/99		11/8/99	11/23/99	11/28/99	12/5/99	12/13/99
Temp deg C												
EC	267.0	339.0	441.0	446.0	481.0	586.0	583.0	578.0	608.0	632.0	584.0	624.0
pH	8.2	8.2	8.2	8.1	8.1	8.2	8.2	8.6	8.1	8.2	8.3	8.1
Turbidity	35.0	32.0	20.0	15.0	21.0	15.0	30.0	9.0	33.0	32.0	21.0	20.0
TSS mg/L	88.0	103.0	58.0	37.0	54.0	24.0	72.0	21.0	54.0	72.0	39.0	24.0
TDS mg/L			210.0	280.0			350.0			290.0	260.0	
T SO4 mg/L	54.0	92.0	88.0	106.0	200.0	130.0	140.0	145.0	155.2	140.8	138.0	170.0
T. Hardness mg/L	120.0	146.0	161.0	148.0	174.0	198.0	192.0	208.0	214.0	230.0	217.0	232.0
Calcium +2	40.9	40.0	51.3	49.7	50.1	65.7	65.8	65.6	68.1	72.1	76.1	60.9
Magnesium +2	4.4	11.0	8.0	5.8	11.9	8.3	6.8	11.2	10.7	12.2	11.4	19.5
P Alkalinity	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	1.0	0.0	0.0
M Alkalinity	86.0	112.0	104.0	100.0	106.0	114.0	112.0	100.0	126.0	132.0	124.0	130.0
SiO2	10.3	10.1	8.5	8.0	8.9	7.8	9.1	8.9	9.1	9.2	8.8	10.2
PNM Diversion After Settling Pond.												
Turbidity NTU												
TSS mg/L												
TDS mg/L												
percent reduction in NTU due to settling												
percent reduction in suspended solids due to s												

Design Water Quality
Navajo Gallup Water Supply Project

Water Analysis				
Navajo Gallup Water Supply Project				
PNM Diversion - River Quality - 1999				
Design Water Quality San Juan Diversion				
Source : Weekly sampling/analysis by				
San Juan Generating Station				
Parameters	12/20/99	Average	Max	Min
Temp deg C		16.10	16.1	16.1
EC	599.0	446.7	632.0	214.0
pH	8.1	8.1	8.6	7.6
Turbidity	20.0	506.0	6700.0	9.0
TSS mg/L	30.0	879.6	10810.0	21.0
TDS mg/L		208.3	350.0	24.0
T SO4 mg/L	184.0	119.3	200.0	38.0
T. Hardness mg/L	230.0	162.9	232.0	84.0
Calcium +2	70.0	50.8	78.0	23.9
Magnesium +2	14.0	10.1	54.0	1.9
P Alkalinity	0.0	0.5	4.0	0.0
M Alkalinity	128.0	99.3	132.0	4.8
SiO2	5.8	8.1	13.2	4.9
PNM Diversion After Settling Pond.				
Turbidity NTU		19.4		
TSS mg/L		30.4		
TDS mg/L		227.3		
percent reduction in NTU due to settling		95.0		
percent reduction in suspended solids due to s		96.1		

Design r Quality
Navajo Gallup Water Supply Project

Water Analysis - Navajo Gallup Water Supply Project
Samples Taken by the Field and Analyzed by the TSC Labs

Hogback Diversion — Design Water Quality San Juan Diversion

Parameters	4/14/00	5/9/2000*	5/12/00	5/25/00	6/6/00	6/27/00	23-Aug	23-Aug	Hog Back Averages	Samples Ranges	PNM Historic Average	PNM Historic Range
							Note 1	Note 2	Note 3			
EC	376	251	308	203	224	445	1155		301.17	203-1155		
pH	8.16	7.53	8.16	7.53	7.9	8.66	7.85		7.99	7.53-8.66		
Temp F	53.6	55.2	53	55.7	52.1	74.1	62.4		57.28	62.4-74.1		
Turbidity	85	113	36.38	149	79.07	5.41	4266		77.98	4266-5.41		
TSS mg/L	141	140	42	195	331		15334		169.80	15334-42		
TDS mg/L	282	177	184	168	141		884		190.40	884-141		
T SO4 mg/L	83.4	53.5	64.2	42.6	42.2		476.5		57.18	476.5-42.2		
TOC mg/L	4	2.89	2.98	3.71	3.3		4.76		3.38	4.76-2.89		
Chloride mg/L	8.42	3.9	5.06	2.98	2.91		26.8		4.65	26.6-2.91		
T. Hardness mg/L				106	107		1535		106.50	1535-106		
Calcium +2												
Magnesium +2												
P Alkalinity												
M Alkalinity												
SiO2												

* Sample taken in the canal downstream of the hogback diversion.
Turbidity (T1) = turbidity after 1 hour of settling

Note 1	Sample taken after storm event. Turbidity after settling 7 hrs - 57.9, after settling for 24 hrs 9.36 NTU
Note 2	Water Quality of 8/23/00 water after 4 hours of settling
Note 3	Average does not include 8/23/00 water sample. But does include that water after 4 hours of settling

NIIP Water Quality

Samples taken the summer of 2000 by U.S. Bureau of Reclamation

Sample taken at "Cutter Diversion" storet numbers DRSSJO78A

Parameter	4/14/00	5/9/00	Averages
Time	1000	1200	
EC	205	187	196.00
pH	7.7	7.71	7.71
Temp F	45.3	45.6	45.45
Turbidity	3.11	3.16	3.14
Turbidity (T0)	3	2.8	2.90
Turbidity (T1)	3	2.5	2.75
Turbidity (T4)	3	2.3	2.65
TSS	<4	1	1.00
TDS	181	140	160.50
T SO4	38.2	29.7	33.95
TOC	8	2.29	5.15
Chlorides	1.2	1.9	1.55

SOURCE WATER QUALITY
NIIP ALTERNATIVE
CUTTER DIVERSION

Table 1. Water Quality for San Juan River at different Locations

Data compiled from USGS database for noted sampling point

Parameter	Units	Navajo Reservoir Dam RM 225.4				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L					
Calcium (Ca^{+2})	mg/L					
Magnesium (Mg^{+2})	mg/L					
Sodium (Na^{+})	mg/L					
Potassium (k^{+})	mg/L					
Total Alkalinity as $CaCO_3$	mg/L					
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L					
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L					
Nitrate as N (NO^{-3})	mg/L					
Phosphate (PO_4^{-3})	mg/L					
Aluminum (Al^{+3})	µg/L					
Barium (Ba^{+2})	mg/L					
Copper (Cu^{+2})	µg/L					
Iron (Total)	µg/L					
Iron (Dissolved-Fe^{+2})	µg/L					
Manganese (Total)	µg/L					
Manganese (Dissolved-Mn^{+2})	µg/L					
Arsenic (As^{+3})	µg/L	4/20/94	6/20/95	2.533	1	6
Selenium (Total)	µg/L	4/20/94	6/20/95	1	1	1
Selenium (Dissolved-Se^{-2})	µg/L	4/20/94	6/20/95	1.267	1	5
Strontium (Sr^{+2})	µg/L					
Ammonia as N (NH_4^{+})	mg/L					
Dissolved Oxygen (O_2)	mg/L	5/16/94	6/20/95	7.081	3.1	11.1
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L					
Specific Conductivity	µohm/cm	4/20/94	6/20/95	233.333	214	282
Total Dissolved Solids (TDS,Cond. meter)	mg/L					
Total Organic Carbon as C	mg/L					
Temperature	°C	4/20/94	6/20/95	14.201	6.42	24.39
Turbidity	NTU	5/16/94	6/20/95	7.214	0.8	35
pH	Unitless	4/20/94	6/20/95	7.456	0.214	8.62
Total Suspended Solids (TSS)	mg/L	5/16/94	6/20/95	11.714	2	58

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at Farmington Rm 180.1				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L	5/10/62	2/22/82	189.322	65	820
Calcium (Ca^{+2})	mg/L	10/16/96	2/19/97	71.5	55.3	78.3
Magnesium (Mg^{+2})	mg/L	10/16/96	2/19/97	11.88	9.3	13.5
Sodium (Na^{+})	mg/L	10/16/96	2/19/97	37.7	26.5	44
Potassium (k^{+})	mg/L	10/16/96	2/19/97	3.12	2.3	5.5
Total Alkalinity as $CaCO_3$	mg/L	10/2/65	2/22/82	113.852	49	302
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L	5/10/62	2/4/91	154.231	25	827
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L	5/10/62	2/4/91	9.783	1.3	160
Nitrate as N (NO^{-3})	mg/L	10/3/69	9/30/70	0.28	0	1
Phosphate (PO_4^{-3})	mg/L	5/24/79	5/24/79	0.37	0.37	0.37
Aluminum (Al^{+3})	µg/L	5/31/68	3/20/97	579.056	0.39	6300
Barium (Ba^{+2})	mg/L	4/27/77	2/19/97	128.618	0.076	400
Copper (Cu^{+2})	µg/L	3/10/75	3/20/97	34.328	0.005	550
Iron (Total)	µg/L	3/10/75	10/29/81	25690.67	760	310000
Iron (Dissolved-Fe^{+2})	µg/L	9/10/69	2/4/91	48.693	0	1699.997
Manganese (Total)	µg/L	3/10/75	2/19/97	805.047	0.056	12000
Manganese (Dissolved-Mn^{+2})	µg/L	11/9/70	2/19/97	15.584	0.02	70
Arsenic (As^{+3})	µg/L	3/10/75	3/20/97	3.591	0.005	30
Selenium (Total)	µg/L	4/2/74	3/20/97	0.839	0	2
Selenium (Dissolved-Se^{-2})	µg/L	3/10/75	3/20/97	0.966	0	5
Strontium (Sr^{+2})	µg/L	4/27/77	2/19/97	125.772	0.71	750
Ammonia as N (NH_4^{+})	mg/L	11/30/72	2/22/82	0.159	0.01	0.66
Dissolved Oxygen (O_2)	mg/L	12/3/68	3/20/97	9.595	3.7	14.6
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L	10/16/96	2/19/97	19.46	8	50.2
Specific Conductivity	µohm/cm	11/6/80	3/20/97	319.594	0.293	630
Total Dissolved Solids (TDS,Cond. meter)	mg/L	10/16/96	3/20/97	372	230	450
Total Organic Carbon as C	mg/L	8/1/72	1/6/82	10.862	1.5	110
Temperature	°C	12/3/68	3/20/97	10.608	0	27
Turbidity	NTU	5/19/94	3/20/97	144.37	2.5	1880
pH	Unitless	4/20/94	3/20/97	8.098	7.24	8.69
Total Suspended Solids (TSS)	mg/L	5/19/94	3/20/97	262.41	5	2660

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at Fruitland RM 167.4				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L	1/27/78	7/11/86	167.659	97	270
Calcium (Ca^{+2})	mg/L	5/18/94	2/19/97	69.167	38	83.3
Magnesium (Mg^{+2})	mg/L	5/18/94	2/19/97	13.167	8	16.6
Sodium (Na^{+})	mg/L	5/18/94	2/19/97	37.083	13	47.5
Potassium (k^{+})	mg/L	5/18/94	2/19/97	3.3	2.5	4.9
Total Alkalinity as $CaCO_3$	mg/L	1/27/78	8/18/87	101.852	56	154
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L	1/27/78	5/6/92	137.5	50	400
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L	1/27/78	5/6/92	9.502	1	23
Nitrate as N (NO^{-3})	mg/L					
Phosphate (PO_4^{-3})	mg/L	4/25/79	6/19/79	0.535	0.21	0.86
Aluminum (Al^{+3})	µg/L	5/18/94	3/20/97	814.968	0.6	8910
Barium (Ba^{+2})	mg/L	7/20/78	2/19/97	184.742	0	800
Copper (Cu^{+2})	µg/L	7/20/78	3/20/97	14.51	0.006	94
Iron (Total)	µg/L	10/30/80	9/5/84	32589.38	530	420000
Iron (Dissolved-Fe^{+2})	µg/L	1/27/78	8/8/90	39.135	3	270
Manganese (Total)	µg/L	7/20/78	2/19/97	945.583	0.04	20000
Manganese (Dissolved-Mn^{+2})	µg/L	4/26/78	2/19/97	10.843	0.013	40
Arsenic (As^{+3})	µg/L	7/20/78	3/20/97	3.143	0.005	10
Selenium (Total)	µg/L	4/26/78	3/20/97	0.837	0	2
Selenium (Dissolved-Se^{-2})	µg/L	7/20/78	3/20/97	0.765	0	1
Strontium (Sr^{+2})	µg/L	11/25/80	2/19/97	193.108	0.76	680
Ammonia as N (NH_4^{+})	mg/L	1/27/78	9/5/84	0.061	0	0.35
Dissolved Oxygen (O_2)	mg/L	1/27/78	3/20/97	9.792	3.46	15.18
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L	5/18/94	2/19/97	26.317	10	55.3
Specific Conductivity	µohm/cm	10/30/80	3/20/97	351.63	0.289	695
Total Dissolved Solids (TDS,Cond. meter)	mg/L	10/16/96	3/20/97	397	280	510
Total Organic Carbon as C	mg/L					
Temperature	°C	1/3/78	3/20/97	11.872	0.21	25.5
Turbidity	NTU	5/18/94	3/20/97	152.535	2.6	1750
pH	Unitless	4/20/94	3/20/97	8.274	7.7	9.19
Total Suspended Solids (TSS)	mg/L	5/18/94	3/20/97	322.923	5	3100

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at Shiprock Bridge RM 147.8				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L					
Calcium (Ca^{+2})	mg/L	5/18/94	2/20/97	72.517	40	87.3
Magnesium (Mg^{+2})	mg/L	5/18/94	2/20/97	14.75	9	18.6
Sodium (Na^{+})	mg/L	5/18/94	2/20/97	39.833	14	50.1
Potassium (k^{+})	mg/L	5/18/94	2/20/97	3.5	2.5	4.8
Total Alkalinity as $CaCO_3$	mg/L					
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L					
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L					
Nitrate as N (NO^{-3})	mg/L					
Phosphate (PO_4^{-3})	mg/L					
Aluminum (Al^{+3})	µg/L	5/18/94	3/19/97	681.368	0.41	11200
Barium (Ba^{+2})	mg/L	5/18/94	2/20/97	31.784	0.072	190
Copper (Cu^{+2})	µg/L	5/18/94	3/19/97	2.39	0.009	40
Iron (Total)	µg/L					
Iron (Dissolved-Fe^{+2})	µg/L					
Manganese (Total)	µg/L	5/18/94	2/20/97	71.827	0.027	430
Manganese (Dissolved-Mn^{+2})	µg/L	5/18/94	2/20/97	1.687	0.005	10
Arsenic (As^{+3})	µg/L	4/21/94	3/19/97	5.156	0.005	44
Selenium (Total)	µg/L	4/21/94	3/19/97	0.79	0.001	1
Selenium (Dissolved-Se^{-2})	µg/L	4/21/94	3/19/97	0.856	0.001	3
Strontium (Sr^{+2})	µg/L	5/18/94	2/20/97	64.12	0.77	380
Ammonia as N (NH_4^{+})	mg/L					
Dissolved Oxygen (O_2)	mg/L	5/18/94	3/19/97	9.651	3.6	13.94
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L	5/18/94	2/20/97	35.55	6	65.9
Specific Conductivity	µohm/cm	4/21/94	3/19/97	415.695	0.28	808
Total Dissolved Solids (TDS,Cond. meter)	mg/L	10/16/96	3/19/97	421.875	280	550
Total Organic Carbon as C	mg/L					
Temperature	°C	4/21/94	3/19/97	11.666	0.08	23.67
Turbidity	NTU	5/18/94	3/19/97	732.485	3.8	11100
pH	Unitless	4/21/94	3/19/97	8.26	7.66	8.89
Total Suspended Solids (TSS)	mg/L	5/18/94	3/19/97	1322.162	5	17700

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at Hogback Diversion Dam RM 158.9				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L	8/12/93	7/26/94	965	730	1200
Calcium (Ca^{+2})	mg/L					
Magnesium (Mg^{+2})	mg/L					
Sodium (Na^{+})	mg/L					
Potassium (k^{+})	mg/L					
Total Alkalinity as $CaCO_3$	mg/L					
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L	8/12/93	7/26/94	815	630	1000
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L	8/12/93	7/26/94	116	62	170
Nitrate as N (NO^{-3})	mg/L					
Phosphate (PO_4^{-3})	mg/L					
Aluminum (Al^{+3})	µg/L					
Barium (Ba^{+2})	mg/L					
Copper (Cu^{+2})	µg/L					
Iron (Total)	µg/L					
Iron (Dissolved-Fe^{+2})	µg/L					
Manganese (Total)	µg/L					
Manganese (Dissolved-Mn^{+2})	µg/L					
Arsenic (As^{+3})	µg/L	4/19/94	6/20/95	3.833	1.2	11
Selenium (Total)	µg/L	8/12/93	6/20/95	1	1	1
Selenium (Dissolved-Se^{-2})	µg/L	4/19/94	6/20/95	1	1	1
Strontium (Sr^{+2})	µg/L					
Ammonia as N (NH_4^{+})	mg/L					
Dissolved Oxygen (O_2)	mg/L	8/12/93	6/20/95	8.722	3.62	13.57
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L					
Specific Conductivity	µohm/cm	4/19/94	6/20/95	476.667	248	646
Total Dissolved Solids (TDS,Cond. meter)	mg/L					
Total Organic Carbon as C	mg/L					
Temperature	°C	8/12/93	6/20/95	13.345	1.7	27.5
Turbidity	NTU	5/18/94	6/20/95	272.071	4.3	1900
pH	Unitless	4/19/94	6/20/95	8.249	7.77	8.97
Total Suspended Solids (TSS)	mg/L	5/18/94	6/20/95	607.214	2	4000

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at Shiprock Below Bridge				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L	9/18/58	7/9/86	248.63	76	990
Calcium (Ca^{+2})	mg/L					
Magnesium (Mg^{+2})	mg/L					
Sodium (Na^{+})	mg/L					
Potassium (k^{+})	mg/L					
Total Alkalinity as $CaCO_3$	mg/L	9/18/58	8/19/87	120.498	32	250
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L	9/18/58	5/6/92	234.873	38	1200
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L	9/18/58	5/6/92	17.762	1.6	196
Nitrate as N (NO^{-3})	mg/L	10/2/69	10/14/70	0.621	0	3.2
Phosphate (PO_4^{-3})	mg/L	4/18/79	6/13/79	1.34	0.28	2.4
Aluminum (Al^{+3})	µg/L	11/17/61	11/17/61	400	400	400
Barium (Ba^{+2})	mg/L	2/22/78	9/1/81	613.33	100	5400
Copper (Cu^{+2})	µg/L	9/26/74	9/7/82	58.217	0	580
Iron (Total)	µg/L	9/26/74	9/7/82	28959.55	460	349999.9
Iron (Dissolved-Fe^{+2})	µg/L	9/18/58	5/6/92	31.673	0	1700
Manganese (Total)	µg/L	11/17/61	9/7/82	1178.696	50	12000
Manganese (Dissolved-Mn^{+2})	µg/L	9/18/58	5/6/92	63.809	0	2099.996
Arsenic (As^{+3})	µg/L	9/26/74	9/7/82	10.478	1	56
Selenium (Total)	µg/L	9/18/58	5/6/92	2.379	0	50
Selenium (Dissolved-Se^{-2})	µg/L	9/26/74	9/7/82	2.609	1	10
Strontium (Sr^{+2})	µg/L	2/5/80	5/6/81	561.667	470	620
Ammonia as N (NH_4^{+})	mg/L	11/29/72	6/9/92	0.073	0	0.09
Dissolved Oxygen (O_2)	mg/L	8/5/69	6/9/92	9.968	4.6	14.5
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L					
Specific Conductivity	µohm/cm					
Total Dissolved Solids (TDS,Cond. meter)	mg/L					
Total Organic Carbon as C	mg/L	10/25/72	5/6/81	12.706	2.4	110
Temperature	°C	2/26/59	6/9/92	12.578	0	30
Turbidity	NTU					
pH	Unitless					
Total Suspended Solids (TSS)	mg/L	12/14/70	9/28/71	1916.299	96.5	7799.996

Table 1. Water Quality for San Juan River

Data compiled from USGS database for noted sampling point

Parameter	Units	San Juan River at PNM Diversion Structure				
		Start Date	End Date	Mean	Min	Max
Total Hardness as $CaCO_3$	mg/L	1/5/99	1/2/00	164	84	232
Calcium (Ca^{+2})	mg/L	1/5/99	1/2/00	51.1	28.1	78
Magnesium (Mg^{+2})	mg/L	1/5/99	1/2/00	9.0	1.9	22.3
Sodium (Na^{+})	mg/L					
Potassium (k^{+})	mg/L					
Total Alkalinity as $CaCO_3$	mg/L	1/5/99	1/2/00	97.9	0	132
Carbonate (CO_3^{-2})	mg/L					
Bicarbonate (HCO_3^{-})	mg/L					
Total sulfate (SO_4)	mg/L	1/5/99	1/2/00	120.0	38	200
Flouride (F^{-})	mg/L					
Chloride (Cl^{-})	mg/L					
Nitrate as N (NO^{-3})	mg/L					
Phosphate (PO_4^{-3})	mg/L					
Aluminum (Al^{+3})	µg/L					
Barium (Ba^{+2})	mg/L					
Copper (Cu^{+2})	µg/L					
Iron (Total)	µg/L					
Iron (Dissolved-Fe^{+2})	µg/L					
Manganese (Total)	µg/L					
Manganese (Dissolved-Mn^{+2})	µg/L					
Arsenic (As^{+3})	µg/L					
Selenium (Total)	µg/L					
Selenium (Dissolved-Se^{-2})	µg/L					
Strontium (Sr^{+2})	µg/L					
Ammonia as N (NH_4^{+})	mg/L					
Dissolved Oxygen (O_2)	mg/L					
Hydrogen Sulfide/Sulfide as S	mg/L					
Silica (SiO_2)	mg/L	1/5/99	1/2/00	9.2	4.85	58
Specific Conductivity	µohm/cm	1/5/99	1/2/00	449.7	214	632
Total Dissolved Solids (TDS,Cond. meter)	mg/L	1/5/99	1/2/00	202.9	24	350
Total Organic Carbon as C	mg/L					
Temperature	°C					
Turbidity	NTU	1/5/99	1/2/00	496.4	9	6700
pH	Unitless	1/5/99	1/2/00	8.1	7.62	8.56
Total Suspended Solids (TSS)	mg/L	1/5/99	1/2/00	893.4	21	10810

CITY OF SOMERTON, WATER BLENDING STUDY

CITY OF SOMERTON
WATER BLENDING STUDY

Summary

The proposed blending of Colorado River water with Somerton well water will improve the Somerton drinking water quality. The maximum benefit will be achieved with the maximum amount of river water used in the blend. More work needs to be done to obtain additional analyses and perform corrosion testing of the actual blended waters.

Background

The City of Somerton is planning to blend Colorado River water with Somerton well water in the future. This study investigates the major water quality and corrosion issues of the blended water in order to anticipate possible problem areas. Calculations were done based on currently available water quality data.

Blending Calculations

For the blending calculations,"The Rothberg, Tamburini & Winsor Model for Corrosion Control and Process Chemistry", version 3.0 was used. This software is available from the American Water Works Association. Table 1 shows the data used to calculate the typical composition of the City of Somerton water treatment plant effluent. Table 2 shows the data from the first half of 2000 used to calculate the typical Colorado River water composition. More data needs to be obtained to get a better estimate of the actual river water composition. A temperature of 25°C was assumed for the river water.

For the first case, blend calculations of the percent of Somerton water to Colorado River water were done for 0, 25, 50, 75, & 100 %. For example, the 100% blend contained no Colorado River water, the 50% blend contained 50% Somerton water & 50% Colorado River water, and the 0% blend was all Colorado River water. The blended water was not treated further. The results of the calculation are shown in the first section of the Table 3. The calculation sheets are shown in Appendix A. These results are the "interim values", meaning that the water remains supersaturated in calcium carbonate. The final values are for the blends which are saturated and that have precipitated all calcium carbonate.

The concentration of the major species are plotted in Chart 1 as a function of the Somerton water blend. As can be seen, the water quality improves as the Somerton blend decreases. It should be noted that the total dissolved solids (TDS) is 677 mg/l with 100% Colorado River water which is above the 500 mg/l secondary drinking water standard. The chloride secondary standard of 250 mg/l is met with a 50% blend. The sulfate secondary standard of 250 mg/l is nearly met with 100% Colorado River water.

The pH of the blended water is plotted in Chart 2. As the Somerton blend is decreased, the pH increases. The pH at 100% Colorado River water is 8.39 which is less than the secondary standard maximum of 8.5.

The calcium carbonate precipitation potential is plotted in Chart 3. This is the maximum amount of precipitation which will occur in the blended water. As the Somerton blend is decreased, the precipitation potential decreases to a minimum of 19 mg/l. In general, this value should be less than 10 mg/l to minimize calcium carbonate scale formation.

The Langelier Index and the ratio of alkalinity to the sum of chloride and sulfate concentration are plotted in Chart 4. In general, the Langelier index should be positive to insure some calcium carbonate formation. The value is positive in all cases. The ratio of alkalinity to the sum of chloride & sulfate concentration is a measure of the corrosiveness of the blended water. In general, this "corrosion" ratio should be above 5. For these blends, the maximum value is 0.4 with Colorado River water. This is due to the high concentrations of chloride and sulfate.

For the second case, carbon dioxide was added to the blended water in order to reduce the precipitation potential. The results of the calculation are shown in the second section of the Table 3. The calculation sheets are shown in Appendix B. The advantage of using carbon dioxide is that it can reduce the pH without reducing alkalinity. Carbon dioxide was added until the precipitation potential was reduced to less than the maximum recommended of 10 mg/l.

The pH of this "stabilized" water is plotted in Chart 5. This treatment reduced the interim blend pH by about 0.7 units.

The precipitation potential of the blended stabilized water is plotted in Chart 6. In all cases, the potential is less than 10 mg/l.

The Langelier Index and corrosion ratio is plotted for the blended stabilized water in Chart 7. The Langelier index remains positive for all blends whereas the corrosion ratio is unaffected.

The amount of carbon dioxide added for the blend calculations is shown in Chart 8. A maximum of 25 mg/l is added for the 100% Somerton water blend.

The final blended unstabilized water characteristics are shown in Chart 9. Although the calcium and alkalinity values are reduced somewhat, the TDS is not reduced significantly. The chloride & sulfate values are not affected by the calcium carbonate precipitation.

The pH of the final unstabilized blend is shown in Chart 10. The values are within the secondary standard of 6.5 to 8.5.

The final stabilized blend characteristics are shown in Chart 11. The calcium & alkalinity values are higher than the unstabilized final blend due to the reduction in precipitation potential.

The pH of the final stabilized blend is shown in Chart 12. For all blends, the secondary standard is met.

Discussion of Results

Although the water quality is improved by blending Somerton well water with Colorado River water, not all secondary standards can be met. The chloride secondary standard can be met with a 50% blend. The Somerton well water is very super-saturated in calcium carbonate as indicated by the precipitating potential of 40 mg/l. Blending tends to reduce this value. Carbon dioxide or acid can be used to reduce the precipitation potential to less than 10 mg/l. Due to the high concentrations of chloride and sulfate ions in the blended water, the water will tend to be corrosive even though calcium carbonate tends to precipitate.

Conclusions

The blending of Colorado River water with Somerton well water improves the potable water quality. The maximum effectiveness is achieved with the highest proportions of Colorado River water. Although this blended water will have calcium carbonate scaling potential, blending tends to reduce the amount of scale formation. Due to the high amounts of sulfate and chloride in the blended water, the "corrosion" ratio of the water is only slightly improved. However, the RTW model does not predict actual corrosion rates. So despite having a positive Langelier Index, which would tend to indicate a non-corrosive water, the high amounts of sulfate and chloride indicate that this could be a corrosive water.

Recommendations

1. To improve the potable water quality for the City of Somerton, the maximum amount of Colorado River water should be used to blend with Somerton well water.
2. Obtain full analyses of components such as toxic elements identified in the Drinking Water Standards and perform blend calculations to ensure compliance.
3. Perform corrosion testing using blends of actual waters with various anti-corrosion additives.

4. Consider membrane treatment processes to obtain water quality consistent with secondary drinking water standards.

City of Somerton								
Water Treatment Plant Effluent								
Date Sampled	TDS, Σ (mg/l)	Temp. (°C)	pH (lab)	Alkalinity (mg/l $CaCO_3$)	Calcium (mg/l)	Calcium (mg/l $CaCO_3$)	Chloride (mg/l)	Sulfate (mg/l)
01/24/2000	1350	20.0	7.76	214	175	437	361	393
04/03/2000	1380		7.72	214	182	454	363	414
Average	1365	20	7.74	214	179	446	362	404

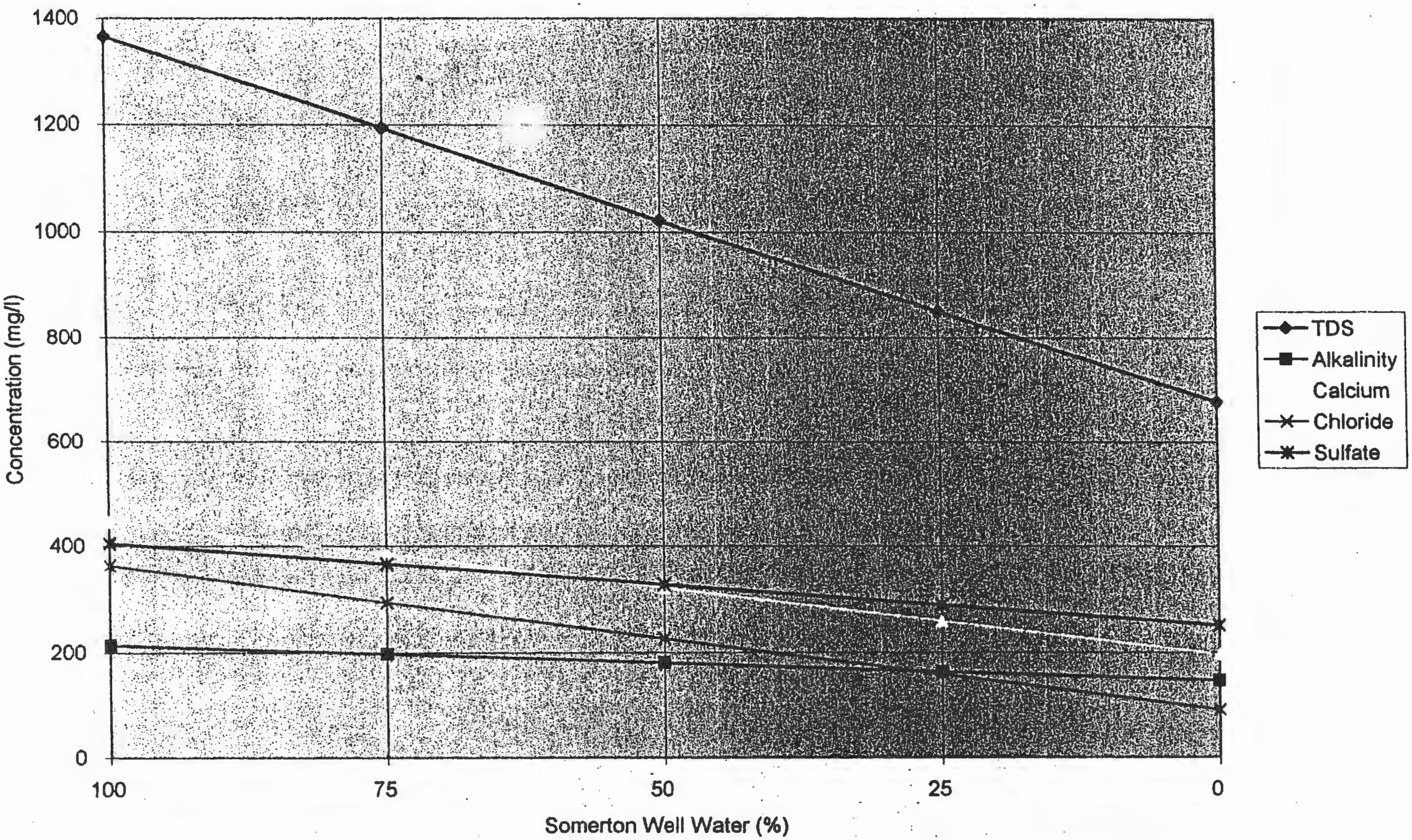
Tε 2

Colorado River								
Imperial Dam								
Date Sampled	TDS, Evap. (mg/l)	Temp. (°C)	pH (lab)	Alkalinity (mg/l $CaCO_3$)	Calcium (mg/l)	Calcium (mg/l $CaCO_3$)	Chloride (mg/l)	Sulfate (mg/l)
01/03/2000	750	25.0	8.26	154.1	81.1	203	96.0	249
01/18/2000	732		8.27	150.5	83.6	209	98.0	271
02/07/2000	668		8.25	146.1	79.5	199	92.0	252
03/06/2000	660		8.30	146.4	81.1	203	96.4	261
04/03/2000	670		8.95	144	77.0	192	92.0	250
04/17/2000	626		8.35	140	73.7	184	78.1	234
05/01/2000	626		8.31	142	77.1	193	81.3	249
05/15/2000	684		8.33	145	77.0	192	87.1	242
Average	677	25	8.38	146	79	197	90	251

1. 3

Blended, Untreated Water										
Interim Blend										
Somerton										
Water	TDS	Alkalinity	Calcium	Chloride	Sulfate	pH	Precipitation Potential	Langelier Index	Alk/($Cl+SO_4$)	CO_2 Added
(%)	(mg/L)	(mg/l $CaCO_3$)	(mg/l $CaCO_3$)	(mg/l)	(mg/l)		(mg/l)			(mg/l)
100	1365	214	446	362	404	7.73	39.53	0.743	0.280	
75	1193	197	383	294	365	7.81	33.36	0.754	0.299	
50	1021	180	321	226	327	7.94	27.84	0.804	0.325	
25	849	163	259	158	289	8.13	23.06	0.895	0.365	
0	677	146	197	90	251	8.39	19.13	1.029	0.428	
Blended, Treated Water										
Interim Blend										
100	1390	214	446	362	404	7.09	9.08	0.103	0.280	25
75	1211	197	383	294	365	7.19	9.90	0.134	0.299	18
50	1034	180	321	226	327	7.3	9.66	0.164	0.325	13
25	858	163	259	158	289	7.46	9.49	0.225	0.365	9
0	683	146	197	90	251	7.68	9.35	0.319	0.428	6
Blended, Untreated Water										
Final Blend										
100	1325	174	406	362	404	7.12				
75	1160	164	350	294	365	7.18				
50	993	152	293	226	327	7.25				
25	826	140	236	158	289	7.34				
0	658	127	178	90	251	7.47				
Blended, Treated Water										
Final Blend										
100	1356	205	437	362	404	7.02				
75	1183	187	374	294	365	7.09				
50	1011	170	312	226	327	7.17				
25	840	154	249	158	289	7.28				
0	668	137	187	90	251	7.41				

Interim Blended Unstablilized Water Characteristics



.2

Interim Blended Unstablilized Water pH

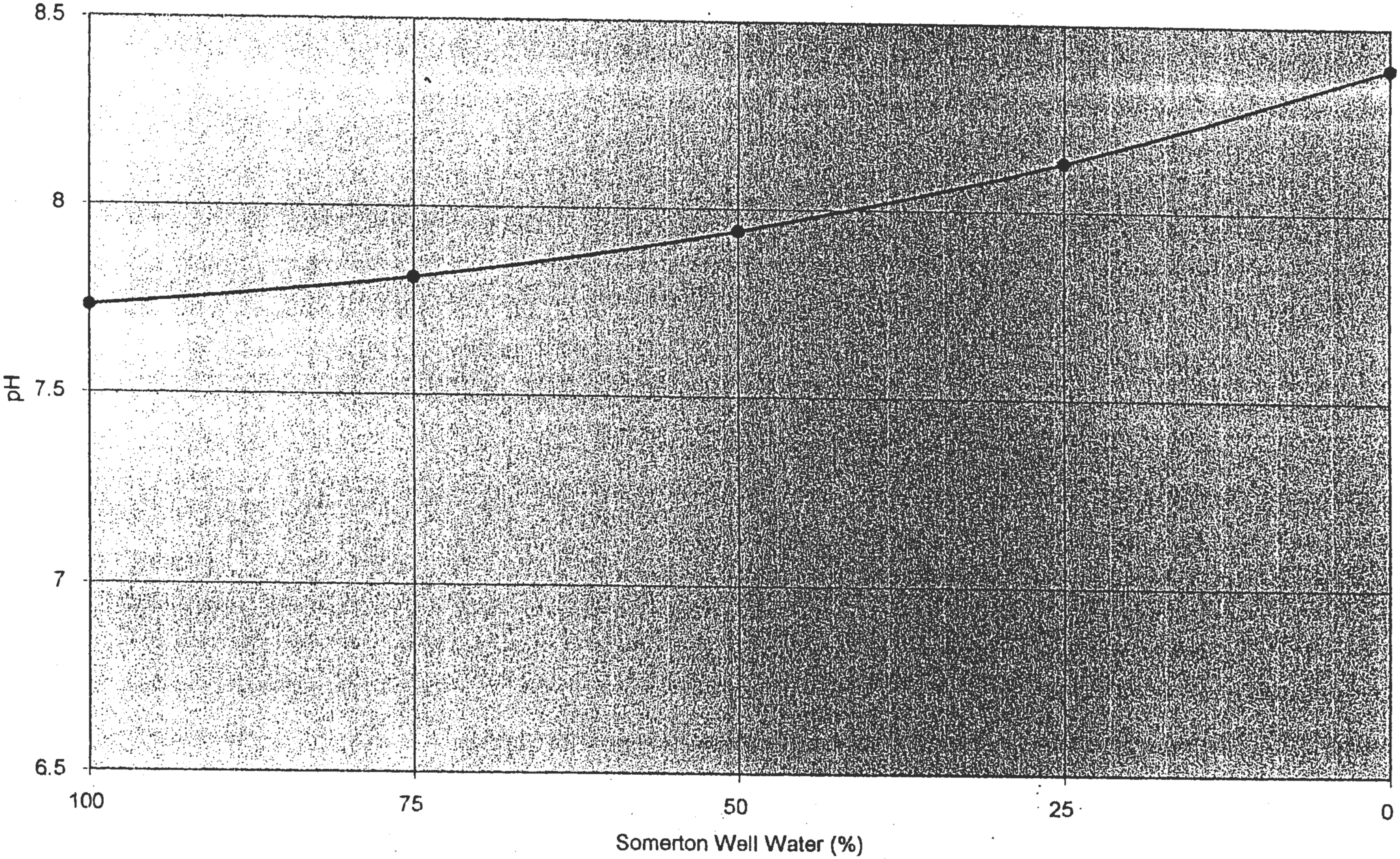


Chart 3

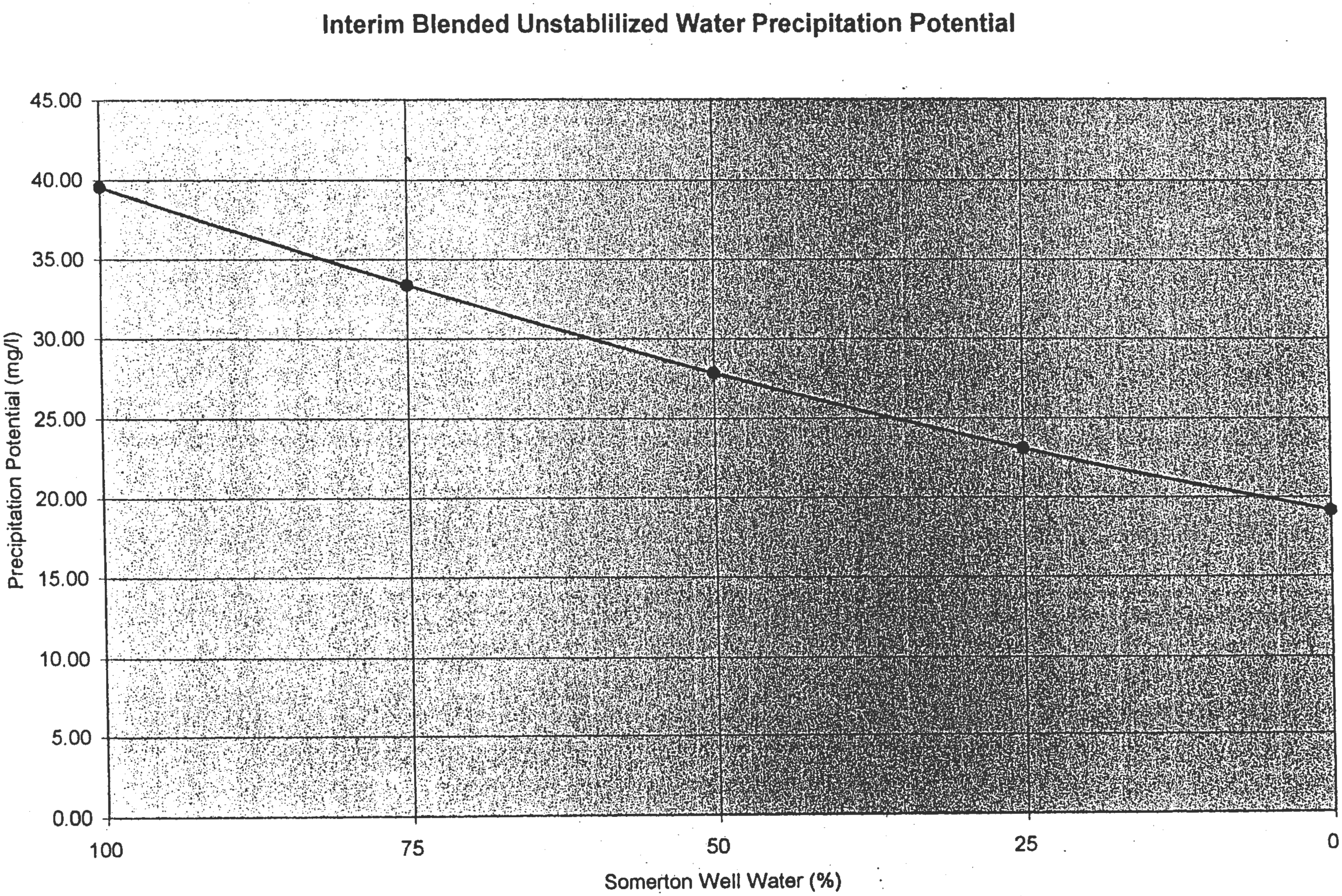
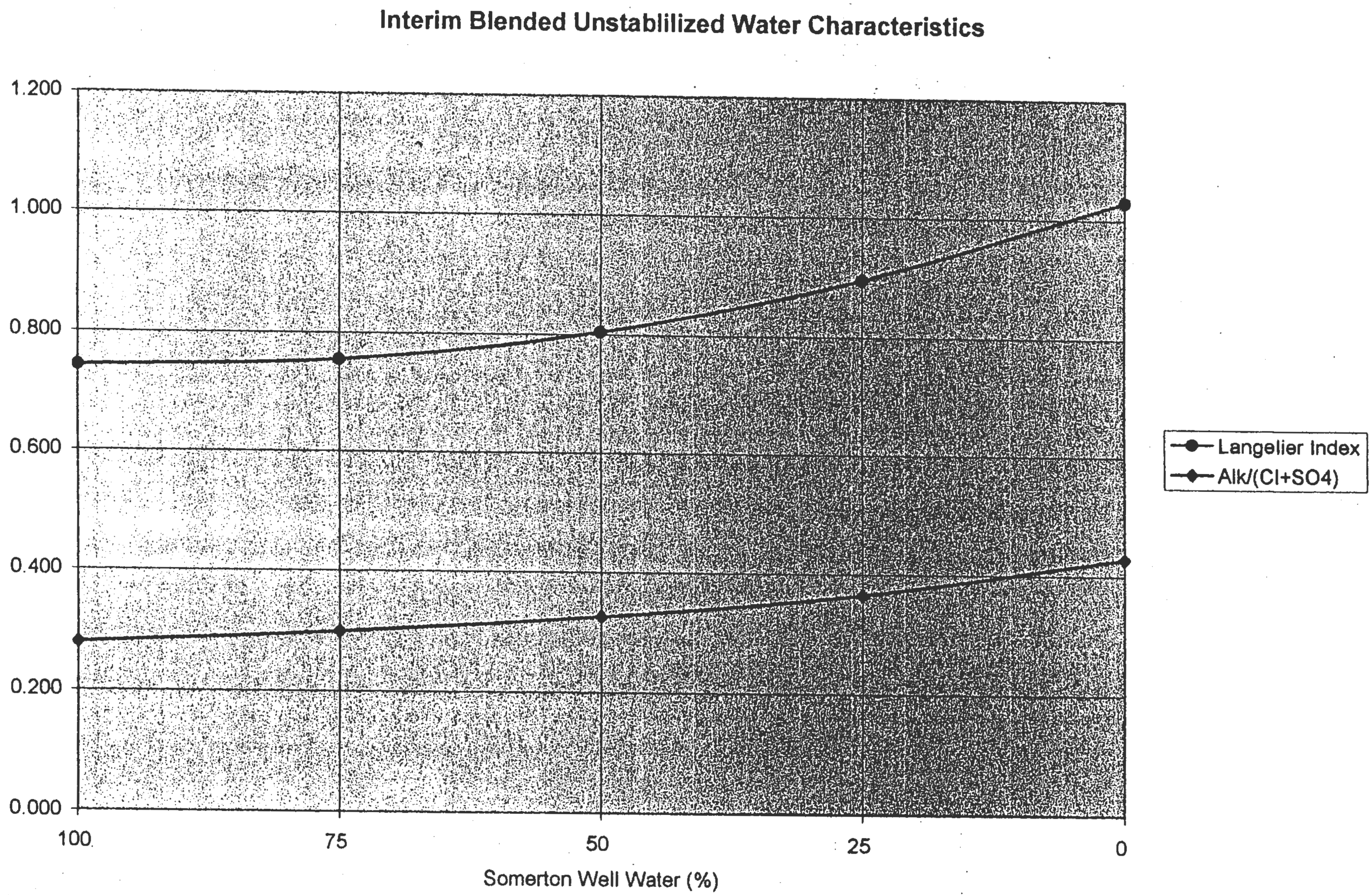
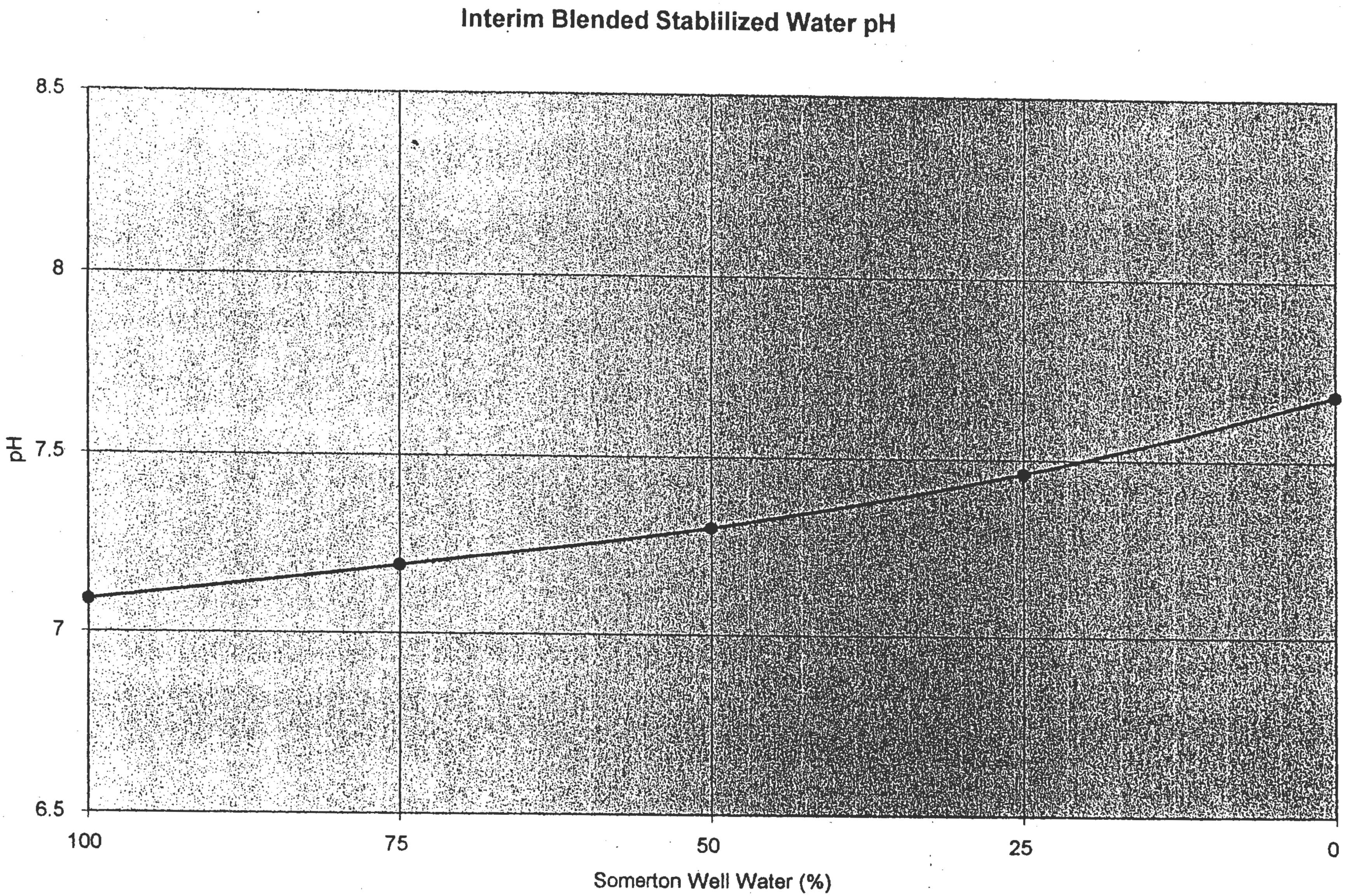

Interim Blended Unstablilized Water Precipitation Potential
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Precipitation Potential (mg/l)
100
75
50
25
0
Somerton Well Water (%)

Chart 4



Interim Blended Unstablilized Water Characteristics
1.200
1.000
0.800
0.600
0.400
0.200
0.000
100
75
50
25
0
Somerton Well Water (%)
Langelier Index
Alk/(Cl+SO4)

Chart 5



Interim Blended Stablilized Water pH
8.5
8
7.5
7
6.5
pH
100
75
50
25
0
Somerton Well Water (%)

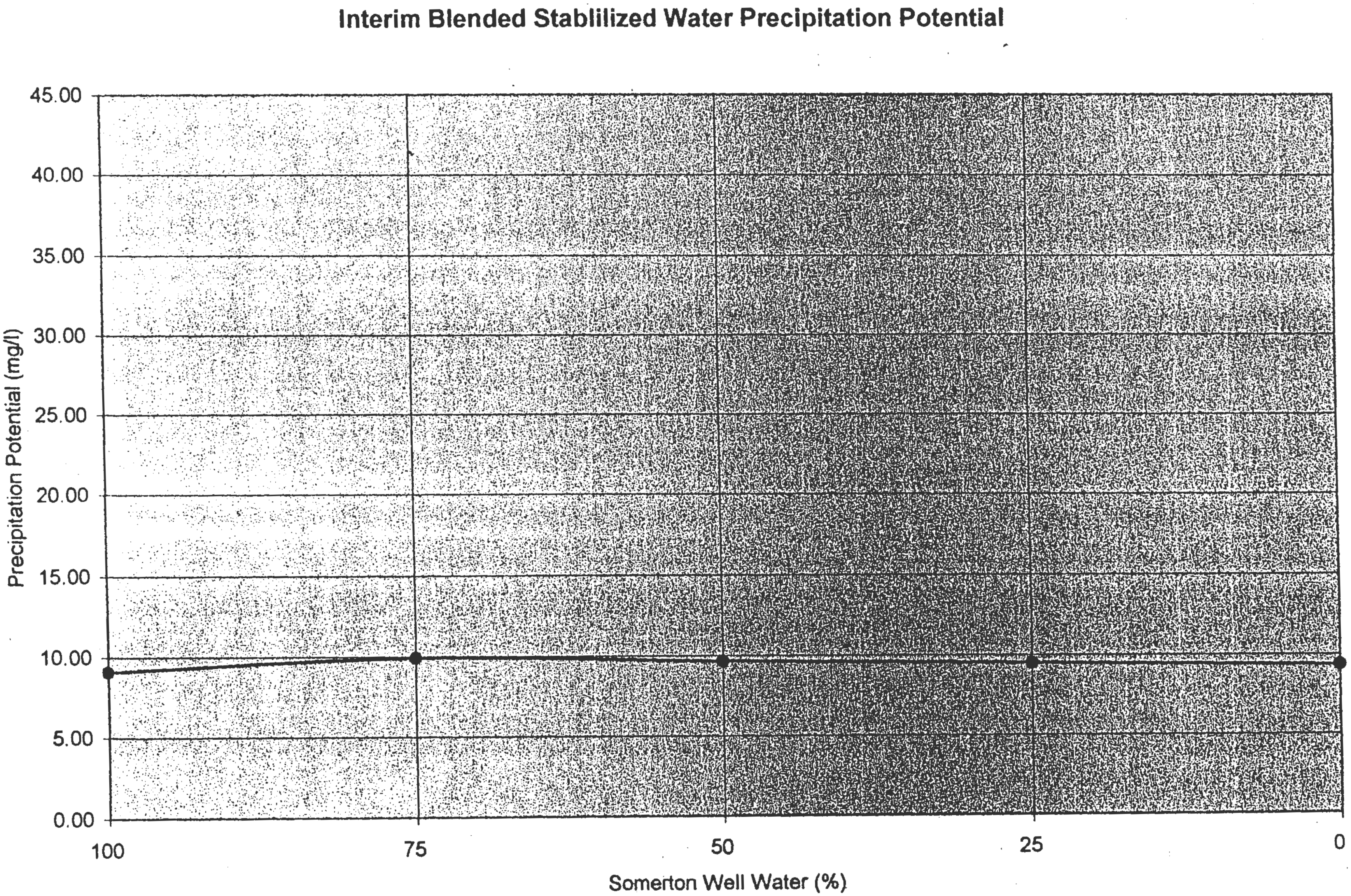

Interim Blended Stablilized Water Precipitation Potential
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Precipitation Potential (mg/l)
100
75
50
25
0
Somerton Well Water (%)

Chart 7

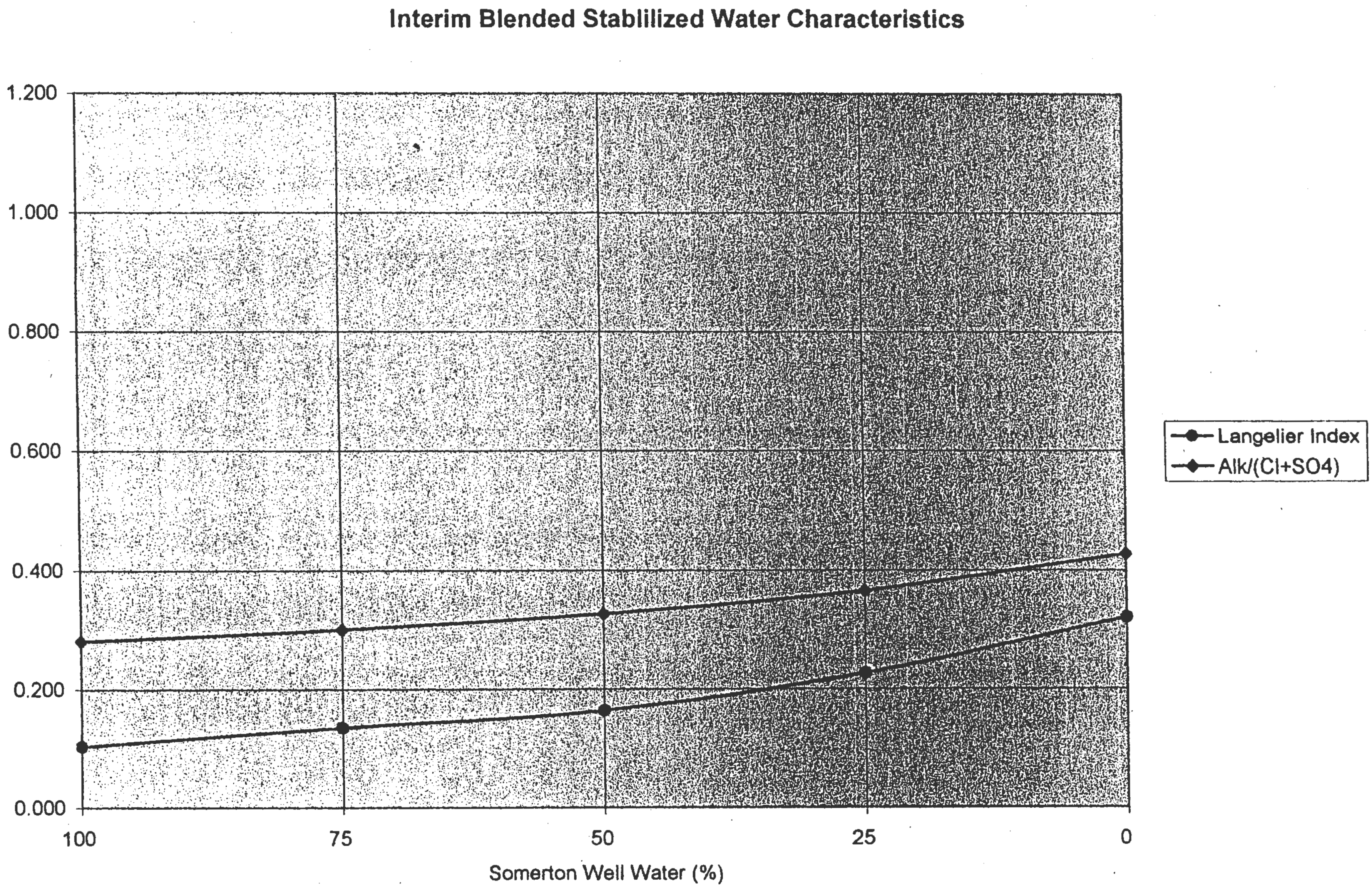

Interim Blended Stablilized Water Characteristics
1.200
1.000
0.800
0.600
0.400
0.200
0.000
100
75
50
25
0
Somerton Well Water (%)
Langelier Index
Alk/(Cl+SO4)

Chart 8

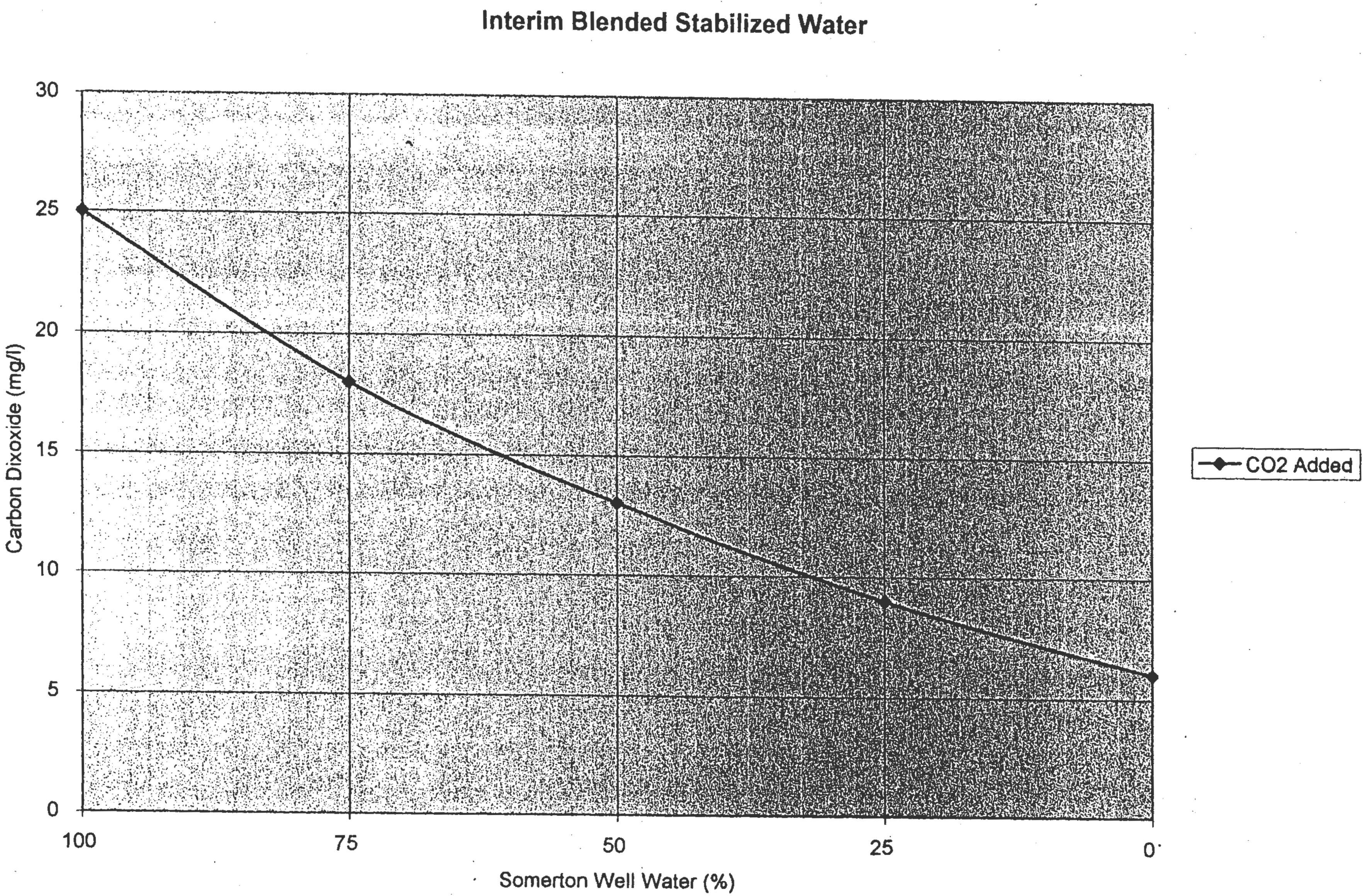
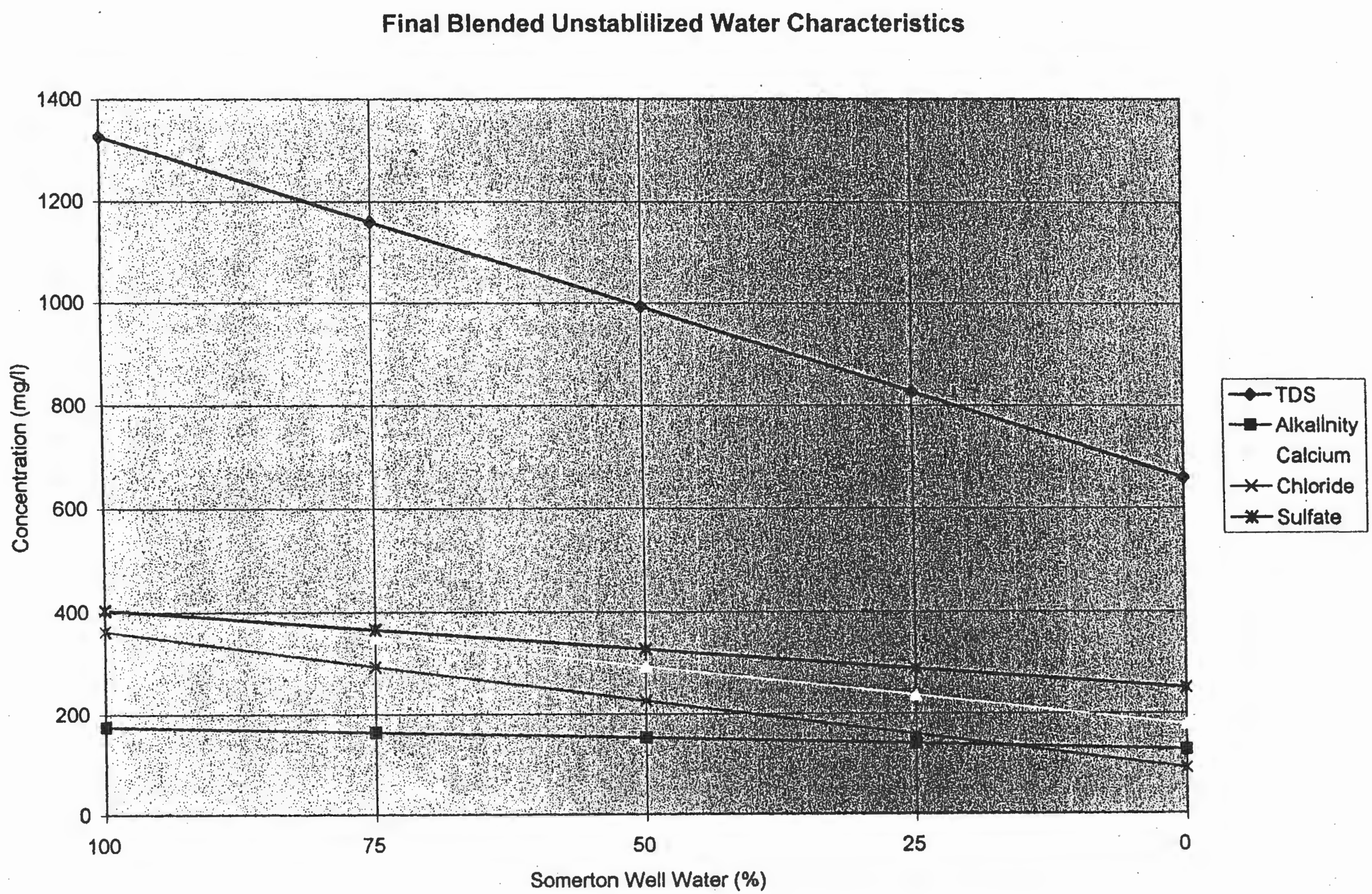

Interim Blended Stabilized Water
30
25
20
15
10
5
0
Carbon Dixoxide (mg/l)
100
75
50
25
0
Somerton Well Water (%)
CO2 Added

Chart 9



Final Blended Unstablilized Water Characteristics
1400
1200
1000
800
600
400
200
0
Concentration (mg/l)
100
75
50
25
0
Somerton Well Water (%)
TDS
Alkalinity
Calcium
Chloride
Sulfate

Ch... 10

Final Blended Unstablilized Water pH

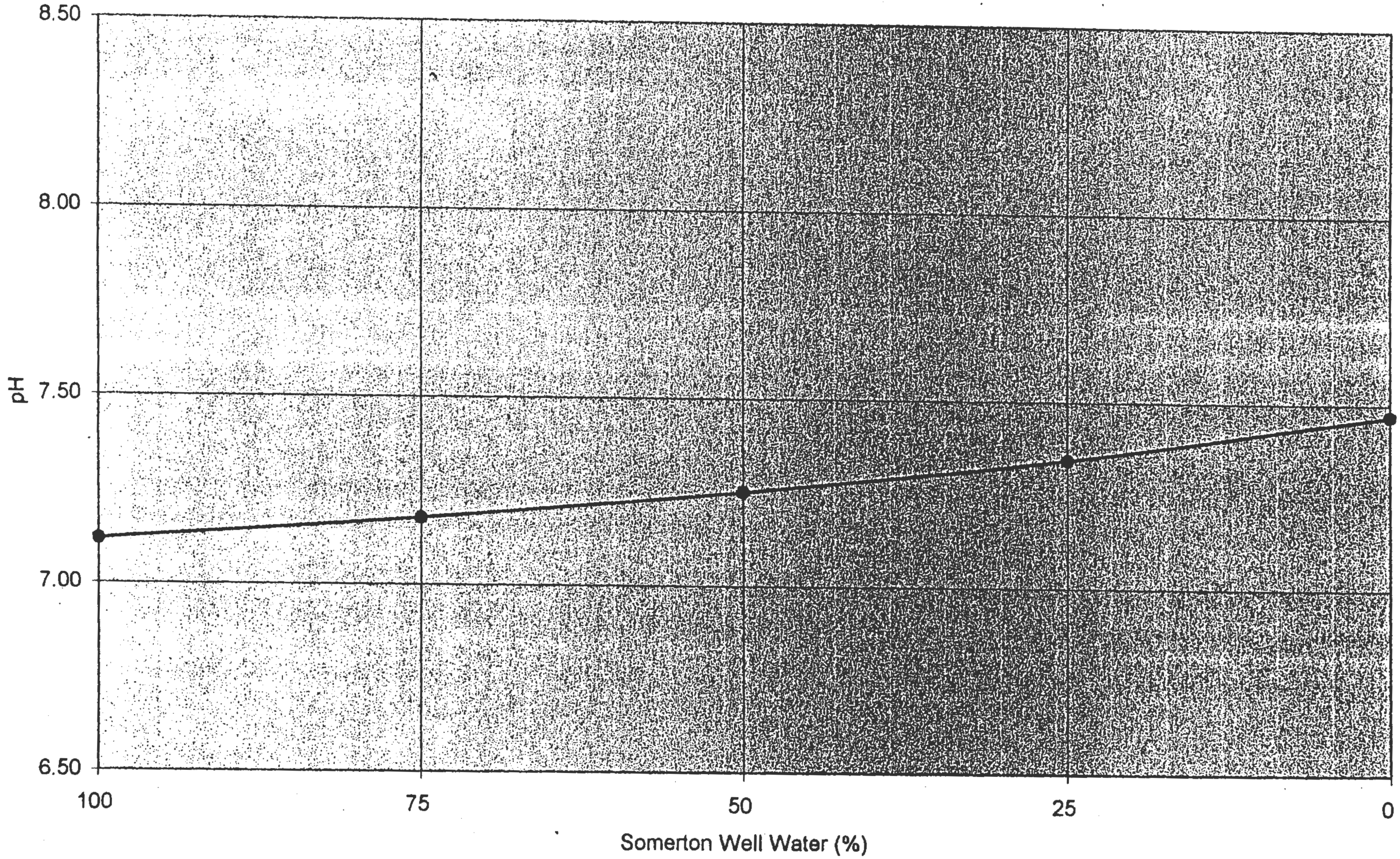
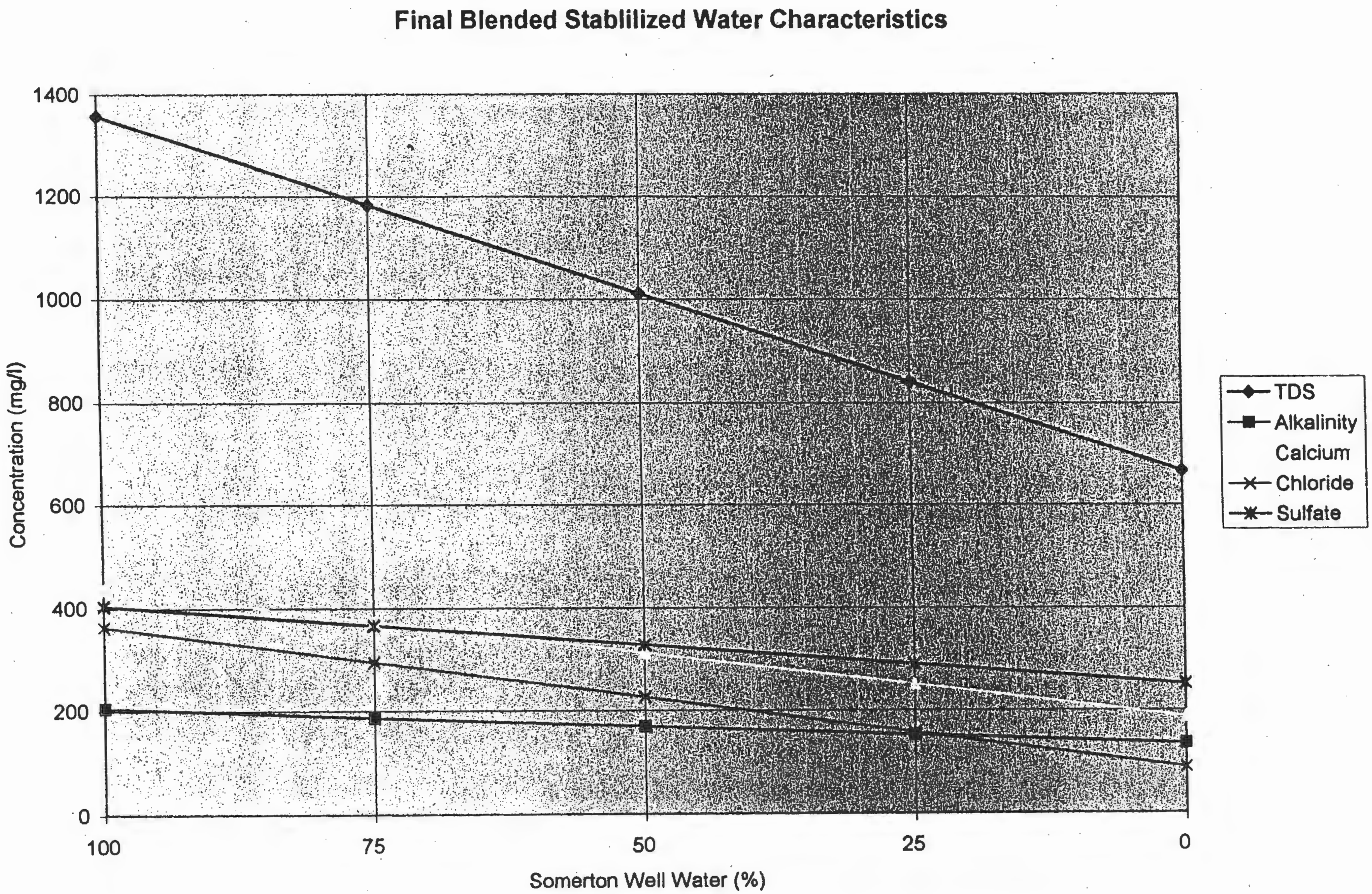
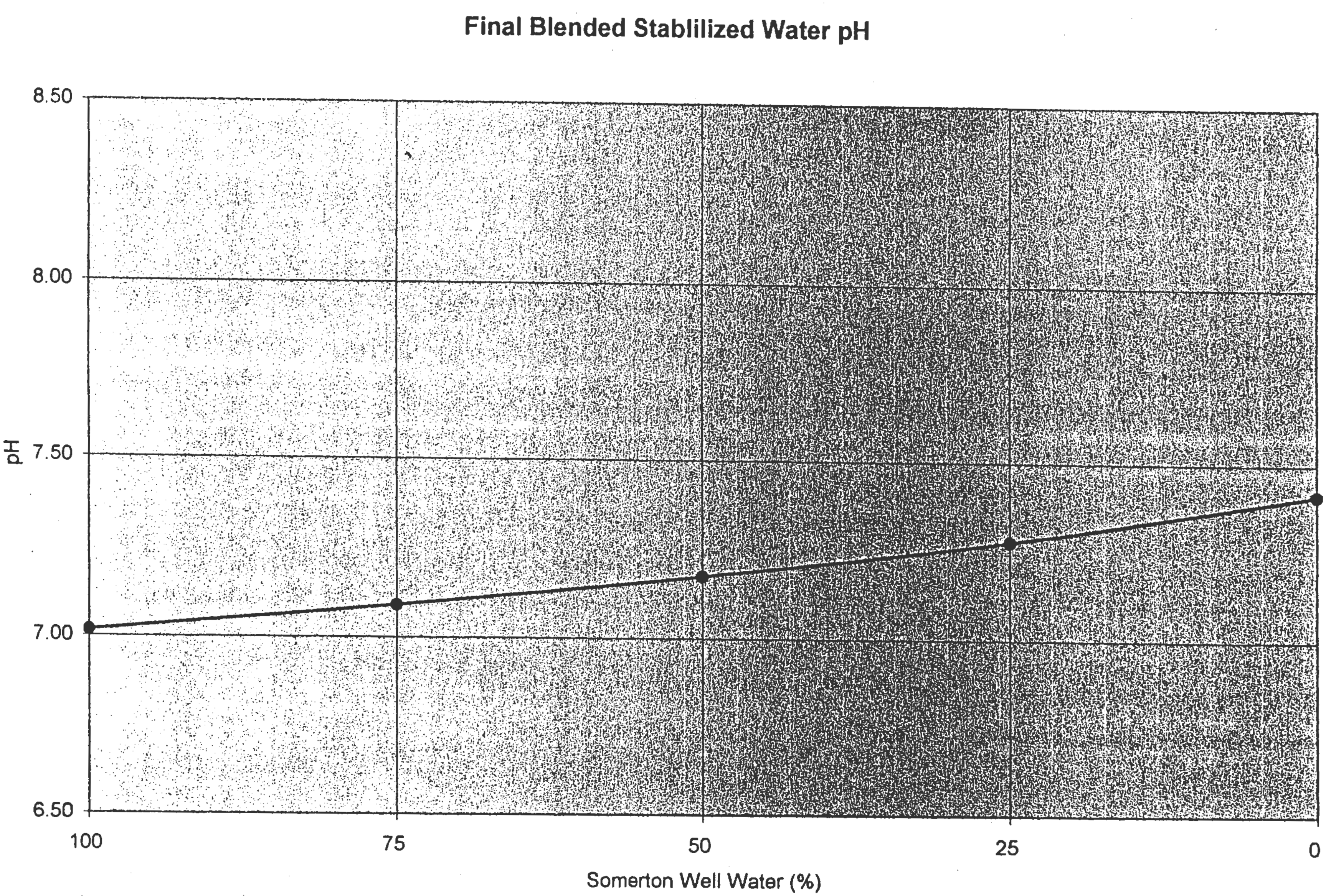


Chart 11



Final Blended Stablilized Water Characteristics
1400
1200
1000
800
600
400
200
0
Concentration (mg/l)
100
75
50
25
0
Somerton Well Water (%)
TDS
Alkalinity
Calcium
Chloride
Sulfate

Ch... 12



Final Blended Stablilized Water pH
pH
8.50
8.00
7.50
7.00
6.50
100
75
50
25
0
Somerton Well Water (%)

APPENDIX A

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**0**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	677	mg/L
Temperature	25	deg C
pH	8.39	
Alkalinity, as CaCO3	146.0125	mg/L
Ca, as CaCO3	196.6861552	mg/L
Cl	90.1125	mg/L
SO4	251	mg/L
Acidity	143	mg/L
Ca sat, as CaCO3	19	mg/L
DIC, as CaCO3	289	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	146	mg/L	> 40 mg/L	Interim pH	8.39		6.8-9.3
Interim Ca, as CaCO3	197	mg/L	> 40 mg/L	Precipitation potential	19.13	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.4		> 5.0	Langelier index	1.03		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	143	mg/L
Interim Ca sat, as CaCO3	19	mg/L
Ryznar index	6.33	
Interim DIC, as CaCO3	289	mg/L
Aggressiveness Index	12.85	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	127	mg/L
Final Ca	178	mg/L
Final acidity	143	mg/L
Final pH	7.47	
Final DIC, as CaCO3	270	mg/L

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L
Temperature	**20**	deg C
pH	**7.74**	
Alkalinity, as CaCO3	**214**	mg/L
Ca, as CaCO3	**445.7511976**	mg/L
Cl	**362**	mg/L
SO4	**403.5**	mg/L

????

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	25	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	849	mg/L
Temperature	23.75	deg C
pH	8.13	
Alkalinity, as CaCO3	163.009375	mg/L
Ca, as CaCO3	258.9524158	mg/L
Cl	158.084375	mg/L
SO4	289.125	mg/L
Acidity	165	mg/L
Ca sat, as CaCO3	34	mg/L
DIC, as CaCO3	328	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	163	mg/L	> 40 mg/L	Interim pH	8.13		6.8-9.3
Interim Ca, as CaCO3	259	mg/L	> 40 mg/L	Precipitation potential	23.06	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.4		> 5.0	Langelier index	0.90		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	165	mg/L
Interim Ca sat, as CaCO3	34	mg/L
Ryznar index	6.34	
Interim DIC, as CaCO3	328	mg/L
Aggressiveness Index	12.76	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	140	mg/L
Final Ca	236	mg/L
Final acidity	165	mg/L
Final pH	7.34	
Final DIC, as CaCO3	305	mg/L

The RTW Model Ver. 3.0

Blending Application Package

ID: **Water A=WTP Effluent, Water B=Colorado River**

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L
Temperature	**20**	deg C
pH	**7.74**	
Alkalinity, as CaCO3	**214**	mg/L
Ca, as CaCO3	**445.7511976**	mg/L
Cl	**362**	mg/L
SO4	**403.5**	mg/L

????

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**50**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1021	mg/L
Temperature	22.5	deg C
pH	7.94	
Alkalinity, as CaCO3	180.00625	mg/L
Ca, as CaCO3	321.2186764	mg/L
Cl	226.05625	mg/L
SO4	327.25	mg/L
Acidity	186	mg/L
Ca sat, as CaCO3	51	mg/L
DIC, as CaCO3	366	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	180	mg/L	> 40 mg/L	Interim pH	7.94		6.8-9.3
Interim Ca, as CaCO3	321	mg/L	> 40 mg/L	Precipitation potential	27.84	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.3		> 5.0	Langelier index	0.80		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	186	mg/L
Interim Ca sat, as CaCO3	51	mg/L
Ryznar index	6.33	
Interim DIC, as CaCO3	366	mg/L
Aggressiveness Index	12.70	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	152	mg/L
Final Ca	293	mg/L
Final acidity	186	mg/L
Final pH	7.25	
Final DIC, as CaCO3	338	mg/L

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L
Temperature	**20**	deg C
pH	**7.74**	
Alkalinity, as CaCO3	**214**	mg/L
Ca, as CaCO3	**445.7511976**	mg/L
Cl	**362**	mg/L
SO4	**403.5**	mg/L

????

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**75**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1193	mg/L
Temperature	21.25	deg C
pH	7.81	
Alkalinity, as CaCO3	197.003125	mg/L
Ca, as CaCO3	383.484937	mg/L
Cl	294.028125	mg/L
SO4	365.375	mg/L
Acidity	208	mg/L
Ca sat, as CaCO3	68	mg/L
DIC, as CaCO3	405	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	197	mg/L	> 40 mg/L	Interim pH	7.81		6.8-9.3
Interim Ca, as CaCO3	383	mg/L	> 40 mg/L	Precipitation potential	33.36	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.3		> 5.0	Langelier index	0.75		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	208	mg/L
Interim Ca sat, as CaCO3	68	mg/L
Ryznar index	6.30	
Interim DIC, as CaCO3	405	mg/L
Aggressiveness Index	12.69	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	164	mg/L
Final Ca	350	mg/L
Final acidity	208	mg/L
Final pH	7.18	
Final DIC, as CaCO3	371	mg/L

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**100**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1365	mg/L
Temperature	20	deg C
pH	7.73	
Alkalinity, as CaCO3	214	mg/L
Ca, as CaCO3	445.7511976	mg/L
Cl	362	mg/L
SO4	403.5	mg/L
Acidity	229	mg/L
Ca sat, as CaCO3	81	mg/L
DIC, as CaCO3	443	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**0**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	214	mg/L	> 40 mg/L	Interim pH	7.73		6.8-9.3
Interim Ca, as CaCO3	446	mg/L	> 40 mg/L	Precipitation potential	39.53	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.3		> 5.0	Langelier index	0.74		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	229	mg/L
Interim Ca sat, as CaCO3	81	mg/L
Ryznar index	6.24	
Interim DIC, as CaCO3	443	mg/L
Aggressiveness Index	12.71	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	174	mg/L
Final Ca	406	mg/L
Final acidity	229	mg/L
Final pH	7.12	
Final DIC, as CaCO3	403	mg/L

APPENDIX B

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	0	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	677	mg/L
Temperature	25	deg C
pH	8.39	
Alkalinity, as CaCO3	146.0125	mg/L
Ca, as CaCO3	196.6861552	mg/L
Cl	90.1125	mg/L
SO4	251	mg/L
Acidity	143	mg/L
Ca sat, as CaCO3	19	mg/L
DIC, as CaCO3	289	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).
Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**6**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired
Interim alkalinity	146	mg/L	> 40 mg/L
Interim Ca, as CaCO3	197	mg/L	> 40 mg/L
Alk/(Cl+SO4)	0.4		> 5.0

Theoretical interim characteristics			Desired
Interim pH	7.68		6.8-9.3
Precipitation potential	9.35	mg/L	4-10 mg/L
Langelier index	0.32		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	157	mg/L
Interim Ca sat, as CaCO3	95	mg/L
Ryznar index	7.04	
Interim DIC, as CaCO3	303	mg/L
Aggressiveness Index	12.14	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	137	mg/L
Final Ca	187	mg/L
Final acidity	157	mg/L
Final pH	7.41	
Final DIC, as CaCO3	294	mg/L

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**25**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	849	mg/L
Temperature	23.75	deg C
pH	8.13	
Alkalinity, as CaCO3	163.009375	mg/L
Ca, as CaCO3	258.9524158	mg/L
Cl	158.084375	mg/L
SO4	289.125	mg/L
Acidity	165	mg/L
Ca sat, as CaCO3	34	mg/L
DIC, as CaCO3	328	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**9**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	163	mg/L	> 40 mg/L	Interim pH	7.46		6.8-9.3
Interim Ca, as CaCO3	259	mg/L	> 40 mg/L	Precipitation potential	9.49	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.4		> 5.0	Langelier index	0.23		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	185	mg/L
Interim Ca sat, as CaCO3	155	mg/L
Ryznar index	7.01	
Interim DIC, as CaCO3	348	mg/L
Aggressiveness Index	12.09	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	154	mg/L
Final Ca	249	mg/L
Final acidity	185	mg/L
Final pH	7.28	
Final DIC, as CaCO3	339	mg/L

The RTW Model Ver. 3.0

Blending Application Package

ID: **Water A=WTP Effluent, Water B=Colorado River**

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**50**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1021	mg/L
Temperature	22.5	deg C
pH	7.94	
Alkalinity, as CaCO3	180.00625	mg/L
Ca, as CaCO3	321.2186764	mg/L
Cl	226.05625	mg/L
SO4	327.25	mg/L
Acidity	186	mg/L
Ca sat, as CaCO3	51	mg/L
DIC, as CaCO3	366	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**13**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	180	mg/L	> 40 mg/L	Interim pH	7.30		6.8-9.3
Interim Ca, as CaCO3	321	mg/L	> 40 mg/L	Precipitation potential	9.66	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.3		> 5.0	Langelier index	0.16		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	216	mg/L
Interim Ca sat, as CaCO3	221	mg/L
Ryznar index	6.97	
Interim DIC, as CaCO3	396	mg/L
Aggressiveness Index	12.06	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	170	mg/L
Final Ca	312	mg/L
Final acidity	216	mg/L
Final pH	7.17	
Final DIC, as CaCO3	386	mg/L

The RTW Model Ver. 3.0 ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L	????
Temperature	**20**	deg C	
pH	**7.74**		
Alkalinity, as CaCO3	**214**	mg/L	
Ca, as CaCO3	**445.7511976**	mg/L	
Cl	**362**	mg/L	
SO4	**403.5**	mg/L	

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**75**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1193	mg/L
Temperature	21.25	deg C
pH	7.81	
Alkalinity, as CaCO3	197.003125	mg/L
Ca, as CaCO3	383.484937	mg/L
Cl	294.028125	mg/L
SO4	365.375	mg/L
Acidity	208	mg/L
Ca sat, as CaCO3	68	mg/L
DIC, as CaCO3	405	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).

Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**18**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired	Theoretical interim characteristics			Desired
Interim alkalinity	197	mg/L	> 40 mg/L	Interim pH	7.19		6.8-9.3
Interim Ca, as CaCO3	383	mg/L	> 40 mg/L	Precipitation potential	9.90	mg/L	4-10 mg/L
Alk/(Cl+SO4)	0.3		> 5.0	Langelier index	0.13		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	249	mg/L
Interim Ca sat, as CaCO3	282	mg/L
Ryznar index	6.92	
Interim DIC, as CaCO3	446	mg/L
Aggressiveness Index	12.07	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	187	mg/L
Final Ca	374	mg/L
Final acidity	249	mg/L
Final pH	7.09	
Final DIC, as CaCO3	436	mg/L

The RTW Model Ver. 3.0

ID: **Water A=WTP Effluent, Water B=Colorado River**

Blending Application Package

STEP 1: Enter characteristics for waters to be blended.

Water A

TDS	**1365**	mg/L
Temperature	**20**	deg C
pH	**7.74**	
Alkalinity, as CaCO3	**214**	mg/L
Ca, as CaCO3	**445.7511976**	mg/L
Cl	**362**	mg/L
SO4	**403.5**	mg/L

????

Water B

TDS	**677**	mg/L
Temperature	**25**	deg C
pH	**8.3775**	
Alkalinity, as CaCO3	**146.013**	mg/L
Ca, as CaCO3	**196.686**	mg/L
Cl	**90.1125**	mg/L
SO4	**251**	mg/L

STEP 2: Enter portion of blend that is Water A

% Water A in blend	**100**	%

Press PAGE DOWN for blended water characteristics and chemical treatment calculations.

Press PAGE UP to review characteristics of waters A & B prior to blending

Initial blended water characteristics.

TDS	1365	mg/L
Temperature	20	deg C
pH	7.73	
Alkalinity, as CaCO3	214	mg/L
Ca, as CaCO3	445.7511976	mg/L
Cl	362	mg/L
SO4	403.5	mg/L
Acidity	229	mg/L
Ca sat, as CaCO3	81	mg/L
DIC, as CaCO3	443	mg/L

STEP 3: Enter amount of each chemical to be added to blended water (expressed as 100% chemical).
Press Ctrl+C to select chemicals for this list.

Alum *18H2O	**0**	mg/L
Alum 50% solution	**0**	mg/L
Carbon dioxide	**25**	mg/L
Caustic soda	**0**	mg/L
Chlorine gas	**0**	mg/L
Hydrochloric acid	**0**	mg/L
Hydrofluosilicic acid	**0**	mg/L
Lime (slaked)	**0**	mg/L
Soda ash	**0**	mg/L
Sodium bicarbonate	**0**	mg/L

STEP 4: Adjust at Step 3 until interim blended water characteristics meet your criteria.

Theoretical interim characteristics			Desired
Interim alkalinity	214	mg/L	> 40 mg/L
Interim Ca, as CaCO3	446	mg/L	> 40 mg/L
Alk/(Cl+SO4)	0.3		> 5.0

Theoretical interim characteristics			Desired
Interim pH	7.09		6.8-9.3
Precipitation potential	9.08	mg/L	4-10 mg/L
Langelier index	0.10		>0

Press PAGE DOWN for additional interim and final blended water characteristics if desired.

Press PAGE UP to review initial blended water characteristics, chemical addition quantities and additional interim blended water characteristics.

Theoretical interim blended water characteristics

Interim acidity	286	mg/L
Interim Ca sat, as CaCO3	352	mg/L
Ryznar index	6.88	
Interim DIC, as CaCO3	500	mg/L
Aggressiveness Index	12.07	

Theoretical final blended water characteristics after CaCO3 precipitation

Final alkalinity	205	mg/L
Final Ca	437	mg/L
Final acidity	286	mg/L
Final pH	7.02	
Final DIC, as CaCO3	491	mg/L