

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	100-gpm RCF System without Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.W. on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 2,400	\$ 2,400	Quotes from Ryan Herco & Core-Rosion; 70/75 gal PE, outdoor, incl. seismic; in 2015 dollars
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quotes from C.P. Crowley & HTP; 0.21 gph; 1 duty/ 1 stdby; in 2015 dollars
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2015 dollars
Reduction Tank					
Tank and Mixer	1	EA	\$ 9,600	\$ 9,600	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars
NaOCl Feed System					
Storage Tank	1	LS	\$ 600	\$ 600	Quote from Polyprocessing; 55 gal, HDPE, outdoor, incl. seismic, adjusted to 2015 dollars
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 0.06 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2015 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank and Mixer	1	EA	\$ 9,600	\$ 9,600	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; in 2015 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 297,000	\$ 297,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf, (2) 6.5 ft dia VPF, 1 duty/ 1 stdby; adjusted to 2015 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,900	\$ 11,800	Quotes from DTT and Cortech; 55 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars
Pumps					
Filter Feed Pumps (Centrifugal)	2	EA	\$ 5,600	\$ 11,200	Quotes from Cortech & Flow-Systems; 100 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars (Centrifugal)
Polymer Feed Systems					
Polymer Feed System (Coagulant Aid)	1	LS	\$ 29,000	\$ 29,000	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Filtrate Tank for Backwash	1	EA	\$ 28,000	\$ 28,000	Quotes from Core-Rosion & Ryan Herco; 12,500 gal PE, outdoor, incl. seismic; adjusted to 2015 dollars
Backwash Pumps	2	EA	\$ 9,400	\$ 18,800	Quotes from ITT & Cortech; 600 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Backwash Waste Storage Tank	1	EA	\$ 36,000	\$ 36,000	Based on previous quotes for various tank sizes, estimated for 21,000 gal, adjusted to 2015 dollars
Sewer Discharge Pumps	2	EA	\$ 5,200	\$ 10,400	Quote based upon 175 gpm Hydromatic Submersible pump, 1 duty/ 1 stdby
<b>Subtotal</b>				<b>\$ 486,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 146,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,330	\$ 3,262	Adjusted to 2015 dollars
Equipment Concrete Pads	22	CY	\$ 1,330	\$ 29,260	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 665,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 49,875	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 33,250	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 33,250	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 100,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 100,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 981,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 196,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 1,177,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 235,400	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 235,400	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 1,648,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,154,000	-30%
High Estimate				\$ 2,472,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	500-gpm RCF System without Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.W. on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<b>FeSO<sub>4</sub> Feed System</b>					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 400/500 gal PE, outdoor, incl. seismic; in 2015 dollars.
Metering Pumps	2	EA	\$ 4,600	\$ 9,200	Quotes from C.P. Crowley & HTP; 1.04 gph; 1 duty/ 1 stdby; in 2015 dollars.
Static Mixer	1	EA	\$ 2,300	\$ 2,300	Quotes from Komax & EWS; 8-inch; adjusted to 2015 dollars.
<b>Reduction Tank</b>					
Tank and Mixer	1	EA	\$ 15,400	\$ 15,400	Quotes from Core-Rosion & Ryan Herco; 2,500 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
<b>NaOCl Feed System</b>					
Storage Tank	1	EA	\$ 1,100	\$ 1,100	Quote from Polyprocessing; 115 gal, HDPE, outdoor, incl. seismic; adjusted to 2015 dollars.
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 0.30 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars.
Static Mixers	1	EA	\$ 2,300	\$ 2,300	Quotes from Komax & EWS; 8-inch; adjusted to 2015 dollars.
<b>Polymer Mixing Tank</b>					
Rapid Mixing Tank and Mixer	1	EA	\$ 15,400	\$ 15,400	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2015 dollars.
<b>Filters</b>					
Filter Equipment (Pressure Filters)	1	LS	\$ 494,000	\$ 494,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf; Coombs-Hopkins filters, 10' x 24' (4 cells, 3 duty/ 1 stdby); Layne filters, (2) 8" x 22', 1 duty/ 1 stdby; adjusted to 2015 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 5,100	\$ 10,200	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars.
<b>Pumps</b>					
Filter Feed Pumps (Centrifugal)	2	EA	\$ 9,000	\$ 18,000	Quotes from Cortech & Flow-Systems; 500 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars. (Centrifugal)
<b>Polymer Feed Systems</b>					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Filtrate Tank for Backwash	1	EA	\$ 42,000	\$ 42,000	Quotes from Superior; 22,000 gal; 15 ft dia x 16 ft height; adjusted to 2015 dollars.
Backwash Pumps	2	EA	\$ 15,200	\$ 30,400	Quotes from ITT & Cortech; 1,050 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars.
Backwash Waste Storage Tank	1	EA	\$ 72,800	\$ 72,800	Based on previous quotes for various tank sizes, estimated for 85,000 gal, adjusted to 2015 dollars
Sewer Discharge Pumps	2	EA	\$ 5,200	\$ 10,400	Quote based upon 175 gpm Hydromatic Submersible pump, 1 duty/ 1 stdby
<b>Subtotal</b>				<b>\$ 748,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 225,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	6	CY	\$ 1,330	\$ 8,638	Adjusted to 2015 dollars
Equipment Concrete Pads	56	CY	\$ 1,330	\$ 74,480	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,057,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 79,275	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 52,850	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 52,850	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 159,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 159,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 1,560,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 312,000	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 1,872,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 374,400	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 374,400	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 2,621,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,835,000	-30%
High Estimate				\$ 3,932,000	+50%

**Notes:**

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2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	1000-gpm RCF System without Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.W. on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 5,300	\$ 5,300	Quotes from Core-Rosion & Ryan Herco; 685/750 gal PE, outdoor, incl. seismic; in 2015 Dollars.
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quotes from C.P. Crowley & HTP; 2 gph; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Static Mixers	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & Koflo; 10-inch; in 2015 dollars.
Reduction Tank					
Tank and Mixer	1	EA	\$ 29,000	\$ 29,000	Quotes from Core-Rosion & Ryan Herco; 5,000 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
NaOCl Feed System					
Storage Tank	1	EA	\$ 2,800	\$ 2,800	Quote from Polyprocessing; 230/210 gal, HDPE, outdoor, incl. seismic; in 2015 dollars.
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quote from Prominent; 0.52 gph, 1 duty/ 1 stdby; in 2015 dollars.
Static Mixers	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & Koflo; 10-inch; in 2015 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank and Mixer	1	EA	\$ 29,000	\$ 29,000	Quotes from Core-Rosion & Ryan Herco; 5000 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 599,000	\$ 599,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, 12' x 38' (4 cells, 3 duty/ 1 stdby); Layne filters, (1) 10" x 36", (4 cells, 3 duty/1 standby); in 2015 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 5,300	\$ 10,600	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Pumps					
Filter Feed Pumps (centrifugal)	2	EA	\$ 16,000	\$ 32,000	Quotes from Cortech & Flow-Systems; 1000 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Filtrate Tank for Backwash	1	EA	\$ 60,000	\$ 60,000	Quotes from Superior; 43,000 gal; 23' diameter x 16' high; in 2015 dollars.
Backwash Pumps	2	EA	\$ 22,800	\$ 45,600	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Backwash Waste Storage Tank	1	EA	\$ 155,000	\$ 155,000	Based on previous quotes for various tank sizes, estimated for 170,000 gal, in 2015 dollars
Sewer Discharge Pumps	2	EA	\$ 5,200	\$ 10,400	Quote based upon 175 gpm Hydromatic Submersible pump, 1 duty/ 1 stdby; adjusted to 2015 dollars
<b>Subtotal</b>				<b>\$ 1,020,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 306,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	9	CY	\$ 1,330	\$ 11,614	Adjusted to 2015 dollars
Equipment Concrete Pads	98	CY	\$ 1,330	\$ 130,340	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,468,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 110,100	Division I requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 73,400	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 73,400	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 221,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 221,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 2,167,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 433,400	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 2,600,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 520,000	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 520,000	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 3,640,000</b>	Rounded up to \$1000
Low Estimate				\$ 2,548,000	-30%
High Estimate				\$ 5,460,000	+50%

**Notes:**

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	2000-gpm RCF System without Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.W. on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 8,000	\$ 8,000	Quotes from Core-Rosion & Ryan Herco; 1,400/1,500 gal PE, outdoor, incl. seismic; in 2015 dollars
Metering Pumps	2	EA	\$ 7,000	\$ 14,000	Quotes from C.P. Crowley & HTP; 4.17 gph; in 2015 dollars
Static Mixers	1	EA	\$ 4,500	\$ 4,500	Quotes from Komax & EWS; 14-inch; adjusted to 2015 dollars
Reduction Tank					
Mixers	1	EA	\$ 18,000	\$ 18,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2015 dollars
NaOCl Feed System					
Storage Tank	1	LS	\$ 2,400	\$ 2,400	Quote from Polyprocessing; 475 gal, HDPE, outdoor, incl. seismic; adjusted to 2015 dollars
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 1.22 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars
Static Mixers	1	EA	\$ 4,500	\$ 4,500	Quotes from Komax & EWS; 14-inch; adjusted to 2015 dollars.
Polymer Mixing Tanks					
Mixers	1	EA	\$ 18,000	\$ 18,000	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2015 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 1,044,000	\$ 1,044,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, (2) 10' x 42', 4 cells per filter, 3 duty / 1 stdby; Layne filters, (4) 10' x 24', 3 duty/ 1 stdby; adjusted to 2015 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,300	\$ 10,600	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars
Pumps					
Filter Feed Pumps (Centrifugal)	3	EA	\$ 21,000	\$ 63,000	Quotes from Cortech & Flow-Systems; 2,000 gpm @ 70 ft; 2 duty/ 1 stdby; in 2015 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Filtrate Tank for Backwash	1	EA	\$ 53,000	\$ 53,000	Quotes from Superior; 30,250 gal; 18 ft dia x 16 ft height; adjusted to 2015 dollars
Backwash Pumps	2	EA	\$ 22,800	\$ 45,600	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Backwash Waste Storage Tank	1	EA	\$ 175,000	\$ 175,000	Based on previous quotes for various tank sizes, estimated for 286,000 gal, adjusted to 2015 dollars
Sewer Discharge Pumps	2	EA	\$ 5,200	\$ 10,400	Quote based upon 175 gpm Hydromatic Submersible pump, 1 duty/ 1stdby; adjusted to 2015 dollars
<b>Subtotal</b>				<b>\$ 1,493,000</b>	Rounded up to \$1000
Equipment Installation Cost (30% of Equipment)	30%			\$ 448,000	Including tax, freight, installation and manufacturer services.
Reduction Tanks					10,000 gal based on 5 min detention time
Slab	17	CY	\$ 740	\$ 12,580	Based on 2 ft slab or wall; \$735/CY; adjusted to 2015 dollars.
Walls	35	CY	\$ 850	\$ 29,750	Based on 2 ft slab or wall; and 2 ft freeboard; \$840/CY; adjusted to 2015 dollars
Elevated Slab	17	CY	\$ 1,170	\$ 19,890	Based on 2 ft slab or wall; \$1155/CY; adjusted to 2015 dollars.
Chlorine Contact Tanks					15 ft x 15 ft tank
Slab	17	CY		\$ -	Based on 2 ft slab or wall; \$735/CY; adjusted to 2014 dollars.
Walls	35	CY		\$ -	Based on 2 ft slab or wall; and 2 ft freeboard; \$840/CY; adjusted to 2014 dollars
Elevated Slab	17	CY		\$ -	Based on 2 ft slab or wall; \$1155/CY; adjusted to 2014 dollars.
Rapid Mixing Tanks					15 ft x 15 ft tank
Slab	17	CY	\$ 740	\$ 12,580	Based on 2 ft slab or wall; \$735/CY; adjusted to 2015 dollars.
Walls	35	CY	\$ 850	\$ 29,750	Based on 2 ft slab or wall; and 2 ft freeboard; \$840/CY; adjusted to 2015 dollars
Elevated Slab	17	CY	\$ 1,170	\$ 19,890	Based on 2 ft slab or wall; \$1155/CY; adjusted to 2015 dollars.
Chemical Storage Containment	15	CY	\$ 1,330	\$ 19,965	Adjusted to 2015 dollars
Equipment Concrete Pads	124	CY	\$ 1,330	\$ 164,920	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 2,250,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 168,750	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 112,500	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 112,500	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 338,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 338,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 3,320,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 664,000	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 3,984,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 796,800	Budget item to cover change orders due to unforeseen conditions

**OPINION OF PROBABLE PROJECT COST**

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Item	2000-gpm RCF System without Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.W. on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Engineering, Legal and Administrative	20%			\$ 796,800	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 5,578,000</b>	Rounded up to \$1000
Low Estimate				\$ 3,905,000	-30%
High Estimate				\$ 8,367,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
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**Estimated Annual O&M Costs for RCF without Recycle**

<b>RCF System Size (gpm)</b>	<b>Residuals Disposal (Sewer)</b>	<b>Chemicals</b>	<b>Labor</b>	<b>Filter Media Replacement</b>	<b>Maintenance and Spare Parts</b>	<b>Electricity</b>	<b>Lab and Field Analysis</b>	<b>Annual O&amp;M (Rounded up to \$1,000)</b>
100	\$ 10,400	\$ 8,800	\$ 137,000	\$ 600	\$ 6,700	\$ 1,700	\$ 20,800	\$ 186,000
500	\$ 37,000	\$ 36,700	\$ 137,000	\$ 2,700	\$ 10,600	\$ 5,800	\$ 31,700	\$ 262,000
1,000	\$ 70,200	\$ 71,700	\$ 137,000	\$ 3,700	\$ 14,700	\$ 12,200	\$ 33,773	\$ 343,000
2000	\$ 136,600	\$ 141,500	\$ 205,000	\$ 6,500	\$ 22,500	\$ 23,400	\$ 63,500	\$ 599,000

Costs are in 2015 dollars.

**OPINION OF PROBABLE PROJECT COST**

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Item	100-gpm RCF System with Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 2,400	\$ 2,400	Quotes from Ryan Herco & Core-Rosion; 70/75 gal PE, outdoor, incl. seismic; in 2015 dollars
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quotes from C.P. Crowley & HTP; 0.21 gph; 1 duty/ 1 stdby; in 2015 dollars
Static Mixer	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2015 dollars
Reduction Tank					
Tank and Mixer	1	EA	\$ 9,600	\$ 9,600	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; in 2015 dollars
NaOCl Feed System					
Storage Tank	1	LS	\$ 600	\$ 600	Quote from Polyprocessing; 55 gal, HDPE, outdoor, incl. seismic, adjusted to 2015 dollars
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 0.06 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars
Static Mixer	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2015 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank and Mixer	1	EA	\$ 9,600	\$ 9,600	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 297,000	\$ 297,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf, (2) 6.5 ft dia VPF, 1 duty/ 1 stdby; adjusted to 2015 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,900	\$ 11,800	Quotes from DTI and Cortech; 55 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars
Filter Feed Pumps (Centrifugal)	2	EA	\$ 5,600	\$ 11,200	Quotes from Cortech & Flow-Systems; 100 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars (Centrifugal)
Polymer Feed Systems					
Polymer Feed System (Coagulant Aid)	1	LS	\$ 29,000	\$ 29,000	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Polymer Feed System (Solids Settling Aid)	1	LS	\$ 11,000	\$ 11,000	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Filtrate Tank for Backwash	1	EA	\$ 28,000	\$ 28,000	Quotes from Core-Rosion & Ryan Herco; 12,500 gal PE, outdoor, incl. seismic; adjusted to 2015 dollars
Backwash Pumps	2	EA	\$ 9,400	\$ 18,800	Quotes from ITT & Cortech; 600 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Residuals Treatment System					
Gravity Thickener	2	EA	\$ 34,000	\$ 68,000	Quote from Plastic-Mart for 13,000-gallon cone bottom tank with stand; adjusted to 2015 dollars
Flo-Trend SludgeMate Container	2	EA	\$ 15,100	\$ 30,200	Quote from Flo-Trend for 6-CY SludgeMate container; adjusted to 2015 dollars
Pumps	1	LS	\$ 10,600	\$ 10,600	Includes all sludge pumps and recycle pumps, one duty and one standby; adjusted to 2015 dollars
<b>Subtotal</b>				<b>\$ 559,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 168,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,330	\$ 3,262	Adjusted to 2015 dollars
Equipment Concrete Pads	62	CY	\$ 1,330	\$ 82,460	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 813,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 60,975	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 40,650	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 40,650	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 122,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 122,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 1,199,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 239,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 1,439,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 287,800	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 287,800	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 2,015,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,411,000	-30%
High Estimate				\$ 3,023,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

<b>Client</b>	City of Glendale
<b>Project</b>	Enhanced RCF Testing for Removing Hexavalent Chromium
<b>Item</b>	500-gpm RCF System with Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<b>FeSO<sub>4</sub> Feed System</b>					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 400/500 gal PE, outdoor, incl. seismic; in 2015 dollars.
Metering Pumps	2	EA	\$ 4,600	\$ 9,200	Quotes from C.P. Crowley & HTP; 1.04 gph; 1 duty/ 1 stdby; in 2015 dollars.
Static Mixer	1	EA	\$ 2,300	\$ 2,300	Quotes from Komax & EWS; 8-inch; adjusted to 2015 dollars.
<b>Reduction Tank</b>					
Tank and Mixer	1	EA	\$ 15,400	\$ 15,400	Quotes from Core-Rosion & Ryan Herco; 2,500 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
<b>NaOCl Feed System</b>					
Storage Tank	1	EA	\$ 1,100	\$ 1,100	Quote from Polyprocessing; 115 gal, HDPE, outdoor, incl. seismic; adjusted to 2015 dollars.
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 0.30 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars.
Static Mixer	1	EA	\$ 2,300	\$ 2,300	Quotes from Komax & EWS; 8-inch; adjusted to 2015 dollars.
<b>Polymer Mixing Tank</b>					
Rapid Mixing Tank and Mixer	1	EA	\$ 15,400	\$ 15,400	Quotes from Core-Rosion & Ryan Herco; 2500 gal PE, outdoor, incl. seismic; in 2015 dollars.
<b>Filters</b>					
Filter Equipment (Pressure Filters)	1	LS	\$ 494,000	\$ 494,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf; Coombs-Hopkins filters, 10' x 24' (4 cells, 3 duty/ 1 stdby); Layne filters, (2) 8' x 22'; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 5,100	\$ 10,200	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Filter Feed Pumps (Centrifugal)	2	EA	\$ 9,000	\$ 18,000	Quotes from Cortech & Flow-Systems; 500 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars. (Centrifugal)
<b>Polymer Feed Systems</b>					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Polymer Feed Systems (Solids Settling Aid)	1	LS	\$ 12,100	\$ 12,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Filtrate Tank for Backwash	1	EA	\$ 42,000	\$ 42,000	Quotes from Superior; 22,000 gal; 15 ft dia x 16 ft height; adjusted to 2015 dollars.
Backwash Pumps	2	EA	\$ 15,200	\$ 30,400	Quotes from ITT & Cortech; 1,050 gpm @ 50 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars.
<b>Residuals Treatment System</b>					
Equalization Tank	1	EA	\$ 129,000	\$ 121,154	Adjusted installed costs from RS Means for 90,000-gal tank, which was divided by 1.3 to exclude installation cost (assuming an installation cost of 30%); adjusted to 2015 dollars.
Plate Settler	1	EA	\$ 62,000	\$ 62,000	Quote from Meurer Research, Inc. and Parkson for a system handles a 26-gpm sludge flow; adjusted to 2015 dollars.
Flo-Trend SludgeMate Container	3	EA	\$ 27,400	\$ 82,200	Quote from Flo-Trend for 15-CY SludgeMate container; adjusted to 2015 dollars.
Pumps	1	LS	\$ 15,900	\$ 15,900	Includes all sludge pumps and recycle pumps, one duty and one standby; adjusted to 2015 dollars.
<b>Subtotal</b>				<b>\$ 959,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 288,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	6	CY	\$ 1,330	\$ 8,638	Adjusted to 2015 dollars
Equipment Concrete Pads	157	CY	\$ 1,330	\$ 208,810	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,465,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 109,875	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 73,250	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 73,250	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 220,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 220,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 2,161,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 432,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 2,593,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 518,600	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 518,600	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 3,631,000</b>	Rounded up to \$1000
Low Estimate				\$ 2,542,000	-30%
High Estimate				\$ 5,447,000	+50%

**Notes:**

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.



**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	1000-gpm RCF System with Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Description	Quantity	Unit	Unit Cost	Total Cost	Notes
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 5,300	\$ 5,300	Quotes from Core-Rosion & Ryan Herco; 685/750 gal PE, outdoor, incl. seismic; in 2015 Dollars.
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quotes from C.P. Crowley & HTP; 2 gph; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Static Mixer	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & Koflo; 10-inch; in 2015 dollars.
Reduction Tank					
Tank and Mixer	1	EA	\$ 29,000	\$ 29,000	Quotes from Core-Rosion & Ryan Herco; 5,000 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
NaOCl Feed System					
Storage Tank	1	EA	\$ 2,800	\$ 2,800	Quote from Polyprocessing; 230/210 gal, HDPE, outdoor, incl. seismic; in 2015 dollars.
Metering Pumps	2	EA	\$ 4,500	\$ 9,000	Quote from Prominent; 0.52 gph, 1 duty/ 1 stdby; in 2015 dollars.
Static Mixer	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & Koflo; 10-inch; in 2015 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank and Mixer	1	EA	\$ 29,000	\$ 29,000	Quotes from Core-Rosion & Ryan Herco; 5,000 gal PE, outdoor, incl. seismic; one mixer is included; in 2015 dollars.
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 599,000	\$ 599,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, 12' x 38' (4 cells, 3 duty/ 1 stdby); Layne filters, (1) 10' x 36', (4 cells, 3 duty/ 1 stdby); in 2015 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 5,300	\$ 10,600	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Filter Feed Pumps (centrifugal)	2	EA	\$ 16,000	\$ 32,000	Quotes from Cortech & Flow-Systems; 1000 gpm @ 70 ft; 1 duty/ 1 stdby; in 2015 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Polymer Feed Systems (Solids Settling Aid)	1	LS	\$ 11,800	\$ 11,800	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars.
Filtrate Tank for Backwash	1	EA	\$ 60,000	\$ 60,000	Quotes from Superior; 43,000 gal; 23' diameter x 16' high ; in 2015 dollars.
Backwash Pumps	2	EA	\$ 22,800	\$ 45,600	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Residuals Treatment System					
Equalization Tank	1	EA	\$ 155,000	\$ 155,000	Use same size tank as the non-recycle option in 2015 dollars.
Plate Settler	1	EA	\$ 68,000	\$ 68,000	Quote from Meurer Research, Inc. and Parkson for a system handles a 44-gpm sludge flow; in 2015 dollars.
Flo-Trend SludgeMate Container	3	EA	\$ 32,350	\$ 97,050	Quote from Flo-Trend for 25-CY SludgeMate container; adjusted to 2015 dollars.
Pumps	1	LS	\$ 19,600	\$ 19,600	Includes all sludge pumps and recycle pumps, one duty and one standby; adjusted to 2015 dollars.
<b>Subtotal</b>				<b>\$ 1,206,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 362,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	9	CY	\$ 1,330	\$ 11,614	Adjusted to 2015 dollars
Equipment Concrete Pads	183	CY	\$ 1,330	\$ 243,390	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,824,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 136,800	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 91,200	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 91,200	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 274,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 274,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 2,691,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 538,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 3,229,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 645,800	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 645,800	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 4,521,000</b>	Rounded up to \$1000
Low Estimate				\$ 3,165,000	-30%
High Estimate				\$ 6,782,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

<b>Client</b>	City of Glendale
<b>Project</b>	Enhanced RCF Testing for Removing Hexavalent Chromium
<b>Item</b>	2000-gpm RCF System with Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
FeSO <sub>4</sub> Feed System					
Storage Tank	1	EA	\$ 8,000	\$ 8,000	Quotes from Core-Rosion & Ryan Herco; 1,400/1,500 gal PE, outdoor, incl. seismic; in 2015 dollars
Metering Pumps	2	EA	\$ 7,000	\$ 14,000	Quotes from C.P. Crowley & HTP; 5 gph; in 2015 dollars
Static Mixer	1	EA	\$ 4,500	\$ 4,500	Quotes from Komax & EWS; 14-inch; adjusted to 2015 dollars
Reduction Tank					
Mixer	1	EA	\$ 18,000	\$ 18,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2015 dollars
NaOCl Feed System					
Storage Tank	1	LS	\$ 2,400	\$ 2,400	Quote from Polyprocessing; 475 gal, HDPE, outdoor, incl. seismic; adjusted to 2015 dollars
Metering Pumps	2	EA	\$ 5,000	\$ 10,000	Quote from Prominent; 1.22 gph, 1 duty/ 1 stdby; adjusted to 2015 dollars
Static Mixer	1	EA	\$ 4,500	\$ 4,500	Quotes from Komax & EWS; 14-inch; adjusted to 2015 dollars.
Polymer Mixing Tanks					
Mixer	1	EA	\$ 18,000	\$ 18,000	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2015 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 1,044,000	\$ 1,044,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, (2) 10' x 42', 4 cells per filter, 3 duty / 1 stdby; Layne filters, (4) 10' x 24', 3 duty/ 1 stdby; adjusted to 2015 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,300	\$ 10,600	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2015 dollars
Filter Feed Pumps (Centrifugal)	3	EA	\$ 21,000	\$ 63,000	Quotes from Cortech & Flow-Systems; 2,000 gpm @ 70 ft; 2 duty/ 1 stdby; in 2015 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 11,100	\$ 11,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Polymer Feed Systems (Solids Settling Aid)	1	LS	\$ 12,100	\$ 12,100	Quotes from Siemens & C.P. Crowley; adjusted to 2015 dollars
Filtrate Tank for Backwash	1	EA	\$ 53,000	\$ 53,000	Quotes from Superior; 30,250 gal; 18 ft dia x 16 ft height; adjusted to 2015 dollars
Backwash Pumps	2	EA	\$ 22,800	\$ 45,600	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2015 dollars
Residuals Treatment System					
Equalization Tank	1	EA	\$ 146,000	\$ 137,385	Adjusted installed costs from RS Means for 280,000-gal tank, which was divided by 1.3 to exclude installation cost (assuming a installation cost of 30%); adjusted to 2015 dollars
Plate Settler	1	EA	\$ 82,000	\$ 82,000	Quote from Meurer Research, Inc. and Parkson for a system handles a 88-gpm sludge flow; adjusted to 2015 dollars
Flo-Trend SludgeMate Container	3	EA	\$ 40,800	\$ 122,400	Quote from Flo-Trend for 40-CY SludgeMate container; adjusted to 2015 dollars
Pumps	1	LS	\$ 23,000	\$ 23,000	Includes sludge pumps and recycle pumps for equalization tank and plate settlers, one duty and one standby; adjusted to 2015 dollars.
<b>Subtotal</b>				<b>\$ 1,684,000</b>	Rounded up to \$1000
Equipment Installation Cost (30% of Equipment)	30%			\$ 506,000	Including tax, freight, installation and manufacturer services.
Reduction Tank					15 ft x 15 ft tank
Slab	17	CY	\$ 740	\$ 12,580	Based on 2 ft slab or wall; adjusted to 2015 dollars.
Walls	35	CY	\$ 850	\$ 29,750	Based on 2 ft slab or wall; and 2 ft freeboard; adjusted to 2015 dollars
Elevated Slab	17	CY	\$ 1,170	\$ 19,890	Based on 2 ft slab or wall; adjusted to 2015 dollars.
Rapid Mixing Tank					15 ft x 15 ft tank
Slab	17	CY	\$ 740	\$ 12,580	Based on 2 ft slab or wall; adjusted to 2015 dollars.
Walls	35	CY	\$ 850	\$ 29,750	Based on 2 ft slab or wall; and 2 ft freeboard; adjusted to 2015 dollars
Elevated Slab	17	CY	\$ 1,170	\$ 19,890	Based on 2 ft slab or wall; adjusted to 2015 dollars.
Chemical Storage Containment	15	CY	\$ 1,330	\$ 19,968	Adjusted to 2015 dollars
Equipment Concrete Pads	281	CY	\$ 1,330	\$ 373,730	Adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 2,708,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 203,100	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 135,400	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 135,400	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 407,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 407,000	PLC and SCADA equipment to control

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	2000-gpm RCF System with Recycle (5-min reduction, with chlorination without aeration, granular media filter)

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

<b>Total Direct Costs</b>				<b>\$ 3,996,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 799,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 4,795,200</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 959,040	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 959,040	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 6,714,000</b>	Rounded up to \$1000
Low Estimate				\$ 4,700,000	-30%
High Estimate				\$ 10,071,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**Estimated Annual O&M Costs for RCF with Recycle**

<b>System Size (gpm)</b>	<b>Residuals Disposal</b>	<b>Chemicals</b>	<b>Labor</b>	<b>Filter Media Replacement</b>	<b>Maintenance and Spare Parts</b>	<b>Electricity</b>	<b>Lab and Field Analysis</b>	<b>Annual O&amp;M (Rounded up to \$1,000)</b>
100	\$ 28,500	\$ 8,900	\$ 210,000	\$ 600	\$ 8,100	\$ 1,700	\$ 38,200	\$ 296,000
500	\$ 142,700	\$ 37,400	\$ 210,000	\$ 2,600	\$ 14,700	\$ 6,100	\$ 53,500	\$ 467,000
1000	\$ 285,400	\$ 73,000	\$ 210,000	\$ 3,700	\$ 18,200	\$ 12,800	\$ 59,864	\$ 663,000
2000	\$ 570,800	\$ 144,300	\$ 273,000	\$ 6,400	\$ 27,100	\$ 24,500	\$ 80,400	\$ 1,127,000

Costs are in 2015 dollars.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	100-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<i>Pretreatment</i>					
Bag Filters	1	LS	\$ 4,400	\$ 4,400	Includes one standby; one quote from 2011 and one from 2015; scaled to 2015\$
<i>Treatment</i>					
Ion Exchange Equipment	1	LS	\$ 156,700	\$ 156,700	Quote from Evoqua for two service vessels and one standby/regen vessel; quote from Envirogen for three service vessels and one standby/regen vessel.
<i>Storage Tanks</i>					
Brine Storage Tank (Fresh 26% Brine)	1	EA	\$ 3,100	\$ 3,100	600 gal, PE, single-wall, incl. seismic; quote from Brine Make-up and Storage Systems
Treated Water Tank ( Brine Dilution)	1	EA	\$ 4,100	\$ 4,100	1200 gal, PE, single-wall, incl. seismic; quote from Brine Make-up and Storage Systems
Diluted Brine Tank (12% Brine)	1	EA	\$ 4,100	\$ 4,100	1200 gal, PE, single-wall, incl. seismic; quote from Brine Make-up and Storage Systems
Slow-Rinse/Clarified Brine Waste Storage Tank	1	EA	\$ 5,100	\$ 5,100	2025 gal, PE, single-wall, incl. seismic; quote from Brine Make-up and Storage Systems
Backwash/Fast-Rinse Waste Storage Tank	1	EA	\$ 5,400	\$ 5,400	2363 gal, PE, single-wall, incl. seismic, quote from Brine Make-up and Storage Systems
Ferrous Sulfate Storage Tank	1	EA	\$ 1,900	\$ 1,900	53 gal, PE, single-wall, incl. seismic, quote from Brine Make-up and Storage Systems
<i>Pumps</i>					
Backwash Pump (Backwash, Fast/Slow Rinse)	2	EA	\$ 15,100	\$ 30,200	29 gpm Backwash Pump, 1 duty/1 standby
Brine Pump (From Brine Storage Tank to either Backwash/Fast-Rinse or Slow-Rinse/Waste Brine Tank)	2	EA	\$ 14,400	\$ 28,800	5 gpm Brine Pump, 1 duty/1 standby
Return Pump (From Fast-Rinse Tank to Wellhead)	2	EA	\$ 15,100	\$ 30,200	20 gpm Return Pump, 1 duty/1 standby
Waste Pump (from Slow-Rinse/Waste Brine Tank to Clarification Tank)	2	EA	\$ 15,100	\$ 30,200	21 gpm Waste Pump
Ferrous Sulfate Pump	2	EA	\$ 4,600	\$ 9,200	12 gph Ferrous Sulfate Pump
Sludge Pump	4	EA	\$ 3,100	\$ 12,400	6 gpm, Sludge and Recycle pumps, 1 duty/1 standby each
Recovered Dewatered Pump	2	EA	\$ 15,100	\$ 30,200	Allow 20 gpm, 1 duty/1 standby
<i>Solids Handling</i>					
Gravity Thickener (Ferrous Iron precipitation)	2	EA	\$ 3,300	\$ 6,600	338 gal cone bottom tank, including stand
Gravity Thickener Blower	2	EA	\$ 793	\$ 1,586	1181 CFM; 0.25 HP; B135 Ultrafan Pak 2000
Dewatering Equipment	2	EA	\$ 39,800	\$ 79,600	5 cy Sludgemate
Polymer Dosing System	1	EA	\$ 12,000	\$ 12,000	0.02 gal/hour
<b>Subtotal</b>				<b>\$ 456,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 136,800	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pads/Containment Wall	39	CY	\$ 1,000	\$ 38,700	Assume pad for all pumps, IX System, Bag Filters, Tanks and Polymer System
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 632,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 47,400	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 31,600	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 31,600	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 94,800	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 94,800	PLC and SCADA equipment to control

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	100-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

<b>Total Direct Costs</b>				<b>\$ 932,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 186,400	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Engineering, Legal and Administrative	20%			\$ 186,400	Includes permits, legal fees and engineering fees for design and construction
Contingency	20%			\$ 186,400	
<b>Project Total</b>				<b>\$ 1,492,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,044,000	-30%
High Estimate				\$ 2,238,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	500-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<i>Pretreatment</i>					
Bag Filters	1	LS	\$ 16,500	\$ 16,500	includes one standby; one quote from 2011 and one from 2015; scaled to 2015\$
<i>Treatment</i>					
Ion Exchange Equipment	1	LS	\$ 378,900	\$ 378,900	Quote from Evoqua for two service vessels and one standby/regen vessel; quote from Envirogen for 13 service vessels and 3 standby/regen vessel.
<i>Storage Tanks</i>					
Brine Storage Tank (fresh 26%)	1	EA	\$ 6,100	\$ 6,100	3000 gallon Brine Tank
Treated Water Tank (for brine dilution)	1	EA	\$ 10,500	\$ 10,500	6000 gallon Treated Water Tank
Diluted Brine Tank (12%)	1	EA	\$ 10,500	\$ 10,500	6000 gallon Diluted Water Tank
Slow-Rinse/Clarified Brine Tank (Waste Storage)	1	EA	\$ 19,400	\$ 19,400	10125 gal Clarifier Brine/Slow Rinse Tank
Backwash/Fast-Rinse Tank (Waste Storage)	1	EA	\$ 22,500	\$ 22,500	11813 gal Backwash/Fast Rinse Tank
Ferrous Sulfate Tank	1	EA	\$ 2,000	\$ 2,000	263 gal Ferrous Sulfate Tank
<i>Pumps</i>					
Backwash Pump (Backwash, Fast/Slow Rinse)	2	EA	\$ 17,000	\$ 34,000	85 gpm Backwash Pump, 1 duty/1 standby
Brine Pump (From Brine Storage Tank to either Backwash/Fast-Rinse or Slow-Rinse/Waste Brine Tank)	2	EA	\$ 15,100	\$ 30,200	25 gpm Brine Pump, 1 duty/1 standby
Return Pump (From Fast-Rinse Tank to Wellhead)	2	EA	\$ 15,100	\$ 30,200	20 gpm Return Pump, 1 duty/1 standby
Waste Pump (from Slow-Rinse/Waste Brine Tank to Clarification Tank)	2	EA	\$ 18,500	\$ 37,000	101 gpm Waste Pump
Ferrous Sulfate Pump	2	EA	\$ 5,000	\$ 10,000	57 gph Ferrous Sulfate Pump
Sludge Pump	4	EA	\$ 3,600	\$ 14,400	29 gpm, Sludge and Recycle pumps, 1 duty/1 standby each
Recovered Dewatered Pump	2	EA	\$ 15,100	\$ 30,200	Allow 20 gpm, 1 duty/1 standby
<i>Solids Handling</i>			\$ -	\$ -	
Gravity Thickener (Ferrous Iron precipitation)	2	EA	\$ 5,200	\$ 10,400	1688 gal cone bottom tank, including stand
Gravity Thickener Blower	2	EA	\$ 1,541	\$ 3,082	5905 CFM; 1.5 HP; B222 Ultrafan Pak 2000
Dewatering Equipment	2	EA	\$ 102,300	\$ 204,600	25 cy Sludgemate
Polymer Dosing System	1	EA	\$ -	\$ 12,000	0.11 gal/hour
<b>Subtotal</b>				<b>\$ 883,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 264,900	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pads/Containment Wall	115	CY	\$ 1,000	\$ 114,800	Assume pad for all pumps, IX System, Bag Filters, Tanks and Polymer System

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	500-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,263,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 94,800	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 63,200	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 63,200	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 189,500	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 189,500	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 1,863,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 372,600	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Engineering, Legal and Administrative	20%			\$ 372,600	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 2,609,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,826,000	-30%
High Estimate				\$ 3,914,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.



**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	1,000-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<i>Pretreatment</i>					
Bag Filters	1	LS	\$ 27,100	\$ 27,100	Includes one standby; one quote from 2011 and one from 2015; scaled to 2015\$
<i>Treatment</i>					
Ion Exchange Equipment	1	LS	\$ 575,100	\$ 575,100	Quote from Evoqua for two PTISSA120x96 systems; quote from Envirogen for 13 service vessels and 3 standby/regen vessels.
<i>Storage Tanks</i>					
Brine Storage Tank (fresh 26%)	1	EA	\$ 10,500	\$ 10,500	6000 gallon Brine Tank
Treated Water Tank (for brine dilution)	1	EA	\$ 22,500	\$ 22,500	12000 gallon Treated Water Tank
Diluted Brine Tank (12%)	1	EA	\$ 22,500	\$ 22,500	12000 gallon Diluted Water Tank
Slow-Rinse/Clarified Brine Tank (Waste Storage)	1	EA	\$ 44,500	\$ 44,500	20250 gal Clarifier Brine/Slow Rinse Tank, RFP
Backwash/Fast-Rinse Tank (Waste Storage)	1	EA	\$ 46,000	\$ 46,000	23625 gal Backwash/Fast Rinse Tank, RFP
Ferrous Sulfate Tank	1	EA	\$ 2,700	\$ 2,700	525 gal Ferrous Sulfate Tank
<i>Pumps</i>					
Backwash Pump (Backwash, Fast/Slow Rinse)	2	EA	\$ 20,500	\$ 41,000	151 gpm Backwash Pump, 1 duty/1 standby
Brine Pump (From Brine Storage Tank to either Backwash/Fast-Rinse or Slow-Rinse/Waste Brine Tank)	2	EA	\$ 17,000	\$ 34,000	50 gpm Brine Pump, 1 duty/1 standby
Return Pump (From Fast-Rinse Tank to Wellhead)	2	EA	\$ 15,100	\$ 30,200	20 gpm Return Pump, 1 duty/1 standby
Waste Pump (from Slow-Rinse/Waste Brine Tank to Clarification Tank)	2	EA	\$ 20,200	\$ 40,400	201 gpm Waste Pump
Ferrous Sulfate Pump	2	EA	\$ 6,400	\$ 12,800	1.88 gpm Ferrous Sulfate Pump
Sludge Pump	4	EA	\$ 5,100	\$ 20,400	57 gpm, Sludge and Recycle pumps, 1 duty/1 standby each
Recovered Dewatered Pump	2	EA	\$ 15,100	\$ 30,200	Allow 20 gpm, 1 duty/1 standby
<i>Solids Handling</i>			\$ -	\$ -	
Gravity Thickener (Ferrous Iron precipitation)	2	EA	\$ 9,700	\$ 19,400	3375 gal cone bottom tank, including stand
Gravity Thickener Blower	2	EA	\$ 1,541	\$ 3,082	5905 CFM; 1.5 HP; B222 Ultrafan Pak 2000
Dewatering Equipment	2	EA	\$ 172,200	\$ 344,400	50 cy Sludgemate. Factored.
Polymer Dosing System	1	EA	\$ -	\$ 12,000	0.22 gal/hour
<b>Subtotal</b>				<b>\$ 1,339,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 401,700	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pads/Containment Wall	184	CY	\$ 1,000	\$ 184,400	Assume pad for all pumps, IX System, Bag Filters, Tanks and Polymer System
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,926,000</b>	Rounded up to \$1000

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	1,000-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

General Requirements	7.5%			\$ 144,500	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 96,300	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 96,300	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 288,900	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 288,900	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 2,841,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 568,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Engineering, Legal and Administrative	20%			\$ 568,200	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 3,978,000</b>	Rounded up to \$1000
Low Estimate				\$ 2,785,000	-30%
High Estimate				\$ 5,967,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	2,000-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
<b>Equipment</b>					
<i>Pretreatment</i>					
Bag Filters	1	LS	\$ 46,900	\$ 46,900	includes one standby; one quote from 2011 and one from 2015; scaled to 2015\$
Ion Exchange Equipment	1	LS	\$ 1,126,000	\$ 1,126,000	Quote from Evoqua for 3 service vessels and one standby/regen vessel; quote from Envirogen for 26 service vessels and 6 standby/regen vessels.
<i>Storage Tanks</i>					
Brine Storage Tank (fresh 26%)	1	EA	\$ 14,300	\$ 14,300	8000 gallon Brine Tank
Treated Water Tank (for brine dilution)	1	EA	\$ 39,300	\$ 39,300	16000 gallon Treated Water Tank
Diluted Brine Tank (12%)	1	EA	\$ 39,300	\$ 39,300	16000 gallon Diluted Water Tank
Slow-Rinse/Clarified Brine Tank (Waste Storage)	1	EA	\$ 92,800	\$ 92,800	40500 gal Clarifier Brine/Slow Rinse Tank, FRP
Backwash/Fast-Rinse Tank (Waste Storage)	1	EA	\$ 97,900	\$ 97,900	42000 gal Backwash/Fast Rinse Tank, FRP
Ferrous Sulfate Tank	1	EA	\$ 3,600	\$ 3,600	1049 gal Ferrous Sulfate Tank
<i>Pumps</i>					
Backwash Pump (Backwash, Fast/Slow Rinse)	2	EA	\$ 25,500	\$ 51,000	236 gpm Backwash Pump, 1 duty/1 standby
Brine Pump (From Brine Storage Tank to either Backwash/Fast-Rinse or Slow-Rinse/Waste Brine Tank)	2	EA	\$ 16,900	\$ 33,800	67 gpm Brine Pump, 1 duty/1 standby
Return Pump (From Fast-Rinse Tank to Wellhead)	2	EA	\$ 15,000	\$ 30,000	20 gpm Return Pump, 1 duty/1 standby
Waste Pump (from Slow-Rinse/Waste Brine Tank to Clarification Tank)	2	EA	\$ 20,100	\$ 40,200	268 gpm Waste Pump
Ferrous Sulfate Pump	2	EA	\$ 7,700	\$ 15,400	2.5 gpm Ferrous Sulfate Pump
Sludge Pump	4	EA	\$ 5,100	\$ 20,400	75 gpm, Sludge and Recycle pumps, 1 duty/1 standby each
Recovered Dewatered Pump	2	EA	\$ 15,000	\$ 30,000	Allow 20 gpm, 1 duty/1 standby
<i>Solids Handling</i>			\$ -	\$ -	
Gravity Thickener (Ferrous Iron precipitation)	2	EA	\$ 11,000	\$ 22,000	4500 gal cone bottom tank, including stand
Gravity Thickener Blower	2	EA	\$ 1,841	\$ 3,682	11809 CFM; 2.68 HP; B3330 Ultrafan Pak 2000
Dewatering Equipment	4	EA	\$ 171,700	\$ 686,800	100 cy Sludgemate. Assume 50 cy containers
Polymer Dosing System	1	EA	\$ 12,000	\$ 12,000	0.3 gal/hour
<b>Subtotal</b>				<b>\$ 2,406,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 721,800	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pads/Containment Wall	274	CY	\$ 1,000	\$ 274,100	Assume pad for all pumps, IX System, Bag Filters, Tanks and Polymer System
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 3,402,000</b>	Rounded up to \$1000

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	2,000-gpm SBA System

Hazen and Sawyer Project No. 20002-004	
By Y.W. & C.P.	Updated by M.P.
Date: Dec. 2014	Date: May 2015

General Requirements	7.5%			\$ 255,200	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 170,100	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 170,100	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 510,300	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 510,300	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 5,018,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 1,003,600	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Engineering, Legal and Administrative	20%			\$ 1,003,600	Includes permits, legal fees and engineering fees for design and construction
<b>Project Total</b>				<b>\$ 7,026,000</b>	Rounded up to \$1000
Low Estimate				\$ 4,918,000	-30%
High Estimate				\$ 10,539,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**Estimated Annual O&M Costs for SBA**

Sulfate = 50 mg/L

System Flow Rate (gpm)	Electricity	Chemicals	Resin Replacement (Fresh Resin and Spent Resin Disposal)	Residuals Disposal (Brine and Wastewater)	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M (Rounded up to \$1000)
100	\$ 2,318	\$ 1,354	\$ 2,290	\$ 9,394	\$ 136,500	\$ 1,632	\$ 5,630	\$ 29,616	\$ 189,000
500	\$ 6,043	\$ 6,768	\$ 11,452	\$ 31,850	\$ 136,500	\$ 1,632	\$ 9,364	\$ 29,616	\$ 233,000
1000	\$ 10,700	\$ 13,537	\$ 22,904	\$ 59,919	\$ 136,500	\$ 1,632	\$ 13,851	\$ 29,616	\$ 289,000
2000	\$ 20,013	\$ 27,074	\$ 45,808	\$ 116,059	\$ 136,500	\$ 1,632	\$ 22,226	\$ 39,153	\$ 408,000

Sulfate = 110 mg/L

System Flow Rate (gpm)	Electricity	Chemicals	Resin Replacement (Fresh Resin and Spent Resin Disposal)	Residuals Disposal (Brine and Wastewater)	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M (Rounded up to \$1000)
100	\$ 2,348	\$ 1,679	\$ 2,290	\$ 10,908	\$ 136,500	\$ 1,632	\$ 5,630	\$ 36,406	\$ 197,000
500	\$ 6,193	\$ 8,397	\$ 11,452	\$ 39,422	\$ 136,500	\$ 1,632	\$ 9,364	\$ 36,406	\$ 249,000
1000	\$ 10,999	\$ 16,795	\$ 22,904	\$ 75,064	\$ 136,500	\$ 1,632	\$ 13,851	\$ 36,406	\$ 314,000
2000	\$ 20,611	\$ 33,589	\$ 45,808	\$ 146,348	\$ 136,500	\$ 1,632	\$ 22,226	\$ 49,339	\$ 456,000

Costs are in 2015 dollars.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	100-gpm WBA System

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Description	Quantity	Unit	Unit Cost	Total Cost	Notes
<b>Equipment</b>					
CO <sub>2</sub> Feed System	1	LS	\$ 164,000	\$ 164,000	Quote from TOMCO; 15 lb/hr PSF and 6 ton storage; adjusted to 2015 dollars.
CO <sub>2</sub> Feed Water Pump	2	EA	\$ 7,600	\$ 15,200	Quote from ITT; centrifugal; 15 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2015 dollars.
Static Mixer	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2015 dollars.
Bag Filters	2	EA	\$ 2,200	\$ 4,400	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Ion Exchange Equipment	1	LS	\$ 65,000	\$ 65,000	Quotes from Evoqua, not including first fill of resin; adjusted to 2015 dollars.
Booster Pump	2	EA	\$ 8,200	\$ 16,400	Quote from ITT, 100 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2015 dollars.
Antiscalant Feed System for Aeration	1	LS	\$ 7,000	\$ 7,000	Including one 60-gal storage tank and two chemical pumps. Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdby; adjusted to 2015 dollars
Aeration Equipment	1	EA	\$ 105,000	\$ 105,000	Quote from CECO and JAWS; 18-24/30" tower; in 2015 dollars.
<b>Subtotal</b>				<b>\$ 378,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 113,400	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,330	\$ 2,660	\$1330/CY, adjusted to 2015 dollars
Equipment Concrete Pad	52	CY	\$ 1,330	\$ 69,500	\$1330/CY, adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 564,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 42,300	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 28,200	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 28,200	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 85,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 85,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 833,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 166,600	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 999,600</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 199,920	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 199,920	Includes permits, legal fees and engineering fees for design and construction
Initial Fill of Resin	1	LS	\$ 33,000	\$ 33,000	Including tax, freight, installation and manufacturer services.
<b>Project Total</b>				<b>\$ 1,433,000</b>	Rounded up to \$1000
Low Estimate				\$ 1,003,000	-30%
High Estimate				\$ 2,150,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	500-gpm WBA System

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Description	Quantity	Unit	Unit Cost	Total Cost	Notes
<b>Equipment</b>					
CO <sub>2</sub> Feed System	1	LS	\$ 202,000	\$ 202,000	Quote from TOMCO; 75 lb/hr PSF and 14 ton storage; adjusted to 2015 dollars.
CO <sub>2</sub> Feed Water Pump	2	EA	\$ 8,000	\$ 16,000	Quote from ITT; centrifugal; 75 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2015 dollars.
Static Mixer	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & EWS; 8-inch; adjusted to 2015 dollars.
Bag Filters	2	EA	\$ 10,000	\$ 20,000	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Ion Exchange Equipment	1	LS	\$ 253,000	\$ 253,000	Quotes from Evoqua, not including first fill of resin; adjusted to 2015 dollars.
Booster Pump	2	EA	\$ 12,000	\$ 24,000	Quote from ITT, 500 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2015 dollars.
Antiscalant Feed System for Aeration	1	LS	\$ 8,000	\$ 8,000	Including one 120-gal storage tank and two chemical pumps. Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/1 stdby; adjusted to 2015 dollars
Aeration Equipment	1	EA	\$ 153,000	\$ 153,000	Quote from CECO and JAWS; 54-60/72" tower; in 2015 dollars.
<b>Subtotal</b>				<b>\$ 682,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 204,600	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,330	\$ 2,660	\$1330/CY, adjusted to 2015 dollars
Equipment Concrete Pad	157	CY	\$ 1,330	\$ 209,000	\$1330/CY, adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,099,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 82,425	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 54,950	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 54,950	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 165,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 165,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 1,621,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 324,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 1,945,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 389,000	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 389,000	Includes permits, legal fees and engineering fees for design and construction
Initial Fill of Resin	1	LS	\$ 164,000	\$ 164,000	Including tax, freight, installation and manufacturer services.
<b>Project Total</b>				<b>\$ 2,887,000</b>	Rounded up to \$1000
Low Estimate				\$ 2,021,000	-30%
High Estimate				\$ 4,331,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	1000-gpm WBA System

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Description	Quantity	Unit	Unit Cost	Total Cost	Notes
<b>Equipment</b>					
CO <sub>2</sub> Feed System	1	LS	\$ 250,000	\$ 250,000	Quote from TOMCO; 150 lb/hr PSF and 25 ton storage; in 2015 dollars.
CO <sub>2</sub> Feed Water Pump	2	EA	\$ 7,200	\$ 14,400	Quote from Cortech; centrifugal; 153 gpm @ 80 psi; 1 duty/1 stdby
Static Mixer	1	EA	\$ 5,900	\$ 5,900	Quotes from Komax & KOFLO; 10-inch.
Bag Filters	2	EA	\$ 19,600	\$ 39,200	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; in 2015 dollars.
Ion Exchange Equipment	1	LS	\$ 301,500	\$ 301,500	Quotes from Evoqua and Calgon, not including first fill of resin; in 2015 dollars.
Booster Pump	2	EA	\$ 14,500	\$ 29,000	Quote from ITT, 1000 gpm @ 15 ft; 1 duty/1 stdby
Antiscalant Feed System for Aeration	1	LS	\$ 7,000	\$ 7,000	Including one 60-gal storage tank and two chemical pumps. Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdby; adjusted to 2014 dollars
Aeration Equipment	1	LS	\$ 200,000	\$ 200,000	Quote from CECO and JAWS; 72/96" tower; in 2015 dollars.
<b>Subtotal</b>				<b>\$ 847,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 254,100	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	1	CY	\$ 1,330	\$ 1,330	\$1330/CY, adjusted to 2015 dollars
Equipment Concrete Pad	177	CY	\$ 1,330	\$ 234,778	\$1250/CY, adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 1,338,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 100,350	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 66,900	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 66,900	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 201,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 201,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 1,974,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 394,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 2,369,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 473,800	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 473,800	Includes permits, legal fees and engineering fees for design and construction
Initial Fill of Resin	1	LS	\$ 328,000	\$ 328,000	Including tax, freight, installation and manufacturer services.
<b>Project Total</b>				<b>\$ 3,645,000</b>	Rounded up to \$1000
Low Estimate				\$ 2,552,000	-30%
High Estimate				\$ 5,468,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.



**OPINION OF PROBABLE PROJECT COST**

Client	City of Glendale
Project	Enhanced RCF Testing for Removing Hexavalent Chromium
Item	2000-gpm WBA System

Hazen and Sawyer Project No. 20002-004
Based on the costs in Blute et al. 2013b.
Updated by Y.Wu on 3/13/2014.
Updated by M. Santos on 3/25/2015.

Description	Quantity	Unit	Unit Cost	Total Cost	Notes
<b>Equipment</b>					
CO <sub>2</sub> Feed System	1	LS	\$ 292,000	\$ 292,000	Quote from TOMCO; 300 lb/hr and 50 ton storage; adjusted to 2015 dollars.
CO <sub>2</sub> Feed Water Pump	2	EA	\$ 9,200	\$ 18,400	Quote from ITT; centrifugal; 305 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2015 dollars.
Static Mixer	1	EA	\$ 9,500	\$ 9,500	Quotes from Komax & EWS; 14-inch; adjusted to 2015 dollars.
Bag Filters	2	EA	\$ 30,100	\$ 60,200	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2015 dollars.
Ion Exchange Equipment	1	LS	\$ 692,000	\$ 692,000	Quotes from Evoqua, not including first fill of resin; adjusted to 2015 dollars.
Antiscalant Feed System for Aeration	1	LS	\$ 8,000	\$ 8,000	Including one 120-gal storage tank and two chemical pumps. Quotes from C.P. Crowley & HTP; 1.3 gph; 1 duty/ 1 stdby; adjusted to 2015 dollars
Aeration Equipment	1	EA	\$ 302,000	\$ 302,000	Quote from CECO and JAWS; 108/144" tower; in 2015 dollars.
<b>Subtotal</b>				<b>\$ 1,433,000</b>	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 429,900	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,330	\$ 2,660	\$1330/CY, adjusted to 2015 dollars
Equipment Concrete Pad	270	CY	\$ 1,330	\$ 359,400	\$1330/CY, adjusted to 2015 dollars
<b>Subtotal (Installed Equipment Costs)</b>				<b>\$ 2,225,000</b>	Rounded up to \$1000
General Requirements	7.5%			\$ 166,875	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 111,250	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 111,250	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 334,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 334,000	PLC and SCADA equipment to control
<b>Total Direct Costs</b>				<b>\$ 3,282,000</b>	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 656,400	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
<b>Construction Total</b>				<b>\$ 3,938,000</b>	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 787,600	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 787,600	Includes permits, legal fees and engineering fees for design and construction
Initial Fill of Resin	1	LS	\$ 658,000	\$ 658,000	Including tax, freight, installation and manufacturer services.
<b>Project Total</b>				<b>\$ 6,172,000</b>	Rounded up to \$1000
Low Estimate				\$ 4,320,000	-30%
High Estimate				\$ 9,258,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2015 dollars.
3. Costs for land or easements are not included.

**Estimated Annual O&M Costs for WBA with Purolite S106 Resin**

System Size (gpm)	Electricity*	Chemicals	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis &	Annual O&M (Rounded up to \$1000)
100	\$ 2,300	\$ 11,200	\$ 12,300	\$ 11,600	\$ 42,000	\$ 130	\$ 5,600	\$ 27,871	\$ 113,000
500	\$ 11,700	\$ 56,126	\$ 34,700	\$ 37,000	\$ 42,432	\$ 540	\$ 11,000	\$ 27,871	\$ 221,000
1000	\$ 28,000	\$ 112,100	\$ 62,629	\$ 68,758	\$ 42,432	\$ 1,100	\$ 13,400	\$ 27,871	\$ 356,000
2000	\$ 43,000	\$ 224,503	\$ 115,000	\$ 132,240	\$ 68,951	\$ 1,600	\$ 22,300	\$ 47,651	\$ 655,000

\* Electricity does not include power for aeration off-gas treatment. Estimated costs were \$700, \$11,000 and \$22,000 for 100, 500 and 2000 gpm, respectively.

& Lab and field analysis does not include cost for aeration off-gas analysis.

Costs are in 2015 dollars.