ELECTRICAL SUBSTATION CAPACITY ANALYSIS

THE ELECTRIC DEPARTMENT
CITY OF FAIRHOPE
FAIRHOPE, ALABAMA

PROJECT NO. 1655

JUNE, 2016

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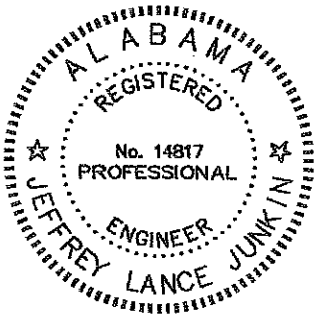

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EXHIBITS

I. PURPOSE

This Electrical Substation Capacity Analysis has been performed to determine the electrical loading and physical conditions of the City of Fairhope's Electrical Distribution System Substation Equipment. It outlines the Electrical Substation improvements, complete with cost estimates, which are recommended to enable the City to operate the Electrical System reliably for the next five years, and beyond.

II. INTRODUCTION

The City of Fairhope is located in West Central Baldwin County, on the East side of Mobile Bay. The City owns and operates an Electrical Distribution System providing service to approximately 6,600 consumers. These consumers are mainly residential and commercial with a few industrial consumers. The largest consumer is Thomas Hospital.

The City purchases power for its Electrical System from Alabama Municipal Electric Authority (AMEA) on the source side of the 115/46 KV Twin Beech Transmission Substation. The City takes this purchased power, steps it down to 46 KV, and then energizes the City owned 46 KV System. This 46 KV System then feeds five Distribution Substations around the City.

II. INTRODUCTION – Cont.

These existing Fairhope owned Electrical Substations are listed below:

A. Transmission Substation

1. Twin Beech Transmission Substation
   115/46 KV ... 3 @ 20,000 KVA
   Location: Twin Beech Road, East of Section Street South

B. Distribution Substations

1. Church Street Substation
   46/12.47 KV...10,000 KVA
   Location: Church Street and Morphy Avenue

2. Fairhope Avenue Substation
   46/12.47 KV...10,000 KVA
   Location: Fairhope Avenue, East of Bishop Road

3. Nichols Avenue Substation
   46/12.47 KV ...10,000 KVA
   Location: Nichols Avenue and Young Street

4. Volanta Avenue Substation
   46/12.47 KV...7,500 KVA
   Location: Volanta Avenue, West of Greeno Road

5. Young Street Substation
   46/12.47 KV ...12,000 KVA
   Location: Twin Beech Road, East of Section Street South

III. SYSTEM DATA

The data required for this Analysis was obtained from the following sources:

a. Service Point (115 KV) demand data history was obtained from AMEA.

b. Individual Distribution Substation demand data history was estimated from in-house (Fairhope) metering records.

c. Substation Transformer oil analysis history results were obtained from in-house (Fairhope) records.

d. Substation equipment capacities, age, and condition were obtained from thorough field inspections performed by Stewart Engineering and the Fairhope Electrical Superintendent, and staff.

IV. EXISTING CONDITIONS

Peak loading in KVA on the existing Substations, during the 2015 Summer peak conditions, is shown on Charts I and II below:

CHART I (Transmission – 2015)

TRANSFORMERS.....	115 KV West	115 KV Middle	115 KV East
Base Capacity (KVA)	20,000	20,000	20,000
Maximum Demand (KVA)	18,368	8,953	17,150
Base Percent Loading	92%	45%	86%
Maximum Fanned Rating	29,870	37,300	29,870

Note: The System 2015 peak (simultaneous) loading was 43,216 KVA.

CHART II (Distribution – 2015)

SUBSTATIONS.....	46 KV Church Street	46 KV Fairhope Avenue	46 KV Nichols Avenue	46 KV Volanta Avenue	46 KV Young Street
Base Capacity (KVA)	10,000	10,000	10,000	7,500	12,000
Maximum Demand (KVA)	8,829	10,554	8,296	7,719	8,953
Base Percent Loading	88%	106%	83%	103%	75%
Maximum Fanned Rating	10,000	14,000	14,000	10,500	22,400

IV. EXISTING CONDITIONS – Cont.

A. Transmission Substation

1. **Twin Beech Transmission Substation** has three 20,000 KVA, 115 KV to 46 KV 3-phase transformers.

   The Fairhope Electric Department purchases its power at this location at the service voltage of 115 KV. The largest simultaneous 2015 peak demand set by the Fairhope Electrical System was 43,216 KVA in July.

   The 2015 peak at the West Transformer was 18,368 KVA, 92% of base capacity. The 2015 peak at the Middle Transformer was 8,953 KVA, 45% of base capacity. The 2015 peak at the East Transformer was 17,150 KVA, 86% of base capacity.

   Fairhope has two (2) 46 KV breakers in Twin Beech Substation. One breaker, downstream from the West Transformer, normally feeds Fairhope Avenue and Volanta Avenue Substations. The other breaker, downstream from the East Transformer, normally feeds Church Street and Nichols Avenue Substation.

   The Middle Transformer normally feeds the adjacent Young Street Substation via a 46 KV Circuit Switcher.

IV. EXISTING CONDITIONS – Cont.

CONCERNS:

a. The peak loading as a percentage of base capacity is high. If the Middle Transformer required attention during a period of loading equal to 2015 peak conditions, and we utilized the East Transformer to temporarily feed the Young Street Substation too, then the East Transformer would be loaded to 131% of base capacity, and 87% of maximum fanned capacity. Stressing a transformer with this age, to these limits, could easily result in a transformer failure.

b. The West and East Transformers are 43 years old. They are certainly nearing the end of life.

c. The East Transformer oil test results indicate that the internal water content is borderline high.

d. The protective devices protecting the West and East Transformers are 37 year old S&C Transrupters. They have reached the end of their useful life, and as such may not perform their appointed task of protecting their associated power transformer. Additionally, these devices are very bothersome since you cannot use them to directly pick up any load after an outage. The new circuit switchers, like the one installed to protect the Middle Transformer are more reliable, and can be used to directly pick up load.

IV. EXISTING CONDITIONS – Cont.

e. The lowside bay, downstream from the West Transformer has a very old 46 KV breaker bypass switch attached to switch base using old brown insulators. This old brown porcelain glass is easily broken / sheared, and as such can certainly reduce reliability, and create unsafe working conditions.

f. The lowside bay, downstream from the East Transformer is constructed using very old 46 KV switches and insulators. The switches are attached to switch bases using old brown insulators. This old brown porcelain glass is easily broken / sheared, and as such can certainly reduce reliability, and create unsafe working conditions.

g. There are three (3) other 46 KV gang operated switches that are very old. One is on the lowside of the West Transformer, one is on the lowside of the East Transformer, and one is on the West end of the East-West 46 KV bus. The switches are attached to switch bases using old brown insulators. This old brown porcelain glass is easily broken / sheared, and as such can certainly reduce reliability, and create unsafe working conditions.

h. There are also approximately six (6) steel lightning protection poles inside this Substation that are very old, and rusted out.

IV. EXISTING CONDITIONS – Cont.

B. Distribution Substations

1. **Church Street Substation** has one (1) 10,000 KVA 3-phase transformer 46 KV to 12.47 KV. The 2015 peak demand was 8,829 KVA. This represents 88 % of the base capacity of this substation. There are three (3) 416 KVA single-phase bus regulators, loaded to 71% at the 2015 peak.

   There are two (2) lowside breakers, each feeding one feeder from the Substation.

   CONCERNS:

   a. The peak loading as a percentage of base capacity is high. Combined with the fact that this is a very old re-built transformer, with limited extra capacity since it has a 65° C rise rating, our concerns are increased significantly. There is simply very little margin. This high percentage loading effectively renders this Substation useless to pick up additional load during planned or emergency outages during peak conditions.

   b. The previous power transformer in this substation failed approximately 2 years ago. Due to the long delivery time associated with a new transformer, a re-built transformer was purchased from a third party vendor. This transformer was originally manufactured by the H. K. Porter Company, many

IV. EXISTING CONDITIONS – Cont.

years ago. At some point in time it had failed and was re-built by U. S. Transformer, many years ago. It is a 65° C rise transformer, and as such has less maximum capacity than a 55° C rise transformer, such as the transformer at Fairhope Avenue. Whenever re-built transformers are used, reliability and remaining life span are always of great concern.

c. The three (3) bus regulators at this Substation were also replaced with re-built equipment at this same time. Same as above, whenever re-built regulators are used, reliability and life span are of great concern.

d. The two (2) 12.47 KV breaker bypass switches, and the 12.47 KV regulator bypass switch, are very old. The switches are attached to switch bases using old brown insulators. This old brown porcelain glass is easily broken / sheared, and as such can certainly reduce reliability, and creates unsafe working conditions.

e. The energized parts (bushing terminals) on the regulators are too low to the ground. As such they are in violation of current National Electrical Safety Code minimum recommendations and pose a safety hazard to anyone inside this Substation fence.

IV. EXISTING CONDITIONS – Cont.

f. The block retaining wall immediately behind the South chain link fence is caving in.

g. The Substation was constructed somewhat down-in-a-hole. There are retaining walls on all sides. The retaining walls on the North and East sides are somewhat taller, however the fence posts are installed at the Substation ground level. As such the top of the fence on the North and East side (especially on the East side) is not very high above the ground immediately outside of the Substation. Although there are some plantings along this fence, this situation lends itself to easier than normal access for vandalism.

2. **Fairhope Avenue Substation** has one (1) 10,000 KVA 3-phase transformer 46 KV to 12.47 KV. The 2015 peak demand was 10,554 KVA. This represents 106% of the base capacity of this substation.

There are three (3) 416 KVA single-phase bus regulators, loaded to 85% at the 2015 peak.

There are two (2) low side breakers, each feeding one feeder from the Substation.

IV. EXISTING CONDITIONS – Cont.

CONCERNS:

a. The peak loading as a percentage of base capacity is high. It is our understanding from the Electrical Superintendent, and from bank meter records, that this level of loading is "normal" for this Substation. There is more growth occurring in the Eastern, and Northern portions of Fairhope. Such a high percentage loading effectively renders this Substation useless to pick up additional load during planned or emergency outages during peak conditions.

b. This power transformer oil test results indicate that the internal water content is borderline high.

3. **Nichols Avenue Substation** has one (1) 10,000 KVA 3-phase transformer 46 KV to 12.47 KV. The 2015 peak demand was 8,296 KVA. This represents 83 % of the base capacity of this Substation.

There are three (3) 416 KVA single-phase bus regulators, loaded to 66% at the 2015 peak.

There are two (2) low side breakers, each feeding one feeder from the Substation.

CONCERNS:

a. This power transformer is 39 years old. Therefore, it is rapidly approaching end of life.

IV. EXISTING CONDITIONS – Cont.

a. The oil test results on this transformer indicate that the internal water content is borderline high.

b. The energized parts (bushing terminals) on the regulators are too low to the ground. As such they are in violation of current National Electrical Safety Code minimum recommendations and pose a safety hazard to anyone inside this Substation fence.

4. **Volanta Avenue Substation** has one (1) 7500 KVA 3-phase transformer 46 KV to 12.47 KV. The 2015 peak demand was 7,719 KVA. This represents 103 % of the base capacity of this Substation.

There are two (2) 250 KVA single-phase bus regulators, and one (1) 333 KVA single-phase bus regulator. The 250 KVA regulators were loaded to 103% of capacity at the 2015 peak. The 333 KVA regulator was loaded to 77% of capacity at the 2015 peak.

There are two (2) low side breakers, each feeding one feeder from the Substation.

CONCERNS:

a. The peak loading as a percentage of base capacity is high. There are more growth opportunities in the Northern and Eastern portions of Fairhope. Such a high percentage loading

effectively renders this Substation useless to pick up additional load during planned or emergency outages during peak conditions.

b. This power transformer is 46 years old. Therefore it is very near the end of life.

c. The oil test results on this transformer indicate that the levels of methane, ethane, and ethylene are borderline high. This indicates possible internal sparking and overheating.

d. The 46 KV fuse assembly is in good condition, and the source and lowside disconnects above the 12.47 KV breakers are in good condition. However, all other switches and bus support insulators are very old and in poor condition. The switches are attached to switch bases using old brown insulators. This old brown porcelain glass is easily broken / sheared, and as such can certainly reduce reliability, and creates unsafe working conditions.

e. The main 46 KV bus tubing, on the incoming 46 KV structure, has been frozen at some time(s) in the past, and has split. The damage makes this buswork extremely unreliable.

EXISTING CONDITIONS – Cont.

f. This Substation was constructed somewhat down-in-a-hole. The terrain rises fast outside the West fence. This combined with the borderline low fence height makes for increased vulnerability to vandalism.

5. **Young Street Substation** has one (1) 12,000 KVA 3-phase transformer 46 KV to 12.47 KV. The 2015 peak demand was 8,953 KVA. This represents 75% of the base capacity of this Substation.

There are three (3) 887 KVA single-phase bus regulators, loaded to 34% at the 2015 peak.

There are two (2) low side breakers, each feeding one feeder from the Substation.

This Substation was upgraded with all new equipment in 2005. All equipment is still in good condition.

V. PROJECTED CONDITIONS

The peak loads of 2015 were used as our baseline for projecting forward through the 2021 peak, five years from now.

Based on historical data, combined with knowledge of the growth opportunities for this City, after a detailed discussion with the Electrical Superintendent and staff, we concluded that for a five (5) year projection, an estimated overall growth rate of 1.5% per year would be appropriate. Over the last ten (10) years, the peak demand has grown at approximately 0.5% per year. However, over the last three (3) years, the peak demand has grown at approximately 2.4% per year. Weather patterns certainly affect these percentages.

Overall, we believe 1.5% is a reasonable estimate.

With that said, we also believe that certain areas are likely to experience more growth than other areas.

On a Substation by Substation basis, we believe the following growth rates are reasonable for purposes of this Analysis:

Church Street Substation	2.0%
Fairhope Avenue Substation	2.5%
Nichols Avenue Substation	0.5%
Volanta Avenue Substation	1.0%
Young Street Substation	1.5%

V. PROJECTED CONDITIONS – Cont.

Peak loading in KVA on the existing Substations projected to 2021, is shown on Charts III and IV below:

CHART III (Transmission – 2021)

	115 KV	115 KV	115 KV
TRANSFORMERS.....	**West**	**Middle**	**East**
Base Capacity (KVA)	20,000	20,000	20,000
Maximum Demand (KVA)	18,368	8,953	17,150
Base Percent Loading	92%	45%	86%
Projected Growth Rate	**1.8%**	**1.5%**	**1.3%**
Projected Demand (KVA) (2021)	**20,443**	**9,790**	**18,532**
Base Percent Loading	**102%**	**49%**	**93%**

CHART IV (Distribution – 2021)

	46 KV	46 KV	46 KV	46 KV	46 KV
SUBSTATIONS.....	**Church Street**	**Fairhope Avenue**	**Nichols Avenue**	**Volanta Avenue**	**Young Street**
Base Capacity (KVA)	10,000	10,000	10,000	7,500	12,000
Maximum					
Demand (KVA) (2015)	8,829	10,554	8,296	7,719	8,953
Base Percent Loaded (2015)	88%	106%	83%	103%	75%
Projected Growth Rate	**2.0%**	**2.5%**	**0.5%**	**1.0%**	**1.5%**
Projected Demand					
(KVA) (2021)	**9,943**	**12,239**	**8,548**	**8,194**	**9,790**
Base Percent Loading (2021)	**99%**	**122%**	**85%**	**109%**	**82%**

V. PROJECTED CONDITIONS – Cont.

A. Transmission Substation

1. Twin Beech Transmission Substation

a. The peak loading as a percentage of base capacity will be higher, with the West Transformer loading projected at 102% of base capacity. The transformers will be 48 years old, if they live to that time. If the Middle Transformer required attention during 2021 projected peak conditions and we utilized the East Transformer to temporarily feed the Young Street Substation too, then the East Transformer would be loaded to 142% of base capacity, and 95% of maximum fanned capacity. This high load during peak conditions can bring about a transformer failure.

V. PROJECTED CONDITIONS – Cont.

B. Distribution Substations

1. Church Street Substation

a. The peak loading as a percentage of base (and maximum) capacity is projected to increase to 99% in 2021.

2. Fairhope Avenue Substation

a. The peak loading as a percentage of base capacity is projected to increase to 122% in 2021.

3. Nichols Avenue Substation

a. This transformer will be 44 years old in 2021. The peak loading as a percentage of base capacity is projected to increase to 85% in 2021.

4. Volanta Avenue Substation

a. This transformer will be 51 years old if it lives until 2021. The peak loading as a percentage of base capacity is projected to increase to 109% in 2021.

5. Young Street Substation

a. The peak loading as a percentage of base capacity is projected to increase to 82% in 2021.

VI. RECOMMENDATIONS

When analyzing Electrical Systems, there are often multiple paths or options, each of which could address noted concerns, and thereby equip the City to provide reliable electrical service over the time period for which the analysis is being performed.

In this Electrical Substation Capacity Analysis, we have developed one list of needed improvements at Twin Beech Transmission Substation, Fairhope Avenue Substation, and Volanta Avenue Substation. However, we will address concerns at Church Street Substation and Nichols Avenue Substation by presenting three different options for consideration by the City. Each has pro's and con's which will be discussed / evaluated in this document. There are no recommended improvements for the Young Street Substation.

We will call the three (3) different options PLAN A, PLAN B, and PLAN C. Again, our recommendations at Twin Beech Transmission Substation, Fairhope Avenue Substation, and Volanta Avenue Substation are the same in all three (3) PLANS.

Our detailed recommendations for each PLAN are itemized below.

VI. RECOMMENDATIONS – Cont.

PLAN A

A. Transmission Substation

1. Twin Beech Transmission Substation

a. Replace the West and East power transformers with new larger 115/46 KV, 30,000 KVA transformers.

b. Replace the West and East power transformer protection Transrupters with new Circuit Switchers. Install new protection relays inside existing Control Building.

c. Replace all 46 KV switches and insulators in East 46 KV breaker bay. Replace 46 KV breaker bypass switch in West breaker bay. Replace three (3) 46 KV switches located between the power transformers and the 46 KV breaker bays.

d. Replace old rusted out lightning protective poles.

B. Distribution Substations

1. Church Street Substation

a. Dismantle this Substation.

b. Complete feeder modifications such that all load presently served from this Substation will be served from the NEW Substation (see VI. PLAN A, B.6).

c. Remove 0.7 miles of 46 KV transmission line (approximately 15 structures) along Morphy Avenue, from Young Street, West to Church Street.

VI. RECOMMENDATIONS – Cont.

2. Fairhope Avenue Substation

a. Replace this transformer with a new larger 46/12.47 KV, 15,000 KVA transformer, and new matching regulators.

b. Replace the existing transformer protection fuses with a new Circuit Switcher. Install new Control Building for batteries and protection relays.

c. Replace older model ABB breaker with new breaker with an SEL-351S relay, matching the other system feeder breaker relays.

3. Nichols Avenue Substation

a. Dismantle this Substation.

b. Complete 12.47 KV Feeder modifications such that all load presently served from this Substation will be served from the NEW Substation (see VI. PLAN A, B6).

4. Volanta Avenue Substation

a. Replace this transformer and regulators with the existing, relocated larger transformer and regulators from Fairhope Avenue Substation. Have transformer oil filtered or replaced as necessary, and find / repair any leak points which may be allowing water to enter the tank.

b. Upgrade this Substation by replacing all old switches and bus support insulators, replacing the damaged 46 KV bus tubing, and replacing the fence with a new taller fence.

VI. RECOMMENDATIONS – Cont.

5. Young Street Substation

No improvements needed or recommended.

6. NEW Substation

a. Install a new double Substation to replace the existing Church Street and Nichols Avenue Substations. New Substation will be 46/12.47 KV, with (2) 15,000 KVA transformers. Procure a new substation lot somewhere along Young Street, between Nichols Avenue and Morphy Avenue. New Substation will be surrounded by attractive greenery, thereby presenting a more aesthetically appealing appearance.

VI. RECOMMENDATIONS – Cont.

PLAN B

A. Transmission Substation

1. Twin Beech Transmission Substation

a. Replace the West and East power transformers with new larger 115/46 KV, 30,000 KVA transformers.

b. Replace the West and East power transformer protection Transrupters with new Circuit Switchers. Install new protection relays inside existing Control Building.

c. Replace all 46 KV switches and insulators in East 46 KV breaker bay. Replace 46 KV breaker bypass switch in West breaker bay. Replace three (3) 46 KV switches located between the power transformers and the 46 KV breaker bays.

d. Replace old rusted out lightning protection poles.

B. Distribution Substations

1. Church Street Substation

a. Replace existing re-built transformer with a new larger 46/12.47 KV, 10,000 KVA (maximum fanned rating of 14,000 KVA) transformer, and new matching regulators.

b. Replace two (2) old 12.47 KV breaker bypass switches, and the old 12.47 KV regulator bypass switch.

c. Repair / replace damaged retaining wall, and replace fence with a new taller fence.

VI. RECOMMENDATIONS – Cont.

2. Fairhope Avenue Substation

a. Replace this transformer (relocate it to Volanta Avenue Substation) with a new larger 46/12.47 KV, 15,000 KVA transformer, and new matching regulators.

b. Replace the existing transformer protection fuses with a new Circuit Switcher. Install new Control Building for batteries and protection relays.

c. Replace older model ABB breaker with new breaker with an SEL-351S relay, matching the other system feeder breaker relays.

3. Nichols Avenue Substation

a. Replace existing transformer with a new larger 46/12.47 KV, 12,000 KVA transformer, and new matching regulators.

b. Replace the existing transformer protection fuses with a new Circuit Switcher. Install new Control Building for batteries and protection relays.

4. Volanta Avenue Substation

a. Replace this transformer and regulators with the existing, relocated larger transformer and regulators from Fairhope Avenue Substation. Have oil filtered or replaced as necessary, and find / repair any leak points which may be allowing water to enter the tank.

VI. RECOMMENDATIONS – Cont.

b. Upgrade this Substation by replacing all old switches and bus support insulators, replacing the damaged 46 KV bus tubing, and replacing the fence with a new taller fence.

5. Young Street Substation

No improvements needed or recommended.

VI. RECOMMENDATIONS – Cont.

PLAN C

A. Transmission Substation

1. Twin Beech Transmission Substation

a. Replace the West and East power transformers with new larger 115/46 KV, 30,000 KVA transformers.

b. Replace the West and East power transformer protection Transrupters with new Circuit Switchers. Install new protection relays inside existing Control Building.

c. Replace all 46 KV switches and insulators in East 46 KV breaker bay. Replace 46 KV breaker bypass switch in West breaker bay. Replace three (3) 46 KV switches located between the power transformers and the 46 KV breaker bays.

d. Replace old rusted out lightning protection poles.

B. Distribution Substations

1. Church Street Substation

a. Replace two (2) old 12.47 KV breaker bypass switches.

b. Repair / replace damaged retaining wall, and replace fence with a new taller fence.

2. Fairhope Avenue Substation

a. Replace this transformer (relocate it to Volanta Avenue Substation) with a new larger 46/12.47 KV, 15,000 KVA transformer, and new matching regulators.

VI. RECOMMENDATIONS – Cont.

b. Replace the existing transformer protection fuses with a new Circuit Switcher. Install new Control Building for batteries and protection relays.

c. Replace older model ABB breaker with new breaker with an SEL-351S relay, matching the other system feeder breaker relay.

3. Nichols Avenue Substation

a. Have existing transformer oil filtered or replaced as necessary, and find / repair any leak points which may be allowing water to enter the tank.

4. Volanta Avenue Substation

a. Replace this transformer and regulators with the existing, relocated larger transformer and regulators from Fairhope Avenue Substation. Have oil filtered or replaced as necessary, and find / repair any leak points which may be allowing water to enter the tank.

b. Upgrade this Substation by replacing all old switches and bus support insulators, replacing the damaged 46 KV bus tubing, and replacing the fence with a new taller fence.

5. Young Street Substation

No improvements needed or recommended.

VII. COST ESTIMATES

PLAN A

Item A. 1. a. - Twin Beech – Replace two (2) Power Transformers	$	1,600,000
Item A. 1. b. - Twin Beech – Replace Transformer Protection Transrupters with new Circuit Switchers	$	250,000
Item A. 1. c. - Twin Beech – Replace old switches and insulators	$	250,000
Item B. 1. a. - Church Street – Dismantle existing Substation	$	50,000
Item B. 1. b. - Church Street – Distribution Feeder Modifications	$	200,000
Item B. 1. c. - Church Street – Remove 0.7 miles of 46 KV transmission line and associated structures	$	250,000
Item B. 2. a. - Fairhope Avenue – Replace Power Transformer and Regulators	$	500,000
Item B. 2. b. - Fairhope Avenue – Replace Transformer Protection Fuses with new Circuit Switcher. Install new Control Building	$	300,000
Item B. 2. c. - Fairhope Avenue – Replace 15 KV Circuit Breaker	$	40,000
Item B. 3. a. - Nichols Avenue – Dismantle existing Substation	$	50,000
Item B. 3. b. - Nichols Avenue – Distribution Feeder Modifications	$	800,000
Item B. 4. a. - Volanta Avenue – Replace Power Transformer and Regulators with existing Fairhope Avenue Power Transformer and Regulators	$	80,000
Item B. 4. b. - Volanta Avenue – Replace old switches, insulators, damaged bus, and fence	$	300,000
Item B. 6. a. - New Substation	$	2,800,000
CONSTRUCTION	$	7,470,000
CONTINGENCY	$	560,000
TOTAL CONSTRUCTION	**$**	**8,030,000**
ENGINEERING	$	725,000

VII. COST ESTIMATES – Cont.

PLAN B

Item A. 1. A. -	Twin Beech – Replace two (2) Power Transformers	$ 1,600,000
Item A. 1. B. -	Twin Beech – Replace Transformer Protection Transrupters with new Circuit Switchers	$ 250,000
Item A. 1. c. -	Twin Beech – Replace old switches and insulators	$ 250,000
Item B. 1. a. -	Church Street – Replace Power Transformer and Regulators	$ 360,000
Item B. 1. b. -	Church Street – Replace old switches	$ 60,000
Item B. 1. c. -	Church Street – Repair / replace old retaining wall and replace fence	$ 70,000
Item B. 2. a. -	Fairhope Avenue – Replace Power Transformer and Regulators	$ 500,000
Item B. 2. b. -	Fairhope Avenue – Replace Transformer Protection Fuses with new Circuit Switcher. Install new Control Building	$ 300,000
Item B. 2. c. -	Fairhope Avenue – Replace 15 KV Circuit Breaker	$ 40,000
Item B. 3. a. -	Nichols Avenue – Replace Power Transformer and and Regulators	$ 420,000
Item B. 3. b. -	Nichols Avenue – Replace transformer protection Fuses with new Circuit Switcher. Install new Control Building	$ 350,000
Item B. 4. a. -	Volanta Avenue – Replace Power Transformer and Regulators with existing Fairhope Avenue Power Transformer and Regulators	$ 80,000
Item B. 4. b. -	Volanta Avenue – Replace old switches, insulators, damaged bus, and fence	$ 300,000
	CONSTRUCTION	$ 4,580,000
	CONTINGENCY	$ 350,000
	TOTAL CONSTRUCTION	**$ 4,930,000**
	ENGINEERING	$ 445,000

VII. COST ESTIMATES – Cont.

PLAN C

Item A. 1. a. - Twin Beech – Replace two (2) Power Transformers	$	1,600,000
Item A. 1. b. - Twin Beech – Replace Transformer Protection Transrupters with new Circuit Switchers	$	250,000
Item A. 1. c. - Twin Beech – Replace old switches and insulators	$	250,000
Item B. 1. a. - Church Street – Replace old switches	$	60,000
Item B. 1. b. - Church Street – Repair / replace retaining wall and replace fence	$	70,000
Item B. 2. a. - Fairhope Avenue – Replace Power Transformer and Regulators	$	500,000
Item B. 2. b. - Fairhope Avenue – Replace Transformer Protection Fuses with new Circuit Switcher. Install new Control Building	$	300,000
Item B. 2. c. - Fairhope Avenue – Replace 15 KV Circuit Breaker	$	40,000
Item B. 3. a. - Nichols Avenue – Filter / replace existing transformer oil and find / repair leaks	$	50,000
Item B. 4. a. - Volanta Avenue – Replace Power Transformer and Regulators with existing Fairhope Avenue Power Transformer and Regulators	$	80,000
Item B. 4. b. - Volanta Avenue – Replace old switches, insulators, damaged bus, and fence	$	300,000
CONSTRUCTION	$	3,500,000
CONTINGENCY	$	260,000
TOTAL CONSTRUCTION	**$**	**3,760,000**
ENGINEERING	$	340,000

VIII. CAPACITY / EQUIPMENT AGE ANALYSIS

A. CAPACITY COMPARISONS

PLAN A

DISTRIBUTION SUBSTATION	BASE KVA	MAXIMUM FANNED KVA
Church Street	0	0
Fairhope Avenue	15,000	28,000
Nichols Avenue	0	0
Volanta Avenue	10,000	14,000
Young Street	12,000	22,400
New Substation	30,000	56,000
	67,000	120,400

PLAN B

DISTRIBUTION SUBSTATION	BASE KVA	MAXIMUM FANNED KVA
Church Street	10,000	14,000
Fairhope Avenue	15,000	28,000
Nichols Avenue	12,000	22,400
Volanta Avenue	10,000	14,000
Young Street	12,000	22,400
New Substation	N/A	N/A
	59,000	100,800

PLAN C

DISTRIBUTION SUBSTATION	BASE KVA	MAXIMUM FANNED KVA
Church Street	10,000	10,000
Fairhope Avenue	15,000	28,000
Nichols Avenue	10,000	14,000
Volanta Avenue	10,000	14,000
Young Street	12,000	22,400
New Substation	N/A	N/A
	57,000	88,400

VIII. CAPACITY / EQUIPMENT AGE ANALYSIS – Cont.

B. EQUIPMENT AGE COMPARISONS

PLAN A

In 2021, upon completion of PLAN A, the average age of the City's Distribution Substation Power Transformers will be 8.7 years.

PLAN B

In 2021, upon completion of PLAN B, the average age of the City's Distribution Substation Power Transformers will be 8.7 years.

PLAN C

In 2021, upon completion of PLAN C, the average age of the City's Distribution Substation Power Transformers will be 23.5 years.

IX. SUMMARY

The following table, and subsequent lists of pro's / con's, summarize the results of this Analysis, and the comparison of these three (3) PLANS:

	CONSTRUCTION COST	AVERAGE DISTRIBUTION SUBSTATION POWER TRANSFORMER AGE IN 2021	RESULTING DISTRIBUTION SUBSTATION TRANSFORMER CAPACITY (MAXIMUM FANNED)
PLAN A (Includes New Substation)	$8,030,000	8.7 Years	120,400 KVA
PLAN B (Includes Replacing Existing Transformers at Church Street and Nichols Avenue Substation)	$4,930,000	8.7 Years	100,800 KVA
PLAN C (Includes keeping Existing Transformers at Church Street and Nichols Avenue Substation)	$3,760,000	23.5 Years	88,400 KVA

IX. SUMMARY – Cont.

PLAN A

Pro's

1. Old Church Street Substation lot will be vacated.
2. Old Nichols Avenue Substation lot will be vacated.
3. The 46 KV transmission line along Morphy Avenue, from Young Street, West to Church Street will be removed, thereby improving the aesthetics along this heavily traveled road. City will also save the expense associated with maintaining this overhead 46 KV line.
4. The New Substation will be much more aesthetically pleasing than either of the two (2) older substations that it will replace.
5. Average age of Transmission Substation Power Transformer in 2021 will drop from 40 years (no action taken), to 9.7 years under PLAN A. Oldest Transmission Substation Transformer will be 24 years old under PLAN A.
6. Average age of Distribution Substation Power Transformer in 2021 will drop from 33 years (no action taken), to 8.7 years under PLAN A. The oldest Distribution Substation Transformer will be 20 years under PLAN A.
7. City customers, presently served from Church Street Substation, will have higher service reliability with the New

IX. SUMMARY – Cont.

PLAN A – Cont.

Substation connected to the 46 KV loop, as opposed to the present 46 KV radial tap along Morphy Avenue.

8. Highest resulting Distribution Substation Capacity of any of the PLANS. PLAN A results in 19% more maximum capacity than PLAN B, and 36% more than PLAN C.

9. Based on younger average Substation, equipment age, and highest resulting Substation capacity, PLAN A will take the City further into the future when compared to either of the other two PLANS, before additional future upgrades are needed.

Con's

1. Highest initial cost.

IX. SUMMARY – Cont.

PLAN B

Pro's

1. Average age of Transmission Substation Power Transformer in 2021 will drop from 40 years (no action taken), to 9.7 years under PLAN B. Oldest Transmission Substation Transformer will be 24 years old under PLAN B.
2. Average age of Distribution Substation Power Transformer in 2021 will drop from 33 years (no action taken), to 8.7 years under PLAN B. The oldest Distribution Substation Transformer will be 20 years under PLAN B.

Con's

1. Aesthetically speaking, old substation structures remain at Church Street and Nichols Avenue Substations.
2. Aesthetically speaking, 46 KV Transmission line along Morphy Avenue, from Young Street, West to Church Street, will remain.
3. Resulting Distribution Substation Base Capacity is 12% less than under PLAN A. Maximum Fanned capacity is 16% less than under PLAN A.

IX. SUMMARY – Cont.

PLAN C

Pro's

1. Average age of Transmission Substation Power Transformer in 2021 will drop from 40 years (no action taken), to 9.7 years under PLAN C. Oldest Transmission Substation Transformer will be 24 years old under PLAN C.
2. Lowest initial cost.

Con's

1. Aesthetically speaking, old substation structures remain at Church Street and Nichols Avenue Substations.
2. Aesthetically speaking, 46 KV Transmission line along Morphy Avenue, from Young Street, West to Church Street, will remain.
3. Average age of Distribution Substation Transformers in 2021 under PLAN C is 23.5 years, almost 3 times the resulting average associated with PLAN A or PLAN B. The oldest Distribution Substation Transformer will be 44 years under PLAN C.
4. Resulting Distribution Substation Base Capacity is 15% less than under PLAN A. Maximum Fanned Capacity is 27% less than under PLAN A.

IX. SUMMARY – Cont.

PLAN C – Cont.

5. Based on the older Substation equipment age, and the lowest resulting Substation capacity, PLAN C will result in the shortest time period before future upgrades are needed.
6. The long term reliability of the re-built power Transformer at Church Street Substation remains a point of concern.

X. CONCLUSION

We recommend that the City of Fairhope implement PLAN A.

Positive results associated with the implementation of this PLAN A include:

- Highest resulting total Distribution Substation Transformer capacity.
- Lowest resulting average Distribution Substation Transformer age.
- Reduction in ongoing 46 KV line maintenance costs resulting from 46 KV removal along Morphy Avenue, from Young Street to Church Street.
- Best PLAN from perspective of improved aesthetics along the City streets.
- Best PLAN from perspective of customer service reliability.
- Best PLAN from perspective of extending the time period before future Substation improvement expenditures are required.

The expedient implementation of PLAN A is needed, and recommended.

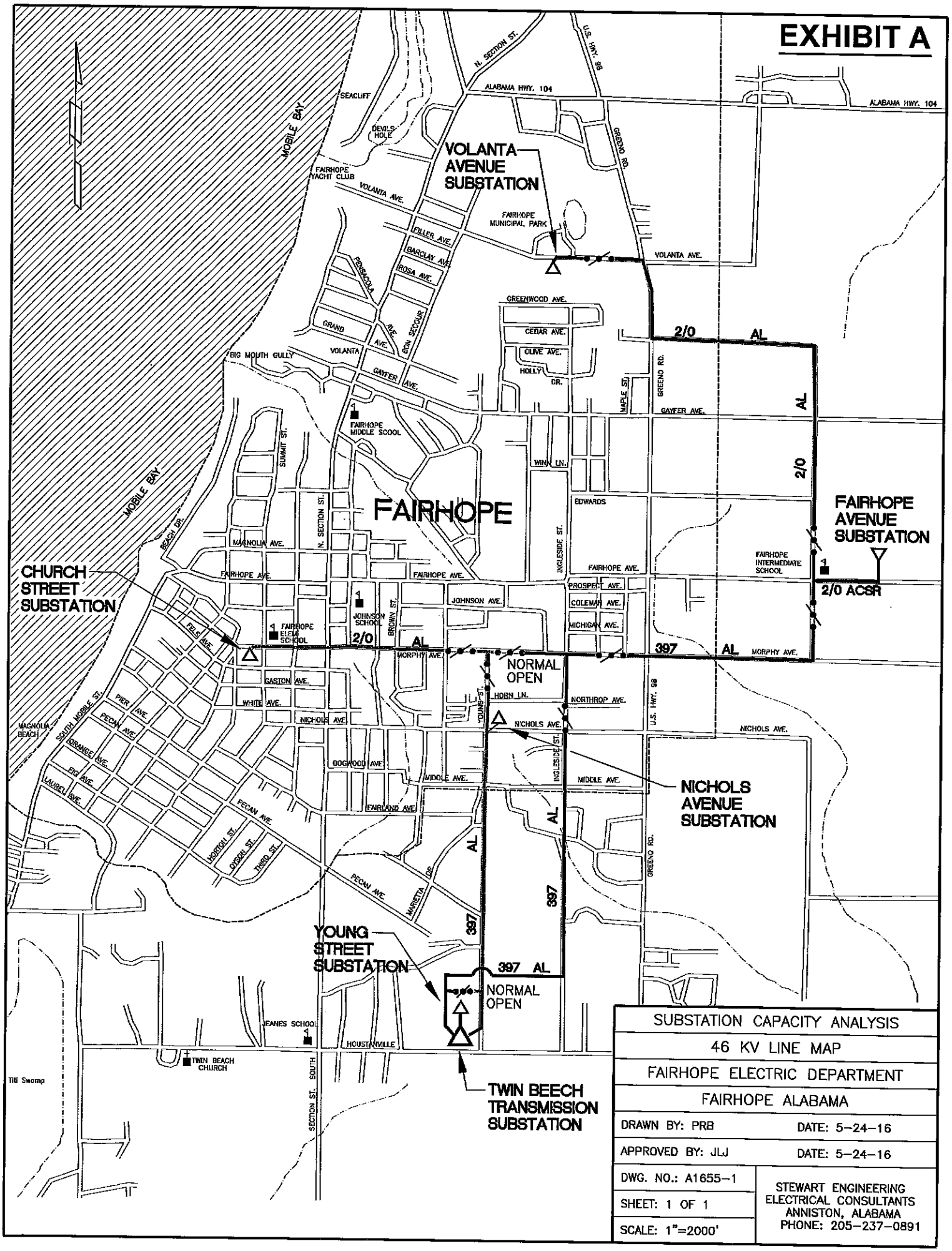
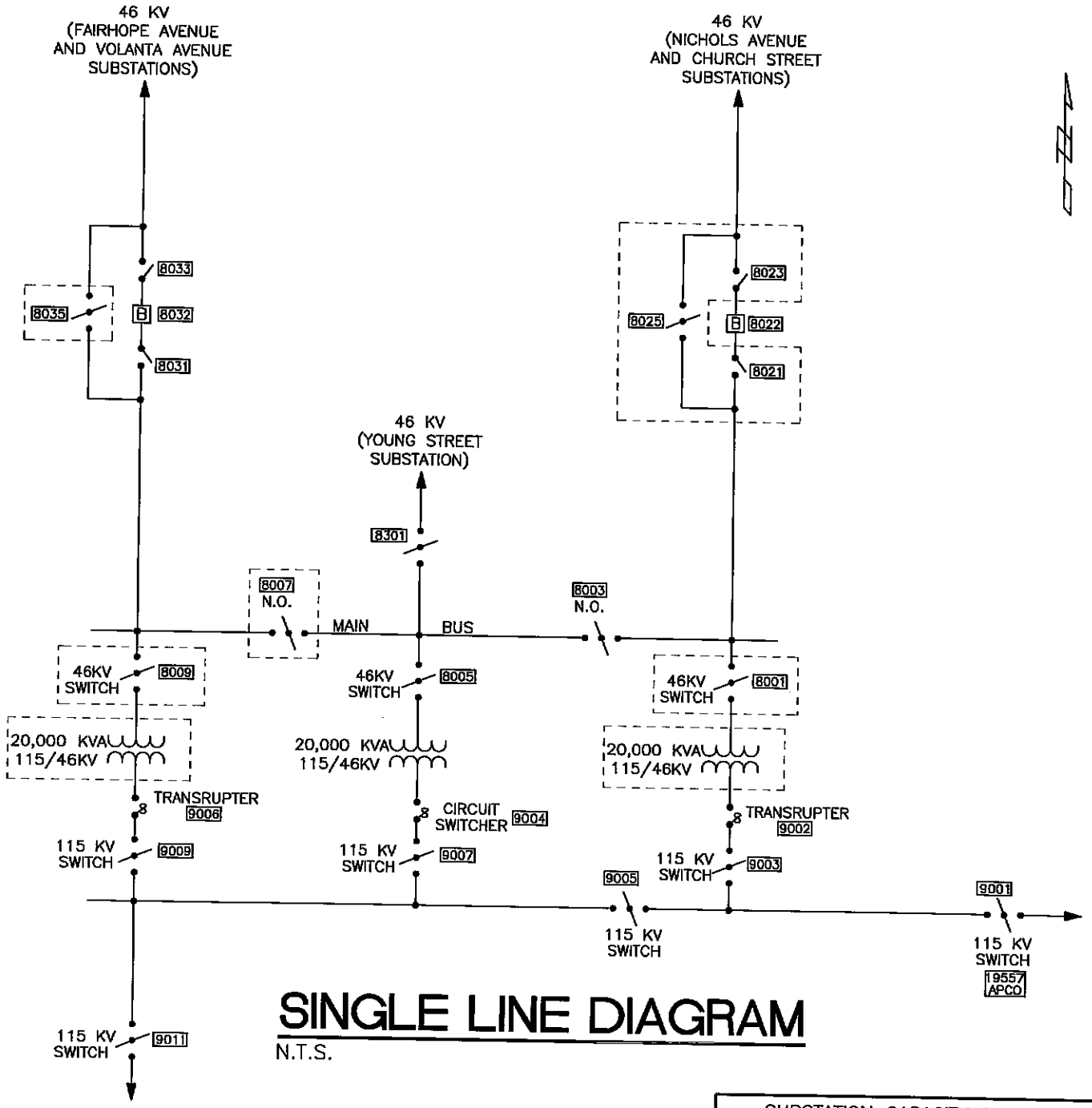


EXHIBIT A
VOLANTA AVENUE SUBSTATION
FAIRHOPE AVENUE SUBSTATION
CHURCH STREET SUBSTATION
NICHOLS AVENUE SUBSTATION
YOUNG STREET SUBSTATION
TWIN BEECH TRANSMISSION SUBSTATION
FAIRHOPE
MOBILE BAY
2/0 AL
2/0
397 AL
NORMAL OPEN
2/0 ACSR
ALABAMA HWY. 104
N. SECTION ST.
U.S. HWY. 98
GREENO RD.
VOLANTA AVE.
GAYFER AVE.
FAIRHOPE AVE.
MORPHY AVE.
NICHOLS AVE.
MIDDLE AVE.
PECAN AVE.
SECTION ST. SOUTH
SUBSTATION CAPACITY ANALYSIS
46 KV LINE MAP
FAIRHOPE ELECTRIC DEPARTMENT
FAIRHOPE ALABAMA
DRAWN BY: PRB
DATE: 5-24-16
APPROVED BY: JLJ
DATE: 5-24-16
DWG. NO.: A1655-1
SHEET: 1 OF 1
SCALE: 1"=2000'
STEWART ENGINEERING
ELECTRICAL CONSULTANTS
ANNISTON, ALABAMA
PHONE: 205-237-0891

EXHIBIT B



SINGLE LINE DIAGRAM

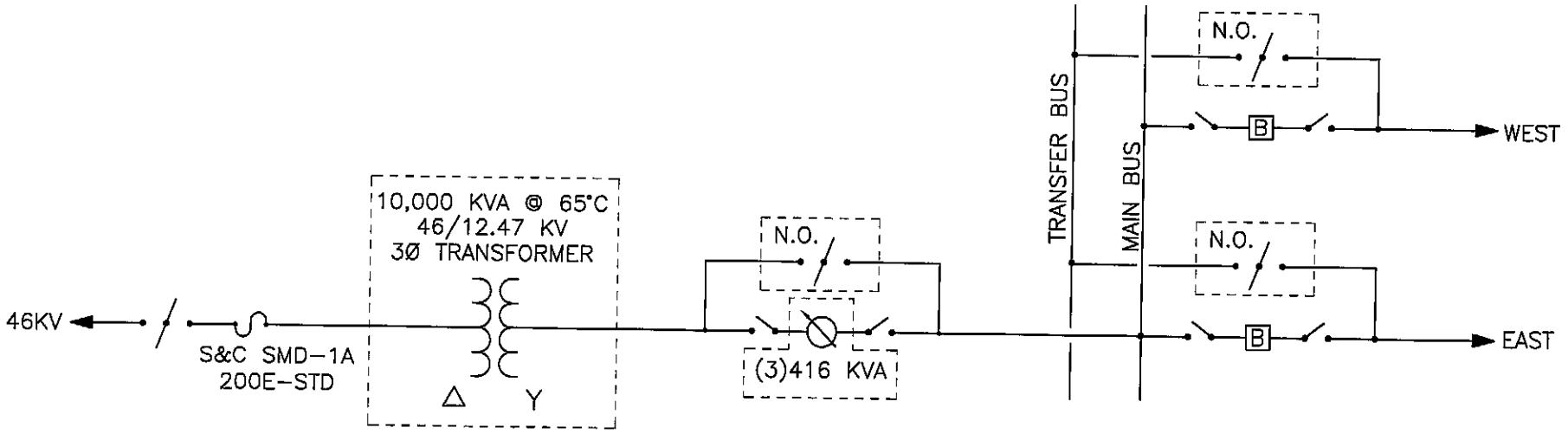
N.T.S.

AREAS OF CONCERN
DISCUSSED IN ANALYSIS

ALABAMA
REGISTERED
No. 14817
PROFESSIONAL
ENGINEER
JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS
TWIN BEECH SUBSTATION
SINGLE LINE DIAGRAM
FAIRHOPE ELECTRIC DEPARTMENT
FAIRHOPE ALABAMA

DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
DWG. NO.: A1655-2	STEWART ENGINEERING ELECTRICAL CONSULTANTS ANNISTON, ALABAMA PHONE: 205-237-0891
SHEET: 1 OF 6	
SCALE: N.T.S.	



SINGLE LINE DIAGRAM

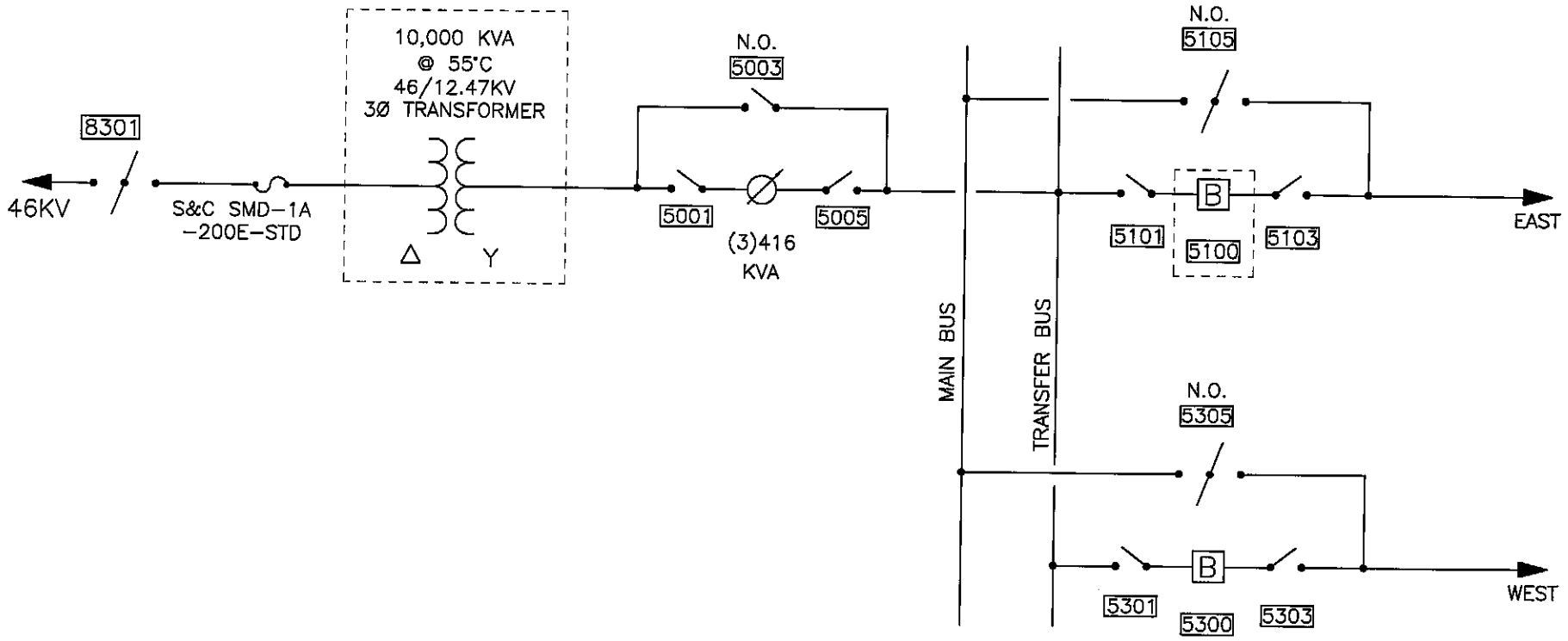
N.T.S.

AREAS OF CONCERN
DISCUSSED IN ANALYSIS

ALABAMA REGISTERED No. 14817 PROFESSIONAL ENGINEER JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS	
CHURCH STREET SUBSTATION	
SINGLE LINE DIAGRAM	
FAIRHOPE ELECTRIC DEPARTMENT	
FAIRHOPE ALABAMA	
DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
DWG. NO.: A1655-2	STEWART ENGINEERING ELECTRICAL CONSULTANTS ANNISTON, ALABAMA PHONE: 205-237-0891
SHEET: 2 OF 6	
SCALE: N.T.S.	

EXHIBIT B



SINGLE LINE DIAGRAM

N.T.S.

----- AREAS OF CONCERN DISCUSSED IN ANALYSIS

ALABAMA REGISTERED No. 14817 PROFESSIONAL ENGINEER JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS	
FAIRHOPE AVENUE SUBSTATION	
SINGLE LINE DIAGRAM	
FAIRHOPE ELECTRIC DEPARTMENT	
FAIRHOPE ALABAMA	
DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
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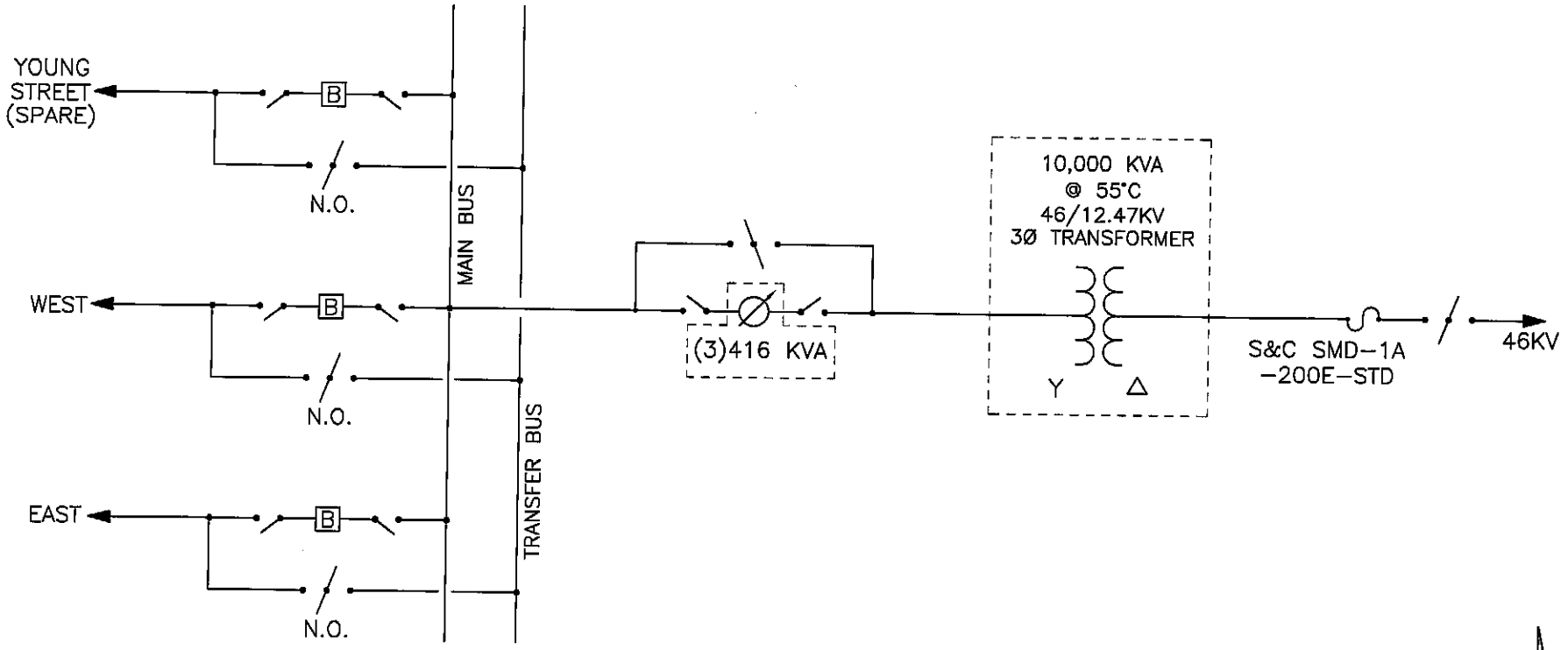
SHEET: 3 OF 6	
SCALE: N.T.S.	

EXHIBIT B



SINGLE LINE DIAGRAM

N.T.S.

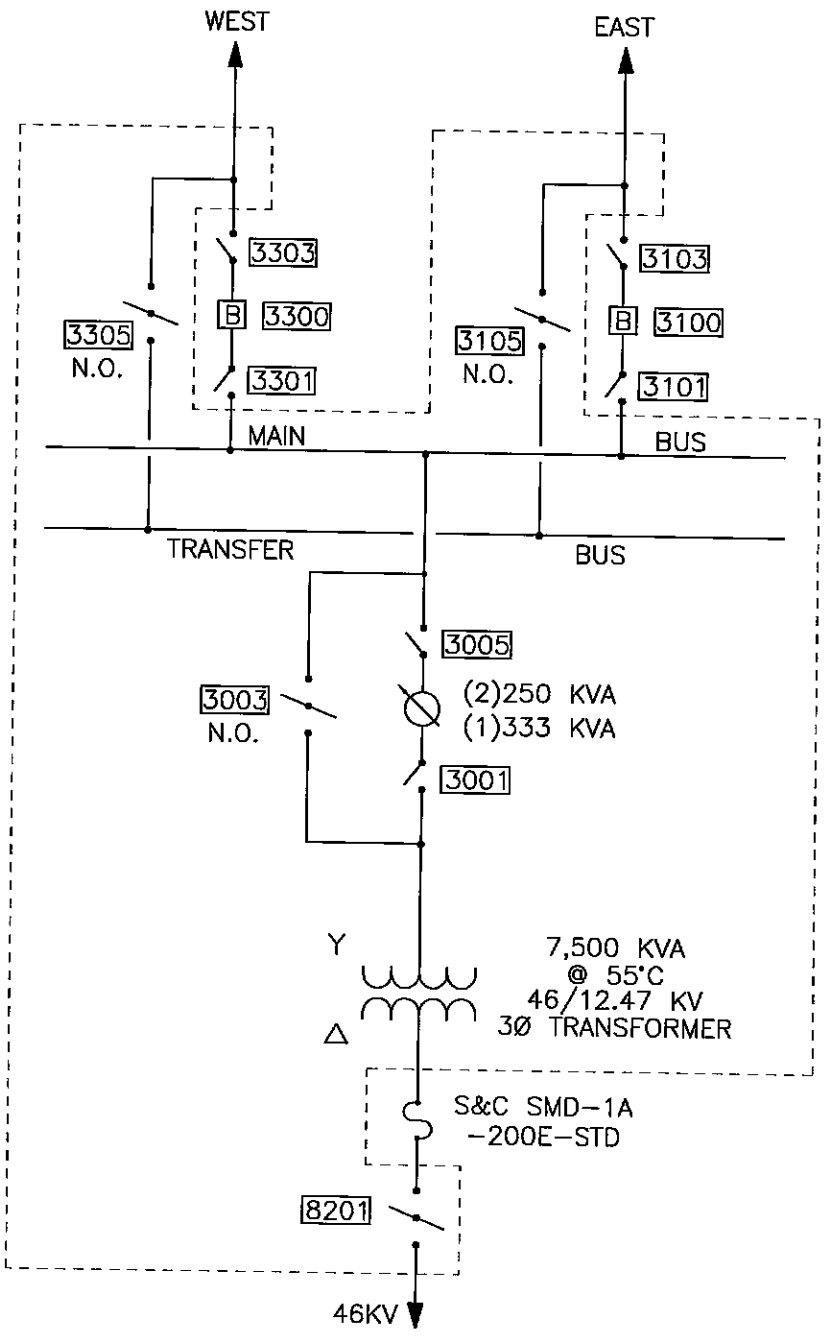
----- AREAS OF CONCERN DISCUSSED IN ANALYSIS

ALABAMA REGISTERED No. 14817 PROFESSIONAL ENGINEER JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS	
NICHOLS AVENUE SUBSTATION	
SINGLE LINE DIAGRAM	
FAIRHOPE ELECTRIC DEPARTMENT	
FAIRHOPE ALABAMA	
DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
DWG. NO.: A1655-2	STEWART ENGINEERING ELECTRICAL CONSULTANTS ANNISTON, ALABAMA PHONE: 205-237-0891
SHEET: 4 OF 6	
SCALE: N.T.S.	

EXHIBIT B

EXHIBIT B



SINGLE LINE DIAGRAM

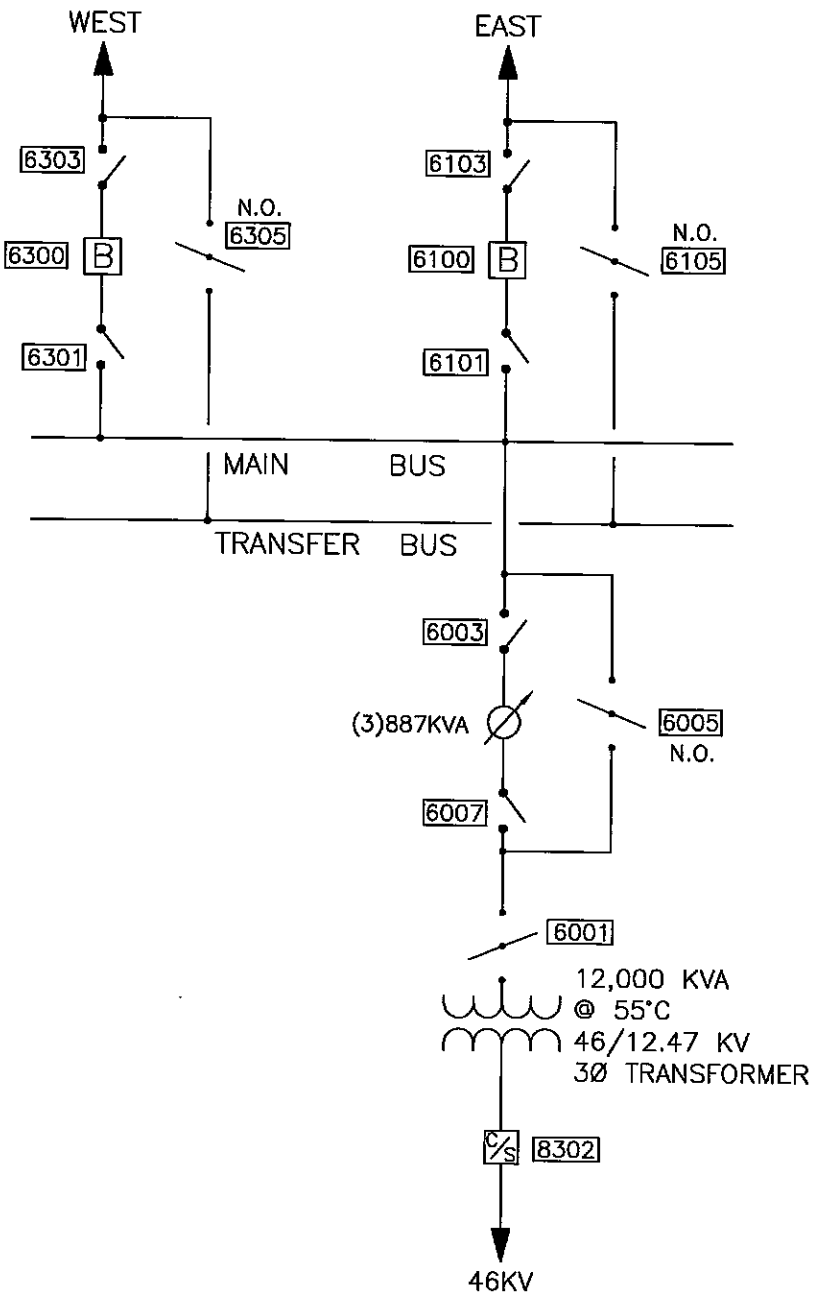
N.T.S.

AREAS OF CONCERN DISCUSSED IN ANALYSIS

ALABAMA REGISTERED No. 14817 PROFESSIONAL ENGINEER JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS	
VOLANTA AVENUE SUBSTATION	
SINGLE LINE DIAGRAM	
FAIRHOPE ELECTRIC DEPARTMENT	
FAIRHOPE ALABAMA	
DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
DWG. NO.: A1655-2	STEWART ENGINEERING ELECTRICAL CONSULTANTS ANNISTON, ALABAMA PHONE: 205-237-0891
SHEET: 5 OF 6	
SCALE: N.T.S.	

EXHIBIT B



SINGLE LINE DIAGRAM

N.T.S.

AREAS OF CONCERN
DISCUSSED IN ANALYSIS

ALABAMA
REGISTERED
No. 14817
PROFESSIONAL
ENGINEER
JEFFREY LANCE JUNKIN

SUBSTATION CAPACITY ANALYSIS	
YOUNG STREET SUBSTATION	
SINGLE LINE DIAGRAM	
FAIRHOPE ELECTRIC DEPARTMENT	
FAIRHOPE ALABAMA	
DRAWN BY: PRB	DATE: 5-24-16
APPROVED BY: JLJ	DATE: 5-24-16
DWG. NO.: A1655-2	STEWART ENGINEERING ELECTRICAL CONSULTANTS ANNISTON, ALABAMA PHONE: 205-237-0891
SHEET: 6 OF 6	
SCALE: N.T.S.	

EXHIBIT C

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

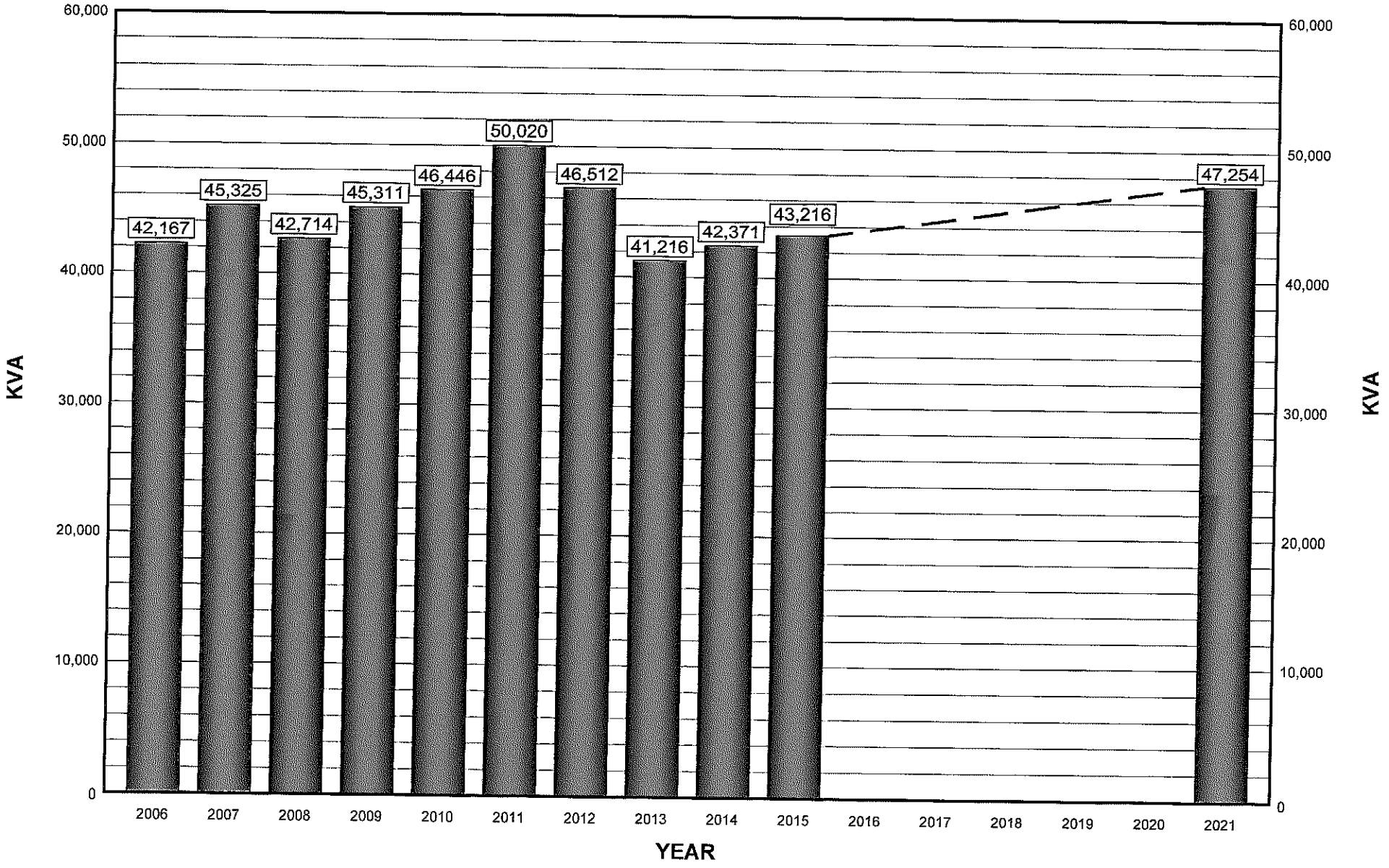


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

TWIN BEECH SUBSTATION - WEST

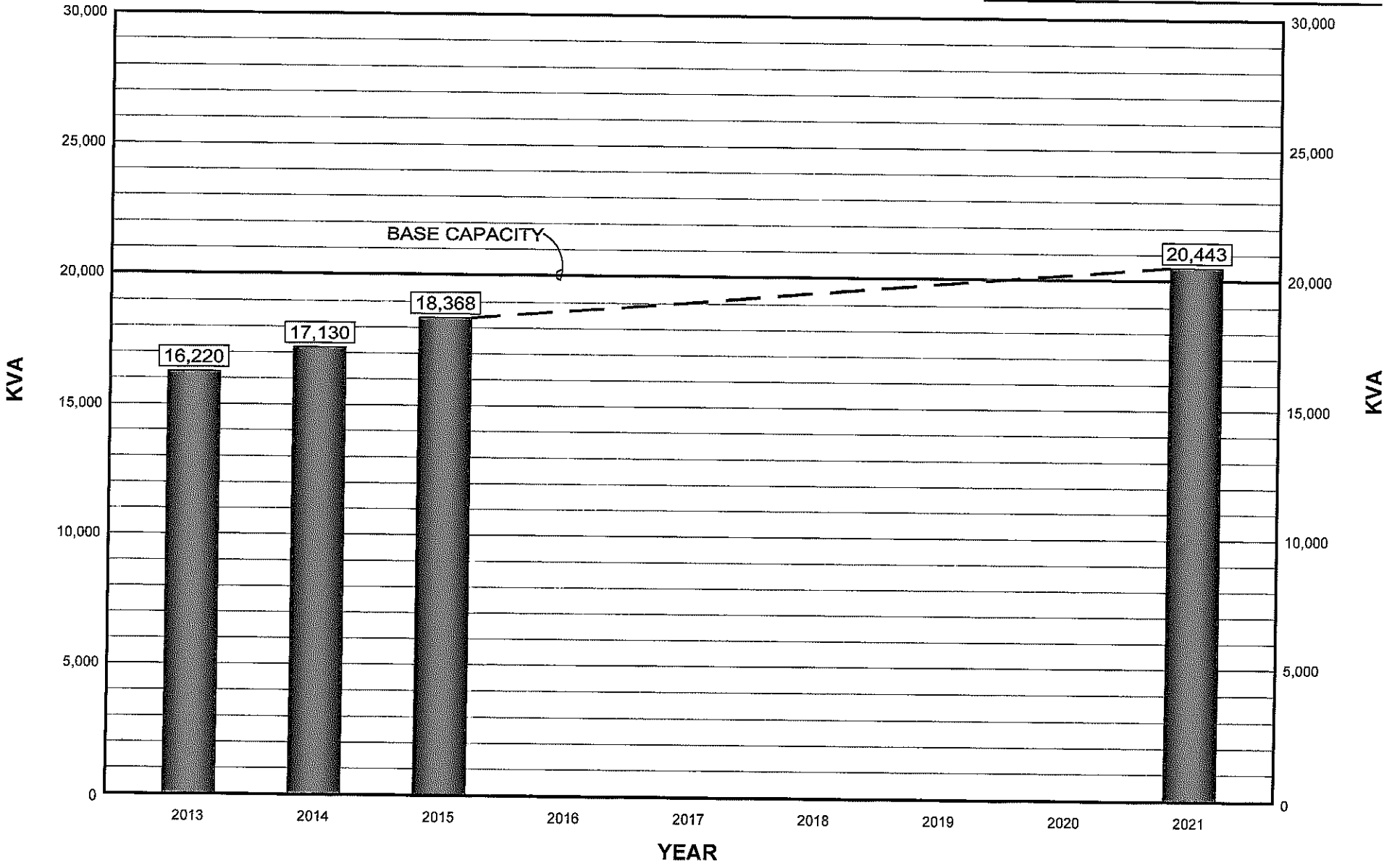


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

TWIN BEECH SUBSTATION - MIDDLE

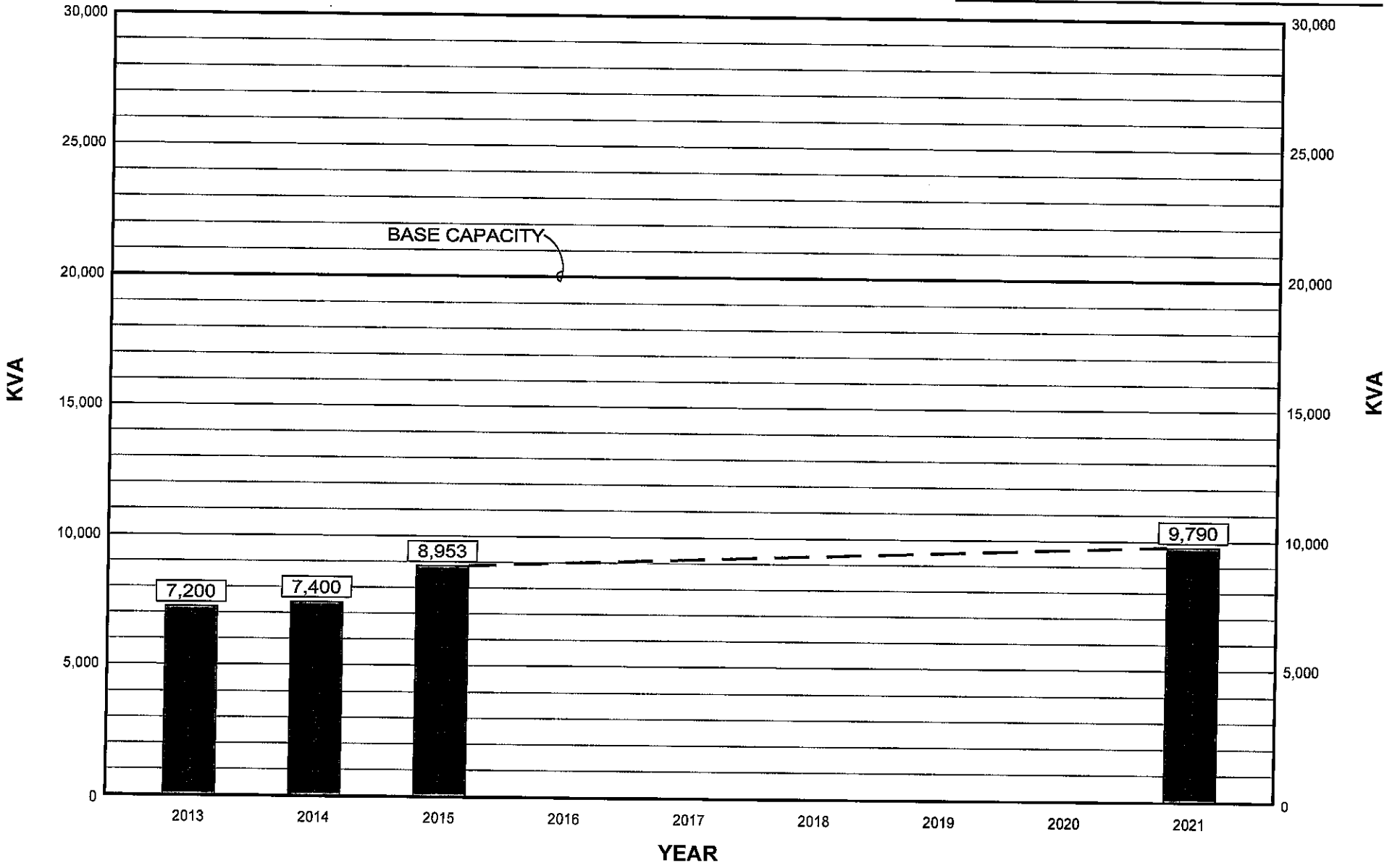


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

TWIN BEECH SUBSTATION - EAST

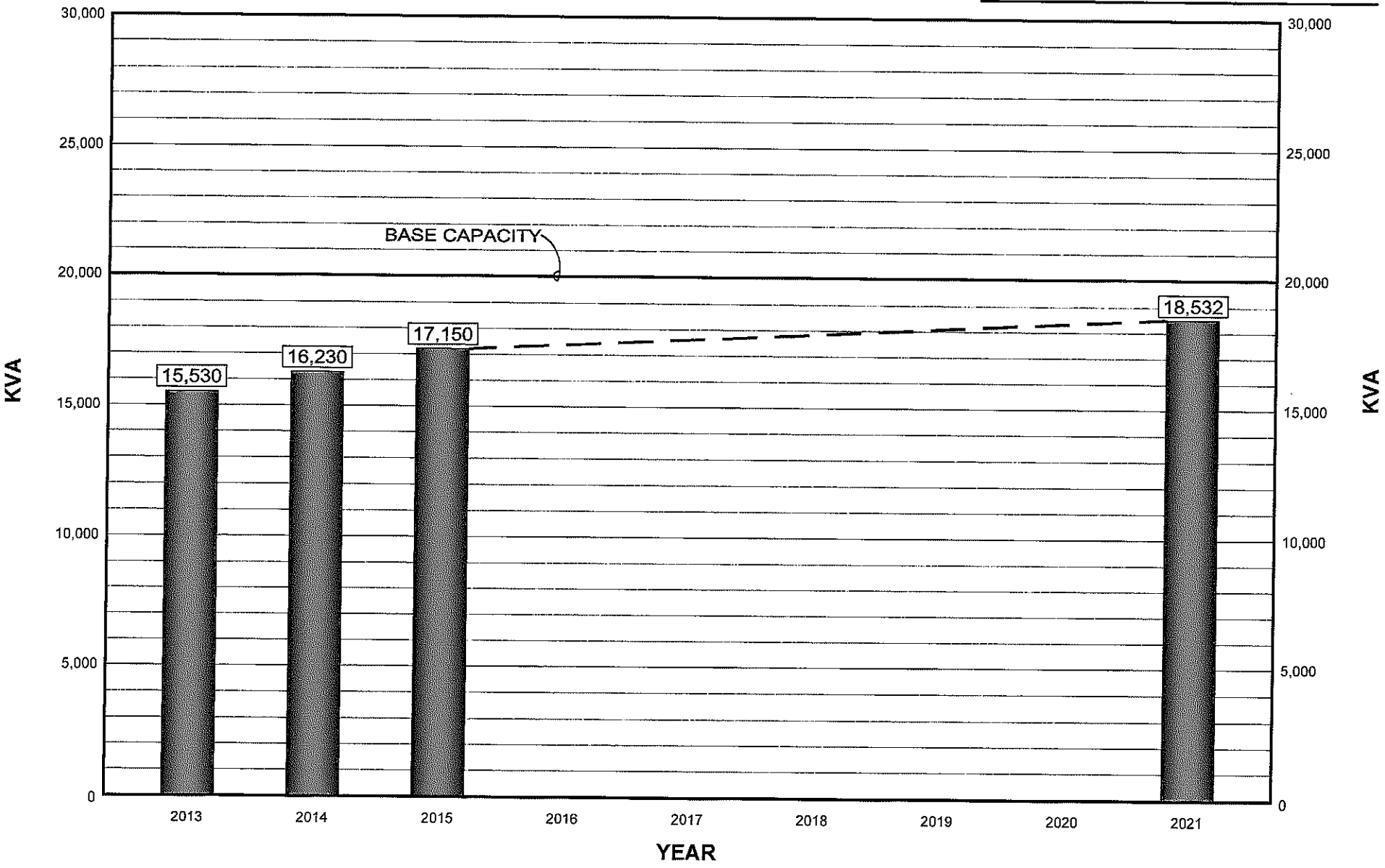


EXHIBIT D

CITY OF FAIRHOPE
ELECTRICAL PEAK DEMAND (SUMMER)
CHURCH STREET SUBSTATION

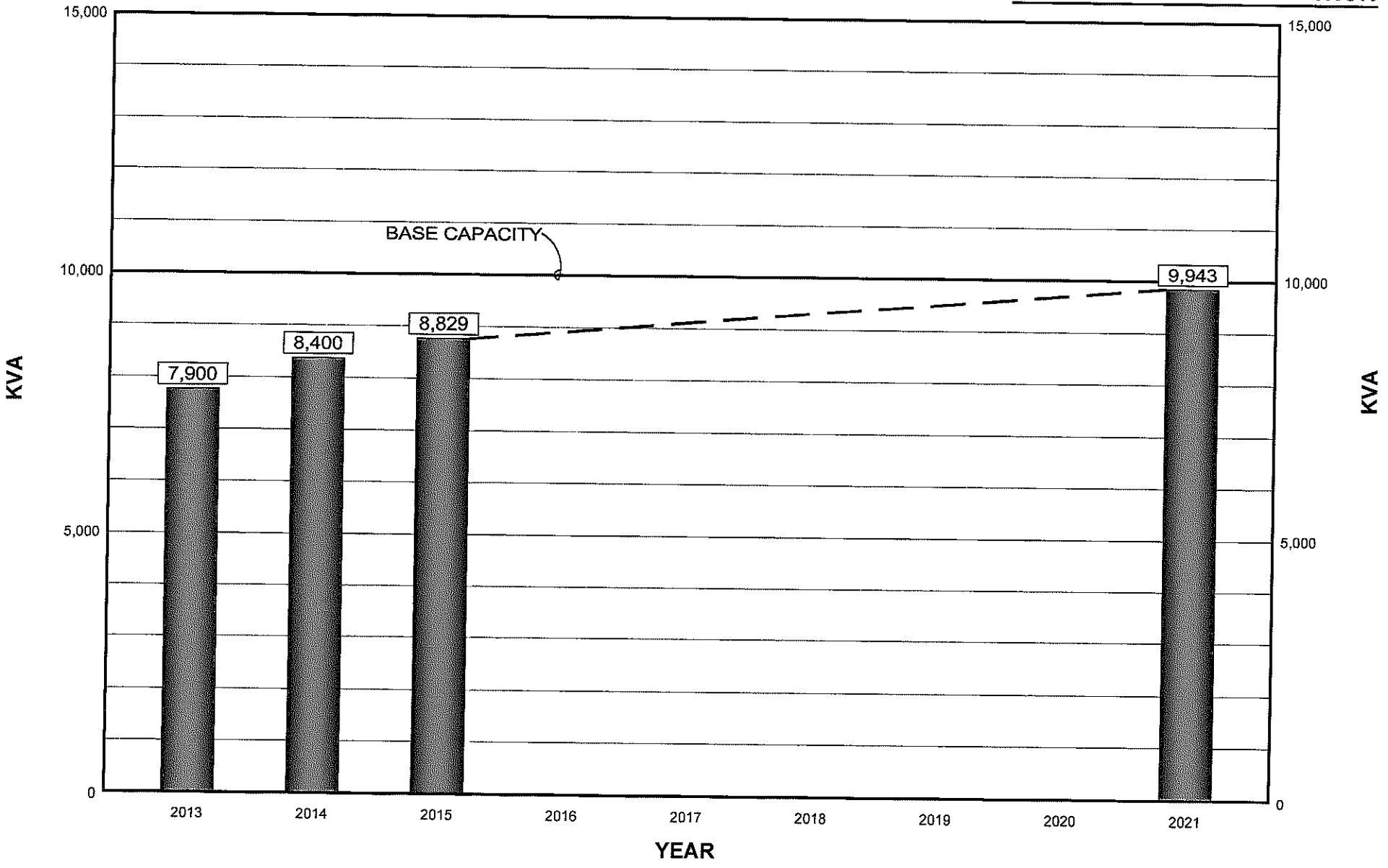


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

FAIRHOPE AVENUE SUBSTATION

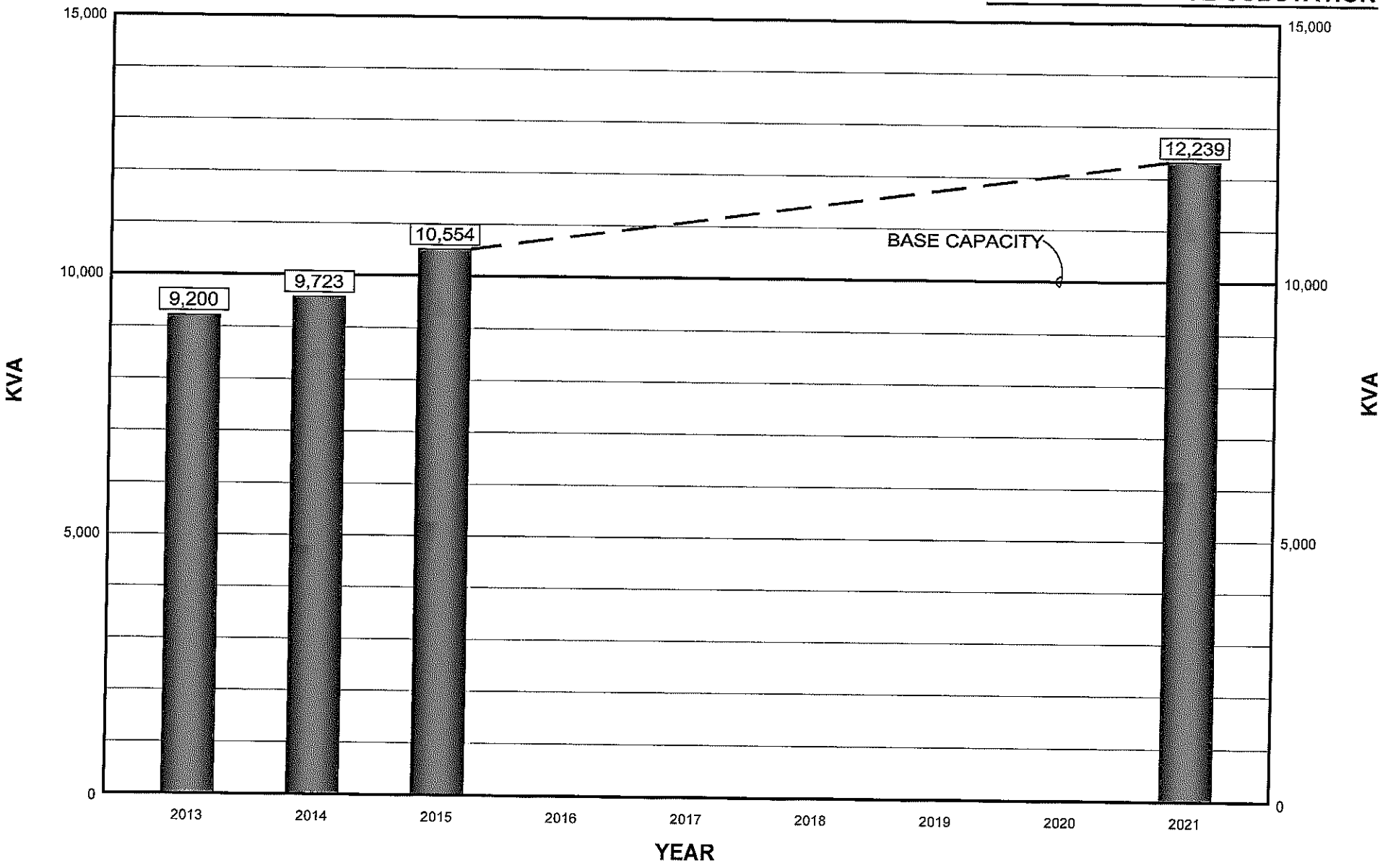


EXHIBIT D

CITY OF FAIRHOPE
ELECTRICAL PEAK DEMAND (SUMMER)
NICHOLS AVENUE SUBSTATION

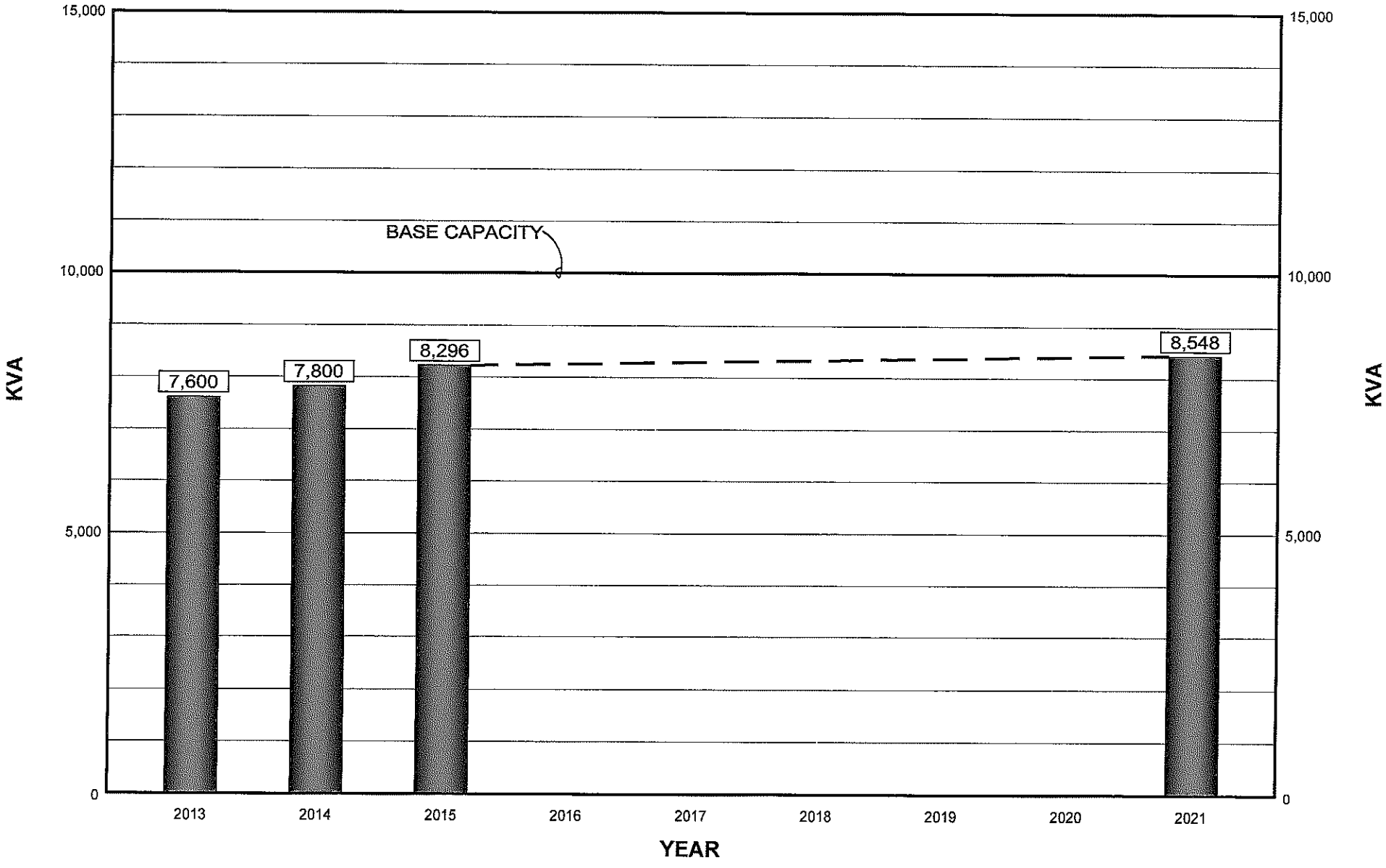


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

VOLANTA AVENUE SUBSTATION

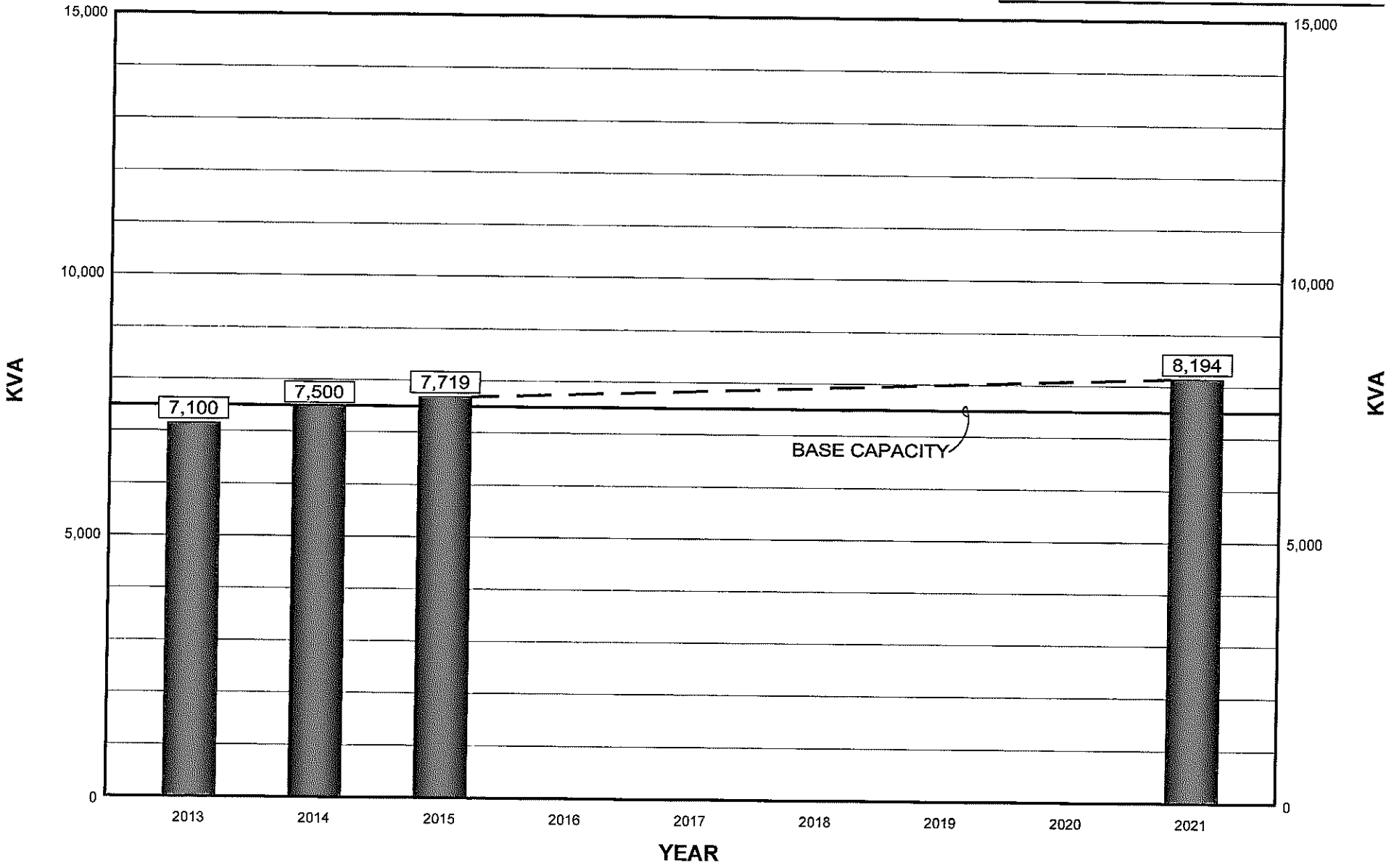


EXHIBIT D

CITY OF FAIRHOPE

ELECTRICAL PEAK DEMAND (SUMMER)

YOUNG STREET SUBSTATION