

TurkeyPointLANPEM Resource

From: Hoeg, Tim
Sent: Friday, November 21, 2014 8:22 AM
To: Sandal, Shane
Cc: Klett, Audrey; Endress, Matthew
Subject: FW: CCS History
Attachments: PTN CCS Water Quality History Final.docx

FYI. Licensee provided this doc to us today. I thought you may be interested.

*Tim Hoeg
Senior Resident Inspector
Region II, Division of Reactor Projects
U.S. Nuclear Regulatory Commission*

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From: Tomonto, Bob [mailto:Bob.Tomonto@fpl.com]
Sent: Friday, November 21, 2014 8:12 AM
To: Hoeg, Tim; Endress, Matthew
Subject: FW: CCS History

From: Scroggs, Steven
Sent: Friday, November 21, 2014 8:09 AM
To: Tomonto, Bob
Subject: CCS History

Sincerely,

Steven D. Scroggs
Senior Director, Project Development
Florida Power & Light Company
O: 561-694-5051

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Sent Date: 11/21/2014 8:21:39 AM
Received Date: 11/21/2014 8:21:59 AM
From: Hoeg, Tim

Created By: Tim.Hoeg@nrc.gov

Recipients:

"Klett, Audrey" <Audrey.Klett@nrc.gov>
Tracking Status: None
"Endress, Matthew" <Matthew.Endress@nrc.gov>
Tracking Status: None
"Sandal, Shane" <Shane.Sandal@nrc.gov>
Tracking Status: None

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Turkey Point Cooling Canal System
Recent Water Quality History
November 2014

Introduction

In 2014, The Turkey Point Power Plant experienced higher than normal salinity and temperature in the cooling canal system (CCS) for an extended period of time. The CCS also experienced an algal bloom unlike the site had seen historically. As discussed below, the high salinity, increase in temperature, and heavy algal concentration appear to be the result of multiple, compounding factors.

Background

The Turkey Point nuclear and fossil units utilize a 5,900-acre closed-cycle cooling canal system, of which 4,370 acres is water surface, for condenser and auxiliary equipment cooling. Makeup water for the canal system comes from process water (permitted discharge from the existing Units), rainfall, stormwater runoff and groundwater infiltration. The makeup water replaces evaporative and seepage losses that occur while the CCS is operating. The CCS has a “no discharge” NPDES permit that does not allow discharges directly to surface waters but does allow canal water to interchange with groundwater through the porous canal bottom. The canal system does not directly discharge to fresh or marine surface waters. By design, the CCS receives inflow from and sends outflow to the saline aquifer beneath the CCS. The groundwater infiltration component is particularly important during periods of low rainfall and high evaporation.

FPL has had an extensive monitoring program in place, in and around the CCS, since 2009 in association with the Extended Power Uprate (EPU). The Monitoring Plan results in the collection of groundwater, surface water, meteorological, and ecological data to evaluate Pre- and Post-Uprated conditions. Figure 1 depicts the surface water and groundwater monitoring stations. This monitoring program was approved by the Florida Department of Environmental Protection (FDEP), South Florida Water Management District (SFWMD) and Miami Dade County (MDC).

The EPU required alternating shutdowns of Units 3 and 4 for extended periods. Unit 3 was shut down from February 2012 until November 2012. Unit 4 subsequently shut down from November 2012 until May 2013. During these outages, the canals were at a reduced flow for a total of approximately 15 months. This time period also coincided with periods of low rainfall and high evaporation rates. The historic trends show an increase in salinity beginning in October 2012. This coincides with the warm summer months during 2012 and the Unit 3 shutdown. In August 2012, FPL noticed increases in turbidity in the CCS and (based on a change in water color) suspected that a minor algal bloom was occurring. FPL took water samples that same month and had them analyzed for algae content. The results showed that the species was *Aphanothecsp*.

and the cell count was approximately 680,000 cells/ml. FPL analyzed for algae again in September 2012, and the count had decreased by approximately 55%. In March 2014, however, FPL noticed the turbidity and pH were increasing again and that the water color had changed. Surface water samples from the CCS were collected in April 2014 and analyzed for cell count. These result showed that the cell count was up to 1,050,000 cells/ml.

Contributing Factors to High Salinity, Temperature and Algal Bloom

The CCS has been in operation since 1973. The system is subject to seasonal fluctuations in temperature and salinity based on weather conditions in the vicinity of the plant (Figure 2). There were a combination of factors that contributed to the unusually high temperature and salinity conditions that were experienced during the summer of 2014. Figure 3 depicts the interaction between the various factors that contributed to the CCS poor health. The factors FPL has identified to date as being related to those conditions are listed below and will be briefly discussed.

- Increase in Salinity:
 - Reduced rainfall and increased evaporation
 - Reduced groundwater interaction
 - Reduced flow during 15 month Uprate period
- Increase in Temperature:
 - Reduced canal flow due to sedimentation, effectively reducing surface area for heat exchange (70% of flow now goes through 40% of canals).
 - Reduced rainfall and increased evaporation
 - Reduced groundwater interaction
 - Increased turbidity
- Algal Bloom
 - Increased salinity and temperature
 - Increased nutrient levels
 - Reduced flow during 15 month EPU period.

Salinity Increase

Salinity fluctuations are a normal occurrence in the CCS. Salinity is calculated from actual conductance and temperature. During the dry season, salinity can increase but once the rainy season arrives, the salinity will drop. Since the end of the rainy season in 2012 (October 2012) the CCS specific conductance has steadily increased. This can be attributed in part to a drier than normal rainy season within the boundaries of the CCS in 2013 and 2014. The rainfall data taken from a meteorological station in the middle of the CCS indicated

approximately 74 inches of rain fell in 2012, 20 inches fell in 2013, and 3 inches fell through May of 2014 (Table 1).

From 2012 through May 2014, there has been a decline in average CCS water levels (Table 2), indicating less input from rainfall and/or groundwater inflows. A reduction in fresher water inputs results in higher salinities which also favors the specific algal species.

High Temperatures - Increased Evaporation

Water temperatures in the CCS are greatly affected by meteorological conditions and reflect seasonal trends as expected (Figure 4). The average temperature in the CCS, based on the average of 7 surface water stations, was 98.0°F in August 2013 and 84.6°F in January 2014. Within the CCS, the water temperature varies based on location. The CCS water is pumped from the intake side of the plant and routed through condensers to cool the power units. As the water passes through the condensers, it is heated and eventually discharged on the west side of the plant back into the CCS. The water cools as it is routed through the CCS.

The higher temperatures have increased the evaporation rate of water. This increase in evaporation results in higher salinities. The higher salinities favor the growth of the algal species present in the CCS. The reduced canal flow due to sedimentation effectively reduced the surface area for heat exchange (70% of flow now goes through 40% of canals), thus increasing the canal temperatures.

Algal Bloom

An algal bloom was initially identified in August 2012 and proliferated in March 2014. The species was identified as cyanobacteria, *Aphanothece* sp., which is commonly referred to as blue-green algae (algae). Under favorable environmental conditions these algae can quickly grow in numbers. Most blue-green algae species are buoyant and will float to the surface, where they form scum layers or floating mats often referred to as an “algae bloom”.

This particular species is adapted to and thrives in hypersaline warm waters such as the conditions prevalent in the CCS in recent years. The algae can also form a gelatinous layer that has the potential to trap in heat within the water column. Figure 5 shows the algal counts and turbidity values over the past several years along with salinity in the CCS. There were several changes that occurred in the past few years that have contributed to conditions favored by algae and therefore to the increased algae growth.

- Increase nutrient load to the CCS - through nitrogen fixing by the algae and the release of nutrients as the aquatic grass population died off
- Increased salinity that favors this species of algae

- Increased temperature in the CCS
- Sedimentation of biomass/organic material has resulted in plugging of the canal bottoms, which has reduced interaction between the CCS and the groundwater system

Nutrients Increase

One of the potential factors that may have indirectly contributed to the increased salinity and temperatures in the CCS is the increase in nutrient concentrations. During the EPU, the Site made physical changes to the intake structures. These changes included adding a macerator unit that ultimately grinds up floating algae and puts it in the discharge side of the CCS. This physical change may have contributed to the nutrient loading. Nutrient samples are collected semi-annually. From June 2010 to September 2012, total nitrogen (TN) concentrations were consistent within the CCS, i.e. approximately 2.0 mg/L. During the Uprating period however, TN increased steadily (Figure 6), peaking just after the Uprate.

The algae bloom observed from August 2012 through this year, appear to be correlated to the increase in TN; over 90% of TN is the organic biologically-derived nitrogen. Increased nitrogen concentration within the CCS would have promoted the growth of the algae, and potentially promoted nitrogen-fixing conditions within this species as well. The algal productivity would have increased turbidity in the water as well as heat retention within the water column, resulting in seagrass die-off and further nutrient enrichment of this system. Algal turnover within the CCS would have also contributed to increased sedimentation as cells died and sank to the bottom of the CCS.

Reduced Groundwater Interaction

Historic Turkey Point reports indicate that efforts to remove organic sediments and biomass from the CCS via dredging and mechanical plant harvesting have been successful in improving the water quality and thermal efficiency of the CCS. The accumulation of organic matter in the CCS can be considered a potential factor contributing to the algae and loss of thermal efficiency. Another factor affecting the design operation of the CCS is the steadily building sediment layer throughout the CCS. The sedimentation has two negative impacts to CCS operation. First, sedimentation gradually decouples the canal water from the groundwater below. Second, the sedimentation is not uniformly distributed and gradually changes the flow balance of the CCS, changing the effective surface area of the CCS. With the algal bloom events, a gelatinous sediment layer (Figure 7) of reduced permeability was added to the canal bottoms and creates a highly impermeable layer between the CCS water and the groundwater below. It is possible that the accumulated organic load in the CCS is recycling nutrients into the water column and the nutrients may have facilitated higher algae

populations. The removal of the organic material should help break the nutrient source for the algae and also improve the exchange of CCS water with the groundwater.

This sedimentation accumulation has slowly reduced groundwater interchange, robbing the CCS of an important compensating water source (especially during dry periods). It has also changed/reduced the flow balance (and effective heat exchange surface area) and associated heat exchange capability of the CCS. Figure 8 is a thermographic map that indicates the CCS is working with a 30-40% less effective radiant cooling.

The increased thermal output of Units 3&4 from the EPU is not a direct factor contributing to the increase in temperature or salinity. In fact, with the recent shutdown of fossil Unit 2, the net heat input into the system is currently lower than the heat input of Units 1 through 4 prior to the EPU. The actual BTU/hr output, based on the current Pre and Post-Uprated conditions indicates the Post-Uprate thermal loading is lower than the Pre-Uprate (Table 3. Pre-Uprate (Units 1,2,3, and 4) 14.6E+09 BTU/hr. Post-Uprate (Units 1,3, and 4) 13.99E+09 BTU/hr). This suggests that there are other contributing factors, as described above, occurring at the same time that are impacting water quality and thermal efficiency of the CCS.

In the course of conducting the EPU outages, the system experience non-standard operating conditions of low flow for 15 months. It is believed that this low flow, coupled with the already increasing salinity, temperature and nutrient content, provided a more conducive environment to support an algal bloom. Therefore, operating conditions during the EPU period, coupled with an already degraded water quality, enhanced the necessary conditions that supported the algal bloom.

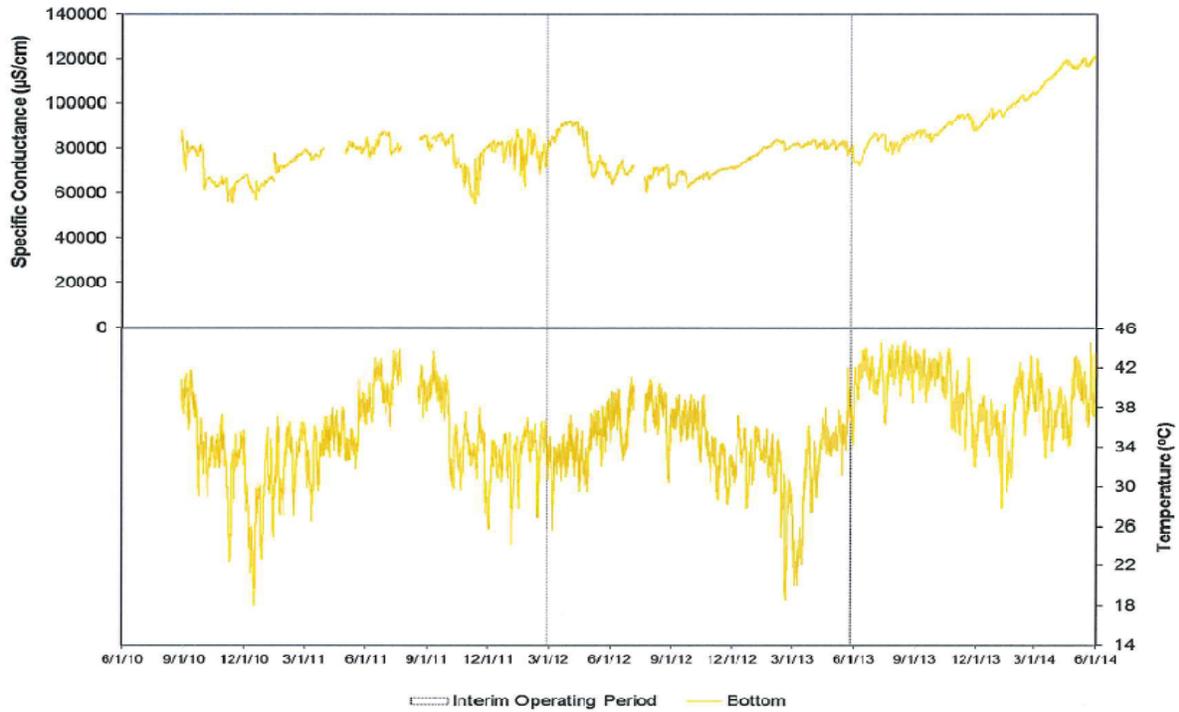


Figure 2. Seasonal Fluctuation Temperature and Salinity in the CCS (TPSWCCS – 1)

FACTORS CAUSING INCREASES IN SALINITY AND TEMPERATURE IN THE CCS

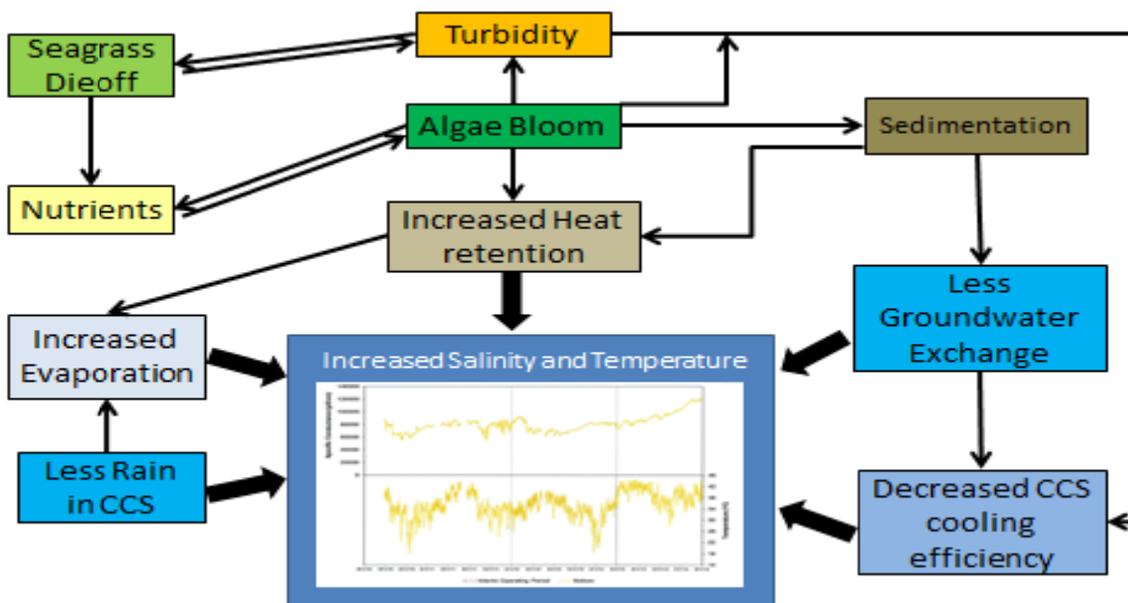


Figure 3. Potential Contributing Factors

Jan-Dec (Yr)	Rainfall (inches) from TPM-1
2011	52.18
2012	74.25
2013	19.65*
2014	2.62**

Table 1. Rainfall Data 2011-2014

*Unit out of repair for half of June 2013.

**Data validated through May 2014

Year	Elevation (ft, in NAVD 88)
2012	-0.47
2013	-0.65
2014	-0.88

Table 2. CCS Elevation Data 2012-2014

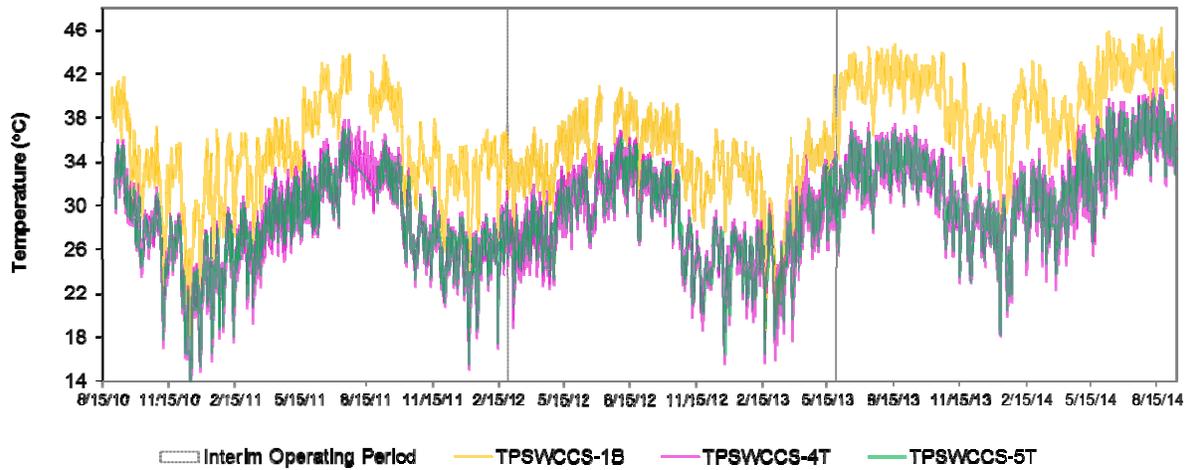


Figure 4. Temperature – August 2010 – August 2014

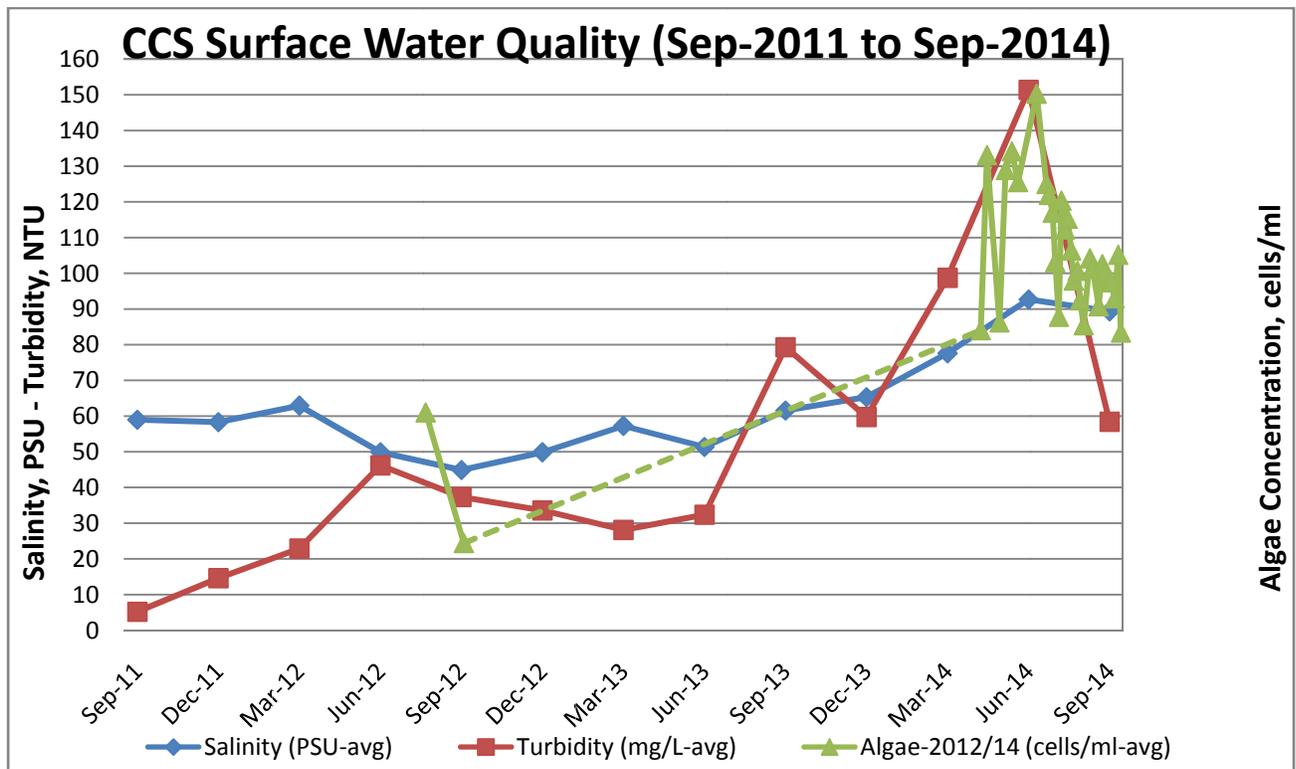


Figure 5. Salinity, Turbidity and Algae – September 2011 – September 2014

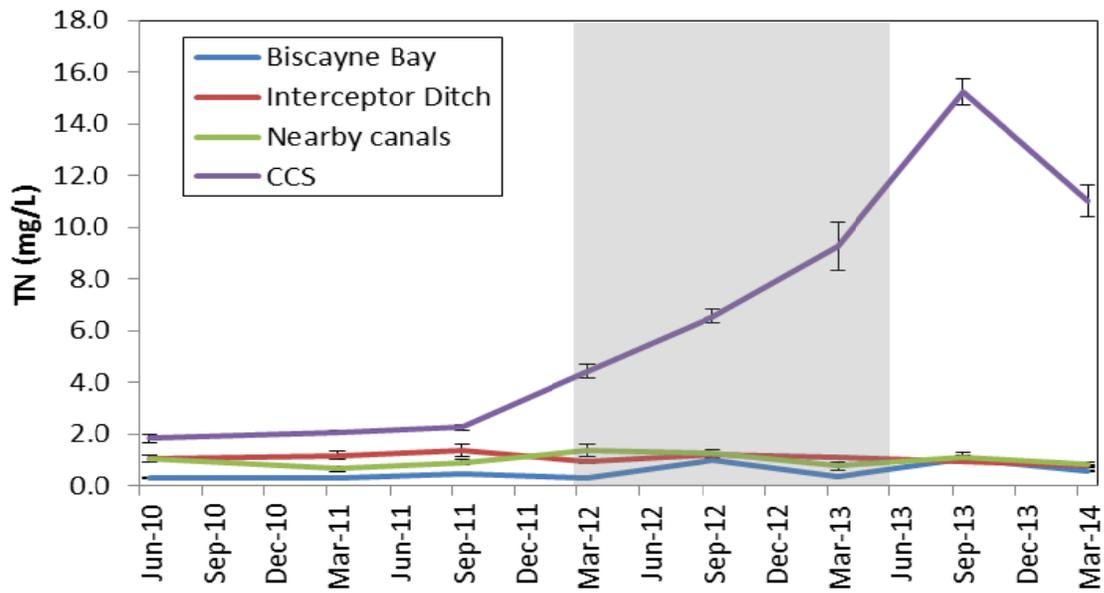


Figure 6. Total Nitrogen (TN) - June 2010 – March 2014. Shaded area shows the Uprating period. (BBSW – Biscayne Bay Surface Water Station, ID – Interceptor Ditch Stations, SWC – Surface Water Station adjacent to the CCS, and CCS – Stations within the CCS)



Figure 7. Gelatinous Algal Layer

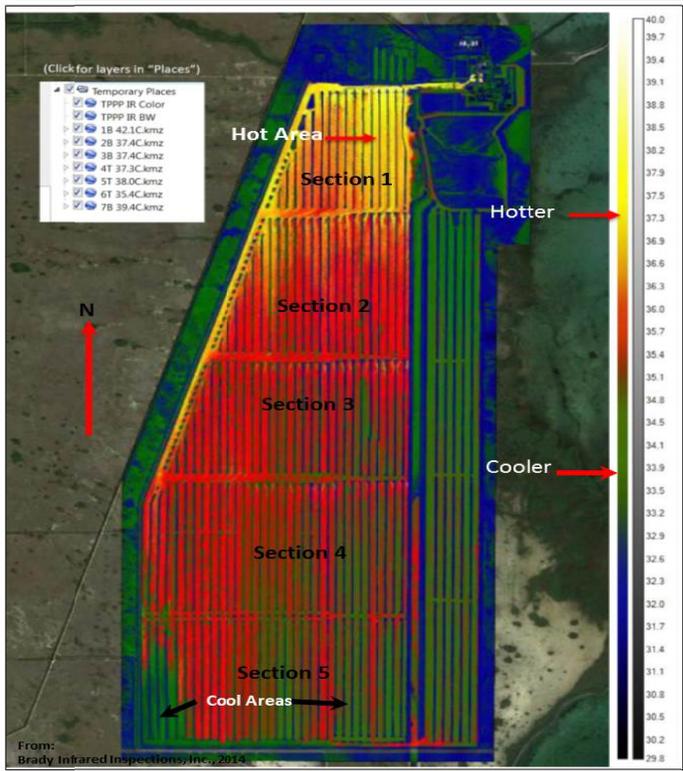


Figure 8. Thermal Efficiency of the CCS

PRE-UPRATE

- Turkey Point Plant (Units 1 – 4) Heat Discharge to CCS: **14.6E+09 BTU/Hr** (FPL SCA - Appendix 10.6)
 - Turkey Point Unit 3 Heat Discharge to CCS: 5.35E+09 BTU/Hr. (EPU LAR Attachment 7, 7-21)
 - Turkey Point Unit 4 Heat Discharge to CCS: 5.35E+09 BTU/Hr. (EPU LAR Attachment 7, 7-21)
- Therefore Turkey Point Units 1 & 2 Heat Discharge to CCS: 3.9E+09 BTU/Hr. (14.6-10.7 = 3.9)

AND

- Turkey Point Unit 1 Heat Discharge to CCS: 1.95E+09 BTU/Hr. (3.9/2 = 1.95) (FPL SCA - Appendix 10.6)
- Turkey Point Unit 2 Heat Discharge to CCS: 1.95E+09 BTU/Hr. (3.9/2 = 1.95) (FPL SCA - Appendix 10.6)

POST-UPRATE

- Turkey Point Plant (Units 1, 3, 4) Heat Discharge to CCS: **13.99E+09 BTU/Hr.** (6.02 + 6.02 + 1.95)
 - Turkey Point Unit 3 Heat Discharge to CCS: 6.02E+09 BTU/Hr. (Ian Waters based on Unit 3)
 - Turkey Point Unit 4 Heat Discharge to CCS: 6.02E+09 BTU/Hr. (Steam Turbine Test Report)
 - Turkey Point Unit 1 Heat Discharge to CCS: 1.95E+09 BTU/Hr. (3.9/2 = 1.95)
 - Turkey Point Unit 2 Heat Discharge to CCS: Dedicated to Synchronous Condenser Operating Mode

Table 3. Thermal Loading Pre-Uprate and Post-Uprate