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February 26, 2019

VIA ELECTRONIC FILING AND HAND DELIVERY

Ms. M. Lynn Jarvis, Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, North Carolina 27699-4300

Re: Duke Energy Carolinas, LLC's REPS Cost Recovery Rider and 2018 Compliance Report
Docket No. E-7, Sub 1191

Dear Ms. Jarvis:

Enclosed for filing with the North Carolina Utilities Commission ("Commission") please find the Application of Duke Energy Carolinas, LLC ("DEC" or the "Company") pursuant to N.C. Gen. Stat. §62-133.8 and Commission Rule R8-67 relating to incremental costs for compliance with the renewable energy and energy efficiency portfolio standard ("REPS") for electric utilities, together with the testimony and exhibits of Megan W. Jennings and Veronica I. Williams containing the information required by Commission Rule R8-67. DEC's 2018 REPS Compliance Report, filed pursuant to N.C. Gen. Stat. §62-133.8 and Commission Rule R8-67(c), is attached as Exhibit No. 1 to Ms. Jennings' testimony in support of the Application. I will deliver fifteen (15) paper copies of the filing to the Clerk's Office by close of business on February 27, 2019.

Certain information contained in the exhibits of Ms. Williams and Ms. Jennings is a trade secret, and confidential, proprietary, and commercially sensitive information. For that reason, it is being filed under seal pursuant to N.C. Gen. Stat. §132-1.2. Parties to the docket may contact the Company regarding obtaining copies pursuant to an appropriate confidentiality agreement.

Please do not hesitate to contact me if you have any questions.

Sincerely,

/Robert W. Kaylor

Robert W. Kaylor

Enclosure
cc: David Drooz (w/ attachments)

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

DOCKET NO. E-7, SUB 1191

In the Matter of:)	
)	
Application of Duke Energy Carolinas, LLC)	**APPLICATION FOR APPROVAL OF REPS COST RECOVERY RIDER AND 2018 REPS COMPLIANCE REPORT**
for Approval of Renewable Energy and)	
Energy Efficiency Portfolio Standard)	
(REPS) Compliance Report and Cost)	
Recovery Rider Pursuant to N.C. Gen. Stat.)	
§ 62-133.8 and Commission Rule R8-67)	

Duke Energy Carolinas, LLC ("DEC" or the "Company"), pursuant to N.C. Gen. Stat. § 62-133.8 and Rule R8-67 of the Rules and Regulations of the North Carolina Utilities Commission ("Commission"), hereby makes this Application (1) for approval of its 2018 Renewable Energy Portfolio Standard ("REPS") Compliance Report, and (2) to implement a monthly charge to recover the incremental costs associated with compliance with the REPS. In support of this Application, the Company respectfully shows the following:

1. The Company is a public utility operating in the states of North Carolina and South Carolina where it is engaged in the generation, transmission, distribution, and sale of electricity for compensation. Its general offices are located at 550 South Tryon Street, Charlotte, North Carolina, and its mailing address is DEC 45A, 550 South Tryon Street, Charlotte, North Carolina 28202.

2. The attorneys for the Company, to whom all communications and pleadings should be addressed, are:

Kendrick C. Fentress
Associate General Counsel
Duke Energy Corporation
P.O. Box 1551

Raleigh, North Carolina 27602
919.546.6733
Kendrick.Fentress@duke-energy.com

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3. N.C. Gen. Stat. § 62-133.8 requires North Carolina's electric power suppliers to supply ten (10) percent of their North Carolina retail kilowatt hours ("kWh") sales from "renewable energy resources," as that term is defined by N.C. Gen. Stat. § 62-133.8(a)(8), for calendar year 2018. In addition, N.C. Gen. Stat. § 62-133.8(d) requires that the electric power suppliers supply 0.20 percent of their North Carolina retail kWh sales from solar photovoltaic or thermal solar resources in 2018. Further, N.C. Gen. Stat. § 62-133.8(e) and (f) require that the electric power suppliers also obtain their allocated share of the state-wide requirement of 0.20 percent of the total North Carolina retail kWh sold from swine waste resources and 900,000 megawatt hours ("MWh") of the total electric power sold to North Carolina retail customers from poultry waste resources, respectively, in 2018.[1]

4. N.C. Gen. Stat. § 62-133.8(h) provides that the electric public utilities shall be allowed to recover the incremental costs[2] associated with complying with N.C.

[1] Both the Poultry Waste and Swine Waste Set-Aside Requirements established by N.C. Gen. Stat. § 62-133.8 have been modified by Commission order pursuant to N.C. Gen. Stat. § 62-133.8(i)(2), as discussed herein.

[2] "Incremental costs" include (1) all reasonable and prudent costs incurred by an electric utility to meet the solar and renewable generation requirements of the statute that are in excess of the utility's avoided costs, (2) costs associated with research that encourages the development of renewable energy, energy efficiency, or improved air quality provided those research costs do not exceed one million dollars ($1,000,000) per year, and (3) costs, including program costs, incurred to provide incentives to customers pursuant to N.C.Gen. Stat. § 62-155(f) (solar rebate program costs and incentives).

Gen. Stat. § 62-133.8 through an annual rider not to exceed the following per-account charges:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$ 10.00	$ 12.00	$ 27.00
Commercial per account	$ 50.00	$ 150.00	$ 150.00
Industrial per account	$ 500.00	$ 1,000.00	$1,000.00

The statute provides that the Commission shall ensure that the incremental costs to be recovered from individual customers on a per-account basis are in the same proportion as the per-account annual charges for each customer class set out in the chart above.

5. Rule R8-67(c) requires the Commission to conduct an annual proceeding for each electric public utility to review the utility's costs to comply with N.C. Gen. Stat. § 62-133.8 and establish the electric public utility's annual rider to recover such costs in a timely manner. The Commission shall also establish an experience modification factor ("EMF") to collect the difference between the electric public utility's actual reasonable and prudent REPS costs incurred during the test period and the actual revenues realized during the test period. Rule R8-67(c) further provides that the Commission shall consider each electric public utility's REPS compliance report at the hearing provided for in Rule R8-67(e) and shall determine whether the electric public utility has complied with N.C. Gen. Stat. § 62-133.8(b), (d), (e) and (f).

6. According to Rules R8-67(c) and (e), the electric public utility is to file its application for recovery of its REPS costs, as well as its REPS compliance report, at the same time it files the information required by Rule R8-55, and the Commission is to conduct an annual rider hearing as soon as practicable after the hearing required by Rule R8-55.

7. Pursuant to the provisions of N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67(e), DEC requests the Commission to establish a rider to recover its reasonable and prudent forecasted REPS compliance costs to be incurred during the rate period. As provided in Rule R8-67(e), the Company requests to return to DEC's retail customers, through the EMF, $1,956,331of REPS costs incurred and other credits for the period beginning January 1, 2018 through December 31, 2018 ("EMF Period") and collect from DEC's retail customers $34,984,948__ for REPS costs to be incurred during the rate period from September 1, 2019 through August 31, 2020 ("Billing Period"). The REPS rider and EMF will be in effect for the twelve-month period September 1, 2019 through August 31, 2020.

8. Pursuant to the provisions of N.C. Gen. Stat. § 62-133.8 and Rule R8-67, DEC requests Commission approval of the annual billing statements, including both the REPS monthly charge and the EMF monthly charge, for each customer class as follows:

Customer Class	**REPS Monthly Charge** (excl. regulatory fee)	**Monthly EMF** (excl. regulatory fee)	**Total REPS Monthly Charge** (excl. regulatory fee)	**Total REPS Monthly Charge** (incl. regulatory fee)
Residential	$ 0.94	$ (0.07)	$ 0.87	$ 0.87
General[3]	$ 4.82	$ (0.18)	$ 4.64	$ 4.65
Industrial	$20.53	$ 0.75	$21.28	$21.31

The calculation of these rates is set forth in Exhibit No. 4 of the direct testimony of Veronica I. Williams filed with this Application.

[3] Duke Energy Carolinas' General Service rate schedule generally covers the class of customers intended to be captured by the "Commercial" class included within N.C. Gen. Stat. § 62-133.8. The Company does not have a rate schedule for "Commercial" customers.

9. Further, pursuant to the provisions of N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67(c), the Company requests Commission approval of its 2018 REPS Compliance Report, attached as an exhibit to the direct testimony of Megan Jennings filed in support of this Application. As described by Ms. Jennings' testimony, and illustrated in DEC's 2018 REPS Compliance Report, the Company has complied with the requirements of N.C. Gen. Stat. § 62-133.8(b) and (d) for 2018. In its October 8, 2018 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements and Providing Other Relief*, in Docket No. E-100, Sub 113, the Commission lowered the 2018 Poultry Waste Set-Aside Requirement (N.C. Gen. Stat. § 62-133.8(f)) to 300,000 MWh and delayed by one year the scheduled increases in that requirement. The Commission also lowered the Swine Waste Set-Aside Requirement for DEC, Duke Energy Progress, LLC and Dominion Energy North Carolina to 0.02% of prior-year retail sales, delaying the scheduled increase to 0.07% of prior-year retail sales to begin in calendar year 2019, and delaying future increases by one year.[4] The Company has complied with these modified Poultry Waste and Swine Waste Set-Aside Requirements.

[4] In its *Order Modifying the Poultry and Swine Waste Set-Aside and Granting Other Relief* issued in Docket No. E-100, Sub 113 (November 29, 2012), the Commission eliminated the Swine Waste Set-Aside Requirement for 2012 and delayed for one year the Poultry Waste Set-Aside Requirement. In its March 26, 2014, *Final Order Modifying the Poultry and Swine Waste Set-Aside Requirements and Providing Other Relief*, the Commission delayed the Swine and Poultry Waste Set-Aside Requirements for an additional year. In its November 13, 2014 *Order Modifying the Swine Waste Set-Aside Requirement and Providing Other Relief*, the Commission directed that Swine Waste Set-Aside Requirement remain at 0.07 percent for the years 2015-2016. Subsequently, in its December 1, 2015 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements and Providing Other Relief*, the Commission directed that the Swine Waste Set-Aside Requirement for 2015 be delayed an additional year and that the 2015 Poultry Waste Set-Aside Requirement would be the same as the 2014 level. In its October 17, 2016 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements and Providing Other Relief*, the Commission directed that the 2016 Swine Waste Set-Aside Requirement be delayed an additional year and that the 2016 Poultry Waste Set-Aside Requirement remain at the same level as the 2015 requirement and delayed by one year the scheduled increases in that requirement. In its October 16, 2017 *Order Modifying the Swine and Poultry*

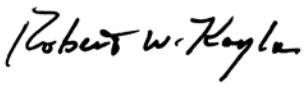
10. The information and data required to be filed under Commission Rule R8-67 is contained in the direct testimony and exhibits of Witnesses Jennings and Williams, which are being filed simultaneously with this Application and incorporated herein by reference.

WHEREFORE, the Company respectfully prays:

That consistent with this Application, the Commission approves the Company's 2018 REPS Compliance Report and allows the Company to implement the rate riders as set forth above.

Waste Set-Aside Requirements and Providing Other Relief, in Docket No. E-100, Sub 113, the Commission directed that the 2017 Swine Waste Set-Aside Requirement be delayed an additional year and that the 2017 Poultry Waste Set-Aside Requirement (N.C. Gen. Stat. § 62-133.8(f)) remain at the same level as the 2016 requirement, which the Commission had previously approved at 170,000 MWh, and delayed by one year the scheduled increases in that requirement. In its October 8, 2018 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements And Providing Other Relief* in Docket No. E-100, Sub 113, the Commission modified the 2018 Swine Waste Set-Aside Requirement for electric public utilities to 0.02% and delayed by one year the scheduled increases to the requirement. The Commission also modified the 2018 Poultry Waste Set-Aside Requirement to 300,000 MWh, and delayed by one year the scheduled increases in the requirement.

Respectfully submitted, this the 26th day of February, 2019.



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ATTORNEYS FOR DUKE ENERGY CAROLINAS, LLC

VERIFICATION

STATE OF NORTH CAROLINA)
)
COUNTY OF MECKLENBURG)

DOCKET NO. E-7, SUB 1191

Veronica I. Williams, being first duly sworn, deposes and says:

That she is Rates and Regulatory Strategy Manager for Duke Energy Carolinas, LLC; that she has read the foregoing Application and knows the contents thereof; that the same is true except as to those matters stated on information and belief; and as to those matters, she believes them to be true.

Veronica I. Williams

Sworn to and subscribed before me
this the 22nd day of February, 2019.

Notary Public Aloma M. Felder

My Commission Expires: July 21, 2021

ALOMA M. FELDER
NOTARY
PUBLIC
CABARRUS COUNTY, N. C.

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

DOCKET NO. E-7, SUB 1191

In the Matter of Application of Duke Energy Carolinas, LLC for Approval of Renewable Energy and Energy Efficiency Portfolio Standard (REPS) Compliance Report and Cost Recovery Rider Pursuant to N.C. Gen. Stat. 62-133.8 and Commission Rule R8-67	)	**DIRECT TESTIMONY OF MEGAN W. JENNINGS**

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Megan W. Jennings, and my business address is 400 South Tryon Street, Charlotte, North Carolina.

Q. PLEASE STATE YOUR POSITION WITH DUKE ENERGY AND DESCRIBE YOUR CURRENT RESPONSIBILITIES.

A. In my capacity as Renewable Compliance Manager, I am responsible for the development and implementation of renewable energy compliance strategies for Duke Energy Carolinas, LLC ("Duke Energy Carolinas," "DEC" or "the Company"), Duke Energy Progress, LLC ("Duke Energy Progress") and Duke Energy Ohio, LLC. My responsibilities include compliance with North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard ("REPS"), compliance with Ohio's Renewable Energy Portfolio Standard and evaluation of renewable generation initiatives and customer programs that relate to renewable compliance.

Q. PLEASE BRIEFLY SUMMARIZE YOUR EDUCATIONAL BACKGROUND.

A. I received a Bachelor of Science in Mathematical Sciences from Clemson University and a Masters of Financial Mathematics from North Carolina State University.

Q. PLEASE DESCRIBE YOUR BUSINESS BACKGROUND AND EXPERIENCE.

A. I joined Progress Energy, Inc. in 2008, where I held positions in Investor Relations and Regulatory Planning. Following the merger of Progress

Energy, Inc. with Duke Energy Corporation, I worked in the Rates and Regulatory Strategy Department until June of 2015, when I moved to my current position as Renewable Compliance Manager in the Distributed Energy Technology Department.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE NORTH CAROLINA UTILITIES COMMISSION?

A. Yes, I most recently provided testimony in Docket No. E-2, Sub 1175 on Duke Energy Progress's 2017 REPS compliance report and application for approval of its REPS cost recovery rider and in Docket No. E-7, Sub 1162 on Duke Energy Carolinas' 2017 REPS compliance report and application for approval of its REPS cost recovery rider.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to describe Duke Energy Carolinas' activities and the costs it has incurred, or projects it will incur, in support of compliance with North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard under N.C. Gen. Stat. ("G.S.") § 62-133.8 during the twelve months beginning on January 1, 2018 and ending on December 31, 2018 ("Test Period"), as well as during the twelve months beginning on September 1, 2019 and ending on August 31, 2020 ("Billing Period").

Q. PLEASE DESCRIBE THE EXHIBITS TO YOUR TESTIMONY.

A. My testimony includes twenty-three exhibits: Jennings Confidential Exhibit No. 1 is the Company's 2018 REPS Compliance Report, and Jennings

Confidential Exhibit No. 2 provides actual and forecasted REPS compliance costs, by resource, that the Company has incurred during the Test Period and projects to incur during the Billing Period in support of compliance with REPS. Jennings Confidential Exhibit No. 3 is a worksheet detailing the other incremental costs included in the DEC REPS filing, listing the labor costs by activity, as directed by the North Carolina Utilities Commission ("Commission") in its August 17, 2018 Order in Docket No. E-7, Sub 1162. Jennings Confidential Exhibit No. 4 provides information on DEC's Renewable Energy Certificate ("REC") sales, as required to comply with the Commission's May 13, 2014 *Order Regarding Accounting Treatment for REC Sales* in Docket No. E-100, Sub 113. Jennings Exhibit Nos. 5-23 are the results of studies the costs of which the Company is recovering via the REPS Rider.

Q. WERE THESE EXHIBITS PREPARED BY YOU OR AT YOUR DIRECTION AND UNDER YOUR SUPERVISION?

A. Jennings Confidential Exhibit Nos. 1-4 were prepared by me or under my supervision. Jennings Exhibit Nos. 5-23 include the results of studies not prepared under my supervision. In my role at Duke Energy, however, I am familiar with the studies.

Compliance with REPS Requirements

Q. WHAT ARE DUKE ENERGY CAROLINAS' REPS REQUIREMENTS UNDER G.S. § 62-133.8?

A. Pursuant to G.S. § 62-133.8,[1] as an electric power supplier, Duke Energy Carolinas is required to comply with the overall REPS requirement ("Total Requirement") by submitting for retirement a total volume of RECs equivalent to the following percentages of its North Carolina retail sales in the prior year:

- Beginning in 2012, three percent (3%);
- In 2015, six percent (6%);
- In 2018, ten percent (10%); and
- In 2021 and thereafter, twelve point five percent (12.5%).

Furthermore, each electric power supplier must comply with the requirements of G.S. § 62-133.8 (d), (e), and (f) (individually referred to as the "Solar Set-Aside," "Swine Waste Set-Aside," and "Poultry Waste Set-Aside," respectively). That is, within the Total Requirement described above, each electric power supplier is to ensure that specific quantities of qualifying solar RECs, swine waste RECs, and poultry waste RECs are also submitted for retirement. The Company generally refers to its Total Requirement net of the three set-asides as its "General Requirement."

[1] In its *Order Clarifying Electric Power Suppliers' Annual REPS Requirements*, Docket No. E-100, Sub 113 (November 26, 2008), the Commission clarified that the calculation of these requirements for each year shall be based upon the electric utility's North Carolina retail sales for the prior year.

Specifically, each electric power supplier is to comply with the Solar Set-Aside by submitting for retirement a volume of qualifying solar RECs equivalent to the following percentages of its North Carolina retail sales in the prior year:

- Beginning in 2010, two-hundredths of one percent (0.02%);
- In 2012, seven-hundredths of one percent (0.07%);
- In 2015, fourteen-hundredths of one percent (0.14%); and
- In 2018 and thereafter, two-tenths of one percent (0.2%).

Each electric power supplier is also to comply with the Swine Waste Set-Aside by submitting for retirement a volume of qualifying swine waste RECs equivalent to its pro-rata share of total retail electric power sold in North Carolina multiplied by the statewide, aggregate Swine Waste Set-Aside Requirement.[2] Duke Energy Carolinas' Swine Waste Set-Aside Requirements, as modified by the Commission[3], are as follows:

- In 2018, its pro-rata share of two-hundredths of one percent (0.02%) of the total retail electric power sold in North Carolina in the year prior;

[2] In its *Order on Pro Rata Allocation of Aggregate Swine and Poultry Waste Set-Aside Requirements and Motion for Clarification* in Docket No. E-100, Sub 113 (March 31, 2010), the Commission approved the electric power suppliers' proposed pro-rata allocation of the statewide aggregate swine and poultry waste set-aside requirements, such that the aggregate requirements will be allocated among the electric power suppliers based on the ratio of each electric power supplier's prior year retail sales to the total statewide retail sales.

[3]In its *Order Modifying the Swine and Poultry Waste Set-Aside Requirements And Providing Other Relief* (October 8, 2018) Docket No. E-100, Sub 113, the Commission modified the 2018 Swine Waste Set-Aside Requirement for electric public utilities to 0.02% and delayed by one year the scheduled increases to the requirement. The Commission also modified the 2018 Poultry Waste Set-Aside Requirement to 300,000 MWh, and delayed by one year the scheduled increases in the requirement.

- In 2019, its pro-rata share of seven-hundredths of one percent (0.07%) of the total retail electric power sold in North Carolina in the year prior;
- In 2021, its pro-rata share of fourteen-hundredths of one percent (0.14%) of total retail electric power sold in North Carolina in the year prior; and
- In 2024 and thereafter, its pro-rata share of two-tenths of one percent (0.2%) of total retail electric power sold in North Carolina in the year prior.

Finally, each electric power supplier is also to submit for retirement a volume of qualifying poultry waste RECs equivalent to its pro-rata share of the aggregate state-wide Poultry Waste Set-Aside requirement. Duke Energy Carolinas' Poultry Waste Set-Aside Requirements, as modified by the Commission, are as follows:

- Beginning in 2014, its pro-rata share of 170,000 megawatt-hours ("MWh");
- In 2018, its pro-rata share of 300,000 MWh;
- In 2019, its pro-rata share of 700,000 MWh; and
- In 2020 and thereafter, its pro-rata share of 900,000 MWh.

The requirements that are described in this testimony and accompanying exhibits reflect the aggregation of the REPS requirements of Duke Energy Carolinas' retail customers as well as those wholesale customers, specifically Blue Ridge Electric Membership Corporation,

Rutherford Electric Membership Corporation, Town of Dallas, Town of Forest City, City of Concord, Town of Highlands, and City of Kings Mountain (collectively "Wholesale"), for which the Company has been contracted to provide REPS compliance services. DEC's contracts to provide REPS compliance services for the City of Concord and the City of Kings Mountain end in December 2018, and thus the compliance requirements have been adjusted accordingly.

Q. PLEASE DISCUSS DUKE ENERGY CAROLINAS' REPS REQUIREMENTS FOR THE TEST AND BILLING PERIODS.

A. For the Test Period, the Company has submitted for retirement 5,923,670 RECs, which includes 14,084 Senate Bill 886 ("SB 886") RECs, each of which counts for two poultry waste and one general REC, to meet its Total Requirement of 5,951,838 RECs. Within this total, the Company has submitted for retirement 119,041 RECs to meet the Solar Set-Aside Requirement, 108,493 RECs, along with 14,084 SB 886 RECs (which count as 28,168 Poultry Waste Set-Aside RECs), to meet the Poultry Waste Set-Aside Requirement, and 11,203 RECs to meet the Swine Waste Set-Aside Requirement. During the prospective Billing Period, which spans two calendar years, with different requirements in each year, the Company's estimated requirements are as follows[4]:

In 2019, the Company estimates that it will be required to submit for retirement 6,217,691 RECs to meet its Total Requirement. Within this total,

[4] The Company's projected requirements are based upon retail sales estimates and will be subject to change based upon actual prior-year North Carolina retail sales data.

the Company is also required to retire the following: 124,357 solar RECs, 43,526 swine waste RECs and 313,614 poultry waste RECs.

In 2020, the Company estimates that it will be required to submit for retirement 6,020,898 RECs to meet its Total Requirement. Within this total, the Company estimates that it will be required to retire approximately 120,421 solar RECs, 42,150 swine waste RECs and 313,614 poultry waste RECs.

Q. HAS THE COMPANY COMPLIED WITH ITS GENERAL REQUIREMENT FOR 2018?

A. Yes. The Company has met its 2018 General Requirement of 5,684,933 RECs. Specifically, the RECs to be used for 2018 compliance have been transferred from the North Carolina Renewable Energy Tracking System ("NC-RETS") Duke Energy Electric Power Supplier account to the Duke Energy Compliance Sub-Account and the Sub-Accounts of its Wholesale customers. Upon completion of this regulatory proceeding, the Commission will finalize retirement of the RECs.

Q. WILL THE COMPANY COMPLY WITH ITS GENERAL REQUIREMENT IN 2019?

A. Yes, the Company is well-positioned to comply with its General Requirement in 2019.

Q. WHAT ACTIONS HAS DUKE ENERGY CAROLINAS TAKEN DURING THE TEST PERIOD TO SATISFY ITS CURRENT AND FUTURE REPS REQUIREMENTS?

A. During the Test Period, Duke Energy Carolinas has continued to produce and procure RECs to satisfy its REPS requirements. Specifically, the Company has taken the following actions: (1) executed and continued negotiations for additional REC purchase agreements with renewable facilities; (2) completed construction and operated three utility-scale solar projects totaling 81 megawatts ("MW"), generating RECs for compliance purposes - the Mocksville Solar Facility, placed in service in December 2016, the Monroe Solar Facility, placed in service in April 2017, and the Woodleaf Solar Facility, placed in service in December 2018; (3) continued operations of its solar and hydroelectric facilities; (4) enhanced and expanded energy efficiency programs that will generate savings that can be counted towards the Company's REPS requirement; (5) performed research studies, both directly and through strategic partnerships, to enhance the Company's ability to comply with its future REPS requirements; (6) obtained approval from the Commission on a method by which to calculate the RECs generated from net metering facilities and track these RECs for use in meeting the Company's REPS requirements; and (7) issued a Request for Proposals as part of the Competitive Procurement of Renewable Energy ("CPRE") Program of North Carolina House Bill 589 ("NC HB 589"), the RECs from which will be used to meet the Company's future REPS requirements.

Q. IS THE COMPANY ABLE TO USE RECS GENERATED FROM NET METERING FACILITIES TO SATISFY ITS FUTURE REPS REQUIREMENTS?

A. Yes. Under the current Net Metering for Renewable Energy Facilities Rider offered by DEC (Rider NM), a customer receiving electric service under a schedule other than a time-of-use schedule with demand rates ("NMNTD customer") shall provide any RECs to DEC at no cost. Per the Commission's June 5, 2018 *Order Approving Rider and Granting Waiver Request* ("NMNTD Order") in Docket Nos. E-2, Sub 1106 and E-7, Sub 1113, for NMNTD customers, DEC may use the PVWatts™ Solar Calculator developed by the National Renewable Energy Laboratory for estimating the generation from NMNTD customers' solar facilities, as permitted by Commission Rule R8-67(g)(2). Commission Rule R8-67(g)(2) allows the use of a scalable conversion factor for estimating annual generation from program participants. DEC shall then report the total amount of electricity produced by facilities under the Rider directly into NC-RETS in a separately identified generation project. DEC has complied with these requirements and reported generation from NMNTD customers to NC-RETS. The RECs from these facilities are currently in DEC's REC inventory and available for use for future compliance requirements.

Q. ARE THERE OTHER COMPLIANCE REQUIREMENTS IN THE NMNTD ORDER WITH WHICH DEC MUST COMPLY?

A. Yes. The NMNTD Order also requires that DEC shall provide NC-RETS on a monthly basis with a list of participating customers, including location and the kW capacity of their installations, to be made available on the NC-RETS website. DEC has complied, and continues to comply, with this requirement. In addition, the NMNTD Order requires that for two years, DEC shall verify through site visits to a statistically significant number of participating residences that the solar installations covered by this Rider continue to be operating, and shall include the findings of its site visits in its annual REPS compliance filing. DEC has hired a third-party contractor to perform the required site visits which are underway and should be completed by June 2019. Therefore, the results of these visits will be reported in the Company's 2019 compliance filing.

Q. HOW WILL THE CPRE PROGRAM OF NC HB 589 IMPACT DEC'S COMPLIANCE WITH ITS GENERAL REQUIREMENT?

A. Under G.S. § 62-110.8(a), DEC and DEP are responsible for procuring renewable energy and capacity through a competitive procurement program with the purpose of adding renewable energy to the state's generation portfolio in a manner that allows DEC and DEP to continue to reliably and cost-effectively serve their customers' future energy needs. To meet the CPRE Program requirements, the Companies must issue requests for proposals to procure energy and capacity from renewable energy facilities in the aggregate amount of 2,660 MW (subject to adjustment in certain

circumstances) reasonably allocated over a term of 45 months beginning on February 21, 2018, when the Commission approved the CPRE Program.

Renewable energy facilities eligible to participate in the CPRE solicitation(s) include those facilities that use renewable energy resources identified in G. S. § 62-133.8(a)(8), the REPS statute. The renewable energy facilities to be developed or acquired by the Companies or procured from a third party through a power purchase agreement under the CPRE Program, must also deliver to the Companies the environmental and renewable attributes, or RECs, associated with the power. The Company's annual CPRE Program Plan, filed on September 1, 2018 in Docket No. E-100, Sub 157, includes a planned allocation of ~1,460 to ~1,960 MWs between the DEC and DEP service territories, as well as a planned timeline for each solicitation. DEC plans to use the RECs acquired through the CPRE RFP solicitations for its future REPS compliance requirements and has therefore included the planned MW allocation and timeline in its REPS compliance planning process. Because the Company will use the RECs acquired through CPRE for REPS compliance, CPRE program implementation costs could be recovered through the REPS Rider. However, as I noted in my testimony in last year's annual REPS cost-recovery proceeding in Docket No. E-7, Sub 1162, the Company has elected to recover the reasonable and prudent costs incurred to implement the CPRE Program through the CPRE Rider as contemplated under Commission Rule R8-71(j).

Q. HAS THE COMPANY COMPLIED WITH ITS SOLAR SET-ASIDE REQUIREMENT FOR 2018?

A. Yes. The Company has met the 2018 Solar Set-Aside Requirement of 119,041 solar RECs. Pursuant to the NC-RETS Operating Procedures, the Company has submitted for retirement 119,041 solar RECs. Specifically, the RECs to be used for 2018 compliance have been transferred from the NC-RETS Duke Energy Electric Power Supplier account to the Duke Energy Compliance Sub-Account and the Sub-Accounts of its Wholesale customers. Upon completion of this regulatory proceeding, the Commission will finalize retirement of the RECs.

Q. WILL THE COMPANY COMPLY WITH ITS SOLAR SET-ASIDE REQUIREMENT IN 2019?

A. Yes, the Company is well-positioned to comply with its Solar Set-Aside Requirement in 2019.

Q. PLEASE PROVIDE AN UPDATE ON THE COMPANY'S EFFORTS TO COMPLY WITH ITS SOLAR SET-ASIDE REQUIREMENT.

A. The Company is well-positioned to comply with its Solar Set-Aside Requirement in 2019 through a diverse and balanced portfolio of solar resources. The Company's efforts to comply with the Solar Set-Aside Requirement include REC generation and procurement from solar renewable energy facilities.

As previously noted, the Company constructed three DEC-owned solar photovoltaic ("PV") facilities, which will generate an estimated

155,000 RECs per year over the life of the projects. These facilities include the Monroe Solar Facility, 60 MW located in Union County, the Mocksville Solar Facility, 15 MW located in Davie County, and the Woodleaf Solar Facility, 6 MW located in Rowan County.

Q. PLEASE DESCRIBE THE OPERATIONAL STATUS OF THE COMPANY'S PV DISTRIBUTED GENERATION ASSETS.

A. The Company's approximately 10 MW-DC of solar PV generation facilities were operational and generating power for the benefit of its customers during the test period. One of the sites is currently in a partial outage to repair damaged conduit. The repair work is estimated to be completed in the second quarter of 2019. In 2019, the Company plans to continue updating monitoring equipment at its 18 nonresidential sites.

Q. HAS THE COMPANY COMPLIED WITH ITS POULTRY WASTE SET-ASIDE REQUIREMENT FOR 2018?

A. Yes. The Company has met the 2018 Poultry Waste Set-Aside Requirement of 136,661 RECs. Pursuant to NC-RETS Operating Procedures, the Company has submitted for retirement 108,493 poultry RECs and 14,084 SB 886 RECs (which count as 28,168 Poultry Waste Set-Aside RECs). Accordingly, the Company has submitted the equivalent of 136,661 poultry RECs for compliance. Specifically, the RECs to be used for 2018 compliance have been transferred from the NC-RETS Duke Energy Electric Power Supplier account to the Duke Energy Compliance Sub-Account and the Sub-Accounts of its Wholesale customers. Upon

completion of this regulatory proceeding, the Commission will finalize retirement of the RECs.

Q. WILL THE COMPANY COMPLY WITH ITS POULTRY WASTE SET-ASIDE REQUIREMENT IN 2019?

A. The Company's ability to comply with its Poultry Waste Set-Aside Requirement in 2019 is dependent on the performance of poultry waste-to-energy developers on current contracts and two new poultry waste-to-energy projects that are scheduled to come online during 2019. Three poultry waste-to-energy facilities that were previously operational encountered operational issues and were shut down in 2018 to perform plant modifications. One facility is already back online, another is expected back online in mid-2019, and the third is expected back online in late 2019, but 2019 production will be lower than originally expected.

Q. WHAT ACTIONS HAS THE COMPANY TAKEN DURING THE TEST PERIOD TO PROCURE OR DEVELOP POULTRY WASTE-TO-ENERGY RESOURCES TO SATISFY ITS POULTRY WASTE SET-ASIDE REQUIREMENTS?

A. In the Test Period, the Company (1) continued direct negotiations for additional supplies of both in-state and out-of-state resources with multiple counterparties; (2) secured contracts for additional poultry waste-to-energy resources; (3) worked diligently to understand the technological, permitting, and operational risks associated with various methods of producing qualifying poultry RECs to aid developers in overcoming those risks; when

those risks could not be overcome, the Company worked with developers via contract amendments to adjust for more realistic outcomes; (4) explored leveraging current biomass contracts by working with developers to add poultry waste to their fuel mix; (5) explored adding thermal capabilities to current poultry sites to bolster REC production; (6) explored poultry-derived directed biogas at facilities located in North Carolina and directing such biogas to combined cycle plants for combustion and electric generation; (7) utilized the Company's REC trader to search the broker market for out-of-state poultry RECs available in the market; and (8) participated in the North Carolina Energy Policy Council Biogas Working Group. Additional information on the Company's compliance with the Poultry Waste Set-Aside requirement can be found in the Company's Joint Semiannual Progress Report, filed on November 30, 2018 in Docket No. E-100, Sub 113A.

The Company remains committed to satisfying its statutory requirements for the Poultry Waste Set-Aside and will continue to reasonably and prudently pursue procurement of these resources.

Q. HAS THE COMPANY COMPLIED WITH ITS SWINE WASTE SET-ASIDE REQUIREMENT FOR 2018?

A. Yes. The Company has met the 2018 Swine Waste Set-Aside Requirement of 11,203 swine RECs. Pursuant to the NC-RETS Operating Procedures, the Company has submitted for retirement 11,203 swine RECs. Specifically, the RECs to be used for 2018 compliance have been

transferred from the NC-RETS Duke Energy Electric Power Supplier account to the Duke Energy Compliance Sub-Account. Upon completion of this regulatory proceeding, the Commission will finalize retirement of the RECs.

Q. WILL THE COMPANY COMPLY WITH ITS SWINE WASTE SET-ASIDE REQUIREMENT IN 2019?

A. The Company's ability to comply with its Swine Waste Set-Aside Requirement in 2019 is dependent on the performance of swine waste-to-energy developers on current contracts, particularly achievement of projected delivery requirements and commercial operation milestones.

As part of its efforts to achieve compliance with the Swine Waste Set-Aside Requirement, the Company, together with Duke Energy Progress (jointly, "The Companies"), in December 2017 issued a Request for Proposals for swine waste fueled proposals, soliciting up to 750,000 MMBtu of swine waste fueled biogas, or the equivalent in MWh, which is approximately 110,000 MWh, of electric power fueled by swine waste. The Companies received seven responses to the RFP, have evaluated the proposals, and have executed contracts with two of the projects. Under these contracts, the Company will purchase the swine-derived biogas generated by the facilities, one being built in Union County, NC and the other in Wilson County, NC, and use it for generating power at the Companies' combined cycle facilities. The two projects are due online in 2021.

The Company understands that current swine waste-to-energy projects have encountered difficulties in achieving the full REC output of their contracts due to issues including local opposition to siting of the facilities, the inability to secure firm and reliable sources of swine waste feedstock from waste producers in North Carolina, difficulties securing project financing and technological challenges encountered when ramping up production. In addition, after terminating four contracts for swine waste RECs in 2017 due to failure to perform, force majeure events and project bankruptcy, the Company was notified by another project in January 2019 that the project will not be continuing due to failure to operate.

Q. WHAT ACTIONS HAS DUKE ENERGY CAROLINAS TAKEN DURING THE TEST PERIOD TO PROCURE OR DEVELOP SWINE WASTE-TO-ENERGY RESOURCES TO MEET ITS SWINE WASTE SET-ASIDE REQUIREMENTS?

A. In the Test Period, the Company (1) continued direct negotiations for additional supplies of both in-state and out-of-state resources; (2) continued support of the Loyd Ray Farms research and development project; (3) worked diligently to understand the technological, permitting, and operational risks associated with various methods of producing qualifying swine RECs to aid developers in overcoming those risks; when those risks could not be overcome, the Company worked with developers via contract amendments to adjust for outcomes that the developers believe are achievable based on new experience; (4) explored and is engaging in

modification of current biomass and set-asides contracts by working with developers to add swine waste to their fuel mix; (5) continued pursuit of swine-derived directed biogas from North Carolina facilities; (6) utilized the Company's REC trader to search the broker market for out-of-state swine RECs available in the market; (7) engaged the North Carolina Pork Council ("NCPC") in a project evaluation collaboration effort that will allow the Company and the NCPC to discuss project viability, as appropriate, with respect to the Company's obligations to keep certain sensitive commercial information confidential; and (8) participated in the North Carolina Energy Policy Council Biogas Working Group. Additional information on the Company's compliance with the Swine Waste Set-Aside requirement can be found in the Company's Joint Semiannual Progress Report, filed on November 30, 2018 in Docket No. E-100, Sub 113A.

The Company remains committed to satisfying its statutory requirements for the Swine Waste Set-Aside and will continue to reasonably and prudently pursue procurement of these resources.

Q. IS DUKE ENERGY CAROLINAS CONTINUING TO EXECUTE ADDITIONAL REC PURCHASE AGREEMENTS?

A. Yes. The Company continues to execute additional REC purchase agreements and maintains an open solicitation for proposals from developers of renewable energy resources.

Q. DID THE COMPANY SELL ANY RECS DURING THE TEST PERIOD?

A. Yes, the Company sold poultry RECs during the test period to other electric suppliers in North Carolina to enable the state's electric power suppliers to comply with the aggregate Poultry Waste Set-Aside Requirement. These sales did not negatively impact compliance, and the proceeds were credited back to the Company's retail and Wholesale REPS customers.

Q. HAS THE COMPANY COMPLIED WITH THE COMMISSION'S MAY 2014 ORDER IN DOCKET NO. E-100, SUB 113, PERTAINING TO ACCOUNTING FOR REC SALES?

A. Yes. Please see Jennings Confidential Exhibit No. 4 for information on the Company's REC sales, as required by this Order.

Q. DOES THE COMPANY HAVE IN ITS INVENTORY ANY RECS THAT IT CANNOT USE FOR ITS OWN REPS COMPLIANCE REQUIREMENTS?

A. Yes. DEC has RECs in its inventory that it cannot use for its own REPS compliance requirements. The RECs were generated by specific hydroelectric generating facilities owned by the Company, each of which has a generation capacity of 10 MW or less and was placed into service prior to January 1, 2007.

Q. PLEASE EXPLAIN WHY THE COMPANY CANNOT USE THESE RECS TO MEET ITS OWN COMPLIANCE REQUIREMENTS.

A. Under G.S. § 62-133.8(b)(2), an electric public utility, such as DEC, may meet its REPS compliance requirement through several methods, including by "generat[ing] electric power at a new renewable energy facility." The

Commission accepted the registration of these DEC-owned hydroelectric facilities as renewable energy facilities, but not as *new* renewable energy facilities, in its July 31, 2009 *Order Accepting Registration of Renewable Energy Facilities* in Docket Nos. E-7, Subs 886, 887, 888, 900, 903 and 904 ("*June 31, 2009 Registration Order*") and its December 9, 2010 *Order Accepting Registration of Renewable Energy Facilities* in Docket Nos. E-7, Subs 942, 943, 945 and 946 (collectively, "*Registration Orders*"). In the *Registration Orders*, the Commission specifically cited its June 17, 2009 *Order on Public Staff's Motion for Clarification* in Docket No. E-100, Sub 113, where it concluded that these utility-owned hydroelectric facilities do not meet the delivery requirement of G.S. § 62-133.8(a)(5)(c), which requires the delivery of electric power to an electric power supplier, such as DEC, by an entity other than the electric power supplier to qualify as a *new* renewable energy facility.

Q. WHAT HAS THE COMPANY PROPOSED TO DO WITH THESE HYDROELECTRIC RECS THAT IT CANNOT USE FOR ITS OWN REPS COMPLIANCE?

A. In last year's REPS cost recovery proceeding, Docket No. E-7, Sub 1162, the Company proposed to exchange a portion of these hydroelectric RECs for RECs within the inventory of the North Carolina Electric Membership Corporation ("NCEMC"). Unlike DEC, NCEMC can use these hydroelectric RECs to comply with its REPS requirements because G.S. § 62-133.8(c)(2)(d) allows electric membership corporations and

municipalities to meet their REPS requirements through the purchase of RECs derived from renewable, as opposed to new renewable, energy facilities. Additionally, the Company noted that the REC exchange would benefit DEC's customers because it would allow DEC to meet part of its general REPS requirements through the RECs exchanged with NCEMC at no cost to DEC's customers rather than through the purchase of additional RECs from new renewable energy facilities. NCEMC's customers are held harmless in the transaction as this exchange simply replaces RECs in NCEMC's inventory with different RECs that NCEMC will use to meet its General Requirement. The Public Staff of the North Carolina Utilities Commission supported the Company's proposed REC transfer with NCEMC, and the Commission concluded that the proposed transfer was reasonable and served the public interest in its *Order Approving REPS and REPS EMF Riders and 2017 REPS Compliance Report*, issued on August 17, 2018 in Docket No. E-7, Sub 1162.

Q. HAS THE COMPANY EXCHANGED ANY OF THESE HYDROELECTRIC RECS WITH NCEMC?

A. Yes. The Company has executed contracts with NCEMC exchanging a portion of these hydroelectric RECs for an equal number of General Requirement RECs in NCEMC's inventory that DEC can use for REPS compliance.

Cost of REPS Compliance

Q. WHAT ARE THE COMPANY'S COSTS ASSOCIATED WITH REPS COMPLIANCE DURING THIS TEST PERIOD AND THE UPCOMING BILLING PERIOD?

A. Duke Energy Carolinas' costs associated with REPS compliance are reflected in Jennings Confidential Exhibit No. 2 and are categorized by actual costs incurred during the Test Period and projected costs for the Billing Period.

Q. IN ADDITION TO RENEWABLE ENERGY AND REC COSTS, WHAT OTHER COSTS OF REPS COMPLIANCE DOES THE COMPANY SEEK TO RECOVER IN THIS PROCEEDING?

A. Jennings Confidential Exhibit Nos. 2 and 3 identify "Other Incremental Cost," "Solar Rebate Program Cost" and "Research Cost" that the Company has incurred, and estimates it will incur, in association with REPS compliance.

Other Incremental Costs and Solar Rebate Program Costs

Q. PLEASE EXPLAIN THE OTHER INCREMENTAL COSTS INCLUDED FOR RECOVERY IN THIS PROCEEDING.

A. Other Incremental Costs include labor costs associated with REPS compliance activities and non-labor costs associated with administration of REPS compliance. Among the non-labor costs associated with REPS compliance are the Company's subscription to NC-RETS, and accounting and tracking tools related to RECs, reduced by proceeds from REC sales

and agreed-upon liquidated damages paid by sellers for failure to meet contractual milestones, and amounts paid for administrative contractual amendments requested by sellers.

Q. PLEASE PROVIDE INFORMATION ON THE NC HB 589 SOLAR REBATE PROGRAM.

A. As required by G.S. § 62-155(f), DEC developed a Solar Rebate Program offering reasonable incentives to residential and nonresidential customers for the installation of small customer owned or leased solar energy facilities participating in the Company's net metering tariff. The incentive is limited to 10 kilowatts alternating current ("kW AC") for residential solar installations and 100 kW AC for nonresidential solar installations. The program incentive shall be limited to 10,000 kW of installed capacity annually starting January 1, 2018 and continuing until December 31, 2022.

Q. ARE COSTS RELATED TO THE NC HB 589 SOLAR REBATE PROGRAM INCLUDED FOR RECOVERY IN THIS FILING?

A. Yes. Pursuant to G.S. § 62-155(f), each public utility required to offer a solar rebate program, "shall be authorized to recover all reasonable and prudent costs of incentives provided to customers and program administrative costs by amortizing the total program incentives distributed during a calendar year and administrative costs over a 20-year period, including a return component adjusted for income taxes at the utility's overall weighted average cost of capital established in its most recent general rate case, which shall be included in the costs recoverable by the

public utility pursuant to G.S. 62-133.8(h).” G.S. § 62-133.8(h) provides for an electric power supplier’s cost recovery and customer charges under the REPS statute; NC HB 589 amended it by adding a provision to allow for the recovery of incremental costs incurred to “provide incentives to customers, including program costs, incurred pursuant to G.S. § 62-155(f).” Therefore, DEC has included for recovery in this filing costs incurred during the EMF period, and projected to be incurred in the Billing Period, related to the implementation of the NC HB 589 Solar Rebate Program. As detailed on Jennings Confidential Exhibit No. 3, these costs include the annual amortization of incentives paid to customers and program administration costs, which includes labor, information technology and marketing costs.

Q. PLEASE PROVIDE DETAIL ON THE NON-LABOR COSTS ASSOCIATED WITH THE NC HB 589 SOLAR REBATE PROGRAM.

A. Non-labor costs associated with the NC HB 589 Solar Rebate Program include the rebate incentives paid to customers, program marketing costs and information technology costs for the automation of program administrative tasks.

The NC HB 589 Solar Rebate Program launched on July 9, 2018. On July 26, 2018, DEC filed a notice that the 2018 annual participation limits for residential and non-residential customers under the Solar Rebate Program, exclusive of the non-profit participation set-aside, had been

reached. Rebate payments were made to customers accepted into the program, upon installation of their generating system. Beginning in 2019, for a residential customer who obtains a rebate reservation prior to installation, the installation must be completed no later than December 31 in the year in which the reservation was obtained. For a nonresidential customer who obtains a rebate reservation prior to installation, the installation must be completed no later than 365 days from the date of an executed interconnection agreement. Therefore, rebate payments for the 2018 program year will continue into 2019, and the same principle will apply for subsequent program years, with payments continuing into 2023 after the final program year of 2022. In accordance with the September 20, 2018 Order issued by the Commission in Docket Nos. E-2, Sub 1167, and E-7, Sub 1166, after December 31, 2018, a reallocation was completed to assign capacity and pay rebates to those defined as 'Affected Customers' within the Order. This resulted in an increase in rebate payments made at the beginning of 2019. On January 4, 2019, DEC filed a notice that the 2019 annual participation limits for residential and non-residential customers under the Solar Rebate Program, exclusive of the non-profit participation set-aside, had been reached.

Q. PLEASE PROVIDE DETAIL ON THE INTERNAL LABOR COSTS ASSOCIATED WITH THE NC HB 589 SOLAR REBATE PROGRAM.

A. The labor dollars related to the NC HB 589 Solar Rebate Program included for recovery in this filing include projected costs for one Program Manager, two Program Specialists, complex billing staff, information technology, and compliance, accounting and rates support. The Program Manager is responsible for marketing, installer communications, reporting and overseeing the Program Specialists, who are responsible for processing applications, initiating incentive payments and handling customer inquiries. In addition, incremental employees are needed in complex billing as the number of net metering accounts has increased as a result of the NC HB 589 Solar Rebate Program. Information technology work is performed by both internal employees and contractors and included implementation of an electronic application process, including automation required to receive and process solar rebate applications and payments. These employees and contractors continue to provide support and enhancements to this platform to ensure rebate applications are able to be accepted, tracked and monitored. Compliance, accounting, and rates are responsible for ensuring program costs incurred and included for recovery are valid and have appropriate support, rebate payments made comply with the terms outlined in the Solar Rebate Rider, and detail included in required website and updates to the Commission is accurate.

Q. PLEASE PROVIDE DETAIL ON THE INTERNAL LABOR COSTS THAT ARE ASSOCIATED WITH REPS COMPLIANCE AND NC HB 589 SOLAR REBATE PROGRAM ACTIVITIES THAT ARE

INCLUDED IN DEC'S CURRENT APPLICATION FOR REPS COST RECOVERY.

A. DEC charges only the incremental cost of REPS compliance and the NC HB 589 Solar Rebate Program to the REPS cost recovery rider. Consistent with that policy and DEC's practices in previous applications for cost recovery for REPS compliance, internal employees that work to comply with G.S. § 62-133.8 and G.S. § 62-155(f) charge only that portion of their labor to REPS. The departments/functions that charged labor to REPS during the Test Period are detailed in Jennings Confidential Exhibit No. 3.

Q. HOW DO EMPLOYEES CHARGE THEIR REPS-RELATED AND NC HB 589 SOLAR REBATE PROGRAM-RELATED LABOR COSTS TO REPS?

A. Employees positively report their time, which means that each employee is required to submit a timesheet every two weeks in DEC's time reporting system. The hours reported for the period are split according to the accounting entered in the time reporting system for that specific employee. The division of hours is updated for the reporting period as necessary, as the nature of the employee's work changes.

To educate employees to account for their time properly, DEC annually provides instructions for charging time to REPS to affected employees and the management of the employee groups performing REPS work. Additionally, every year prior to filing for approval of the DEC REPS

Compliance Report and Cost-Recovery Rider, the labor hours charged are carefully reviewed and confirmed.

Q. ARE THERE ANY LABOR AND NON-LABOR INTERCONNECTION-RELATED COSTS INCLUDED FOR RECOVERY IN THIS FILING?

A. No. As directed by the Commission in Docket No. E-2, Sub 1109, all internal interconnection-related labor costs, such as those related to employees in the Distributed Energy Resources Standard PPAs and Interconnection Team and the Renewables Service Center, contract labor costs, such as those for temporary employees working on interconnection information technology projects and non-labor costs, such as PowerClerk platform costs, have not been included for recovery in this filing.

Research Costs

With respect to Research and Development ("R&D") activities during the Test Period and projected for the Billing Period, the Company has incurred or projects to incur costs associated with the support of various pilot projects and studies related to distributed energy technology and the Company's REPS compliance.

Q. THE COMMISSION'S *ORDER APPROVING REPS AND REPS EMF RIDERS AND 2012 REPS COMPLIANCE* REQUIRES DUKE ENERGY CAROLINAS TO FILE WITH ITS 2018 REPS RIDER APPLICATION STUDY RESULTS FOR ANY STUDIES THE COSTS OF WHICH IT HAS RECOVERED VIA THE REPS RIDER.

IS THE COMPANY SUPPLYING SUCH STUDIES IN THIS FILING?

A. Yes. The Company's R&D efforts are an integral part of its REPS Compliance efforts. The following summary outlines efforts undertaken by the Company in the test period and specifies the availability of applicable study results.

- CAPER, Short Course Development – In 2018, the Company worked with the Center for Advanced Power Engineering Research ("CAPER"), on a project to develop a short course of "Fundamentals of Power Engineering and Integration of Distributed Energy Resources." This five-week course will provide a comprehensive overview of the fundamentals of power engineering. Topics include three-phase fundamentals, transformers, power flows, power system planning, analysis, protection, dynamics, stability, control, transients, and distributed energy resources and integration into the grid. The course is designed to act as a refresher for the basics and as a brief introduction for more advanced topics for industry professionals who have completed at least a Bachelor of Science degree in Electrical Engineering or have adequate work experience. The course syllabus can be found in Jennings Exhibit No. 5.
- CAPER, Smart Battery Gauge ("SBG") – In 2018, the Company worked with North Carolina State University ("NC State") and

Clemson University, through CAPER, on a project to develop the SBG and to validate the value proposition of the SBG by demonstrating its ability to accurately estimate the State of Charge, State of Health and the Remaining Useful Life in real-time and while the energy storage device is in use. The results of this project can be found in Jennings Confidential Exhibit No. 6. This project is ongoing and is estimated to be completed in 2019.

- Clemson University – Small DG Interface Testing – In 2018, the Company engaged with the eGRID laboratory located at Clemson University on a project to test and validate the function and performance of the Company's small DG interface. A description of the project background can be found in Jennings Confidential Exhibit No. 7.
- Closed Loop Biomass – In 2018, the Company continued to support a closed-loop biomass research project to better understand yield potential for various woody crops, including Loblolly Pine, Hybrid Poplar, Hybrid Aspen, Sweetgum, Willow and Cottonwood trees. American Forest Management ("AFM") provided project management support and periodic updates to the Company. In addition to their regular crop assessments, in 2017 and 2018 AFM collected woody biomass samples from various plots. These were then provided to Mineral Labs so that the lab could perform Ultimate Analysis on each woody biomass sample. Jennings Exhibit No. 8

provides AFM's 2018 Inventory Report, and Jennings Exhibit No. 9 provides the lab results from Mineral Labs. The work on this project concluded in 2018.

- Coalition for Renewable Natural Gas – The Company joined the Coalition for Renewable Natural Gas in 2017, and renewed its membership in 2018, to add a valuable resource of knowledge and public policy advocation in this growing sector of potential animal waste supply. The Coalition for Renewable Natural Gas provides its members with exclusive whitepapers, support on model pipeline gas specifications and access to other members for discussions on current and future projects.
- DER Risks to Transformers and Transmission – In 2018, the Company worked with ABB and Pike Engineering on a project to evaluate the distribution energy resource interconnection impacts to the Transmission to Distribution transformers and the transmission system. The results of this project can be found in Jennings Confidential Exhibit No. 10. The report contains Critical Energy Infrastructure Information as defined by the Federal Energy Regulatory Commission. As such, Exhibit 10 should be treated as strictly confidential.
- Eos Energy Storage Technology Development – The Company and Eos Services started a collaborative technology development program to validate, demonstrate, and quantify the benefits of an

Eos Aurora Battery System that is DC Coupled to a PV facility at the McAlpine Creek Substation 50 kW Solar Facility. The expected completion date of the project is in 2020.

- Electric Power Research Institute ("EPRI") – In 2018, the Company subscribed to the following EPRI programs, the costs of which were recovered via the REPS rider: Program 174 – Integration of Distributed Energy Resources. The company participated in a supplemental project under this program – "Evaluation of Inverter On-Board Detection Methods to Prevent Unintended Islanding." EPRI designates such study results as proprietary or as trade secrets and licenses such results to EPRI members, including Duke Energy Carolinas. As such, the Company may not disclose the information publicly. Non-members may access these studies for a fee. Information regarding access to this information can be found at http://www.epri.com/Pages/Default.aspx.
- ETO - Mitigation of Transformer High Inrush Current – In 2018, the Company started working with multiple vendors on a project to test and evaluate different options to mitigate the transformer high inrush current. Transformers are very expensive components of the electric power system. The transformers installed in the utility scale solar generating facilities are experiencing high inrush current during energization. Transformer inrush currents are short duration currents that flow into the transformer primary every time the

transformer is energized. These currents are typically high magnitude (up to 20 times the nominal current), harmonic currents with some DC component. These high inrush currents can cause numerous problems on the electrical system, such as breaker tripping, voltage sags, voltage flicker, mechanical stress on the transformer windings, oscillatory torque in motors and system resonance. A detailed description of the project can be found in Jennings Confidential Exhibit No. 11. The expected completion date of the project is by the end of 2019.

- NC State University's Future Renewable Electric Energy Delivery and Management ("FREEDM") Systems Center – Duke Energy supports NC State's FREEDM Center through annual membership dues. The FREEDM partnership provides Duke Energy with the ability to influence and focus research on materials, technology, and products that will enable the utility industry to transform the electric grid into a 2-way power flow system supporting distributed generation.
- Institute for Electrical and Electronics Engineers ("IEEE") 1547 Conformity Assessment – The IEEE 1547 Conformity Assessment Steering Committee has been working to develop industry standard tools and methodologies to assure consistent and comprehensive compliance prior to utility grid interconnection sign off. IEEE and the Company share a common goal to accelerate and broaden

industry adoption through the development and publication of well-designed and managed conformity assessment and certification programs. This project was about establishment and execution of an IEEE 1547 Commissioning Test demonstration for solar installations within the eGRID laboratory located at Clemson University. The project formally commissioned the operation of a 50kW inverter and established an operational test bed for more advanced interconnection evaluation. The results of this project can be found in Jennings Confidential Exhibit No. 12.

- Loyd Ray Farms – The Company partnered with Duke University to develop a pilot-scale, sixty-five kW swine waste-to-energy facility, which initiated operation and began producing renewable energy in 2011. Jennings Exhibit No. 13 summarizes the project's progress through December 31, 2018.
- Marshall Solar Site Algorithm – In 2018, the Company continued to work with the University of North Carolina at Charlotte ("UNCC") on a project to utilize the operational data to design and implement an autonomous active and reactive power dispatch algorithm with PV farms and/or Battery Energy Storage system on any feeder considering DMS coordination. The work in 2018 was to develop a battery degradation model that can be seamlessly integrated to a stacked energy storage application controller. The methodology has been tested on a specific battery type and compared with other

battery models. The Phase IV results of this project can be found in Jennings Confidential Exhibit No. 14. The Company is continuing to support the next phase of this project which will be completed in the summer of 2019.

- Mini-DVAR Project – In 2016, the Company started a project to investigate a new technology manufactured by American Superconductor Corporation which makes a device called Mini-DVAR. This device can potentially be used for voltage stability/VAR support for renewable energy applications such as voltage compliance, grid reliability, efficiency, energy savings and grid integration of distributed PV. The project also included engineering design of a protection scheme with Schweitzer Engineering Laboratories, and the procurement of switch gear from ABB. In 2017, the Company completed installation and commissioning of the mini-DVAR to verify it was fully functional. This project continued in 2018 to collect operational data and to analyze its application and benefit in Volt VAR Optimization of the distribution system. The results of this project can be found in Jennings Confidential Exhibit Nos. 15-17.
- NC State University – ETO – Grid-forming Battery Energy Storage System Characterization and Testing – Starting from late 2018, the Company worked with NC State on a project to install and commission a Battery Energy Storage System ("BESS") and to

study the loading capabilities of the BESS operating in grid-forming mode. A BESS may need to power up a microgrid after an outage, thus supplying all of the magnetizing currents to line-start machines as well as isolation transformers in the microgrid. There is a need to understand the capabilities of the state-of-the art BESS inverters to support these loads. Though simulating such behavior is feasible, experimental validation is required to guarantee that the system will operate as expected, and the BESS inverter protection will not trip. The expected completion date of the project is by the end of 2019.

- NC State University – Interactions of PV Installations with Distribution Systems – Starting from late 2018, the Company worked with NC State on a project to construct a testbed and analysis framework for investigating how large PV penetration on a feeder affects the operation of the distribution system. The expected completion date of the project is by the end of 2019.
- PNNL – Dynamic Var Compensator ("DVC") Pilot – In 2018, the Company worked with One-Cycle Control, Inc. and Pacific Northwest National Laboratory ("PNNL") on a project, which is part of DOE SunlAmp Contract: 0000-1714, to install and commission two DVC devices in the Company's distribution system, and to evaluate its performance in mitigating the voltage variability due to high penetration of distributed photovoltaic on a

distribution feeder. A detailed description of the project can be found in Jennings Confidential Exhibit Nos. 18-19.

- Research Triangle Institute – Biogas Utilization in North Carolina – In 2018, the Company began support of the Research Triangle Institute project for the NC Energy Policy Council to determine the potential bioenergy/biogas resources available in NC, and to identify the most beneficial and optimum utilization of resources to maximize economic, environmental and societal advantages. An overview of the project can be found in Jennings Exhibit No. 20.
- Rocky Mountain Institute ("RMI") – The Company participates in eLab, a forum sponsored by RMI, composed of a number of North Carolina and nationally based entities, and organized to overcome barriers to economic deployment of distributed energy resources in the U.S. electric sector. Specifically, the Company seeks to gauge customer desires related to distributed resources and provide ideas of potential long-term solutions for distributed energy resources and microgrids. Please visit RMI's website at http://www.rmi.org/elab for more information on eLab.
- Swine Extrusion/Poultry Mortality – The Animal and Poultry Waste Management Center ("APWMC") at NC State University – In 2018, the Company continued support of the various projects being undertaken by the APWMC. This work is centered around drying swine lagoon solids, bagged lagoon sludge and lagoon sludge mixed

with agricultural wastes at a farm-based level to create a higher MMBtu fuel that can be safely and easily transported to a central plant for combustion. A detailed description of the project along with future testing plans can be found in Jennings Confidential Exhibit No. 21.

- UNCC – Evaluation of DER Fault Scenarios and Mitigation Techniques – In 2018, the Company worked with UNCC on a project to evaluate behavior of inverter-based power sources during fault conditions and make recommendations to enhance protection algorithms to standard vendors of protection and control systems. The results of this project can be found in Jennings Confidential Exhibit No. 22.
- UNCC – Hardware Cyber Security for DER Inverters – In 2018, the Company worked with UNCC on a project to provide hardware assurance in an affordable manner to transition a global supply chain to producing solar inverters with trusted hardware for secure control and communications. In this work, the Company and UNCC investigated the enhancement of security of power grid converters using reconfigurable architecture and hardware-based crypto processors. The results of this project can be found in Jennings Confidential Exhibit No. 23.

Q. ARE YOU SATISFIED THAT THE ACTUAL COSTS INCURRED IN THE TEST PERIOD HAVE BEEN, AND THAT THE

PROJECTED COSTS OF THE BILLING PERIOD WILL BE, PRUDENTLY INCURRED?

A. Yes. Duke Energy Carolinas believes it has incurred and projects to incur all of these costs associated with REPS compliance in a prudent manner. The Company continues to exercise thorough and rigorous technical and economic analysis to evaluate all options for compliance with its REPS requirements. Duke Energy Carolinas has developed strong foundational market knowledge related to renewable resources. The Company continues to enhance and develop expertise in this field through the Company's various solicitations for renewable energy and the operation of its unsolicited bid process, its implementation of the Duke Energy North Carolina Solar PV Distributed Generation Program, its construction of DEC-owned utility-scale solar facilities, its participation in industry research, and daily interaction with developers of renewable energy facilities. As a result of these efforts, the Company has been able to identify, procure, and develop a diverse portfolio of renewable resources to meet its REPS requirements in a prudent, reasonable and cost-effective manner.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

JENNINGS EXHIBIT NO. 1
*****REDACTED VERSION*****

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

DOCKET NO. E-7, SUB 1191

In the Matter of Application of Duke Energy Carolinas, LLC for Approval of Renewable Energy and Energy Efficiency Portfolio Standard (REPS) Compliance Report and Cost Recovery Rider Pursuant to N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67	)	DUKE ENERGY CAROLINAS, LLC 2018 RENEWABLE ENERGY & ENERGY EFFICIENCY PORTFOLIO STANDARD COMPLIANCE REPORT

DUKE ENERGY CAROLINAS, LLC
RENEWABLE ENERGY AND ENERGY EFFICIENCY
PORTFOLIO STANDARD ("REPS")
COMPLIANCE REPORT

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(A) INTRODUCTION

Duke Energy Carolinas, LLC ("Duke Energy Carolinas," "DEC," or the "Company") submits its Renewable Energy and Energy Efficiency Portfolio Standard ("REPS") Compliance Report ("Compliance Report") in accordance with N.C. Gen. Stat. § 62-133.8 and Commission Rule R8-67(c). This Compliance Report provides the required information for 2018 calendar year reporting period.[1] As part of its REPS Compliance Plan, filed in Docket No. E-100, Sub 157, Duke Energy Carolinas plans to provide services to native load priority wholesale customers that contract with the Company for services to meet the REPS requirements, including delivery of renewable energy resources and compliance planning and reporting. These native load priority wholesale customers – including distribution cooperatives and municipalities – may rely on Duke Energy Carolinas to provide this renewable energy delivery service in accordance with N.C. Gen. Stat. § 62-133.8(c)(2)e.

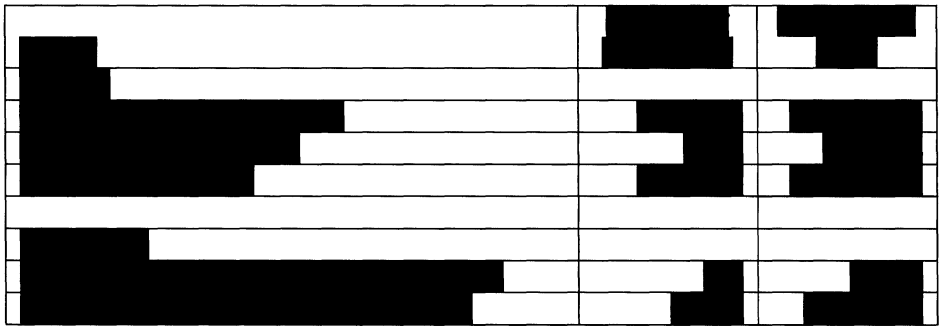
This Compliance Report provides the required information in aggregate for the Company and the following wholesale customers for whom the Company provided renewable energy resources and compliance reporting services: Blue Ridge Electric Membership Corporation, Rutherford Electric Membership Corporation, City of Concord, Town of Dallas, Town of Forest City, Town of Highlands, and City of Kings Mountain ("Wholesale")[2].

(B) REPS COMPLIANCE REPORT

I. RENEWABLE ENERGY CERTIFICATES

The table below reflects the renewable energy certificates ("RECs") used to comply with N.C. Gen. Stat. § 62-133.8(d) for the year 2018.

[BEGIN CONFIDENTIAL]



[1] Pursuant to NCUC Rule R8-67(c)(1), this Compliance Report reflects Duke Energy Carolinas' efforts to meet the REPS requirements for the previous calendar year.

[2] The Company's contractual obligation to provide REPS compliance services to the City of Concord and City of Kings Mountain ends effective December 31, 2018. Information provided within this Compliance Report for REPS reporting year 2018 includes City of Concord and City of Kings Mountain.

Totals may not foot due to rounding.

[END CONFIDENTIAL]

II. ACTUAL 2018 TOTAL NORTH CAROLINA RETAIL SALES AND YEAR-END NUMBER OF ACCOUNTS, BY CUSTOMER CLASS

North Carolina Retail Sales (MWh)	2018
Duke Energy Carolinas	59,480,703
Wholesale	3,799,058
Total MWh Sales	**63,279,761**

2018 Year-end Number of REPS Accounts			
Account Type	Duke Energy Carolinas	Wholesale	Total
Residential	1,732,150	164,935	1,897,085
General	247,163	19,752	266,915
Industrial	4,771	274	5,045

III. AVOIDED COST RATES

The avoided cost rates below, applicable to energy received pursuant to power purchase agreements, represent the annualized avoided cost rates in Schedule PP or PP-N (NC), Distribution Interconnection, approved in the following avoided cost proceedings:

ANNUALIZED TOTAL CAPACITY AND ENERGY RATES (CENTS PER KWH)						
Docket No.:	**E-100 Sub 148 (Current)**	**E-100, Sub 140**	**E-100, Sub 136**	**E-100, Sub 127**	**E-100, Sub 117**	**E-100, Sub 106**
Year filed:	2016	2014	2012	2010	2008	2006
Variable Rate	3.26	4.32	4.98	5.48	6.4	5.4
5 Year	N/A	4.52	5.19	5.63	6.39	5.46
10 Year	3.86	5.15	5.52	6.28	6.42	5.51
15 Year	N/A	5.62	5.84	6.63	6.56	5.64

IV. ACTUAL TOTAL AND INCREMENTAL COSTS INCURRED IN 2018

Actual costs incurred in 2018 for REPS compliance were comprised of the following cost of energy purchases and the purchase of various types of RECs, solar distributed generation at Duke Energy Carolinas-owned facilities, and other reasonable and prudent costs incurred to meet the requirements of the statute.

Actual Costs Incurred	**Energy and REC Costs**	**Other**	**Total Costs**
Total costs incurred	$97,682,102	$2,104,766	$99,786,868
Avoided costs	$71,522,732	$0	$71,522,732
Incremental costs	$26,159,370	$2,104,766	$28,264,136

V. ACTUAL INCREMENTAL COSTS COMPARISON TO THE ANNUAL COST CAP AS OF THE PREVIOUS CALENDAR YEAR

Account Type	Total 2017 Year-end number of Retail Accounts[1]	Annual Per-Account Cost Cap	Total Annual Cost Cap
Residential	1,867,227	$27	$50,415,129
General	263,118	$150	$39,467,700
Industrial	5,093	$1000	$5,093,000
	Total Annual Cost Cap		**$94,975,829**
	Actual Incremental Costs		**$28,264,136**

VI. STATUS OF COMPLIANCE WITH REPS REQUIREMENTS

Pursuant to N.C. Gen. Stat. § 62-133.8(b) for Duke Energy Carolinas retail and N.C. Gen. Stat. § 62-133.8(c) for the Company's Wholesale REPS customers, the REPS requirement for calendar year 2018 is set at 10% of 2017 North Carolina ("NC") retail sales. To comply with the combined REPS obligation for Duke Energy Carolinas Retail and its Wholesale REPS customers, the Company submitted 5,923,670 RECs for retirement, including 14,084 Senate Bill 886 ("SB886") RECs, each of which counts for two poultry waste and one general requirement REC. Accordingly, the Company submitted for retirement the equivalent of 5,951,838 RECs, representing 10% of combined 2017 retail megawatt-hour sales of 59,518,351. Details of the composition of RECs retired to meet the total REPS compliance requirement are contained in Section I. of this report.

Pursuant to N.C. Gen. Stat. § 62-133.8(d), for calendar year 2018, at least 0.20% of total NC retail sales (measured according to prior calendar year NC retail sales) shall be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities. As a result, 119,041 solar RECs were submitted for retirement to meet the solar set-aside requirement. 1,899,433 additional solar RECs were submitted for retirement toward compliance with the general requirement (the total REPS requirement net of the solar, poultry, and swine set-aside obligations).

In its October 8, 2018 *Order Modifying the Swine and Poultry Waste Set-Aside Requirements and Providing Other Relief* ("2018 Delay Order") in Docket No. E-100, Sub 113, the Commission modified the swine waste set-aside requirement for 2018 to 0.02% of total NC retail sales, and specified that the requirement applies to electric public utilities only, not to electric

[1] Includes number of retail accounts for Duke Energy Carolinas and its Wholesale REPS customers.

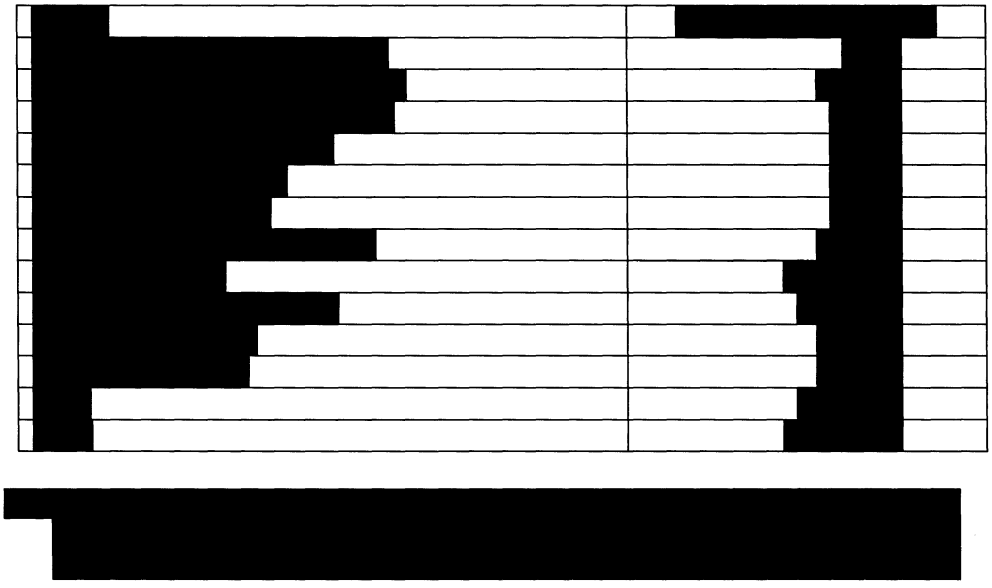
membership cooperatives or municipalities (which were excused from the swine waste set-aside requirement for 2018). To comply with the swine waste set-aside requirement applicable to DEC's NC retail sales, the Company submitted for retirement 11,203 swine RECs.

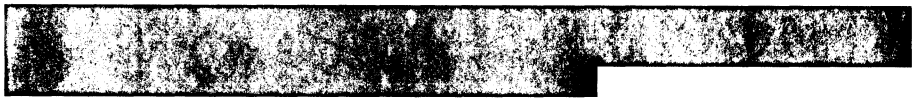
The 2018 Delay Order also reduced the 2018 poultry waste set-aside requirement to 300,000 MWh state-wide, and set the 2019 and 2020 levels at 700,000 MWh and 900,000 MWh, respectively. In its August 5, 2016 *Order Establishing 2016, 2017, and 2018 Poultry Waste Set-Aside Requirement Allocation* in Docket No. E-100, Sub 113, the Commission directed the annual aggregate poultry waste set-aside requirement to be allocated among electric power suppliers and utility compliance aggregators based on the load ratio share calculations shown on the spreadsheet filed by the NC-RETS Administrator in the same docket on July 11, 2016. These percentages were applied to the modified 2018 state-wide requirement to determine the swine waste set-aside requirements applicable to DEC NC retail and to the Company's Wholesale customers for reporting year 2018. The Company submitted for retirement 108,493 poultry waste RECs along with 14,084 SB886 RECs, which count as 28,168 poultry waste set-aside RECs. Accordingly, the Company submitted the equivalent of 136,661 poultry RECs for compliance, and met its 2018 poultry waste set-aside requirement.

VII. IDENTIFICATION OF RECs CARRIED FORWARD

The table below reflects the RECs at year-end 2018 that the Company has banked for use in compliance in future years.

[BEGIN CONFIDENTIAL]





[END CONFIDENTIAL]

VIII. DATES AND AMOUNTS OF ALL PAYMENTS MADE FOR RENEWABLE ENERGY CERTIFICATES

Confidential Appendix 1 provides the dates and amounts of payments made for RECs for calendar year 2018.

(C) METHODOLOGY FOR DETERMINING NUMBER OF CUSTOMERS AND CUSTOMER CAP

In its *Order Approving REPS Riders*, issued in Docket No. E-7, Sub 872 (December 15, 2009), the Commission approved the following method of determining number of customer accounts as proposed by Duke Energy Carolinas. For purposes of defining which accounts will be assessed a REPS charge, and determining account totals by class that will be included in calculating its annual cap on costs incurred to comply with REPS requirements, the Company implemented the method described below. The Company defines "account" as an "agreement," or "tariff rate," between Duke Energy Carolinas and a customer to determine the monthly REPS charge for each account, and to compare the charges per account for a twelve-month period to the applicable annual per-account cost cap established in N.C. Gen. Stat. § 62-133.8(h)(4). The same definition applies when compiling account totals by class, to which the annual per-account caps are applied to determine the overall cap for total annual compliance costs incurred established in N.C. Gen. Stat. § 62-133.8(h)(3). There is a limited number of exceptions to this definition of account. The following service schedules should not be considered accounts for purposes of the per-account charge because of the near certainty that customers served under these schedules already will pay a per-account charge under another residential, general service or industrial service agreement and because they represent small auxiliary service loads. The following agreements fall within this exception[3]:

- Outdoor Lighting Service (Schedule OL)
- Floodlighting Service (Schedule FL and FL-N)
- Street and Public Lighting Service (Schedule PL)
- Yard Lighting (Schedule YL)
- Governmental Lighting (Schedule GL)
- Nonstandard Lighting (Schedule NL)

[3] Lighting service schedules have been updated to reflect the addition of new schedules Governmental Lighting service (Schedule GL) and Nonstandard Lighting service (Schedule NL) and the cancellation of Street Lighting service (Schedule SL) as approved by the Commission on December 7, 2009 in Docket No. E-7, Sub 909, *Order Granting General Rate Increase and Approving Amended Stipulation.*

- Off-Peak Water Heating (Schedule WC is a sub-metered service)
- Non-demand metered, nonresidential service, provided on Schedule SGS, at the same premises, with the same service address, and with the same account name as an agreement for which a monthly REPS charge has been applied.

Within the Wholesale customer group, Blue Ridge Electric Membership Corporation, Rutherford Electric Membership Corporation, Town of Forest City and the City of Concord have proposed a methodology for determining Wholesale year-end number of accounts that is generally consistent with that proposed by Duke Energy Carolinas. The Town of Highlands, Town of Dallas, and City of Kings Mountain propose to define an account in the manner the information is reported to the Energy Information Administration for annual electric sales and revenue reporting.

Respectfully submitted this 26th day of February, 2019.

/Robert W. Kaylor

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Counterparty and Payment Dates		REC Cost
[BEGIN CONFIDENTIAL]		
[redacted]		
Apr-2018	$	1,380
Aug-2018	$	1,620
Dec-2018	$	1,000
Feb-2018	$	1,152
Jan-2018	$	920
Jul-2018	$	1,736
Jun-2018	$	1,568
Mar-2018	$	852
May-2018	$	1,564
Nov-2018	$	1,380
Oct-2018	$	1,272
Sep-2018	$	1,684
[redacted]		
Jan-2018	$	34,500
[redacted]		
Apr-2018	$	2,140
Aug-2018	$	2,352
Dec-2018	$	1,484
Feb-2018	$	1,712
Jan-2018	$	1,328
Jul-2018	$	2,484
Jun-2018	$	2,320
Mar-2018	$	1,320
May-2018	$	2,340
Nov-2018	$	2,068
Oct-2018	$	1,808
Sep-2018	$	2,532
[redacted]		
Apr-2018	$	4,280
Aug-2018	$	4,775
Dec-2018	$	2,805
Feb-2018	$	3,075
Jan-2018	$	1,900
Jul-2018	$	5,030
Jun-2018	$	4,675
Mar-2018	$	2,440
May-2018	$	4,705
Nov-2018	$	3,900
Oct-2018	$	3,625
Sep-2018	$	4,865
[redacted]		
Apr-2018	$	4,355
Aug-2018	$	4,895
Dec-2018	$	3,045
Feb-2018	$	3,450
Jan-2018	$	2,585
Jul-2018	$	5,250
Jun-2018	$	4,580
Mar-2018	$	2,550
May-2018	$	4,765
Nov-2018	$	3,455

Counterparty and Payment Dates		REC Cost
Oct-2018	$	3,365
Sep-2018	$	4,925
[redacted]		
Apr-2018	$	2,252
Aug-2018	$	2,224
Dec-2018	$	2,256
Feb-2018	$	1,280
Jan-2018	$	655
Jul-2018	$	2,272
Jun-2018	$	2,272
Mar-2018	$	1,692
May-2018	$	2,272
Nov-2018	$	2,204
Oct-2018	$	1,624
Sep-2018	$	2,268
[redacted]		
Apr-2018	$	4,683
Aug-2018	$	5,872
Dec-2018	$	1,028
Feb-2018	$	2,545
Jan-2018	$	288
Jul-2018	$	23,282
Jun-2018	$	3,615
Mar-2018	$	6,333
May-2018	$	4,048
Nov-2018	$	3,324
Oct-2018	$	3,092
Sep-2018	$	5,372
[redacted]		
Apr-2018	$	1,878
Aug-2018	$	2,200
Dec-2018	$	1,400
Feb-2018	$	1,640
Jan-2018	$	1,190
Jul-2018	$	2,298
Jun-2018	$	2,183
Mar-2018	$	1,095
May-2018	$	2,205
Nov-2018	$	1,908
Oct-2018	$	1,678
Sep-2018	$	2,238
[redacted]		
Apr-2018	$	1,852
Aug-2018	$	1,996
Dec-2018	$	1,204
Feb-2018	$	1,336
Jan-2018	$	948
Jul-2018	$	2,172
Jun-2018	$	2,052
Mar-2018	$	1,076
May-2018	$	2,024
Nov-2018	$	1,716
Oct-2018	$	1,552
Sep-2018	$	1,944

Counterparty and Payment Dates		REC Cost
[redacted]		
Apr-2018	$	1,716
Aug-2018	$	900
Dec-2018	$	2,092
Feb-2018	$	788
Jan-2018	$	664
Jul-2018	$	1,260
Jun-2018	$	1,952
Mar-2018	$	1,600
May-2018	$	1,736
Nov-2018	$	1,892
Oct-2018	$	1,768
Sep-2018	$	1,516
[redacted]		
Apr-2018	$	-
Aug-2018	$	-
Dec-2018	$	-
Feb-2018	$	-
Jan-2018	$	2,440
Jul-2018	$	-
Jun-2018	$	-
Mar-2018	$	-
May-2018	$	-
Nov-2018	$	-
Oct-2018	$	-
Sep-2018	$	-
[redacted]		
Apr-2018	$	2,628
Aug-2018	$	3,256
Dec-2018	$	1,776
Feb-2018	$	352
Jul-2018	$	3,356
Jun-2018	$	3,100
Mar-2018	$	1,500
May-2018	$	3,108
Nov-2018	$	2,508
Oct-2018	$	2,172
Sep-2018	$	3,176
[redacted]		
Feb-2018	$	188
Jan-2018	$	145
Mar-2018	$	120
[redacted]		
Apr-2018	$	2,520
Aug-2018	$	2,800
Dec-2018	$	1,664
Feb-2018	$	1,944
Jan-2018	$	1,528
Jul-2018	$	2,988
Jun-2018	$	2,648
Mar-2018	$	1,472
May-2018	$	2,524
Nov-2018	$	2,356
Oct-2018	$	2,168

Counterparty and Payment Dates		REC Cost
Sep-2018	$	2,804
[redacted]		
Apr-2018	$	1,663
Aug-2018	$	1,780
Dec-2018	$	1,170
Feb-2018	$	1,338
Jan-2018	$	1,003
Jul-2018	$	1,868
Jun-2018	$	1,748
Mar-2018	$	965
May-2018	$	1,765
Nov-2018	$	1,553
Oct-2018	$	1,363
Sep-2018	$	1,855
[redacted]		
Apr-2018	$	3,840
Aug-2018	$	4,535
Dec-2018	$	2,660
Feb-2018	$	2,565
Jan-2018	$	2,410
Jul-2018	$	3,505
Jun-2018	$	4,595
Mar-2018	$	1,460
May-2018	$	4,625
Nov-2018	$	3,275
Oct-2018	$	3,110
Sep-2018	$	4,740
[redacted]		
Apr-2018	$	2,125
Aug-2018	$	2,500
Dec-2018	$	895
Feb-2018	$	1,405
Jan-2018	$	1,305
Jul-2018	$	2,610
Jun-2018	$	2,610
Mar-2018	$	1,235
May-2018	$	2,590
Nov-2018	$	1,005
Oct-2018	$	1,435
Sep-2018	$	2,495
[redacted]		
Jan-2018	$	41,847
[redacted]		
Apr-2018	$	2,324
Aug-2018	$	2,560
Dec-2018	$	1,516
Feb-2018	$	816
Jan-2018	$	1,260
Jul-2018	$	2,424
Jun-2018	$	2,008
Mar-2018	$	1,336
May-2018	$	2,628
Nov-2018	$	1,940
Oct-2018	$	1,888

Counterparty and Payment Dates		REC Cost
Sep-2018	$	2,604
[redacted]		
Apr-2018	$	69,468
Aug-2018	$	70,568
Dec-2018	$	70,236
Feb-2018	$	62,852
Jan-2018	$	125,528
Jul-2018	$	135,868
Mar-2018	$	73,328
May-2018	$	49,260
Oct-2018	$	26,076
Sep-2018	$	64,560
[redacted]		
Apr-2018	$	2,232
Aug-2018	$	2,904
Dec-2018	$	1,672
Feb-2018	$	1,804
Jan-2018	$	1,408
Jul-2018	$	3,128
Jun-2018	$	2,568
Mar-2018	$	1,276
May-2018	$	2,664
Nov-2018	$	2,116
Oct-2018	$	2,044
Sep-2018	$	2,852
[redacted]		
Apr-2018	$	524
Aug-2018	$	16,301
Dec-2018	$	544
Feb-2018	$	818
Jan-2018	$	1,287
Jul-2018	$	15,243
Jun-2018	$	1,119
Mar-2018	$	690
May-2018	$	724
Nov-2018	$	982
Oct-2018	$	11,204
Sep-2018	$	14,771
[redacted]		
Apr-2018	$	3,320
Aug-2018	$	3,312
Dec-2018	$	2,248
Feb-2018	$	2,644
Jan-2018	$	2,040
Jul-2018	$	3,884
Jun-2018	$	3,628
Mar-2018	$	1,996
May-2018	$	3,448
Nov-2018	$	3,156
Oct-2018	$	2,844
Sep-2018	$	3,744
[redacted]		
Apr-2018	$	2,723
Feb-2018	$	1,443

Counterparty and Payment Dates		REC Cost
Jan-2018	$	1,040
Mar-2018	$	2,250
May-2018	$	1,535
[redacted]		
Apr-2018	$	580
Aug-2018	$	640
Dec-2018	$	244
Feb-2018	$	568
Jan-2018	$	303
Jul-2018	$	384
Jun-2018	$	280
Mar-2018	$	564
May-2018	$	424
Nov-2018	$	240
Oct-2018	$	280
Sep-2018	$	560
[redacted]		
Apr-2018	$	3,224
Aug-2018	$	3,576
Dec-2018	$	1,820
Feb-2018	$	3,172
Jul-2018	$	3,900
Jun-2018	$	3,596
Mar-2018	$	1,648
May-2018	$	3,636
Nov-2018	$	2,732
Oct-2018	$	2,628
Sep-2018	$	3,592
[redacted]		
Apr-2018	$	7,025
Aug-2018	$	7,136
Dec-2018	$	10,168
Feb-2018	$	7,331
Jan-2018	$	7,336
Jul-2018	$	4,980
Jun-2018	$	4,535
Mar-2018	$	6,496
May-2018	$	6,719
Nov-2018	$	10,516
Oct-2018	$	9,862
Sep-2018	$	9,793
[redacted]		
Apr-2018	$	61,251
Aug-2018	$	56,692
Dec-2018	$	59,388
Feb-2018	$	62,555
Jan-2018	$	51,779
Jul-2018	$	61,018
Jun-2018	$	63,034
Mar-2018	$	62,463
May-2018	$	60,364
Nov-2018	$	55,330
Oct-2018	$	49,261
Sep-2018	$	53,662

Counterparty and Payment Dates		REC Cost
[redacted]		
Sep-2018	$	8,589
[redacted]		
Apr-2018	$	1,312
Aug-2018	$	1,472
Dec-2018	$	900
Feb-2018	$	1,020
Jan-2018	$	772
Jul-2018	$	1,560
Jun-2018	$	1,436
Mar-2018	$	792
May-2018	$	1,440
Nov-2018	$	1,284
Oct-2018	$	1,156
Sep-2018	$	1,524
[redacted]		
Apr-2018	$	154,896
Jul-2018	$	73,948
Jun-2018	$	98,088
Mar-2018	$	99,012
May-2018	$	94,356
Nov-2018	$	77,560
Oct-2018	$	133,328
Sep-2018	$	91,960
[redacted]		
Apr-2018	$	3,920
Aug-2018	$	4,510
Dec-2018	$	2,590
Feb-2018	$	3,175
Jan-2018	$	2,360
Jul-2018	$	4,780
Jun-2018	$	4,515
Mar-2018	$	2,360
May-2018	$	4,465
Nov-2018	$	3,525
Oct-2018	$	2,960
Sep-2018	$	4,510
[redacted]		
Apr-2018	$	18,884
Aug-2018	$	18,702
Dec-2018	$	18,900
Feb-2018	$	16,881
Jan-2018	$	19,347
Jul-2018	$	17,526
Jun-2018	$	17,973
Mar-2018	$	17,179
May-2018	$	18,271
Nov-2018	$	13,919
Oct-2018	$	18,751
Sep-2018	$	19,099
[redacted]		
Apr-2018	$	1,910
Aug-2018	$	2,298
Dec-2018	$	1,360

Counterparty and Payment Dates		REC Cost
Feb-2018	$	1,610
Jan-2018	$	1,215
Jul-2018	$	2,310
Jun-2018	$	2,283
Mar-2018	$	1,098
May-2018	$	2,240
Nov-2018	$	1,385
Oct-2018	$	1,540
Sep-2018	$	2,245
Apr-2018	$	9,302
Aug-2018	$	10,599
Dec-2018	$	7,230
Feb-2018	$	8,337
Jan-2018	$	6,314
Jul-2018	$	11,928
Jun-2018	$	11,058
Mar-2018	$	5,600
May-2018	$	10,647
Nov-2018	$	9,634
Oct-2018	$	7,989
Sep-2018	$	10,963
Apr-2018	$	4,105
Aug-2018	$	4,500
Dec-2018	$	2,720
Feb-2018	$	3,115
Jan-2018	$	2,270
Jul-2018	$	4,915
Jun-2018	$	4,540
Mar-2018	$	2,460
May-2018	$	4,535
Nov-2018	$	3,805
Oct-2018	$	3,410
Sep-2018	$	4,715
Apr-2018	$	4,255
Aug-2018	$	1,665
Dec-2018	$	1,200
Feb-2018	$	1,230
Jan-2018	$	2,810
Jun-2018	$	3,600
Nov-2018	$	1,380
Oct-2018	$	1,550
Sep-2018	$	1,645
Apr-2018	$	27,868
Aug-2018	$	26,589
Dec-2018	$	26,936
Feb-2018	$	25,462
Jan-2018	$	26,042
Jul-2018	$	26,936
Jun-2018	$	27,001
Mar-2018	$	26,676

*Information in italices is confidential

Counterparty and Payment Dates		REC Cost
May-2018	$	28,821
Nov-2018	$	27,434
Oct-2018	$	26,351
Sep-2018	$	28,149
[redacted]		
Apr-2018	$	2,104
Aug-2018	$	2,628
Dec-2018	$	1,332
Feb-2018	$	1,436
Jan-2018	$	1,080
Jul-2018	$	2,664
Jun-2018	$	2,600
Mar-2018	$	1,272
May-2018	$	2,540
Nov-2018	$	1,932
Oct-2018	$	1,732
Sep-2018	$	2,576
[redacted]		
Apr-2018	$	968
Aug-2018	$	1,544
Dec-2018	$	960
Feb-2018	$	840
Jan-2018	$	844
Jul-2018	$	1,240
Jun-2018	$	1,516
Mar-2018	$	920
May-2018	$	1,516
Nov-2018	$	844
Oct-2018	$	1,236
Sep-2018	$	1,344
[redacted]		
Apr-2018	$	4,000
Aug-2018	$	4,165
Dec-2018	$	2,905
Feb-2018	$	3,385
Jan-2018	$	2,735
Jul-2018	$	4,515
Jun-2018	$	4,180
Mar-2018	$	2,480
May-2018	$	4,560
Nov-2018	$	3,455
Oct-2018	$	3,450
Sep-2018	$	4,725
[redacted]		
Apr-2018	$	3,212
Aug-2018	$	3,512
Dec-2018	$	2,060
Feb-2018	$	2,180
Jan-2018	$	1,660
Jul-2018	$	3,408
Jun-2018	$	3,448
Mar-2018	$	1,848
May-2018	$	3,572
Nov-2018	$	2,772

Counterparty and Payment Dates		REC Cost
Oct-2018	$	2,592
Sep-2018	$	3,560
[redacted]		
Jan-2018	$	23,019
Jun-2018	$	194,970
May-2018	$	14,810
Oct-2018	$	74,310
[redacted]		
Feb-2018	$	7,250
[redacted]		
Apr-2018	$	3,256
Aug-2018	$	3,672
Dec-2018	$	2,336
Feb-2018	$	2,592
Jan-2018	$	2,100
Jul-2018	$	3,684
Jun-2018	$	3,420
Mar-2018	$	1,900
May-2018	$	3,484
Nov-2018	$	3,108
Oct-2018	$	2,932
Sep-2018	$	3,876
[redacted]		
Apr-2018	$	2,240
Aug-2018	$	2,476
Dec-2018	$	1,336
Feb-2018	$	1,444
Jan-2018	$	1,024
Jul-2018	$	2,624
Jun-2018	$	2,436
Mar-2018	$	1,248
May-2018	$	2,524
Nov-2018	$	1,952
Oct-2018	$	1,496
Sep-2018	$	2,316
[redacted]		
Apr-2018	$	1,864
Aug-2018	$	2,308
Dec-2018	$	1,092
Feb-2018	$	1,324
Jan-2018	$	1,020
Jul-2018	$	2,296
Jun-2018	$	2,268
Mar-2018	$	1,112
May-2018	$	2,188
Nov-2018	$	1,716
Oct-2018	$	1,496
Sep-2018	$	2,160
[redacted]		
Apr-2018	$	25,861
Aug-2018	$	25,435
Dec-2018	$	24,887
Feb-2018	$	26,556
Jan-2018	$	24,291

Counterparty and Payment Dates		REC Cost
Jul-2018	$	3,857
Jun-2018	$	12,721
Mar-2018	$	22,741
May-2018	$	23,861
Nov-2018	$	25,840
Oct-2018	$	24,531
Sep-2018	$	25,233
[redacted]		
Apr-2018	$	61,277
Aug-2018	$	62,460
Dec-2018	$	62,105
Feb-2018	$	54,419
Jan-2018	$	40,692
Jul-2018	$	53,449
Jun-2018	$	60,993
Mar-2018	$	60,047
May-2018	$	48,743
Nov-2018	$	61,963
Oct-2018	$	58,841
Sep-2018	$	57,493
[redacted]		
Apr-2018	$	14,661
Aug-2018	$	15,183
Dec-2018	$	11,706
Feb-2018	$	15,739
Jan-2018	$	12,107
Jul-2018	$	10,674
Jun-2018	$	13,305
Mar-2018	$	12,819
May-2018	$	14,557
Nov-2018	$	11,520
Oct-2018	$	10,790
Sep-2018	$	13,630
[redacted]		
Apr-2018	$	3,516
Aug-2018	$	580
Dec-2018	$	3,444
Feb-2018	$	1,468
Jan-2018	$	348
Jul-2018	$	688
Jun-2018	$	2,284
Mar-2018	$	2,512
May-2018	$	2,988
Nov-2018	$	2,044
Oct-2018	$	1,476
Sep-2018	$	2,396
[redacted]		
Apr-2018	$	1,728
Aug-2018	$	1,850
Dec-2018	$	1,107
Feb-2018	$	1,276
Jan-2018	$	884
Jul-2018	$	1,964
Jun-2018	$	1,827

Counterparty and Payment Dates		REC Cost
Mar-2018	$	990
May-2018	$	1,872
Nov-2018	$	1,508
Oct-2018	$	1,341
Sep-2018	$	1,895
[redacted]		
Jan-2018	$	60
[redacted]		
Apr-2018	$	3,216
Aug-2018	$	3,596
Dec-2018	$	2,264
Feb-2018	$	2,644
Jan-2018	$	2,116
Jul-2018	$	3,820
Jun-2018	$	3,660
Mar-2018	$	1,916
May-2018	$	3,600
Nov-2018	$	2,972
Oct-2018	$	2,600
Sep-2018	$	3,636
[redacted]		
Apr-2018	$	2,860
Aug-2018	$	3,784
Dec-2018	$	1,964
Feb-2018	$	2,288
Jan-2018	$	1,624
Jul-2018	$	3,916
Jun-2018	$	3,472
Mar-2018	$	1,668
May-2018	$	3,284
Nov-2018	$	2,576
Oct-2018	$	2,508
Sep-2018	$	3,700
[redacted]		
Apr-2018	$	4,065
Aug-2018	$	4,830
Dec-2018	$	2,895
Feb-2018	$	2,215
Jan-2018	$	2,550
Jul-2018	$	5,160
Jun-2018	$	4,975
Mar-2018	$	2,465
May-2018	$	4,720
Nov-2018	$	4,195
Oct-2018	$	3,960
Sep-2018	$	5,335
[redacted]		
Apr-2018	$	1,565
Aug-2018	$	1,710
Dec-2018	$	1,110
Feb-2018	$	1,275
Jan-2018	$	800
Jul-2018	$	1,835
Jun-2018	$	1,665

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Counterparty and Payment Dates		REC Cost
Mar-2018	$	1,030
May-2018	$	1,780
Nov-2018	$	1,460
Oct-2018	$	1,415
Sep-2018	$	1,700
Apr-2018	$	1,530
Aug-2018	$	1,670
Dec-2018	$	1,010
Feb-2018	$	1,195
Jan-2018	$	890
Jul-2018	$	1,715
Jun-2018	$	1,585
Mar-2018	$	860
May-2018	$	1,660
Nov-2018	$	1,400
Oct-2018	$	1,285
Sep-2018	$	1,665
Apr-2018	$	1,256
Aug-2018	$	1,336
Dec-2018	$	852
Feb-2018	$	928
Jan-2018	$	612
Jul-2018	$	1,460
Jun-2018	$	1,320
Mar-2018	$	808
May-2018	$	1,436
Nov-2018	$	1,132
Oct-2018	$	1,092
Sep-2018	$	1,324
Apr-2018	$	1,384
Aug-2018	$	1,476
Dec-2018	$	932
Feb-2018	$	1,088
Jan-2018	$	840
Jul-2018	$	1,608
Jun-2018	$	1,468
Mar-2018	$	836
May-2018	$	1,488
Nov-2018	$	1,300
Oct-2018	$	1,180
Sep-2018	$	1,560
Apr-2018	$	1,324
Aug-2018	$	1,564
Dec-2018	$	880
Feb-2018	$	956
Jan-2018	$	736
Jul-2018	$	1,684
Jun-2018	$	1,516
Mar-2018	$	788
May-2018	$	1,520

Counterparty and Payment Dates		REC Cost
Nov-2018	$	1,272
Oct-2018	$	1,216
Sep-2018	$	1,632
[redacted]		
Apr-2018	$	1,288
Aug-2018	$	1,472
Dec-2018	$	888
Feb-2018	$	1,020
Jan-2018	$	732
Jul-2018	$	1,564
Jun-2018	$	1,448
Mar-2018	$	788
May-2018	$	1,480
Nov-2018	$	1,200
Oct-2018	$	1,088
Sep-2018	$	1,468
[redacted]		
Apr-2018	$	20,723
Jun-2018	$	6,964
May-2018	$	34,814
[redacted]		
Feb-2018	$	51,000
May-2018	$	34,000
[redacted]		
Apr-2018	$	1,468
Aug-2018	$	1,292
Dec-2018	$	1,212
Feb-2018	$	784
Jan-2018	$	740
Jul-2018	$	1,400
Jun-2018	$	1,364
Mar-2018	$	1,240
May-2018	$	1,392
Nov-2018	$	1,312
Oct-2018	$	1,104
Sep-2018	$	1,188
[redacted]		
Sep-2018	$	138
[redacted]		
Apr-2018	$	1,248
Aug-2018	$	1,492
Dec-2018	$	700
Feb-2018	$	724
Jan-2018	$	548
Jul-2018	$	1,604
Jun-2018	$	1,432
Mar-2018	$	696
May-2018	$	1,408
Nov-2018	$	1,100
Oct-2018	$	1,068
Sep-2018	$	1,488
[redacted]		
Apr-2018	$	3,456
Aug-2018	$	3,748

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Counterparty and Payment Dates		REC Cost
Dec-2018	$	2,164
Feb-2018	$	2,736
Jan-2018	$	2,124
Jul-2018	$	4,072
Jun-2018	$	3,708
Mar-2018	$	2,096
May-2018	$	3,744
Nov-2018	$	3,284
Oct-2018	$	3,004
Sep-2018	$	3,972
[redacted]		
Apr-2018	$	11,303
Aug-2018	$	8,397
Dec-2018	$	6,155
Feb-2018	$	8,443
Jan-2018	$	6,433
Jul-2018	$	9,884
Jun-2018	$	10,754
Mar-2018	$	9,976
May-2018	$	9,861
Nov-2018	$	6,086
Oct-2018	$	5,606
Sep-2018	$	7,802
[redacted]		
Apr-2018	$	13,293
Aug-2018	$	8,374
Dec-2018	$	6,498
Feb-2018	$	9,816
Jan-2018	$	7,155
Jul-2018	$	10,937
Jun-2018	$	12,653
Mar-2018	$	11,097
May-2018	$	12,264
Nov-2018	$	4,988
Oct-2018	$	5,148
Sep-2018	$	7,596
[redacted]		
Apr-2018	$	18,768
Aug-2018	$	24,264
Dec-2018	$	22,488
Feb-2018	$	18,000
Jan-2018	$	18,480
Jul-2018	$	19,308
Jun-2018	$	12,564
Mar-2018	$	15,792
May-2018	$	13,452
Nov-2018	$	25,524
Oct-2018	$	24,480
Sep-2018	$	23,904
[redacted]		
Apr-2018	$	14,094
Aug-2018	$	8,603
Dec-2018	$	7,939
Feb-2018	$	8,237

Counterparty and Payment Dates		REC Cost
Jan-2018	$	7,093
Jul-2018	$	9,427
Jun-2018	$	10,616
Mar-2018	$	11,646
May-2018	$	13,179
Nov-2018	$	8,260
Oct-2018	$	7,733
Sep-2018	$	8,557
Apr-2018	$	18,530
Aug-2018	$	20,559
Dec-2018	$	17,590
Feb-2018	$	22,192
Jan-2018	$	21,893
Jul-2018	$	22,118
Jun-2018	$	19,347
Mar-2018	$	19,743
May-2018	$	17,417
Nov-2018	$	21,078
Oct-2018	$	23,775
Sep-2018	$	22,711
Apr-2018	$	3,230
Aug-2018	$	3,920
Dec-2018	$	2,095
Feb-2018	$	2,525
Jan-2018	$	2,045
Jul-2018	$	3,875
Jun-2018	$	3,905
Mar-2018	$	1,930
May-2018	$	3,805
Nov-2018	$	2,140
Oct-2018	$	2,430
Sep-2018	$	3,960
Apr-2018	$	-
Aug-2018	$	-
Dec-2018	$	-
Feb-2018	$	-
Jan-2018	$	-
Jul-2018	$	-
Jun-2018	$	-
Mar-2018	$	-
May-2018	$	-
Sep-2018	$	-
Apr-2018	$	1,376
Aug-2018	$	1,628
Dec-2018	$	1,008
Feb-2018	$	1,032
Jan-2018	$	920
Jul-2018	$	1,736
Jun-2018	$	1,572
Mar-2018	$	856

Counterparty and Payment Dates		REC Cost
May-2018	$	1,556
Nov-2018	$	1,372
Oct-2018	$	1,260
Sep-2018	$	1,652
[redacted]		
Jan-2018	$	180
[redacted]		
Apr-2018	$	3,408
Aug-2018	$	3,652
Dec-2018	$	2,416
Feb-2018	$	2,780
Jan-2018	$	2,200
Jul-2018	$	3,956
Jun-2018	$	3,660
Mar-2018	$	2,036
May-2018	$	3,644
Nov-2018	$	3,168
Oct-2018	$	2,876
Sep-2018	$	3,656
[redacted]		
Apr-2018	$	3,730
Aug-2018	$	4,505
Dec-2018	$	2,480
Feb-2018	$	2,775
Jan-2018	$	2,195
Jul-2018	$	4,665
Jun-2018	$	4,520
Mar-2018	$	2,085
May-2018	$	4,400
Nov-2018	$	3,410
Oct-2018	$	2,990
Sep-2018	$	4,480
[redacted]		
Apr-2018	$	1,654
Aug-2018	$	1,618
Dec-2018	$	1,141
Feb-2018	$	1,370
Jan-2018	$	1,087
Jul-2018	$	1,712
Jun-2018	$	1,872
Mar-2018	$	1,042
May-2018	$	1,766
Nov-2018	$	1,467
Oct-2018	$	1,316
Sep-2018	$	1,724
[redacted]		
Apr-2018	$	1,364
Aug-2018	$	776
Dec-2018	$	2,128
Feb-2018	$	692
Jan-2018	$	672
Jul-2018	$	1,040
Jun-2018	$	1,572
Mar-2018	$	1,236

Counterparty and Payment Dates		REC Cost
May-2018	$	1,328
Nov-2018	$	1,744
Oct-2018	$	1,512
Sep-2018	$	1,260
Feb-2018	$	51,000
May-2018	$	34,000
Dec-2018	$	-
Nov-2018	$	14,813
Apr-2018	$	3,396
Aug-2018	$	3,928
Dec-2018	$	2,224
Feb-2018	$	2,572
Jan-2018	$	2,056
Jul-2018	$	4,180
Jun-2018	$	3,796
Mar-2018	$	2,004
May-2018	$	3,848
Nov-2018	$	2,604
Oct-2018	$	2,352
Sep-2018	$	4,028
Feb-2018	$	85,000
Apr-2018	$	2,824
Aug-2018	$	500
Dec-2018	$	648
Feb-2018	$	988
Jan-2018	$	323
Jul-2018	$	2,328
Jun-2018	$	2,608
Mar-2018	$	1,944
May-2018	$	2,172
Apr-2018	$	4,120
Aug-2018	$	4,920
Dec-2018	$	2,920
Feb-2018	$	3,260
Jan-2018	$	2,685
Jul-2018	$	5,145
Jun-2018	$	4,945
Mar-2018	$	2,520
May-2018	$	4,750
Nov-2018	$	3,850
Oct-2018	$	3,485
Sep-2018	$	4,920
Apr-2018	$	1,928
Aug-2018	$	2,332
Dec-2018	$	1,344
Feb-2018	$	1,628
Jan-2018	$	1,272

Counterparty and Payment Dates		REC Cost
Jul-2018	$	2,440
Jun-2018	$	2,360
Mar-2018	$	1,152
May-2018	$	2,280
Nov-2018	$	1,076
Oct-2018	$	1,436
Sep-2018	$	2,304
[redacted]		
Apr-2018	$	1,928
Aug-2018	$	2,336
Dec-2018	$	1,312
Feb-2018	$	1,552
Jan-2018	$	1,224
Jul-2018	$	2,372
Jun-2018	$	2,328
Mar-2018	$	1,164
May-2018	$	2,256
Nov-2018	$	1,556
Oct-2018	$	1,036
Sep-2018	$	1,384
[redacted]		
Apr-2018	$	3,228
Aug-2018	$	2,736
Dec-2018	$	2,204
Feb-2018	$	2,584
Jan-2018	$	2,064
Jul-2018	$	3,696
Jun-2018	$	3,628
Mar-2018	$	1,908
May-2018	$	3,596
Nov-2018	$	2,728
Oct-2018	$	2,672
Sep-2018	$	3,384
[redacted]		
Apr-2018	$	1,998
Aug-2018	$	2,233
Dec-2018	$	1,338
Feb-2018	$	1,660
Jan-2018	$	1,203
Jul-2018	$	2,380
Jun-2018	$	1,933
Mar-2018	$	1,203
May-2018	$	2,210
Nov-2018	$	1,883
Oct-2018	$	1,635
Sep-2018	$	2,345
[redacted]		
Apr-2018	$	3,228
Aug-2018	$	3,724
Dec-2018	$	2,316
Feb-2018	$	2,120
Jan-2018	$	2,196
Jul-2018	$	4,064
Jun-2018	$	3,912

Counterparty and Payment Dates		REC Cost
Mar-2018	$	2,096
May-2018	$	2,424
Nov-2018	$	2,984
Oct-2018	$	2,620
Sep-2018	$	3,728
Apr-2018	$	1,634
Aug-2018	$	1,949
Dec-2018	$	1,078
Feb-2018	$	1,341
Jan-2018	$	990
Jul-2018	$	1,998
Jun-2018	$	1,924
Mar-2018	$	925
May-2018	$	1,872
Nov-2018	$	1,463
Oct-2018	$	1,303
Sep-2018	$	1,922
Aug-2018	$	4,689
Dec-2018	$	715
Jul-2018	$	2,265
Nov-2018	$	813
Oct-2018	$	778
Sep-2018	$	1,225
Nov-2018	$	13,941
Apr-2018	$	1,104
Aug-2018	$	1,440
Dec-2018	$	984
Feb-2018	$	900
Jan-2018	$	588
Jul-2018	$	1,556
Jun-2018	$	1,384
Mar-2018	$	936
May-2018	$	1,548
Nov-2018	$	1,196
Oct-2018	$	1,420
Sep-2018	$	1,488
Apr-2018	$	3,715
Aug-2018	$	4,445
Dec-2018	$	2,560
Feb-2018	$	3,020
Jan-2018	$	2,395
Jul-2018	$	4,500
Jun-2018	$	4,395
Mar-2018	$	2,195
May-2018	$	4,350
Nov-2018	$	3,410
Oct-2018	$	3,075
Sep-2018	$	4,430

Counterparty and Payment Dates		REC Cost
Apr-2018	$	1,644
Aug-2018	$	928
Dec-2018	$	2,012
Feb-2018	$	972
Jan-2018	$	596
Jul-2018	$	1,924
Jun-2018	$	1,768
Mar-2018	$	1,156
May-2018	$	1,668
Nov-2018	$	728
Oct-2018	$	456
Sep-2018	$	1,260
[redacted]		
Apr-2018	$	4,808
Aug-2018	$	4,048
Dec-2018	$	4,728
Feb-2018	$	3,624
Jan-2018	$	2,496
Jul-2018	$	5,320
Jun-2018	$	4,528
Mar-2018	$	5,020
May-2018	$	4,632
Nov-2018	$	3,524
Oct-2018	$	3,336
Sep-2018	$	3,592
[redacted]		
Apr-2018	$	3,468
Aug-2018	$	2,844
Dec-2018	$	4,268
Feb-2018	$	2,192
Jan-2018	$	1,300
Jul-2018	$	5,324
Jun-2018	$	3,692
Mar-2018	$	4,748
May-2018	$	3,112
Nov-2018	$	2,700
Oct-2018	$	2,596
Sep-2018	$	4,572
[redacted]		
Apr-2018	$	5,888
Aug-2018	$	5,516
Dec-2018	$	8,636
Feb-2018	$	4,260
Jan-2018	$	3,104
Jul-2018	$	11,008
Jun-2018	$	8,244
Mar-2018	$	8,716
May-2018	$	5,436
Nov-2018	$	6,752
Oct-2018	$	5,340
Sep-2018	$	6,284
[redacted]		
Dec-2018	$	970,800
May-2018	$	3,686,130

Counterparty and Payment Dates		REC Cost
[redacted]		
Dec-2018	$	220
Nov-2018	$	440
Oct-2018	$	406
Sep-2018	$	521
[redacted]		
Apr-2018	$	88,132
Aug-2018	$	229,498
Dec-2018	$	112,500
Feb-2018	$	72,526
Jan-2018	$	63,728
Jul-2018	$	106,720
Oct-2018	$	78,670
[redacted]		
Apr-2018	$	3,440
Aug-2018	$	3,844
Dec-2018	$	2,356
Feb-2018	$	2,704
Jan-2018	$	2,064
Jul-2018	$	4,144
Jun-2018	$	3,720
Mar-2018	$	1,968
May-2018	$	3,824
Nov-2018	$	3,168
Oct-2018	$	2,360
Sep-2018	$	3,624
[redacted]		
Apr-2018	$	4,036
Aug-2018	$	2,552
Dec-2018	$	4,496
Feb-2018	$	2,912
Jan-2018	$	1,080
Jul-2018	$	3,708
Jun-2018	$	4,792
Mar-2018	$	5,748
May-2018	$	3,908
Nov-2018	$	3,088
Oct-2018	$	2,216
Sep-2018	$	4,724
[redacted]		
Apr-2018	$	2,956
Aug-2018	$	1,980
Dec-2018	$	3,436
Feb-2018	$	2,108
Jan-2018	$	723
Jul-2018	$	2,964
Jun-2018	$	3,200
Mar-2018	$	3,428
May-2018	$	2,852
Nov-2018	$	2,444
Oct-2018	$	1,716
Sep-2018	$	1,468
[redacted]		
Apr-2018	$	504

*Information in italices is confidential

Counterparty and Payment Dates		REC Cost
Aug-2018	$	360
Feb-2018	$	392
Jan-2018	$	158
Jul-2018	$	484
Jun-2018	$	456
Mar-2018	$	380
May-2018	$	268
Nov-2018	$	292
Oct-2018	$	220
Sep-2018	$	364
[redacted]		
Dec-2018	$	237,915
Feb-2018	$	1,010
Jan-2018	$	65,029
Nov-2018	$	277,355
Oct-2018	$	140,335
[redacted]		
Apr-2018	$	4,573
Aug-2018	$	4,407
Feb-2018	$	6,037
Jan-2018	$	5,123
Jul-2018	$	4,303
Jun-2018	$	7,712
Mar-2018	$	3,123
Nov-2018	$	3,619
Oct-2018	$	3,367
Sep-2018	$	3,609
[redacted]		
Apr-2018	$	2,556
Aug-2018	$	2,652
Dec-2018	$	1,580
Feb-2018	$	1,780
Jan-2018	$	1,280
Jul-2018	$	2,836
Jun-2018	$	2,680
Mar-2018	$	1,444
May-2018	$	2,792
Nov-2018	$	2,184
Oct-2018	$	1,976
Sep-2018	$	2,632
[redacted]		
Sep-2018	$	7,750
[redacted]		
Apr-2018	$	1,740
Aug-2018	$	2,075
Dec-2018	$	1,225
Feb-2018	$	1,445
Jan-2018	$	1,110
Jul-2018	$	2,145
Jun-2018	$	2,030
Mar-2018	$	1,045
May-2018	$	1,945
Nov-2018	$	1,660
Oct-2018	$	1,490

Counterparty and Payment Dates		REC Cost
Sep-2018	$	2,150
[redacted]		
Feb-2018	$	126,791
Jan-2018	$	105,336
Mar-2018	$	37,170
[redacted]		
Apr-2018	$	2,549
Feb-2018	$	2,724
Jul-2018	$	7,508
Oct-2018	$	8,679
[redacted]		
Apr-2018	$	689
Feb-2018	$	8,705
Jul-2018	$	5,786
Oct-2018	$	8,472
[redacted]		
Apr-2018	$	2,670
Aug-2018	$	2,785
Dec-2018	$	1,765
Feb-2018	$	2,140
Jan-2018	$	1,660
Jul-2018	$	3,095
Jun-2018	$	2,975
Mar-2018	$	1,585
May-2018	$	2,975
Nov-2018	$	2,390
Oct-2018	$	2,120
Sep-2018	$	2,905
[redacted]		
Jan-2018	$	20
[redacted]		
Apr-2018	$	4,110
Aug-2018	$	4,885
Dec-2018	$	2,925
Feb-2018	$	3,410
Jan-2018	$	2,660
Jul-2018	$	5,130
Jun-2018	$	4,740
Mar-2018	$	2,540
May-2018	$	4,535
Nov-2018	$	4,120
Oct-2018	$	3,705
Sep-2018	$	5,085
[redacted]		
Apr-2018	$	1,675
Aug-2018	$	3,160
Dec-2018	$	2,630
Feb-2018	$	1,235
Jan-2018	$	2,700
Jun-2018	$	1,770
Mar-2018	$	2,495
May-2018	$	1,485
Nov-2018	$	1,035
Sep-2018	$	1,910

Counterparty and Payment Dates		REC Cost
[redacted]		
Apr-2018	$	668
Aug-2018	$	1,436
Dec-2018	$	457
Feb-2018	$	1,602
Jul-2018	$	783
Mar-2018	$	997
May-2018	$	779
Nov-2018	$	556
Oct-2018	$	1,357
[redacted]		
Dec-2018	$	2,644
[redacted]		
Sep-2018	$	8,283
[redacted]		
Apr-2018	$	1,332
Aug-2018	$	1,564
Dec-2018	$	648
Feb-2018	$	596
Jan-2018	$	400
Jul-2018	$	1,688
Jun-2018	$	1,528
Mar-2018	$	740
May-2018	$	1,504
Nov-2018	$	1,236
Oct-2018	$	1,192
Sep-2018	$	1,584
[redacted]		
Apr-2018	$	3,116
Aug-2018	$	3,748
Dec-2018	$	1,728
Feb-2018	$	1,816
Jan-2018	$	1,356
Jul-2018	$	4,012
Jun-2018	$	3,616
Mar-2018	$	1,760
May-2018	$	3,552
Nov-2018	$	2,824
Oct-2018	$	2,760
Sep-2018	$	3,776
[redacted]		
Apr-2018	$	4,060
Aug-2018	$	4,555
Dec-2018	$	2,305
Feb-2018	$	3,035
Jan-2018	$	2,350
Jul-2018	$	4,840
Jun-2018	$	4,400
Mar-2018	$	2,400
May-2018	$	1,360
Nov-2018	$	3,585
Oct-2018	$	3,465
Sep-2018	$	4,580
[redacted]		

Counterparty and Payment Dates		REC Cost
Sep-2018	$	9,824
[redacted]		
Apr-2018	$	2,972
Aug-2018	$	3,216
Dec-2018	$	1,724
Feb-2018	$	2,256
Jan-2018	$	1,732
Jul-2018	$	3,496
Jun-2018	$	3,304
Mar-2018	$	1,760
May-2018	$	3,256
Nov-2018	$	2,004
Oct-2018	$	2,020
Sep-2018	$	3,424
[redacted]		
Apr-2018	$	1,016
Aug-2018	$	316
Dec-2018	$	1,272
Feb-2018	$	644
Jan-2018	$	273
Jul-2018	$	644
Jun-2018	$	1,008
Mar-2018	$	1,040
May-2018	$	1,020
Nov-2018	$	704
Oct-2018	$	296
Sep-2018	$	376
[redacted]		
Apr-2018	$	2,972
Aug-2018	$	3,792
Dec-2018	$	2,168
Feb-2018	$	2,408
Jan-2018	$	1,912
Jul-2018	$	4,044
Jun-2018	$	3,820
Mar-2018	$	1,764
May-2018	$	3,552
Nov-2018	$	3,036
Oct-2018	$	2,696
Sep-2018	$	3,864
[redacted]		
Apr-2018	$	504
Aug-2018	$	480
Dec-2018	$	424
Feb-2018	$	520
Jan-2018	$	480
Jul-2018	$	544
Jun-2018	$	504
Mar-2018	$	488
May-2018	$	556
Nov-2018	$	480
Oct-2018	$	428
Sep-2018	$	544
[redacted]		

*Information in italices is confidential

Counterparty and Payment Dates		REC Cost
Feb-2018	$	17,000
May-2018	$	17,000
[redacted]		
Apr-2018	$	3,236
Aug-2018	$	4,032
Dec-2018	$	2,300
Feb-2018	$	2,692
Jan-2018	$	2,104
Jul-2018	$	4,148
Jun-2018	$	3,940
Mar-2018	$	1,928
May-2018	$	3,800
Nov-2018	$	2,968
Oct-2018	$	2,716
Sep-2018	$	4,024
[redacted]		
Apr-2018	$	24,450
Aug-2018	$	18,825
Feb-2018	$	25,275
Jan-2018	$	21,945
Jul-2018	$	21,450
Jun-2018	$	23,400
Mar-2018	$	23,250
May-2018	$	26,175
Nov-2018	$	10,950
Oct-2018	$	9,300
Sep-2018	$	19,500
[redacted]		
Apr-2018	$	3,865
Aug-2018	$	4,635
Dec-2018	$	2,625
Feb-2018	$	3,045
Jan-2018	$	2,530
Jul-2018	$	4,785
Jun-2018	$	4,610
Mar-2018	$	2,380
May-2018	$	4,565
Nov-2018	$	3,435
Oct-2018	$	2,450
Sep-2018	$	4,440
[redacted]		
Apr-2018	$	25,734
Aug-2018	$	28,747
Dec-2018	$	18,736
Feb-2018	$	21,553
Jan-2018	$	19,389
Jul-2018	$	30,473
Jun-2018	$	30,049
Mar-2018	$	19,881
May-2018	$	28,445
Nov-2018	$	20,435
Oct-2018	$	23,674
Sep-2018	$	29,247
[redacted]		

Counterparty and Payment Dates		REC Cost
Apr-2018	$	785
Aug-2018	$	963
Dec-2018	$	464
Feb-2018	$	499
Jan-2018	$	348
Jul-2018	$	1,034
Jun-2018	$	963
Mar-2018	$	392
May-2018	$	927
Nov-2018	$	678
Oct-2018	$	606
Sep-2018	$	963
Apr-2018	$	37,994
Aug-2018	$	42,150
Dec-2018	$	25,971
Feb-2018	$	31,313
Jan-2018	$	27,379
Jul-2018	$	43,631
Jun-2018	$	41,819
Mar-2018	$	27,833
May-2018	$	41,101
Nov-2018	$	27,853
Oct-2018	$	32,954
Sep-2018	$	42,344
Apr-2018	$	3,968
Aug-2018	$	4,610
Dec-2018	$	2,468
Feb-2018	$	2,788
Jan-2018	$	2,360
Jul-2018	$	5,040
Jun-2018	$	4,718
Mar-2018	$	2,252
May-2018	$	4,611
Nov-2018	$	3,325
Oct-2018	$	3,325
Sep-2018	$	4,719
Apr-2018	$	3,332
Aug-2018	$	3,580
Dec-2018	$	2,252
Feb-2018	$	2,716
Jan-2018	$	2,072
Jul-2018	$	3,968
Jun-2018	$	3,856
Mar-2018	$	1,992
May-2018	$	3,756
Nov-2018	$	2,892
Oct-2018	$	2,744
Sep-2018	$	3,880
Jan-2018	$	2,215

Counterparty and Payment Dates		REC Cost
Apr-2018	$	3,400
Aug-2018	$	4,128
Dec-2018	$	2,184
Feb-2018	$	2,792
Jan-2018	$	2,076
Jul-2018	$	4,292
Jun-2018	$	3,844
Mar-2018	$	2,056
May-2018	$	3,884
Nov-2018	$	3,200
Oct-2018	$	2,180
Sep-2018	$	4,208
Apr-2018	$	1,995
Aug-2018	$	2,168
Dec-2018	$	1,325
Feb-2018	$	1,488
Jan-2018	$	1,123
Jul-2018	$	2,308
Jun-2018	$	2,143
Mar-2018	$	1,153
May-2018	$	2,163
Nov-2018	$	1,788
Oct-2018	$	1,655
Sep-2018	$	2,143
Apr-2018	$	344
Aug-2018	$	432
Dec-2018	$	264
Feb-2018	$	272
Jan-2018	$	212
Jul-2018	$	404
Jun-2018	$	404
Mar-2018	$	196
May-2018	$	480
Nov-2018	$	380
Oct-2018	$	276
Sep-2018	$	444
Apr-2018	$	1,798
Aug-2018	$	1,985
Dec-2018	$	1,231
Feb-2018	$	1,436
Jan-2018	$	1,069
Jul-2018	$	2,050
Jun-2018	$	1,953
Mar-2018	$	1,044
May-2018	$	1,976
Nov-2018	$	1,658
Oct-2018	$	1,573
Sep-2018	$	2,039
Apr-2018	$	174,478
Aug-2018	$	94,288

*Information in italices is confidential

Counterparty and Payment Dates		REC Cost
Dec-2018	$	286,026
Feb-2018	$	181,906
Jan-2018	$	197,751
Jul-2018	$	229,930
Mar-2018	$	188,664
May-2018	$	105,836
Nov-2018	$	276,958
Oct-2018	$	216,730
Sep-2018	$	218,870
Apr-2018	$	286,126
Aug-2018	$	286,636
Dec-2018	$	369,816
Feb-2018	$	195,268
Jan-2018	$	251,387
Jul-2018	$	495,902
Mar-2018	$	287,688
May-2018	$	212,508
Nov-2018	$	406,402
Oct-2018	$	318,406
Sep-2018	$	419,394
Apr-2018	$	37,426
Aug-2018	$	45,382
Dec-2018	$	70,812
Feb-2018	$	46,905
Jan-2018	$	26,835
Jul-2018	$	69,812
Mar-2018	$	43,172
May-2018	$	35,406
Nov-2018	$	63,084
Oct-2018	$	48,620
Sep-2018	$	61,388
Mar-2018	$	1,678
Apr-2018	$	3,810
Aug-2018	$	4,650
Dec-2018	$	2,350
Feb-2018	$	2,660
Jan-2018	$	2,165
Jul-2018	$	4,780
Jun-2018	$	4,610
Mar-2018	$	2,210
May-2018	$	4,400
Nov-2018	$	3,380
Oct-2018	$	3,365
Sep-2018	$	4,755
Apr-2018	$	1,665
Aug-2018	$	1,928
Dec-2018	$	1,206
Feb-2018	$	1,400
Jan-2018	$	1,105

*Information in italices is confidential

Counterparty and Payment Dates		REC Cost
Jul-2018	$	1,877
Jun-2018	$	1,843
Mar-2018	$	1,008
May-2018	$	1,892
Nov-2018	$	1,409
Oct-2018	$	1,301
Sep-2018	$	1,886
[redacted]		
Apr-2018	$	1,300
Aug-2018	$	1,640
Dec-2018	$	840
Feb-2018	$	880
Jan-2018	$	700
Jul-2018	$	1,668
Jun-2018	$	1,604
Mar-2018	$	800
May-2018	$	1,520
Nov-2018	$	1,088
Oct-2018	$	1,112
Sep-2018	$	1,648
[redacted]		
Apr-2018	$	14,041
Aug-2018	$	12,481
Dec-2018	$	15,531
Feb-2018	$	14,674
Jan-2018	$	12,803
Jul-2018	$	12,680
Jun-2018	$	12,739
Mar-2018	$	12,563
May-2018	$	12,856
Nov-2018	$	13,478
Oct-2018	$	12,187
Sep-2018	$	13,513
[redacted]		
Apr-2018	$	2,280
Aug-2018	$	2,608
Dec-2018	$	1,524
Feb-2018	$	1,848
Jan-2018	$	1,368
Jul-2018	$	2,768
Jun-2018	$	2,584
Mar-2018	$	1,272
May-2018	$	2,656
Nov-2018	$	2,128
Oct-2018	$	1,804
Sep-2018	$	2,652
[redacted]		
Apr-2018	$	1,272
Aug-2018	$	1,456
Dec-2018	$	844
Feb-2018	$	972
Jan-2018	$	752
Jul-2018	$	1,588
Jun-2018	$	1,436

Counterparty and Payment Dates		REC Cost
Mar-2018	$	756
May-2018	$	1,444
Nov-2018	$	1,180
Oct-2018	$	1,144
Sep-2018	$	1,512

[END CONFIDENTIAL]

REDACTED VERSION

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	EMF Period Total Cost per Unit	EMF Period Total Cost	EMF Period RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Billing Period Total Cost per Unit	Billing Period Total Cost	Billing Period RECs
[redacted]										

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	EMF Period Total Cost per Unit	EMF Period Total Cost	EMF Period RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Billing Period Total Cost per Unit	Billing Period Total Cost	Billing Period RECs
[redacted]										

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

REDACTED VERSION

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	EMF Period Total Cost per Unit	EMF Period Total Cost	EMF Period RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Billing Period Total Cost per Unit	Billing Period Total Cost	Billing Period RECs
[redacted]										

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
[redacted]										

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191

Compliance Costs

Line No.	Renewable Resource	RECs only	EMF Period January 1, 2018 - December 31, 2018 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs	Billing Period September 1, 2019 - August 31, 2020 Total Units (A) (B)	Total Cost per Unit	Total Cost	RECs
1	Other Incremental (see Jennings Exhibit No. 3 for Incremental Cost worksheet}				$ 1,030,461				$ 1,567,500	
2	Billing Period estimated receipts related to contract performance				$ -	Note 1			$ (1,000,000)	Note 1
3	Solar Rebate Program (see Jennings Exhibit No. 3 for cost detail)				$ 135,912				$ 1,137,395	
4	Research (see Jennings Exhibit No. 3 for Research cost detail)				$ 938,393				$ 895,000	
5	**Total Other Incremental and Research Cost**				**$ 2,104,766**				**$ 2,599,895**	
1	EMF Period actual credits for receipts related to contracts - to Williams Exhibit No.4 - footnote (3)				$ (1,011,160)	Note 1				

Note 1: EMF Period contract receipts are not included in the under/overcollection calculation on Williams Exhibit No. 2, instead they are credited directly to customer class on Williams Exhibit No. 4. Estimated contract receipts are included in Billing Period total other incremental cost as a reduction in REPS charges proposed for the Billing Period.

Footnotes:

REDACTED VERSION*

Line No.	Incremental Cost Worksheet:	EMF Period Jan 2018 - Dec 2018	Projected Billing Period Sep 2019 - Aug 2020
	Labor by activity:		
1	[redacted]		
2			
3			
4			
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20			
21			
22			
23	**Total Other Incremental Cost**	**$ 1,030,461**	**$ 1,567,500**
	Solar Rebate Program Cost Detail (recovery in REPS pursuant to G.S. 62-155(f)): (1)		
24	Annual Amortization of Incentives Provided to Customers, plus return on unamortized balance	128,528	$ 1,055,610
25	Annual Amortization of Program Administrative Labor Costs, plus return on unamortized balance	[redacted]	
26	Annual Amortization of Program Administrative Contract Labor & Other Administrative Costs, plus return on unamortized balance		
27	**Total Solar Rebate Program Cost**	**$ 135,912**	**$ 1,137,395**

(1) All annual Solar Rebate Program costs reflect amortization of incurred costs over 20 years, including a return on the unamortized balance.

REDACTED VERSION*

Line No.	Incremental Cost Worksheet:	EMF Period Jan 2018 - Dec 2018	Projected Billing Period Sep 2019 - Aug 2020
	Research Cost Detail:		
28	CAPER - Short Course Development	[redacted]	
29	CAPER - Smart Battery Gauge		
30	Clemson University - Small DG Interface Testing		
31	Closed Loop Biomass		
32	Coalition for Renewable Natural Gas Membership		
33	DER Risks to Transformers and Transmission		
34	Eos Energy Storage Technology Development - McAlpine		
35	EPRI Membership		
36	EPRI - Inverter Onboard Islanding Detection Case Study Project		
37	ETO - Mitigation of Transformer High Inrush Current		
38	FREEDM Center - NCSU		
39	IEEE 1547 Conformity Assessment Test		
40	Loyd Ray Farms - Duke University		
41	Marshall Solar Site Storage Integration and Controller Design		
42	Mini-DVAR		
43	NCSU - ETO - Grid-forming Battery Energy Storage System Characterization & Testing		
44	NCSU - Interactions of PV Installations with Distribution Systems		
45	PNNL - Dynamic Var Compensator Pilot		
46	Research Triangle Institute - Biogas Utilitzation in NC		
47	Rocky Mountain Institute - eLab		
48	Swine Extrusion/Poultry Mortality - NC State Natural Resources Foundation		
49	UNCC - Evaluation of Fault Scenarios and Mitigation Techniques		
50	UNCC - Hardware Cyber Security for DER Inverters		
51	**Total Research Cost**	**$ 938,393**	**$ 895,000**
52	**Total Other Incremental Cost**	$ 1,030,461	$ 1,567,500
53	Projected credits for receipts related to contract amendments/liquidated damages, etc		$ (1,000,000)
54	**Total Other Incremental Cost and other credits**	$ 1,030,461	$ 567,500
55	**Total Solar Rebate Program Cost**	135,912	$ 1,137,395
56	**Total Research Cost**	938,393	$ 895,000
57	**Grand Total - Other Incremental, Solar Rebate Program, and Research Cost, other credits**	**$ 2,104,766**	**$ 2,599,895**
58	EMF Period actual credits for receipts related to contracts - see **Note 1**	$ (1,011,160)	
59	**Net Other Incremental, Solar Rebate Program and Research Cost**	**$ 1,093,606**	**$ 2,599,895**

Note 1: EMF Period contract receipts are not included in the under/overcollection calculation on Williams Exhibit No. 2, instead they are credited directly to customer class on Williams Exhibit No. 4. Estimated contract receipts are included in Billing Period total other incremental cost as a reduction in REPS charges proposed for the Billing Period.

**** Information in italics is confidential***

REDACTED VERSION

DUKE ENERGY CAROLINAS, LLC
Docket No. E-7, Sub 1191
REC sales for EMF Period January 1, 2018 - December 31, 2018

Note:

Pursuant to the Commission's May 13, 2014 *Order Regarding Accounting Treatment For REC Sales* issued in Docket No. E-100, Sub 113, the Company provides the following transaction details for all RECs sold by the Company during the calendar year 2018 REPS rider true-up (EMF) period. All REC sales transactions for the test period involved selling RECs to other electric power suppliers in the State for the purpose of meeting the aggregate poultry compliance requirement for the 2017 compliance year.

Line No.	Month RECs sold	Fuel Type (NC-RETS)	REC Vintage	Quantity	Original purchase price / REC	Sales price / REC	Sales proceeds (a)	Incremental transaction costs [1] (b)	Interest [2] (c)	Net proceeds from REC sales (a) - (b) - (c)	Cost of replacement RECs
[redacted]											

Footnotes:

(1) No incremental administrative costs, brokerage fees, or other transaction costs were identified with respect to these REC sales.

[redacted]

(3) All REC sales transactions were made in support of the meeting the 2017 statewide aggregate poultry compliance requirement, and no poultry REC purchases by the Company were specifically obtained or identified as replacements for the RECs sold.

(4) Net REC sales proceeds are included as a credit in Other Incremental Cost for the EMF period as detailed in the worksheet reflected on Jennings Exhibit No. 3.

Information in italics is confidential

Summer Course Syllabus | Summer 2019

CAPER Summer Course
Fundamentals of Power Engineering and Integration of Distributed Energy Resources

Instructors:

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References: A copy of the textbook will be provided to each registered student.

- Power System Analysis & Design, 6th Ed. by Glover, Overbye & Sarma, CL Engineering, 2016

Additional references:

- Class notes
- Power point slides

Course Objectives: This five-week course will provide a comprehensive overview of the fundamentals of power engineering. Topics include Three-phase fundamentals, transformers, power Flows, Power System Planning, Analysis, Protection, Dynamics, Stability, Control, Transients, and Distributed Energy Resources and Integration into the Grid. The course is designed to act as a refresher for the basics and as a brief introduction for more advanced topics.

At the completion of the course, student should be able to:

- Perform three-phase analysis
- Understand the per-unit system
- Analyze transmission line electrical performance
- Understand and perform power flow analysis
- Perform balanced and unsymmetrical fault calculations
- Understand symmetrical components and their role in unsymmetrical fault analysis
- Analyze symmetrical and unsymmetrical short circuit scenarios
- Understand different form of stability studies

Software: PowerWorld, PSSE, CYME, MS Office, and MATLAB will be required at minimum.

Summer Course Syllabus | Summer 2019

Lecture: Monday, May 13th – Friday, May 17h, 2019
Monday, June 10th – Friday, June 14th, 2019
8:00 am – 4:30 pm, daily

Class credit: PDH Certificate

Office hours: By appointment.

Prerequisites: This course is designed for industry professionals who have completed at least a Bachelors of Science degree in Electrical Engineering or have adequate work experience.

Admin Information: Crista Hartenstein (charten@clemson.edu)
Office location: Zucker Graduate Education Center
Office hours: Monday – Friday, 9 am – 4 pm

Course Outline:

Before Course Begin: Self-review *Chapter 1: Introduction* and *Chapter 2: Fundamentals*

Week 1:

Day 1	9:00 am – 12:00 pm	Review *Chapter 1: Introduction*
		Review *Chapter 2: Fundamentals*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 3: Transformers and the Per-Unit System*
Day 2	9:00 am – 12:00 pm	*Chapter 4: Rotating Synchronous Machinery – Generators*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 5: Transmission Lines*
Day 3	9:00 am – 12:00 pm	*Chapter 6: Electric Power Substations*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 7: Power System Analysis – Distribution Systems*
Day 4	9:00 am – 12:00 pm	*Chapter 8: Electric Power Utilization*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 9: Power System Analysis – Power Flow*
Day 5	9:00 am – 11:30 am	Self-study assignment:
		Chapter 10: Power Systems Planning and
		Chapter 11: Operation of the Power Systems
	11:30 am – 12:30 pm	Lunch
	12:30 pm – 2:30 pm	Technical site visit and tour

Weeks 2 - 4: Self-study assignment: *Chapters 10: Power System Planning* and *Chapter 11: Operation of the Power Systems*

Week 5:

Day 1	9:00 am – 12:00 pm	Review of Week 1, Midterm test & feedback
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 12: Power Systems Analysis - Faults*

Summer Course Syllabus | Summer 2019

Day 2	9:00 am – 12:00 pm	*Chapter 12: Power Systems Analysis – Faults*, continued
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 13: Power System Protection*
Day 3	9:00 am – 12:00 pm	*Chapter 14: Power System Dynamics, Stability, and Control*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 15: Power System Transients*
Day 4	9:00 am – 12:00 pm	*Chapter 16: Distributed Energy Resources and Integration into the Grid*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 4:00 pm	*Chapter 16: Renewables,* continued
Day 5	9:00 am – 12:00 pm	*Chapter 17: Power Quality*
	12:00 pm – 1:00 pm	Lunch
	1:00 pm – 2:00 pm	Final test & feedback

Pricing:

- CAPER Members: $2,495
- Non-CAPER Members: $2,995
- Early Bird discount: Register by April 19th, 2019 and the membership rate is $2,245

Important Dates:

- Registration open: February 1st, 2019
- Early Bird deadline: April 19th, 2019
- Course begin: May 13th, 2019

To register, please visit http://caper-usa.com/university-programs/professional-development/caper-summer-course/

Classroom Policies: Attendance is voluntary but strongly encouraged. No make up for missed classes, quizzes, or assignments will be given. Students are responsible for all material covered and all assignments given in every lecture. Some lectures may cover material not found in the textbook. It is the responsibility of each student to make up any deficiencies that result from missed classes. Students are expected to wait 15 minutes before leaving if the instructor is late. Cell phones must be turned off or silenced before coming into class.

Changes to Syllabus: The instructors reserve the right to make changes to this syllabus during the semester. Students will be given adequate notice in class of any changes.

Agreement: If you disagree with any of the policies or procedures spelled out above or cannot accept the demands of the course (i.e., the amount of time and work required), you need to drop the course as soon as possible. By staying in the course, you agree to comply with all the policies and procedures described in this syllabus

JENNINGS CONFIDENTIAL EXHIBIT NO. 6

DOCKET NO. E-7, SUB 1191

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JENNINGS CONFIDENTIAL EXHIBIT NO. 7

DOCKET NO. E-7, SUB 1191

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2018 Inventory Report

SC8 Biomass Project

AMERICAN FOREST
MANAGEMENT

December 2018

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Inventory Report
SC8 Biomass Project

December, 2018

Executive Summary

This report comprises the 2018 inventory report for biomass crops on the SC8 property in Chester County, SC. It contains several sections:

- Project history
- Inventory data
- Analysis and conclusions
- Recommendations for future management

After the initial project planning was complete in 2009 and 2010, three general biomass research areas were established:

1. Loblolly Nelder Plot: Investigate effects of stand density and genetics on loblolly pine growth.
2. High Density Loblolly Pine Plantations: Investigate effects of stand density on loblolly pine growth for two selected spacings (1082 and 1452 trees per acre)
3. Hardwood Plantations on Upland and Bottomland Sites: Investigate growth of 5 hardwood species (cottonwood, hybrid poplar, aspen, sweetgum, and black willow) on two sites types (upland and bottomland).

Results from the Nelder plot indicate that, for short-rotation biomass crops, there is little difference in the performance of the three broad loblolly pine genotypes tested: (1) Open-pollinated 2nd generation orchard seedlings; (2) Mass-controlled pollinated seed from 2nd generation orchards; and (3) Clonal material from good performing clones. The most economical 2nd-generation seedlings should be used to minimize establishment costs. There is some evidence from the study that containerized material is superior in performance than bareroot seedlings. If the marginal cost increase of containerized versus bareroot material is not excessive it would be a recommended choice. While there is still some uncertainty in an ideal loblolly pine biomass planting density, somewhere between 800 and 1,000 trees per acre is suggested as the best combination of overall yield and economical establishment cost for biomass production.

Results from the high-density loblolly plantings suggest that 1082 trees per acre is a better choice than 1452 trees per acre. The 1082 density has the additional advantage of outperforming the 1452 density in the event of conversion to a traditional timber management regime.

For the 2011 upland site planted to poplar and aspen, both species have similar yields at age 7. Both species have most likely passed the age of their maximum mean annual increment, suggesting that they should be harvested as soon as suitable market and operating conditions exist. Following harvest the second rotation yields from coppice and root sprouts can be evaluated.

The bottomland sites were planted in 2012 to sweetgum, black willow, cottonwood, and hybrid poplar. At the time of the 2018 measurement (age 6) the hybrid poplar block had the highest yields followed by the blocks planted to cottonwood, black willow, and sweetgum. The data for the cottonwood and hybrid poplar plots suggest ages 8 to 10 to be ones that would be optimal for the first rotation biomass harvest which would then be followed by a coppice rotation. The growth of biomass in the black willow from the 2015 to the 2018 exceeded the growth in the other species' blocks. As expected based on its general growth characteristics, sweetgum has lower short-rotation biomass yields than the other three species. However, an advantage of sweetgum (and to some extent cottonwood) is that it provides the management flexibility to produce both biomass and higher-valued product yields for the landowner.

Data analysis was restricted to biometrics only; no specific economic analyses were performed. Final conclusions and operational recommendations should consider seedling costs, establishment and maintenance cost differences over multiple rotations, and operational factors, not the least of which is harvesting cost.

While the project has reached its end, consideration should be given to maintenance of research sites for future evaluation. Maintenance generally consists of periodic inspections to verify site health and integrity. Existing projections and conclusions can be improved through additional formal inventories and analysis in 2021.

Project History

The SC8 property was acquired in 2007 as a potential power generation site. In 2009, with no concrete plans for generation development, attention was turned to establishing a site for biomass crop evaluations. Several goals were established: Develop a knowledge base for biomass crop establishment and management; grow biomass crops and investigate their yields; and provide a demonstration site for potential biomass producers to evaluate growth and yield in an operational setting.

Starting in 2011, a number of woody biomass crops were established:

- Loblolly pine
- Cottonwood
- Aspen
- Hybrid poplar

Additional hardwood plantings were established in 2012 on bottomland sites:

- Cottonwood
- Aspen
- Hybrid poplar
- Sweetgum
- Black willow

With the exception of black willow, a number of different genotypes for each species were planted.

Since establishment, crops have been maintained through a variety of methods (fertilization, insect control, weed control), regularly inspected, and were formally inventoried in 2015 and 2018.

Inventory Data

This section describes the results of the 2018 inventory project. It is divided into sections by species group and subsections by categories within each group. Inventory job control specifications, including tract maps, cruise maps, and specific data collection procedures, can be found in Appendix 1.

Loblolly Nelder Plot

A Nelder plot, also called a Nelder Wheel or Nelder Fan, is a systematic planting design in which plants or trees are planted at the intersection of circular arcs and linear spokes. In general, Nelder plots allow many different planting densities to be examined in a single plot. This is frequently more efficient and requires less area than planting a different plot for each planting density. Nelder plots can be constructed that allow the effect of different planting geometries to be examined in a single plot.

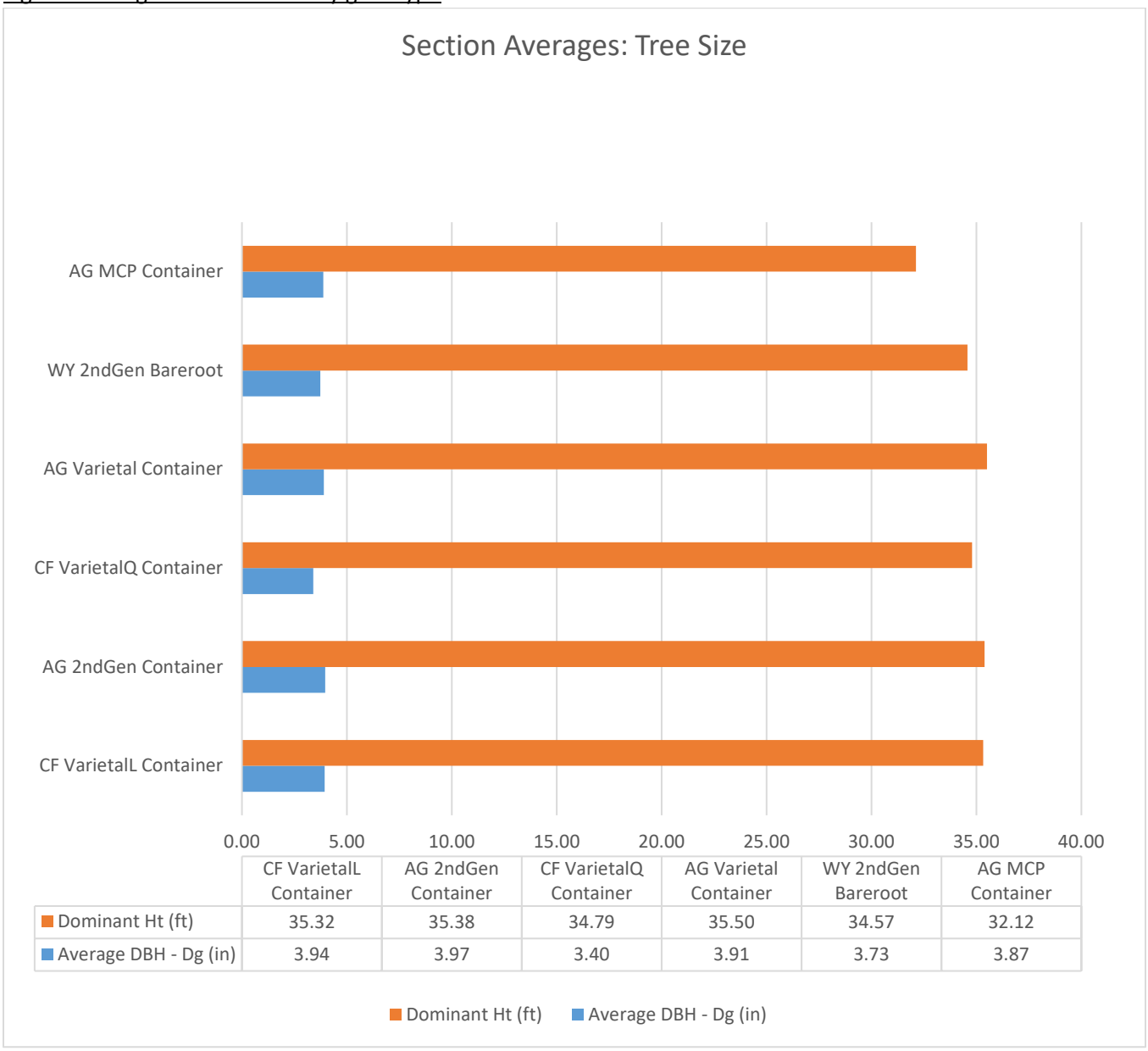
The layout and genotype composition for the SC8 Nelder plot can be found in Appendix 1, Loblolly Nelder Schematic Map. Planting density ranges from 1,349 trees per acre (TPA) at the center to 39 TPA at the perimeter. The Nelder plot was established in February 2011. Its location can be found in Appendix 1, Overview Map.

Table 1. Nelder planting stock and identification

Nelder Section Code	Producer	Planting Stock	Variety	Producer and Variety	Classification	Graph Label
A	CELLFOR	Containerized	L-3791 128L	CELLFOR L-3791 128L	Varietal	CF VarietalL Container
B	ArborGen	Containerized	AG-88 LB-A02-09	ArborGen AG-88 LB-A02-09	2nd Generation Orchard Pollination	AG 2ndGen Container
C	CELLFOR	Containerized	Q-7766 128L	CELLFOR Q-7766 128L	Varietal	CF VarietalQ Container
D	ArborGen	Containerized	AVG-102	ArborGen AVG-102	Varietal	AG Varietal Container
E	WeyCo	Bareroot	007056.LD	WeyCo 007056.LD	2nd Generation Orchard Pollination	WY 2ndGen Bareroot
F	ArborGen	Containerized	AGM-37 LB SBI-09E	ArborGen AGM-37 LB SBI-09E	Mass Controlled Polination	AG MCP Container

Figures 1 through 4 show the average values for each of the Nelder sections.

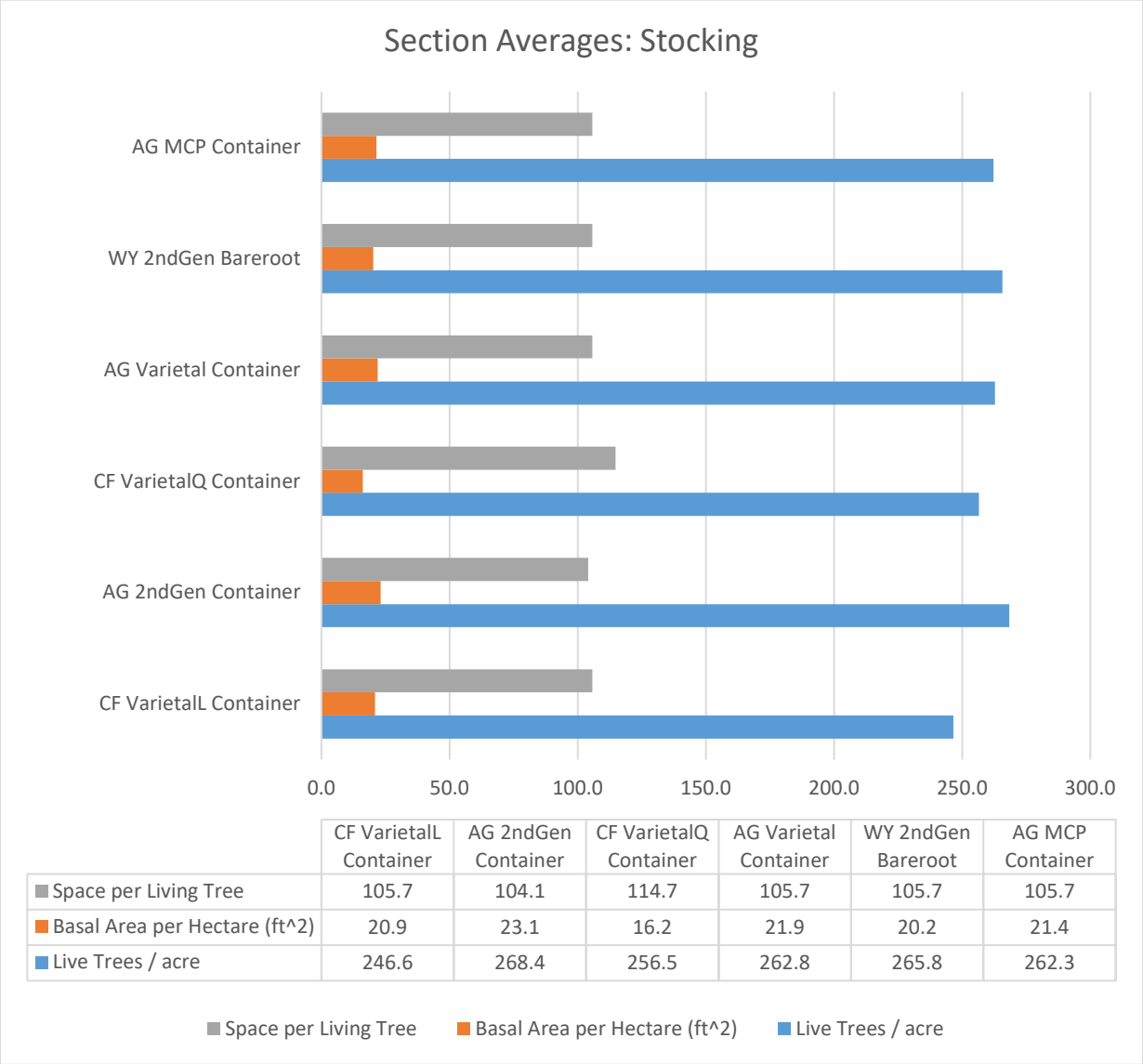
Figure 1. Height and diameter by genotype



	CF VarietalL Container	AG 2ndGen Container	CF VarietalQ Container	AG Varietal Container	WY 2ndGen Bareroot	AG MCP Container
Dominant Ht (ft)	35.32	35.38	34.79	35.50	34.57	32.12
Average DBH - Dg (in)	3.94	3.97	3.40	3.91	3.73	3.87

Figure 2. Stocking by genotype

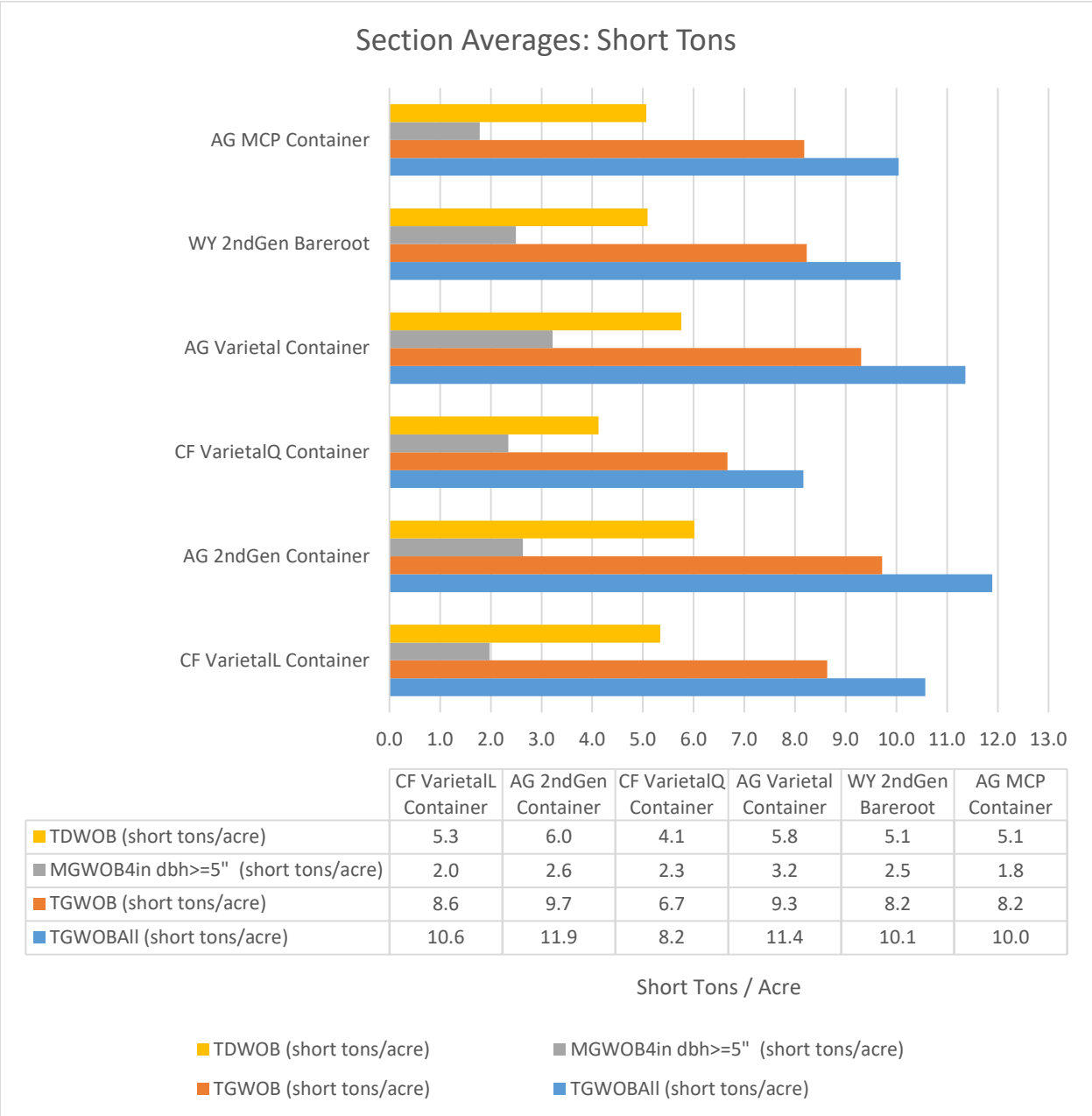
Displays growing space per tree, basal area per hectare, and live trees per acre for each genotype.



	CF VarietalL Container	AG 2ndGen Container	CF VarietalQ Container	AG Varietal Container	WY 2ndGen Bareroot	AG MCP Container
Space per Living Tree	105.7	104.1	114.7	105.7	105.7	105.7
Basal Area per Hectare (ft^2)	20.9	23.1	16.2	21.9	20.2	21.4
Live Trees / acre	246.6	268.4	256.5	262.8	265.8	262.3

Figure 3. Tree weight by genotype

Displays tons per acre for total dry weight outside bark (TDWOB), merchantable green weight outside bark (MGWOB), main stem total green weight outside bark (TGWOB), and entire tree total green weight outside bark (TGWOBAll).



	CF VarietalL Container	AG 2ndGen Container	CF VarietalQ Container	AG Varietal Container	WY 2ndGen Bareroot	AG MCP Container
TDWOB (short tons/acre)	5.3	6.0	4.1	5.8	5.1	5.1
MGWOB4in dbh>=5" (short tons/acre)	2.0	2.6	2.3	3.2	2.5	1.8
TGWOB (short tons/acre)	8.6	9.7	6.7	9.3	8.2	8.2
TGWOBAll (short tons/acre)	10.6	11.9	8.2	11.4	10.1	10.0

Figure 4. Tree weight by tree quality

1: Always pulpwood 2: Potential sawtimber 3: Definite sawtimber

	CF VarietalL Container	AG 2ndGen Container	CF VarietalQ Container	AG Varietal Container	WY 2ndGen Bareroot	AG MCP Container
TGWOB (short tons/acre)	8.6	9.7	6.7	9.3	8.2	8.2
TGWOB (short tons/acre) Quality = 3	6.4	7.2	4.9	6.9	4.6	6.4
TGWOB (short tons/acre) Quality = 2	1.8	2.1	1.5	1.4	2.2	0.8
TGWOB (short tons/acre) Quality = 1	0.4	0.5	0.3	1.0	1.5	1.0

Figures 5 through 9 illustrate various combined average values for all sections for the different trees per acre classes represented by each ring of the Nelder plot.

Figure 5. Average weight by trees per acre

These weight categories are: main stem green weight outside bark (TGWOB), entire tree green weight outside bark (TGWOBAll), merchantable stem green weight outside bark (MGWOB), and dry weight outside bark (TDWOB).

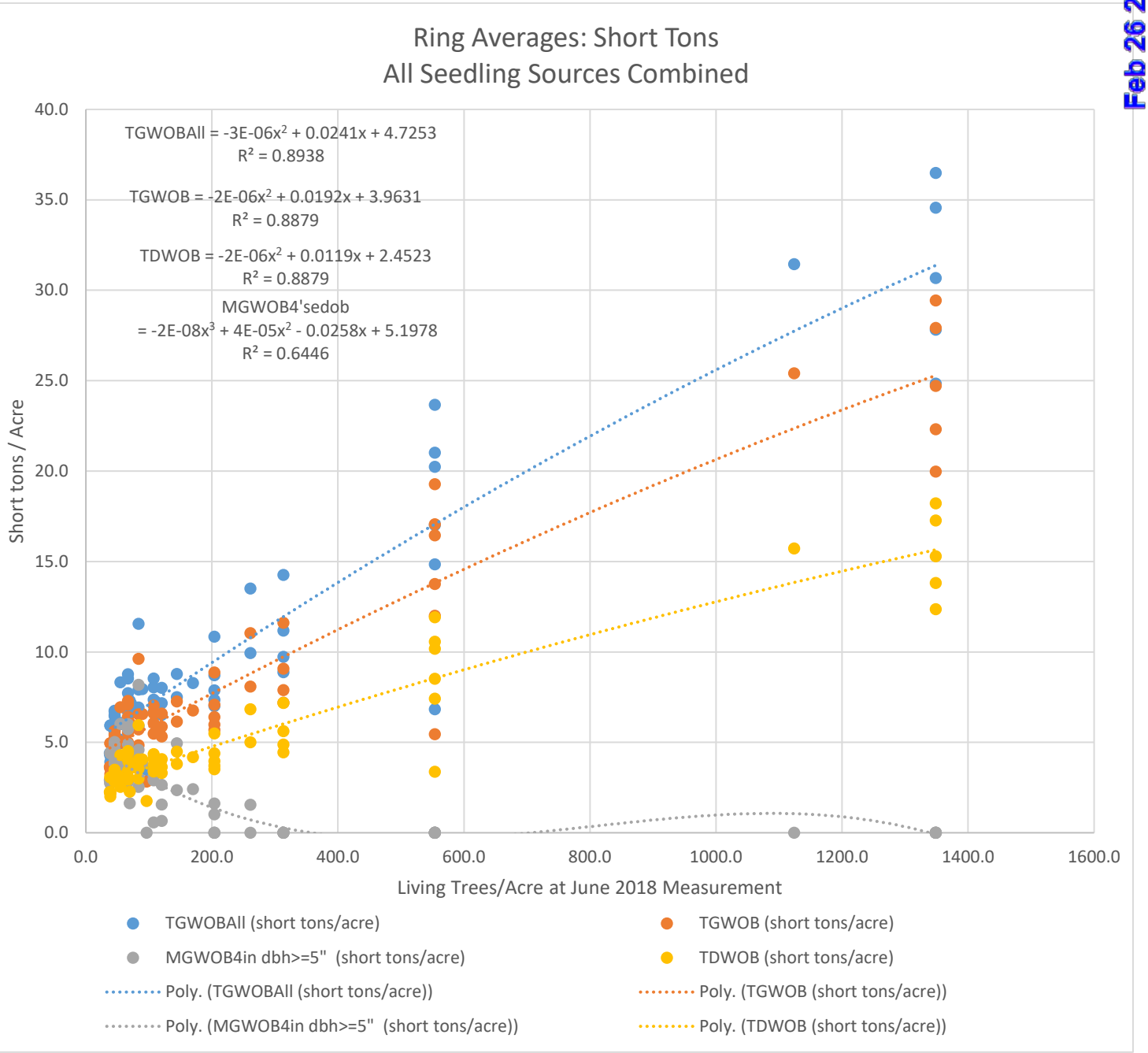


Figure 6. Average weight by seedling type and trees per acre

Displays weight for varietal container-grown, orchard-mix container-grown, orchard-mix bareroot, and mass-control pollinated container-grown.

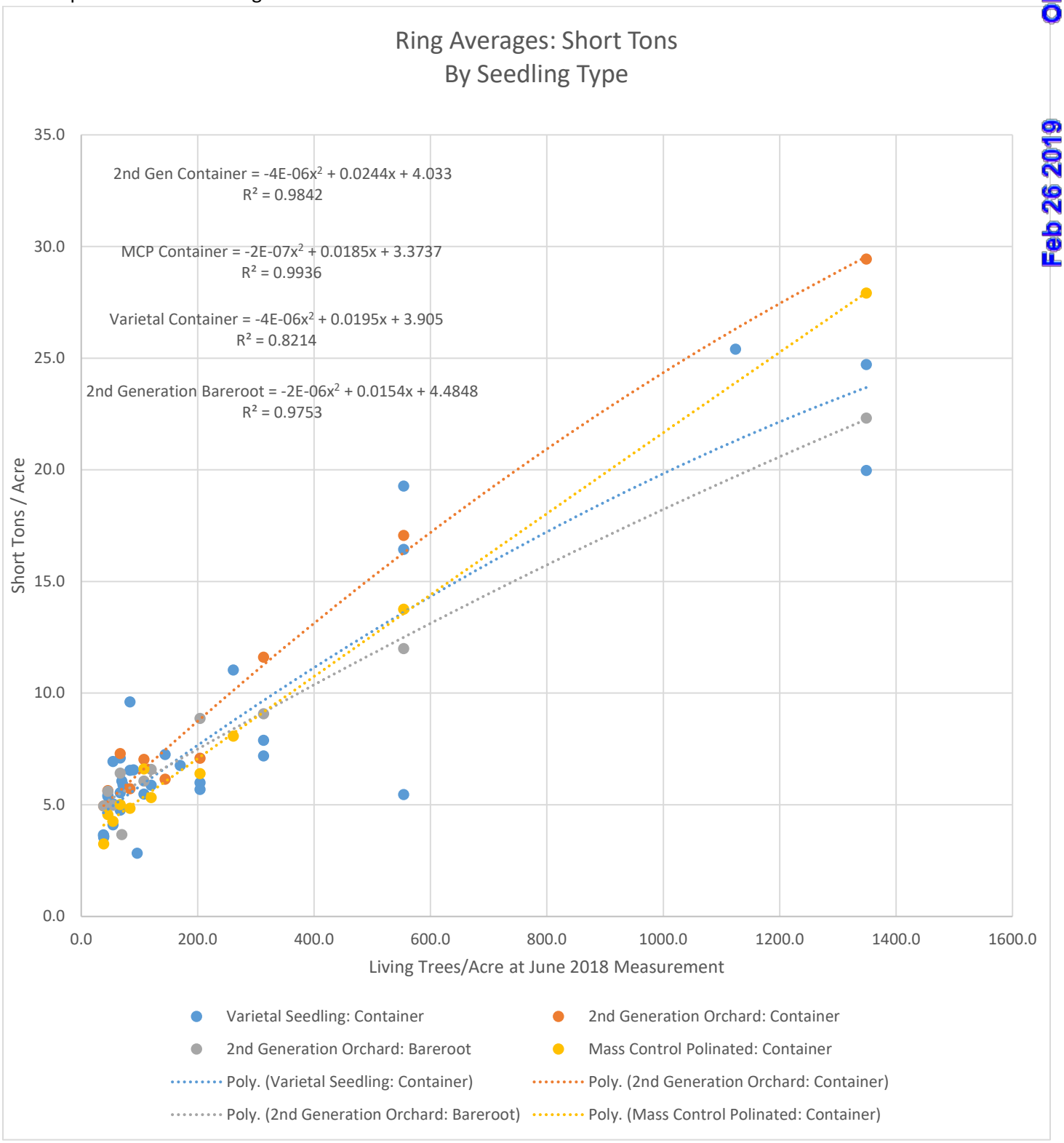


Figure 7. Overall basal area per acre and quality 3 basal area by planting density

Displays basal area for all trees regardless of quality, and only those trees meeting quality grade 3 (definite sawtimber), as growing space per tree changes.

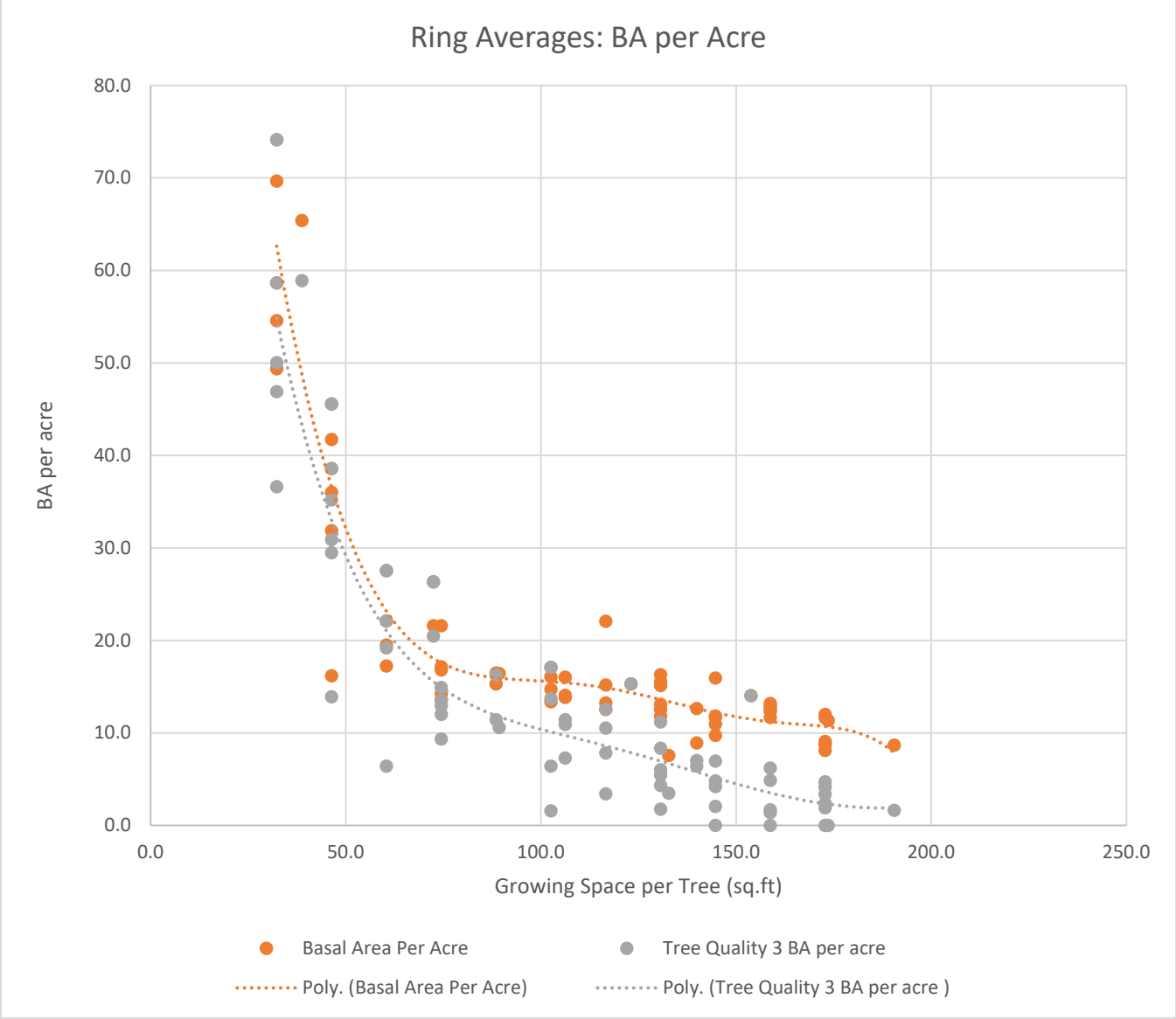


Figure 8. Tree metrics by growing space per tree

Displays basal area, DBH, dominant height, and average total height based on growing space per tree. Higher trees-per-acre values correspond to lower growing space per tree.

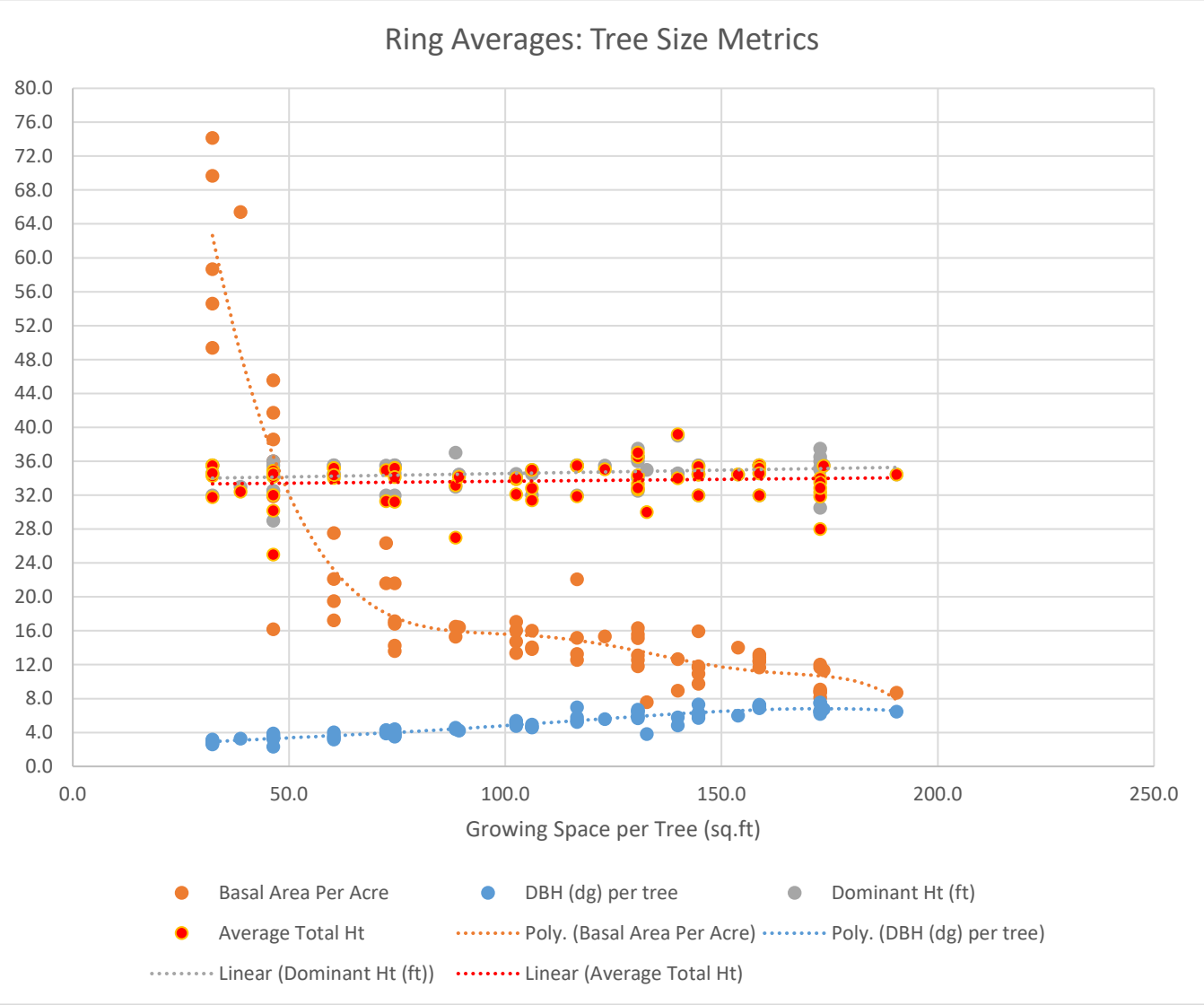
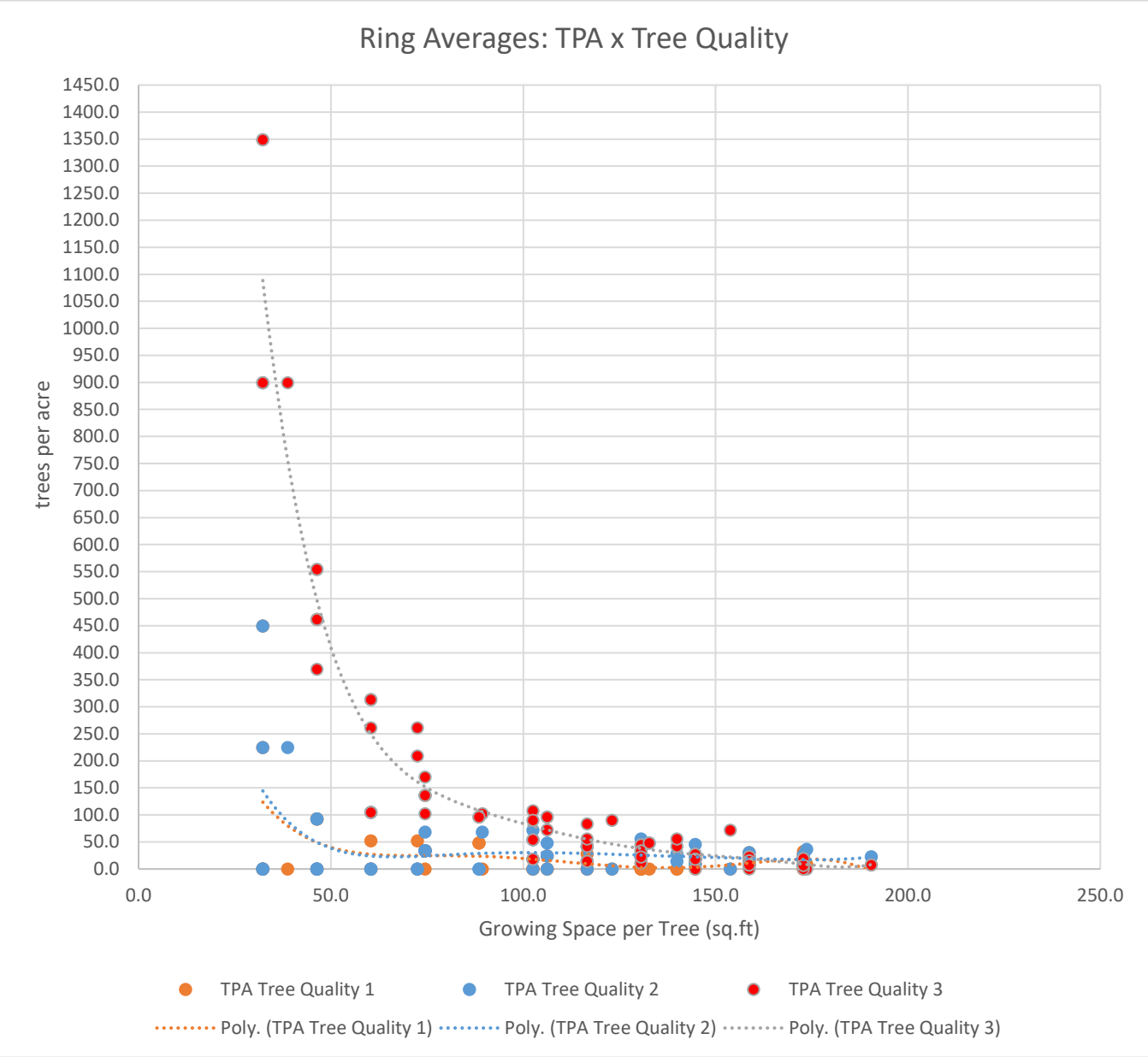


Figure 9. Tree quality by growing space per tree

1: Always pulpwood 2: Potential sawtimber 3: Definite sawtimber



Planted Loblolly Pine

Two plantation spacings were chosen to investigate the effects of planting density on short-rotation loblolly pine growth for a single genotype (007056.LD); 1082 trees per acre and 1452 trees per acre. 146.7 acres were planted at the 1082 density and 142.6 acres were planted at the 1452 density. Location of planting sites can be found in Appendix 1, Overview Map. These areas were established in February 2011.

Observed living trees during the 2018 inventory were below expectations based on their original planting densities. To develop estimates from these data that reflect what we think could be expected in the future from planting at these densities, the Nelder plot results were used to adjust these measurement data. At this time it is unclear whether the low observed survival was due to factors at time of planting (poor planting quality, issues with seedlings, actual planting density) or factors since planting (losses from natural causes).

Results from both measured data (indicated by an M) and Nelder-adjusted data (indicated by an N) are displayed in the following figures.

Consideration was also given to the possibility of converting a biomass management regime (one with no thinning prior to final harvest) to a traditional timber management regime with two thinnings and a final harvest. Yields from the following two scenarios were projected from the 2018 measurement data:

- Thinning at ages 14 and 22 with a final harvest at age 30, and
- Thinning at ages 16 and 26 with a final harvest at age 32.

Figure 10. Greenweight mean annual increment

Displays growth rate in green tons per acre per year at both planting densities (1082, 1452 TPA) and for both measured (M) and Nelder-adjusted (N) data.

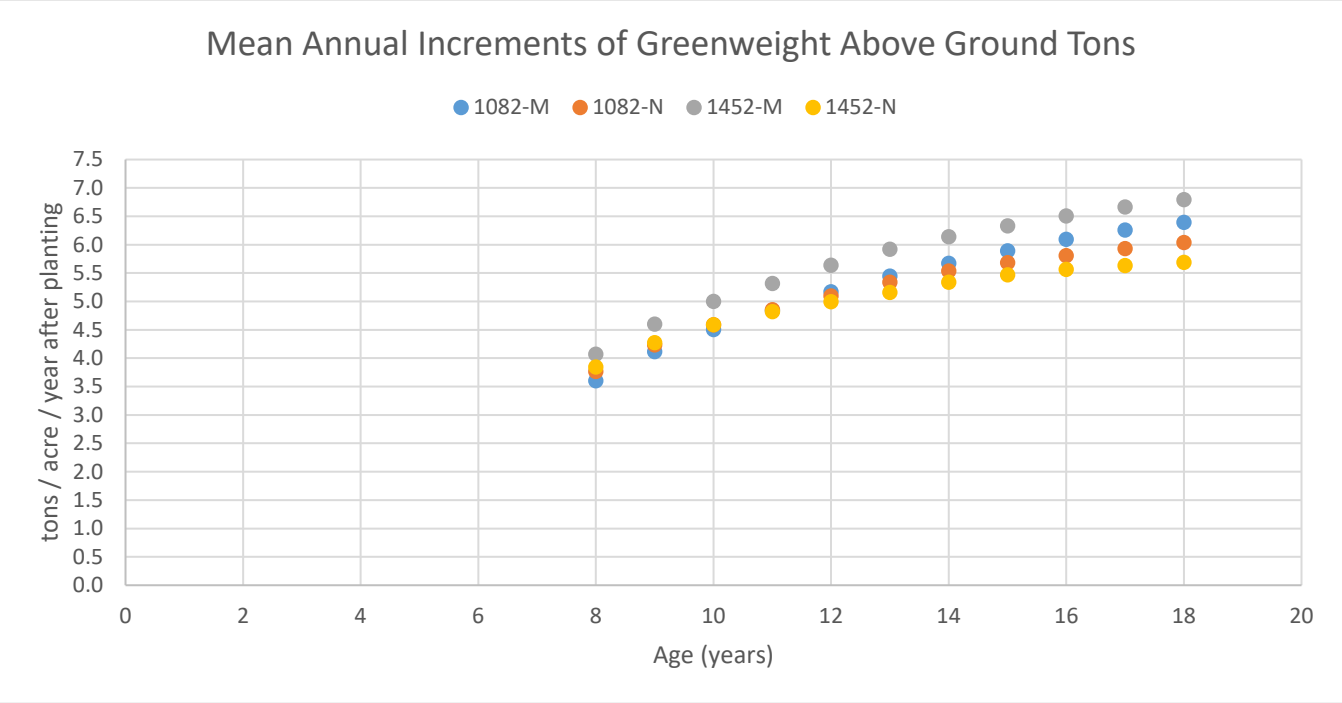


Figure 11. Dryweight mean annual increment

Displays growth rate in oven-dry tons per acre per year at both planting densities (1082, 1452 TPA) and for both measured (M) and Nelder-adjusted (N) data.

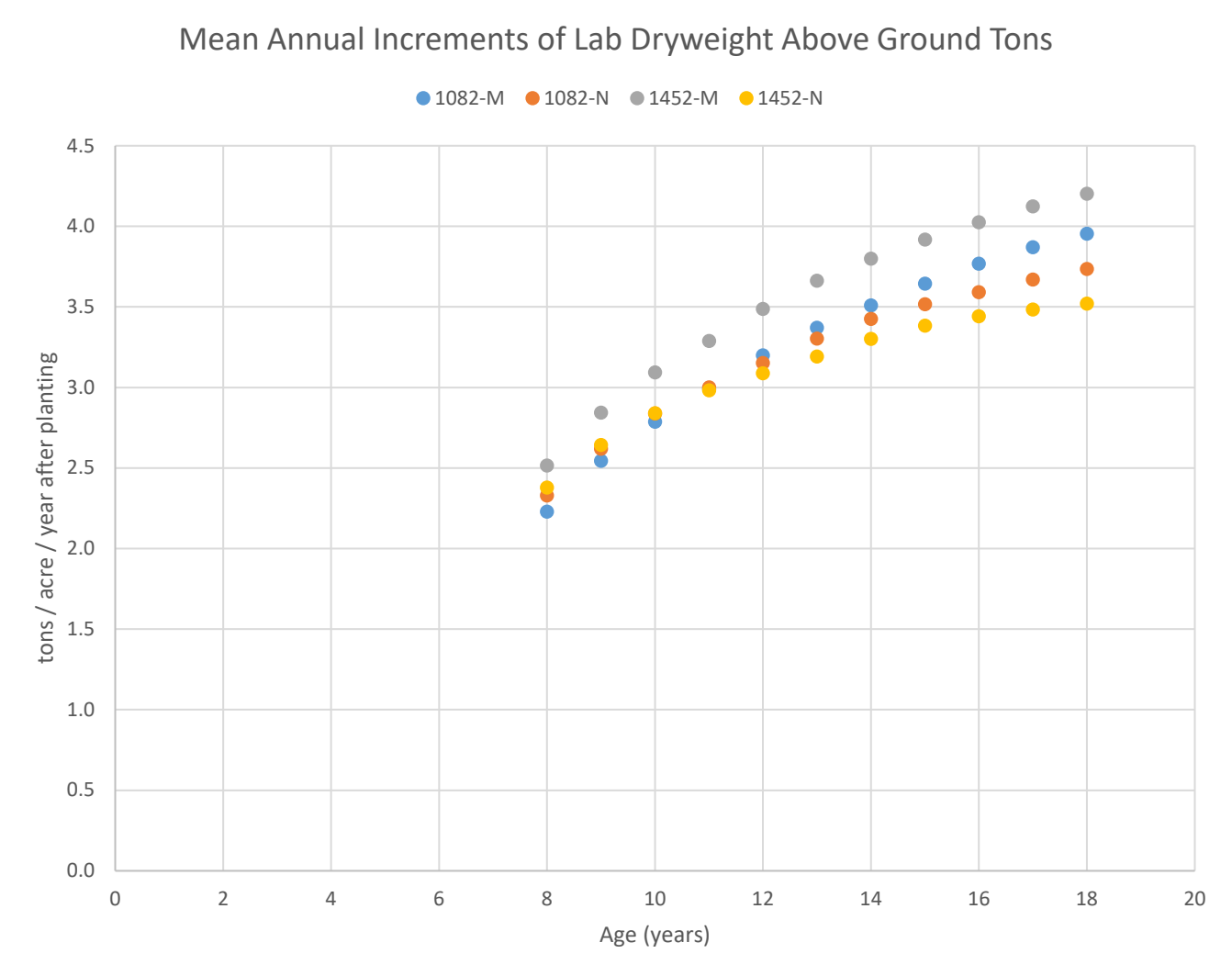


Table 2. Projected biomass yields at selected ages

Displays green weight of total biomass, oven-dry weight of bark-only biomass, oven-dry weight of wood-only biomass, and oven-dry weight of total biomass, at selected ages.

Calculations include both planting densities (1082, 1452) and for measured (M) and Nelder-derived (N) projections. All values are in tons per acre.

Scenario	AGE	Biomass (GreenWeight)	Bark Biomass (DryWeight)	Wood Biomass (DryWeight)	Total Biomass (DryWeight)
StandNumber	inv.age	biomassGW.tonspa	biomassDWBark.tonspa	biomassDWWood.tonspa	biomassDWWoodandBark.tonspa
1082-M	12	62.1	5.0	33.4	38.4
1082-M	14	79.4	6.4	42.7	49.1
1082-M	16	97.5	7.9	52.5	60.3
1082-N	12	61.1	4.9	32.9	37.8
1082-N	14	77.5	6.2	41.7	48.0
1082-N	16	92.9	7.5	50.0	57.5
1452-M	12	67.7	5.5	36.4	41.9
1452-M	14	86.0	6.9	46.3	53.2
1452-M	16	104.1	8.4	56.0	64.4
1452-N	12	59.9	4.8	32.2	37.1
1452-N	14	74.7	6.0	40.2	46.2
1452-N	16	89.0	7.2	47.9	55.1

Table 3. Timber conversion projected yields, thin at ages 14 and 22 with final harvest at age 30

Displays merchantable weight removed at each thin age and final harvest for both planting densities (1082, 1452) and for measured (M) and Nelder-derived (N) projections. All values are in tons per acre, green weight basis.

Scenario	AGE	Total Removed	Pulp Removed	Chip'n Saw Removed	Sawtimber Removed	TopwoodRemoved
StandNumber	inv.age	merch.tonspa	pulp.tonspa	cns.tonspa	saw.tonspa	top.tonspa
1082-M	14	44.3	40.4	2.1	0.0	1.8
1082-M	22	77.9	59.0	12.5	0.0	6.3
1082-N	14	47.1	47.1	0.0	0.0	0.0
1082-N	22	83.8	83.8	0.0	0.0	0.0
1452-M	14	52.8	47.9	2.7	0.0	2.3
1452-M	22	95.2	74.4	13.7	0.0	7.1
1452-N	14	41.5	40.9	0.0	0.0	0.6
1452-N	22	90.4	90.4	0.0	0.0	0.0
1082-M	30	136.3	22.4	64.3	12.8	36.8
1082-N	30	141.7	40.0	60.3	0.0	41.4
1452-M	30	173.7	32.2	77.5	16.0	48.0
1452-N	30	193.0	115.0	46.2	0.0	31.8

Table 4. Timber conversion projected yields, thin at ages 16 and 25 with final harvest at age 32

Displays merchantable weight removed at each thin age and final harvest for both planting densities (1082, 1452) and for measured (M) and Nelder-derived (N) projections. All values are in tons per acre, green weight basis.

Scenario	AGE	Total Removed	Pulp Removed	Chip'n Saw Removed	Sawtimber Removed	TopwoodRemoved
StandNumber	inv.age	merch.tonspa	pulp.tonspa	cns.tonspa	saw.tonspa	top.tonspa
1082-M	16	49.7	45.8	2.1	0.0	1.8
1082-M	25	82.1	41.6	25.8	0.0	14.7
1082-N	16	47.5	47.5	0.0	0.0	0.0
1082-N	25	73.6	64.7	4.8	0.0	4.1
1452-M	16	54.6	49.7	2.7	0.0	2.3
1452-M	25	84.7	44.2	25.6	0.0	14.9
1452-N	16	43.3	42.7	0.0	0.0	0.6
1452-N	25	91.0	91.0	0.0	0.0	0.0
1082-M	32	164.1	23.2	83.5	18.3	39.1
1082-N	32	123.5	50.2	49.5	0.0	23.8
1452-M	32	176.0	25.1	87.9	22.3	40.7
1452-N	32	157.7	130.0	16.7	0.0	11.0

Planted Hardwood

Hardwood plantations containing cottonwood, hybrid poplar, aspen, sweetgum, and black willow were established on both upland and bottomland sites. The upland sites were planted in 2011 and the bottomland sites were planted in 2012. A variety of genotypes within each species group were planted - 37 unique genotypes from 4 different producers were installed at the SC8 site.

While inventory field data were collected by genotype and site type, this report merges all data within each species group and site type into a single stratum. The purpose was to investigate yield within each species group, on an operational level, and not to prepare genotype-level calculations.

Yield projection only exists for cottonwood group as models were either not available or had suspect results for hybrid poplar, aspen, sweetgum, and black willow.

Location of general planting sites is in Appendix 1, Overview Map, and species-group specific planting sites can be found in the accompanying cruise maps.

Figure 12. Trees per acre by site type and species group

Displays trees per acre by species group and site type, for both natural and planted trees.

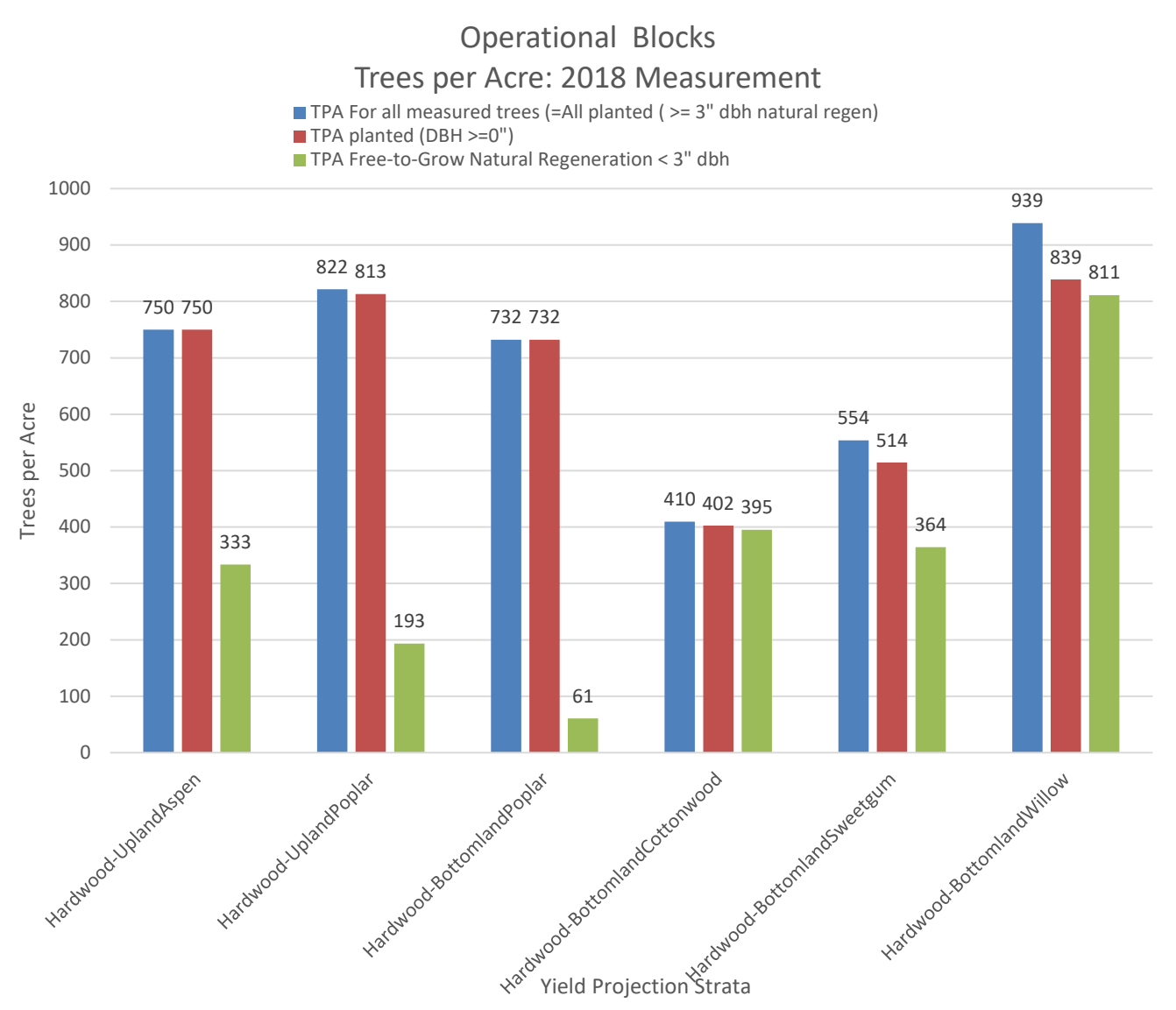


Figure 13. Basal area, average total height, and dominant height

Displays basal area and height metrics by species group and site type.

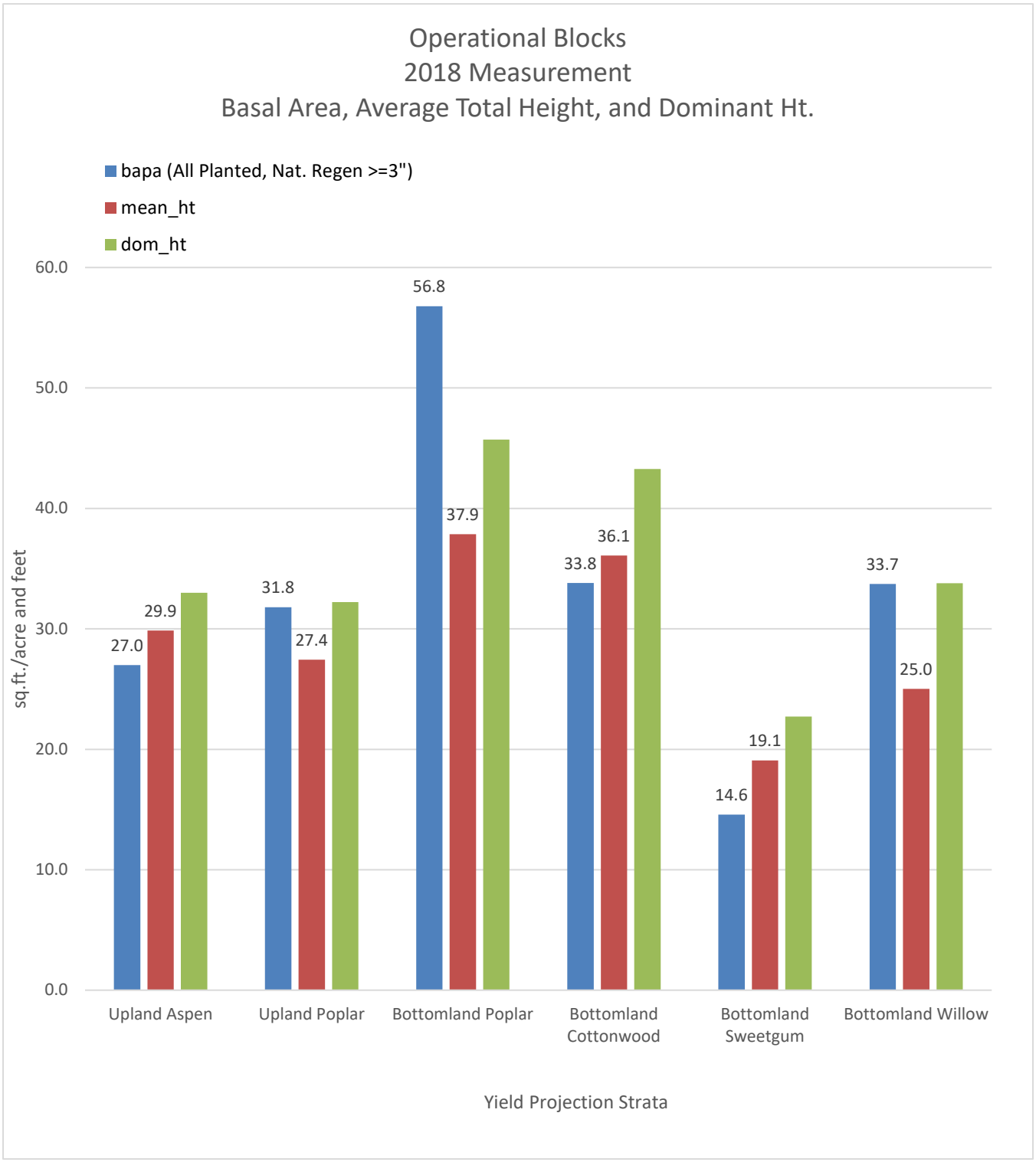


Figure 14. Green weight and dry weight biomass yields

Displays tons per acre both green and dry by species group and site type.

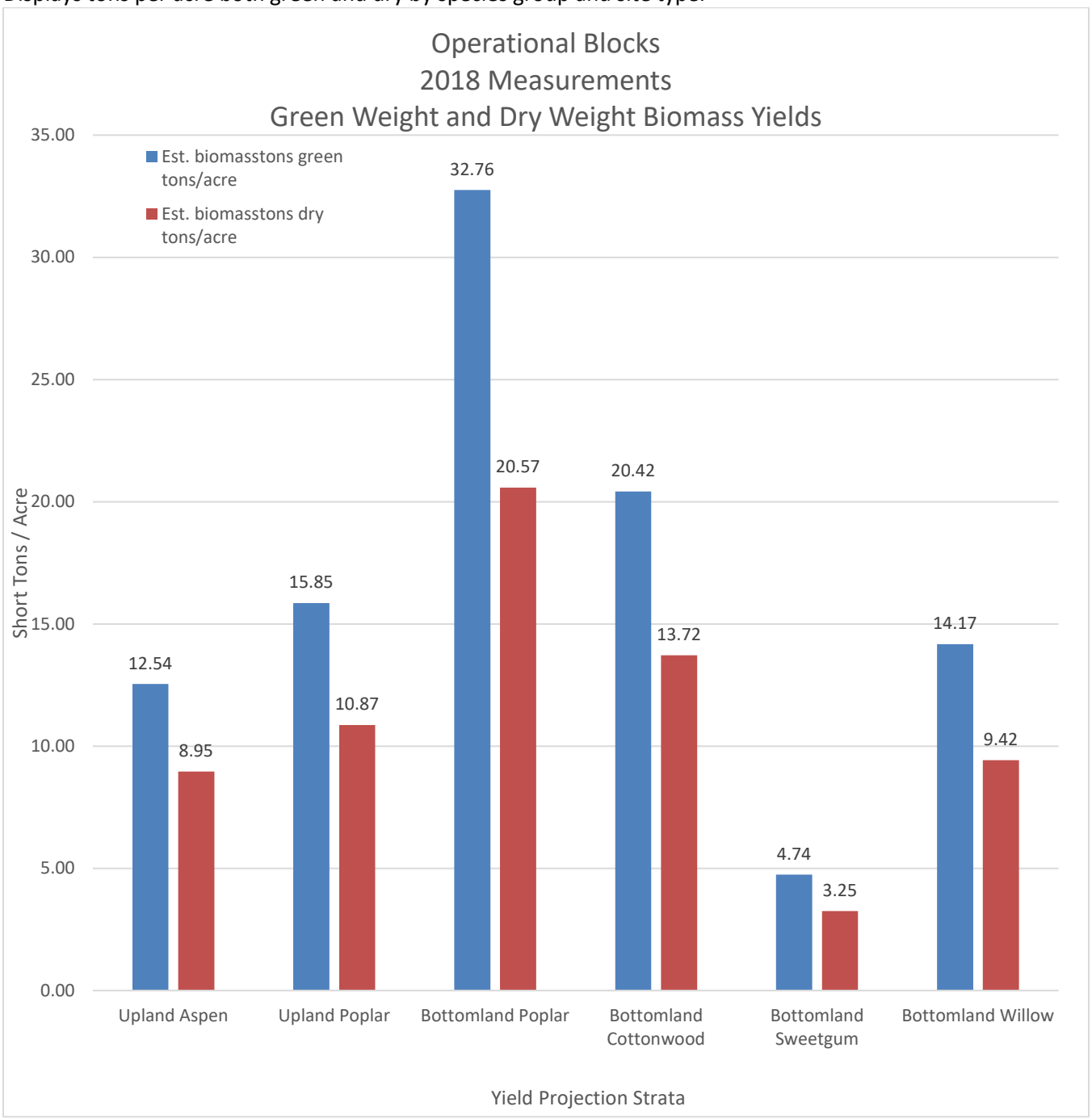


Figure 15. Green weight change in values from 2015 measurement

Displays the change in biomass green weights since the 2015 inventory.

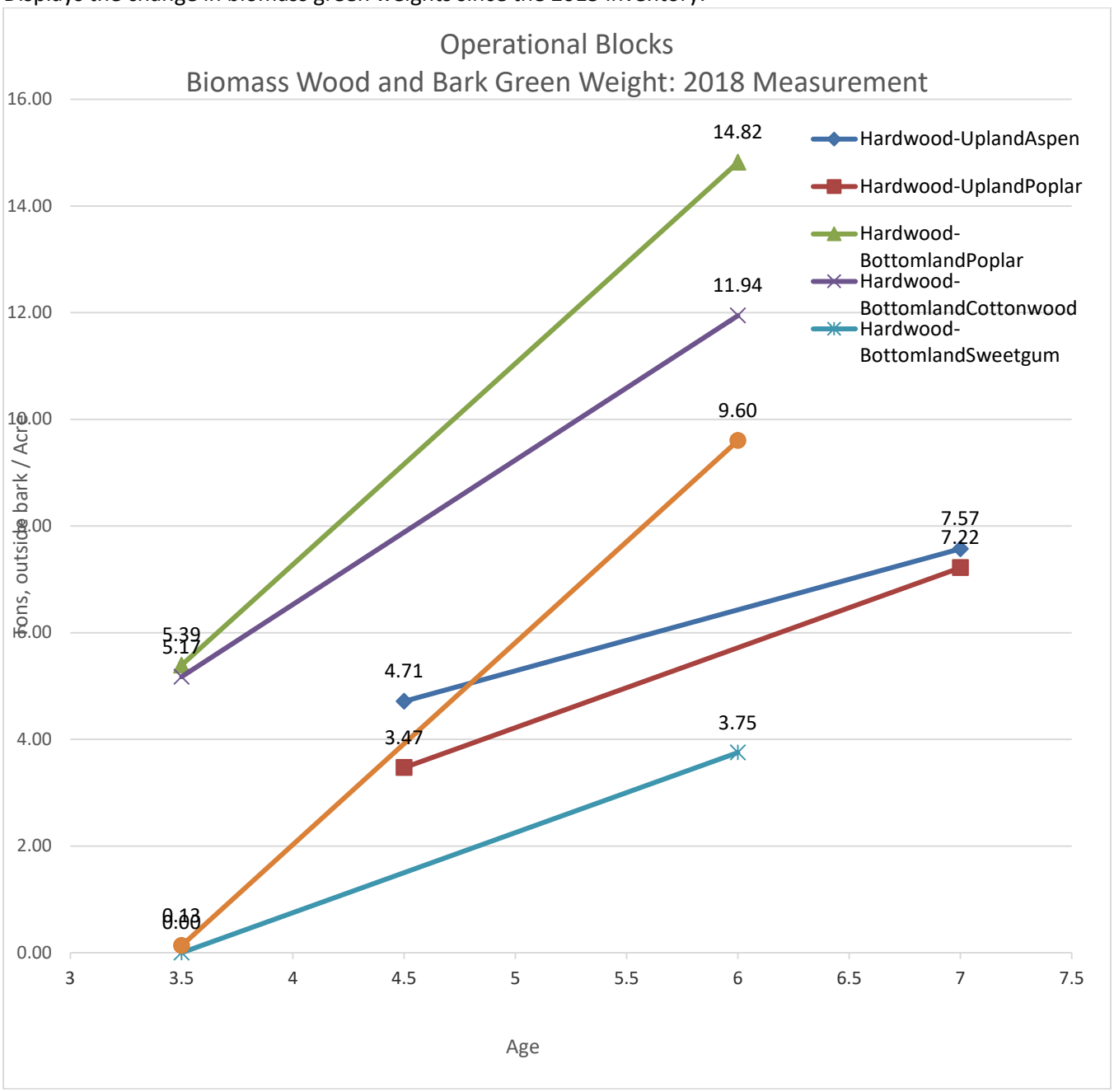


Figure 16. Dry weight change in values from 2015 measurement

Displays the change in biomass dry weights since the 2015 inventory.

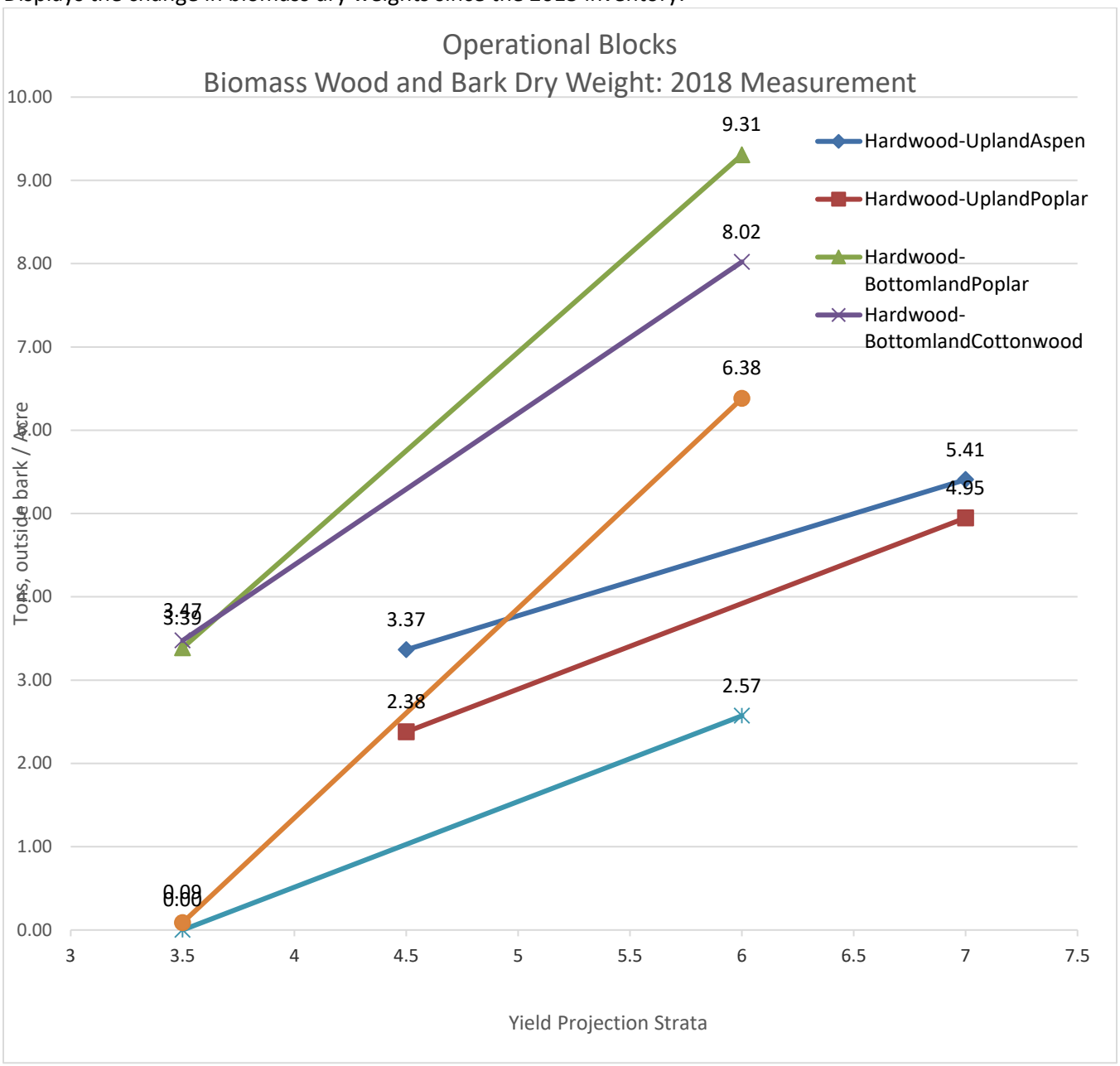


Figure 17. Projected cottonwood dry weight outside bark

Displays the dry weight projected yields for cottonwood through age 10 for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and revised projections based on actual growth observed between 2015 and 2018.

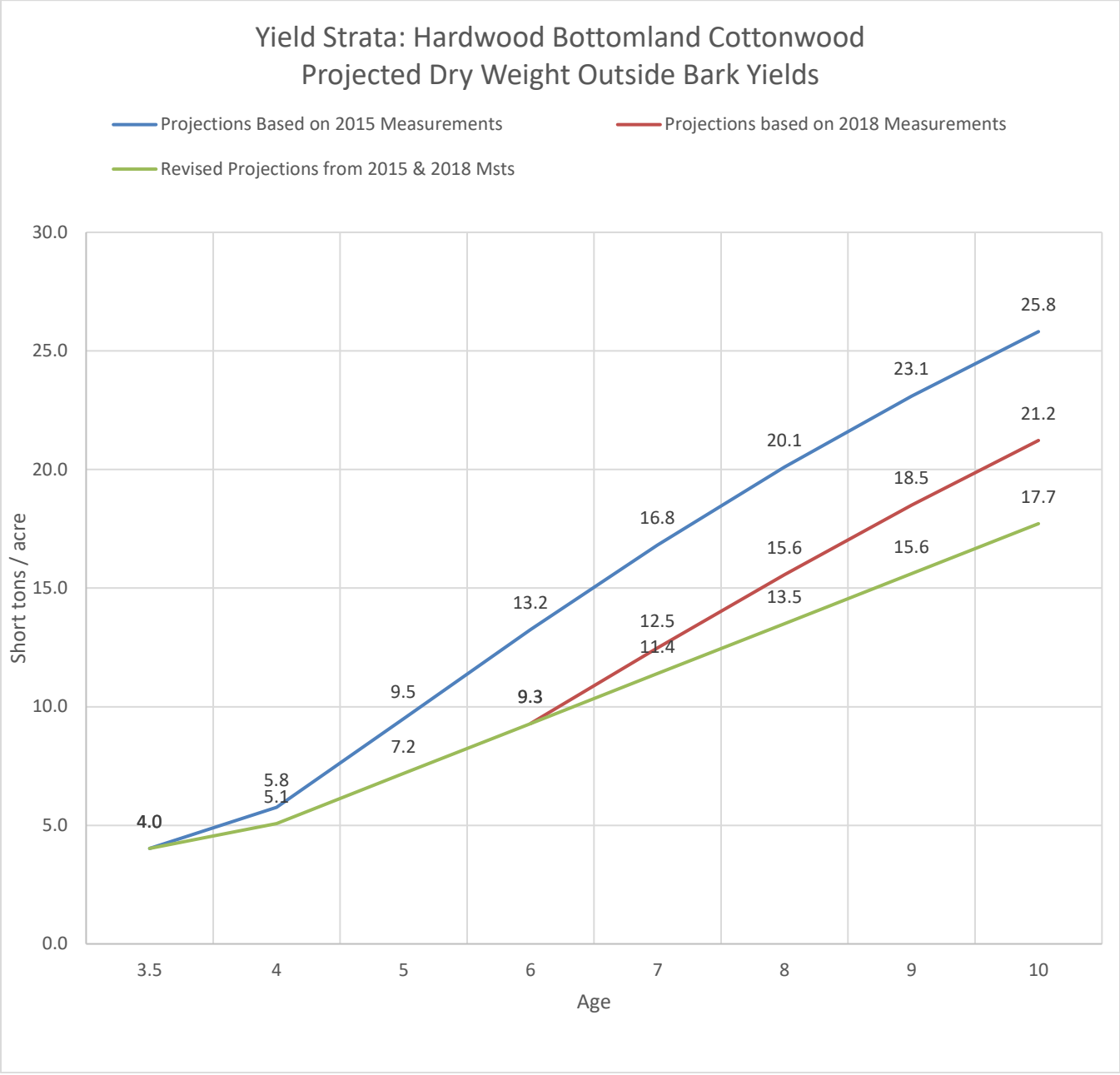


Figure 18. Projected cottonwood dry weight outside bark mean annual increment

Displays the projected dry weight MAI through age 10 for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and revised projections based on actual growth observed between 2015 and 2018.

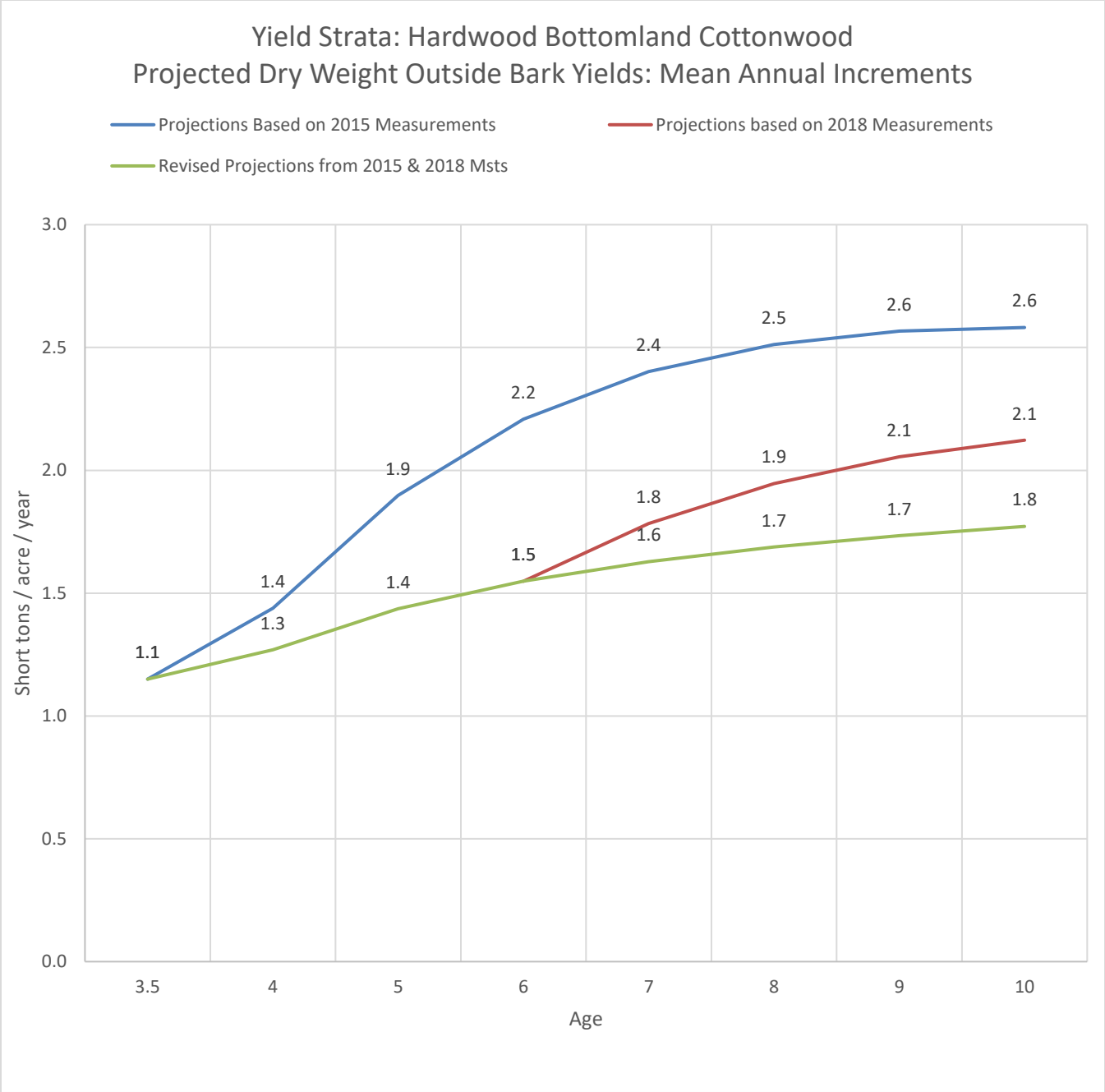


Figure 19. Projected cottonwood green weight outside bark

Displays the green weight projected yields for cottonwood through age 10 for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and revised projections based on actual growth observed between 2015 and 2018.

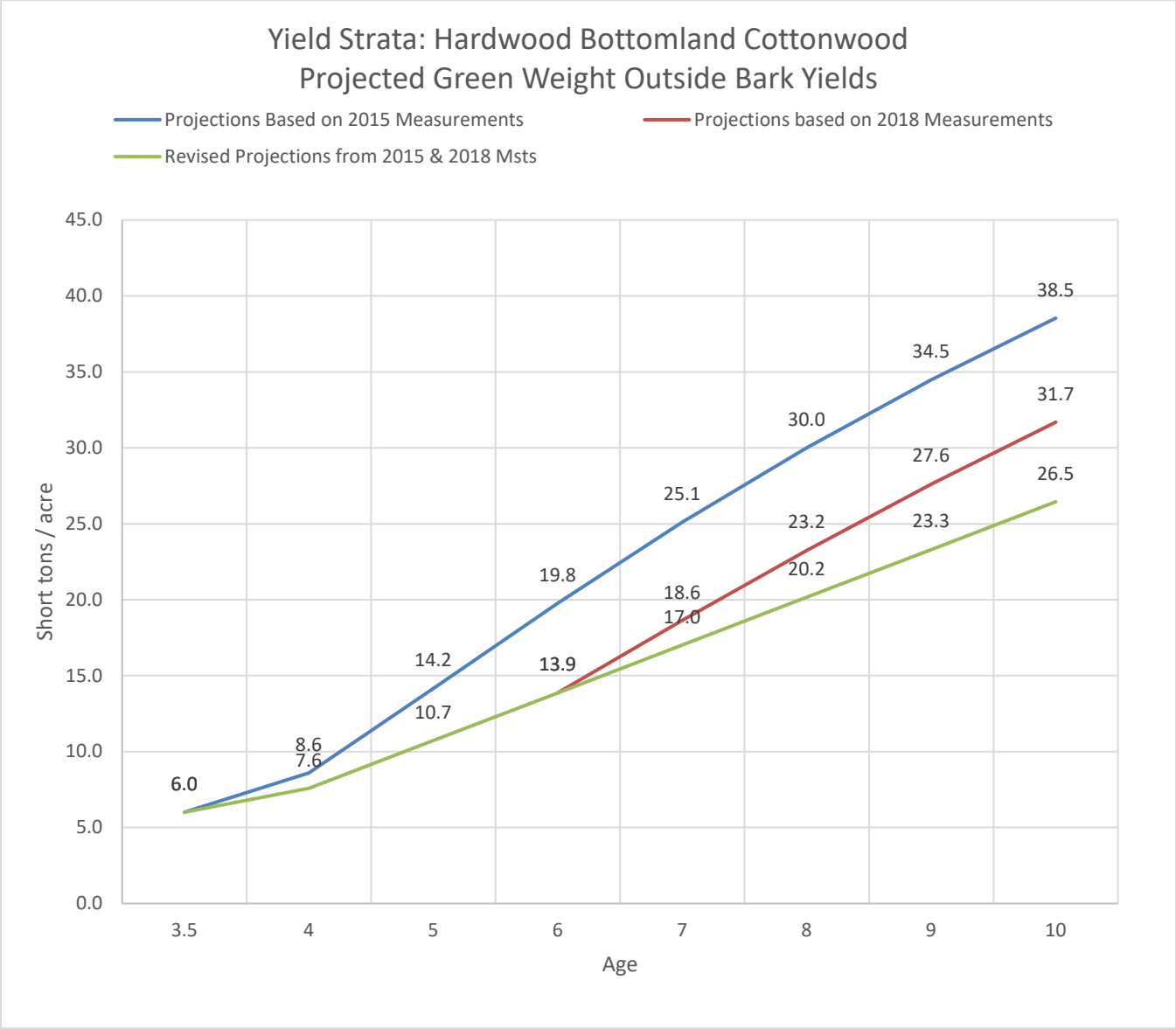
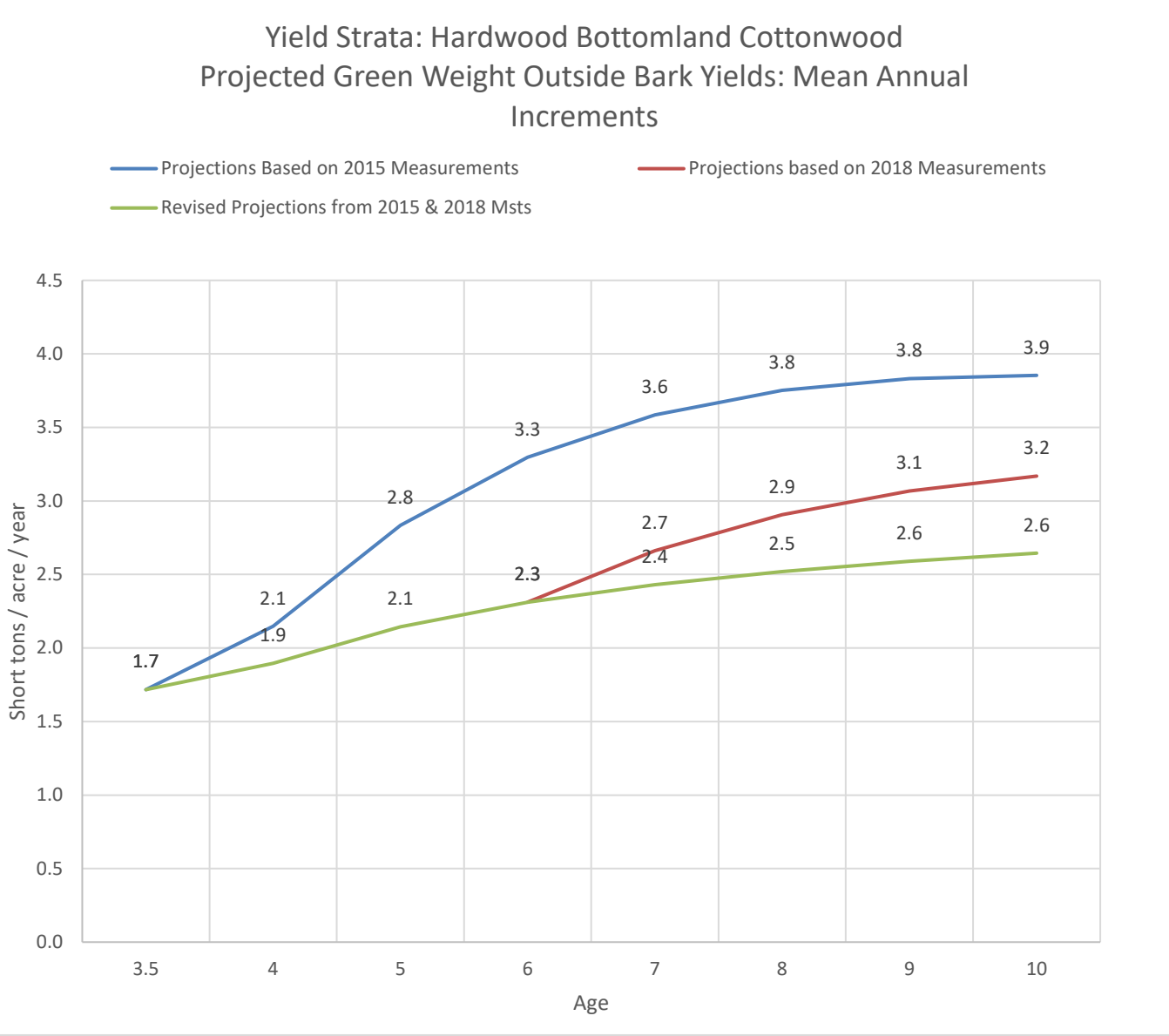


Figure 20. Projected cottonwood green weight outside bark mean annual increment

Displays the projected green weight MAI through age 10 for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and revised projections based on actual growth observed between 2015 and 2018.



Analysis and Conclusions

Data analysis was restricted to biometrics only; no specific economic analyses were performed. Final conclusions and operational recommendations should consider seedling costs, establishment and maintenance cost differences over multiple rotations, and operational factors, not the least of which is harvesting cost.

Loblolly Nelder

While the primary purpose of a Nelder plot is to investigate the effects of tree spacing on growth, the SC8 Nelder implementation also allowed investigation of growth difference between 6 different genotypes.

Height and Diameter by Genotype

While the AG Varietal Container expressed the tallest height (35.50') and the AG MCP Container expressed the shortest height (32.12'), there was no significant difference in height growth across all genotypes. Furthermore, tree age was young enough (7.5 years) that long-term height growth potential between genotypes may not have had time to be fully expressed.

Similarly, DBH variation across genotypes expressed no significant difference; while the CF Varietal Container had the largest DBH (3.94") and CF VarietalQ Container had the smallest (3.40"), observed variation cannot be definitively attributed to genotype at this young age.

Stocking by Genotype

Stocking, a function of trees per acre (TPA) and basal area per hectare (which is additionally based on tree diameter), also expressed no significant differences among genotypes. One interesting observation, however, was that the genotype with the lowest TPA, CF VarietalL Container, did not have the lowest basal area; indicating that this genotype was able to efficiently capture the increased growing room per tree in accelerated diameter growth.

Tree Weight by Genotype

Four weight metrics were examined for each genotype: entire tree (main stem, limbs, needles) dry weight, merchantable (main stem of trees greater than 5" DBH) green weight, main stem (all trees, regardless of DBH) green weight, and entire tree green weight.

AG 2ndGen Container expressed the highest values for weight measurements across all measurement categories. With the exception of merchantable green weight, ranking between genotypes remained constant for all weight categories (the AG Varietal Container genotype expressed the highest merchantable weight).

Tree Weight by Tree Quality

All Nelder plot trees were evaluated for their future timber quality suitability. Categories included 1 - always pulpwood, 2 - potential sawtimber, and 3 - definite sawtimber. These measurements can assist in determining the best genotype to select for crops where there may be a future timber (as opposed to biomass) management regime conversion. The measured value was total green weight.

The AG 2ndGen Container expressed the highest value across all quality categories. This genotype maintained its top rank for quality 3, was ranked a very close second for quality 2, but fell to rank 4 for quality 1 (the WY 2ndGen Bareroot took top ranking for quality 1 trees).

Weight by Trees per Acre

Four weight metrics were examined for all genotypes combined across the range of trees per acre: main stem green weight, entire tree green weight, merchantable stem green weight, and entire tree dry weight.

As expected main stem green weight, entire tree green weight, and entire tree dry weight increased more or less linearly across the range of 39 TPA at the Nelder rim to 1,349 TPA at the core. Merchantable stem weight, however, decreased to zero from 39 TPA to roughly 300 TPA, then appeared again and started increasing around 700 TPA, peaked around 1,100 TPA, and again fell to zero around 1,400 TPA. This effect for merchantable stems can be attributed to trees being too small to qualify for merchantability at stocking levels of 300-700 TPA from inter-tree competition at age 7.5.

As stocking levels increase above 700 TPA the sheet number of trees provides for at least a few to be of merchantable size, but this effect peaks at extremely high densities (above 1,100 TPA) again due to inter-tree competition. Low densities (below 300 TPA) provide sufficient growing room for many trees to reach merchantable size, but the low numbers of overall trees at these reduced stocking levels limits total merchantable stem availability.

Weight by Seedling Type and Trees per Acre

Seedlings were combined into four different categories (varietal container, orchard-mix container, orchard mix bareroot, and mass-control pollinated container) based on production method and genetic lineage to investigate weight production across the range of planting densities.

All categories expressed more or less linear response to planting density; the more trees planted per acre, the higher the yield. Orchard-mix container trees expressed the largest values and orchard-mix bareroot the smallest. The mass-control pollinated trees exhibited the greatest change as planting density increased, moving from the lowest weight values at low densities to nearly as high as the orchard-mix container trees at high densities. Rankings of the other seedling categories were unchanged across the range of planting densities.

Basal Area and Tree Quality by Planting Density

Both overall basal area per acre and quality 3 (definite sawtimber) basal area was evaluated as growing space per tree (the inverse of trees per acre) changed. As growing space per tree increased both overall basal area and quality 3 basal area decreased (fewer trees available at wider spacings to provide basal area). At lower densities (more growing room per tree), however, quality 3 tree basal area decreased more rapidly than overall basal area; the result of inter-tree effects on tree form (widely spaced trees retain limbs longer and grow with more taper than closely spaced trees).

Tree Metrics by Growing Space per Tree

Changes to basal area per acre, DBH, dominant height, and average height as growing space increased was examined. As seen previously, basal area per acre decreased as growing space per tree increased. DBH increased roughly 100% from high density to low density stocking, while dominant height and average height remained relatively constant. These observations compare well with the concepts that height growth is relatively unaffected by stand density while diameter growth is significantly affected by stand density.

Tree Quality by Growing Space per Tree

The final metric analyzed was how tree quality changes as growing space per tree increases. Numbers of quality 1 (pulpwood only) and 2 (potential sawtimber) trees both started at about 150 TPA at high stand densities, decreased dramatically early in the curve, and flattened out and remained more or less constant through the lowest stand densities. As previously seen quality 3 trees followed the same general trend but with much higher numbers in where growing room was low and a much more dramatic fall-off as growing room increased.

Conclusions

The Nelder plot is an extremely effective tool in evaluating the effects of stand density on tree growth and somewhat less effective on evaluating differences between different genotypes, at least at young stand ages.

Considering only stand density, volume production increases in an essentially linear fashion as stand density increases. The implication is that, for biomass production, higher stand densities for short-rotation loblolly crops will yield significantly higher tonnages. We believe there will be a point of diminishing returns if economic factors (seedling and labor cost) are considered, and while an economic analysis was not performed this point will probably be reached between 800 and 1,000 trees per acre.

Considering only genotype, it is clear that expensive seedlings (containerized and/or varietal) do not perform at a level that justifies their cost in biomass crops and the more economical bareroot seedlings should be selected for such crops.

Planted Loblolly Pine

Two plantation spacings were chosen to investigate the effects of planting density on short-rotation loblolly pine growth for a single genotype (007056.LD); 1082 trees per acre and 1452 trees per acre. 146.7 acres were planted at the 1082 density and 142.6 acres were planted at the 1452 density.

Greenweight Mean Annual Increment

Green weight MAI (average growth per year) was projected for both spacings for the next 10 years, using as growth and yield model input both empirical (M) measurements at age 8 and Nelder-adjusted (N) data.

1082 (M) MAI starts out lower than 1452 (M) MAI at age 8 and continues to remain below 1452 (M) values through age 18. The curves for both planting densities parallel each other over the period (i.e. no significant relative change to each other).

Using Nelder-adjusted inputs, the 1452 (N) MAI curve again starts out above the 1082 (N) curve, but their positions are revered around age 11. From that point onward the 1082 (N) curve surpasses the 1452 (N) curve, and increases slightly relative to the 1452 (N) curve over the period.

Overall, the 1452 (M) data set had the highest MAI across the period.

Dryweight Mean Annual Increment

Dry weight MAI was also projected for both spacings and both data sets (measured and Nelder) for a 10 year period.

1082 (M) MAI starts out and remains below 1452 (M) MAI at all ages. 1082 (N) starts out below 1452 (N) MAI, but it surpasses the 1452 (N) projection around age 11 and increases at a slightly increasing rate over the 1452 (N) curve through age 18.

Considering both M and N model inputs, the 1452 (M) data once again remains the highest MAI across the period.

Projected Biomass Yields

Biomass yield projections assumed that no thinnings would occur and the entire stand would be harvested for biomass at some age at or before 16 years. Four metrics associated with har4evst were projected: green weight, bark-only dry weight, wood-only dry weight, and wood and bark dry weight.

The 1082 (M) projection yields fewer green tons per acre than the 1452 (M) projection at every age. Using Nelder-adjusted data, however, the 1082 (N) yields more green tons per acre at each age.

This relationship between the 1082 and 1452 planting densities (and M and N data sets) hold true for all weight measurements, wood and bark separate or combined.

Timber Conversion Projections

Thought was given the possibility that a loblolly pine biomass crop may be converted to a traditional timber management regime. Reasons for possible conversion are many; they include changing value of biomass markets, changing ownership objectives, or regulatory or taxation changes that affect a producers overall position in the marketplace.

Conversion of a biomass regime to a timber regime was modelled through thinning the biomass crop to a timber regime density at first thin, and then continuing as if it had been established as a timber regime. Two scenarios were modelled; thinning at ages 14 and 22 with a final harvest at age 30, and thinning at ages 16 and 25 with a final harvest at age 32.

Both plantation densities (1082 and 1452) and data sets (M and N) were evaluated.

Using the M data model input and the 14/22/30 scenario, the 1082 planting density produced fewer tons than the 1452 density, both overall and on a product-level basis. This same relationship held true for the N data input, except that the 1082 density produced slightly more topwood than the 1452 density. All M yields were lower than the corresponding N yields with the exception of topwood; in that product class the M yields were somewhat higher than the N yields.

Using the M data model input and the 16/25/32 scenario, the 1082 planting density again produced fewer tons than the 1452 density, both overall and in every product class. This same relationship held true for the N data input for pulpwood; however the 1082 yield surpassed the 1452 yield in every other product class.

Comparing the 14/22/30 scenario to the 16/25/32 scenario, the 1082 planting density produces fewer total tons than the 1452 planting density for the M data set, but produces more tons for the N data set.

Conclusions

Considering that projections for the M data set produce different results than the N data set, any conclusions drawn from the planted pine analysis may be subject to some dispute. However, we believe that the N data set more accurately reflects what would be observed in additional trials, and therefore it is appropriate to use that data set to develop conclusions. The reader is cautioned that this analysis does not factor in the relative establishment costs or economic value of different timber products, and only considers the ability of each planting density to produce wood.

Recommended planting density for biomass crops will depend to a large degree on planned harvest age. For rotations less than 11 years the projections suggest that a planting density of 1452 trees per acre will generate higher yields; rotations longer than 11 years would see some benefit to planting at the lower 1082 density. Recommended planting density for a potential timber regime conversion favors the 1082 planting density and the 14/22/30 management regime scenario.

In summary, the only time one might consider planting to the 1452 density is when the expected harvest age is less than 11 years and the possibility of adopting a timber regime is low. In all other instances maximum yield will be gained by planting to 1082 trees per acre.

Planted Hardwood

Hardwood plantations containing cottonwood, hybrid poplar, aspen, sweetgum, and black willow were established on both upland and bottomland sites. The upland sites were planted in 2011 and the bottomland sites were planted in 2012. 2015 and 2018 field measurements were analyzed for stand density, biomass yields, and change in growth from 2015 to 2018. In addition yields for the cottonwood group were projected out to age 10.

Basal Area, Average Height, Dominant Height

Of the 6 species/site groups, highest basal area, average height, and dominant height values were observed in bottomland poplar. On upland sites poplar had a higher basal area but lower average and total heights than aspen. The lowest values were found in bottomland sweetgum; its basal area was roughly 25% of poplar and heights were roughly 50% of those observed for poplar.

Comparing upland and bottomland poplar, the upland site had about half the basal area and 75% of the height of the bottomland site.

Green and Dry Weight Yields

Following the trend established by tree metrics, highest yields (green and dry) were observed with bottomland poplar. Considering upland vs. bottomland sites, poplar again had the highest green and dry yields. The worst producer was again bottomland sweetgum; its yield was roughly 14% of the poplar yield.

Comparing upland and bottomland poplar; the upland site produced roughly half what the bottomland site produced.

Yield Changes from 2015 to 2018

For both green and dry weights, bottomland poplar once again ranked first. Bottomland cottonwood was a close second, followed by upland aspen, upland poplar, and sweetgum. Black willow and sweetgum had similar yields in 2015. However, the biomass growth rate in the black willow block was significantly greater than all of the other blocks suggesting that in the next several years black willow biomass may equal that in the cottonwood and hybrid poplar blocks.

Cottonwood Green and Dry Weight Projections

Yield projections through age 10 were prepared for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and a revised projection based on actual growth from between 2015 and 2018.

The 2015 initial data had the highest projected yields for both green and dry material at all ages, followed by the projections based on the 2018 measurement. The revised projection using the actual 2015 and 2018 growth rate is lower. Projected yield increases (dry and green) between age 6 and 10 were 95% for the 2015 data, 127% for the 2018 data, and 90% for the revised data. The lower projections from both the 2018 measurement and the revised projections can be partly explained by "operational fall down" meaning that projection models are often based on experimental plots under tightly controlled conditions.

Cottonwood Green and Dry MAI Projections

MAI projections through age 10 were prepared for two initial data points and two projection methods: 2015 inventory data, 2018 inventory data, and a revised projection based on actual growth from between 2015 and 2018.

The 2015 initial data had the highest MAI for both green and dry material at all ages, followed by the 2018 initial data and finally the revised data based on actual growth. Projected MAI increases (dry and green) between age 6 and 10 were 18% for the 2015 data, 39% for the 2018 data, and 13% for the revised data. MAI increase gradually levels off as tree age approaches 10 years; most pronounced for the 2015 data, somewhat less for the 2018 data, and then returning to the 2015 trend for the revised data.

Conclusions

The data clearly shows that hybrid poplar, planted on bottomland sites, is the best biomass producer. Second best is bottomland cottonwood (roughly 60% of poplar production). Poplar is also the tree of choice to plant on upland sites for biomass production, but upland poplar only produces about half what bottomland poplar can produce (and 75% of bottomland cottonwood production).

Given the high establishment costs for hardwood plantations in general, and biomass crops in particular, planting anything other than hybrid poplar or cottonwood on bottomland sites is not recommended.

Future Management

2018 marks the end of the SC8 biomass project in its current form. A great deal of time, effort, and expense has gone into establishing and managing this project, and maintaining the study sites for potential future evaluation will take a minimum of time and expense.

Loblolly Nelder

Long-term maintenance will only require periodic (2-3 times per year) qualitative inspections to observe tree health and site integrity. The area should be protected from harvesting activities in adjacent stands at all times (a protective buffer of 1-1.5 times the adjacent tree heights is suggested).

Consideration should be given to an additional formal inventory in 2021 to determine if any additional differentiation between genotypes has occurred and to verify and calibrate the growth and yield models for projecting future yields.

Planted Loblolly Pine

With significant acreages in both planting densities, a reduced study site size is suggested to maintain the viability of potential future measurements. 10 acres in each of the planting densities could be retained and the remaining acreage converted to a traditional timber regime. Conversion of the majority of each density to a timber regime will simplify overall tract management and provide an enhanced revenue stream with more acres being available for timber production.

In the event fuelwood markets improve and contractors become available, consideration should be given to fuelwood harvest of half the retained study sites to obtain empirical biomass yields. Empirical data could then be compared to modelled yields with an eye towards improving models for high-density, short rotation loblolly biomass crops.

Consideration should be given to an additional formal inventory in 2021 to determine if any additional differentiation between planting densities has occurred.

Planted Hardwood

As with the Nelder plot, long-term maintenance will only require periodic (2-3 times per year) qualitative inspections to observe tree health and site integrity. The areas should be protected from harvesting activities in adjacent stands at all times (a minimal protective buffer of 15-20 feet is suggested).

In the event fuelwood markets improve and contractors become available, consideration should be given to fuelwood harvest of half the study sites to obtain empirical biomass yields. Empirical data could then be compared to modelled yields with an eye towards improving models for upland and bottomland hardwood biomass crops. Furthermore, the harvest would provide an opportunity to investigate natural regeneration associated with coppice and root suckering and comparative yields in future rotations.

Consideration should be given to an additional formal inventory in 2021 to investigate yields at age 10 (upland plantings) and age 9 (bottomland plantings).

Appendix 1 – Job Control Specifications, SC8 2018 Biomass Inventory

Job Control Specifications
SC8 2018 Biomass Inventory

Hardwood Plantations

Plot Size & Layout

Fixed radius plots (1/50th acre, 16.65' radius) will be used to measure sample trees in upland and bottomland hardwood plantations. Plots will be located on tract maps by AFM staff prior to starting fieldwork. Plot location data files suitable for Garmin GPS units or field computers with Solo software will be provided

Marking Sample Plots

The center of each plot was previously located during the 2015 inventory and should be marked with a white PVC stake. Plot centers will be re-established/marked as needed by ensuring the PVC stake is in place and hanging flagging at eye level near plot center. The plot number and cruiser initials will be marked on the flag at plot center. These will continue to be permanent sample plots. Tally will start with the first **planted** tree to the north and continue clockwise; this tree will also be flagged.

Tree Measurements

The following characteristics will be recorded for each planted hardwood lying within the plot:

- Species: From the stand lister on cruise maps
- Genotype: From the stand lister on cruise maps
- Diameter: DBH to nearest tenth of an inch. Use of calipers instead of a D-tape is recommended. For planted hardwoods not yet having DBH ground-line diameter (GLD) will be recorded instead of DBH (GLD values will be recorded in the GLD column on tally sheets).
- Height: Total height to nearest foot

Number of competing, free-to-grow (FTG) natural trees found on sample plots will be recorded by:

- Species (will generally be a pine species, cottonwood, sweetgum, or red maple but other species may be present). Species codes include:
    - A: Ash
    - Asp: Aspen
    - C: Cottonwood
    - P: Poplar (any *Populus* species)
    - Pn: Pine (any *Pinus* species)
    - Rm: Red maple
    - S: Sweetgum
    - Syc: Sycamore
    - Yp: Yellow-poplar
    - Additional species can be added if needed so long as their identifier is uniform across all plots.
- Number occurring on the sample plot. No more than 25 individuals of a particular species will be recorded
- FTG is defined as being in the general level of the canopy as planted trees. For gaps or holes in the planted canopy FTG trees are those wherein a +/- 30-degree cone extending from the terminal bud of the natural tree does not intersect the out canopy edge of planted trees. Use your judgement; in certain situations trees not meeting the exact FTG spec may be tallied. The goal is to provide an indication of natural trees that will survive, thrive, and present potential competitive pressures on planted trees.

Tally sheets have been provided. Plot level data (Block ID, Plot #) is not required for each tree but only once per plot. Block IDs and plot numbers are preassigned and must be entered as indicated on cruise maps.

Loblolly Nelder (Refer to attached Pine Nelder Detail Map)

Each tree within the Nelder plot has been pre-identified via the attached schematic; that naming convention will be used for identifying sample trees. Data to be collected includes:

- Section Identifier: per the attached schematic
- Row Identifier: per the attached schematic
- Tree Identifier: per the attached schematic
- DBH: nearest tenth of an inch for every tree
- Height: total height to nearest foot for tree numbers 2, 5, 8, and 11 within each row. If the designated tree is dead (no longer present) then the next-higher tree number will be measured.

A sample tally sheet has been attached.

OVERVIEW MAP
SC8 Biomass Project

AMERICAN FOREST MANAGEMENT
americanforestmanagement.com
(804) 516-2194
fred.schatzki@afmforest.com

OWNER: TBP Properties, LLC
COUNTY: Chester
DATE: January 9, 2018
PREPARED BY: Fred Schatzki, RF #1371
Mercator
1":1,650' (1:19,800) or 1" = 25 Chains
81°19'56" W:34°38'25" N

N
S

Sandy River
Sandy River
Sandy River Rd
Carter Rd
State Hwy 72
W End Rd
SC 72
Stone Rd

Description	Est_Yr	GISAcres
Hardwood-Bottomland 1	2012	23.52
Hardwood-Bottomland 2	2012	21.53
Hardwood-Upland	2011	16.21
Loblolly @ 1,082	2011	146.62
Loblolly @ 1,452	2011	142.57
Loblolly-Natural	2006	79.29
Loblolly-Nelder	2011	1.25

0 1650 ft

LEGEND

Biomass Overview
- Hardwood-Bottomland 1
- Hardwood-Bottomland 2
- Hardwood-Upland
- Loblolly @ 1,082
- Loblolly @ 1,452
- Loblolly-Natural
- Loblolly-Nelder

Boundary
- Property

Transportation
- Highways
- Streets
- Woods Road
- Railroad

Hydrography
- Perennial/Intermittent
- Ephemeral

CRUISE MAP
SC8 Bottomland Hardwood 1

AMERICAN FOREST MANAGEMENT
americanforestmanagement.com
(804) 516-2194
fred.schatzki@afmforest.com

OWNER: TBP Properties, LLC
COUNTY: Chester
DATE: January 9, 2018
PREPARED BY: Fred Schatzki, RF #1371
State Plane - South Carolina
(NAD 83, feet)
1 in : 200 ft/1:2400
81°20'37" W:34°38'32" N

N
S

59683
59682
59681
59701
59697
59695
59696
59699
59698
59700
59702
59693
59689
59684

ID	Description	Species	Genotype	Spacing	Producer	Est_Yr	GISAcres
59681	Hardwood-Bottomland	Sweetgum	10-151	4x	ArborGen	2012	6.24
59682	Hardwood-Bottomland	Sweetgum	10-313	8x	ArborGen	2012	0.66
59683	Hardwood-Bottomland	Sweetgum	10-151	8x	ArborGen	2012	0.73
59684	Hardwood-Bottomland	Sweetgum	10-313	3x	ArborGen	2012	1.83
59689	Hardwood-Bottomland	Sweetgum	10-151	3x	ArborGen	2012	2.78
59693	Hardwood-Bottomland	Willow	S.nigra	4x	TN Nursery	2012	2.95
59695	Hardwood-Bottomland	Poplar	Populus Rep 1	7x	ArborGen	2012	0.96
59696	Hardwood-Bottomland	Aspen	Aspen	7x	ArborGen	2012	1.08
59697	Hardwood-Bottomland	Willow	S.nigra	8x	TN Nursery	2012	1.44
59698	Hardwood-Bottomland	Sweetgum	55-12	5x	ArborGen	2012	0.06
59699	Hardwood-Bottomland	Poplar	Populus Rep 2	7x	ArborGen	2012	1.13
59700	Hardwood-Bottomland	Sweetgum	19-2	5x	ArborGen	2012	0.05
59701	Hardwood-Bottomland	Sweetgum	10-313	4x	ArborGen	2012	1.66
59702	Hardwood-Bottomland	Willow	S.nigra	3x	TN Nursery	2012	1.95

LEGEND

- 12345 — Block ID
- Sample Point
- **BiomassGROSS**
- Hardwood-Bottomland
- Hardwood-Upland
- Nelder
- Pine-Upland

0 200 ft US

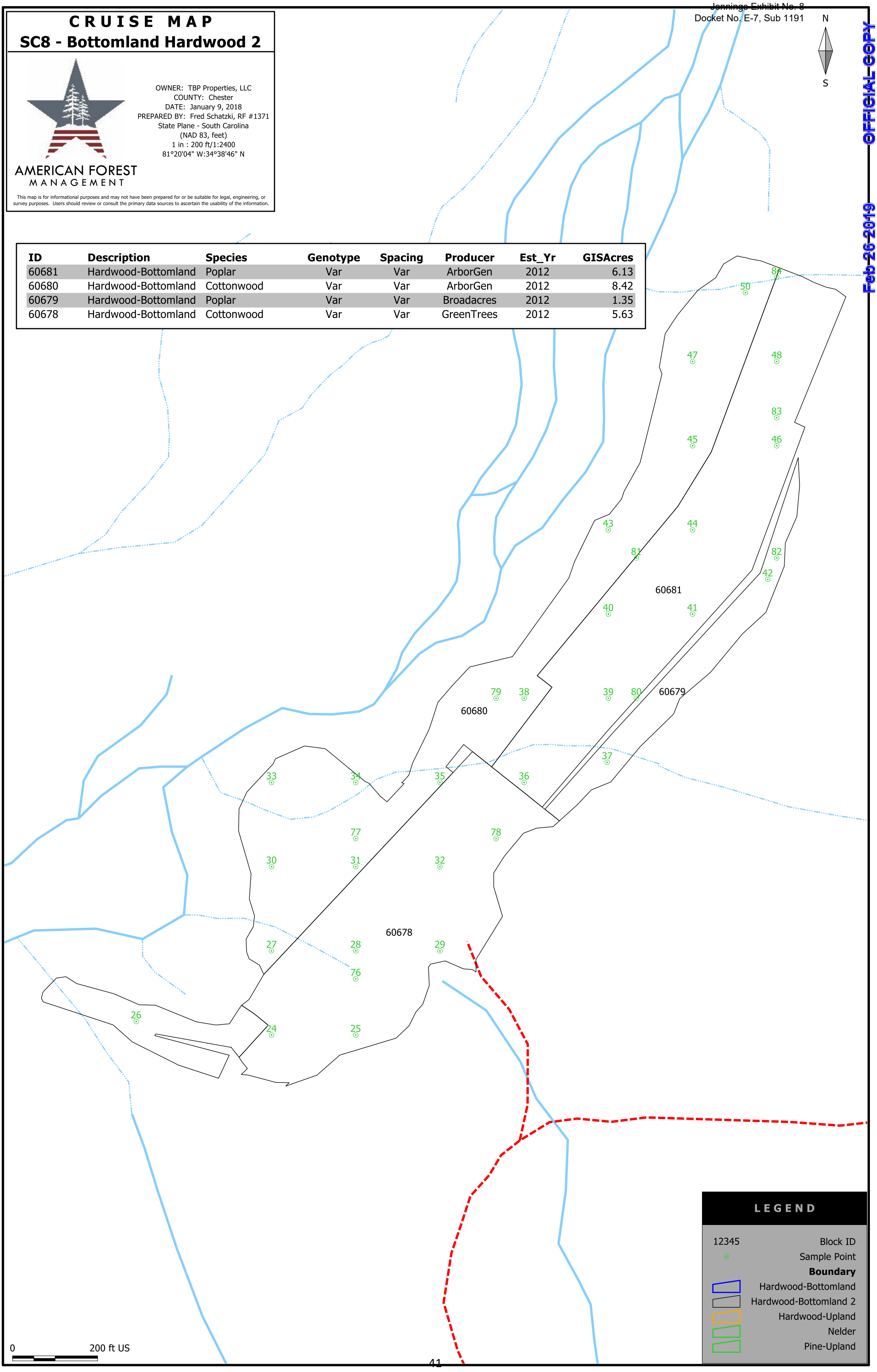
40

CRUISE MAP
SC8 - Bottomland Hardwood 2

AMERICAN FOREST MANAGEMENT

OWNER: TBP Properties, LLC
COUNTY: Chester
DATE: January 9, 2018
PREPARED BY: Fred Schatzki, RF #1371
State Plane - South Carolina
(NAD 83, feet)
1 in : 200 ft/1:2400
81°20'04" W:34°38'46" N

ID	Description	Species	Genotype	Spacing	Producer	Est_Yr	GISAcres
60681	Hardwood-Bottomland	Poplar	Var	Var	ArborGen	2012	6.13
60680	Hardwood-Bottomland	Cottonwood	Var	Var	ArborGen	2012	8.42
60679	Hardwood-Bottomland	Poplar	Var	Var	Broadacres	2012	1.35
60678	Hardwood-Bottomland	Cottonwood	Var	Var	GreenTrees	2012	5.63



LEGEND

12345 Block ID
Sample Point
Boundary
Hardwood-Bottomland
Hardwood-Bottomland 2
Hardwood-Upland
Nelder
Pine-Upland

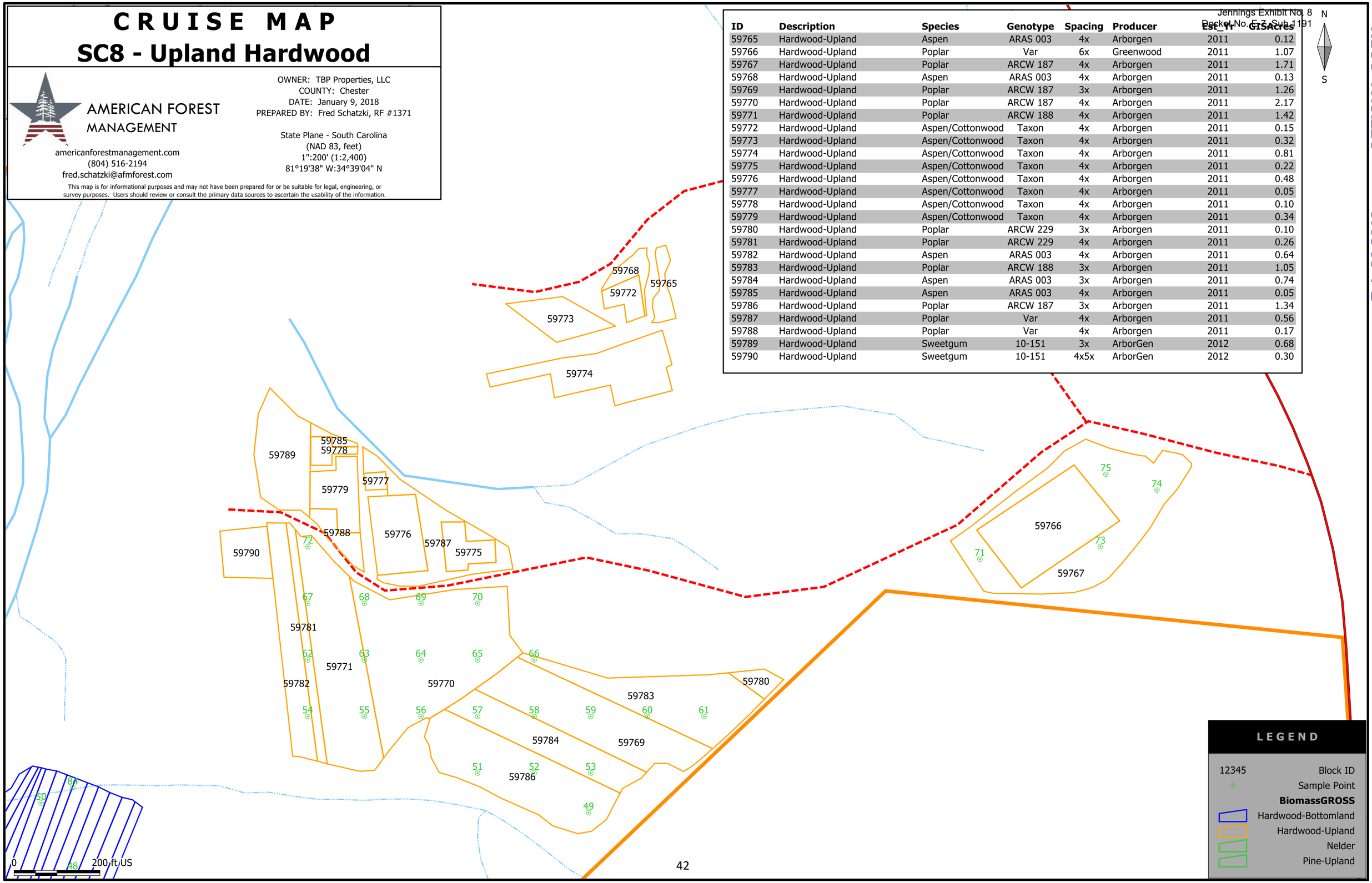
CRUISE MAP
SC8 - Upland Hardwood

AMERICAN FOREST MANAGEMENT
americanforestmanagement.com
(804) 516-2194
fred.schatzki@afmforest.com

OWNER: TBP Properties, LLC
COUNTY: Chester
DATE: January 9, 2018
PREPARED BY: Fred Schatzki, RF #1371

State Plane - South Carolina
(NAD 83, feet)
1":200' (1:2,400)
81°19'38" W:34°39'04" N

ID	Description	Species	Genotype	Spacing	Producer	Est_Yr	GISAcres
59765	Hardwood-Upland	Aspen	ARAS 003	4x	Arborgen	2011	0.12
59766	Hardwood-Upland	Poplar	Var	6x	Greenwood	2011	1.07
59767	Hardwood-Upland	Poplar	ARCW 187	4x	Arborgen	2011	1.71
59768	Hardwood-Upland	Aspen	ARAS 003	4x	Arborgen	2011	0.13
59769	Hardwood-Upland	Poplar	ARCW 187	3x	Arborgen	2011	1.26
59770	Hardwood-Upland	Poplar	ARCW 187	4x	Arborgen	2011	2.17
59771	Hardwood-Upland	Poplar	ARCW 188	4x	Arborgen	2011	1.42
59772	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.15
59773	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.32
59774	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.81
59775	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.22
59776	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.48
59777	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.05
59778	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.10
59779	Hardwood-Upland	Aspen/Cottonwood	Taxon	4x	Arborgen	2011	0.34
59780	Hardwood-Upland	Poplar	ARCW 229	3x	Arborgen	2011	0.10
59781	Hardwood-Upland	Poplar	ARCW 229	4x	Arborgen	2011	0.26
59782	Hardwood-Upland	Aspen	ARAS 003	4x	Arborgen	2011	0.64
59783	Hardwood-Upland	Poplar	ARCW 188	3x	Arborgen	2011	1.05
59784	Hardwood-Upland	Aspen	ARAS 003	3x	Arborgen	2011	0.74
59785	Hardwood-Upland	Aspen	ARAS 003	4x	Arborgen	2011	0.05
59786	Hardwood-Upland	Poplar	ARCW 187	3x	Arborgen	2011	1.34
59787	Hardwood-Upland	Poplar	Var	4x	Arborgen	2011	0.56
59788	Hardwood-Upland	Poplar	Var	4x	Arborgen	2011	0.17
59789	Hardwood-Upland	Sweetgum	10-151	3x	ArborGen	2012	0.68
59790	Hardwood-Upland	Sweetgum	10-151	4x5x	ArborGen	2012	0.30



SC8 2018 Biomass Inventory Tally Sheet

Cruiser ____________ Date ____________ Sheet____________ of ____________ Naturals only, max 25

Block ID	Plot #	Species	Genotype	DBH	GLD	Height	Count

PINE NELDER SITE
Scematic Map. Planted 2011

AMERICAN FOREST MANAGEMENT

OWNER: TBP Properties, LLC
COUNTY: Chester
DATE: January 9, 2018
PREPARED BY: Fred Schatzki, RF #1371
Mercator
1":50' (1:600)
81°20'35" W:34°37'52" N

americanforestmanagement.com
(804) 516-2194
fred.schatzki@afmforest.com

N

S

Section A
Orange
CELLFOR
L-3791 128L
Varietal #1
Containerized

Section B
Yellow
Arborgen
AG-88 LB-A02-09
Elite, 2nd Gen, OP
Containerized

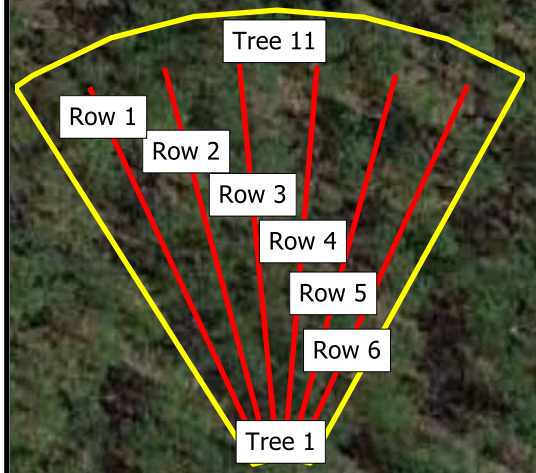
Section C
Blue
CELLFOR
Q-7766 128L
Varietal #2
Containerized

Section D
Red
Arborgen
AVG-102
Varietal #3
Containerized

Section E
White
WeyCo
007056.LD
2nd Gen OP
Bareroot

Section F
Pink
Arborgen
AGM-37 LB-SBI-09E
MCP
Containerized

WeyCo
007056.LD



Tree Naming/Identification Convention
Section (A-F)
Row (1-6)
Tree (1-11)
Ex. B-4-2 is second tree from center, fourth row, in Arborgen AG-88 plot.

SC8 2018 Nelder Tally Sheet

Cruiser _____ Date _____

Section	Row	Tree	DBH	Height		Section	Row	Tree	DBH	Height		Section	Row	Tree	DBH	Height
A	**1**	1				A	**2**	1				A	**3**	1		
A	**1**	2			*	A	**2**	2			*	A	**3**	2		
A	**1**	3				A	**2**	3				A	**3**	3		
A	**1**	4				A	**2**	4				A	**3**	4		
A	**1**	5			*	A	**2**	5			*	A	**3**	5		
A	**1**	6				A	**2**	6				A	**3**	6		
A	**1**	7				A	**2**	7				A	**3**	7		
A	**1**	8			*	A	**2**	8			*	A	**3**	8		
A	**1**	9				A	**2**	9				A	**3**	9		
A	**1**	10				A	**2**	10				A	**3**	10		
A	**1**	11			*	A	**2**	11			*	A	**3**	11		
A	**4**	1				A	**5**	1				A	**6**	1		
A	**4**	2			*	A	**5**	2			*	A	**6**	2		
A	**4**	3				A	**5**	3				A	**6**	3		
A	**4**	4				A	**5**	4				A	**6**	4		
A	**4**	5			*	A	**5**	5			*	A	**6**	5		
A	**4**	6				A	**5**	6				A	**6**	6		
A	**4**	7				A	**5**	7				A	**6**	7		
A	**4**	8			*	A	**5**	8			*	A	**6**	8		
A	**4**	9				A	**5**	9				A	**6**	9		
A	**4**	10				A	**5**	10				A	**6**	10		
A	**4**	11			*	A	**5**	11			*	A	**6**	11		

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606) 349-6145

Jennings Exhibit No. 9
Docket No. E-7, Sub 1191

Certificate of Analysis

COMPANY REQUESTING ANALYSIS:		
Duke Energy SC8 Biomass **400 S. Tryon St.** **Charlotte, NC 28202**	**Date Analyzed:**	7/20/2018
	Lab No.	18021716
	Sampled By/Type:	Customer

Sample ID: Mail In: Wood Bark: LB 756 BO: July 2018: Duke Energy SC8 Site: Chester, SC: 179.8 grams

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture (D3302/D3173)	26.74	
% Ash (D3174)	0.68	0.93
% Volatile (D3175)	xxxxx	xxxxx
% Fixed Carbon (Calculated)	xxxxx	xxxxx
B.T.U (D5865/D5864)	7075	9657
M.A.F.B.T.U. (Calculated)	9748	
% Sulfur (D4239)	0.04	0.06
SO_2 lbs./mm Btu	0.12	
Ash lbs./mm Btu	0.96	

ULTIMATE ANALYSIS (ASTM D5373)	As Received	Dry Basis
Moisture	26.74	
Carbon	40.23	54.92
Hydrogen	5.41	7.39
Nitrogen	0.24	0.33
Sulfur	0.04	0.06
Ash	0.68	0.93
Oxygen (diff.)	26.64	36.37

SULFUR FORMS (ASTM D2492)	As Received	Dry Basis
% Pyritic Sulfur	xxxxx	xxxxx
% Sulfate Sulfur	xxxxx	xxxxx
% Organic Sulfur	xxxxx	xxxxx
% Total Sulfur	xxxxx	xxxxx

MINERAL ANALYSIS (ASTM D4326)		% Wt. Ignited Basis
Silicon dioxide	SiO_2	xxxxx
Aluminum oxide	Al_2O_3	xxxxx
Titanium dioxide	TiO_2	xxxxx
Iron oxide	Fe_2O_3	xxxxx
Calcium oxide	CaO	xxxxx
Magnesium oxide	MgO	xxxxx
Potassium oxide	K_2O	xxxxx
Sodium oxide	Na_2O	xxxxx
Sulfur trioxide	SO_3	xxxxx
Phosphorus pentoxide	P_2O_5	xxxxx
Strontium oxide	SrO	xxxxx
Barium oxide	BaO	xxxxx
Manganese oxide	MnO	xxxxx
Undetermined		xxxxx

FUSION TEMPERATURE OF ASH (D1857)	Reducing (°F)	Oxidizing (°F)
Initial Temp.	xxxxx	xxxxx
Softening Temp. H=W	xxxxx	xxxxx
Hemispherical Temp. H=1/2 W	xxxxx	xxxxx
Fluid Temp	xxxxx	xxxxx

T-250 Temp. of Ash	xxxxx

Base/Acid Ratio	xxxxx
Fouling Factor	xxxxx
Slagging Factor	xxxxx

WATER SOLUBLE ALKALIES (Reported in %)	
CaO	xxxxx
K_2O	xxxxx
Na_2O	xxxxx

Arsenic ppm (ASTM D6357)	xxxxx
Chlorine ppm (ASTM 6721)	xxxxx
Mercury ppm (ASTM D6722)	xxxxx
Oxidation (ASTM D5263)	xxxxx
Selenium ppm (ASTM D6357;MOD)	xxxxx
Free Swelling Index (D720)	xxxxx
Equilibrium Moisture (ASTM D1412)	xxxxx
Grindability Index (D409)	xxxxx

Submitted By: Sharlinda Matthews

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606) 349-6145

Jennings Exhibit No. 9
Docket No. E-7, Sub 1191

Certificate of Analysis

COMPANY REQUESTING ANALYSIS:		
Duke Energy SC8 Biomass **400 S. Tryon St.** **Charlotte, NC 28202**	**Date Analyzed:**	7/20/2018
	Lab No.	18021717
	Sampled By/Type:	Customer

Sample ID: Mail In: Wood Bark: LB 756 WO: July 2018: Duke Energy SC8 Site: Chester, SC: 957.8 grams

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture (D3302/D3173)	39.53	
% Ash (D3174)	0.51	0.85
% Volatile (D3175)	xxxxx	xxxxx
% Fixed Carbon (Calculated)	xxxxx	xxxxx
B.T.U (D5865/D5864)	5905	9765
M.A.F.B.T.U. (Calculated)	9849	
% Sulfur (D4239)	0.53	0.88
SO_2 lbs./mm Btu	1.80	
Ash lbs./mm Btu	0.87	

ULTIMATE ANALYSIS (ASTM D5373)	As Received	Dry Basis
Moisture	39.53	
Carbon	31.35	51.85
Hydrogen	4.98	8.23
Nitrogen	0.15	0.24
Sulfur	0.53	0.88
Ash	0.51	0.85
Oxygen (diff.)	22.95	37.95

SULFUR FORMS (ASTM D2492)	As Received	Dry Basis
% Pyritic Sulfur	xxxxx	xxxxx
% Sulfate Sulfur	xxxxx	xxxxx
% Organic Sulfur	xxxxx	xxxxx
% Total Sulfur	xxxxx	xxxxx

MINERAL ANALYSIS (ASTM D4326)		% Wt. Ignited Basis
Silicon dioxide	SiO_2	xxxxx
Aluminum oxide	Al_2O_3	xxxxx
Titanium dioxide	TiO_2	xxxxx
Iron oxide	Fe_2O_3	xxxxx
Calcium oxide	CaO	xxxxx
Magnesium oxide	MgO	xxxxx
Potassium oxide	K_2O	xxxxx
Sodium oxide	Na_2O	xxxxx
Sulfur trioxide	SO_3	xxxxx
Phosphorus pentoxide	P_2O_5	xxxxx
Strontium oxide	SrO	xxxxx
Barium oxide	BaO	xxxxx
Manganese oxide	MnO	xxxxx
Undetermined		xxxxx

FUSION TEMPERATURE OF ASH (D1857)	Reducing (°F)	Oxidizing (°F)
Initial Temp.	xxxxx	xxxxx
Softening Temp. H=W	xxxxx	xxxxx
Hemispherical Temp. H=1/2 W	xxxxx	xxxxx
Fluid Temp	xxxxx	xxxxx

T-250 Temp. of Ash	xxxxx

Base/Acid Ratio	xxxxx
Fouling Factor	xxxxx
Slagging Factor	xxxxx

WATER SOLUBLE ALKALIES (Reported in %)	
CaO	xxxxx
K_2O	xxxxx
Na_2O	xxxxx

Arsenic ppm (ASTM D6357)	xxxxx
Chlorine ppm (ASTM 6721)	xxxxx
Mercury ppm (ASTM D6722)	xxxxx
Oxidation (ASTM D5263)	xxxxx
Selenium ppm (ASTM D6357;MOD)	xxxxx
Free Swelling Index (D720)	xxxxx
Equilibrium Moisture (ASTM D1412)	xxxxx
Grindability Index (D409)	xxxxx

Submitted By: Sharlinda Matthews

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606) 349-6145

Jennings Exhibit No. 9
Docket No. E-7, Sub 1191

Certificate of Analysis

COMPANY REQUESTING ANALYSIS:		
Duke Energy SC8 Biomass **400 S. Tryon St.** **Charlotte, NC 28202**	**Date Analyzed:**	7/20/2018
	Lab No.	18021718
	Sampled By/Type:	Customer

Sample ID: Mail In: Wood: LB 756 WB: July 2018: Duke Energy SC8 Site: Chester, SC: 753.4 grams

PROXIMATE ANALYSIS	As Received	Dry Basis
% Moisture (D3302/D3173)	xxxxx	
% Ash (D3174)	xxxxx	0.74
% Volatile (D3175)	xxxxx	xxxxx
% Fixed Carbon (Calculated)	xxxxx	xxxxx
B.T.U (D5865/D5864)	xxxxx	9138
M.A.F.B.T.U. (Calculated)	9206	
% Sulfur (D4239)	xxxxx	0.42
SO_2 lbs./mm Btu	0.92	
Ash lbs./mm Btu	0.81	

ULTIMATE ANALYSIS (ASTM D5373)	As Received	Dry Basis
Moisture	xxxxx	
Carbon	xxxxx	50.20
Hydrogen	xxxxx	8.09
Nitrogen	xxxxx	0.16
Sulfur	xxxxx	0.42
Ash	xxxxx	0.74
Oxygen (diff.)	xxxxx	40.39

SULFUR FORMS (ASTM D2492)	As Received	Dry Basis
% Pyritic Sulfur	xxxxx	xxxxx
% Sulfate Sulfur	xxxxx	xxxxx
% Organic Sulfur	xxxxx	xxxxx
% Total Sulfur	xxxxx	xxxxx

MINERAL ANALYSIS (ASTM D4326)		% Wt. Ignited Basis
Silicon dioxide	SiO_2	xxxxx
Aluminum oxide	Al_2O_3	xxxxx
Titanium dioxide	TiO_2	xxxxx
Iron oxide	Fe_2O_3	xxxxx
Calcium oxide	CaO	xxxxx
Magnesium oxide	MgO	xxxxx
Potassium oxide	K_2O	xxxxx
Sodium oxide	Na_2O	xxxxx
Sulfur trioxide	SO_3	xxxxx
Phosphorus pentoxide	P_2O_5	xxxxx
Strontium oxide	SrO	xxxxx
Barium oxide	BaO	xxxxx
Manganese oxide	MnO	xxxxx
Undetermined		xxxxx

FUSION TEMPERATURE OF ASH (D1857)	Reducing (°F)	Oxidizing (°F)
Initial Temp.	xxxxx	xxxxx
Softening Temp. H=W	xxxxx	xxxxx
Hemispherical Temp. H=1/2 W	xxxxx	xxxxx
Fluid Temp	xxxxx	xxxxx

T-250 Temp. of Ash	xxxxx

Base/Acid Ratio	xxxxx
Fouling Factor	xxxxx
Slagging Factor	xxxxx

WATER SOLUBLE ALKALIES (Reported in %)	
CaO	xxxxx
K_2O	xxxxx
Na_2O	xxxxx

Arsenic ppm (ASTM D6357)	xxxxx
Chlorine ppm (ASTM 6721)	xxxxx
Mercury ppm (ASTM D6722)	xxxxx
Oxidation (ASTM D5263)	xxxxx
Selenium ppm (ASTM D6357;MOD)	xxxxx
Free Swelling Index (D720)	xxxxx
Equilibrium Moisture (ASTM D1412)	xxxxx
Grindability Index (D409)	xxxxx

Submitted By: Sharlinda Matthews

JENNINGS CONFIDENTIAL EXHIBIT NO. 10

DOCKET NO. E-7, SUB 1191

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 11

DOCKET NO. E-7, SUB 1191

CONFIDENTIAL – FILED UNDER SEAL

JENNINGS CONFIDENTIAL EXHIBIT NO. 12

DOCKET NO. E-7, SUB 1191

CONFIDENTIAL – FILED UNDER SEAL