4.4.3 Disposal of Scrubber Wastes

The total quantities of scrubber waste that would be produced annually are 327, 800 tons and 44, 500 tons for the eight utility and four industrial sites considered in this study (Tables 32 and 37), respectively. In addition, approximately 9, 700 tons of purge water would be produced and would likely require disposal if the three industrial sites indicated were to use the double alkali process. The estimated characteristics of the filtered waste containing approximately 70 percent solids are shown in Table 33.

Current regulations do not address the disposal of scrubber wastes in landfills. Since it is not clear whether the disposal of these wastes would be allowed in Class II sites, which are located throughout the Los Angeles area, disposal in Class I sites was considered. This was done for purposes of this feasibility study for several reasons: (1) Without question, Class I landfills can accept the solids and purge liquids produced and (2) they provide a basis for estimating disposal costs. In addition to the disposal costs reported in Section 4. 5. 3, the impact, which was considered relatively minimal, of disposing the anticipated quantities of wastes on the lifetimes of the two Los Angeles area landfills is presented.

4.5 SCRUBBER SYSTEM COSTS

Scrubber system capital and annualized costs applicable to late 1977 were developed. The results as well as the sources of information and computational methods are described in the following paragraphs.

4.5.1 Capital Costs

4.5.1.1 Electrical Utility Installations

Capital cost estimates (in late 1977 dollars) for new-plant (grass roots) scrubber installations were received from various scrubber suppliers for utility and industrial units. These costs are summarized in Table 63. They were of a budgetary nature and differed somewhat in the depth of detail that was included in identifying equipment and estimating its cost. These estimates were corrected to a common base (as shown in subsequent paragraphs) to reflect total capital investment prior to considering retrofit and redundancy factors.

The major items that were included, as well as excluded, in the estimate are indicated in Table 63. In order to adjust them to a common base and also to reflect total capital investment, i.e., owner costs, applicable factors based on the data presented in Table 64, which was derived from Ref. 11, were applied. Application of these factors is reflected in Table 63 and identified as "grass-roots installation, owner's total capital investment". Further, to reflect the effect of retrofitting and redundancy, additional factors were applied to the owner's costs for the grass-roots installations. The basis for retrofit complexity and redundancy factors was from 10 to 40 percent greater than for a new installation (Ref. 12). Three discrete increments were computed: 10, 25, and 40 percent (Table 65). Because the retrofit complexity was considered to affect the cost of the entire installation, the increments were applied to the entire amount of the grass-roots capital investment, whereas the redundancy increments were applied to the FGD capital equipment only. The increment was then added to the grass-roots values in Table 63 and presented in Table 66.

TABLE 63. SCRUBBER SUPPLIER CAPITAL COST ESTIMATES: UTILITY INSTALLATIONS

New facility basis, late 1977 dollars

Installation	Generating capacity, MW	Scrubber supplier capital cost estimates				Grass roots installation, owner's total capital investment			
		A[a] (000,000)	A,[a] $/kW	B[b] (000,000)	B,[b] $/kW	A[a] (000,000)	A,[a] $/kW	B[b] (000,000)	B,[b] $/kW
Southern California Edison									
Alamitos	1,950	45.3	23.2	132.8	68.1	177.0	90.6	179.4	92.0
El Segundo	1,020	29.6	29.0	76.5	75.0	115.6	113.3	103.4	101.4
Etiwanda	904	24.9	27.5	74.7	82.6	97.3	107.4	100.9	111.6
Huntington Beach	870	24.5	28.2	69.0	79.3	95.7	110.2	93.2	107.1
Redondo Beach	1,532	40.4	26.4	94.1[c]	71.8	157.8	103.1	148.6	97.0
Ormond Beach	1,600	41.7	26.1	98.8	61.8	162.9	102.0	133.5	83.4
Los Angeles Department of Water and Power									
Haynes	1,606	41.7	26.0	65.4[d]	57.1	162.9	101.6	123.9	77.1
Valley	533	16.1	30.2	28.6[e]	86.4	62.9	118.0	62.2	116.7

[a] Estimate includes: sulfur dioxide spray tower scrubbers and ducts including mist eliminators, effluent hold tanks, agitators and pumps, booster fans, pumps, motors, dewatering equipment, structural support, and field erection and startup services.
Estimate does not include: reheater, alkali preparation and storage, ductwork, dampers and expansion joints from air preheater to booster fans, waste solids conveying, buildings or enclosures, site preparation, and civil or foundation work.

[b] Estimate includes: sulfur dioxide spray tower scrubbers (including integral recirculation tank and mist eliminators), ductwork, booster fan outlets, scrubber inlets and outlets, dampers and expansion joints, flue gas reheaters (indirect steam), booster fans, pumps, motors, piping and valves, tanks and agitators, lime preparation systems, dewatering equipment, insulation, structural support steel, instrumentation and controls, electrical design and equipment, systems engineering, and field erection and startup services.
Estimate does not include: ductwork, dampers and expansion joints from air preheater to booster fans, lime storage silos and receiving equipment, waste solids conveying, buildings or enclosures, site preparation, and civil or foundation work.

[c] For 1310 MW (Units 5 through 8).

[d] For 1146 MW.

[e] For 331 MW.

TABLE 64. TOTAL CAPITAL INVESTMENT

From Ref. 11

Construction items	Percent of direct investment	Percent of total capital investment	
		Electrical utility	Industrial
Direct investment			
FGD equipment	42.0[a]	25.6	27.6
Concrete	7.0	4.3	4.6
Civil/structural/ architectural	14.0	8.5	9.2
Piping	8.0	4.9	5.2
Control instrumentation	3.5	2.1	2.3
Electrical equipment	8.5	5.2	5.6
Field distributables[g]	17.0	10.4	11.2
Subtotal direct investment	100.0	61.0	65.7
Additional items			
Fee	10.0	6.1	6.6
Contingency	20.0	12.2	13.1
Sales tax[b]	2.0	1.2	1.3
AFDC[c]	9.0	5.5	2.2
Other owner's costs	7.0	4.3	4.6
Escalation during construction	9.6[d]	5.8	2.3
Waste holding pond[e]	0.1	0.061	0.065
Waste conveyor[e]	0.4	0.24	0.26
New stack or stack liner[f]	6.0	3.6	3.9
Total capital investment	164.1	100.0	100.0

[a] Includes lime storage facility - chemical treatment of waste (5 percent included in EPRI Report AF-342 was deducted)

[b] California sales tax on material, 6 percent; estimated as 2 percent of equipment

[c] Allowance for funds during construction, 33 months for electrical utility and 12 months for industrial 3.3 percent;(prorated from 16 percent for 58 months for power plant construction, EPRI Report AF-342)

[d] Based on 7 percent per year. Substitute 3.5 percent for industrial

[e] Ref. 10

[f] Ref. 12

[g] Includes temporary facilities, tools, and equipment required during construction

TABLE 65. RETROFIT AND EQUIPMENT REDUNDANCY COST INCREMENTS

Retrofit,[a] percent	Redundancy		Total increase,[c] percent
	Percent of FGD[b]	Percent of total[a]	
Electrical utility installations			
10	10	2.6	12.6
25	25	6.4	31.4
40	40	10.1	50.4
Industrial installations			
10	10	2.8	12.8
25	25	6.9	31.9
40	40	11.0	51.0

[a] Percent of total capital investment (see Table 64).

[b] Percent of FGD equipment capital cost (see Table 64).

[c] Percentage increment to be added to grass roots installation, owner's total capital investment (see Table 63).

Since the scope of the study was limited, feasibility factors relating to retrofit complexity were not uniquely identified but were included in the complexity factor discussed above and included items such as relocation of existing equipment to accommodate the scrubbers, rerouting underground facilities, complex ducting and damper installations leading into the scrubber and to the chimney, stacking equipment vertically, long pipe runs between scrubber and absorbent preparation site and scrubber and dewatering location, and rerouting existing roads.

For redundancy considerations, specific equipment items for standby purposes were not uniquely identified. The range of 10 to 40 percent for redundancy is expected to cover items such as spare pumps, filters, absorbent handling, and processing equipment, as well as additional components and features built within the scrubber to achieve a significant improvement in reliability without the use of redundant scrubber towers.

Spares of scrubber modules and thickeners, in particular, were not specifically included because of the low average daily capacity factor of the electrical generating units. Improvements in equipment design methods by the scrubber suppliers and availability of the modules for periodic inspection and maintenance would be expected to reduce the need for spare scrubber modules. In addition, the multiple thickener installations at all sites and the multiple scrubber installation for certain units are also expected to provide a measure of redundancy at a reduced level of operation. Strategies to define equipment redundancy for various modes of operation were outside the scope of this study.

The range of costs, based on a 10 to 40 percent retrofit-redundancy factor, is shown in Table 66. This results in an average of $135 per kilowatt for the utility installations. Midrange average values (for a 25 percent, each, retrofit-redundancy factor) were used for all utility installations except El Segundo and Redondo Beach. Because of the limited space available for scrubber installations and the resultant complexity, a 40 percent factor was applied to compute total capital investment on these

TABLE 66. UTILITY SO_2 SCRUBBER TOTAL CAPITAL INVESTMENT

Late 1977 dollars

Installation	Generating capacity,[a] MW	Average capacity factor, 1976	Grass roots installation, owner's capital investment, \$/kW[b] (average)	Total capital investment			
				Maximum[c] \$/kW	Minimum[c] \$/kW	Average[c] \$/kW	Average[d] \$(000,000)
Southern California Edison							
Alamitos	1,950	0.442	91.3	138.1	103.4	120.6	235.2
El Segundo	1,020	0.444	107.4	161.5	120.9	161.5[e]	164.7[e]
Etiwanda	904	0.498	109.5	164.7	123.3	143.9	130.1
Huntington Beach	870	0.434	108.6	163.3	122.3	142.7	124.2
Ormond Beach	1,600	0.454	92.7	139.4	104.4	121.8	194.9
Redondo Beach	1,310 292	0.451[f] 0.15	100.0	150.4	112.6	150.4[e]	197.0[e] 43.9
Los Angeles Department of Water and Power							
Haynes	1,633	0.667	89.4	134.4	100.7	117.5	191.9
Valley	526	0.158	117.4	176.6	132.3	154.3	81.2
Average	--	--	102.01	153.5	115.0	134.9[g]	--

[a]Total generating capacity 10,105 MW

[b]See Table 63

[c]Maximum capital investment includes +40 percent for retrofit and +40 percent for redundancy
Minimum capital costs include +10 percent for retrofit and +10 percent for redundancy
Average capital costs include +25 percent for retrofit and +25 percent for redundancy

[d]Total capital investment is \$1.363 billion

[e]Maximum retrofit and redundancy factors used because of installation complexity

[f]0.451 applies to Units 5 through 8; 0.15 applies to Units 1 through 4

[g]Weighted average

two sites. The $135 per kilowatt represents a total capital cost of $1363 million for the eight utilities. Thirty-three months were estimated for installation and startup.

4.5.1.2 Industrial Installations

Factors similar to the utility installations were applied to industrial process grass-roots capital costs. Industrial capital costs differed only in cost items related to construction, viz., allowance for funds during construction (AFDC) and escalation during construction (Tables 64 and 65). Approximately 12 months were estimated as required for installation and startup.

Capital costs supplied by scrubber suppliers, total capital investment, and the effect of retrofit-redundancy factors are summarized in Table 67. These totaled $82.6 million for the four facilities and were based on average complexity except for the Great Lakes installation, where the maximum complexity-redundancy factors were used because of space constraints.

Capital costs for the double alkali scrubber process were used for all the industrial sites except for the Stauffer sulfuric acid installation as they tended to be somewhat lower than the lime scrubbers. Costs of non-regenerable lime scrubbers were used for the Stauffer units because a single small scrubber was applicable and its size was below the double alkali supplier's product line. It is believed that the higher lime system costs for the three larger installations were due to the modular design approach associated with the specific supplier, which generally resulted in multiple units to handle the gas flows. It is expected that the multiple unit concept could provide a measure of redundancy for the supplier-quoted costs and would not require the same 10 to 40 percent factor applied to the single-unit installation and that the total capital investment for the two systems would be comparable. Although the scope of this study did not include the economic evaluation of alternative systems, it is believed that the capital costs (as adjusted in this study) would be typical of either process when compared on an equivalent retrofit-redundancy basis.

TABLE 67. INDUSTRIAL PROCESS SO_2 SCRUBBER CAPITAL INVESTMENT

Late 1977 dollars

Installation and No. of units	Supplier capital cost estimate, \$(000, 000)	Grass roots installation, owner's total capital investment, \$(000, 000)	Total capital investment, \$(000, 000)		
			Maximum[a]	Minimum[a]	Average[a]
Carbon monoxide boiler--Chevron (1)	2.6[b, c]	9.4	14.1	10.6	12.4
Coke kilns--Great Lakes Carbon (3)	2.8[b, c] (each)	30.4	45.7	34.2	39.9
Coke kiln--Martin Marietta Carbon (1)	2.8[b, c]	10.1	15.2	11.4	13.3
Sulfuric acid units--Stauffer Chemical (3)	0.78[d] (each)	8.5	12.8	9.6	11.2
Total	--	--	--	--	82.6[e]

[a] Maximum based on +40 percent retrofit and +40 percent redundancy factors (see Table 65). Minimum based on +10 percent retrofit and +10 percent redundancy factors. Average based on +25 percent retrofit and +25 percent redundancy factors.

[b] Double alkali process

[c] Includes \$100,000 for reheat heat exchanger estimated from Ref. 10. Adjusted to late 1977 dollars.

[d] Lime scrubbing process

[e] Maximum retrofit and redundancy factors used for Great Lakes Carbon installation because of installation complexity

4.5.2 Scrubbing Costs and Annualized Costs

Costs of operation and maintenance, as well as annualized charges, were computed for each of the installations. Unit costs are shown in Table 68. Waste disposal costs, which were also included, are discussed in greater detail in Section 4.5.3. The annual capital charges for a 20-year life were computed as 19 percent of capital costs (Table 69), based on a 9 percent interest rate. The 19 percent includes taxes and insurance, which were estimated as approximately 5 percent of investment costs annually. The operating and annualized costs for each of the facilities are detailed in Appendix C. A summary of the annualized charges totalling $339.3 million and $21.1 million are provided in Tables 70 and 71 for the utility and industrial processes, respectively.

For the midrange average capital investment of $135 per kilowatt, an average annualized cost of 8.8 mills/kWh was determined for the utility scrubber system operation. Since fuel oil with 0.5 percent was considered as being burned (in contrast to 0.25 percent currently in use), a credit of 1.0 mill/kWh ($0.70 per barrel) was applied, resulting in 7.8 mills/kWh net increase in utility annualized costs. The 7.8 mills/kWh is equivalent to approximately $3600 per ton of SO_2 removed, $5.59 per barrel of oil or $0.91 per million Btu heat input.

For those utility sites where the age of the generating facilities made it questionable that a 20-year life remained and which had a low capacity factor (i.e., Redondo Units 1 through 4 and the Valley station), a 10-year life was estimated. Because of the 10-year life, the annual charge for those units was 24 percent. Coupled with a capacity factor of about 15 percent, the resultant annualized cost for these units was computed as 32 mills/kWh, or approximately $13,500 per ton SO_2.

Currently, Redondo Units 1 through 4 and the Valley station generate 2.9 percent of the SO_2 emissions of the eight sites studied. If these units were left uncontrolled and continue to burn 0.25-percent sulfur, and the

TABLE 68. ESTIMATED UNIT COSTS

Late 1977 dollars

Item		Unit Cost
1.	Makeup water	$0.50/1000 gal
2.	Electrical power	$0.025/kWh, Utilities $0.035/kWh, Industrial
3.	Reheat (low pressure steam)	$1.70/million Btu[a]
4.	Operating labor	$15/hr
5.	Maintenance, labor, and materials	3 percent of capital or supplier estimates (if provided)
6.	Lime	$42/ton[b]
	Soda ash	$80/ton
7.	Disposal	Approximately $7.14/ton[c]
8.	Annual charges, 9 percent on capital 20 yr	19 percent[d]
9.	Taxes, insurance, interim replacement	Approximately 6.5 percent of capital cost (included in item 8)

[a] Ref. 10

[b] Based on verbal estimates for Los Angeles area (Appendix D)

[c] Each site computed on a site specific basis (Table 74)

[d] Based on 20-yr life, 9 percent interest rate, except for DWP Valley and SCE Redondo Units 1 through 4, for 10 yr, 9 percent interest = 24 percent annual charge on capital (Table 69)

TABLF 69. AVERAGE CAPITAL CHARGE RATES

Suggested methodology for cost analysis. State of California Air Resources Board, Request for Proposals, "Assessment of Control Technology for Stationary Sources," January 1978

Interest rate, percent	Percent of total capital investment[a, b]					
	Life of equipment (yr)					
	5	10	15	20	25	30
6	31	21	18	16	15	14
8	33	23	20	18	17	16
10	35	25	22	20	19	18

[a]Straightline is assumed with no salvage value

[b]Taxes estimated 5 percent of investment cost annually

TABLE 70. AVERAGE SULFUR DIOXIDE SCRUBBER ANNUALIZED COSTS--ELECTRICAL UTILITIES

Late 1977 dollars

See Table 66 for total capital investment

Installation	Generating capacity,[a] MW	Average capacity factor, 1976	Annualized costs[b]	
			Average, mills/kWh	Average,[c] $(000, 000)
Southern California Edison				
Alamitos	1,950	0.442	7.6	57.7
El Segundo	1,020	0.444	10.1	39.5
Etiwanda	904	0.498	8.1	32.0
Huntington Beach	870	0.434	9.1	30.1
Ormond Beach	1,600	0.454	7.5	47.9
Redondo Beach	1,310	0.451[d]	9.2	47.5
	292	0.15	-- 31.9	12.2
Los Angeles Department of Water and Power				
Haynes	1,633	0.667	5.2	49.5
Valley	526	0.158	-- 31.4	22.9
Weighted average	--	0.424[e]	8.8[e] 31.6	--

[a]Total generating capital 10,105 MW

[b]See Tables 68 and 71 (20 yr life, 9 percent interest rate, 50°F reheat. Without application of credit of 1.0 mill/kWh ($0.70/barrel) for use of higher (0.5 percent) sulfur fuel oil instead or current 0.25 percent. Scrubber waste disposal costs are included.

[c]Total $339.3 million

[d]0.451 applies to Units 5 through 8; 0.15 applies to Units 1 through 4

[e]Excluding Redondo Beach Units 1 through 4 and Valley

TABLE 71. AVERAGE SULFUR DIOXIDE SCRUBBER ANNUALIZED COSTS -- INDUSTRIAL PROCESSES

All costs in late 1977 dollars

Installation and No. of units	Average annualized cost,[a] $(000,000)	Sulfur dioxide removed annually, tons	Cost of sulfur dioxide removed, $/ton	Annual production, tons	Scrubbing costs, $/ton of product	Approximate selling price of product $/ton	Scrubbing costs, percent of selling price
Carbon monoxide boiler--Chevron (1)	3.2	944	3,440	b	b	b	b
Coke kilns--Great Lakes Carbon (3)	11.7	4,851	2,415	594,000	19.72	110	18
Coke kiln--Martin Marietta Carbon (1)	3.5	3,055	1,140	250,000	13.93	110	13
Sulfuric acid units--Stauffer Chemical (3)	2.7	487	5,544	264,000	10.23	50	20
Total	21.1	--	--	--	--	--	--

[a] 20-year equipment lifetime, 50°F reheat. Scrubber waste disposal costs included.

[b] Not available.

other units from the seven sites removed 90 percent SO_2 from the burning of 0.5 percent oil, the uncontrolled emissions from these two sites would be approximately 15 percent of the controlled SO_2 levels (Table 72). The retention of uncontrolled Redondo 1 through 4 and Valley units, with 90 percent cleanup on the others, would represent an 88.7 percent cleanup overall for the eight utility sites.

Comparable scrubbing costs for the industrial processes range from \$1140 to \$5444 per ton of SO_2 removed.

In cases where the selling cost of a product could be identified, i.e., electricity, petroleum coke, and sulfuric acid, the annualized charges for SO_2 control are in the range of 13 to 20 percent of the product selling cost.

The effect of paying for scrubber equipment at a faster rate than the 20-year lifetime generally considered in this study is defined in Appendix E. If emission source annual capacity factors remain unchanged relative to those in the 20-year cost computation, amortizing the scrubber equipment in five years increases the annualized charges shown in Table 71 by a factor of 1.59. For instance, on a 20-year basis the annualized cost of scrubbing the flue gas from the Chevron carbon monoxide boiler is \$3,440/ton of SO_2 removed. Paying the scrubber equipment in five years (as though there were 5 years life remaining) increases the annual cost to \$5,470/ton of SO_2 removed. The effect of shorter (10 year) useful life for utility scrubbers was discussed earlier in this section.

The operating costs include an estimate for the cost of energy required to heat the flue gases above the adiabatic saturation temperature of the gases leaving the scrubber to increase the buoyancy and the dew point margin relative to the surrounding atmosphere. An increase of 50°F, which is customary for U.S. installations, was included. If reheating of 125°F is required, which is the temperature increase needed to bring utility exhaust gases to the level currently being exhausted which is approximately 255°F, then a further increase in scrubbing costs of approximately 4-1/4 percent is estimated. The actual amount of reheat is site-specific depending on local

TABLE 72. EFFECT OF NONCONTROL OF LOW-CAPACITY FACTOR UTILITY PLANTS ON SULFUR DIOXIDE EMISSIONS

Conditions	Sulfur dioxide emissions, tons/year	Percent of total
Current emissions[a]	50,597	--
Current emissions by low capacity factor plants[b]	1,497	2.9
Emissions from controlled high capacity sites in this study[c]	9,935	--
Emissions from uncontrolled low capacity plants	1,497	13.1
Total emissions from all eight plants burning 0.5 percent sulfur fuel oil	101,194	--
Overall equivalent removal if footnote b plants were uncontrolled and footnote c plants were subjected to 90 percent cleanup	--	88.7

[a] Eight utility sites in this study, 1975-1976 capacity factors, 0.25 percent sulfur fuel oil

[b] Redondo Beach Units 1 through 4 and Valley generating stations

[c] Alamitos, El Segundo, Etiwanda, Huntington Beach, Redondo Beach Units 5 through 8, Ormond Beach, and Haynes, 0.5 percent sulfur fuel oil, 90 percent sulfur dioxide removal

climatological conditions and is not within the scope of this feasibility study. However, such a study would be expected to define temperatures within the 50 to 125°F reheat range, the cost impact of which is defined herein.

All the annualized costs include the costs of trucking and disposing the scrubber wastes in a Class I landfill site. Two such sites are located in Los Angeles County. The disposal costs for each scrubber site and other details are discussed in Section 4.5.3. An average of $7.14 per ton of scrubber waste equates to 0.062 mills/kWh.

4.5.3 Scrubber Waste Disposal

On the basis of the assessment discussed in Section 4.4.3, Class I landfills were considered for disposal of the scrubber wastes.

The map shown in Figure 60 identifies the location of each of the scrubber waste-producing facilities and the location of both Class I landfills in Los Angeles County. The effect of disposing 361,500 tons per year of wastes containing 72.5% solids (Tables 32 and 37) for 30 years at the Calabasas and BKK Company landfills is shown in Table 73. Projections of the landfill lifetimes remaining prior to considering scrubber waste disposal were 52 and 187 years for Calabasas and BKK, respectively. With the distribution of waste disposal shown in Table 73, i.e., the waste being routed to the nearest landfill from the various sites, 38 percent of the total generated for 30 years would be disposed at Calabasas and the remaining at BKK. The closure dates of each landfill would then be advanced 5 years.

Both landfill operators were contacted and indicated that the estimated solid waste quantities could be accommodated for disposal. In order to estimate the cost of disposal, current charges were obtained from each landfill operator as well as rental for 25-ton capacity trucks with drivers.

The Calabasas disposal charge is a constant $3.50 per ton, which includes the California Department of Health Hazardous Waste fee. The BKK charge for single loads is $8 per ton plus $1 per ton State Department of Health fee. For disposal in the quantities and constant rates for this

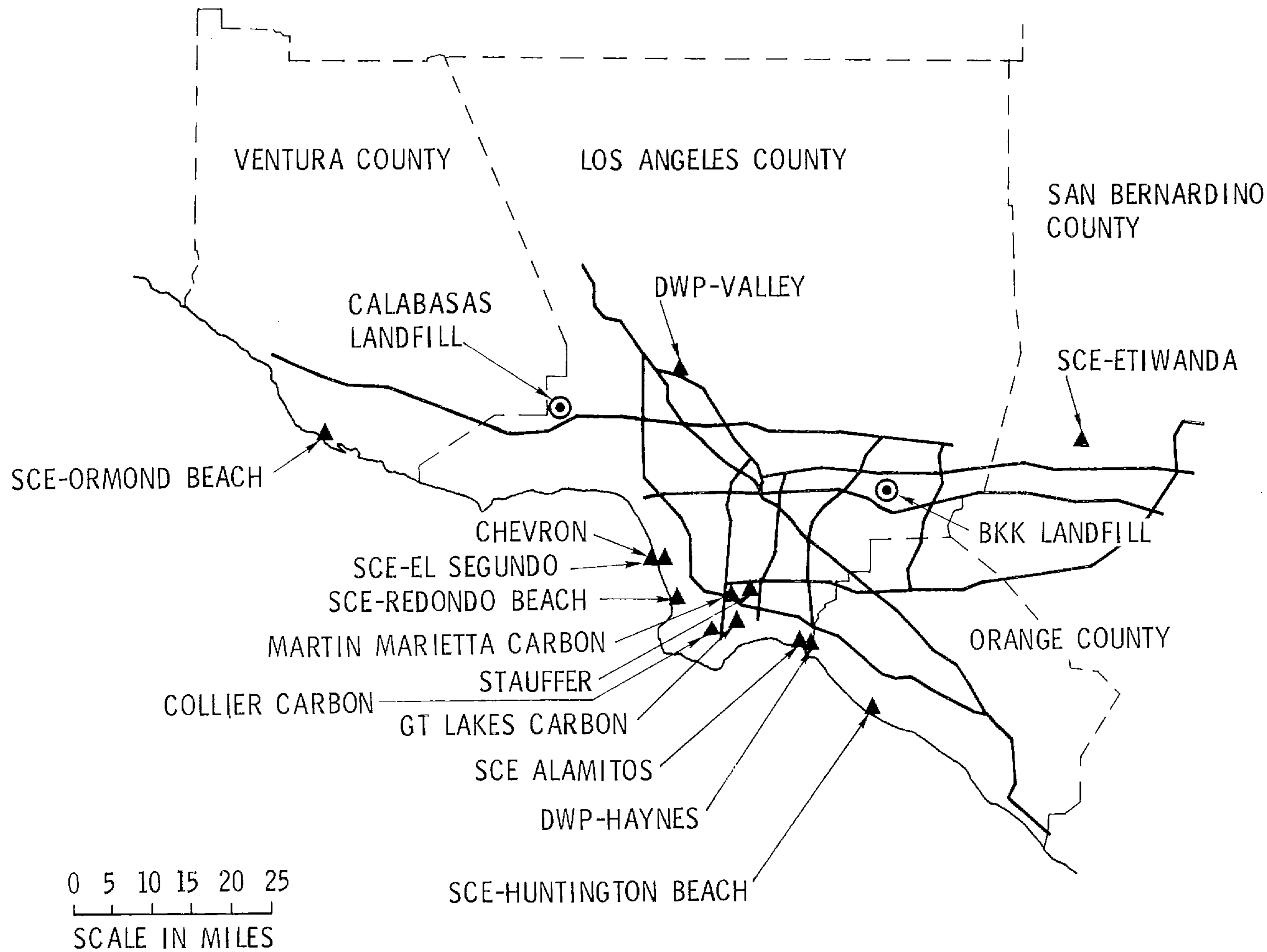


Figure 60. Scrubber waste generation sites, Class I landfills, and major freeways

TABLE 73. IMPACT OF SCRUBBER WASTE DISPOSAL ON CLASS I LANDFILL LIFETIMES

Current status (without scrubber waste addition

Disposal site	Estimated closure,[a] yr	Current fill rate[b]			Remaining capacity[c]		Landfill lifetime, yr remaining
		tons/day	tons/yr	acre-ft/yr	tons (000, 000)	acre-ft[d] (000)	
Calabasas	2030	1,070	332,000	412	17.3	21.4	52
BKK	2165	1,800	558,000	692	104.3	129.3	187

Impact of scrubber waste disposal

Disposal site	Scrubber waste input[e]		Increase in annual fill volume, percent	Landfill lifetime yr remaining[f]	Lifetime reduction, yr
	tons/yr	acre-ft/yr			
Calabasas	137,400	68.3	16.5	47	5
BKK	224,100	111.4	16.1	182	5
Total	361,500	--	--	--	--

[a]County Solid Waste Management Plan--Los Angeles County, October 1975
[b]310 days/yr
[c]From 1978. Computed from estimated closure date and footnote b
[d]Based on 1,000 lb/cu yd compaction density
[e]Based on 72.5% solids and 92.4 lb/cu ft or 2,500 lb/cu yd bulk density
[f]Scrubber waste disposal at annual rate shown on 30-yr basis (for conservative estimation)

study, the BKK disposal fee would be negotiated and might be expected to be about $4 per ton. The California Department of Health Hazardous Waste fee is $1 per ton, up to a maximum of $2500 per month for each waste-producing facility. A negotiated contract rate for a 25-ton payload semi-trailer, tractor, and driver is expected to be about $24 per hour. No problems with secondary road limits were identified for this type of truck.

Using the above data and the amount of waste produced by each facility, the disposal costs were then computed. The results are shown in Table 74. The round-trip road miles between each producing facility and the closest disposal site were scaled from appropriate Los Angeles area maps. An average truck speed of 40 mph was assumed. A 45-minute loading time and a 45-minute unloading time, including time waiting to unload, were also assumed. Based on these premises, the estimated disposal cost for each site was calculated. Since there might be a potential impact from the additional truck traffic density to each disposal facility, the number of truck loads per day were computed on the basis of a 5-day week, with approximately 8 hours per day. These totaled 55.6 per day, or 14,456 trips per year.

The disposal cost ranged between $5.90 and $8.29 per ton, with a weighted average of $7.14 per ton ($0.112 per ton-mile for an average round trip distance of 64 miles). The average disposal cost corresponds to about 0.062 mills/kWh for the electric utilities, or approximately 0.9 percent of the annualized scrubbing cost. For the facilities involved in this study, it represents a total disposal cost of $2.58 million annually for disposal of 361,500 tons of scrubber waste.

TABLE 74. ESTIMATED SCRUBBER WASTE DISPOSAL COSTS

Installation	Scrubber waste, tons/yr	Waste disposed,[a] tons/day		Truck-loads, daily[a, b]	Round trip, mi	Average disposal cost[d]	
		Calabasas	BKK			$/ton[c]	$/yr (000)
Southern California Edison							
Alamitos	60,700	--	233	9.3	54	7.28	441
El Segundo	33,100	127	--	5.1	72	6.60	218
Etiwanda	33,500	--	129	5.2	80	8.29	278
Huntington Beach	26,200	--	101	4.0	58	7.75	204
Ormond Beach	49,700	191	--	7.6	80	6.45	320
Redondo Beach	44,700	172	--	6.9	76	6.46	289
Los Angeles Department of Water and Power							
Haynes	73,400	--	282	11.3	56	7.21	528
Valley	6,500	25	--	1.0	40	5.90	38
Carbon monoxide boiler--Chevron	3,400	13	--	0.5	70	6.65	22
Petroleum coke calcining kilns							
Great Lakes Carbon	17,500	--	67	2.7	72	8.19	143
Martin Marietta Carbon	11,000	--	42	1.7	58	7.80	85
Sulfuric acid units--Stauffer Chemical	1,800	--	7	0.3	56	8.08	15
Total	361,500	528	861	55.6	64[e]	7.14[f]	2,581
		1,389					

[a]Based on 5-day week

[b]Truck capacity 25 tons

[c]72 percent solids (multiply by 1.39 to convert to dry basis)

[d]Basis: Calabasas: $3.50/ton disposal fee including State of California Department of Health $1/ton hazardous waste fee ($2500 maximum per month per disposing facility)

BKK: $4.00/ton disposal, plus State of California Department of Health $1/ton hazardous waste fee ($2500 maximum per month per disposing facility)

Truck rate: $24/hr

Travel time: Average 40 mph; 45 min, each, loading and unloading time

[e]Average round trip distance

[f]Weighted average, all sites

APPENDIX A

STATIONARY SOURCE CHARACTERISTICS

The various organizations operating the sulfur dioxide (SO_2) emission sources provided operating data and other information basic to the conduct of this study. This was in the form of responses to questionnaires prepared by The Aerospace Corporation and are included as Tables A-1 through A-8 for Alamitos, El Segundo, Etiwanda, Huntington Beach, Redondo Beach, Ormond Beach, Haynes, and Valley electrical generating plants, respectively. The information from the industrial sources, namely, Chevron, Collier Carbon, Great Lakes Carbon, Martin Marietta Carbon, and Stauffer Chemical are provided in Tables A-9 through A-13. Copies of the responses that were received are reproduced herein. For purposes of clarity, blank copies of the questionnaires are included as Tables A-14 and A-15.

TABLE A-1.

UTILITY PLANT AND BOILER DATA

PLANT NAME: Alamitos

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer	B+W	B+W	CE	CE	B+W	B+W
2.	Year Placed in Service	1956	1957	1961	1962	1966	1966.
3.	Estimated Lifetime	30yrs	→				→
4.	Type of Service: Base, Peak, etc.	Cycling	→				→
5.	Boiler Operating/Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	175	175	320	320	480	480
7.	Boiler Operation, hrs/yr	6996	7679	6571	6975	5545	7735
8.	Year Applicable	1976	→				→
9.	Boiler Capacity Factor, %[b]	35.7	41.1	51.3	45.5	46.2	45.4
10.	Range Over Which Boiler Operated, % of Max.	10 to 100	→		→	20 to 100	20 to 100
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate		from	data	provided	
12.	Unit Heat Rate, Btu/kwh	9988	9988	9503	9503	8935	8935
13.	Max. Oil Consumption[c], bbl/hr	265	265	460	460	705	705
14.	Percent Excess Air	13	13	10	10	10	10
15.	Serviced by Stack Number	1	2	3	4	5	6
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	~~169,000~~	~~169,000~~	819,000	819,000	1,157,000	1,157,000
17.	Flue Gas Temperature: °F	274	274	258	258	255	255
18.	Projected Life, yrs	Calculate		from	data	provided	
19.	Projected Operating Load Factors	Use	data	in	line 9		

a. % Max. Capacity vs. Time

c. Oil Currently Used

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

TABLE A-1

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	Blended Resid	Blended Resid.
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Calculate from data provided	
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Low Sulfur Oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	758,000	
24.	Source	City	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Sands & gravelly sands	
29.	Depth to Water Table	No ground water to 30 ft.	
30.	Plant Location (city and county)	Long Beach, Los Angeles	
31.	Total Site Area, Acres	200	
32.	Additional Construction Planned?	None	
33.	If Construction Planned, Land Area Needed	—	
34.	Limitations, if any, on Acquisition of Additional Land	Residential Area, Condemnation Required. Very Unlikely that additional land could be obtained	

TABLE A-1

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	6
36.	Stack Heights Above Grade, ft.	200
37.	Height Restrictions, if Any	500' - (Airport Flight Pattern)
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4 year overhaul, 2 yr Boiler Inspections, 6 month acid cleanings on Units 5 & 6
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	None
41.	Other	

TABLE A-2

UTILITY PLANT AND BOILER DATA

PLANT NAME: El Segundo

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer	B+W	B+W	CE	CE	—	—
2.	Year Placed in Service	1955	1956	1964	1965		
3.	Estimated Lifetime	30 yr					
4.	Type of Service: Base, Peak, etc.	Cycling					
5.	Boiler Operating Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	175	175	335	335		
7.	Boiler Operation, hrs/yr	7417	5700	5527	6857		
8.	Year Applicable	1976					
9.	Boiler Capacity Factor, %[b]	47.1	37.2	41.3	52.2		
10.	Range Over Which Boiler Operated, % of Max.	10-100	10-100	10-100	10-100		
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate from data provided					
12.	Unit Heat Rate, Btu/kwh	9988	9988	9503	9503		
13.	Max. Oil Consumption[c], bbl/hr	250	250	480	480		
14.	Percent Excess Air	10	10	10	10		
15.	Serviced by Stack Number	1	2	3	4		
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	450,000	450,000	854,000	854,000		
17.	Flue Gas Temperature: °F	290	290	250	250		
18.	Projected Life, yrs	Calculate from data provided					
19.	Projected Operating Load Factors	Use data in line 9					

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

c. Oil Currently Used

TABLE A-2

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	Blended Resid.	Blended Resid
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Calculate from data provided	
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Low sulfur oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	615,000	
24.	Source	City	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Fine-to-medium sands, some gravel	
29.	Depth to Water Table	12 ft	
30.	Plant Location (city and county)	El Segundo, Los Angeles	
31.	Total Site Area, Acres	40	
32.	Additional Construction Planned?	None	
33.	If Construction Planned, Land Area Needed	—	
34.	Limitations, if any, on Acquisition of Additional Land	Limited to beach property	

TABLE A-2

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	4
36.	Stack Heights Above Grade, ft.	200
37.	Height Restrictions, if Any	None
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4 yr. Overhaul, 2 yr Blr. Inspections
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	None
41.	Other	

TABLE A-3

UTILITY PLANT AND BOILER DATA

PLANT NAME: Etiwanda

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer	CE	CE	CE	CE		
2.	Year Placed in Service	1953	1953	1963	1963		
3.	Estimated Lifetime	30 yrs					
4.	Type of Service: Base, Peak, etc.	Cycling					
5.	Boiler Operating Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	132	132	320	320		
7.	Boiler Operation, hrs/yr	7280	6747	5712	7806		
8.	Year Applicable	1976					
9.	Boiler Capacity Factor, %[b]	51	46	45	57		
10.	Range Over Which Boiler Operated, % of Max.	10-100	10-100	10-100	10-100		
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate from data provided					
12.	Unit Heat Rate, Btu/kwh	10,337	10,337	9619	9619		
13.	Max. Oil Consumption[c], bbl/hr	205	205	460	460		
14.	Percent Excess Air	16	16	10	10		
15.	Serviced by Stack Number	1	2	3	4		
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	384,000	384,000	861,000	861,000		
17.	Flue Gas Temperature: °F	265	265	260	260		
18.	Projected Life, yrs	Calculate from data provided					
19.	Projected Operating Load Factors	Use data in line 9					

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

c. Oil Currently Used

TABLE A-3

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	Blended Resid	Blended Resid
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Calculate from	data provided
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Low Sulfur Oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	6,764,000	
24.	Source	MWD and wells	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Alluvial sands & silt sand mixture	
29.	Depth to Water Table	No ground water to 50 ft.	
30.	Plant Location (city and county)	Etiwanda, San Bernardino	
31.	Total Site Area, Acres	205	
32.	Additional Construction Planned?	None	
33.	If Construction Planned, Land Area Needed	—	
34.	Limitations, if any, on Acquisition of Additional Land		

TABLE A-3

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	4
36.	Stack Heights Above Grade, ft.	200
37.	Height Restrictions, if Any	
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4 yr overhaul, 2 yr Blr Inspect.
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	Railroad Siding
41.	Other	

TABLE A-4

UTILITY PLANT AND BOILER DATA

PLANT NAME: Huntington Beach

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer	B+W	B+W	B+W	B+W		
2.	Year Placed in Service	1958	1958	1961	1961		
3.	Estimated Lifetime	30 yrs					
4.	Type of Service: Base, Peak, etc.	Cycling					
5.	Boiler Operating Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	215	215	215	225		
7.	Boiler Operation, hrs/yr	6996	7679	6571	6975		
8.	Year Applicable	1976					
9.	Boiler Capacity Factor, %[b]	35.7	41.1	51.3	45.5		
10.	Range Over Which Boiler Operated, % of Max.	10-100	10-100	20-100	20-100		
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate from data provided					
12.	Unit Heat Rate, Btu/kwh	9202	9202	9185	9176		
13.	Max. Oil Consumption[c], bbl/hr	305	305	305	320		
14.	Percent Excess Air	15	15	15	15		
15.	Serviced by Stack Number	1	1	2	2		
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	1,203,000		1,207,000			
17.	Flue Gas Temperature: °F	275		250			
18.	Projected Life, yrs	Calculate from data provided					
19.	Projected Operating Load Factors	Use data in line 9					

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

c. Oil Currently Used

TABLE A-4

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	Blended Resid	Blended Resid
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Calculate from data provided	
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Low Sulfur Oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	615,000	
24.	Source	City	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Clay, silt, & sand	
29.	Depth to Water Table	8-9 ft	
30.	Plant Location (city and county)	Huntington Beach, Orange	
31.	Total Site Area, Acres	53	
32.	Additional Construction Planned?	Possible location for Combined Cycle	
33.	If Construction Planned, Land Area Needed	Unknown	
34.	Limitations, if any, on Acquisition of Additional Land		

TABLE A-4

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	2
36.	Stack Heights Above Grade, ft.	200
37.	Height Restrictions, if Any	
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4 yr overhaul, 2 yr blr inspection
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	
41.	Other	

TABLE A-5

UTILITY PLANT AND BOILER DATA

PLANT NAME: Ormond Beach

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer	FW	FW				
2.	Year Placed in Service	1971	1973				
3.	Estimated Lifetime	30 yrs	30 yrs				
4.	Type of Service: Base, Peak, etc.	Cycling	Cycling				
5.	Boiler Operating Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	800	800				
7.	Boiler Operation, hrs/yr	6934	6923				
8.	Year Applicable	1976	1976				
9.	Boiler Capacity Factor, %[b]	47.5	43.3				
10.	Range Over Which Boiler Operated, % of Max.	20-100	20-100				
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate from data provided					
12.	Unit Heat Rate, Btu/kwh	9272	9272				
13.	Max. Oil Consumption[c], bbl/hr	1100	1100				
14.	Percent Excess Air	10	10				
15.	Serviced by Stack Number	1	2				
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	1,728,000	1,728,000 –				
17.	Flue Gas Temperature: °F	255	255				
18.	Projected Life, yrs	Calculate from data provided					
19.	Projected Operating Load Factors	Use data in line 9					

a. % Max. Capacity vs. Time

c. Oil Currently Used

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

TABLE A-5

UTILITY PLANT AND BOILER DATA (continued)

20.	Fuel Oil	Now in Use	Anticipated 0.5% S
	Grade	Blended Resid.	Blended Residual
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Calculate from data provided	
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Low Sulfur Oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	307,500	
24.	Source	City	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Well graded sands	
29.	Depth to Water Table	7-12 ft.	
30.	Plant Location (city and county)	Oxnard, Ventura	
31.	Total Site Area, Acres	280	
32.	Additional Construction Planned?	Possible site for Combined Cycle Installation	
33.	If Construction Planned, Land Area Needed	—	
34.	Limitations, if any, on Acquisition of Additional Land		

TABLE A-5

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	2
36.	Stack Heights Above Grade, ft.	237
37.	Height Restrictions, if Any	
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4yr Overhaul, 2yr Blr Inspection
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	Railroad siding
41.	Other	

TABLE A-6

UTILITY PLANT AND BOILER DATA

PLANT NAME: Redondo

ITEM NO.		BOILER IDENTIFICATION NO. #5	#6	#7	#8	5	6
1.	Boiler Manufacturer	B+W	B+W	B+W	B+W		
2.	Year Placed in Service	1954	1957	1967	1967		
3.	Estimated Lifetime	30yrs					
4.	Type of Service: Base, Peak, etc.	Cycling					
5.	Boiler Operating Cycle[a]	?					
6.	Maximum Continuous Generating Capacity, MW	175	175	480	480		
7.	Boiler Operation, hrs/yr	5670	5907	6257	6525		
8.	Year Applicable	1976					
9.	Boiler Capacity Factor, %[b]	44.3	45.4	41.0	49.6		
10.	Range Over Which Boiler Operated, % of Max.	10-100	10-100	20-100	20-100		
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr	Calculate	from	data	provided		
12.	Unit Heat Rate, Btu/kwh	9988	9988	9045	9045		
13.	Max. Oil Consumption[c], bbl/hr	280	280	700	700		
14.	Percent Excess Air	13	13	10	10		
15.	Serviced by Stack Number	5	6	7	8		
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	469000	469,000	1,157,000	1,157,000		
17.	Flue Gas Temperature: °F	274	274	255	255		
18.	Projected Life, yrs	Calculate	from	data	provided		
19.	Projected Operating Load Factors	Use	data in	line	9		

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

c. Oil Currently Used

TABLE A-6

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	Blended Resid	Blended Resid
	% Sulfur	0.25	0.5
	% Ash	0.01	0.01
	GHV, Btu/bbl	6.0×10^6	6.1×10^6
	Consumption, bbl/day	Compute from data provided	
21.	Emission Controls in Use		
	Particulates	None	
	SO_2	Premium Sulfur Oil	
22.	Unique Characteristics	—	
	Relative to SO_2	—	
	Emissions	—	
23.	Fresh Water Consumption, GPD	779,000	
24.	Source	City	
25.	Any Limitations of Availability of Scrubber System Makeup Water	None	
26.	Water Treatment Facilities	O/W SEPARATION of IN-PLANT DRAINS	
27.	Max. Water Treatment Capacity Gal/day	VARIES GREATLY	
28.	Type of Soil	Sands & some trash fill	
29.	Depth to Water Table	11 ft	
30.	Plant Location (city and county)	Redondo Beach, Los Angeles	
31.	Total Site Area, Acres	41	
32.	Additional Construction Planned?	None	
33.	If Construction Planned, Land Area Needed	—	
34.	Limitations, if any, on Acquisition of Additional Land	No additional land available	

TABLE A-6

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	4
36.	Stack Heights Above Grade, ft.	200
37.	Height Restrictions, if Any	
38.	Plant Equipment Layout (drawings)	
39.	Maintenance Shutdown Schedule	4 yr overhaul, 2 yr Blr Inspection, + 6 month acid cleaning (7 & 8 only)
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	Rail siding
41.	Other	

TABLE A-7

UTILITY PLANT AND BOILER DATA

PLANT NAME: HAYNES GENERATING STATION

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6	
1.	Boiler Manufacturer	C.E.	C.E.	B&W	B&W	B&W	B&W	
2.	Year Placed in Service	1962	1963	1964	1965	1966	1967	
3.	Estimated Lifetime	30	30	30	30	30	30	
4.	Type of Service: Base, Peak, etc.	INTERMEDIATE						
5.	Boiler Operating Cycle[a]	LOADED FROM MINIMUM TO MAXIMUM CAP.						
6.	Maximum Continuous Generating Capacity, MW [GROSS-OIL]	230	240	228	235	350	350	
7.	Boiler Operation, hrs/hr	7050	6106	4222	7096	5964	4062	
8.	Year Applicable	1976						
9.	Boiler Capacity Factor, %[b]	66	64	63	66	67	74	1976 FPC REP.
10.	Range Over Which Boiler Operated, % of Max.	25-100	25-100	20-100	20-100	43-100	43-100	
11.	Maximum Continuous Heat Input (oil), 10^6 Btu/hr	2093	2184	2075	2139	3028	3028	
12.	Unit Heat Rate, Btu/kwh	9100.	9100.	9100.	9100.	8650.	8650.	
13.	Max. Oil Consumption[c], bbl/hr	355.	370.	352.	362.	513.	513.	
14.	Percent Excess Air	10-20	10-20	10-20	10-20	10-20	10-20	
15.	~~Serviced by~~ Stack ~~Number~~ Configuration	SINGLE	SINGLE	DOUBLE	DOUBLE	SINGLE	SINGLE	
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	564,000.	564,000.	587,000.	587,000.	784,000.	784,000.	
17.	Flue Gas Temperature: (°F MAX)	257	257	249	249	247	247	
18.	Projected Life, yrs	NO RETIREMENT PROJECTED WITHIN NEXT 20 YRS						
19.	Projected Operating ~~Load~~ CAPACITY Factors (1977-1986) (%)	41-70	44-71	50-81	44-74	48-71	52-79.	

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap. in KW} \times 8760 \text{ hrs}}$

NOT APPROVED

TABLE A-8

UTILITY PLANT AND BOILER DATA

PLANT NAME: VALLEY GENERATING STATION

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	~~5~~	~~6~~
1.	Boiler Manufacturer	B&W	B&W	RILEY	RILEY		
2.	Year Placed in Service	1954	1954	1955	1956		
3.	Estimated Lifetime	30	30	30	30		
4.	Type of Service: Base, Peak, etc.	INTERMEDIATE					
5.	Boiler Operating Cycle[a]	LOADED FROM MINIMUM TO MAXIMUM CAPACITY					
6.	Maximum Continuous Generating Capacity, MW [NET - OIL]	94	101	171	160		
7.	Boiler Operation, hrs/hr	2000	1900	4800	5300		
8.	Year Applicable	1975	1975	1976	1976		
9.	Boiler Capacity Factor, %[b]	11	10	19	23		
10.	Range Over Which Boiler Operated, % of Max.	18-100	18-100	24-100	24-100		
11.	Maximum Continuous Heat Input (oil), 10^6 Btu/hr	1033	1033	1604	1604		
12.	Unit Heat Rate, Btu/kwh	10,900.	10,900.	10,000.	10,000.		
13.	Max. Oil Consumption[c], bbl/hr	175	175	272	272.		
14.	Percent Excess Air	15-25	15-25	15-25	15-25		
15.	~~Serviced by~~ Stack Configuration Number	SINGLE					
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm	343,000.	343,000.	520,000	520,000.		
17.	Flue Gas Temperature: °F [AFTER AIR PREHEATER]	340	340	250	250		
18.	Projected Life, yrs	NO RETIREMENT PROJECTED WITHIN NEXT TEN YEARS					
19.	Projected Operating ~~Load~~ Capacity Factors [1977-1986]	5-28	6-21	10-33	15-40		

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW x 8760 hrs}}$

c. Oil Currently Used

NOT APPROVED

NOT APPROVED

TABLE A-8

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade	6	WE [illegible]
	% Sulfur	0.25 MAX	DO NOT USE
	% Ash	0.05 MAX	THIS TYPE [illegible]
	GHV, Btu/bbl	5.9×10^6	OIL, [illegible]
	Consumption, bbl/day	20,000.	WE [illegible]
21.	Emission Controls in Use		
	Particulates	MULTIPLE CYCLONES	
	SO_2	[illegible] FUEL OIL	
22.	Unique Characteristics Relative to SO_2 Emissions	NONE	
23.	Fresh Water Consumption, GPD	1,990,000.	
24.	Source	OWENS VALLEY	
25.	Any Limitations of Availability of Scrubber System Makeup Water	WATER CONSERVATION	
26.	Water Treatment Facilities	ATTACHED [illegible]	
27.	Max. Water Treatment Capacity gal/day	0	
28.	Type of Soil	500 FT OF SAND & GRAVEL WITH SOME SILTS [illegible]	
29.	Depth of Water Table	45 FT FROM SURROUNDING GRAVEL PIT AREA	
30.	Plant Location (city and county)	LOS ANGELES LOS ANGELES	
31.	Total Site Area, Acres	155.3	
32.	Additional Construction Planned?	Yes	
33.	If Construction Planned, Land Area Needed	See attached Site Development Dwg	
34.	Limitations, if any, on Acquisition of Additional Land	—	

NOT APPROVED

TABLE A-8

UTILITY PLANT AND BOILER DATE (continued)

35.	Number of Stacks	FOUR			
36.	Stack Heights Above Grade, ft.	250			
37.	Height Restrictions, if Any	FAA			
38.	Plant Equipment Layout (drawings)	M-60008 M-60009 M-60014	M-80019 M-90007		
39.	Maintenance Shutdown Schedule [MAJOR]	UNIT 1 YEAR 1983	2 1983	3 1978	4 1978
40.	Other				

EGM:ep
11-30-77

TABLE A-9. CHEVRON CARBON MONOZIDE BOILER

PLANT PROCESS DATA

NO. 39 BOILER

1.	Plant Name	FLUID CATALYTIC CRACKING UNIT.
2.	Installation Location	CHEVRON U.S.A REFINERY EL SEGUNDO CA. 324 W. ELSEGUNDO BLVD. EL SEG CAL.
3.	Source Characteristics (i.e., Contact acid, etc.)	COMBUSTION PRODUCTS.
4.	Process Flow Diagram (Schematic or Reference, etc.)	ATTACHED.
5.	Source Rating (Tons/Day Product)	2.5 T/D SO_2 700 lb/DAY PARTICULATE
6.	Total Exhaust Discharge, (Volume)	270,000 ACFM (550°F 1atm) ACFM SCFM
7.	Exhaust Gas Temperature	500 - 550 °F
8.	SO_2 Concentration in Exhaust Gas (ppm or Volume %)	225 ppm (AVE) (min) 150 - (max) 400
9.	Oxygen Concentration in Exhaust Gas (%)	1%
10.	Number of Units (If greater than 1, please indicate rates (item 6) for each unit)	1
11.	Number of Stacks	1
12.	Annual Operation (Hrs)	8395 hrs/year (AVE)
13.	Annual Average Operation (% of Maximum Capacity)	85-90%
14.	Hours per year at Maximum Capacity	2000 HRS/YR.
15.	Age of Installation	23 YEARS.
16.	Projected Installation Lifetime (Years)	~ 20 MORE YEARS

TABLE A-9

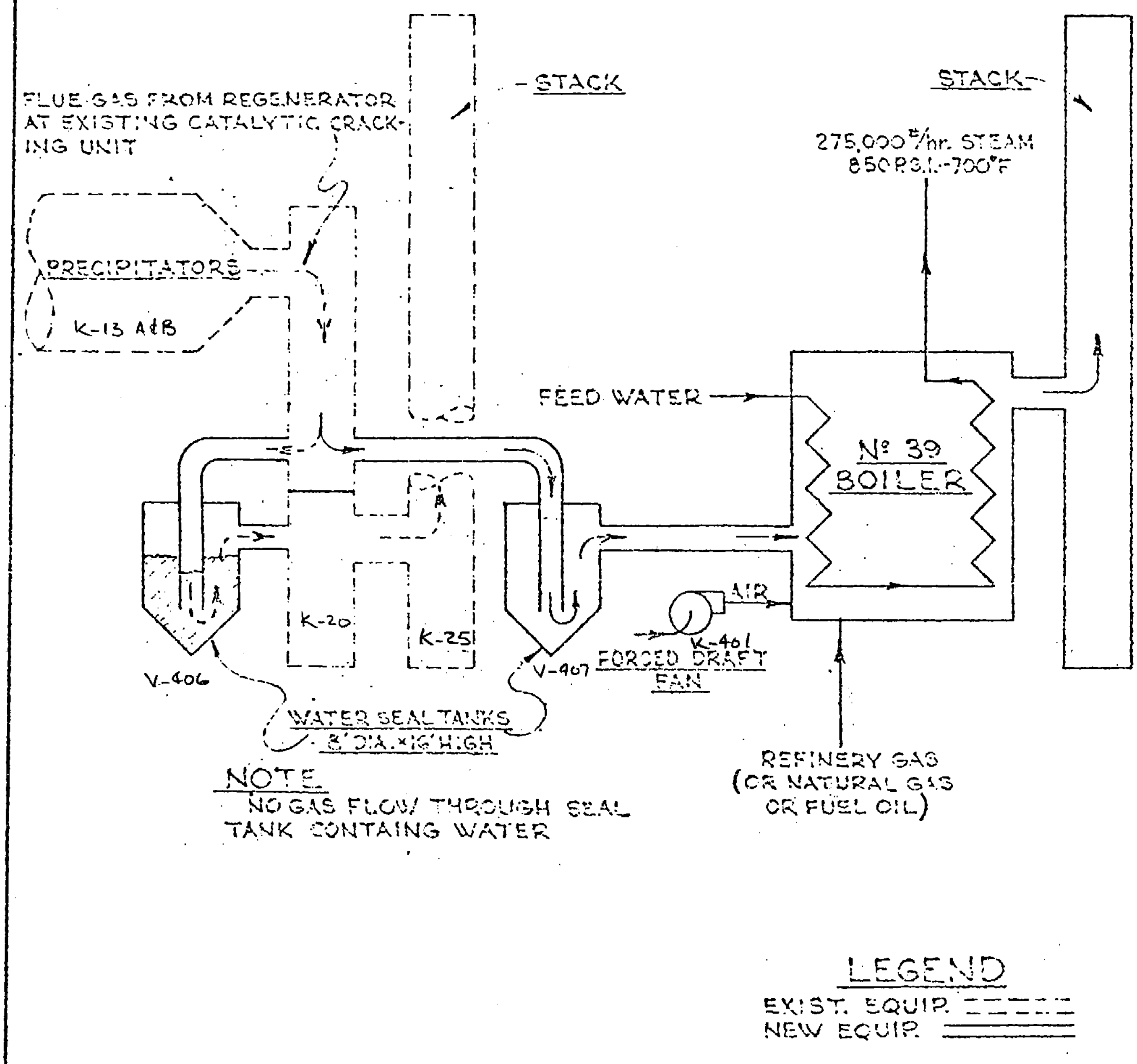
PLANT PROCESS DATA Continued Page 2

17.	Any Projected Change in Operating Mode During Remainder of Projected Lifetime	NO.
18.	Source of Steam and Electrical Power	800 # STM NO ADDITIONAL ELECTRICAL POWER READILY AVAIL.
19.	Emission Controls in Use; Particulates and SO_2	CYCLONES, ELECTROSTATIC PRECIPITATOR
20.	Emission Control Characteristics; i. e., % Removal SO_2, etc.	PARTICULATES 99+%
21.	Fresh Water Consumption, GPD	7.2×10^5 . GPDAY.
22.	Source	DEMIN. WATER. CONDENSATE
23.	Any Limitations of Availability of Scrubber System Makeup Water	NO.
24.	Max. Waste Water Treatment Capacity Gal/day	100 GPM AVAILABLE.
25.	Water Treatment Facilities, Type	ACTIVATED. SLUDGE.
26.	Plant Location (city and county Jurisdiction)	EL SEGUNDO L-A. COUNTY.
27.	Total Site Area, Acres	PLOT PLAN ATTACHED.
28.	Additional Construction Planned?	NO.
29.	If Construction Planned, Land Area Needed	—
30.	Limitations, if any, on Acquisition of Additional Land	NO ADDITIONAL LAND AVAILABLE FOR ACQUISITION NEAR BOILER.

TABLE A-9
PLANT PROCESS DATA Continued Page 3

31.	Restrictions/Limitations on On-Site Disposal of Scrubber Solids	NO SOLID DISPOSAL PERMITTED IN REFINERY
32.	Height Restrictions, if Any	BELOW 200' (ESTIMATED)
33.	Other Considerations Limiting Installation of SO_2 Scrubbers	WASTE DISPOSAL PROBLEMS. ELECTRICAL POWER DISTRIBUTION PROBLEMS
34.	Plant Equipment Layout (Plot Plan)	ATTACHED.
35.	Maintenance Shutdown Schedule	ONCE EVERY TWO YEARS.
36.	Transportation Facilities (Railroad sidings, barge, etc)	RAILROAD, TRUCKS
37.	Other	

Figure A-1



REVS.	1	2

Standard Oil Company of California
WESTERN OPERATIONS, INC.
ENGINEERING DIVISION, EL SEGUNDO REFINERY

CRACKING PLANT
Nº 39 BOILER FLOW DIAGRAM

SCALE NONE. DATE 4-15-55
DR. R.J.B. CH. ENG.
OPRG. DEPT. APPROVED
ENG. DEPT.

SE63240-0

GO. 450F

TABLE A-10. GREAT LAKES CARBON: COKE CALCINING KILNS PLANT PROCESS DATA

1.	Plant Name	Great Lakes Carbon Corporation
2.	Installation Location	1420 Coil Avenue, Wilmington, California
3.	Source Characteristics (i.e., Contact acid, etc.)	Flue gas stream
4.	Process Flow Diagram (Schematic or Reference, etc.)	See figure 1 attached
5.	Source Rating (Tons/Day Product)	3 kilns @ 600 tons/day
6.	Total Exhaust Discharge, (Volume)	3 kilns @ 196,725 ~~ACFM~~ SCFM
7.	Exhaust Gas Temperature	500°F
8.	SO_2 Concentration in Exhaust Gas (ppm or Volume %)	380 PPM
9.	Oxygen Concentration in Exhaust Gas (%)	9%-10%
10.	Number of Units (If greater than 1, please indicate rates (item 6) for each unit)	As noted - 3 units - like sizes
11.	Number of Stacks	4
12.	Annual Operation (Hrs)	7920
13.	Annual Average Operation (% of Maximum Capacity)	90%
14.	Hours per year at Maximum Capacity	7920
15.	Age of Installation	Installation dates #2 - 1952, #3 - 1969, #4 - 1971
16.	Projected Installation Lifetime (Years)	Unknown

TABLE A-10

PLANT PROCESS DATA Continued Page 2

17.	Any Projected Change in Operating Mode During Remainder of Projected Lifetime	Not at this time
18.	Source of Steam and Electrical Power	No steam - electric Dept. of Water & Power
19.	Emission Controls in Use; Particulates and SO_2	Particulates - baghouse; SO_2 - None
20.	Emission Control Characteristics; i.e., % Removal SO_2, etc.	-
21.	Fresh Water Consumption, GPD	Each unit - 424,800
22.	Source	Dept. of Water & Power
23.	Any Limitations of Availability of Scrubber System Makeup Water	Unknown
24.	Max. Waste Water Treatment Capacity Gal/day	None
25.	Water Treatment Facilities, Type	None
26.	Plant Location (city and county Jurisdiction)	City of Los Angeles
27.	Total Site Area, Acres	Approx 11 acres
28.	Additional Construction Planned?	Possible waste heat boiler installation on each unit by Dept. of Water and Power for electrical generation.
29.	If Construction Planned, Land Area Needed	Not finalized
30.	Limitations, if any, on Acquisition of Additional Land	Additional acquisition doubtful

TABLE A-10

PLANT PROCESS DATA Continued Page 3

31.	Restrictions/Limitations on On-Site Disposal of Scrubber Solids	No on site disposal available
32.	Height Restrictions, if Any	Unknown
33.	Other Considerations Limiting Installation of SO_2 Scrubbers	Cost of installation and annual operating cost would make this facility non-competitive in the international market place.
34.	Plant Equipment Layout (Plot Plan)	See photo attached - #93602
35.	Maintenance Shutdown Schedule	As needed - no regular schedule
36.	Transportation Facilities (Railroad sidings, barge, etc)	Rail siding
37.	Other	

TABLE A-11. MARTIN MARIETTA CARBON: COKE CALCINING KILN

PLANT PROCESS DATA

1.	Plant Name	Martin Marietta Carbon Inc.
2.	Installation Location	2021 East Sepulveda Blvd., Carson, Calif. 90745
3.	Source Characteristics (i.e., Contact acid, etc.)	Not applicable.
4.	Process Flow Diagram (Schematic or Reference, etc.)	Refer to Drawing 22-56121-A attached.
5.	Source Rating (Tons/Day Product)	750 Tons/Day
6.	Total Exhaust Discharge, (Volume)	190,000 - 230,000 ACFM 155,000 - 185,000 SCFM
7.	Exhaust Gas Temperature	185 °F
8.	SO_2 Concentration in Exhaust Gas (ppm or Volume %)	700 - 1100 ppm
9.	Oxygen Concentration in Exhaust Gas (%)	7 - 12%
10.	Number of Units (If greater than 1, please indicate rates (item 6) for each unit)	1 Kiln
11.	Number of Stacks	1
12.	Annual Operation (Hrs)	8,040
13.	Annual Average Operation (% of Maximum Capacity)	90%
14.	Hours per year at Maximum Capacity	Variable
15.	Age of Installation	10 Years
16.	Projected Installation Lifetime (Years)	Approximately 40 Years

TABLE A-11

PLANT PROCESS DATA Continued Page 2

17.	Any Projected Change in Operating Mode During Remainder of Projected Lifetime	Tertiary Air System being installed Waste Heat Boiler being studied
18.	Source of Steam and Electrical Power	Southern California Edison
19.	Emission Controls in Use; Particulates and SO_2	Particulate Removal System (Rule 404 & 405) (Quench Tower, Ionizing Wet Scrubbers)
20.	Emission Control Characteristics; i.e., % Removal SO_2, etc.	Particulate removal - Approximately 52% to meet current regulations. No SO_2 removal data available at this time.
21.	Fresh Water Consumption, GPD	864,000 GPD
22.	Source	Dominguez Water Corporation
23.	Any Limitations of Availability of Scrubber System Makeup Water	No present limitations.
24.	Max. Waste Water Treatment Capacity Gal/day	144,000 GPD
25.	Water Treatment Facilities, Type	Settling, Filtering, Chemical Treating
26.	Plant Location (city and county Jurisdiction)	Carson, Los Angeles County
27.	Total Site Area, Acres	Approximately 8½ Acres.
28.	Additional Construction Planned?	Feasibility study in process on Waste Heat Recovery System.
29.	If Construction Planned, Land Area Needed	Land area available for Waste Heat Boiler Installation.
30.	Limitations, if any, on Acquisition of Additional Land	Yes, surrounded on three sides by other facilities and Dominguez Channel on 4th side

TABLE A-11

PLANT PROCESS DATA Continued Page 3

31.	Restrictions/Limitations on On-Site Disposal of Scrubber Solids	On site disposal is impractical.
32.	Height Restrictions, if Any	None
33.	Other Considerations Limiting Installation of SO_2 Scrubbers	High costs. Crowded space near particulate removal system.
34.	Plant Equipment Layout (Plot Plan)	See Drawing No. 22-56121-A1 (attached).
35.	Maintenance Shutdown Schedule	Total of about 30 days per year.
36.	Transportation Facilities (Railroad sidings, barge, etc)	Railroad siding.
37.	Other	

TABLE A-12. STAUFFER CHEMICAL: SULFURIC ACID UNITS
PLANT PROCESS DATA

1.	Plant Name	Stauffer Chemical Co. - Dominguez Plant
2.	Installation Location	20720 S. Wilmington Ave., Carson, Calif.
3.	Source Characteristics (i.e., Contact acid, etc.)	3 Contact Sulfuric Acid Plants
4.	Process Flow Diagram (Schematic or Reference, etc.)	Attached
5.	Source Rating (Tons/Day Product)	800 T/D
6.	Total Exhaust Discharge, (Volume)	#1 Plant - 14,000 #2 Plant - 14,000 #3 Plant - 20,000 ~~XXXXX~~ SCFM
7.	Exhaust Gas Temperature	#1 Plant - 80°F #2 Plant - 80°F #3 Plant - 140°F °F
8.	SO_2 Concentration in Exhaust Gas (ppm or Volume %)	Normally 300 to 500 ppm
9.	Oxygen Concentration in Exhaust Gas (%)	#1 Plant - 8% #2 Plant - 8% #3 Plant - 15%
10.	Number of Units (If greater than 1, please indicate rates (item 6) for each unit)	Three
11.	Number of Stacks	Three
12.	Annual Operation (Hrs)	Continuous
13.	Annual Average Operation (% of Maximum Capacity)	93%
14.	Hours per year at Maximum Capacity	7884
15.	Age of Installation	Most processing equipment: 20-35 years
16.	Projected Installation Lifetime (Years)	Indefinite

17. Any Projected Change in Operating Mode During Remainder of Projected Lifetime	None at this time
18. Source of Steam* and Electrical Power**	*Own byproduct **40% Utility, 50¢ own generation
19. Emission Controls in Use; Particulates and SO_2	#1 Plant - Double Absorption, Stack Gas Prec #2 Plant - Double Absorption, Stack Gas Filt #3 Plant - Stack Gas Filter
20. Emission Control Characteristics; i.e., % Removal SO_2, etc.	99.5% SO_2; 99.9% SO_3/particulate
21. Fresh Water Consumption, GPD	590,000
22. Source	Dominguez Water Corp. Own plant well
23. Any Limitations of Availability of Scrubber System Makeup Water	Yes - utility has imposed 10% curtailment.
24. Max. Waste Water Treatment Capacity Gal/day	500,000
25. Water Treatment Facilities, Type	Lime neutralization
26. Plant Location (city and county Jurisdiction)	Carson; Los Angeles County
27. Total Site Area, Acres	33
28. Additional Construction Planned?	Yes
29. If Construction Planned, Land Area Needed	None (replacement)
30. Limitations, if any, on Acquisition of Additional Land	Yes

31.	Restrictions/Limitations on On-Site Disposal of Scrubber Solids	None known
32.	Height Restrictions, if Any	250 ft.
33.	Other Considerations Limiting Installation of SO_2 Scrubbers	Yes - Please consult with Mr. Jack Reynolds, Stauffer Western Engineering Center, Richmond. Calif.
34.	Plant Equipment Layout (Plot Plan)	Given
35.	Maintenance Shutdown Schedule	Each plant: one 2 week turnaround each year
36.	Transportation Facilities (Railroad sidings, barge, etc)	3 rail spurs
37.	Other	

TABLE A-13. COLLIER CARBON: SULFURIC ACID UNIT PLANT PROCESS DATA

1.	Plant Name	Collier Carbon and Chemical Corporation
2.	Installation Location	1480 W. Anaheim St., Wilmington, Calif. 90744
3.	Source Characteristics (i.e., Contact acid, etc.)	Contact Sulfuric Acid Unit
4.	Process Flow Diagram (Schematic or Reference, etc.)	Attached Flow Diagram
5.	Source Rating (Tons/Day Product)	450
6.	Total Exhaust Discharge, (Volume)	25,480 ACFM SCFM
7.	Exhaust Gas Temperature	150 °F
8.	SO_2 Concentration in Exhaust Gas (ppm or Volume %)	350 ppm
9.	Oxygen Concentration in Exhaust Gas (%)	7%
10.	Number of Units (If greater than 1, please indicate rates (item 6) for each unit)	One (1)
11.	Number of Stacks	One (1)
12.	Annual Operation (Hrs)	8,580
13.	Annual Average Operation (% of Maximum Capacity)	92%
14.	Hours per year at Maximum Capacity	7,500
15.	Age of Installation	17 Years
16.	Projected Installation Lifetime (Years)	30 Years

TABLE A-13
PLANT PROCESS DATA Continued Page 3

31. Restrictions/Limitations on On-Site Disposal of Scrubber Solids	No on-site disposal available
32. Height Restrictions, if Any	
33. Other Considerations Limiting Installation of SO_2 Scrubbers	Currently have SO_2 scrubbers
34. Plant Equipment Layout (drawings)	
35. Maintenance Shutdown Schedule	Maintenance turnaround every 18-24 months
36. Other	

TABLE A-13

PLANT PROCESS DATA Continued Page 2

17.	Any Projected Change in Operating Mode During Remainder of Projected Lifetime	None
18.	Source of Steam and Electrical Power	Steam - self contained power Los Angeles DW&P
19.	Emission Controls in Use; Particulates and SO_2	Ammsox ammonia scrubbing
20.	Emission Control Characteristics; i.e., % Removal SO_2, etc.	90
21.	Fresh Water Consumption, GPD	Total Plant Consumption - 125,000 GPD Ammsox Unit - 11,520 GPD
22.	Source	Los Angeles Dept. Water & Power
23.	Any Limitations of Availability of Scrubber System Makeup Water	None
24.	Max. Waste Water Treatment Capacity Gal/day	36,000
25.	Water Treatment Facilities, Type	Neutralizer Pit - Liar
26.	Plant Location (city and county Jurisdiction)	Wilmington - Los Angeles County
27.	Total Site Area, Acres	13.5
28.	Additional Construction Planned?	None
29.	If Construction Planned, Land Area Needed	---
30.	Limitations, if any, on Acquisition of Additional Land	No additional land available

TABLE A-14
UTILITY PLANT AND BOILER DATA

PLANT NAME: ______________________

ITEM NO.		BOILER IDENTIFICATION NO. 1	2	3	4	5	6
1.	Boiler Manufacturer						
2.	Year Placed in Service						
3.	Estimated Lifetime						
4.	Type of Service: Base, Peak, etc.						
5.	Boiler Operating Cycle[a]						
6.	Maximum Continuous Generating Capacity, MW						
7.	Boiler Operation, hrs/yr						
8.	Year Applicable						
9.	Boiler Capacity Factor, %[b]						
10.	Range Over Which Boiler Operated, % of Max.						
11.	Maximum Continuous Heat Input (Oil), 10^6 Btu/hr						
12.	Unit Heat Rate, Btu/kwh						
13.	Max. Oil Consumption[c], bbl/hr						
14.	Percent Excess Air						
15.	Serviced by Stack Number						
16.	Maximum Continuous Flue Gas (Oil[c]) Rate: acfm						
17.	Flue Gas Temperature: ^{o}F						
18.	Projected Life, yrs						
19.	Projected Operating Load Factors						

a. % Max. Capacity vs. Time

b. Defined as $\frac{\text{KWH Generated in Year}}{\text{Max. Cont. Gen. Cap in KW} \times 8760 \text{ hrs}}$

c. Oil Currently Used

TABLE A-14

UTILITY PLANT AND BOILER DATA (continued)

		Now in Use	Anticipated 0.5% S
20.	Fuel Oil		
	Grade		
	% Sulfur		
	% Ash		
	GHV, Btu/bbl		
	Consumption, bbl/day		
21.	Emission Controls in Use		
	Particulates		
	SO_2		
22.	Unique Characteristics Relative to SO_2 Emissions		
23.	Fresh Water Consumption, GPD		
24.	Source		
25.	Any Limitations of Availability of Scrubber System Makeup Water		
26.	Water Treatment Facilities		
27.	Max. Water Treatment Capacity Gal/day		
28.	Type of Soil		
29.	Depth to Water Table		
30.	Plant Location (city and county)		
31.	Total Site Area, Acres		
32.	Additional Construction Planned?		
33.	If Construction Planned, Land Area Needed		
34.	Limitations, if any, on Acquisition of Additional Land		

TABLE A-14

UTILITY PLANT AND BOILER DATA (continued)

35.	Number of Stacks	______
36.	Stack Heights Above Grade, ft.	______
37.	Height Restrictions, if Any	______
38.	Plant Equipment Layout (drawings)	______
39.	Maintenance Shutdown Schedule	______
40.	Transportation & Unloading Facilities (railroad sidings, docks, etc.	______
41.	Other	______

Preliminary

TABLE A-15
PLANT PROCESS DATA

1. Plant Name

2. Installation Location

3. Source Characteristics (i.e., Contact acid, etc.)

4. Process Flow Diagram (Schematic or Reference, etc.)

5. Source Rating (Tons/Day Product)

6. Total Exhaust Discharge, (Volume) ACFM SCFM

7. Exhaust Gas Temperature °F

8. SO_2 Concentration in Exhaust Gas (ppm or Volume %)

9. Oxygen Concentration in Exhaust Gas (%)

10. Number of Units (If greater than 1, please indicate rates (item 6) for each unit)

11. Number of Stacks

12. Annual Operation (Hrs)

13. Annual Average Operation (% of Maximum Capacity)

14. Hours per year at Maximum Capacity

15. Age of Installation

16. Projected Installation Lifetime (Years)

TABLE A-15

PLANT PROCESS DATA Continued Page 2

17. Any Projected Change in Operating Mode During Remainder of Projected Lifetime ______________________

18. Source of Steam and Electrical Power ______________________

19. Emission Controls in Use; Particulates and SO_2 ______________________

20. Emission Control Characteristics; i. e., % Removal SO_2, etc. ______________________

21. Fresh Water Consumption, GPD ______________________

22. Source ______________________

23. Any Limitations of Availability of Scrubber System Makeup Water ______________________

24. Max. Waste Water Treatment Capacity Gal/day ______________________

25. Water Treatment Facilities, Type ______________________

26. Plant Location (city and county Jurisdiction) ______________________

27. Total Site Area, Acres ______________________

28. Additional Construction Planned? ______________________

29. If Construction Planned, Land Area Needed ______________________

30. Limitations, if any, on Acquisition of Additional Land ______________________

TABLE A-15

PLANT PROCESS DATA Continued Page 3

31. Restrictions/Limitations on On-Site Disposal of Scrubber Solids ____________________

32. Height Restrictions, if Any ____________________

33. Other Considerations Limiting Installation of SO_2 Scrubbers ____________________

34. Plant Equipment Layout (Plot Plan) ____________________

35. Maintenance Shutdown Schedule ____________________

36. Transportation Facilities (Railroad sidings, barge, etc) ____________________

37. Other ____________________

APPENDIX B

STATIONARY SOURCE PLOT PLANS

Plot plans which may be used in conjunction with the illustrations presented in Sections 4.4.1 and 4.4.2 in locating the scrubber system equipment are shown in Figures B-1 through B-11 for the utility and industrial sites. A plot plan for the Great Lakes Carbon facility was not available in the course of the study; a sketch based on on-site visits and aerial photographs is presented in Section 4.4.2

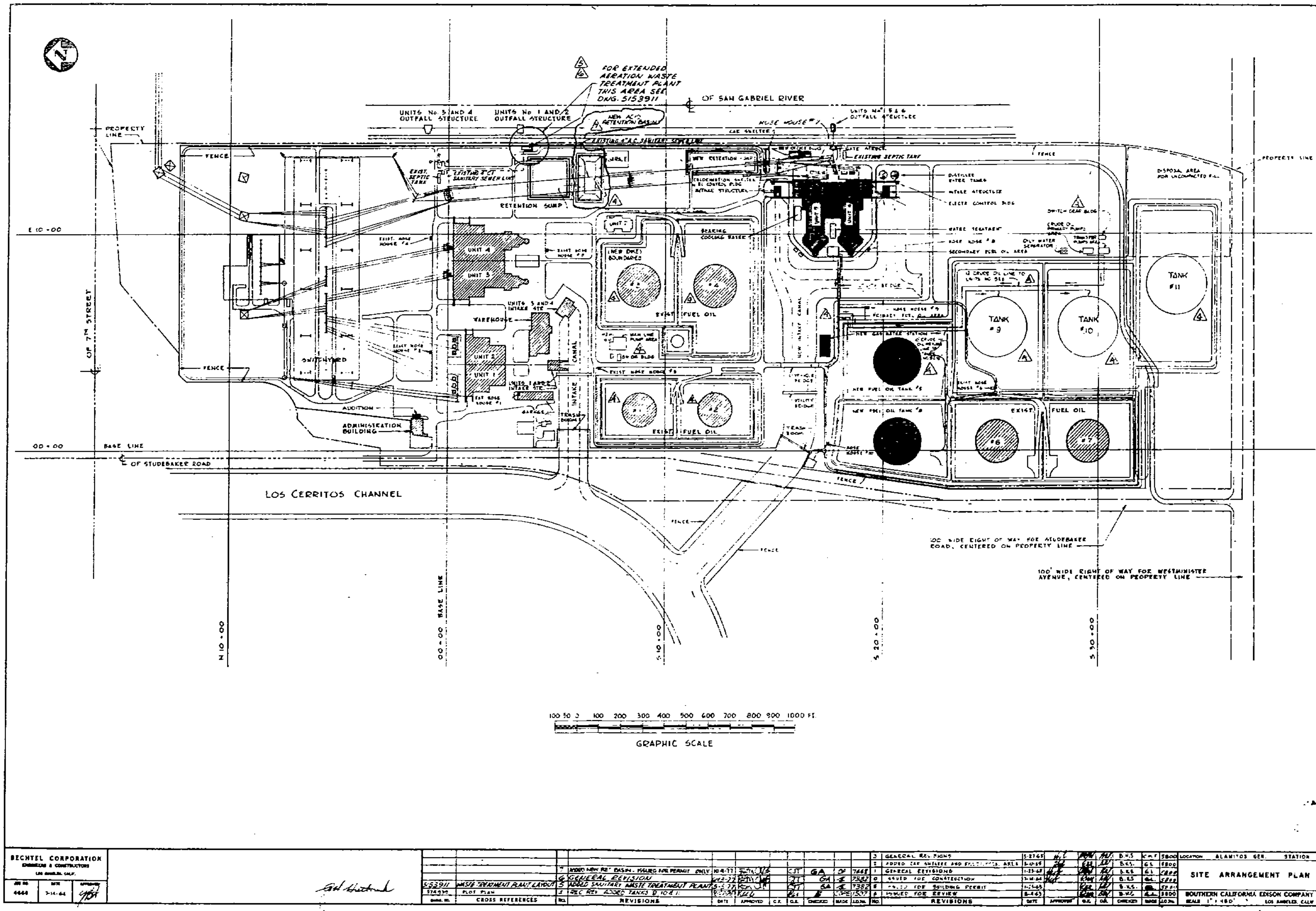


Figure B-1. Plot plan: Alamitos

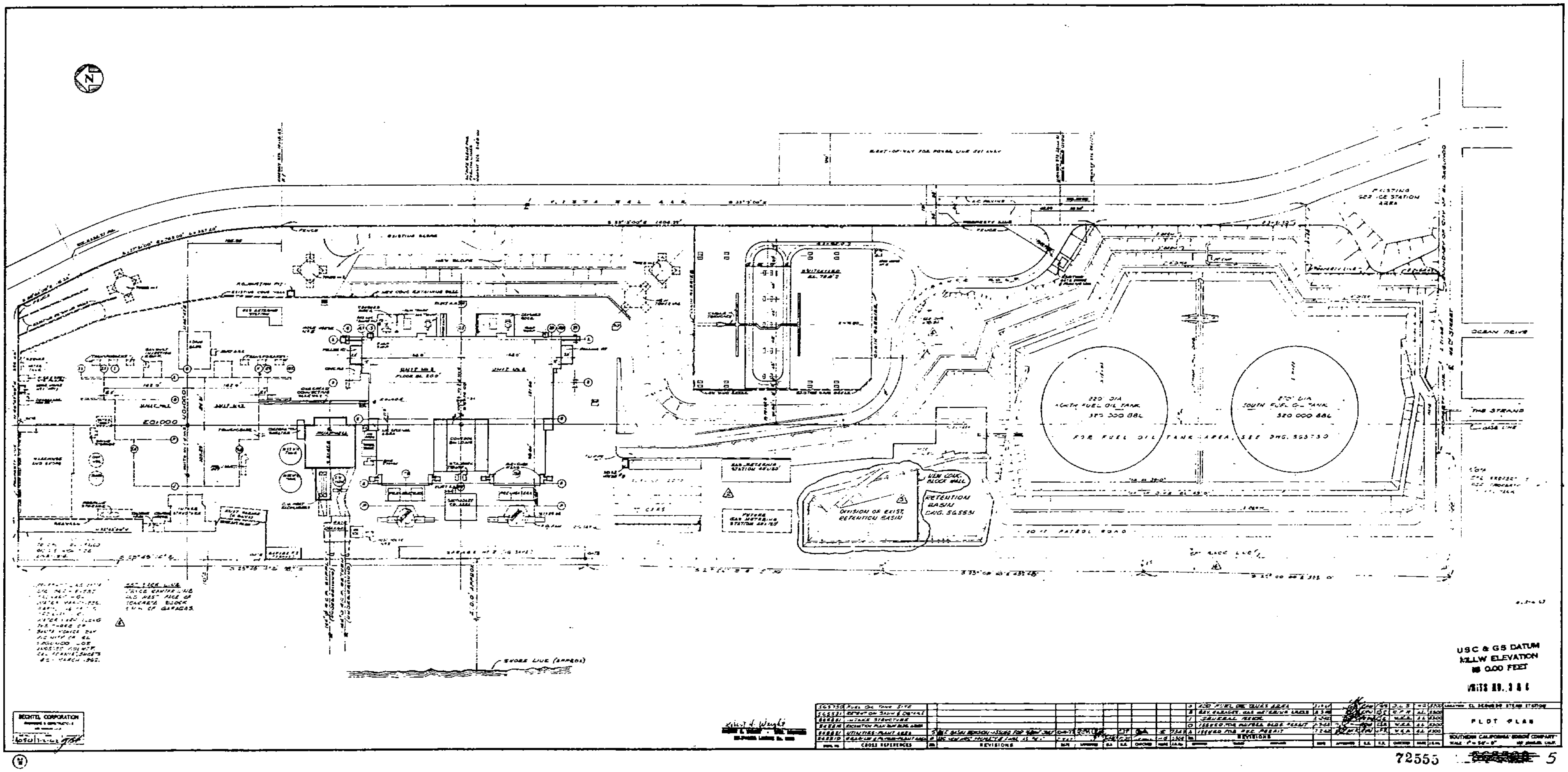


Figure B-2. Plot plan: El Segundo

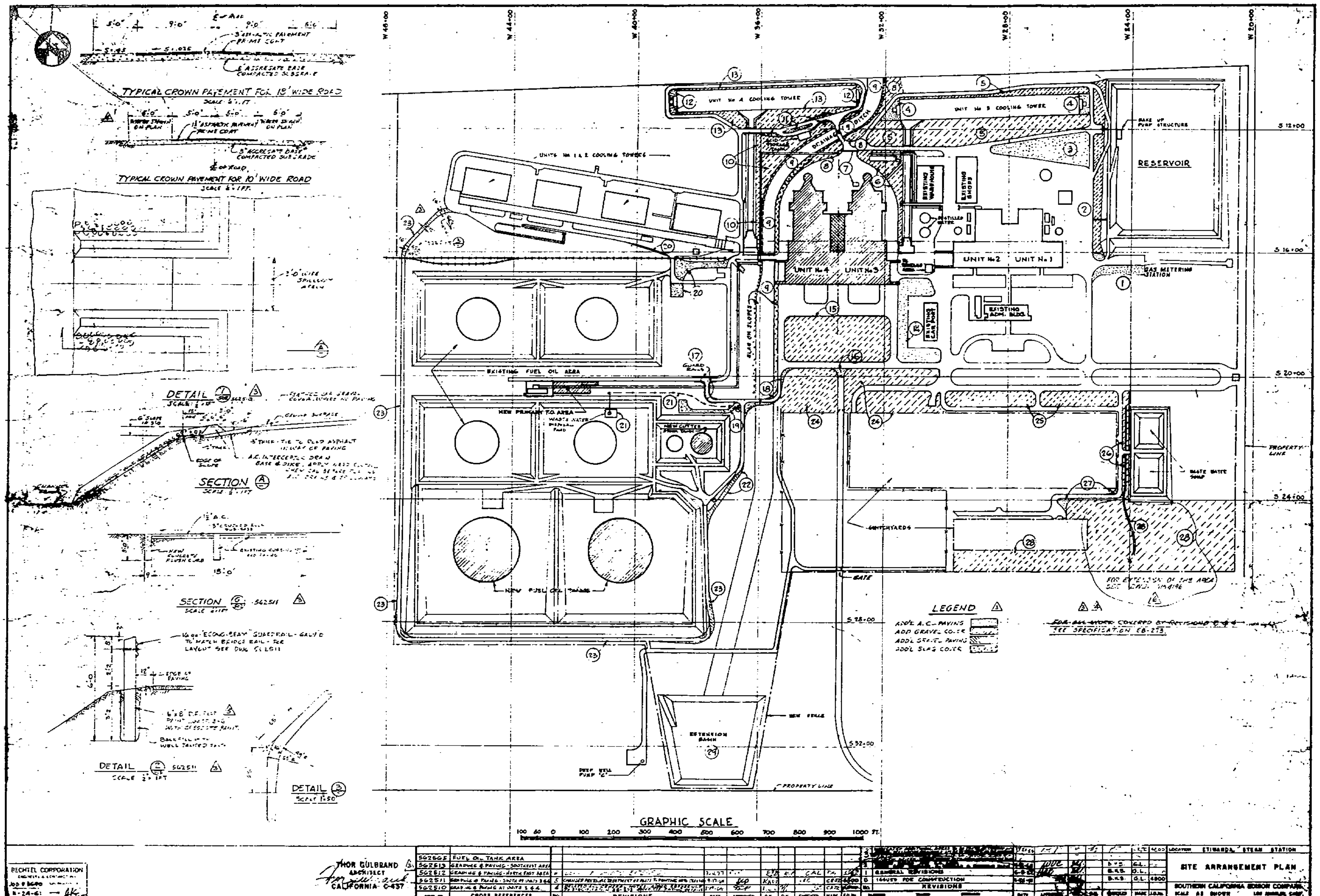


Figure B-3. Plot plan: Etiwanda

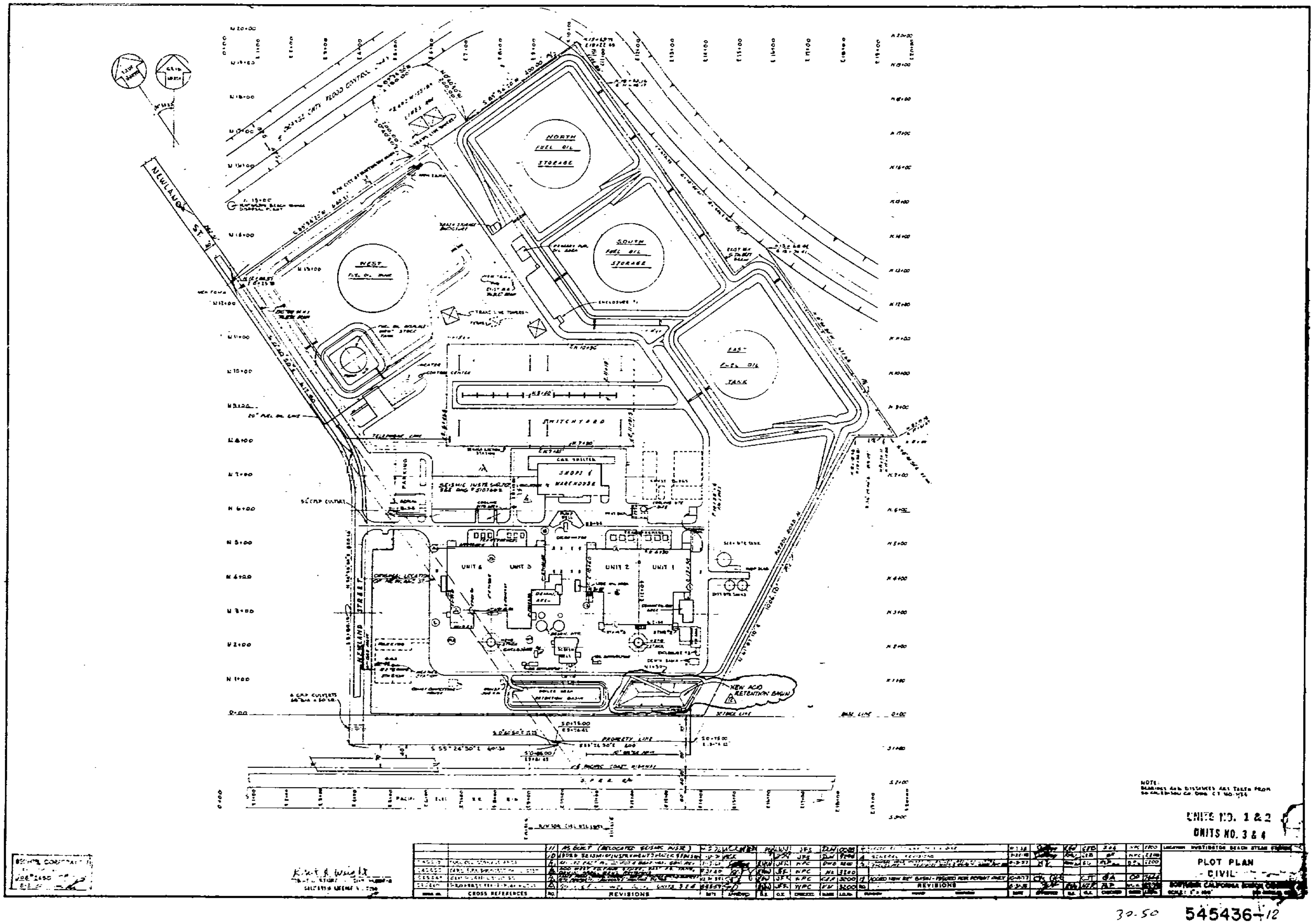


Figure B-4. Plot plan: Huntington Beach

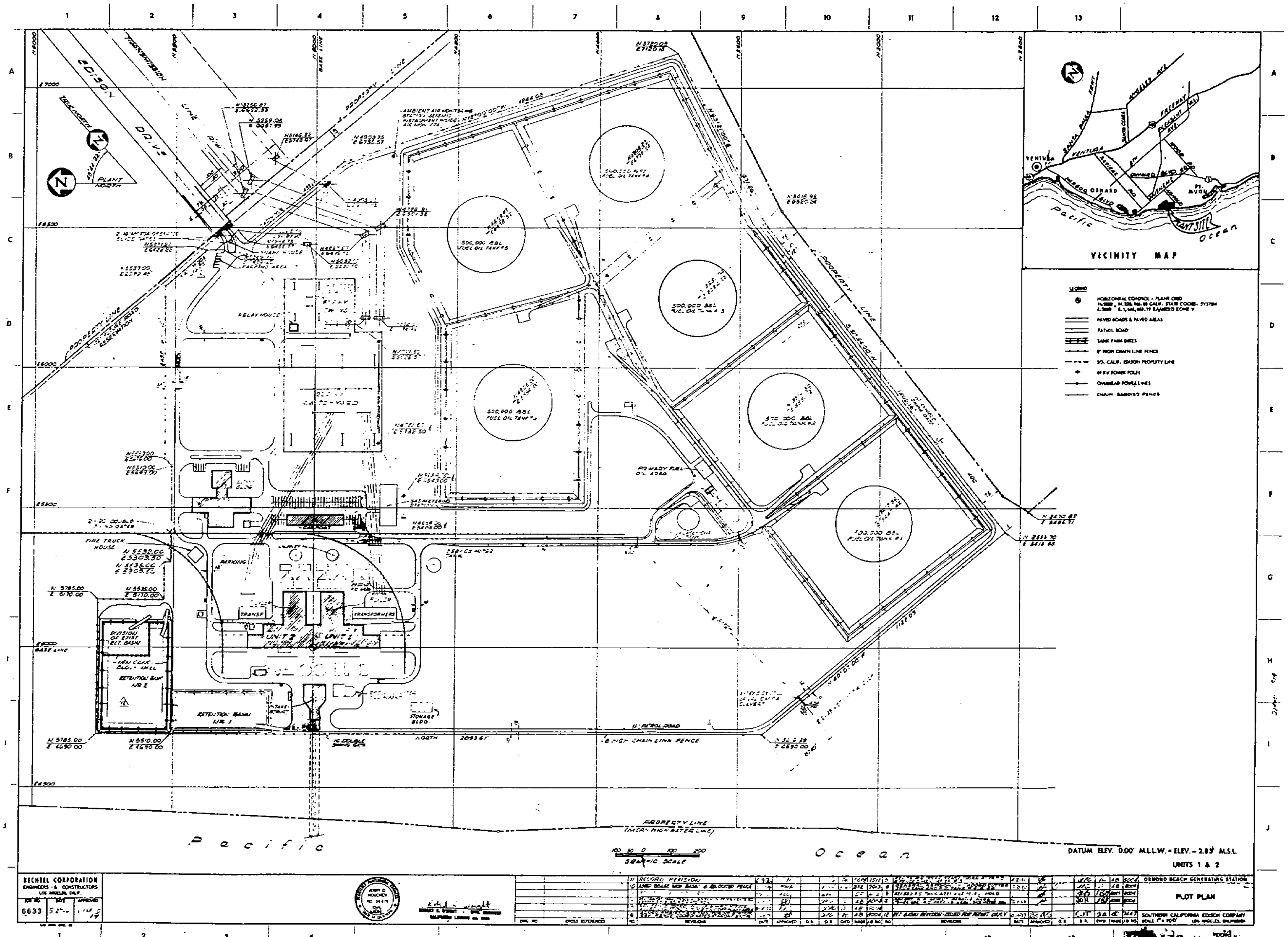


Figure B-5. Plot plan: Ormond Beach

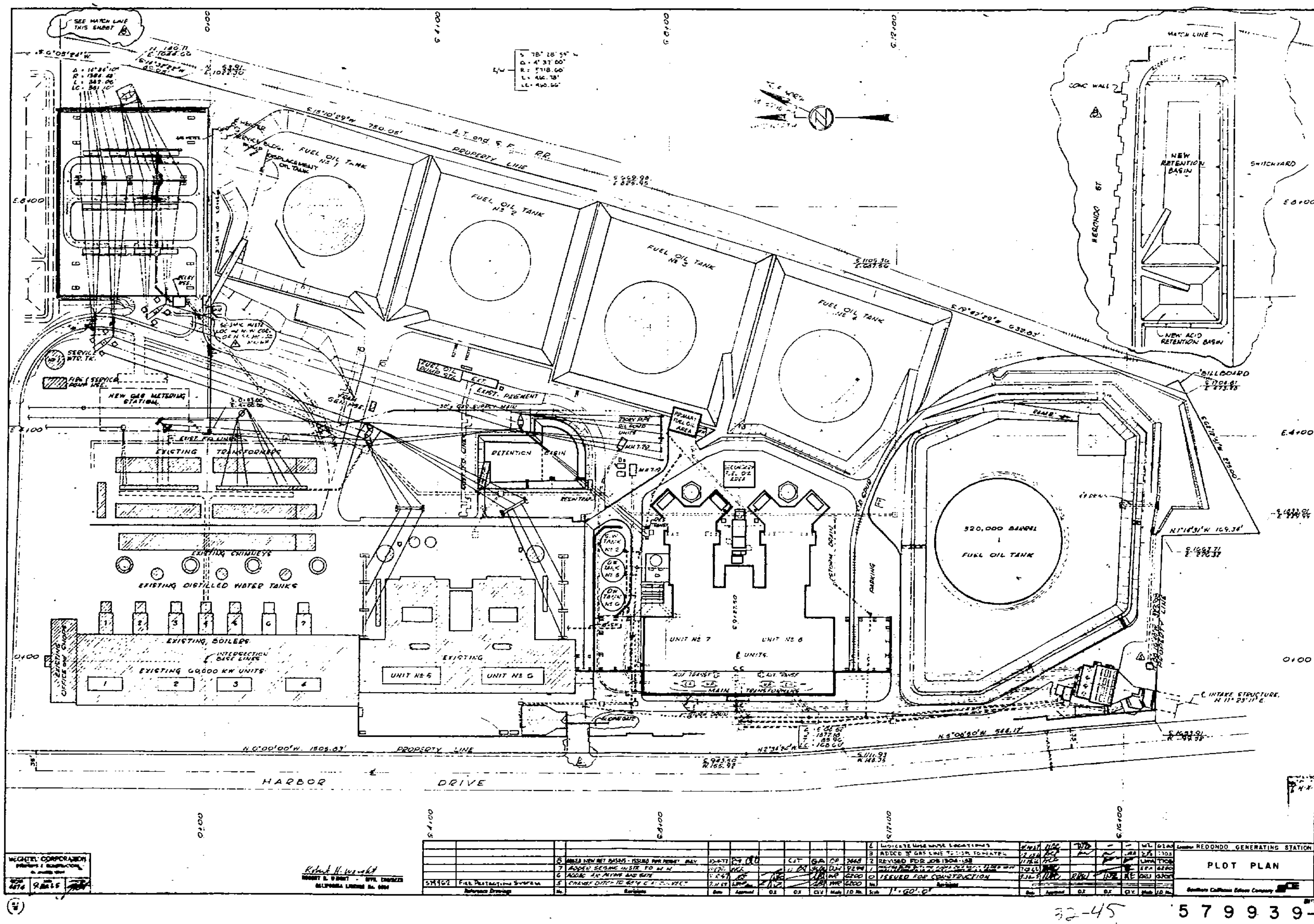


Figure B-6. Plot plan: Redondo Beach

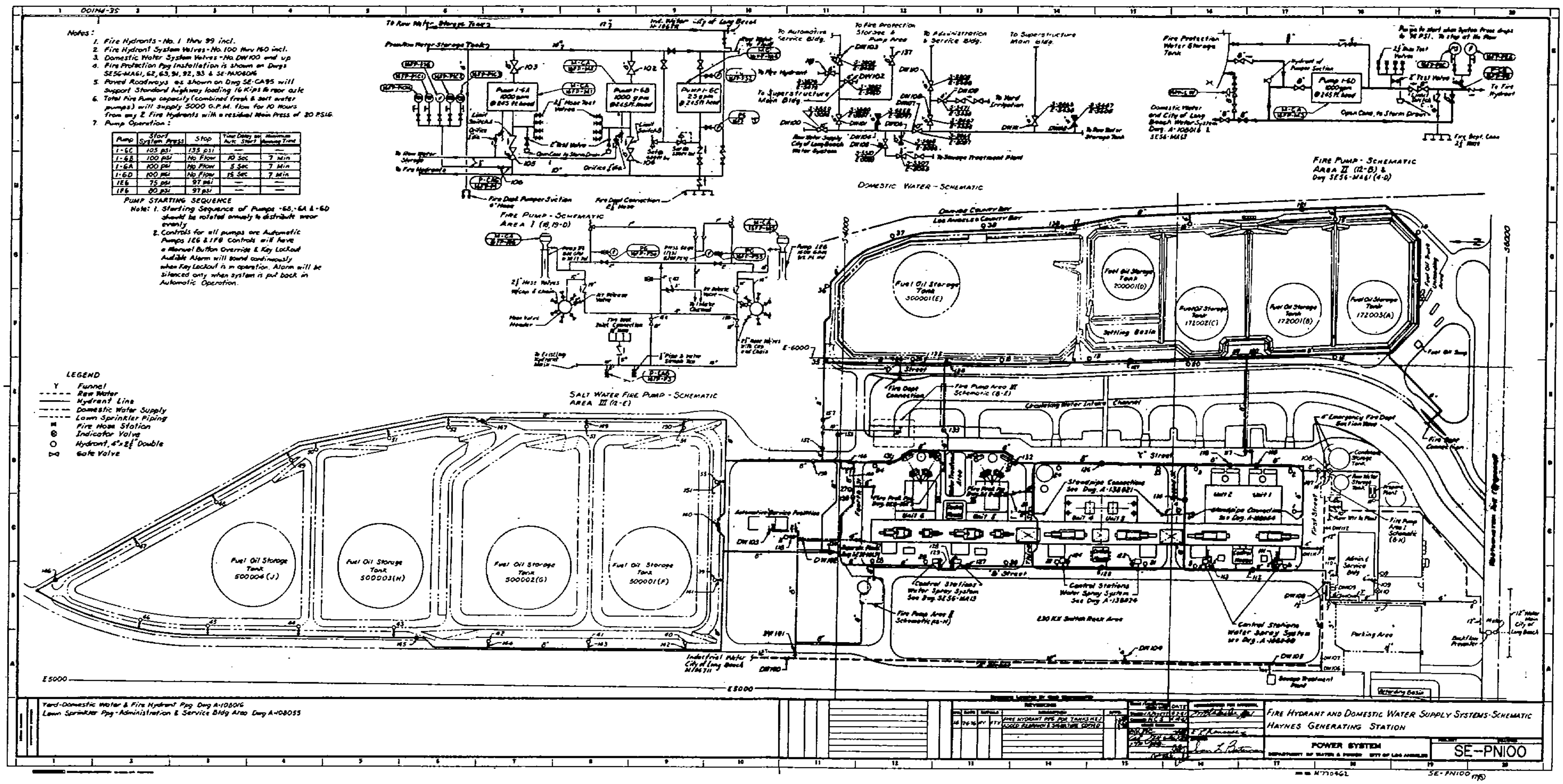


Figure B-7. Plot plan: Haynes

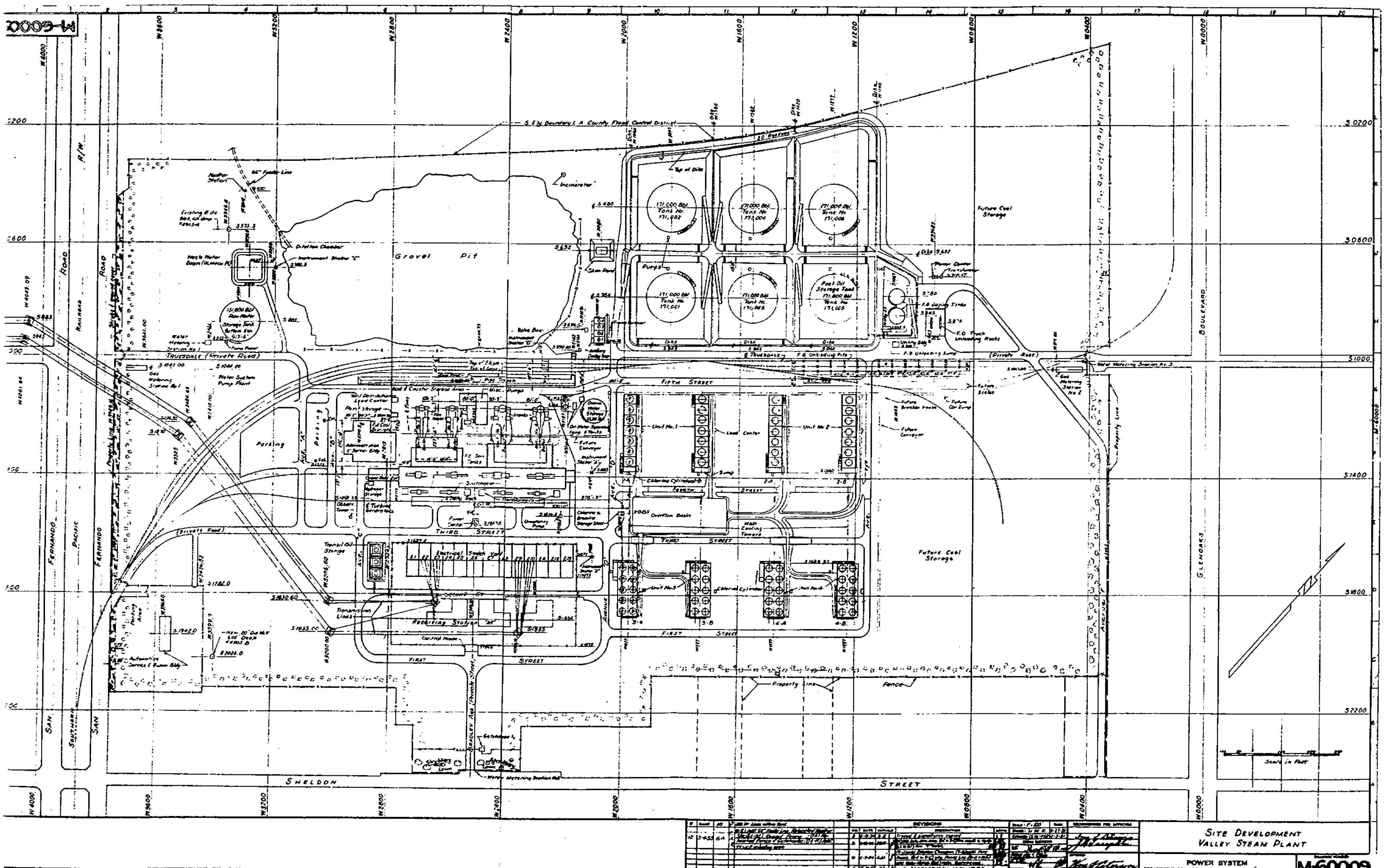


Figure B-8. Plot plan: Valley

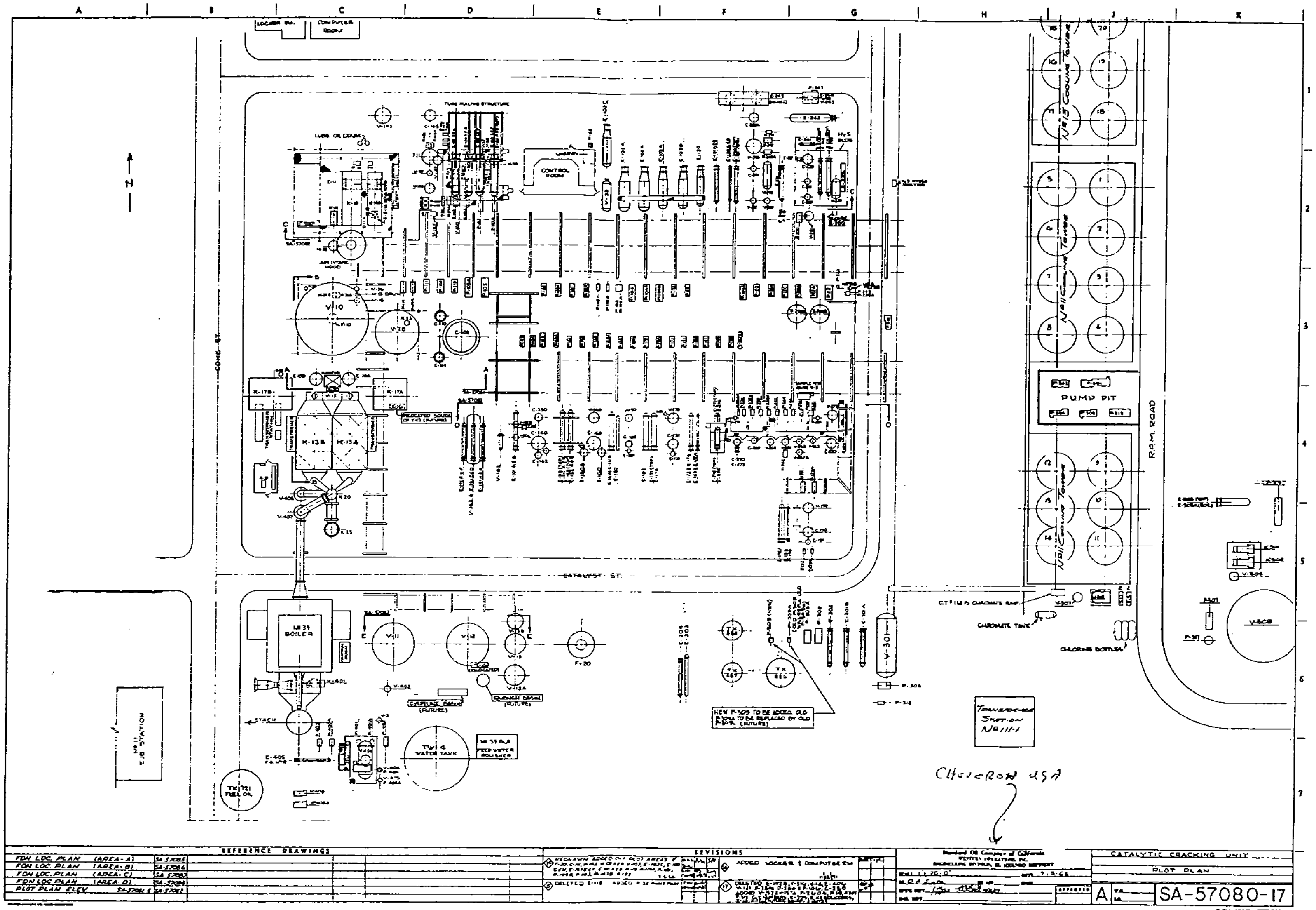


Figure B-9. Plot plan: Chevron, El Segundo

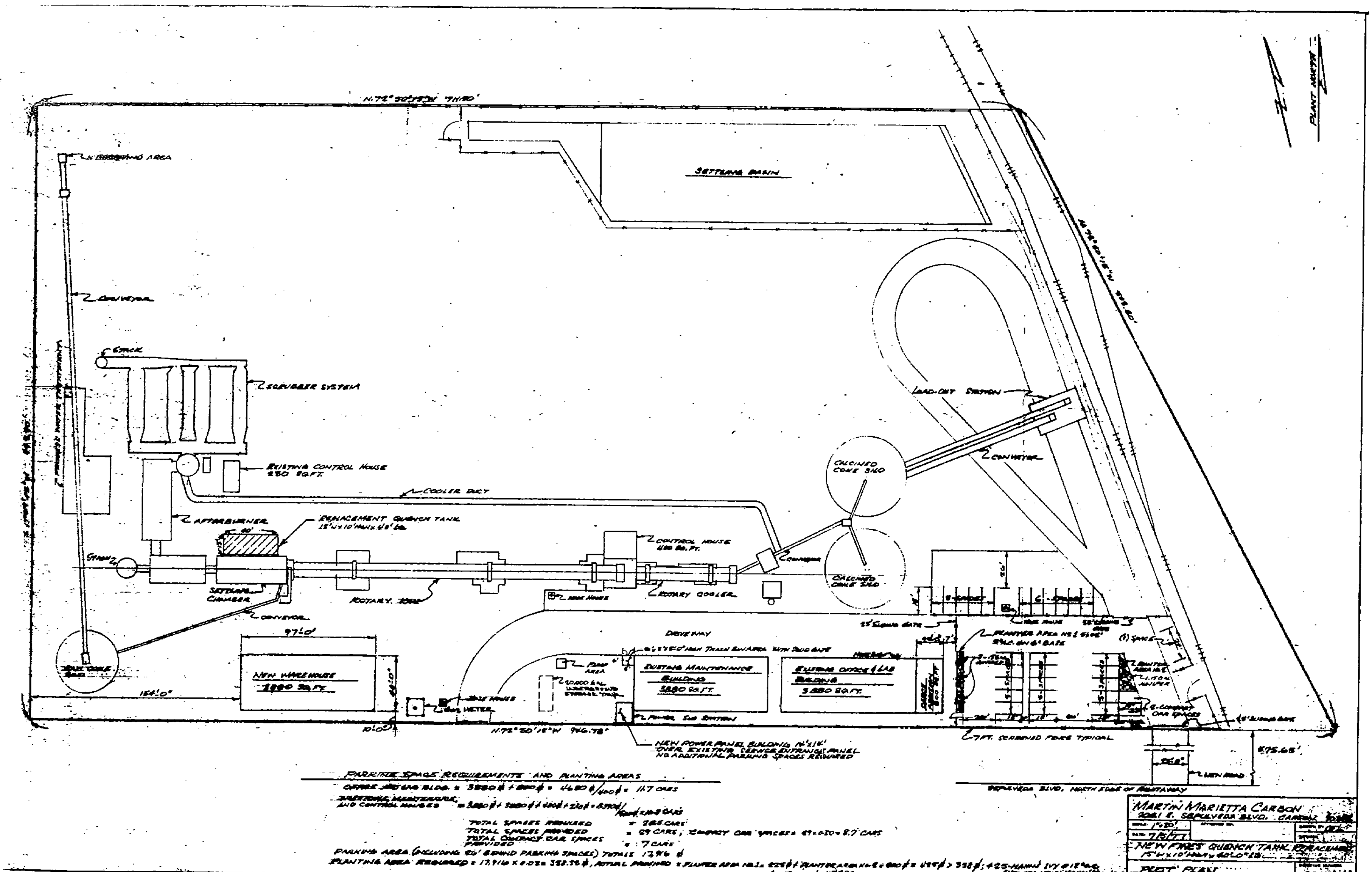


Figure B-10. Plot plan: Martin Marietta Carbon

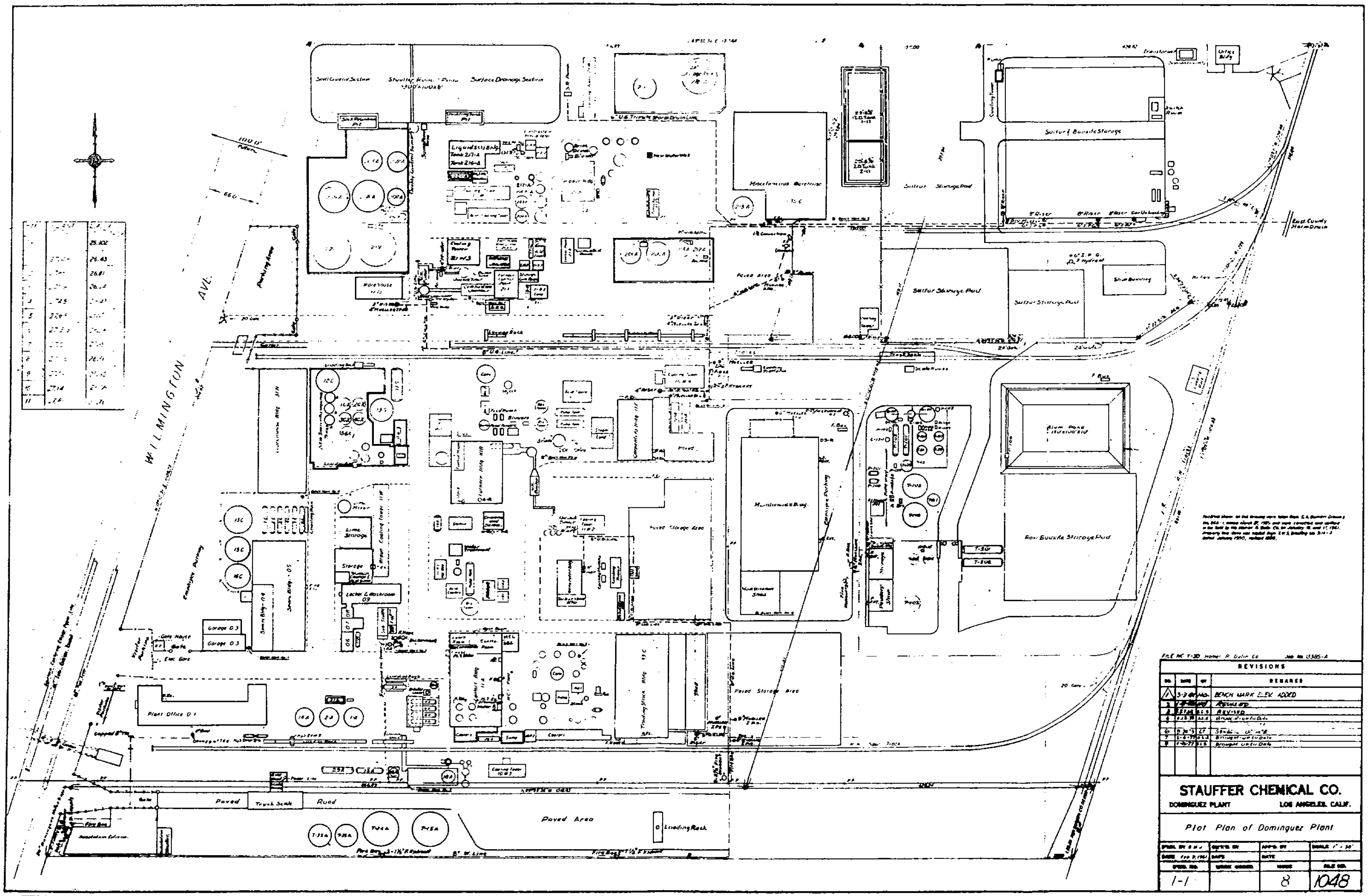


Figure B-11. Plot plan: Stauffer Chemical Company. Dominguez plant

APPENDIX C

SCRUBBING COST DATA

For the utility and industrial plants studied, unit costs are provided in Table C-1, and the basis for operating labor requirements used in computations are shown in Table C-2.

Data sheets outlining the operating and annualized costs for the scrubber processes at each of the eight utility and four industrial sites are provided in Tables C-3 through C-16. Generally, a 20-year lifetime was considered. Because of the age differences of Redondo Units 1 through 4, relative to the other Redondo and the Southern California Edison (SCE) generating facilities. they were computed separately, with a 10-year life assumed.

These costs are summarized and discussed in Section 4. 5. 2.

TABLE C-1. ESTIMATED UNIT COSTS

Late 1977 dollars

	Item	Unit Cost
1.	Makeup water	\$0.50/1000 gal
2.	Electrical power	\$0.025/kWh, Utilities \$0.035/kWh, Industrial
3.	Reheat (low pressure steam)	\$1.70/million Btu[a]
4.	Operating labor	\$15/hr
5.	Maintenance, labor, and materials	3 percent of capital or supplier estimates (if provided)
6.	Lime	\$42/ton[b]
	Soda ash	\$80/ton
7.	Disposal	Approximately \$7.14/ton[c]
8.	Annual charges, 9 percent on capital 20 yr	19 percent[d]
9.	Taxes, insurance, interim replacement	Approximately 6.5 percent of capital cost (included in item 8)

[a]Ref. 10

[b]Based on verbal estimates for Los Angeles area (Appendix D)

[c]Each site computed on a site specific basis (Table 74)

[d]Based on 20-yr life, 9 percent interest rate, except for DWP Valley and SCE Redondo Units 1 through 4, for 10 yr, 9 percent interest = 24 percent annual charge on capital (Table 69)

TABLE C-2. OPERATING LABOR ESTIMATE

Extracted from T. C. Ponder, Jr., et al., <u>Simplified Procedures for Estimating Flue Gas Desulfurization System Costs</u>, EPA-600/2-76-150 (June 1976)

Generating capacity, MW	Men/Shift
100 to 699	3.16
700 to 1200	3.33
1201 to 2500	4.50
2501 and above	5.33

TABLE C-3. SCRUBBING COSTS: ALAMITOS

All costs in late 1977 dollars

MW = 1,950 Capacity factor = 0.442 hr/yr = 3,872[a]

	Item	Quantity	Average annual operating costs, $(000)	
			Reheat = 50°F	125°F
1.	Makeup water (0.67 gpm/MW)	1,310 gpm (maximum) 3.06×10^8 gpy	153	153
2.	Electrical power (1.25 percent of generated)	24,375 kW 94.4×10^6 kWh	2,360	2,360
3.	Steam (reheat)	1.022×10^{12} Btu 2.554×10^{12} Btu	1,737 --	-- 4,340
4.	Operating labor 4.5 men/shift	39,420 hr/yr	591	591
5.	Maintenance 3 percent of capital	$\$235.2 \times 10^6$	7,056	7,056
6.	Lime at $42/ton	16,500 tons/yr	693	693
7.	Disposal at $7.28/ton	61,000 tons/yr	444	444
8.	Annual charges, 19 percent	$\$235.2 \times 10^6$	44,688	44,688
9.	Total	--	57,722	60,325

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	7.6	3,421	5.21	0.85
125°F	8.0	3,575	5.45	0.89

[a] Equivalent hours annually at maximum capacity
[b] 16,873 tons of sulfur dioxide removed annually
[c] 11,070,000 barrels burned annually

TABLE C-4. SCRUBBING COSTS: EL SEGUNDO

All costs in late 1977 dollars

MW = 1,020 Capacity factor = 0.444 hr/yr = 3,889[a]

Item	Quantity	Average annual operating costs, $(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	683 gpm (maximum) 1.59×10^8 gpy	80	80
2. Electrical power (1.25 percent of generated)	12,750 kW 49.6×10^6 kWh	1,240	1,240
3. Steam (reheat)	5.583×10^{11} Btu 1.396×10^{12} Btu	949 --	-- 2,373
4. Operating labor 3.33 men/shift	29,170 hr/yr	438	438
5. Maintenance 3 percent of capital	$\$164.7 \times 10^6$	4,941	4,941
6. Lime at $42/ton	9,000 tons/yr	378	378
7. Disposal at $6.60/ton	33,100 tons/yr	218	218
8. Annual charges, 19 percent	164.7×10^6	31,293	31,293
9. Total	--	39,537	40,961

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	10.1	4,295	6.96	1.14
125°F	10.3	4,449	7.21	1.18

[a]Equivalent hours annually at maximum capacity

[b]9,206 tons of sulfur dioxide removed annually

[c]5,680,000 barrels burned annually

TABLE C-5. SCRUBBING COSTS: ETIWANDA

All costs in late 1977 dollars

MW = 904 Capacity factor = 0.498 hr/yr = 4,362[a]

Item	Quantity	Average annual operating costs, \$(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	605 gpm (maximum) 1.58×10^8 gpy	79	79
2. Electrical power (1.25 percent of generated)	11,300 kW 49.3×10^6 kWh	1,232	1,232
3. Steam (reheat)	5.623×10^{11} Btu 1.406×10^{12} Btu	956 --	-- 2,390
4. Operating labor 3.33 men/shift	29,170 hr/yr	438	438
5. Maintenance 3 percent of capital	$\$130.1 \times 10^6$	3,903	3,903
6. Lime at \$42/ton	9,000 tons/yr	378	378
7. Disposal at \$8.29/ton	33,500 tons/yr	278	278
8. Annual charges, 19 percent	130.1×10^6	24,719	24,719
9. Total	--	31,983	33,417

Reheat	mills/kWh	\$/ton of sulfur dioxide removed[b]	Fuel oil,[c] \$/bbl	\$/MMBtu
50°F	8.1	3,437	5.51	0.90
125°F	8.5	3,591	5.76	0.94

[a] Equivalent hours annually at maximum capacity

[b] 9,305 tons of sulfur dioxide removed annually

[c] 5,800,000 barrels burned annually

TABLE C-6. SCRUBBING COSTS: HUNTINGTON BEACH

All costs in late 1977 dollars

MW = 870 Capacity factor = 0.434 hr/yr = 3,802[a]

	Item	Quantity	Average annual operating costs, \$(000)	
			Reheat = 50°F	125°F
1.	Makeup water (0.67 gpm/MW)	585 gpm (maximum) 1.33×10^8 gpy	66	66
2.	Electrical power (1.25 percent of generated)	10,875 kW 41.3×10^6 kWh	1,032	1,032
3.	Steam (reheat)	4.405×10^{11} Btu 1.101×10^{12} Btu	749 --	-- 1,872
4.	Operating labor 3.33 men/shift	29,170 hr/yr	438	438
5.	Maintenance 3 percent of capital	$\$124.2 \times 10^6$	3,726	3,726
6.	Lime at \$42/ton	7,100 tons/yr	298	298
7.	Disposal at \$7.75/ton	26,200 tons/yr	203	203
8.	Annual charges, 19 percent	$\$124.2 \times 10^6$	23,598	23,598
9.	Total	--	30,110	31,233

Reheat	mills/kWh	\$/ton of sulfur dioxide removed[b]	Fuel oil,[c] \$/bbl	\$/MMBtu
50°F	9.1	4,129	6.41	1.05
125°F	9.4	4,283	6.64	1.09

[a] Equivalent hours annually at maximum capacity
[b] 7,292 tons of sulfur dioxide removed annually
[c] 4,700,000 barrels burned annually

TABLE C-7. SCRUBBING COSTS: REDONDO BEACH (UNITS 1 THROUGH 4)

All costs in late 1977 dollars

MW = 292 Capacity factor = 0.15 hr/yr = 1,314[a]

Item	Quantity	Average annual operating costs $(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	196 gpm (maximum) 1.54×10^7 gpy	8	8
2. Electrical power (1.25 percent of generated)	3,650 kW 4.80×10^6 kWh	120	120
3. Steam (reheat)	5.742×10^{10} Btu 1.435×10^{11} Btu	98 --	-- 244
4. Operating labor 0.8 men/shift	7,008 hr/yr	105	105
5. Maintenance 3 percent of capital	$\$43.9 \times 10^6$	1,317	1,317
6. Lime at $42/ton	900 tons/yr	38	38
7. Disposal at $6.46/ton	3,100 tons/yr	20	20
8. Annual charges, 24 percent	$\$43.9 \times 10^6$	10,536	10,536
9. Total	--	12,242	12,388

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	31.9	14,300	118.8	19.48
125°F	32.3	14,470	120.3	19.72

[a]Equivalent hours annually at maximum capacity

[b]856 tons of sulfur dioxide removed annually

[c]103,000 barrels burned annually

TABLE C-8. SCRUBBING COSTS: REDONDO BEACH (UNITS 5 THROUGH 8)

All costs in late 1977 dollars

MW = 1,310 Capacity factor = 0.451 hr/yr = 3,951[a]

Item		Quantity	Average annual operating costs, $(000)	
			Reheat = 50°F	125°F
1.	Makeup water (0.67 gpm/MW)	878 gpm (maximum) 2.08×10^{8} gpy	104	104
2.	Electrical power (1.25 percent of generated)	16,375 kW 6.47×10 kWh	1,617	1,617
3.	Steam (reheat)	6.978×10^{11} Btu 1.744×10^{12} Btu	1,186 --	-- 2,965
4.	Operating labor 3.7 men/shift	32,412 hr/yr	486	486
5.	Maintenance 3 percent of capital	$\$197.0 \times 10^{6}$	5,910	5,910
6.	Lime at $42/ton	11,200 tons/yr	470	470
7.	Disposal at $6.46/ton	41,600 tons/yr	268	268
8.	Annual charges, 19 percent	$\$197.0 \times 10^{6}$	37,430	37,430
9.	Total	--	47,471	49,250

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	9.2	4,111	6.13	1.00
125°F	9.5	4,265	6.36	1.04

[a] Equivalent hours annually at maximum capacity

[b] 11,548 tons of sulfur dioxide removed annually

[c] 7,740,000 barrels burned annually

TABLE C-9. SCRUBBING COSTS: ORMOND BEACH

All costs in late 1977 dollars

MW = 1,600 Capacity factor = 0.454 hr/yr = 3,977[a]

Item	Quantity	Average annual operating costs, $(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	1,072 gpm (maximum) 2.56×10^8 gpy	128	128
2. Electrical power (1.25 percent of generated)	20,000 kW 7.95 × 10 kWh	1,988	1,988
3. Steam (reheat)	8.555×10^{11} Btu 2.139×10^{12} Btu	1,454 --	-- 3,636
4. Operating labor 4.5 men/shift	39,420 hr/yr	591	591
5. Maintenance 3 percent of capital	$\$194.9 \times 10^6$	5,847	5,847
6. Lime at $42/ton	14,000 tons/yr	588	588
7. Disposal at $6.45/ton	50,000 tons/yr	322	322
8. Annual charges, 19 percent	$\$194.9 \times 10^6$	37,031	37,031
9. Total	--	47,949	50,131

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	7.5	3,474	5.48	0.90
125°F	7.9	3,632	5.73	0.94

[a] Equivalent hours annually at maximum capacity

[b] 13,802 tons of sulfur dioxide removed annually

[c] 8,750,000 barrels burned annually

TABLE C-10. SCRUBBING COSTS: HAYNES

All costs in late 1977 dollars

MW = 1,633 Capacity factor = 0.667 hr/yr = 5,843[a]

Item	Quantity	Average annual operating costs, $(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	1,049 gpm (maximum) 3.84×10^8 gpy	192	192
2. Electrical power (1.25 percent of generated)	20,142 kW 1.19×10^8 kWh	2,975	2,975
3. Steam (reheat)	1.237×10^{12} Btu 3.092×10^{12} Btu	2,103 --	-- 5,256
4. Operating labor 4.5 men/shift	39,420 hr/yr	591	591
5. Maintenance 3 percent of capital	$\$191.9 \times 10^6$	5,757	5,757
6. Lime at $42/ton	20,000 tons/yr	840	840
7. Disposal at $7.21/ton	74,000 tons/yr	534	534
8. Annual charges, 19 percent	191.9×10^6	36,461	36,461
9. Total	--	49,453	52,606

Reheat	mills/kWh	$/ton of sulfur dioxide removed[b]	Fuel oil,[c] $/bbl	$/MMBtu
50°F	5.2	2,426	3.43	0.56
125°F	5.5	2,580	3.65	0.60

[a] Equivalent hours annually at maximum capacity

[b] 20,387 tons of sulfur dioxide removed annually

[c] 14,400,000 barrels burned annually

TABLE C-11. SCRUBBING COSTS: VALLEY

All costs in late 1977 dollars

MW = 526 Capacity factor = 0.158 hr/yr = 1,384[a]

Item	Quantity	Average annual operating costs, \$(000)	
		Reheat = 50°F	125°F
1. Makeup water (0.67 gpm/MW)	352 gpm (maximum) 2.92×10^7 gpy	15	15
2. Electrical power (1.25 percent of generated)	6,575 kW 9.1×10^6 kWh	228	228
3. Steam (reheat)	1.104×10^{11} Btu 2.760×10^{11} Btu	188 --	-- 469
4. Operating labor 3.16 men/shift	27,682 hr/yr	415	415
5. Maintenance 3 percent of capital	$\$81.2 \times 10^6$	2,436	2,436
6. Lime at \$42/ton	1,800 tons/yr	76	76
7. Disposal at \$5.90/ton	6,500 tons/yr	38	38
8. Annual charges, 24 percent	$\$81.2 \times 10^6$	19,488	19,488
9. Total	--	22,884	23,165

Reheat	mills/kWh	\$/ton of sulfur dioxide removed[b]	Fuel oil,[c] \$/bbl	\$/MMBtu
50°F	31.4	12,671	117.0	19.18
125°F	31.8	12,827	118.5	19.43

[a]Equivalent hours annually at maximum capacity

[b]1,806 tons of sulfur dioxide removed annually

[c]195,500 barrels burned annually

TABLE C-12. SCRUBBING COSTS: CHEVRON, EL SEGUNDO (CARBON MONOXIDE BOILER)

All costs in late 1977 dollars

MW = 80 (equivalent)[a] Operating factor = approximately 0.85[b] hr/yr = 8,395[c]

Item		Quantity (1 boiler)	Average annual operating costs, $(000)	
			Reheat = 50°F	125°F
1.	Makeup water	140 gpm (maximum) 6.35×10^7 gpy	32	32
2.	Electrical power (1.25 × supplier estimate)	4.96×10^6 kWh	174	174
3.	Steam (reheat)	4.98×10^{10} Btu 1.24×10^{11} Btu	85 --	-- 211
4.	Operating labor 0.5 men/shift	4,200 hr/yr	63	63
5.	Maintenance 3 percent of capital	$\$12.4 \times 10^6$	372	372
6.	Lime at $42/ton Soda ash at $80/ton	1,360 tons/yr 640 tons/yr	57 51	57 51
7.	Disposal at $6.65/ton	5,666 tons/yr filter solids 2,835 tons/yr liquid[d]	38 19	38 19
8.	Annual charges, 19 percent	$\$12.4 \times 10^6$	2,356	2,356
9.	Total	--	3,247	3,373

Reheat	mills/kWh[e]	$/ton of sulfur dioxide removed[f]
50°F	5.7	3,440
125°F	5.9	3,573

[a]Based on flue gas flow of 1,950 scfm/MW

[b]Fraction of the total hours operated annually (see footnote c) at normal capacity

[c]Total hours operated annually

[d]Sulfate solution purge (liquid)

[e]Based on 80 MW (equivalent)

[f]944 tons of sulfur dioxide removed annually

TABLES C-13. SCRUBBING COSTS: GREAT LAKES CARBON (PETROLEUM COKE CALCINING KILNS)

All costs in late 1977 dollars

MW = 300 (equivalent)[a] Operating factor = 1.0[b] hr/yr = 7,920[c]

Item	Quantity (3 kilns)	Average annual operating costs, $(000)	
		Reheat = 50°F	125°F
1. Makeup water	270 gpm 1.28×10^8 gpy	64	64
2. Electrical power (1.25 × supplier estimate)	19.5×10^6 kWh	682	682
3. Steam (reheat)	6.21×10^{10} Btu 1.55×10^{11} Btu	106 --	-- 264
4. Operating labor 1.5 men/shift	11,880 hr/yr	178	178
5. Maintenance	$\$45.7 \times 10^6$	1,371	1,371
6. Lime at $42/ton Soda ash at $80/ton	5,340 tons/yr 2,250 tons/yr	224 180	224 180
7. Disposal at $8.19/ton	22,770 tons/yr filter solids 4,750 tons/yr liquid[d]	186 39	186 39
8. Annual charges, 19 percent	$\$45.7 \times 10^6$	8,683	8,683
9. Total	--	11,713	11,871

Reheat	mills/kWh[e]	$/ton of sulfur dioxide removed[f]
50°F	4.93	2,415
125°F	5.00	2,447

[a] Three kilns, 1,950 scfm/MW

[b] Fraction of the total hours operated annually (see footnote c) at normal capacity

[c] Total hours operated annually each kiln

[d] Sulfate solution purge (liquid)

[e] Based on 300 MW equivalent

[f] 4,851 tons of sulfur dioxide removed annually

TABLE C-14. SCRUBBING COSTS: MARTIN MARIETTA CARBON (PETROLEUM COKE CALCINING KILN)

All costs in late 1977 dollars

MW = 95 (equivalent)[a] Operating factor = 1.0[b] hr/yr = 8,040[c]

Item	Quantity (1 kiln)	Average annual operating costs, \$(000)	
		Reheat = 50°F	125°F
1. Makeup water	90 gpm 43.4×10^6 gpy	22	22
2. Electrical power (1.25 × supplier estimate)	6.5×10^6 kWh	228	228
3. Steam (reheat)	2.10×10^{10} Btu 5.25×10^{10} Btu	36 --	-- 89
4. Operating labor 0.5 men/shift	4,020 hr/yr	60	60
5. Maintenance 3 percent of capital	$\$13.3 \times 10^6$	399	399
6. Lime at \$42/ton Soda ash at \$80/ton	1,810 tons/yr 765 tons/yr	76 61	76 61
7. Disposal at \$7.80/ton	7,705 tons/yr filter solids 1,610 tons/yr liquid[d]	60 13	60 13
8. Annual charges 19 percent	$\$13.3 \times 10^6$	2,527	2,527
9. Total	--	3,482	3,482

Reheat	mills/kWh[e]	\$/ton of sulfur dioxide removed[f]
50°F	4.6	1,140
125°F	4.7	1,157

[a] One kiln, 1,950 scfm/MW

[b] Fraction of the total hours operated annually (see footnote c) at normal capacity

[c] Total hours operated annually

[d] Sulfate solution purge (liquid)

[e] Based on 95 MW (equivalent)

[f] 3,055 tons of sulfur dioxide removed annually

TABLE C-15. SCRUBBING COSTS: STAUFFER CHEMICAL (SULFURIC ACID UNITS)

All costs in late 1977 dollars

MW = 75 (equivalent)[a] Capacity factor = 0.94[b] hr/yr = 8,424[c]

Item	Quantity (3 Units)	Average annual operating costs, $(000)	
		Reheat = 50° F	125°F[d]
1. Makeup water	5 gpm 2.4×10^6 gpy	12	--
2. Electrical power (1.25 × supplier estimate)	1.28×10^6 kWh	45	--
3. Steam (reheat)	3.2×10^{10} Btu	54	--
4. Operating labor (supplier estimate)	6,000 hr	90	--
5. Maintenance 3 percent of capital	$\$11.2 \times 10^6$	336	--
6. Lime at $42/ton	500 tons/yr	21	--
7. Disposal at $8.08/ton	1,760 tons/yr	14	--
8. Annual charges, 19 percent	$\$11.2 \times 10^6$	2,128	--
9. Total	--	2,700	--

Reheat	mills/kWh[e]	$/ton of sulfur dioxide removed[f]
50°F	4.5	5,544
125°F	--	--

[a]Three units, 1950 scfm/MW

[b]Fraction of the total hours operated annually (see footnote c) at normal capacity

[c]Total hours operated annually each unit

[d]Reheat of 125° F not considered. Currently exhaust exits at approximately 80°F

[e]Based on 75 MW (equivalent)

[f]487 tons of sulfur dioxide removed annually

APPENDIX D

AVAILABILITY OF LIME AND LIMESTONE

A number of local suppliers were contacted by telephone to determine the availability, costs, and purity of lime and limestone. The total quantities required for the installations studied are approximately 244 tons per day of lime or 490 tons per day of limestone (89.0×10^3 or $178 \times 9 \times 10^3$ tons per year, respectively).

Either lime or limestone is available in the Los Angeles area in the bulk from at least one supplier in the requisite amounts. The purity of the product is in excess of 90 percent and may be as high as 99 percent for limestone. The price quoted for limestone delivered to Los Angeles is approximately $25 per ton. The price range of lime varied within a range of $34 to $51 per ton. Price varies with the mesh size, the fine mesh costing more than the coarser material. Table D-1 summarizes the information.

TABLE D-1. LIME AND LIMESTONE AVAILABILITY AND COSTS

Supplier	Price,[a] $/ton delivered		Purity, percent		Remarks
	Lime	Limestone	Lime	Limestone	
A	b	$22.90	b	98	Bulk limestone only - lime not available in bulk
B	$34.00	b	95	b	Adequate supply of bulk lime
C	$51.00	$22.00	90 to 97.5	98.5	Both bulk lime and limestone available in any mesh
D	b	$26.50	b	98 to 99	Bulk limestone available in any mesh

[a]Based on No. 6 mesh (pebble)
[b]Not available

APPENDIX E

EFFECT OF INCREASING RATE OF PAYMENT OF SCRUBBER EQUIPMENT

The lifetimes of the industrial and utility plants were estimated to be 20 years on the basis of responses to questionnaires, except for SCE Redondo Units 1 through 4 and DWP Valley Units 1 through 4. These were estimated as 10 years (the scrubber design lifetimes in all cases were considered to be 20 years). In the event capital equipment were paid off at a rate faster than the 20 years considered in this study, factors were developed to adjust the 20-year values to shorter periods. The factors to be applied to capital charges and annualized costs (Tables 70 and 71, respectively) for industrial scrubber lifetimes less than 20 years at 9 percent interest are presented in Figure E-1. Special cases for Redondo Units 1 through 4 and Valley stations are discussed in Section 4.5.2 and summarized here.

The application of these factors to costs initially calculated on a 20-year lifetime assumes that there is no change in plant capacity factor relative to the 20-year value. Therefore, it should be emphasized that these factors will not apply to utilities directly if shorter lifetimes were defined because, as the anticipated lifetimes are shortened, the capacity factor is also reduced; i.e., with a 10-year projected lifetime for SCE Redondo Units 1 through 4 and DWP Valley Units 1 through 4, the average capacity factor is about 15 versus 42.4 percent for the remaining utilities in the study. Therefore, the annualized costs, in mills/kWh, for 10 years relative to 20 years increase not only due to the effects of increased capital charges but also to decreased outputs. Average annualized costs are 8.8 mills/kWh for 20 years and average capacity factor of 42.4, and 31.6 mills/kWh for 10 years and 15 percent.

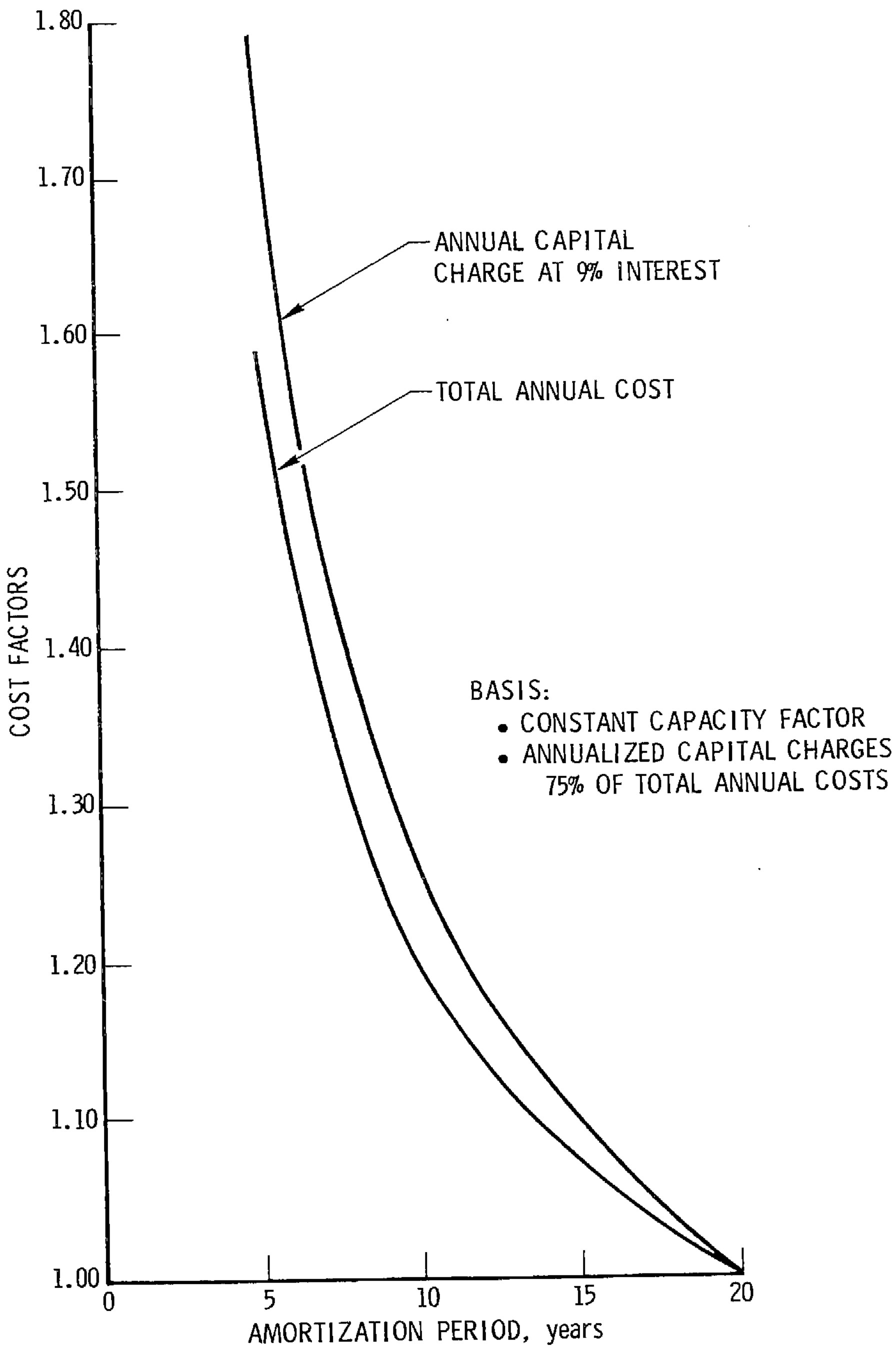


Figure E-1. Cost factors for early payoff of stationary source SO_2 scrubber system relative to 20-year equipment lifetime

An example of the use of Figure E-1 to determine scrubber annualized charges for industrial sources (or any source without a change in capacity factor) as a result of accelerated capital payment is as follows:

a. For 20 years, the annual capital charge rate is 19 percent using a 9 percent interest (Table 69).

b. For a 5-year payoff on scrubber equipment, the annual capital charge rate is $1.79 \times 19\% = 34\%$ (Figure E-1).

c. For Chevron, considering a 20-year SO_2 source lifetime, the annualized cost for scrubbing is \$3440/ton SO_2 removed (Table 71).

d. For Chevron and a 5-year life, the annual cost becomes $1.59 \times 3400 = \$5470$/ton SO_2 removed (Figure E-1).

GLOSSARY

AAF	American Air Filter
AC-FT	acre feet
ACFM	actual cubic feet per minute
AFDC	allowance for funds during construction
B&W	Babcock and Wilcox
CE	Combustion Engineering
CaO	lime
$CaCO_3$	limestone - calcium carbonate
CO	carbon monoxide
DWP	Los Angeles Department of Water and Power
FGD	flue gas desulfurization
gpm	gallons per minute
H_2SO_4	sulfuric acid
IWC	inch water column
kW	kilowatt
kWh	kilowatt-hour
L/G	liquid-to-gas ratio (GPM/1000 ACFM)
MW	megawatt
MWe	megawatt equivalent: The term MWe relates industrial scrubber capacity (based on flue gas flow rates) to an equivalent electrical utility installation. For the industrial SO_2 sources in this study the factor was 1950 actual cubic feet per minute per megawatt (ACFM/MW).
Na_2SO_3	sodium sulfite
O&M	operation and maintenance

ppm	parts per million (by volume)
R-C	Research-Cottrell
SCE	Southern California Edison Company
SCFM	standard cubic feet per minute
SO_2	sulfur dioxide
TCA	turbulent contact absorber
TPY	tons per year
TVA	Tennessee Valley Authority

REFERENCES

1. J. Ando, "Status of SO_2 and NO_x Removal Systems in Japan," Paper presented at the EPA Symposium on Flue Gas Desulfurization, Hollywood, Florida (November 1977).

2. J. Ando and B. A. Laseke, SO_2 Abatement for Stationary Sources in Japan, EPA-600/7-77-103a, U.S. Environmental Protection Agency, Washington, D.C. (September 1977).

3. Summary Report - Flue Gas Desulfurization Systems: May-June 1977, prepared by PEDCO Environmental, Inc., for the U.S. Environmental Agency under Contract 68-01-4147, Research Triangle Park, North Carolina (June 1977).

4. B. A. Laseke, Jr., EPA Utility FGD Survey: December 1977-January 1978, EPA-600/7-78-051a, U.S. Environmental Protection Agency, Washington, D.C. (March 1978).

5. T. Devitt, et al., Flue Gas Desulfurization Systems Capabilities for Coal-Fired Steam Generators, EPA-600/7-78-032a, U.S. Environmental Protection Agency, Washington, D.C. (March 1978).

6. J. Tuttle, et al., EPA Industrial Boiler FGD Survey: First Quarter 1978, EPA-600/7-78-052a, U.S. Environmental Protection Agency, Washington, D.C. (March 1978)

7. Survey Report on SO_2 Control Systems for Non-Utility Combustion and Process Sources, prepared by PEDCO Environmental, Inc., Contract 68-02-2603, for the U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (May 1977).

8. R. L. Sugarek and T. G. Sipes, Controlling SO_2 Emissions from Coal-Fired Steam-Electric Generators: Water Pollution Impact, Vol I, EPA-600/7-78-045a, U.S. Environmental Protection Agency, Washington, D.C. (March 1978).

9. W. C. Thomas, The Energy Requirements for Controlling SO_2 Emissions from Coal-Fired Steam/Electric Generators, EPA-450/3-77-050a, U.S. Environmental Protection Agency, Washington, D.C. (December 1977).

10. T. C. Ponder, Jr., et al., Simplified Procedures for Estimating Flue Gas Defulfurization System Costs, EPA-600/2-76-150, U.S. Environmental Protection Agency, Washington, D.C. (June 1976).

11. Coal-Fired Power Plant Capital Cost Estimates, EPRI Report AF-342, prepared by the Bechtel Power Corporation for the Electric Power Research Institute, Palo Alto, California (January 1977).

12. T. W. Devitt, et al., "Estimating Costs of Flue Gas Desulfurization Systems for Utility Boiler," J. Air Pollution Control Assoc., 26 (3), 204 (March 1976).