



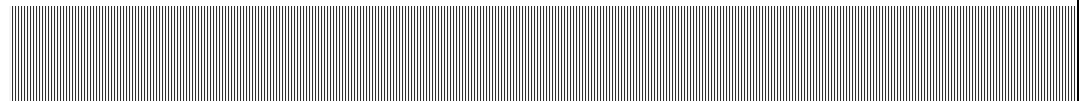
## Glendale Water and Power

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# Phase II Pilot Testing Task 8: Refined Cost Estimates for Hexavalent Chromium Removal Technologies

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Appendix

A. Technology Cost Estimates

# 1. Abstract

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Pilot testing of hexavalent chromium (Cr(VI)) removal technologies revealed that strong base anion exchange (SBA), weak base anion exchange (WBA), and reduction/coagulation/filtration (RCF) could treat contaminated groundwater in Glendale, California to low levels (i.e. less than 5 µg/L, or 95% removal). Using an approach that included the evaluation of vendor cost proposals and standard cost estimation practices, we developed screening-level cost estimates for these Cr(VI) removal technologies in 2005; these initial cost estimates were refined and updated herein to provide feasibility-level estimates. Capital costs and operations and maintenance (O&M) costs were estimated to determine the cost drivers for the different technologies. Two different size systems were considered, including 500 gpm wellhead treatment or 1,000 gpm treatment of two wells, as likely technologies for the Phase III demonstration study.

## 2. Background

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Hexavalent chromium, Cr(VI), is not specifically regulated in drinking water. However, total chromium, Cr(III) plus Cr(VI), has been part of national drinking water regulations since 1975. The federal regulatory maximum contaminant level (MCL) for total chromium is 100 µg/L, while the MCL in California is 50 µg/L. Although no federal limit has been established for Cr(VI) in drinking water, California's Department of Health Services has a mandate by State law to establish a Cr(VI)-specific MCL. The Cr(VI) carcinogenic *de minimis* risk level established by the State in 1999 was 0.2 µg/L, which contributed to a public health goal (PHG) of 2.5 µg/L for total chromium (OEHHA, 1999). Although this PHG was later rescinded and is currently under review, the potential for a new Cr(VI) MCL and a lower California total chromium MCL motivated the effort to identify treatment technologies able to remove Cr(VI) to levels far lower than the current limits. In addition to identifying such treatment technologies, understanding the treatment costs of these Cr(VI) removal technologies is critically important for regulatory development and drinking water utilities that face chromium treatment in the future.

Significant research efforts spearheaded by the City of Glendale have evaluated treatment technologies for chromium removal at both the bench- and pilot-scale. These efforts were prompted in 2000 by public concern over the presence of Cr(VI) in drinking water. In response to this public concern, the City of Glendale, with the participation of the Cities of Los Angeles, Burbank, and San Fernando, initiated a four-phase program to develop full-scale treatment capable of removing Cr(VI) from San Fernando Valley groundwater, which contains plumes with high concentrations of Cr(VI).

The Glendale four-phase program includes:

- Phase I: A bench-scale study that improved the understanding of fundamental Cr chemistry and screened promising treatment technologies (AwwaRF, 2004),
- Phase II: A pilot-scale study that evaluated treatment technologies for removing Cr(VI) to low levels in Glendale groundwater (McGuire et al., 2006; Qin et al., 2005),
- Phase III: A bridge pilot-scale study and a demonstration-scale study that will finalize the technology evaluation and address additional costs and residuals issues, and
- Phase IV: Full-scale implementation of an effective Cr(VI) treatment technology.

Until this comprehensive program, no treatment technology had been shown to reliably remove Cr(VI) in drinking water to levels below 5 µg/L, and no cost estimates of treatment have been developed. This paper reports on the refinement of screening cost estimates for Cr(VI) removal technologies tested in Phase II pilot testing.

### 3. Cost Development Approach

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Technology cost estimates were refined by: (1) obtaining updated quotes for vendor-specific technology cost information directly from vendors, (2) requesting technology cost information from several vendors for the RCF process, and (3) developing independent cost information using existing literature, professional judgment, and industry cost models. Estimates were developed for two system sizes with design flow rates of 500 gpm and 1,000 gpm.

The American Association of Cost Engineers (AACE) defines five categories of estimates in an effort to establish expected accuracy range for various types of cost estimates. The objective of this work was to refine initial conceptual screening cost estimates to provide study or feasibility-level costs. It is expected that an estimate of this type would a Class 4 estimate accurate within -15% or +30%.

**Table 3-1.**  
**AACE Cost Estimation Classification**

| Estimate Class | Level of Project Definition | End Usage: Typical Purpose of Estimate | Typical Budget Estimate Accuracy |
|----------------|-----------------------------|--|----------------------------------|
| Class 5        | 0% to 2%                    | Concept Screening                      | -30% to +50%                     |
| Class 4        | 1% to 15%                   | Study or Feasibility                   | -15% to +30%                     |
| Class 3        | 10% to 40%                  | Budget, Authorization, or Control      | -15% to +30%                     |
| Class 2        | 30% to 70%                  | Control or Bid/Tender                  | -5% to +15%                      |
| Class 1        | 50% to 100%                 | Check Estimate on Bid/Tender           | -5% to +15%                      |

**Vendor Cost Solicitation.** Technology cost information was requested from vendors for those technologies that were most promising in Phase II pilot tests (McGuire et al., 2006). This included U.S. Filter Corporation in partnership with Rohm and Haas (US Filter/R&H) weak- and strong-base ion exchange. In addition, we requested a cost quotation from BasinWater, a strong-base ion exchange vendor with a containerized treatment system. Finally, various vendors were contacted for quotes on unit processes within the RCF treatment process. Vendor-supplied cost quotations were amended using independently-developed capital costs and O&M estimates, as discussed below.

**Independent Cost Development.** Capital cost estimates were developed using the MasterFormat™ framework established by the Construction Specifications Institute. MasterFormat™ provides an organizational structure for performance-based construction specifications and costs.

The Malcolm Pirnie Standard Specifications Format conforms closely to the Construction Specification Institute's (CSI) MasterFormat 1995. The Malcolm Pirnie Standard Specifications Format is based on a Division-Section concept. Each Division is identified by a Division number and title. The Division Title is a broad generic heading based on an interrelationship of place, trade, function, or material. There are eighteen Divisions that are constant in sequence, name, and number, are as follows:

- Division 0 - Bidding Requirements, Contract Forms, Conditions of Contract
- Division 1 - General Requirements
- Division 2 - Site Construction
- Division 3 - Concrete
- Division 4 - Masonry
- Division 5 - Metals
- Division 6 - Wood and Plastics
- Division 7 - Thermal and Moisture Protection
- Division 8 - Doors and Windows
- Division 9 - Finishes
- Division 10 - Specialties
- Division 11 - Equipment
- Division 12 - Furnishings
- Division 13 - Special Construction
- Division 14 - Conveyance Systems
- Division 15 - Mechanical
- Division 16 - Electrical
- Division 17 - Instrumentation and Controls

The Division Titles are primarily an organizational device. Each Division contains a group of related Sections, with each Section generally constituting a unit of work or a single entity such as a particular material, product, or item of equipment.

In addition to specific estimates associated with each Division, several standard capital cost multipliers were applied to the total capital cost (Table 1).

**Table 3-2.  
Standard Capital Cost Multipliers**

| Capital Cost                   | Cost Multiplier |
|--------------------------------|-----------------|
| Insurance                      | 2.5%            |
| Bonds                          | 2.0%            |
| Contractor Overhead and Profit | 10%             |
| Engineering                    | 10%             |
| Contingency                    | 20%             |

**General Cost Assumptions.** A capital interest rate of 5% with a recovery period of 20 years was used to annualize all technology capital costs. All costs are expressed in September 2006 dollars. Labor costs were estimated for each technology based on full-time equivalents (FTEs) with a loaded annual salary of \$100,000 (typical estimate for Glendale, California).

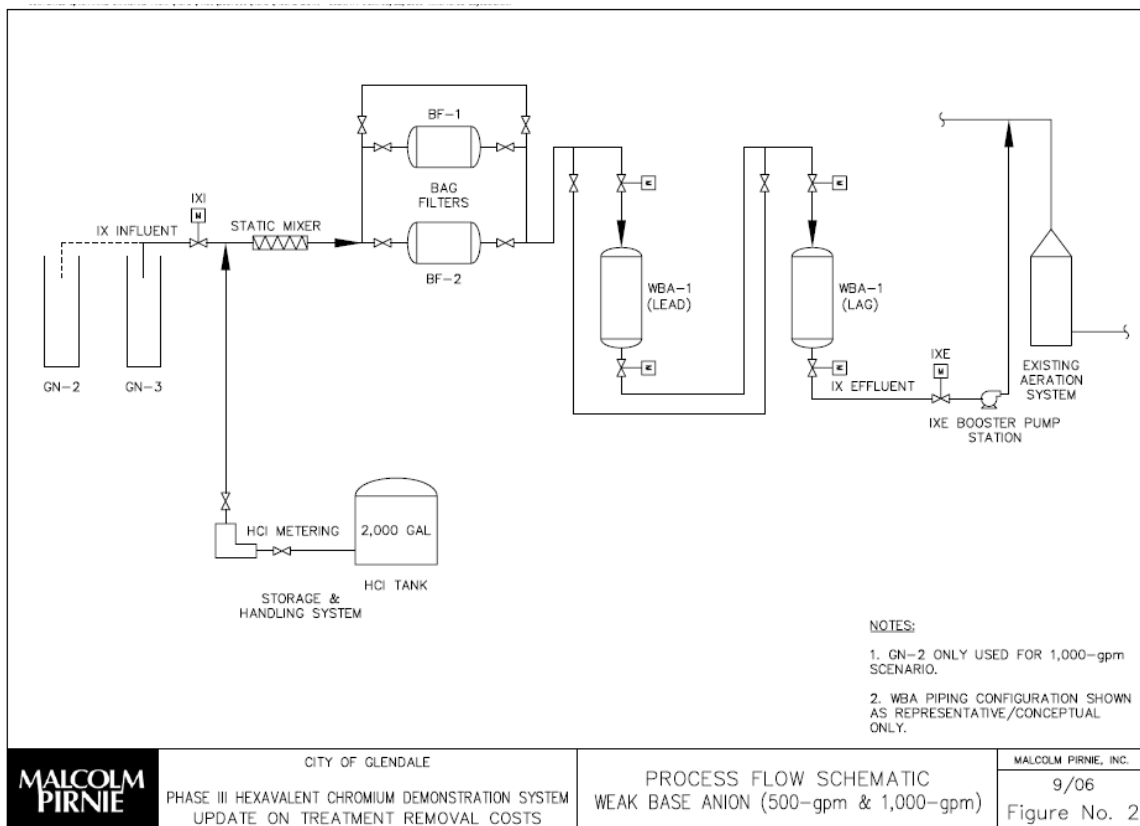


## 4. Technology Cost Estimates

### Weak Base Anion Exchange

**Treatment Process Description.** A WBA exchange system would consist of lead/lag resin vessels with upstream acid addition. Due to its high capacity and difficulty in regeneration, WBA resin is intended be used as a once-through, non-regenerable media. Figure 1 provides a process flow schematic of a WBA system.

**Figure 4-1: Process Flow Schematic of US Filter/R&H WBA System**



This system includes acidification of the influent to protonate the resin for optimal Cr(VI) removal and to limit OH<sup>-</sup> competition with chromate ions. Acid requirements for pH depression to 6.0 determined from the Phase III Bridge Project were approximately 0.00023 gallons of 31% HCl per gallon of water treated. US Filter/R&H specified a volumetric design flow rate for this media of approximately 2.5 gpm per cubic feet, bed volumes of 200 cubic feet, and 8-ft. diameter vessels. Cost estimates are based on removal of Cr(VI) to approximately 100,000 bed volumes, which represents operation to

maximize Cr(VI) capacity but minimize the accumulation of uranium on the resin (i.e., to prevent the formation of low-level radioactive waste). This throughput corresponds to approximately 207 days of operation before the resin is replaced. US Filter/R&H estimated that a weekly low-volume backwash may be necessary to reclassify the media bed, which would yield non-hazardous backwash water.

**Capital Cost Development.** For the 500 gpm demonstration system, two 8-ft. diameter vessels would be plumbed in lead/lag configuration. The 1,000 gpm demonstration system would have two 12-ft. diameter vessels. Other equipment included in this cost estimate are bag filters, a HCl storage and handling system, and a 16,000-gallon liquid waste equalization tank, and a centrifugal pump for regulating the spent backwash water flow to the sewer. Two parallel bag filter housings (5 micron filters, 3-ft. diameter housings) were considered in the estimate. For acid feed, cost estimates were developed using metering pumps capable of 288 gallons per day, a 2,000-gallon HCl storage tank (with a 3,000-gallon secondary containment fiberglass reinforced plastic (FRP) tank), and a scrubber system for acid vapors.

The initial resin inventory (400 cubic feet – divided into two vessels) is also included in the capital cost estimate at a rate of \$500/cubic foot (i.e., the estimate provided by US Filter/R&H, which includes loading and disposal of spent resin). Additional resin loads besides the first fill are accounted for in the O&M costs. Other one-time capital costs are shown by Division in Appendix A.

**Operation and Maintenance Cost Development.** Operating costs for the WBA system were provided by US Filter/R&H and adjusted as necessary. Estimates included the following:

- Media replacement every 207 days, at \$500 per cubic foot,
- Hydrochloric acid for pH depression, at \$1.15/gallon for 2,000 gallon loads of 31% HCl (quote obtained from Basic Chemical, October 2006),
- Non-hazardous liquid waste disposal for backwash, at \$3.22 per 1,000 gallons,
- Bag filter replacement costs, assuming monthly replacement of filters,
- Effluent booster pump energy costs, and
- Labor costs for 0.125 FTE.

The US Filter/R&H WBA system costs are dominated by O&M costs comprised largely of resin costs and acid costs for pH depression. The resin replacement costs are driven by two key assumptions: (1) the anticipated resin usage rate is based on 100,000 bed volumes to breakthrough; and (2) the cost of resin estimated at \$500/cf. The cost of WBA resins has varied significantly in the past two years, increasing from \$350/cf to \$500/cf.

Since the WBA resin requires pH depression to approximately 6.0, the acid needs are significant in Glendale's groundwater that is supersaturated with CO<sub>2</sub>. Phase III Bridge Project testing indicated that the pressurized well water at GS-3 was found to have a pH of 6.8 rather than the pH of 7.2-7.3 that is routinely measured in the laboratory (from

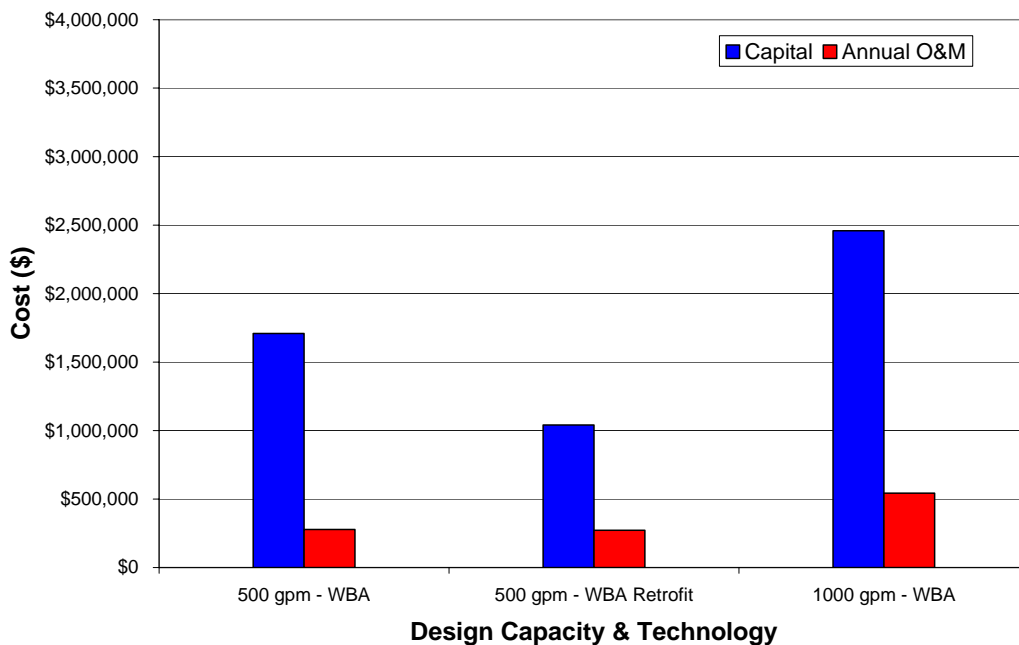
samples that released CO<sub>2</sub> when brought to atmospheric pressure). At a pH of 6.0, approximately 0.00023 gallons of 31% HCl will be needed, which corresponds to about 165 gallons of 31% HCl per day for a flow rate of 500 gpm. Although not tested at pilot-scale, cost savings may be realized if sulfuric acid can be used; this may be a variable that could be tested in the demonstration study.

Residuals streams from the WBA system are limited to spent resin and backwash water. Non-hazardous backwash water could be sent to either the Los Angeles sewer facilities (for the Southern wells) or to the Glendale sewer (for the Northern wells). Spent resin will be hazardous due to high chromium levels, as shown by the California WET test results in the Phases II and III projects.

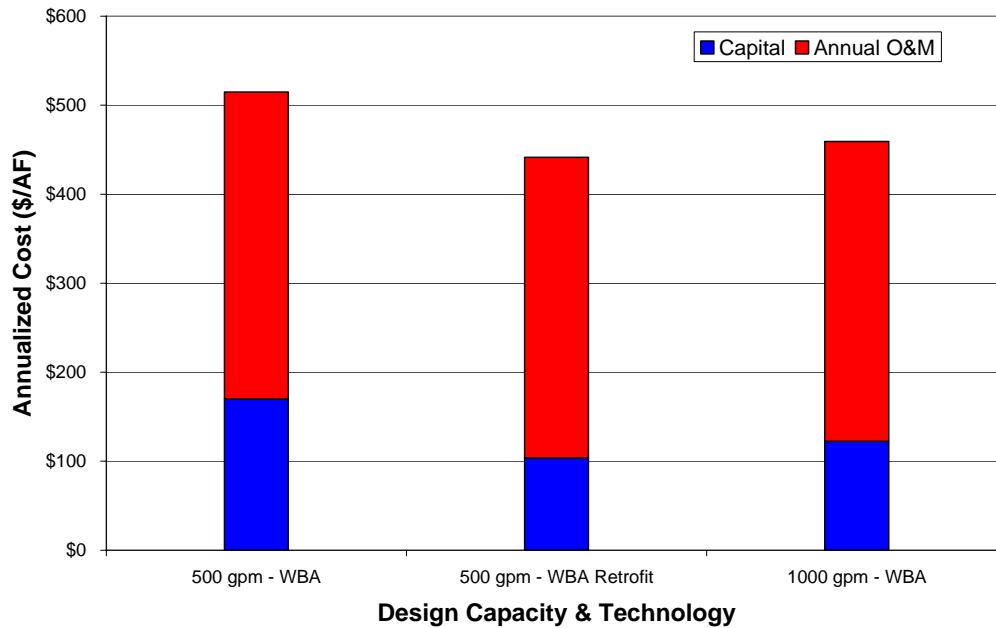
**Estimated Cost Range.** Based on vendor-provided cost estimates and an independent analysis of costs, estimates were developed of the cost range for WBA systems. For WBA, a third case was considered – a 500 gpm retrofit of two GAC vessels at the GS-3 site, which was estimated to save over \$600,000 for capital costs associated with the WBA system.

Figure 2 shows the capital cost and annual O&M cost estimates for 500 and 1,000 gpm systems. Figure 3 displays the annualized costs in dollars per acre-foot of water treated.

**Figure 4-2: Capital Cost Estimates and Annual O&M of the WBA System**



**Figure 4-3: Annualized Cost Estimates of the WBA System**



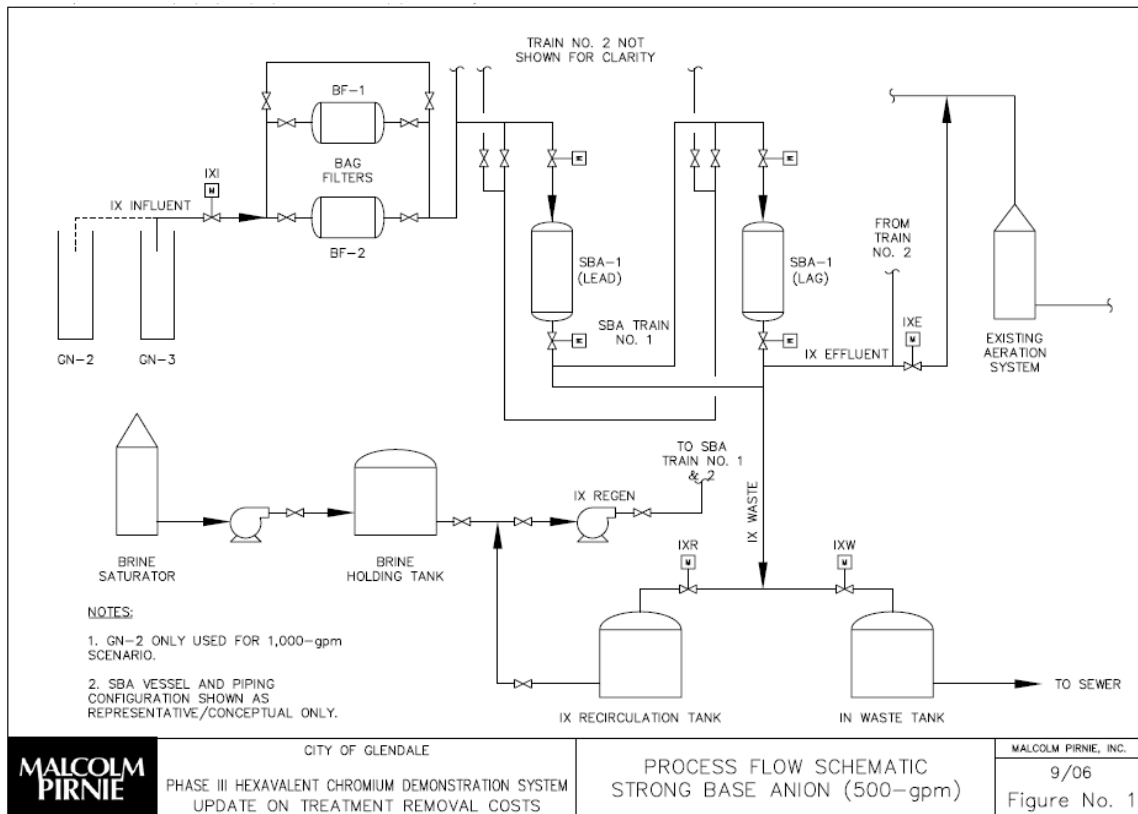
As noted previously and shown in Figure 3, the O&M costs are the largest cost component of the annualized costs, which is due to both resin replacement frequency and acid needs. Since resin costs dramatically increased from 2005 estimates likely due to market pricing, the potential exists for resin costs to come down, particularly if other WBA resins are available to provide competition.

## Strong Base Anion Exchange

**Treatment Process Description.** In the past Phase II cost estimate, US Filter/R&H provided a quotation for a strong base anion exchange system. However, after obtaining experience with this process in Colby, Kansas, US Filter no longer offers regenerable SBA for Cr(VI) removal. During this testing, US Filter encountered difficulty in regenerating the resin to full capacity after approximately 12 to 15 regenerations. Consequently, US Filter now markets only the WBA system and a single-pass SBA system.

An important point about this SBA system is BasinWater's contention that the process is much more efficient than typical SBA systems. As a result, the amount of salt used in the BasinWater system will supposedly be much lower (59 lbs./AF water treated) than other brine regeneration applications (such as Calgon's ISEP process for perchlorate, which uses about 1,600 to 2,400 lbs./AF). Partial data was provided for a BasinWater chromate removal system in Stockton, California; however, no proof of effective regeneration past 12 to 15 cycles was provided.

**Figure 4-4: General Process Flow Schematic of an SBA System**



The BasinWater system also contains a brine processing unit to process the spent brine, thus rendering it non-hazardous. Cr(VI) is reduced and precipitated using a ferrous salt.

The solid waste component will be hazardous by California WET standards. Additional details on the brine processing unit have not been provided by BasinWater.

**Pilot testing results.** Phase II pilot testing showed that US Filter/R&H SBA Resin PWA410C1 was effective at removing Cr(VI) to less than 5 µg/L for approximately 1,900 bed volumes. The SBA resin was effectively regenerated using a saturated brine solution recycled up to 7 times during pilot testing. The need for a lead/lag configuration or multiple beds-in-parallel was confirmed when chromatographic peaking of nitrate was observed, yielding effluent concentrations exceeding the MCL for nitrate. No specific testing on the BasinWater system was conducted; this would have to be done at the demonstration scale if the technology is selected for additional testing.

**Capital Cost Development.** Capital cost estimates provided by BasinWater include a treatment module (mobile container), 6,500-gallon salt storage (saturator) tank, two 6,500-gallon brine wastewater storage tanks, and a brine processing unit. BasinWater provided several options for their system, including purchase, a take-or-pay option with a 10-year service agreement, and a monthly standby with a water service agreement. For purposes of cost comparison, the purchase option was considered in this evaluation. Other one-time capital costs are shown by Division in Appendix A.

**Operation and Maintenance Cost Development.** Operating costs for the SBA system were provided by BasinWater and adjusted as necessary. Estimates included the following:

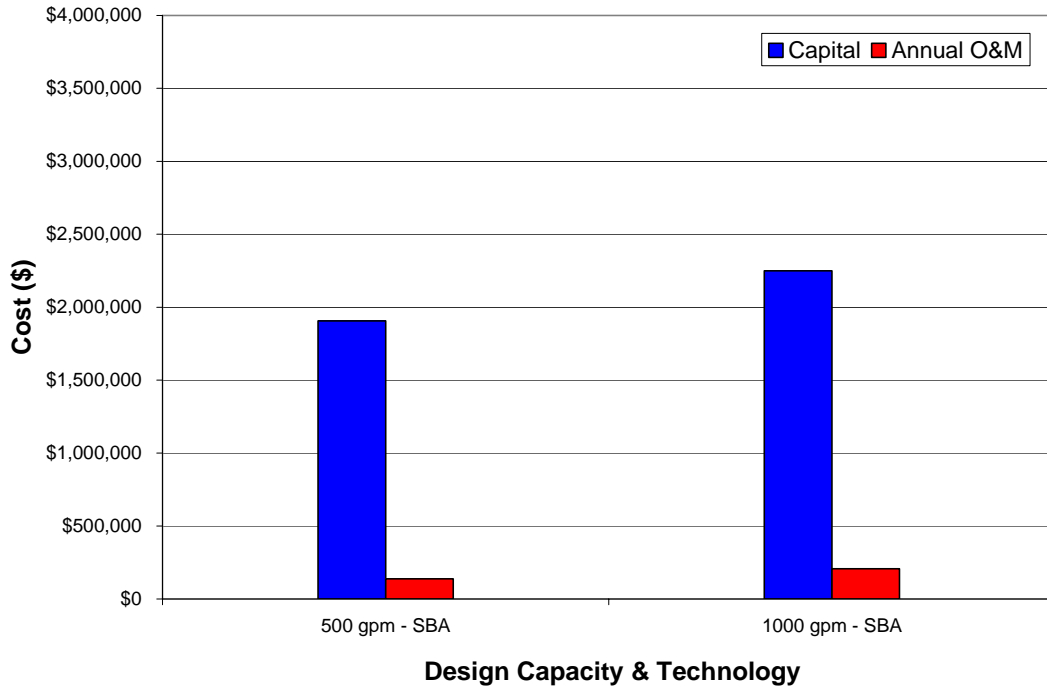
- Salt usage, estimated at 59 lbs. per acre-foot of water treated at \$100/ton of salt,
- Non-hazardous backwash water disposal, at \$3.22 per 1,000 gallons,
- Non-hazardous brine disposal, including trucking costs and discharge fees to Hyperion for a total cost of \$0.15/gallon,
- Solid hazardous waste disposal at a rate of \$445/ton,
- Bag filter replacement costs, assuming monthly filter replacement,
- Effluent booster pump energy costs, and
- Labor costs for 0.5 FTE.

Residuals disposal cost estimates dominated the O&M costs due to the need for trucking non-hazardous (treated) brine to a sewer connection leading to Hyperion. This step is required since the Glendale Wastewater Reclamation Plant will not accept brine. The potential for brine recycle has not been offered by BasinWater and may offer the potential for reduced spent brine volumes. The volume of non-hazardous brine includes regenerant and slow rinse liquid waste. Other sources of residuals waste include fast rinse and backwash liquid waste, which will be sent to the sewer as non-hazardous liquid waste, and solid hazardous waste from brine processing.

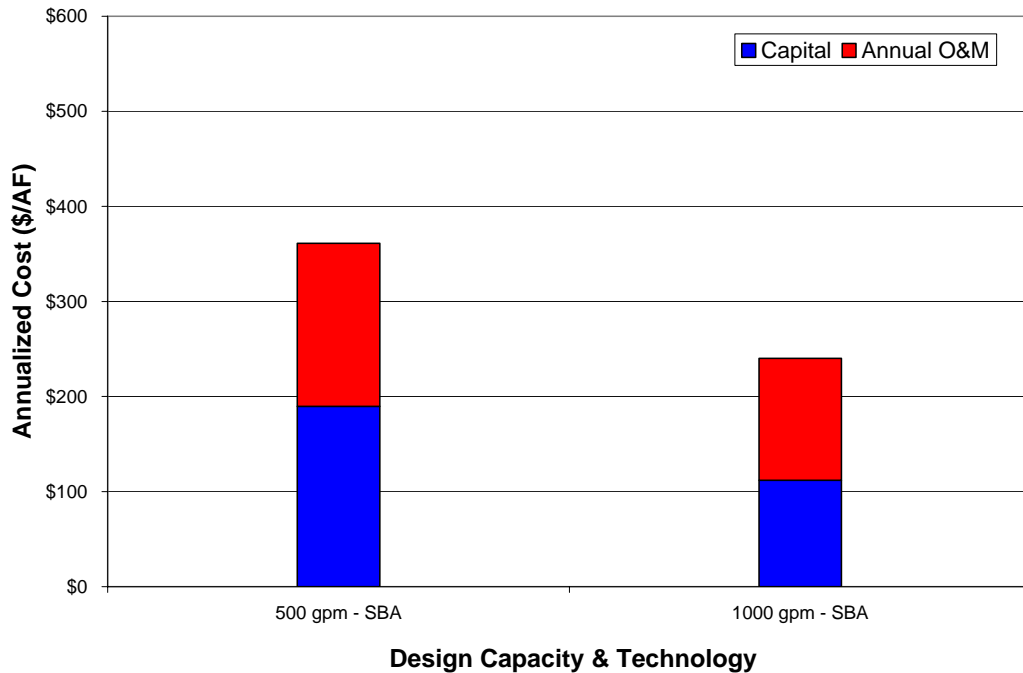
**Estimated Cost Range.** Based on vendor-provided cost estimates and an independent analysis of costs, cost estimates were prepared for SBA treatment. Figure 5 shows total

capital cost and annual O&M cost estimates for 500 and 1,000 gpm systems. Figure 6 displays the annualized costs for SBA systems in dollars per acre-foot of water treated. As shown in Figure 6, the O&M and capital costs are similar on an annualized basis.

**Figure 4-5: Capital Cost Estimates of the BasinWater SBA Treatment System**



**Figure 4-6: Annualized Cost Estimates of the BasinWater SBA Treatment System**



Several variables associated with the SBA technology are unknowns that have the potential to significantly impact SBA treatment process feasibility, including:

- BasinWater has not released data proving the capabilities of the brine processing unit for rendering the liquid component of the brine non-hazardous. Limited research has demonstrated this brine treatment approach, and it is uncertain if the capital (e.g. dewatering equipment) and O&M (e.g. increased labor necessary to manage spent brine treatment and sludge disposal, estimated here to be an extra 0.5 FTE) estimates provided by BasinWater are accurate. Consequently, the residuals cost estimates for the brine treatment systems may not reflect all of the anticipated costs associated with this approach. At this time, however, these costs reflect information provided by BasinWater.
- The amount of salt required for BasinWater SBA regeneration is very low compared to regenerable SBA processes for perchlorate. If larger quantities are required than those estimated by BasinWater, the brine processing unit may be undersized and quantity of waste underestimated.
- Disposal of brine to a connection leading to the Hyperion sewer is not certain in the future; if this is unavailable, costs of brine disposal may significantly increase.
- No data has been provided by BasinWater assuaging the concern that SBA resins may not be regenerable beyond 12 to 15 bed volumes of water treated (as observed by US Filter).

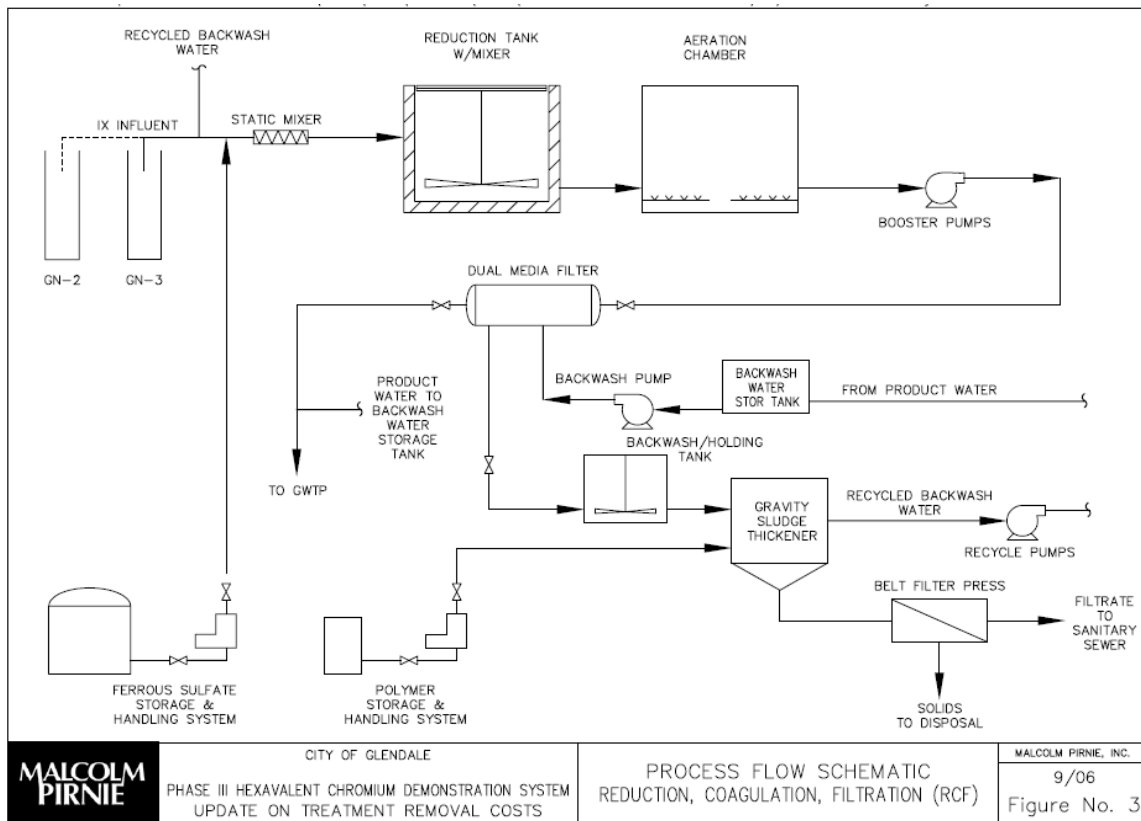


## Reduction, Coagulation, Filtration

**Treatment Process Description.** The removal of hexavalent chromium, Cr(VI), by reduction to trivalent chromium, Cr(III), with ferrous sulfate and subsequent coagulation with ferric iron followed by filtration was demonstrated to successfully remove Cr(VI) during pilot testing. The RCF pilot unit consisted of a reduction tank, aeration columns, and dual-media granular filters; in addition, chemical feed points included those for pH control before the reduction tank and aeration columns, ferrous sulfate addition before the reduction tank, and filter aid polymer addition prior to the filters.

Since the RCF process had never been utilized to remove Cr(VI) in a potable drinking water supply, the RCF technology costs were estimated using a range of sources including quotes from vendors that could supply different unit processes. Figure 7 illustrates the RCF system process flow diagram.

**Figure 4-7: Process Flow Schematic of the RCF System**



**Pilot testing results.** Pilot testing efforts identified optimal operating conditions for the RCF process. At ambient pH conditions and a Fe(II):Cr(VI) mass ratio of 25:1, the system continuously removed chromium (both Cr(VI) and Cr(III)) to below detectable levels for 48 hours before filter head loss and turbidity goals were exceeded. The pilot system was backwashed with air scour and bed fluidization. The bed expansion rate was

controlled at 20 to 30%, and the entire backwash procedure was complete within 10 to 12 minutes.

Waste minimization and disposal options for the chromium-containing backwash water solids were also investigated during pilot testing. It was determined that the backwash solids could be rapidly settled with low doses (0.2 to 1.0 mg/L) of high molecular weight polymer. The resultant settled backwash water may be suitable for recycle to the head of the system, while the settled backwash solids would be dewatered. The liquid residual from the dewatering process would be classified as non-hazardous and sent to the sewer. The dewatered solids would be classified and disposed of as hazardous solid waste.

**Capital Cost Development.** Capital costs for the RCF process include the chemical feed systems, reduction tank, settler, aeration chamber, filters, backwash pumping, and waste handling treatment equipment. Since the pilot testing identified ambient pH conditions as optimal, pH adjustment equipment has not been included in this estimate. One time capital costs developed specifically included the following:

- Reduction tank with mixers (30,000-gallon),
- Gravity settler,
- Aeration chamber (10,000-gallon, with coarse air diffusers, air compressor, and blowers),
- Dual media filter (5-cell),
- Ferrous sulfate feed system, including chemical storage and pumps,
- Polymer addition feed system,
- Backwash water storage tank (30,000-gallon),
- Backwash water (post-backwash) holding tank with mixer (20,000-gallon),
- Belt filter press (1-meter), and
- Booster pumps.

The capital costs estimated for the RCF system are higher than the other technologies evaluated, primarily due to the cost of filters and backwash waste handling and treatment equipment required to dewater the backwash solids. As a potential alternative to granular media filters, microfiltration might offer cost savings. Alternate filtration strategies could be evaluated in the demonstration-scale design.

**Operation and Maintenance Cost Development.** Operational costs for the RCF process included the following:

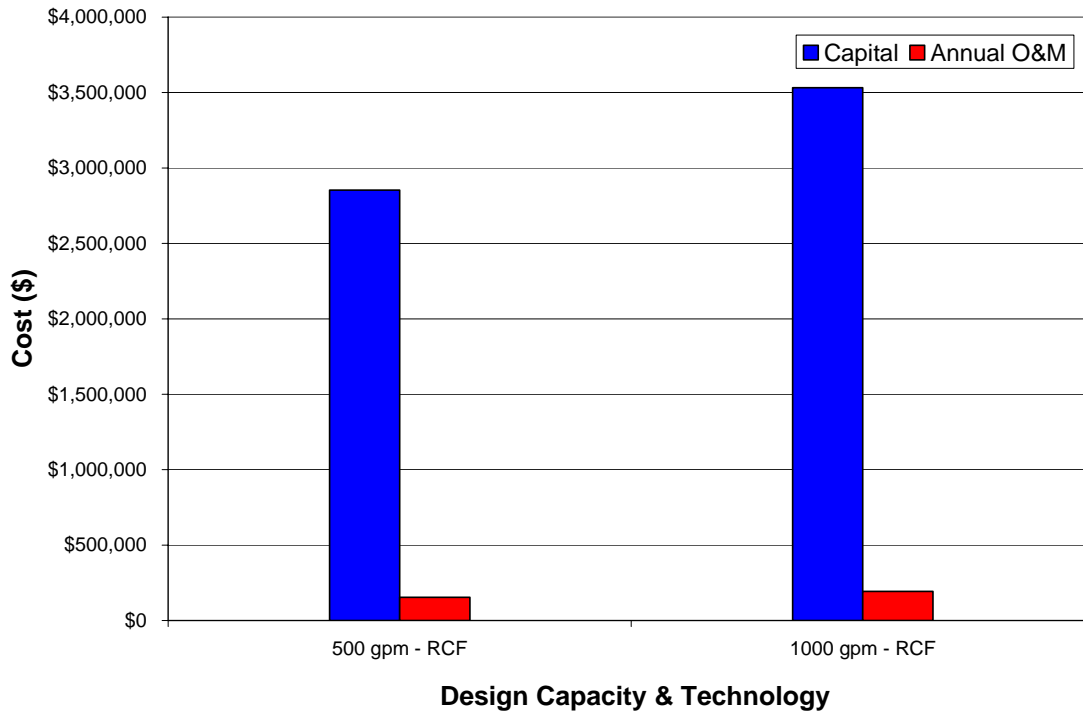
- Ferrous sulfate costs, at \$0.60/gallon (5% Fe) based on a usage rate mass ratio of 25:1 Fe:Cr (2.5 mg/L as Fe for 100 µg/L Cr),
- Non-hazardous backwash water disposal, at \$3.22 per 1,000 gallons,
- Solid hazardous waste disposal at a rate of \$445/ton,
- Filter media replacement, assuming 10% media loss per year,
- Effluent booster pump energy costs, and
- Labor costs for 0.5 FTE.

Residuals streams produced by the RCF process include dewatering liquids classified as non-hazardous waste and sent to sewer, as well as dewatered chromium-containing coagulation solids disposed of as hazardous solid waste. Residuals stream volumes were estimated based on full-scale operational conditions including 24-hour filter run times with a 15-minute backwash duration at 15 gpm/ft<sup>2</sup>. These conditions result in a backwash water volume of 4% of the treated flow. A number of assumptions were then needed to calculate liquid and solid residuals components. The RCF residuals disposal cost estimates rely heavily on the operational assumptions for the process, including backwash duration and quantity, settled backwash water sludge volume, and dewatering efficiency. These operational assumptions dictate the total volumes of dewatering liquids classified as non-hazardous that are sent to sewer, as well as dewatered chromium-containing coagulation solids disposed of as hazardous solid waste. With no available full-scale operational history for the RCF process, these assumptions were limited to industry experience and such texts as *Water Quality and Treatment* citing coagulation practice (Cornwell, 1999).

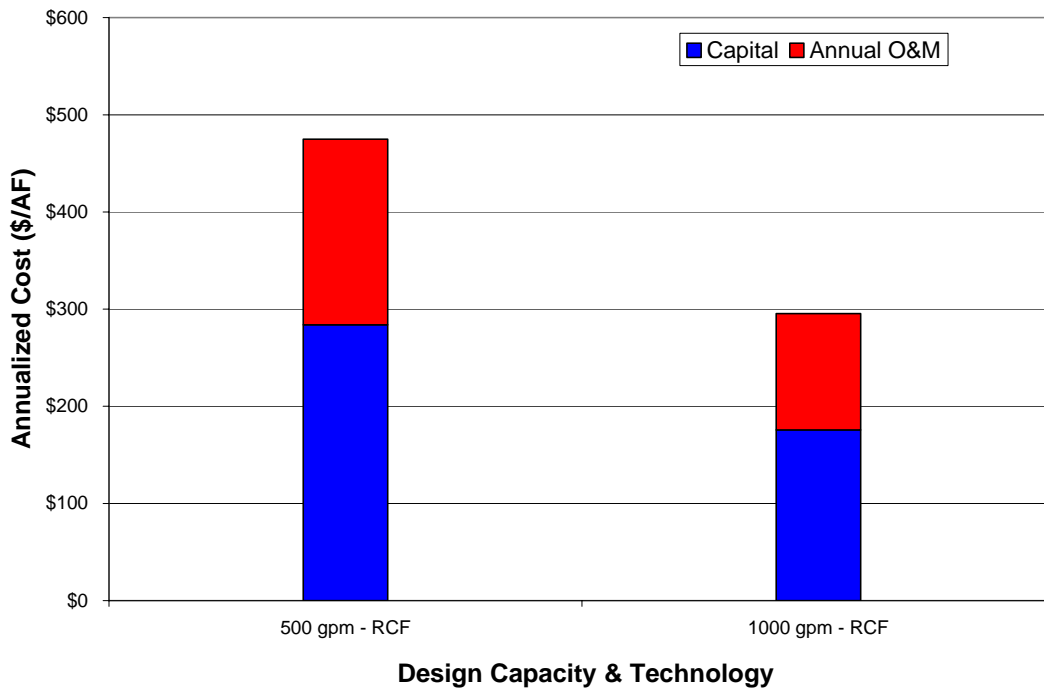
Of the backwash water, 0.58% was assumed to be settled sludge (based on calculations of ferrous doses), and 99.42% of the flow was assumed to be recycled to the head of the plant. The settled sludge was assumed to have 3% solids, and the filter press was assumed to have 80% dewatering efficiency (Cornwell, 1999). These assumptions led to an estimate of 28,000 gallons per day of non-hazardous backwash water sent to the sewer for a 500 gpm system – a small cost component. Solid residuals, on the other hand, were a significant cost at \$445/ton and an estimated 20 tons produced per year.

**Estimated Cost Range.** Based on vendor-provided cost estimates of unit processes and an independent analysis of costs, costs were developed for the RCF treatment process for 500 and 1,000 gpm flows. Figure 8 shows total capital cost and annual O&M cost estimates for two different size systems. Figure 9 displays the annualized costs for RCF systems in dollars per acre-foot of water treated. In general, the RCF system costs are characterized by relatively low O&M costs and high capital costs.

**Figure 4-8: Capital Cost Estimates of the RCF Treatment System**



**Figure 4-9: Annualized Cost Estimates of the RCF Treatment System**

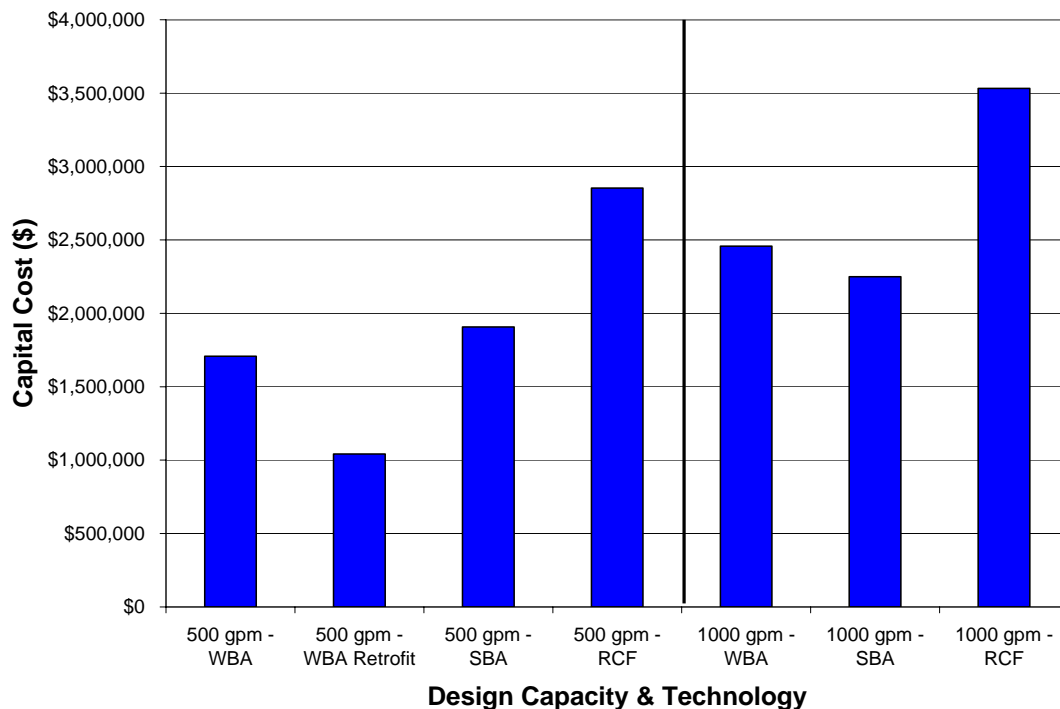


## 5. Comparison of Technology Costs

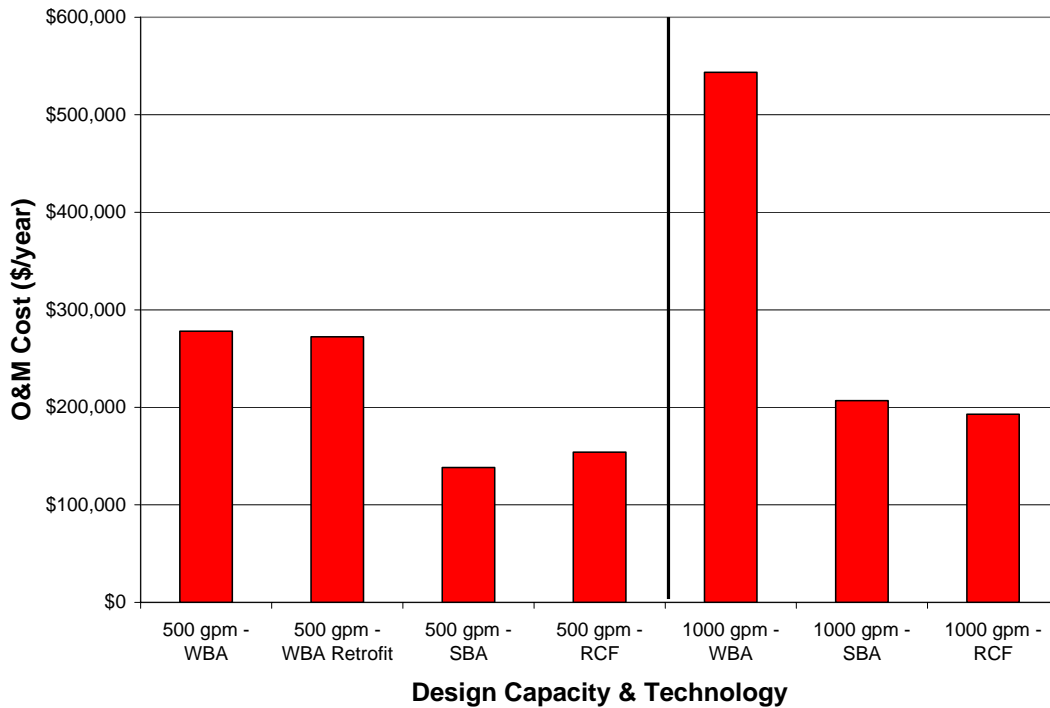
Figure 10 shows a comparison of the capital cost estimates for each of the three technologies at 500 and 1,000 gpm. The figure highlights the relatively high capital costs associated with the RCF technology. SBA and WBA applications had similar capital costs, although the potential retrofit at GS-3 significantly reduced the capital cost by more than \$600,000.

Annual O&M cost estimates are presented in Figure 11. In general, SBA and RCF had lower O&M costs than WBA resin. The high cost of resin replacement and (secondly) acid costs in the WBA system eclipsed the residuals disposal costs that contributed much of the SBA and RCF O&M costs. Finally, Figure 12 shows an annualized cost comparison of the various technologies.

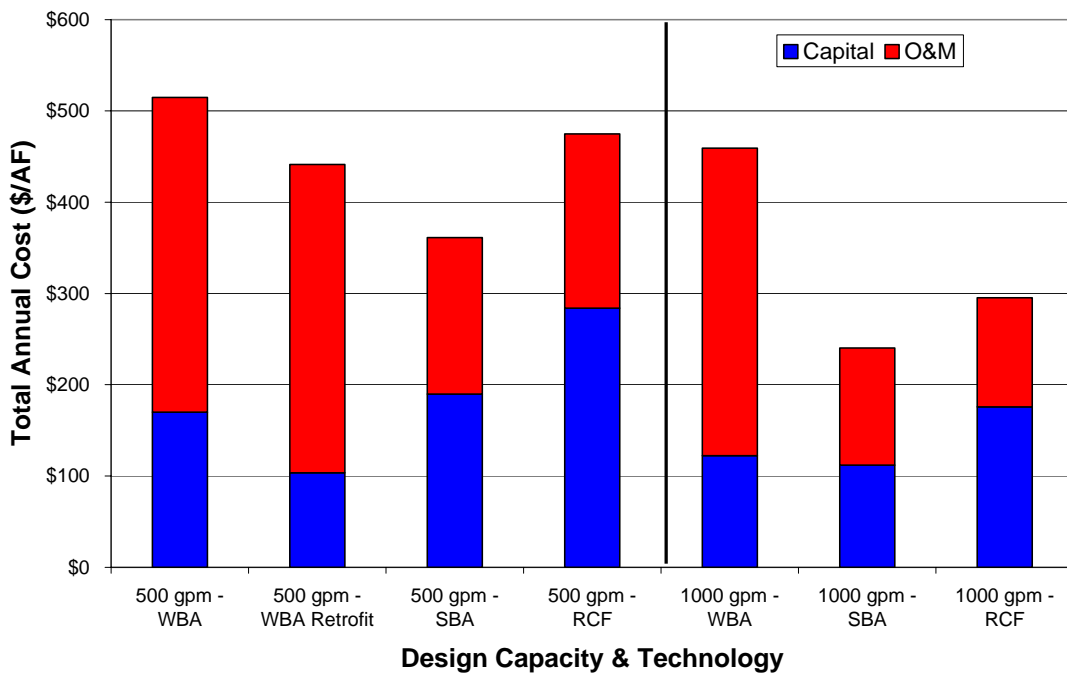
**Figure 5-1: Comparison of Capital Cost Estimates for the Three Technologies at Two Flow Rates**



**Figure 5-2: Comparison of Annual O&M Cost Estimates for the Three Technologies at Two Flow Rates**



**Figure 5-3: Comparison of Annualized Cost Estimates for the Three Technologies at Two Flow Rates**



## 6. Conclusions

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Refined cost estimates were developed for three chromium treatment technologies (SBA, WBA, and RCF) using vendor-based estimates and standard cost estimation practices. For each technology, primary cost drivers were identified and are shown below:

- US Filter/ Rohm & Haas WBA (Duolite A7 resin): Approximately 67% of the annualized costs were O&M costs, including resin replacement and acid for pH depression. This technology is particularly advantageous as a once-through treatment system with only solid residuals (i.e. no brine). Potential exists for the resin cost to be reduced, since costs were significantly lower less than 2 years before this cost update.
- BasinWater Strong Base Anion Exchange: BasinWater system success is predicated on several key unknowns. First, the ability to regenerate the resin many times has been called into question by US Filter's refusal to sell SBA for chromate treatment due to loss of resin capacity after multiple regenerations. Second, brine processing yielding a non-hazardous liquid waste and hazardous solid waste is critical to providing the low costs shown in this evaluation. Inability to make the brine non-hazardous would render the technology significantly more expensive, as shown in the previous Phase II cost evaluation. Finally, the likelihood of future brine disposal to a sewer connection leading to Hyperion introduces a large unknown to the process. Overall, demonstration testing would be critical to ensure that this technology is able to meet performance expectations set forth by BasinWater.
- Reduction/Coagulation/Filtration: Annual costs were split between capital costs, operating costs, and residuals costs. Residuals disposal contributed the largest annual cost, followed by capital due to the need for filters and backwash handling and treatment. Other filtration strategies, such as microfiltration, may offer cost savings in the filtration capital costs. Further testing would be necessary to determine the effectiveness of alternate filtration strategies.

Overall, cost estimates developed in this project revealed that annualized costs were lowest for SBA with brine treatment (assuming non-hazardous brine could be disposed to the sewer over the long term), followed by RCF, then WBA. At 500 gpm, the WBA retrofit of existing GS-3 vessels was comparable to the RCF costs on an annualized basis.

## 7. References

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- McGuire, M.J., N.K. Blute, C. Seidel, G. Qin, L. Fong. 2006. Pilot-Scale Studies of Hexavalent Chromium Removal Technologies. *JAWWA*, 98:2, 134-143.
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- US Filter. 2006. Proposed Cost Information for Hexavalent Chromium Treatment. Submitted to McGuire Malcolm Pirnie. September 2006.
- US Filter. 2006. Proposed Retrofit Cost Information for Hexavalent Chromium Treatment at GS-3. Submitted to McGuire Malcolm Pirnie. March 2006.



## Appendix

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### Technology Cost Estimates, including Capital Cost Summaries, Capital Cost Details, and Operations and Maintenance Costs:

- USFilter/R&H Weak Base Anion Exchange (at pH 6.0) – 500 gpm
- USFilter/R&H Weak Base Anion Exchange (at pH 6.0) – 500 gpm Retrofit
- USFilter/R&H Weak Base Anion Exchange (pH 6.0) – 1,000 gpm
- BasinWater Strong Base Anion Exchange – 500 gpm
- BasinWater Strong Base Anion Exchange – 1,000 gpm
- Reduction, Coagulation, Filtration – 500 gpm
- Reduction, Coagulation, Filtration – 1,000 gpm

## US Filter/R&amp;H Weak Base Anion Exchange (pH 6.0) – 500 gpm:

| City of Glendale<br>Capital Cost Estimate - Weak Base Anion (WBA) 500 gpm |  |                       |
|---|--|-----------------------|
| <b>Company:</b> Malcolm Pirnie, Inc.                                      | <b>Date:</b> 29-Sep-06   |                       |
| <b>Project:</b> Phase III Hexavalent Chromium Demonstration System        | <b>Estimator:</b> SMD  |                       |
| <b>Submittal:</b> Conceptual Design Level Cost Estimate                   | <b>Checker:</b> GB, MJM, NKB                                       |                       |
| <b>Work Task:</b>   | <b>Cost Index:</b> ENR CCI = 8572.47 (Los Angeles, September 2006) |                       |
| <b>Division Summary</b>   |  | <b>Total</b>          |
| <b>Division 1 - General Conditions</b>                                    |  | \$50,000.00           |
| <b>Division 2 - Site Construction</b>                                     |  | \$81,690.00           |
| <b>Division 3 - Concrete</b>  |  | \$55,500.00           |
| <b>Division 4 - Masonry</b>   |  | \$0.00                |
| <b>Division 5 - Metals</b>  |  | \$15,500.00           |
| <b>Division 6 - Wood &amp; Plastics</b>                                   |  | \$0.00                |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                     |  | \$250.00              |
| <b>Division 8 - Doors &amp; Windows</b>                                   |  | \$0.00                |
| <b>Division 9 - Finishes</b>  |  | \$14,750.00           |
| <b>Division 10 - Specialties</b>  |  | \$500.00              |
| <b>Division 11 - Equipment</b>  |  | \$604,059.60          |
| <b>Division 12 - Furnishings</b>  |  | \$0.00                |
| <b>Division 13 - Special Construction</b>                                 |  | \$21,600.00           |
| <b>Division 14 - Conveying Systems</b>                                    |  | \$0.00                |
| <b>Division 15 - Mechanical</b>   |  | \$34,640.00           |
| <b>Division 16 - Electrical</b>   |  | \$150,000.00          |
| <b>Division 17 - Instrumentation and Control</b>                          |  | \$115,000.00          |
|   | <b>Division 1 - 17 Subtotal</b>                                    | <b>\$1,143,489.60</b> |
|   | Insurance @ 2.5%   | <b>\$28,587.24</b>    |
|   | Bonds @ 2.0%   | <b>\$22,869.79</b>    |
|   | Overhead & Profit @ 10%  | <b>\$114,348.96</b>   |
|   | Engineering @ 10%  | <b>\$114,348.96</b>   |
|   | <b>Total</b>   | <b>\$1,423,644.55</b> |
|   | Contingency @ 20.0%  | <b>\$284,728.91</b>   |
|   | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b>                 | <b>\$1,708,373.46</b> |
|   | (September 2006)   |                       |

| City of Glendale<br>Capital Cost Estimate - Weak Base Anion (WBA) 500 gpm |      |   |                  |                     |                       |
|---|------|---|------------------|---------------------|-----------------------|
| Company: Malcolm Pirnie, Inc.   |      | Date: 29-Sep-06   |                  |                     |                       |
| Project: Phase III Hexavalent Chromium Demonstration System               |      | Estimator: SMD  |                  |                     |                       |
| Submittal: Conceptual Design Level Cost Estimate                          |      | Checker: GB, MJM, NKB                                       |                  |                     |                       |
| Work Task:  |      | Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006) |                  |                     |                       |
| Specification Section   | Unit | Quantity  | Cost             | Installation Factor | Total                 |
| <b>Division 1 - General Conditions</b>                                    |      |   |                  |                     |                       |
| Div 1 General Conditions  | LS   | 1   | \$ 50,000.00     | 1.0                 | \$ 50,000.00          |
| Mobilization/Demobilization   |      |   |                  |                     |                       |
| <b>Division 1 Total</b>   |      |   |                  |                     | <b>\$50,000.00</b>    |
| <b>Division 2 - Site Construction</b>                                     |      |   |                  |                     |                       |
| 02220 Site Preparation  | LS   | 1   | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing  |      |   |                  |                     |                       |
| 02315 Excavation and Backfill   |      |   |                  |                     |                       |
| Excavation and grading of demonstration facility limits                   | LS   | 1   | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed   | CY   | 1,570   | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill  | CY   | 785   | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>   |      |   |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>  |      |   |                  |                     |                       |
| 03100 Concrete Formwork   |      |   | In 03300         |                     |                       |
| 03300 Concrete  |      |   |                  |                     |                       |
| Equipment Slab (3,000-sf)   | CY   | 111   | \$ 500.00        | 1.0                 | \$55,500.00           |
| <b>Division 3 Total</b>   |      |   |                  |                     | <b>\$55,500.00</b>    |
| <b>Division 4 - Masonry</b>   |      |   |                  |                     |                       |
| <b>Division 5 - Metals</b>  |      |   |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts                    | LS   | 1   | \$ 500.00        | 1.0                 | \$500.00              |
| 05501 Miscellaneous Metal Fabrications (includes access platforms)        | LS   | 1   | \$ 15,000.00     | 1.0                 | \$15,000.00           |
| <b>Division 5 Total</b>   |      |   |                  |                     | <b>\$15,500.00</b>    |
| <b>Division 6 - Wood &amp; Plastics</b>                                   |      |   |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                     |      |   |                  |                     |                       |
| 07920 Caulking and Sealants   | LS   | 1   | \$ 250.00        | 1.0                 | \$250.00              |
| <b>Division 7 Total</b>   |      |   |                  |                     | <b>\$250.00</b>       |
| <b>Division 8 - Doors &amp; Windows</b>                                   |      |   |                  |                     |                       |
| <b>Division 9 - Finishes</b>  |      |   |                  |                     |                       |
| 09611 Concrete Hardener   | SF   | 3,000   | \$ 3.25          | 1.0                 | \$9,750.00            |
| 09900 Painting  | LS   | 1   | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>   |      |   |                  |                     | <b>\$14,750.00</b>    |
| <b>Division 10 - Specialties</b>  |      |   |                  |                     |                       |
| 10400 Identification Devices  | LS   | 1   | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 10 Total</b>  |      |   |                  |                     | <b>\$500.00</b>       |
| <b>Division 11 - Equipment</b>  |      |   |                  |                     |                       |
| 11179 Fiberglass Reinforced Plastic Tanks (HCl bulk Storage Tank)         | LS   | 1   | \$ 5,000.00      | 1.2                 | \$6,000.00            |
| 11180 Fiberglass Reinforced Plastic Tanks (Waste Equalization Tank)       | LS   | 1   | \$ 12,500.00     | 1.2                 | \$15,000.00           |
| 11216 Hydrochloric Acid Feed System w/ scrubber                           | LS   | 1   | \$ 60,482.00     | 1.2                 | \$72,578.40           |
| 11193 Bag Filters   | EA   | 2   | \$ 17,500.00     | 1.2                 | \$42,000.00           |
| 11195 Fixed Bed Ion Exchange System (Weak Base Anion)                     | LS   | 1   | \$ 161,903.00    | 1.2                 | \$194,283.60          |
| 11196 Weak Base Anion Resin   | LS   | 1   | \$ 198,898.00    | 1.2                 | \$238,677.60          |
| 11530 Pumps, General  | EA   | 2   | \$ 14,800.00     | 1.2                 | \$35,520.00           |
| <b>Division 11 Total</b>  |      |   |                  |                     | <b>\$604,059.60</b>   |
| <b>Division 12 - Furnishings</b>  |      |   |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                                 |      |   |                  |                     |                       |
| 13125 FRP Walk-In Enclosure (MCC)   | LS   | 1   | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>  |      |   |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                                    |      |   |                  |                     |                       |
| <b>Division 15 - Mechanical</b>   |      |   |                  |                     |                       |
| 15051 Buried Piping Installation  |      |   |                  |                     |                       |
| 8" Influent Piping  | FT   | 250   | \$ 21.00         | 1.4                 | \$7,350.00            |
| Effluent Piping   | FT   | 250   | \$ 21.00         | 1.4                 | \$7,350.00            |
| Backwash Waste Piping   | FT   | 100   | \$ 21.00         | 1.4                 | \$2,940.00            |
| 15052 Exposed Piping Installation   |      |   |                  |                     |                       |
| Ion Exchange System Process Piping  |      |   | In 11195         |                     |                       |
| 15055 Pipe Hangers and Supports   | LS   | 1   | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 15061 Ductile Iron Pipe   |      |   | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe  |      |   | In 15051 & 15052 |                     |                       |
| 15100 Valves, 4-Inch and Larger   | LS   | 1   | \$ 10,000.00     | 1.2                 | \$12,000.00           |
| <b>Division 15 Total</b>  |      |   |                  |                     | <b>\$34,640.00</b>    |
| <b>Division 16 - Electrical</b>   |      |   |                  |                     |                       |
| 16050 General Provisions  | LS   | 1   | \$ 150,000.00    | 1.0                 | \$150,000.00          |
| <b>Division 16 Total</b>  |      |   |                  |                     | <b>\$150,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                          |      |   |                  |                     |                       |
| 17400 Instrumentation and Control   | LS   | 1   | \$ 115,000.00    | 1.0                 | \$ 115,000.00         |
| <b>Division 17 Total</b>  |      |   |                  |                     | <b>\$115,000.00</b>   |
| <b>Division 1 - 17 Subtotal</b>   |      |   |                  |                     | <b>\$1,143,489.60</b> |

City of Glendale  
 Operation and Maintenance Costs - Weak Base Anion (WBA) 500 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NKB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                            | O&M Misc. | Energy  | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|--|-----------|---------|-----------|----------------|---------------------|---|
| <b>1.0</b>   | <b>Weak Base Anion System</b>          |           |         |           |                |                     |   |
| 1.1          | Resin/Media Replacement                | \$175,404 |         |           |                | \$175,404.00        | Assumed 100,000 bed-volume capacity<br>Assumed monthly replacement of bag filters<br>Boosting IX effluent to aerator influent. 500-gpm @ 50' TDH<br>Feed water conditioning with 31% HCl. Feed Rate: 165 gpd of 31% HCl. Cost: \$1.15/gal for 2,000-gal loads<br>Assumed 2% of equipment costs (Div 11) |
| 1.2          | Pre-Filters filter replacement         | \$1,440   |         |           |                | \$1,440.00          |   |
| 1.3          | Effluent Booster Pumps                 |           | \$6,345 |           |                | \$6,344.53          |   |
| 1.4          | Chemicals                              |           |         | \$69,259  |                | \$69,258.75         |   |
| 1.5          | Miscellaneous Maintenance              | \$12,081  |         |           |                | \$12,081.19         |   |
|              | <b>Subtotal - WBA System</b>           |           |         |           |                | <b>\$264,528.48</b> |   |
| <b>2.0</b>   | <b>Waste Disposal</b>                  |           |         |           |                |                     |   |
| 2.1          | Liquid Waste Disposal (Backwash Water) |           |         |           | \$1,035        | \$1,035.00          | Backwash waste to sanitary sewer based on 321,000 gallons liquid waste per year (for 500-gpm system)<br>Resin disposal costs included in resin replacement cost (if considered separately, cost would be \$1675 for 6.7 tons at \$445/ton)  |
| 2.2          | Resin/Media Disposal                   |           |         |           |                | \$0.00              |   |
|              | <b>Subtotal - Waste Disposal</b>       |           |         |           |                | <b>\$1,035.00</b>   |   |
| <b>3.0</b>   | <b>Labor</b>                           |           |         |           |                |                     |   |
| 3.1          | Labor                                  | \$12,500  |         |           |                | \$12,500.00         | Labor based 0.125 FTE at \$100,000/yr.  |
|              | <b>Subtotal - Labor</b>                |           |         |           |                | <b>\$12,500.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                 | \$201,425 | \$6,345 | \$69,259  | \$1,035        | <b>\$278,063.48</b> |   |

## US Filter/R&amp;H Weak Base Anion Exchange (pH 6.0) – 500 gpm Retrofit:

| City of Glendale<br>Capital Cost Estimate - Weak Base Anion (WBA) 500 gpm Retrofit |  |  |
|--|--|--|
| <b>Company:</b> Malcolm Pirnie, Inc.   |  | <b>Date:</b> 29-Sep-06   |
| <b>Project:</b> Phase III Hexavalent Chromium Demonstration System                 |  | <b>Estimator:</b> SMD  |
| <b>Submittal:</b> Conceptual Design Level Cost Estimate                            |  | <b>Checker:</b> GB, MJM, NKB                                       |
| <b>Work Task:</b>  |  | <b>Cost Index:</b> ENR CCI = 8572.47 (Los Angeles, September 2006) |
| Division Summary   |  | Total  |
| <b>Division 1 - General Conditions</b>   |  | \$25,000.00  |
| <b>Division 2 - Site Construction</b>  |  | \$5,000.00   |
| <b>Division 3 - Concrete</b>   |  | \$9,500.00   |
| <b>Division 4 - Masonry</b>  |  | \$0.00   |
| <b>Division 5 - Metals</b>   |  | \$15,500.00  |
| <b>Division 6 - Wood &amp; Plastics</b>  |  | \$0.00   |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                              |  | \$0.00   |
| <b>Division 8 - Doors &amp; Windows</b>  |  | \$0.00   |
| <b>Division 9 - Finishes</b>   |  | \$6,625.00   |
| <b>Division 10 - Specialties</b>   |  | \$0.00   |
| <b>Division 11 - Equipment</b>   |  | \$322,759.40   |
| <b>Division 12 - Furnishings</b>   |  | \$0.00   |
| <b>Division 13 - Special Construction</b>  |  | \$21,600.00  |
| <b>Division 14 - Conveying Systems</b>   |  | \$0.00   |
| <b>Division 15 - Mechanical</b>  |  | \$25,820.00  |
| <b>Division 16 - Electrical</b>  |  | \$150,000.00   |
| <b>Division 17 - Instrumentation and Control</b>                                   |  | \$115,000.00   |
|  | Division 1 - 17 Subtotal                           | <b>\$696,804.40</b>  |
|  | Insurance @ 2.5%                                   | <b>\$17,420.11</b>   |
|  | Bonds @ 2.0%                                       | <b>\$13,936.09</b>   |
|  | Overhead & Profit @ 10%                            | <b>\$69,680.44</b>   |
|  | Engineering @ 10%                                  | <b>\$69,680.44</b>   |
|  | Total  | <b>\$867,521.48</b>  |
|  | Contingency @ 20.0%                                | <b>\$173,504.30</b>  |
|  | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b> | <b>\$1,041,025.77</b>  |
|  | (September 2006)                                   |  |

City of Glendale  
Capital Cost Estimate - Weak Base Anion (WBA) Retrofit 500 gpm Retrofit

Company: Malcolm Pirnie, Inc.  
Project: Phase III Hexavalent Chromium Demonstration System  
Submittal: Conceptual Design Level Cost Estimate  
Work Task:

Date: 29-Sep-06  
Estimator: SMD  
Checker: GB, MJM, NKB  
Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section  | Unit | Quantity | Cost             | Installation Factor | Total               |
|--|------|----------|------------------|---------------------|---------------------|
| <b>Division 1 - General Conditions</b>   |      |          |                  |                     |                     |
| Div 1 General Conditions   | LS   | 1        | \$ 25,000.00     | 1.0                 | \$ 25,000.00        |
| Mobilization/Demobilization  |      |          |                  |                     |                     |
| <b>Division 1 Total</b>  |      |          |                  |                     | <b>\$25,000.00</b>  |
| <b>Division 2 - Site Construction</b>  |      |          |                  |                     |                     |
| 02220 Site Preparation   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00          |
| <b>Division 2 Total</b>  |      |          |                  |                     | <b>\$5,000.00</b>   |
| <b>Division 3 - Concrete</b>   |      |          |                  |                     |                     |
| 03100 Concrete Formwork  |      |          | In 03300         |                     |                     |
| 03300 Concrete   |      |          |                  |                     |                     |
| Equipment Slab (500-sf)  | CY   | 19       | \$ 500.00        | 1.0                 | \$9,500.00          |
| <b>Division 3 Total</b>  |      |          |                  |                     | <b>\$9,500.00</b>   |
| <b>Division 4 - Masonry</b>  |      |          |                  |                     |                     |
| <b>Division 5 - Metals</b>   |      |          |                  |                     |                     |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts   | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00            |
| 05501 Miscellaneous Metal Fabrications (includes access platforms)   | LS   | 1        | \$ 15,000.00     | 1.0                 | \$15,000.00         |
| <b>Division 5 Total</b>  |      |          |                  |                     | <b>\$15,500.00</b>  |
| <b>Division 6 - Wood &amp; Plastics</b>  |      |          |                  |                     |                     |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>  |      |          |                  |                     |                     |
| <b>Division 8 - Doors &amp; Windows</b>  |      |          |                  |                     |                     |
| <b>Division 9 - Finishes</b>   |      |          |                  |                     |                     |
| 09611 Concrete Hardener  | SF   | 500      | \$ 3.25          | 1.0                 | \$1,625.00          |
| 09900 Painting   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00          |
| <b>Division 9 Total</b>  |      |          |                  |                     | <b>\$6,625.00</b>   |
| <b>Division 10 - Specialties</b>   |      |          |                  |                     |                     |
| <b>Division 11 - Equipment</b>   |      |          |                  |                     |                     |
| 11179 Fiberglass Reinforced Plastic Tanks (HCl bulk Storage Tank)  | LS   | 1        | \$ 5,000.00      | 1.2                 | \$6,000.00          |
| Fiberglass Reinforced Plastic Tanks (Waste Equilization Tank)  | LS   | 1        | \$ 12,500.00     | 1.2                 | \$15,000.00         |
| 11216 Hydrochloric Acid Feed System w/ scrubber  | LS   | 1        | \$ 60,482.00     | 1.2                 | \$72,578.40         |
| Fixed Bed Ion Exchange System (Weak Base Anion), includes prefilter housings, filters, vessel conversion labor, media loading labor and start-up assistance. | LS   | 1        | \$ 193,661.00    | 1.0                 | \$193,661.00        |
| 11195 Weak Base Anion Resin  | LS   | 1        | -                | 1.0                 | \$0.00              |
| 11530 Pumps, General (Effluent Booster Pumps)  | EA   | 2        | \$ 14,800.00     | 1.2                 | \$35,520.00         |
| <b>Division 11 Total</b>   |      |          |                  |                     | <b>\$322,759.40</b> |
| <b>Division 12 - Furnishings</b>   |      |          |                  |                     |                     |
| <b>Division 13 - Special Construction</b>  |      |          |                  |                     |                     |
| 13125 FRP Walk-In Enclosure (Electrical gear/MCC)  | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00         |
| <b>Division 13 Total</b>   |      |          |                  |                     | <b>\$21,600.00</b>  |
| <b>Division 14 - Conveying Systems</b>   |      |          |                  |                     |                     |
| <b>Division 15 - Mechanical</b>  |      |          |                  |                     |                     |
| 15051 Buried Piping Installation   |      |          |                  |                     |                     |
| 8" Influent Piping   | FT   | 100      | \$ 21.00         | 1.4                 | \$2,940.00          |
| Effluent Piping  | FT   | 100      | \$ 21.00         | 1.4                 | \$2,940.00          |
| Backwash Waste Piping  | FT   | 100      | \$ 21.00         | 1.4                 | \$2,940.00          |
| 15052 Exposed Piping Installation  |      |          |                  |                     |                     |
| Ion Exchange System Process Piping   |      |          | In 11195         |                     |                     |
| 15055 Pipe Hangers and Supports  | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00          |
| 15061 Ductile Iron Pipe  |      |          | In 15051         |                     |                     |
| 15067 Thermoplastic Pipe   |      |          | In 15051 & 15052 |                     |                     |
| 15100 Valves, 4-Inch and Larger  | LS   | 1        | \$ 10,000.00     | 1.2                 | \$12,000.00         |
| <b>Division 15 Total</b>   |      |          |                  |                     | <b>\$25,820.00</b>  |
| <b>Division 16 - Electrical</b>  |      |          |                  |                     |                     |
| 16050 General Provisions   | LS   | 1        | \$ 150,000.00    | 1.0                 | \$150,000.00        |
| <b>Division 16 Total</b>   |      |          |                  |                     | <b>\$150,000.00</b> |
| <b>Division 17 - Instrumentation and Control</b>   |      |          |                  |                     |                     |
| 17400 Instrumentation and Control  | LS   | 1        | \$ 115,000.00    | 1.0                 | \$ 115,000.00       |
| <b>Division 17 Total</b>   |      |          |                  |                     | <b>\$115,000.00</b> |
| Division 1 - 17 Subtotal   |      |          |                  |                     | <b>\$696,804.40</b> |



City of Glendale  
 Operation and Maintenance Costs - Weak Base Anion (WBA) Retrofit

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NKB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                            | O&M Misc. | Energy  | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|--|-----------|---------|-----------|----------------|---------------------|---|
| <b>1.0</b>   | <b>Weak Base Anion System</b>          |           |         |           |                |                     |   |
| 1.1          | Resin/Media Replacement                | \$175,404 |         |           |                | \$175,404.00        | Assumed 100,000 bed-volume capacity<br>Assumed monthly replacement of bag filters<br>Boosting IX effluent to aerator influent. 500-gpm @ 50' TDH<br>Feed water conditioning with 31% HCl. Feed Rate: 165 gpd of 31% HCl. Cost: \$1.15/gal for 2,000-gal loads<br>Assumed 2% of equipment costs (Div 11) |
| 1.2          | Pre-Filters filter replacement         | \$1,440   |         |           |                | \$1,440.00          |   |
| 1.3          | Effluent Booster Pumps                 |           | \$6,345 |           |                | \$6,344.53          |   |
| 1.4          | Chemicals                              |           |         | \$69,259  |                | \$69,258.75         |   |
| 1.5          | Miscellaneous Maintenance              | \$6,455   |         |           |                | \$6,455.19          |   |
|              | <b>Subtotal - WBA System</b>           |           |         |           |                | <b>\$258,902.47</b> |   |
| <b>2.0</b>   | <b>Waste Disposal</b>                  |           |         |           |                |                     |   |
| 2.1          | Liquid Waste Disposal (Backwash Water) |           |         |           | \$1,035        | \$1,035.00          | Backwash waste based on 321,000 gallons liquid waste (for 500-gpm system)<br>Resin disposal costs included in resin replacement cost (if considered separately, cost would be \$1675 for 6.7 tons at \$445/ton)   |
| 2.2          | Resin/Media Disposal                   |           |         |           |                | \$0.00              |   |
|              | <b>Subtotal - Waste Disposal</b>       |           |         |           |                | <b>\$1,035.00</b>   |   |
| <b>3.0</b>   | <b>Labor</b>                           |           |         |           |                |                     |   |
| 3.1          | Labor                                  | \$12,500  |         |           |                | \$12,500.00         | Labor based 0.125 FTE at \$100,000/yr.  |
|              | <b>Subtotal - Labor</b>                |           |         |           |                | <b>\$12,500.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                 | \$195,799 | \$6,345 | \$69,259  | \$1,035        | <b>\$272,437.47</b> |   |

## US Filter/R&amp;H Weak Base Anion Exchange (pH 6.0) – 1,000 gpm:

| City of Glendale<br>Capital Cost Estimate - Weak Base Anion (WBA) 1000 gpm |  |                               |
|--|--|-------------------------------|
| Company: <u>Malcolm Pirnie, Inc.</u>                                       | Date: <u>29-Sep-06</u>                             |                               |
| Project: <u>Phase III Hexavalent Chromium Demonstration System</u>         | Estimator: <u>SMD</u>                              |                               |
| Submittal: <u>Conceptual Design Level Cost Estimate</u>                    | Checker: <u>GB, MJM, NKB</u>                       |                               |
| Work Task: _____   | Cost Index: <u>ENR CCI = 8572.47</u>               | (Los Angeles, September 2006) |
| Division Summary   |  | Total                         |
| <b>Division 1 - General Conditions</b>                                     |  | \$75,000.00                   |
| <b>Division 2 - Site Construction</b>                                      |  | \$81,690.00                   |
| <b>Division 3 - Concrete</b>   |  | \$62,500.00                   |
| <b>Division 4 - Masonry</b>  |  | \$0.00                        |
| <b>Division 5 - Metals</b>   |  | \$15,500.00                   |
| <b>Division 6 - Wood &amp; Plastics</b>                                    |  | \$0.00                        |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                      |  | \$0.00                        |
| <b>Division 8 - Doors &amp; Windows</b>                                    |  | \$0.00                        |
| <b>Division 9 - Finishes</b>   |  | \$16,375.00                   |
| <b>Division 10 - Specialties</b>   |  | \$500.00                      |
| <b>Division 11 - Equipment</b>   |  | \$947,127.60                  |
| <b>Division 12 - Furnishings</b>   |  | \$0.00                        |
| <b>Division 13 - Special Construction</b>                                  |  | \$21,600.00                   |
| <b>Division 14 - Conveying Systems</b>                                     |  | \$0.00                        |
| <b>Division 15 - Mechanical</b>  |  | \$50,000.00                   |
| <b>Division 16 - Electrical</b>  |  | \$210,000.00                  |
| <b>Division 17 - Instrumentation and Control</b>                           |  | \$165,000.00                  |
|  | Division 1 - 17 Subtotal                           | <b>\$1,645,292.60</b>         |
|  | Insurance @ 2.5%                                   | <b>\$41,132.32</b>            |
|  | Bonds @ 2.0%                                       | <b>\$32,905.85</b>            |
|  | Overhead & Profit @ 10%                            | <b>\$164,529.26</b>           |
|  | Engineering @ 10%                                  | <b>\$164,529.26</b>           |
|  | Total  | <b>\$2,048,389.29</b>         |
|  | Contingency @ 20.0%                                | <b>\$409,677.86</b>           |
|  | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b> | <b>\$2,458,067.14</b>         |
|  | (September 2006)                                   |                               |



City of Glendale  
Capital Cost Estimate - Weak Base Anion (WBA) 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NKB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section   | Unit | Quantity | Cost             | Installation Factor | Total                 |
|---|------|----------|------------------|---------------------|-----------------------|
| <b>Division 1 - General Conditions</b>                            |      |          |                  |                     |                       |
| Div 1 General Conditions  | LS   | 1        | \$ 75,000.00     | 1.0                 | \$75,000.00           |
| Mobilization/Demobilization                                       |      |          |                  |                     |                       |
| <b>Division 1 Total</b>   |      |          |                  |                     | <b>\$75,000.00</b>    |
| <b>Division 2 - Site Construction</b>                             |      |          |                  |                     |                       |
| 02220 Site Preparation  | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing  |      |          |                  |                     |                       |
| 02315 Excavation and Backfill                                     |      |          |                  |                     |                       |
| Excavation and grading of demonstration facility limits           | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed                                     | CY   | 1,570    | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill  | CY   | 785      | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>   |      |          |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>                                      |      |          |                  |                     |                       |
| 03100 Concrete Formwork   |      |          | In 03300         |                     |                       |
| 03300 Concrete  |      |          |                  |                     |                       |
| Equipment Slab (3,500-sf)   | CY   | 125      | \$ 500.00        | 1.0                 | \$62,500.00           |
| <b>Division 3 Total</b>   |      |          |                  |                     | <b>\$62,500.00</b>    |
| <b>Division 4 - Masonry</b>                                       |      |          |                  |                     |                       |
| <b>Division 5 - Metals</b>  |      |          |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts            | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| 05501 Miscellaneous Metal Fabrications (includes access platform) | LS   | 1        | \$ 15,000.00     | 1.0                 | \$15,000.00           |
| <b>Division 5 Total</b>   |      |          |                  |                     | <b>\$15,500.00</b>    |
| <b>Division 6 - Wood &amp; Plastics</b>                           |      |          |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>             |      |          |                  |                     |                       |
| <b>Division 8 - Doors &amp; Windows</b>                           |      |          |                  |                     |                       |
| <b>Division 9 - Finishes</b>                                      |      |          |                  |                     |                       |
| 09611 Concrete Hardener   | SF   | 3,500    | \$ 3.25          | 1.0                 | \$11,375.00           |
| 09900 Painting  | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>   |      |          |                  |                     | <b>\$16,375.00</b>    |
| <b>Division 10 - Specialties</b>                                  |      |          |                  |                     |                       |
| 10400 Identification Devices                                      | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 10 Total</b>  |      |          |                  |                     | <b>\$500.00</b>       |
| <b>Division 11 - Equipment</b>                                    |      |          |                  |                     |                       |
| 11179 Fiberglass Reinforced Plastic Tanks (HCl bulk Storage Tank) | LS   | 1        | \$ 5,000.00      | 1.2                 | \$6,000.00            |
| Fiberglass Reinforced Plastic Tanks (Waste Equalization Tank)     | LS   | 1        | \$ 12,500.00     | 1.2                 | \$15,000.00           |
| 11216 Hydrochloric Acid Feed System w/scrubber                    | LS   | 1        | \$ 80,184.00     | 1.2                 | \$96,220.80           |
| 11193 Bag Filters   | EA   | 2        | \$ 19,750.00     | 1.2                 | \$47,400.00           |
| 11195 Fixed Bed Ion Exchange System (Weak Base Anion)             | LS   | 1        | \$ 217,692.00    | 1.2                 | \$261,230.40          |
| 11196 Weak Base Anion Resin                                       | LS   | 1        | \$ 397,797.00    | 1.2                 | \$477,356.40          |
| 15130 Pumps, General  | EA   | 2        | \$ 18,300.00     | 1.2                 | \$43,920.00           |
| <b>Division 11 Total</b>  |      |          |                  |                     | <b>\$947,127.60</b>   |
| <b>Division 12 - Furnishings</b>                                  |      |          |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                         |      |          |                  |                     |                       |
| 13125 FRP Walk-In Enclosure (MCC)                                 | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>  |      |          |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                            |      |          |                  |                     |                       |
| <b>Division 15 - Mechanical</b>                                   |      |          |                  |                     |                       |
| 15051 Buried Piping Installation                                  |      |          |                  |                     |                       |
| 12" Influent Piping   | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Effluent Piping   | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Backwash Waste Piping   | FT   | 100      | \$ 25.00         | 1.4                 | \$3,500.00            |
| 15052 Exposed Piping Installation                                 |      |          |                  |                     |                       |
| Ion Exchange System Process Piping                                |      |          | In 11195         |                     |                       |
| 15055 Pipe Hangers and Supports                                   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 15061 Ductile Iron Pipe   |      |          | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe  |      |          | In 15051 & 15052 |                     |                       |
| 15100 Valves & Fittings (Misc.), 4-Inch and Larger                | LS   | 0        | \$ 20,000.00     | 1.2                 | \$24,000.00           |
| <b>Division 15 Total</b>  |      |          |                  |                     | <b>\$50,000.00</b>    |
| <b>Division 16 - Electrical</b>                                   |      |          |                  |                     |                       |
| 16050 General Provisions  | LS   | 1        | \$ 210,000.00    | 1.0                 | \$210,000.00          |
| <b>Division 16 Total</b>  |      |          |                  |                     | <b>\$210,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                  |      |          |                  |                     |                       |
| 17400 Instrumentation and Control                                 | LS   | 1        | \$ 165,000.00    | 1.0                 | \$165,000.00          |
| <b>Division 17 Total</b>  |      |          |                  |                     | <b>\$165,000.00</b>   |
| <b>Division 1 - 17 Subtotal</b>                                   |      |          |                  |                     | <b>\$1,645,292.60</b> |



City of Glendale  
Operation and Maintenance Costs - Weak Base Anion (WBA) 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NKB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                            | O&M Misc. | Energy  | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|--|-----------|---------|-----------|----------------|---------------------|---|
| <b>1.0</b>   | <b>Weak Base Anion System</b>          |           |         |           |                |                     |   |
| 1.1          | Resin/Media Replacement                | \$350,808 |         |           |                | \$350,808.00        | Assumed 100,000 bed-volume capacity   |
| 1.2          | Pre-Filters filter replacement         | \$1,440   |         |           |                | \$1,440.00          | Assumed monthly replacement of bag filters  |
| 1.3          | Effluent Booster Pumps                 |           | \$6,345 |           |                | \$6,344.53          | Boosting IX effluent to aerator influent. 1,000-gpm @ 50' TDH   |
| 1.4          | Chemicals                              |           |         | \$138,518 |                | \$138,517.50        | Feed water conditioning with 31% HCl. Feed Rate: 165 gpd of 31% HCl. Cost: \$1.15/gal for 2,000-gal loads                     |
| 1.5          | Miscellaneous Maintenance              | \$18,943  |         |           |                | \$18,942.55         | Assumed 2% of equipment costs (Div 11)  |
|              | <b>Subtotal - WBA System</b>           |           |         |           |                | <b>\$516,052.59</b> |   |
| <b>2.0</b>   | <b>Waste Disposal</b>                  |           |         |           |                |                     |   |
| 2.1          | Liquid Waste Disposal (Backwash Water) |           |         |           | \$2,363        | \$2,363.00          | Backwash waste based on 733,000 gallons liquid waste (for 1,000-gpm system)   |
| 2.2          | Resin/Media Disposal                   |           |         |           |                | \$0.00              | Resin disposal costs included in replacement cost (if considered separately, cost would be \$3350 for 13.4 tons at \$445/ton) |
|              | <b>Subtotal - Waste Disposal</b>       |           |         |           |                | <b>\$2,363.00</b>   |   |
| <b>3.0</b>   | <b>Labor</b>                           |           |         |           |                |                     |   |
| 3.1          | Labor                                  | \$25,000  |         |           |                | \$25,000.00         | Labor based on 0.25 FTE at \$100,000/yr.  |
|              | <b>Subtotal - Labor</b>                |           |         |           |                | <b>\$25,000.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                 | \$396,191 | \$6,345 | \$138,518 | \$2,363        | <b>\$543,415.59</b> |   |

## BasinWater Strong Base Anion Exchange – 500 gpm:

| City of Glendale<br>Capital Cost Estimate - Strong Base Anion (SBA) - 500 gpm |   |                       |
|---|---|-----------------------|
| Company: Malcolm Pirnie, Inc.   | Date: 29-Sep-06   |                       |
| Project: Phase III Hexavalent Chromium Demonstration System                   | Estimator: SMD  |                       |
| Submittal: Conceptual Design Level Cost Estimate                              | Checker: GB, MJM, NB  |                       |
| Work Task:  | Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006) |                       |
| Division Summary  |   | Total                 |
| <b>Division 1 - General Conditions</b>  |   | \$50,000.00           |
| <b>Division 2 - Site Construction</b>   |   | \$81,690.00           |
| <b>Division 3 - Concrete</b>  |   | \$66,500.00           |
| <b>Division 4 - Masonry</b>   |   | \$0.00                |
| <b>Division 5 - Metals</b>  |   | \$15,500.00           |
| <b>Division 6 - Wood &amp; Plastics</b>                                       |   | \$0.00                |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                         |   | \$250.00              |
| <b>Division 8 - Doors &amp; Windows</b>                                       |   | \$0.00                |
| <b>Division 9 - Finishes</b>  |   | \$16,700.00           |
| <b>Division 10 - Specialties</b>  |   | \$0.00                |
| <b>Division 11 - Equipment</b>  |   | \$719,344.00          |
| <b>Division 12 - Furnishings</b>  |   | \$0.00                |
| <b>Division 13 - Special Construction</b>                                     |   | \$21,600.00           |
| <b>Division 14 - Conveying Systems</b>  |   | \$0.00                |
| <b>Division 15 - Mechanical</b>   |   | \$34,640.00           |
| <b>Division 16 - Electrical</b>   |   | \$150,000.00          |
| <b>Division 17 - Instrumentation and Control</b>                              |   | \$120,000.00          |
|   | Division 1 - 17 Subtotal                                    | <b>\$1,276,224.00</b> |
|   | Insurance @ 2.5%  | <b>\$31,905.60</b>    |
|   | Bonds @ 2.0%  | <b>\$25,524.48</b>    |
|   | Overhead & Profit @ 10%                                     | <b>\$127,622.40</b>   |
|   | Engineering @ 10%   | <b>\$127,622.40</b>   |
|   | Total   | <b>\$1,588,898.88</b> |
|   | Contingency @ 20.0%   | <b>\$317,779.78</b>   |
|   | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b>          | <b>\$1,906,678.66</b> |
|   | (September 2006)  |                       |

City of Glendale  
Capital Cost Estimate - Strong Base Anion (SBA) - 500 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section  | Unit | Quantity | Cost             | Installation Factor | Total                 |
|--|------|----------|------------------|---------------------|-----------------------|
| <b>Division 1 - General Conditions</b>                             |      |          |                  |                     |                       |
| Div 1 General Conditions   | LS   | 1        | \$ 50,000.00     | 1.0                 | \$ 50,000.00          |
| Mobilization/Demobilization  |      |          |                  |                     |                       |
| <b>Division 1 Total</b>  |      |          |                  |                     | <b>\$50,000.00</b>    |
| <b>Division 2 - Site Construction</b>                              |      |          |                  |                     |                       |
| 02220 Site Preparation   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing   |      |          |                  |                     |                       |
| 02315 Excavation and Backfill                                      |      |          |                  |                     |                       |
| Excavation and grading of demonstration facility limits            | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed                                      | CY   | 1,570    | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill   | CY   | 785      | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>  |      |          |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>                                       |      |          |                  |                     |                       |
| 03100 Concrete Formwork  |      |          | In 03300         |                     |                       |
| 03300 Concrete   |      |          |                  |                     |                       |
| Equipment Slab   | CY   | 133      | \$ 500.00        | 1.0                 | \$66,500.00           |
| <b>Division 3 Total</b>  |      |          |                  |                     | <b>\$66,500.00</b>    |
| <b>Division 4 - Masonry</b>  |      |          |                  |                     |                       |
| <b>Division 5 - Metals</b>   |      |          |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts             | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| 05501 Miscellaneous Metal Fabrications (includes access platforms) | LS   | 1        | \$ 15,000.00     | 1.0                 | \$15,000.00           |
| <b>Division 5 Total</b>  |      |          |                  |                     | <b>\$15,500.00</b>    |
| <b>Division 6 - Wood &amp; Plastics</b>                            |      |          |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>              |      |          |                  |                     |                       |
| 07920 Caulking and Sealants  | LS   | 1        | \$ 250.00        | 1.0                 | \$250.00              |
| <b>Division 7 Total</b>  |      |          |                  |                     | <b>\$250.00</b>       |
| <b>Division 8 - Doors &amp; Windows</b>                            |      |          |                  |                     |                       |
| <b>Division 9 - Finishes</b>                                       |      |          |                  |                     |                       |
| 09611 Concrete Hardener  | SF   | 3,600    | \$ 3.25          | 1.0                 | \$11,700.00           |
| 09900 Painting   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>  |      |          |                  |                     | <b>\$16,700.00</b>    |
| <b>Division 10 - Specialties</b>                                   |      |          |                  |                     |                       |
| <b>Division 11 - Equipment</b>                                     |      |          |                  |                     |                       |
| 11197 Strong Base Anion Equipment (BWIX Treatment System)          | LS   | 1        | \$ 683,824.00    | 1.0                 | \$683,824.00          |
| 11530 Pumps, General   | EA   | 2        | \$ 14,800.00     | 1.2                 | \$35,520.00           |
| <b>Division 11 Total</b>   |      |          |                  |                     | <b>\$719,344.00</b>   |
| <b>Division 12 - Furnishings</b>                                   |      |          |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                          |      |          |                  |                     |                       |
| 13125 FRP Walk-In Enclosure (for MCC/electrical gear)              | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>   |      |          |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                             |      |          |                  |                     |                       |
| <b>Division 15 - Mechanical</b>                                    |      |          |                  |                     |                       |
| 15051 Buried Piping Installation                                   |      |          |                  |                     |                       |
| 8" Influent Piping   | FT   | 250      | \$ 21.00         | 1.4                 | \$7,350.00            |
| Effluent Piping  | FT   | 250      | \$ 21.00         | 1.4                 | \$7,350.00            |
| Waste Piping   | FT   | 100      | \$ 21.00         | 1.4                 | \$2,940.00            |
| 15052 Exposed Piping Installation                                  |      |          |                  |                     |                       |
| Ion Exchange System Process Piping                                 |      |          | In 11195         |                     |                       |
| 15055 Pipe Hangers and Supports                                    | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 15061 Ductile Iron Pipe  |      |          | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe   |      |          | In 15051 & 15052 |                     |                       |
| 15100 Valves, 4-Inch and Larger                                    | LS   | 1        | \$ 10,000.00     | 1.2                 | \$12,000.00           |
| <b>Division 15 Total</b>   |      |          |                  |                     | <b>\$34,640.00</b>    |
| <b>Division 16 - Electrical</b>                                    |      |          |                  |                     |                       |
| 16050 General Provisions   | LS   | 1        | \$ 150,000.00    | 1.0                 | \$150,000.00          |
| <b>Division 16 Total</b>   |      |          |                  |                     | <b>\$150,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                   |      |          |                  |                     |                       |
| 17400 Instrumentation and Control                                  | LS   | 1        | \$ 115,000.00    | 1.0                 | \$120,000.00          |
| <b>Division 17 Total</b>   |      |          |                  |                     | <b>\$120,000.00</b>   |
| <b>Division 1 - 17 Subtotal</b>                                    |      |          |                  |                     | <b>\$1,276,224.00</b> |



City of Glendale  
 Operation and Maintenance Costs - Strong Base Anion (SBA) - 500 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                                 | O&M Misc. | Energy  | Chemicals | Waste Disposal | Total O&M           | Notes  |
|--------------|---|-----------|---------|-----------|----------------|---------------------|--|
| <b>1.0</b>   | <b>Regenerable Strong Base Anion System</b> |           |         |           |                |                     |  |
| 1.1          | Salt Usage                                  |           |         | \$2,379   |                | \$2,379.03          | Assumed 59-lbs per acre-foot of water at \$100/ton   |
| 1.2          | Pre-Filters filter replacement              | \$1,440   |         |           |                | \$1,440.00          | Assumed monthly replacement of bag filters   |
| 1.3          | Effluent Booster Pumps                      |           | \$6,345 |           |                | \$6,344.53          | Boosting IX effluent to aerator influent. 500-gpm @ 50' TDH  |
| 1.4          | Miscellaneous Maintenance                   | \$14,387  |         |           |                | \$14,386.88         | Assumed 2% of equipment costs (Div 11)   |
|              | <b>Subtotal - SBA System</b>                |           |         |           |                | <b>\$24,550.44</b>  |  |
| <b>2.0</b>   | <b>Waste Disposal</b>                       |           |         |           |                |                     |  |
| 2.1          | Backwash Waste Disposal (Non-Haz)           |           |         |           | \$696          | \$696.42            | Based on backwash volume of 262,800 gallons per year disposed of at sanitary sewer.                            |
| 2.2          | Brine Waste Disposal (Haz)                  |           |         |           | \$60,225       | \$60,225.00         | Based on 1,110-gpd disposed off site to sewer leading to Hyperion (includes trucking costs) at \$0.15 per gal. |
| 2.3          | Solids Waste Disposal                       |           |         |           | \$2,817        | \$2,816.88          | Based on 12 drums of solid waste per year at \$445/ton.  |
|              | <b>Subtotal - Waste Disposal</b>            |           |         |           |                | <b>\$63,738.30</b>  |  |
| <b>3.0</b>   | <b>Labor</b>                                |           |         |           |                |                     |  |
| 3.1          | Labor                                       | \$50,000  |         |           |                | \$50,000.00         | Labor based on 0.5 FTE at \$100,000/yr.  |
|              | <b>Subtotal - Labor</b>                     |           |         |           |                | <b>\$50,000.00</b>  |  |
| <b>TOTAL</b> | <b>Subtotals Total</b>                      | \$65,827  | \$6,345 | \$2,379   | \$63,738       | <b>\$138,288.74</b> |  |

## BasinWater Strong Base Anion Exchange – 1,000 gpm:

| City of Glendale<br>Capital Cost Estimate - Strong Base Anion (SBA) - 1000 gpm |  |   |
|--|--|---|
| Company:   | Malcolm Pirnie, Inc.                               | Date: 29-Sep-06   |
| Project:   | Phase III Hexavalent Chromium Demonstration System | Estimator: SMD  |
| Submittal:   | Conceptual Design Level Cost Estimate              | Checker: GB, MJM, NB  |
| Work Task:   |  | Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006) |
| Division Summary   |  | Total   |
| <b>Division 1 - General Conditions</b>   |  | \$75,000.00   |
| <b>Division 2 - Site Construction</b>  |  | \$81,690.00   |
| <b>Division 3 - Concrete</b>   |  | \$66,500.00   |
| <b>Division 4 - Masonry</b>  |  | \$0.00  |
| <b>Division 5 - Metals</b>   |  | \$15,500.00   |
| <b>Division 6 - Wood &amp; Plastics</b>  |  | \$0.00  |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                          |  | \$0.00  |
| <b>Division 8 - Doors &amp; Windows</b>  |  | \$0.00  |
| <b>Division 9 - Finishes</b>   |  | \$16,700.00   |
| <b>Division 10 - Specialties</b>   |  | \$0.00  |
| <b>Division 11 - Equipment</b>   |  | \$848,702.00  |
| <b>Division 12 - Furnishings</b>   |  | \$0.00  |
| <b>Division 13 - Special Construction</b>                                      |  | \$21,600.00   |
| <b>Division 14 - Conveying Systems</b>   |  | \$0.00  |
| <b>Division 15 - Mechanical</b>  |  | \$50,000.00   |
| <b>Division 16 - Electrical</b>  |  | \$210,000.00  |
| <b>Division 17 - Instrumentation and Control</b>                               |  | \$120,000.00  |
|  | Division 1 - 17 Subtotal                           | <b>\$1,505,692.00</b>                                       |
|  | Insurance @ 2.5%                                   | <b>\$37,642.30</b>  |
|  | Bonds @ 2.0%                                       | <b>\$30,113.84</b>  |
|  | Overhead & Profit @ 10%                            | <b>\$150,569.20</b>   |
|  | Engineering @ 10%                                  | <b>\$150,569.20</b>   |
|  | Total  | <b>\$1,874,586.54</b>                                       |
|  | Contingency @ 20.0%                                | <b>\$374,917.31</b>   |
|  | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b> | <b>\$2,249,503.85</b>                                       |
|  | (September 2006)                                   |   |

City of Glendale  
Capital Cost Estimate - Strong Base Anion (SBA) - 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section  | Unit | Quantity | Cost             | Installation Factor | Total                 |
|--|------|----------|------------------|---------------------|-----------------------|
| <b>Division 1 - General Conditions</b>                             |      |          |                  |                     |                       |
| Div 1 General Conditions   | LS   | 1        | \$ 75,000.00     | 1.0                 | \$ 75,000.00          |
| Mobilization/Demobilization  |      |          |                  |                     |                       |
| <b>Division 1 Total</b>  |      |          |                  |                     | <b>\$75,000.00</b>    |
| <b>Division 2 - Site Construction</b>                              |      |          |                  |                     |                       |
| 02220 Site Preparation   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing   |      |          |                  |                     |                       |
| 02315 Excavation and Backfill                                      |      |          |                  |                     |                       |
| Excavation and grading of of demonstration facility limits         | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed                                      | CY   | 1,570    | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill   | CY   | 785      | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>  |      |          |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>                                       |      |          |                  |                     |                       |
| 03100 Concrete Formwork  |      |          | In 03300         |                     |                       |
| 03300 Concrete   |      |          |                  |                     |                       |
| Equipment Slab   | CY   | 133      | \$ 500.00        | 1.0                 | \$66,500.00           |
| <b>Division 3 Total</b>  |      |          |                  |                     | <b>\$66,500.00</b>    |
| <b>Division 4 - Masonry</b>  |      |          |                  |                     |                       |
| <b>Division 5 - Metals</b>   |      |          |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts             | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| 05501 Miscellaneous Metal Fabrications (includes access platforms) | LS   | 1        | \$ 15,000.00     | 1.0                 | \$15,000.00           |
| <b>Division 5 Total</b>  |      |          |                  |                     | <b>\$15,500.00</b>    |
| <b>Division 6 - Wood &amp; Plastics</b>                            |      |          |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>              |      |          |                  |                     |                       |
| <b>Division 8 - Doors &amp; Windows</b>                            |      |          |                  |                     |                       |
| <b>Division 9 - Finishes</b>                                       |      |          |                  |                     |                       |
| 09611 Concrete Hardener  | SF   | 3,600    | \$ 3.25          | 1.0                 | \$11,700.00           |
| 09900 Painting   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>  |      |          |                  |                     | <b>\$16,700.00</b>    |
| <b>Division 10 - Specialties</b>                                   |      |          |                  |                     |                       |
| <b>Division 11 - Equipment</b>                                     |      |          |                  |                     |                       |
| 11197 Strong Base Anion Equipment (BWIX Treatment System)          | LS   | 1        | \$ 804,782.00    | 1.0                 | \$804,782.00          |
| 11530 Pumps, General   | EA   | 2        | \$ 18,300.00     | 1.2                 | \$43,920.00           |
| <b>Division 11 Total</b>   |      |          |                  |                     | <b>\$848,702.00</b>   |
| <b>Division 12 - Furnishings</b>                                   |      |          |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                          |      |          |                  |                     |                       |
| 13125 FRP Walk-In Enclosure (for MCC/electrical gear)              | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>   |      |          |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                             |      |          |                  |                     |                       |
| <b>Division 15 - Mechanical</b>                                    |      |          |                  |                     |                       |
| 15051 Buried Piping Installation                                   |      |          |                  |                     |                       |
| 8" Influent Piping   | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Effluent Piping  | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Brine Waste Piping   | FT   | 100      | \$ 25.00         | 1.4                 | \$3,500.00            |
| 15052 Exposed Piping Installation                                  |      |          |                  |                     |                       |
| Ion Exchange System Process Piping                                 |      |          | In 11195         |                     |                       |
| 15055 Pipe Hangers and Supports                                    | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 15061 Ductile Iron Pipe  |      |          | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe   |      |          | In 15051 & 15052 |                     |                       |
| 15100 Valves, 4-Inch and Larger                                    | LS   | 1        | \$ 20,000.00     | 1.2                 | \$24,000.00           |
| <b>Division 15 Total</b>   |      |          |                  |                     | <b>\$50,000.00</b>    |
| <b>Division 16 - Electrical</b>                                    |      |          |                  |                     |                       |
| 16050 General Provisions   | LS   | 1        | \$ 210,000.00    | 1.0                 | \$210,000.00          |
| <b>Division 16 Total</b>   |      |          |                  |                     | <b>\$210,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                   |      |          |                  |                     |                       |
| 17400 Instrumentation and Control                                  | LS   | 1        | \$ 165,000.00    | 1.0                 | \$120,000.00          |
| <b>Division 17 Total</b>   |      |          |                  |                     | <b>\$120,000.00</b>   |
| <b>Division 1 - 17 Subtotal</b>                                    |      |          |                  |                     | <b>\$1,505,692.00</b> |



City of Glendale  
 Operation and Maintenance Costs - Strong Base Anion (SBA) - 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                                 | O&M Misc. | Energy  | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|---|-----------|---------|-----------|----------------|---------------------|---|
| 1.0          | <b>Regenerable Strong Base Anion System</b> |           |         |           |                |                     |   |
| 1.1          | Salt Usage                                  |           |         | \$4,758   |                | \$4,758.06          | Assumed 59-lbs per acre-foot of water at \$100/ton                                  |
| 1.2          | Pre-Filters filter replacement              | \$1,440   |         |           |                | \$1,440.00          | Assumed monthly replacement of bag filters  |
| 1.3          | Effluent Booster Pumps                      |           | \$6,345 |           |                | \$6,344.53          | Boosting IX effluent to aerator influent. 1,000-gpm @ 50' TDH                       |
| 1.4          | Miscellaneous Maintenance                   | \$16,974  |         |           |                | \$16,974.04         | Assumed 2% of equipment costs (Div 11)  |
|              | <b>Subtotal - SBA System</b>                |           |         |           |                | <b>\$29,516.63</b>  |   |
| 2.0          | <b>Waste Disposal</b>                       |           |         |           |                |                     |   |
| 2.1          | Backwash Waste Disposal (Non-Haz)           |           |         |           | \$1,393        | \$1,392.84          | Based on backwash volume of 525,600 gallons per year disposed of at sanitary sewer. |
| 2.2          | Brine Waste Disposal (Haz)                  |           |         |           | \$120,450      | \$120,450.00        | Based on 2,200-gpd disposed off site (includes trucking costs) at \$0.15 per gal.   |
| 2.3          | Solids Waste Disposal                       |           |         |           | \$5,634        | \$5,633.75          | Based on 24 drums of solid waste per year at \$445/ton.                             |
|              | <b>Subtotal - Waste Disposal</b>            |           |         |           |                | <b>\$1,392.84</b>   |   |
| 3.0          | <b>Labor</b>                                |           |         |           |                |                     |   |
| 3.1          | Labor                                       | \$50,000  |         |           |                | \$50,000.00         | Labor based on 0.5 FTE at \$100,000/yr.   |
|              | <b>Subtotal - Labor</b>                     |           |         |           |                | <b>\$50,000.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                      | \$68,414  | \$6,345 | \$4,758   | \$127,477      | <b>\$206,993.23</b> |   |



## Reduction, Coagulation, Filtration – 500 gpm:

| City of Glendale   |   |   |
|--|---|---|
| Capital Cost Estimate - Reduction, Coagulation, Filtration (RCF) - 500 gpm |   |   |
| Company:   | Malcolm Pirnie, Inc.                                  | Date: 29-Sep-06   |
| Project:   | Phase III Hexavalent Chromium Demonstration System    | Estimator: SMD  |
| Submittal:   | Conceptual Design Level Cost Estimate                 | Checker: GB, MJM, NB  |
| Work Task:   |   | Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006) |
|  | Division Summary                                      | Total   |
|  | <b>Division 1 - General Conditions</b>                | \$50,000.00   |
|  | <b>Division 2 - Site Construction</b>                 | \$81,690.00   |
|  | <b>Division 3 - Concrete</b>                          | \$92,500.00   |
|  | <b>Division 4 - Masonry</b>                           | \$0.00  |
|  | <b>Division 5 - Metals</b>                            | \$500.00  |
|  | <b>Division 6 - Wood &amp; Plastics</b>               | \$0.00  |
|  | <b>Division 7 - Thermal &amp; Moisture Protection</b> | \$0.00  |
|  | <b>Division 8 - Doors &amp; Windows</b>               | \$0.00  |
|  | <b>Division 9 - Finishes</b>                          | \$21,250.00   |
|  | <b>Division 10 - Specialties</b>                      | \$500.00  |
|  | <b>Division 11 - Equipment</b>                        | \$1,337,400.00  |
|  | <b>Division 12 - Furnishings</b>                      | \$0.00  |
|  | <b>Division 13 - Special Construction</b>             | \$21,600.00   |
|  | <b>Division 14 - Conveying Systems</b>                | \$0.00  |
|  | <b>Division 15 - Mechanical</b>                       | \$39,640.00   |
|  | <b>Division 16 - Electrical</b>                       | \$150,000.00  |
|  | <b>Division 17 - Instrumentation and Control</b>      | \$115,000.00  |
|  | Division 1 - 17 Subtotal                              | <b>\$1,910,080.00</b>                                       |
|  | Insurance @ 2.5%                                      | <b>\$47,752.00</b>  |
|  | Bonds @ 2.0%  | <b>\$38,201.60</b>  |
|  | Overhead & Profit @ 10%                               | <b>\$191,008.00</b>   |
|  | Engineering @ 10%                                     | <b>\$191,008.00</b>   |
|  | Total   | <b>\$2,378,049.60</b>                                       |
|  | Contingency @ 20.0%                                   | <b>\$475,609.92</b>   |
|  | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b>    | <b>\$2,853,659.52</b>                                       |
|  | (September 2006)                                      |   |

City of Glendale  
Capital Cost Estimate - Reduction, Coagulation, Filtration (RCF) - 500 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section  | Unit | Quantity | Cost             | Installation Factor | Total                 |
|--|------|----------|------------------|---------------------|-----------------------|
| <b>Division 1 - General Conditions</b>                                   |      |          |                  |                     |                       |
| Div 1 General Conditions   | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Mobilization/Demobilization  |      |          |                  |                     |                       |
| <b>Division 1 Total</b>  |      |          |                  |                     | <b>\$50,000.00</b>    |
| <b>Division 2 - Site Construction</b>                                    |      |          |                  |                     |                       |
| 02220 Site Preparation   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing   |      |          |                  |                     |                       |
| 02315 Excavation and Backfill  |      |          |                  |                     |                       |
| Excavation and grading of demonstration facility limits                  | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed  | CY   | 1,570    | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill   | CY   | 785      | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>  |      |          |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>   |      |          |                  |                     |                       |
| 03100 Concrete Formwork  |      |          | In 03300         |                     |                       |
| 03300 Concrete   |      |          |                  |                     |                       |
| Equipment Slab (5,000-sf)  | CY   | 185      | \$ 500.00        | 1.0                 | \$92,500.00           |
| <b>Division 3 Total</b>  |      |          |                  |                     | <b>\$92,500.00</b>    |
| <b>Division 4 - Masonry</b>  |      |          |                  |                     |                       |
| <b>Division 5 - Metals</b>   |      |          |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts                   | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 5 Total</b>  |      |          |                  |                     | <b>\$500.00</b>       |
| <b>Division 6 - Wood &amp; Plastics</b>                                  |      |          |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                    |      |          |                  |                     |                       |
| <b>Division 8 - Doors &amp; Windows</b>                                  |      |          |                  |                     |                       |
| <b>Division 9 - Finishes</b>   |      |          |                  |                     |                       |
| 09611 Concrete Hardener  | SF   | 5,000    | \$ 3.25          | 1.0                 | \$16,250.00           |
| 09900 Painting   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>  |      |          |                  |                     | <b>\$21,250.00</b>    |
| <b>Division 10 - Specialties</b>   |      |          |                  |                     |                       |
| 10400 Identification Devices   | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 10 Total</b>   |      |          |                  |                     | <b>\$500.00</b>       |
| <b>Division 11 - Equipment</b>   |      |          |                  |                     |                       |
| 11179 Fiberglass Reinforced Plastic Tanks (Ferrous Sulfate Bulk Storage) | LS   | 1        | \$ 5,000.00      | 1.2                 | \$6,000.00            |
| 11180 Backwash Water Holding Tank with mixer (20,000-gal.)               | LS   | 1        | \$ 36,500.00     | 1.2                 | \$43,920.00           |
| 11218 Ferrous Sulfate Feed System  | LS   | 1        | \$ 30,000.00     | 1.2                 | \$36,000.00           |
| 11219 Polymer Addition System  | LS   | 1        | \$ 20,000.00     | 1.2                 | \$24,000.00           |
| 11216 Gravity Settler  | EA   | 1        | \$ 82,900.00     | 1.2                 | \$99,480.00           |
| 11217 Dual Media Filter (5-cell)   | EA   | 1        | \$ 450,000.00    | 1.2                 | \$540,000.00          |
| 11311 Reduction Tank (30,000-gal. Steel Tank) w/ mixers                  | LS   | 1        | \$ 70,000.00     | 1.2                 | \$84,000.00           |
| 11312 Aeration Chamber   | LS   | 1        | \$ 65,000.00     | 1.2                 | \$78,000.00           |
| Steel Tank (10,000-gallons)  |      |          |                  |                     |                       |
| Blowers  |      |          |                  |                     |                       |
| Coarse Air Diffusers   |      |          |                  |                     |                       |
| Air Compressor   |      |          |                  |                     |                       |
| 11315 Belt Filter Press (1-meter)  | EA   | 1        | \$ 220,000.00    | 1.2                 | \$264,000.00          |
| Backwash Water Storage Tank (30,000-gal.)                                | LS   | 1        | \$ 45,000.00     | 1.2                 | \$54,000.00           |
| 15130 Pumps, Booster   | EA   | 6        | \$ 15,000.00     | 1.2                 | \$108,000.00          |
| <b>Division 11 Total</b>   |      |          |                  |                     | <b>\$1,337,400.00</b> |
| <b>Division 12 - Furnishings</b>   |      |          |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                                |      |          |                  |                     |                       |
| 13125 FRP Walk-in Enclosure  | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>   |      |          |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                                   |      |          |                  |                     |                       |
| <b>Division 15 - Mechanical</b>  |      |          |                  |                     |                       |
| 15051 Buried Piping Installation   |      |          |                  |                     |                       |
| 8" Influent Piping   | FT   | 250      | \$ 21.00         | 1.4                 | \$7,350.00            |
| Effluent Piping  | FT   | 250      | \$ 21.00         | 1.4                 | \$7,350.00            |
| Backwash Waste Piping  | FT   | 100      | \$ 21.00         | 1.4                 | \$2,940.00            |
| 15052 Exposed Piping Installation  |      |          |                  |                     |                       |
| 12" Influent Piping  | FT   | 1        | \$ 20.00         | 1.4                 | \$0.00                |
| 15055 Pipe Hangers and Supports  | LS   | 1        | \$ 10,000.00     | 1.0                 | \$10,000.00           |
| 15081 Ductile Iron Pipe  |      |          | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe   |      |          | In 15051 & 15052 |                     |                       |
| 15100 Valves & Fittings (Misc.), 4-Inch and Larger                       | LS   | 0        | \$ 10,000.00     | 1.2                 | \$12,000.00           |
| <b>Division 15 Total</b>   |      |          |                  |                     | <b>\$39,640.00</b>    |
| <b>Division 16 - Electrical</b>  |      |          |                  |                     |                       |
| 16050 General Provisions   | LS   | 1        | \$ 150,000.00    | 1.0                 | \$150,000.00          |
| <b>Division 16 Total</b>   |      |          |                  |                     | <b>\$150,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                         |      |          |                  |                     |                       |
| 17400 Instrumentation and Control  | LS   | 1        | \$ 115,000.00    | 1.0                 | \$115,000.00          |
| <b>Division 17 Total</b>   |      |          |                  |                     | <b>\$115,000.00</b>   |
| Division 1 - 17 Subtotal   |      |          |                  |                     | <b>\$1,910,080.00</b> |

**City of Glendale  
Operation and Maintenance Costs - Reduction, Coagulation, Filtration (RCF) - 500 gpm**

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                             | D&M Misc | Energy   | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|---|----------|----------|-----------|----------------|---------------------|---|
| 1.0          | <b>Reduction Coagulation Filtration</b> |          |          |           |                |                     |   |
| 1.1          | Media Replacement                       | \$10,000 |          |           |                | \$10,000.00         | Assumed 10% media loss per year.  |
| 1.2          | Booster/Backwash Pumps/Blowers          |          | \$35,928 |           |                | \$35,927.83         | Booster pumps, backwash pumps and aeration blowers.   |
| 1.3          | Chemicals                               |          |          | \$7,884   |                | \$7,884.00          | Assuming a 25:1 Fe:Cr mass ratio, Fe dose of 2.5 mg/L as Fe, and cost of 5% (as Fe) ferrous sulfate at \$0.60/gallon  |
| 1.4          | Miscellaneous Maintenance               | \$26,748 |          |           |                | \$26,748.00         | Assumed 2% of equipment costs (Div 11)  |
|              | <b>Subtotal - RCF System</b>            |          |          |           |                | <b>\$80,559.83</b>  |   |
| 2.0          | <b>Waste Disposal</b>                   |          |          |           |                |                     | Backwash water volume of 4% of water treated; 0.58% of backwash water as settled sludge, 99.42% recycled; 3% solids in settled sludge; 80% filter press dewatering efficiency; total backwash water to sewer (in Glendale) of 28,000 gpd waste (for 500-gpm system). If no backwash water could be recycled, this annual sewer disposal cost would be \$19,534 in Glendale and \$33,895 in LA |
| 2.1          | Liquid Waste Disposal (Non-Hazardous)   |          |          |           | \$781          | \$781.00            | Residuals disposal based on 20 tons/year at \$445/ton   |
| 2.2          | Residuals Disposal (Hazardous)          |          |          |           | \$22,695       | \$22,695.00         |   |
|              | <b>Subtotal - Waste Disposal</b>        |          |          |           |                | <b>\$781.00</b>     |   |
| 3.0          | <b>Labor</b>                            |          |          |           |                |                     |   |
| 3.1          | Labor                                   | \$50,000 |          |           |                | \$50,000.00         | Labor based on 0.5 FTE at \$100,000/yr.   |
|              | <b>Subtotal - Labor</b>                 |          |          |           |                | <b>\$50,000.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                  | \$86,748 | \$35,928 | \$7,884   | \$23,476       | <b>\$154,035.83</b> |   |

## Reduction, Coagulation, Filtration – 1,000 gpm:

| City of Glendale  |  |                               |
|---|--|-------------------------------|
| Capital Cost Estimate - Reduction, Coagulation, Filtration (RCF) - 1000 gpm |  |                               |
| Company: <u>Malcolm Pirnie, Inc.</u>  | Date: <u>29-Sep-06</u>                             |                               |
| Project: <u>Phase III Hexavalent Chromium Demonstration System</u>          | Estimator: <u>SMD</u>                              |                               |
| Submittal: <u>Conceptual Design Level Cost Estimate</u>                     | Checker: <u>GB, MJM, NB</u>                        |                               |
| Work Task: _____  | Cost Index: <u>ENR CCI = 8572.47</u>               | (Los Angeles, September 2006) |
| Division Summary  |  | Total                         |
| <b>Division 1 - General Conditions</b>                                      |  | \$75,000.00                   |
| <b>Division 2 - Site Construction</b>                                       |  | \$81,690.00                   |
| <b>Division 3 - Concrete</b>  |  | \$111,000.00                  |
| <b>Division 4 - Masonry</b>   |  | \$0.00                        |
| <b>Division 5 - Metals</b>  |  | \$500.00                      |
| <b>Division 6 - Wood &amp; Plastics</b>                                     |  | \$0.00                        |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                       |  | \$0.00                        |
| <b>Division 8 - Doors &amp; Windows</b>                                     |  | \$0.00                        |
| <b>Division 9 - Finishes</b>  |  | \$24,500.00                   |
| <b>Division 10 - Specialties</b>  |  | \$500.00                      |
| <b>Division 11 - Equipment</b>  |  | \$1,654,560.00                |
| <b>Division 12 - Furnishings</b>  |  | \$0.00                        |
| <b>Division 13 - Special Construction</b>                                   |  | \$21,600.00                   |
| <b>Division 14 - Conveying Systems</b>                                      |  | \$0.00                        |
| <b>Division 15 - Mechanical</b>   |  | \$55,000.00                   |
| <b>Division 16 - Electrical</b>   |  | \$210,000.00                  |
| <b>Division 17 - Instrumentation and Control</b>                            |  | \$130,000.00                  |
|   | Division 1 - 17 Subtotal                           | <b>\$2,364,350.00</b>         |
|   | Insurance @ 2.5%                                   | <b>\$59,108.75</b>            |
|   | Bonds @ 2.0%                                       | <b>\$47,287.00</b>            |
|   | Overhead & Profit @ 10%                            | <b>\$236,435.00</b>           |
|   | Engineering @ 10%                                  | <b>\$236,435.00</b>           |
|   | Total  | <b>\$2,943,615.75</b>         |
|   | Contingency @ 20.0%                                | <b>\$588,723.15</b>           |
|   | <b>CONCEPTUAL LEVEL PROBABLE CONSTRUCTION COST</b> | <b>\$3,532,338.90</b>         |
|   | (September 2006)                                   |                               |

City of Glendale  
Capital Cost Estimate - Reduction, Coagulation, Filtration (RCF) - 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Specification Section  | Unit | Quantity | Cost             | Installation Factor | Total                 |
|--|------|----------|------------------|---------------------|-----------------------|
| <b>Division 1 - General Conditions</b>                                   |      |          |                  |                     |                       |
| Div 1 General Conditions   | LS   | 1        | \$ 75,000.00     | 1.0                 | \$75,000.00           |
| Mobilization/Demobilization  |      |          |                  |                     |                       |
| <b>Division 1 Total</b>  |      |          |                  |                     | <b>\$75,000.00</b>    |
| <b>Division 2 - Site Construction</b>                                    |      |          |                  |                     |                       |
| 02220 Site Preparation   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| 02230 Clearing   |      |          |                  |                     |                       |
| 02315 Excavation and Backfill  |      |          |                  |                     |                       |
| Excavation and grading of demonstration facility limits                  | LS   | 1        | \$ 50,000.00     | 1.0                 | \$50,000.00           |
| Excess Material to be removed  | CY   | 1,570    | \$ 8.00          | 1.0                 | \$12,560.00           |
| Backfill   | CY   | 785      | \$ 18.00         | 1.0                 | \$14,130.00           |
| <b>Division 2 Total</b>  |      |          |                  |                     | <b>\$81,690.00</b>    |
| <b>Division 3 - Concrete</b>   |      |          |                  |                     |                       |
| 03100 Concrete Formwork  |      |          | In 03300         |                     |                       |
| 03300 Concrete   |      |          |                  |                     |                       |
| Equipment Slab (3,500-sf)  | CY   | 222      | \$ 500.00        | 1.0                 | \$111,000.00          |
| <b>Division 3 Total</b>  |      |          |                  |                     | <b>\$111,000.00</b>   |
| <b>Division 4 - Masonry</b>  |      |          |                  |                     |                       |
| <b>Division 5 - Metals</b>   |      |          |                  |                     |                       |
| 05051 Anchor Bolts, Toggle Bolts, and Concrete Inserts                   | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 5 Total</b>  |      |          |                  |                     | <b>\$500.00</b>       |
| <b>Division 6 - Wood &amp; Plastics</b>                                  |      |          |                  |                     |                       |
| <b>Division 7 - Thermal &amp; Moisture Protection</b>                    |      |          |                  |                     |                       |
| <b>Division 8 - Doors &amp; Windows</b>                                  |      |          |                  |                     |                       |
| <b>Division 9 - Finishes</b>   |      |          |                  |                     |                       |
| 09611 Concrete Hardener  | SF   | 6,000    | \$ 3.25          | 1.0                 | \$19,500.00           |
| 09900 Painting   | LS   | 1        | \$ 5,000.00      | 1.0                 | \$5,000.00            |
| <b>Division 9 Total</b>  |      |          |                  |                     | <b>\$24,500.00</b>    |
| <b>Division 10 - Specialties</b>   |      |          |                  |                     |                       |
| 10400 Identification Devices   | LS   | 1        | \$ 500.00        | 1.0                 | \$500.00              |
| <b>Division 10 Total</b>   |      |          |                  |                     | <b>\$500.00</b>       |
| <b>Division 11 - Equipment</b>   |      |          |                  |                     |                       |
| 11179 Fiberglass Reinforced Plastic Tanks (Ferrous Sulfate Bulk Storage) | LS   | 1        | \$ 5,000.00      | 1.2                 | \$6,000.00            |
| 11180 Backwash Water Holding Tank with mixer (20,000-gal.)               | LS   | 1        | \$ 36,600.00     | 1.2                 | \$43,920.00           |
| 11218 Ferrous Sulfate Feed System  | LS   | 1        | \$ 34,500.00     | 1.2                 | \$41,400.00           |
| 11216 Gravity Settler  | EA   | 1        | \$ 82,900.00     | 1.2                 | \$99,480.00           |
| 11217 Dual Media Filter (5-cell)   | EA   | 1        | \$ 625,000.00    | 1.2                 | \$750,000.00          |
| 11219 Polymer Addition System  | LS   | 1        | \$ 20,000.00     | 1.2                 | \$24,000.00           |
| 11311 Reduction Tank (60,000-gal. Steel Tank) w/ mixers                  | LS   | 1        | \$ 110,000.00    | 1.2                 | \$132,000.00          |
| 11312 Aeration Chamber   | LS   | 1        | \$ 90,000.00     | 1.2                 | \$108,000.00          |
| Steel Tank (10,000-gallons)  |      |          |                  |                     |                       |
| Blowers  |      |          |                  |                     |                       |
| Coarse Air Diffusers   |      |          |                  |                     |                       |
| Air Compressor   |      |          |                  |                     |                       |
| 11315 Belt Filter Press (1-meter)  | EA   | 1        | \$ 220,000.00    | 1.2                 | \$264,000.00          |
| Backwash Water Storage Tank (30,000-gal.)                                | LS   | 1        | \$ 45,000.00     | 1.2                 | \$54,000.00           |
| 15130 Pumps, Booster   | EA   | 6        | \$ 18,300.00     | 1.2                 | \$131,760.00          |
| <b>Division 11 Total</b>   |      |          |                  |                     | <b>\$1,654,560.00</b> |
| <b>Division 12 - Furnishings</b>   |      |          |                  |                     |                       |
| <b>Division 13 - Special Construction</b>                                |      |          |                  |                     |                       |
| 13125 FRP Walk-in Enclosure (MCC)  | LS   | 1        | \$ 18,000.00     | 1.2                 | \$21,600.00           |
| <b>Division 13 Total</b>   |      |          |                  |                     | <b>\$21,600.00</b>    |
| <b>Division 14 - Conveying Systems</b>                                   |      |          |                  |                     |                       |
| <b>Division 15 - Mechanical</b>  |      |          |                  |                     |                       |
| 15051 Buried Piping Installation   |      |          |                  |                     |                       |
| 12" Influent Piping  | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Effluent Piping  | FT   | 250      | \$ 25.00         | 1.4                 | \$8,750.00            |
| Backwash Waste Piping  | FT   | 100      | \$ 25.00         | 1.4                 | \$3,500.00            |
| 15052 Exposed Piping Installation  |      |          |                  |                     |                       |
| 12" Influent Piping  | FT   |          | \$ 21.00         | 1.4                 | \$0.00                |
| 15055 Pipe Hangers and Supports  | LS   | 1        | \$ 10,000.00     | 1.0                 | \$10,000.00           |
| 15061 Ductile Iron Pipe  |      |          | In 15051         |                     |                       |
| 15067 Thermoplastic Pipe   |      |          | In 15051 & 15052 |                     |                       |
| 15100 Valves & Fittings (Misc.), 4-Inch and Larger                       | LS   | 0        | \$ 20,000.00     | 1.2                 | \$24,000.00           |
| <b>Division 15 Total</b>   |      |          |                  |                     | <b>\$55,000.00</b>    |
| <b>Division 16 - Electrical</b>  |      |          |                  |                     |                       |
| 16050 General Provisions   | LS   | 1        | \$ 210,000.00    | 1.0                 | \$210,000.00          |
| <b>Division 16 Total</b>   |      |          |                  |                     | <b>\$210,000.00</b>   |
| <b>Division 17 - Instrumentation and Control</b>                         |      |          |                  |                     |                       |
| 17400 Instrumentation and Control  | LS   | 1        | \$ 130,000.00    | 1.0                 | \$130,000.00          |
| <b>Division 17 Total</b>   |      |          |                  |                     | <b>\$130,000.00</b>   |
| <b>Division 1 - 17 Subtotal</b>  |      |          |                  |                     | <b>\$2,364,350.00</b> |

City of Glendale  
 Operation and Maintenance Costs - Reduction, Coagulation, Filtration (RCF) - 1000 gpm

Company: Malcolm Pirnie, Inc. Date: 29-Sep-06  
 Project: Phase III Hexavalent Chromium Demonstration System Estimator: SMD  
 Submittal: Conceptual Design Level Cost Estimate Checker: GB, MJM, NB  
 Work Task: \_\_\_\_\_ Cost Index: ENR CCI = 8572.47 (Los Angeles, September 2006)

| Item         | Description                             | O&M Misc. | Energy   | Chemicals | Waste Disposal | Total O&M           | Notes   |
|--------------|---|-----------|----------|-----------|----------------|---------------------|---|
| 1.0          | <b>Reduction Coagulation Filtration</b> |           |          |           |                |                     |   |
| 1.1          | Media Replacement                       | \$10,000  |          |           |                | \$10,000.00         | Assumed 10% media loss per year. Booster pumps, backwash pumps and aeration blowers.  |
| 1.2          | Booster/Backwash Pumps/Blowers          |           | \$35,928 |           |                | \$35,927.83         |   |
| 1.3          | Chemicals                               |           |          | \$15,768  |                | \$15,768.00         | Assuming a 25:1 Fe:Cr mass ratio, Fe dose of 2.5 mg/L as Fe, and cost of 5% (as Fe) ferrous sulfate at \$0.60/gallon ; Polymer addition at 1 mg/L at \$ Assumed 2% of equipment costs (Div 11)  |
| 1.4          | Miscellaneous Maintenance               | \$33,091  |          |           |                | \$33,091.20         |   |
|              | <b>Subtotal - RCF System</b>            |           |          |           |                | <b>\$94,787.03</b>  |   |
| 2.0          | <b>Waste Disposal</b>                   |           |          |           |                |                     | Backwash water volume of 4% of water treated; 0.58% of backwash water as settled sludge, 99.42% recycled; 3% solids in settled sludge; 80% filter press dewatering efficiency; total backwash water to sewer in Glendale of 57,600 gpd waste (for 1,000-gpm system). If no backwash water could be recycled, this annual sewer disposal cost would be \$39,069 in Glendale and \$67,789 in LA Residuals disposal based on 40 tons/year at \$445/ton |
| 2.1          | Liquid Waste Disposal (Non-Hazardous)   |           |          |           | \$2,712        | \$2,712.00          |   |
| 2.2          | Residuals Disposal (Hazardous)          |           |          |           | \$45,390       | \$45,390.00         |   |
|              | <b>Subtotal - Waste Disposal</b>        |           |          |           |                | <b>\$2,712.00</b>   |   |
| 3.0          | <b>Labor</b>                            |           |          |           |                |                     | Labor based on 0.5 FTE at \$100,000/yr.   |
| 3.1          | Labor                                   | \$50,000  |          |           |                | \$50,000.00         |   |
|              | <b>Subtotal - Labor</b>                 |           |          |           |                | <b>\$50,000.00</b>  |   |
| <b>TOTAL</b> | <b>Subtotals Total</b>                  | \$93,091  | \$35,928 | \$15,768  | \$48,102       | <b>\$192,889.03</b> |   |