



EXPANDED HEAT REMOVAL PILOT STUDY QUARTERLY REPORT

BRIDGETON LANDFILL

BRIDGETON, ST. LOUIS COUNTY, MISSOURI

January 2016

Prepared For:

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Expanded Heat Removal Pilot Study

Quarterly Report

Bridgeton Landfill, LLC

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1 INTRODUCTION

This document is being submitted as a quarterly update regarding the Expanded Heat Removal Pilot Study underway in the South Quarry of the Bridgeton Landfill in Bridgeton, Missouri. This update was requested by the Missouri Department of Natural Resources (MDNR) in a letter dated September 4, 2014, and includes a summary of work and data collected during the third quarter of 2015.

The following discussion includes a summary of activities and field data compiled in the fourth quarter of 2015 regarding the Heat Extraction System Pilot Study underway at Bridgeton Landfill (BL). This update includes presentation of in-waste temperature measurements, heat removal data at each removal location, status of the current system, operating log for the reporting period and discussion of data. The data collected from in-place waste temperatures are presented in **Appendix A**. Heat removal point data is included in **Appendix B**. Plan views of the Temperature Monitoring Probes (TMP) and current heat removal system are included as **Appendix C & D**, respectively. **Appendix E** includes entries made to the Heat Extraction System Operating Log during the third quarter of 2015.

2 SYSTEM OPERATION

The heat extraction system operated consistently during the fourth quarter of 2015. The system has operated with minimal operational or physical changes since the expansion completed on June 26, 2015 (GIW-8, -9, -11, -12 and -13). The system has operated consistently with no significant issues during the reporting period.

3 DATA SUMMARY

The collection of in-waste temperature measurements have been obtained weekly during the fourth quarter of 2015 as part of the pilot study. The measurements of in-waste temperatures are presented graphically in **Appendix A**. The inflow temperature, outflow temperature and flow rate are recorded at each heat removal unit approximately weekly. These parameters are utilized to calculate the heat extraction rate (kilowatts). The heat extraction rate (kilowatts) is presented graphically with the corresponding flow rate (gallons per minute) in **Appendix B**.

4 SUMMARY AND DISCUSSION OF RESULTS

The BL has continued the successful operation of twelve (12) heat removal points this reporting period. The heat removal system has operated with only minor maintenance this period. The system continues to operate with minimal interruption.

The data collected during the reporting period is relatively consistent with data recorded in previous quarters. A review of the in-waste temperature measurements show consistent temperatures during the reporting period. The TMPs at approximately five (5) and nine (9) feet to the north of heat removal points have continued to exhibit significant temperatures reductions compared to measurements obtained prior to the system operation. The in-waste temperature measurements adjacent to heat removal points on the south side have shown a steady reduction from the original temperatures but significantly less in magnitude compared to the north. The in-waste temperatures measured at a greater distance (20 to 30 ft. away) from heat removal points are consistent in maintaining temperature reductions compared to measurements obtained prior to operation of the system.

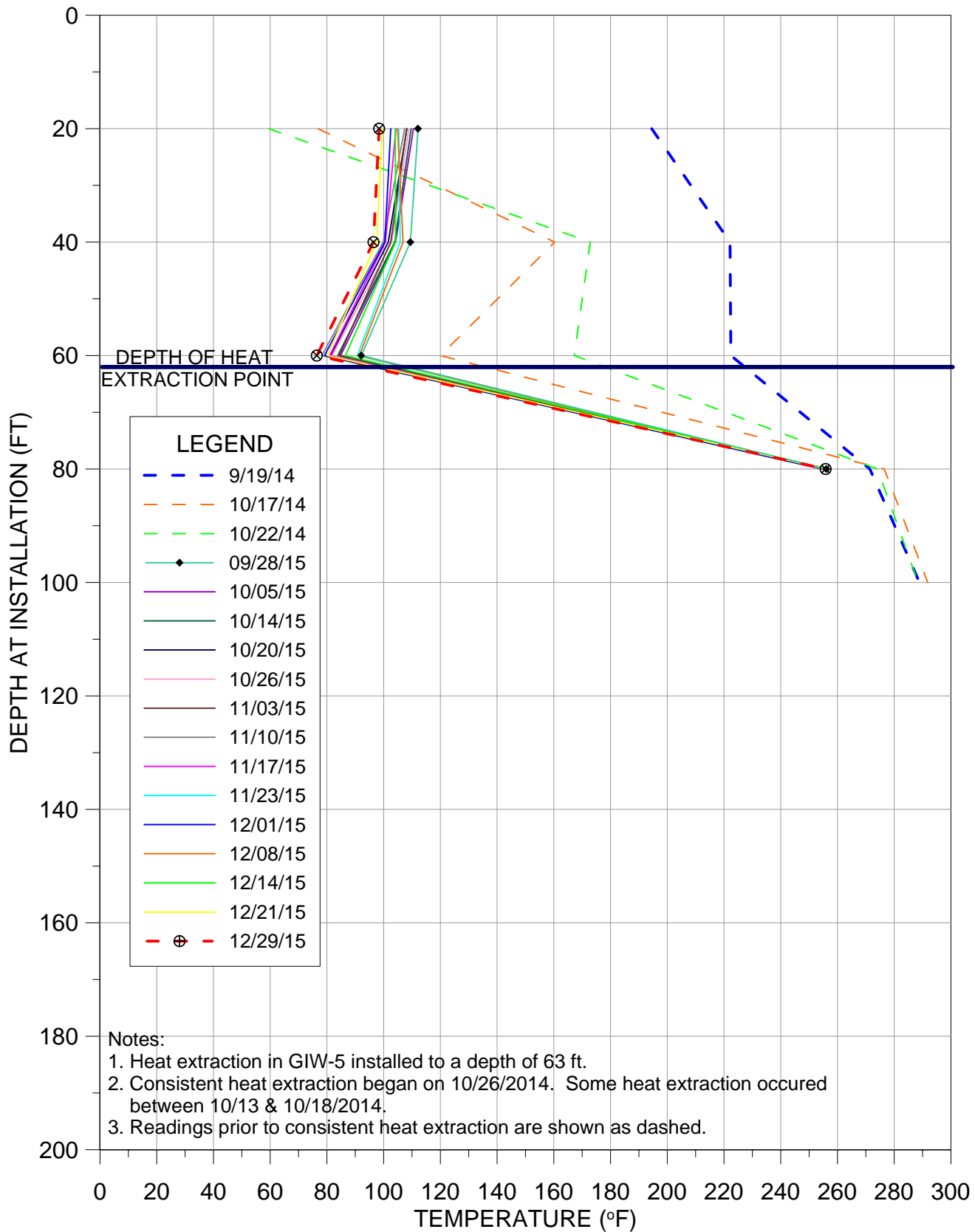
The overall temperatures in the neck area have been consistent for the monitoring period. Also, the temperature on the north side of the heat removal points have remained significantly lower compared to the south side. This indicates normal landfill heat generation in the waste on the north side of the heat removal points.

A review of the heat removal point data for this reporting period has been conducted. The initial or south line of heat removal points have shown relatively steady rates of energy removal. The measurements obtained in early December showed an increase in the extraction rate. This could be contributed to lower ambient temperatures or factors associated with the time of day the reading was obtained. The steady-state removal rate of the northern line of points are higher than the points installed on the south row of points. This is expected and likely attributed to the deeper depth of the heat removal points on the north row.

BL is continuing the operation of the heat removal system at the facility.

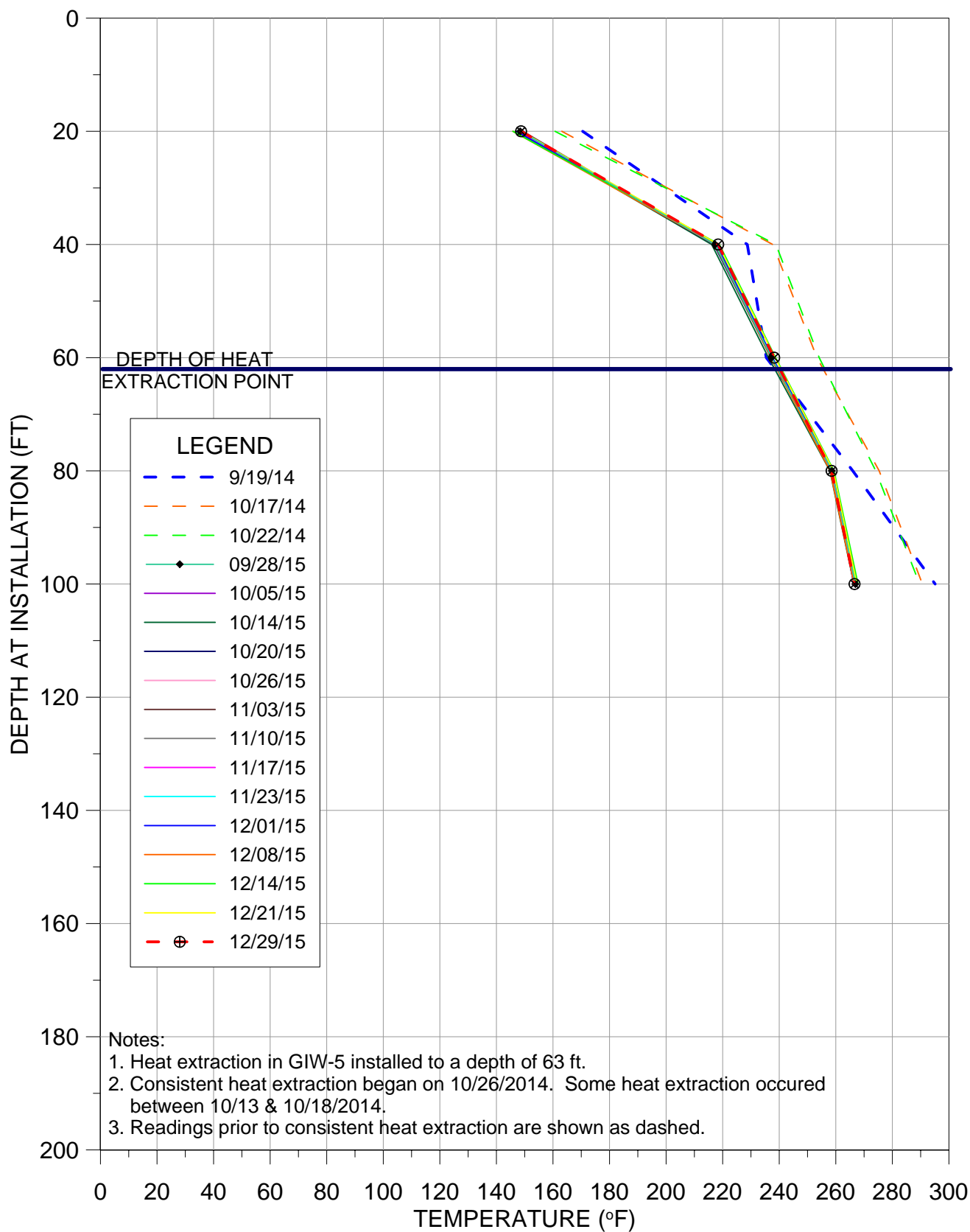
Appendix A – Temperature Monitoring Probe Graphs (Fourth Quarter 2015)

TMP-5-5N



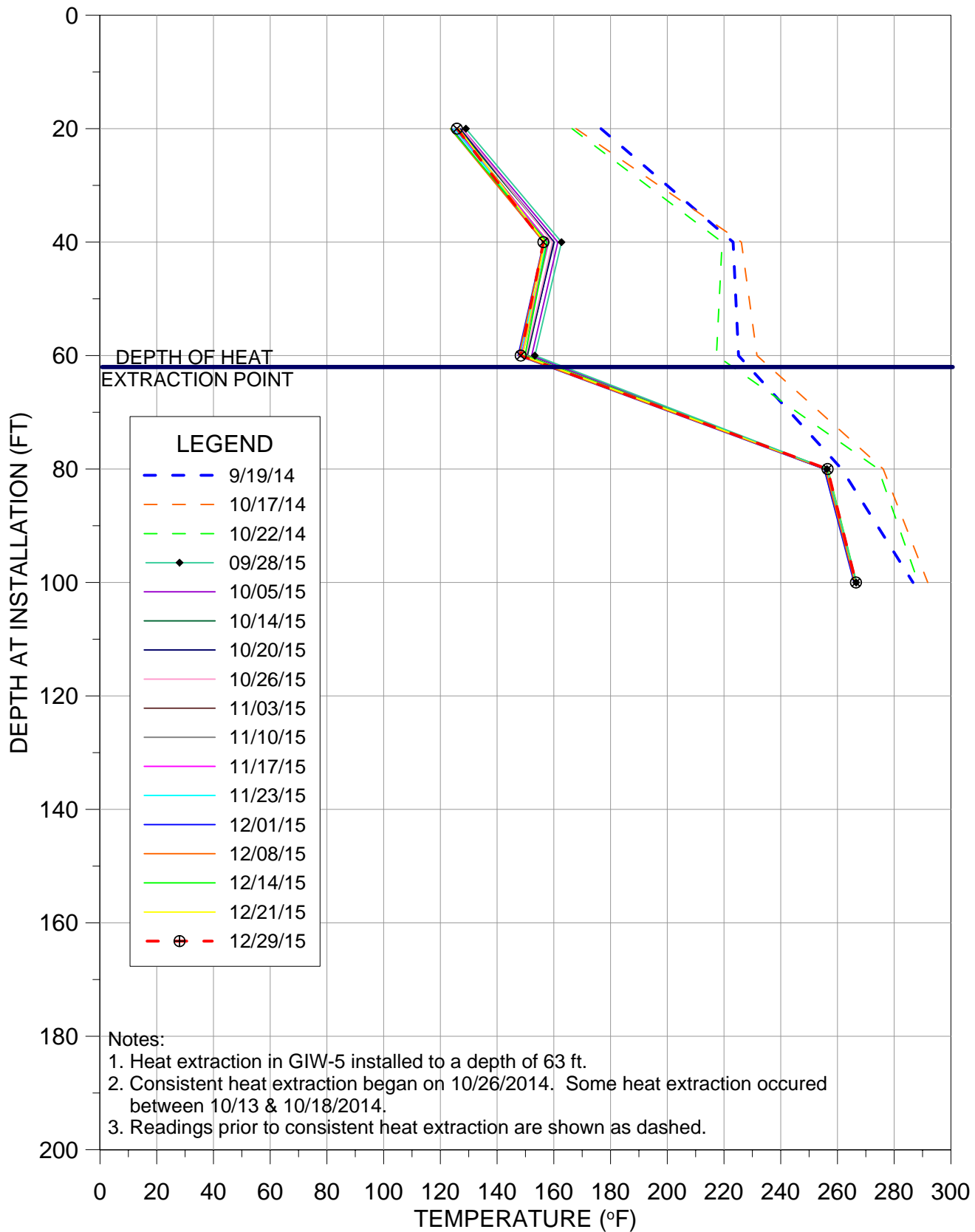
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-5-5S



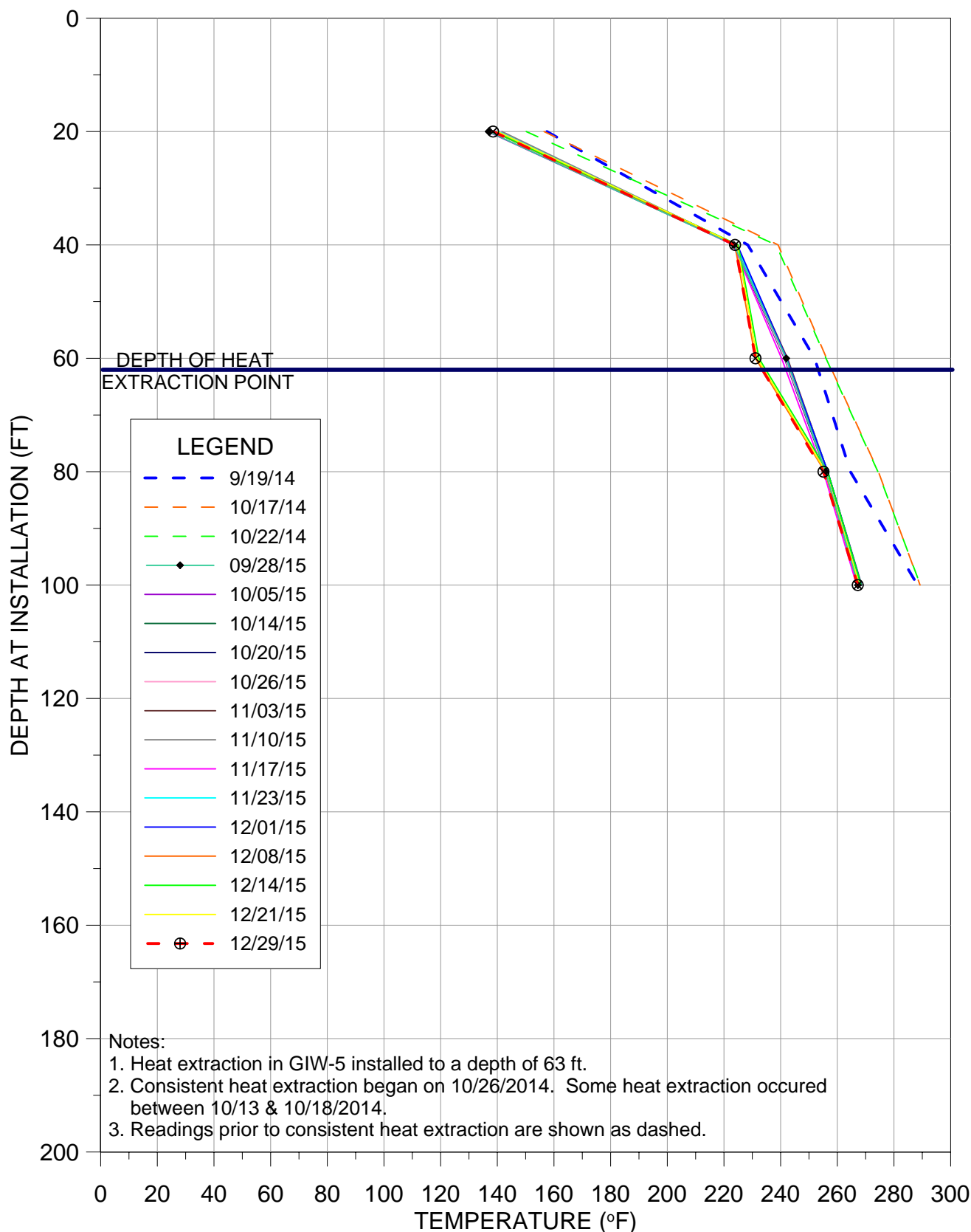
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-5-9N



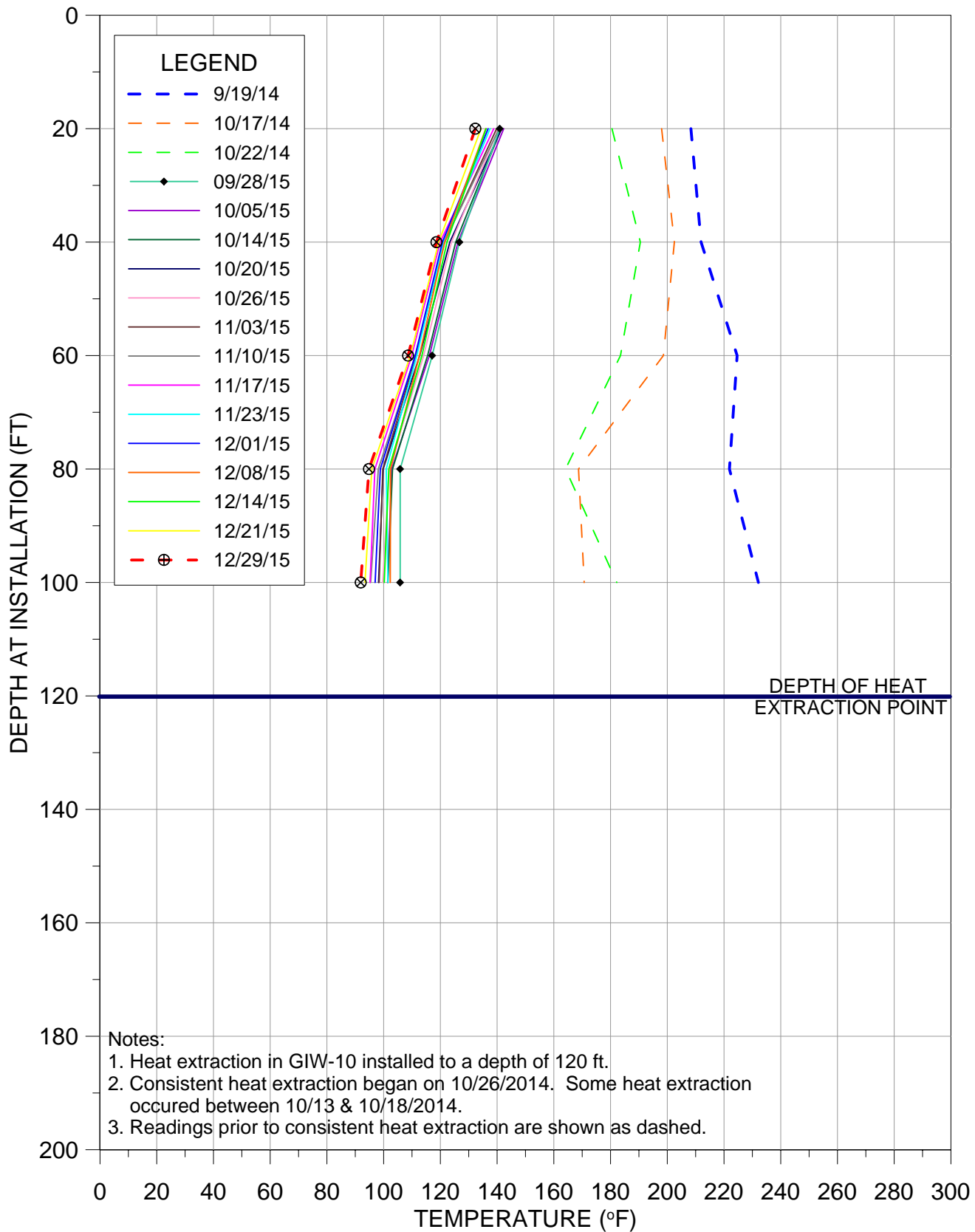
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-5-9S



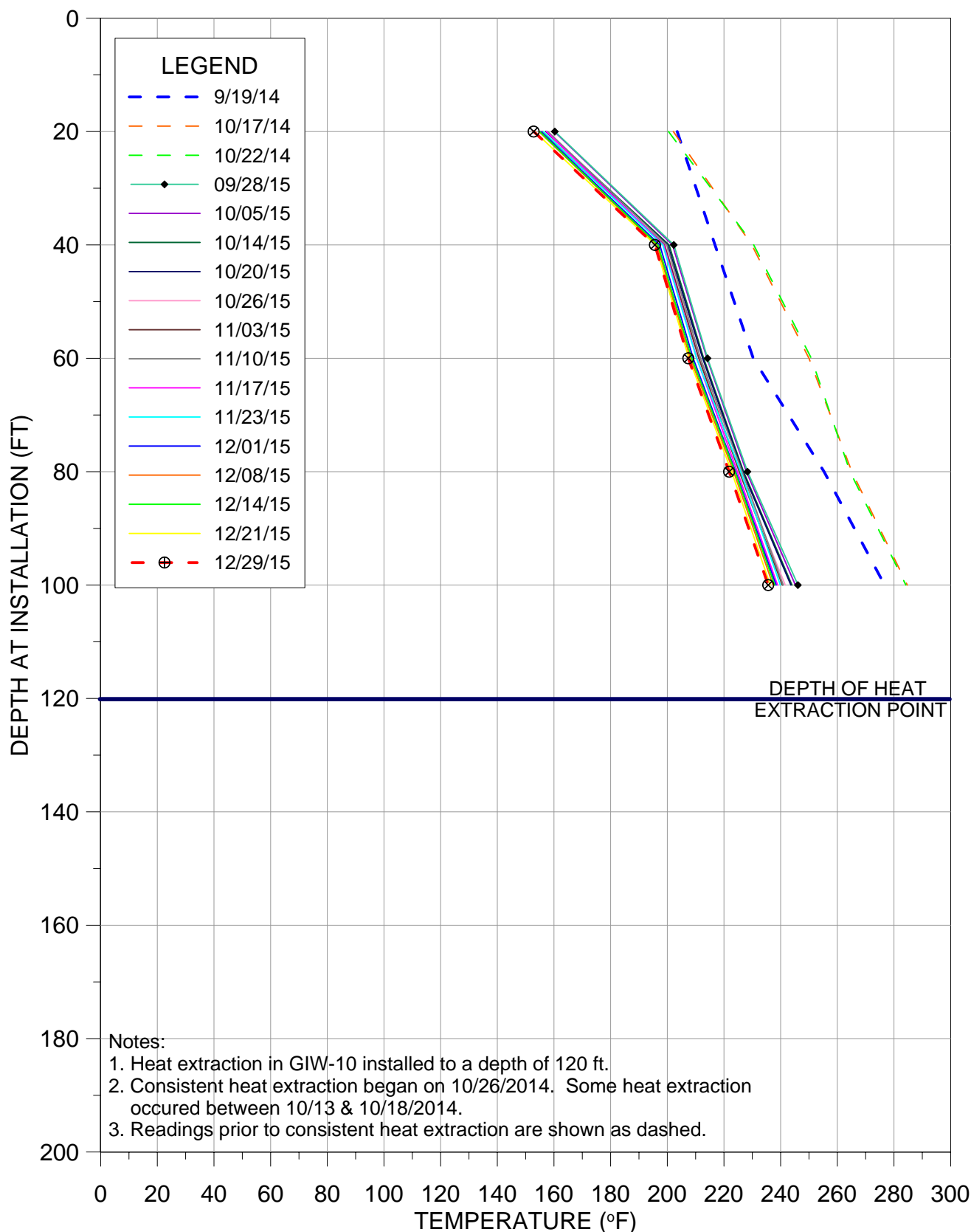
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-10-5N

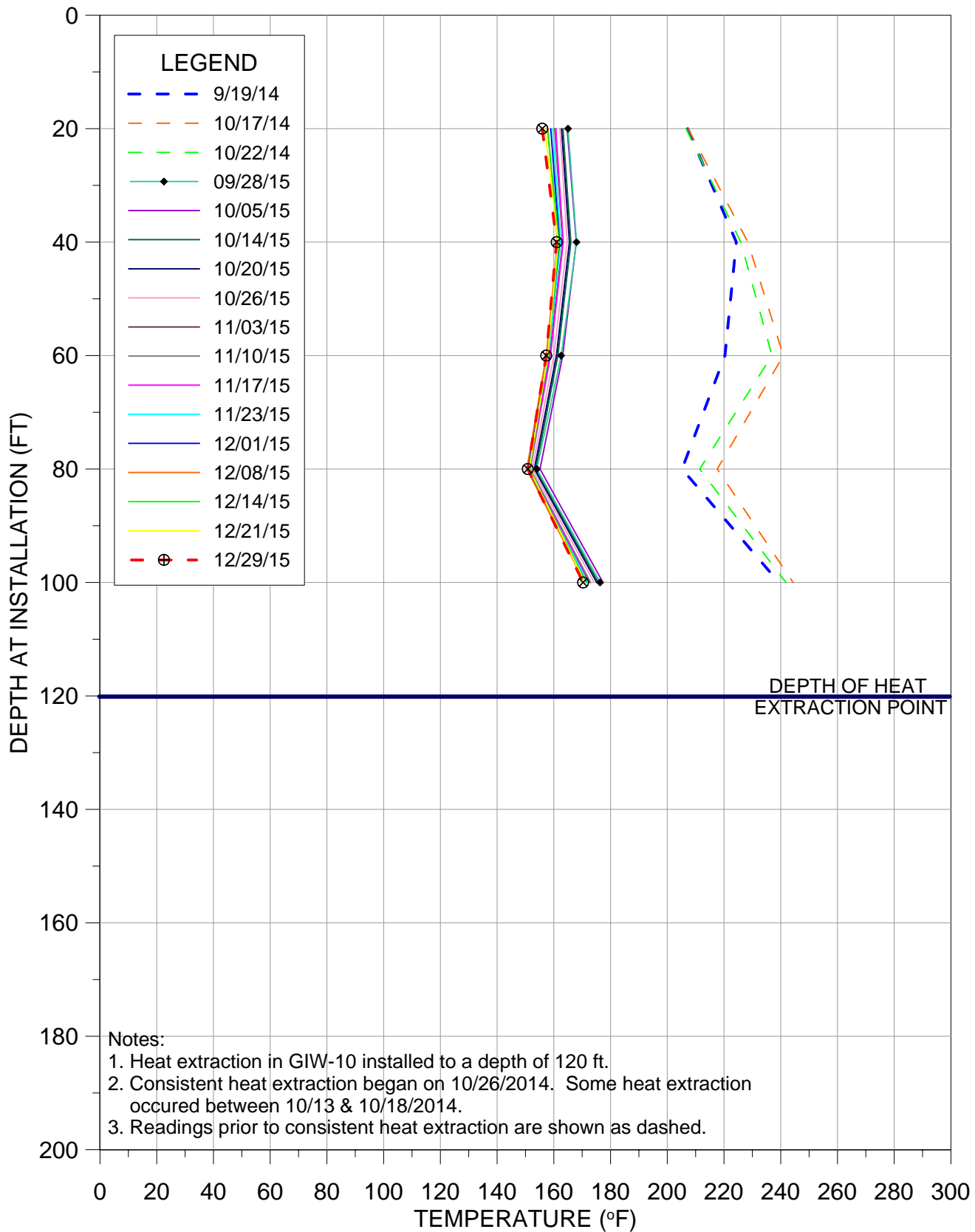


TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-10-5S

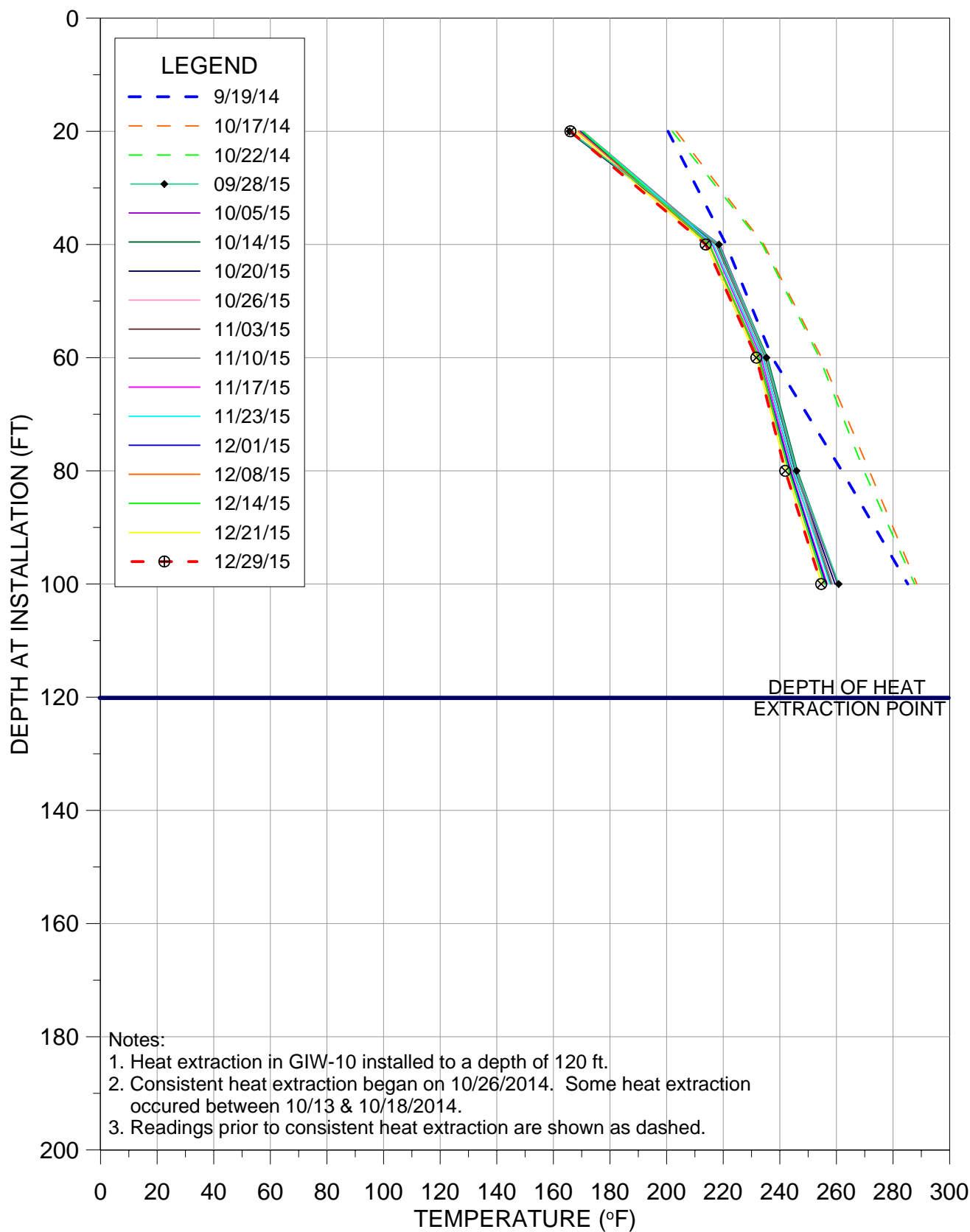


TMP-10-9N



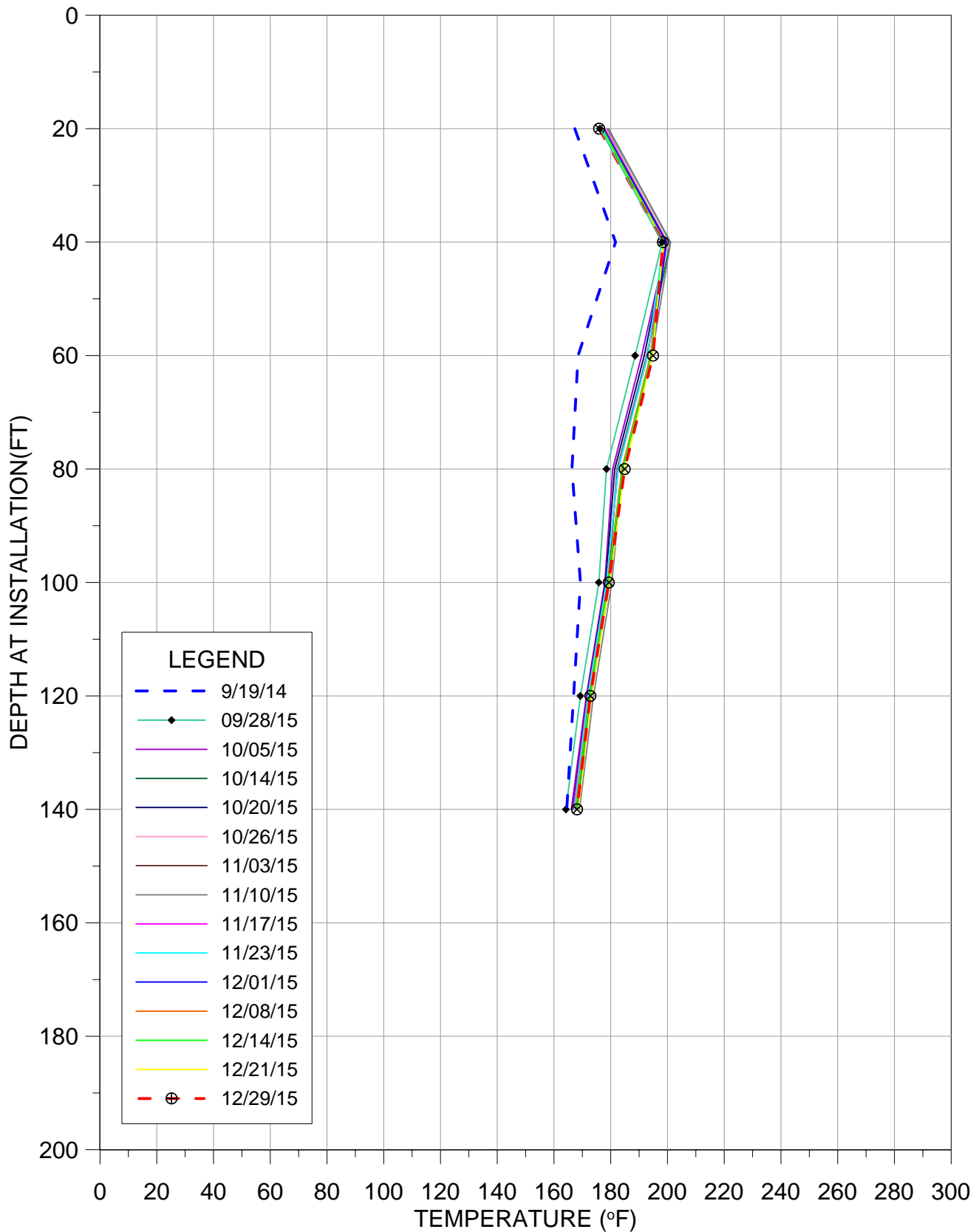
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-10-9S



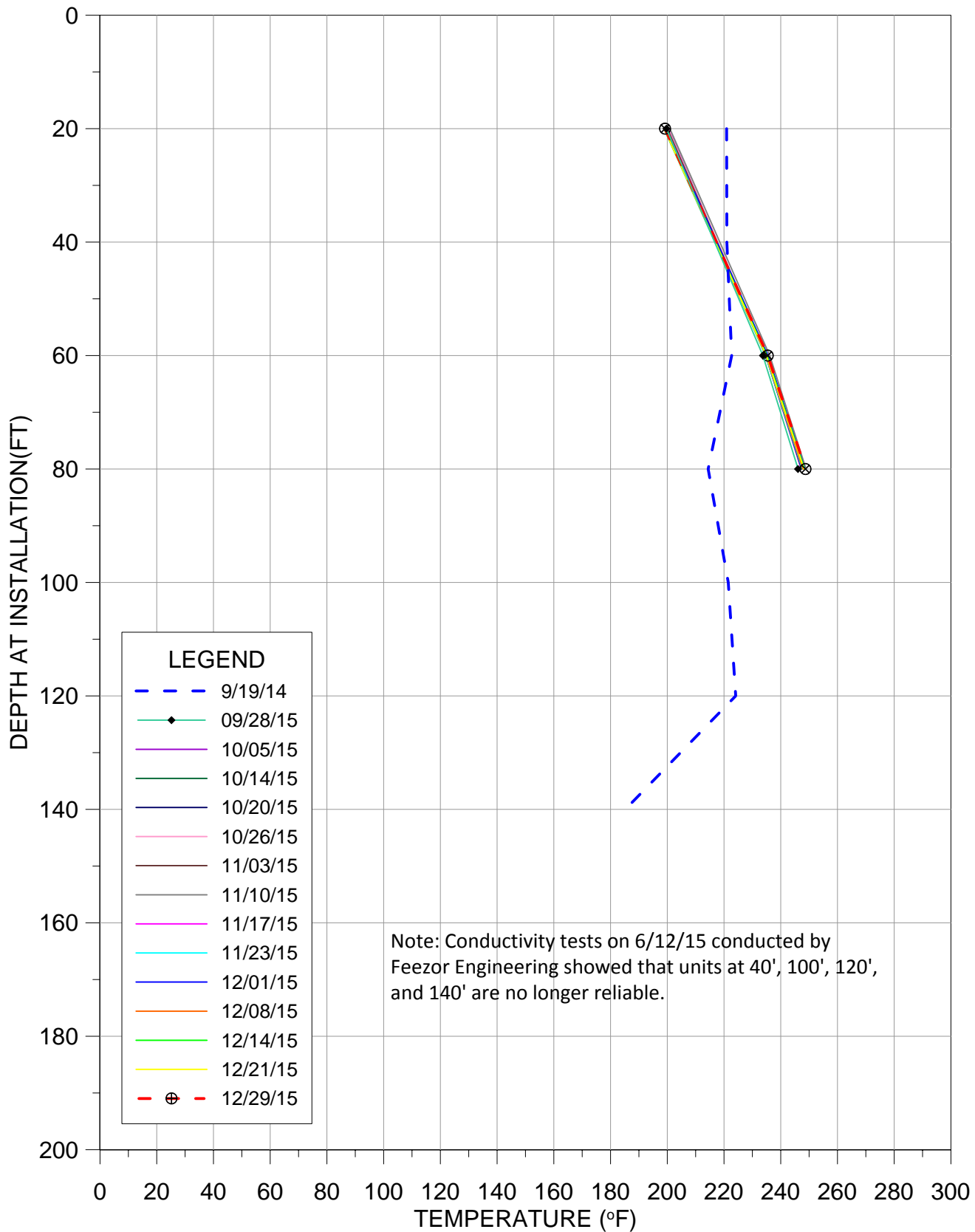
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-14R



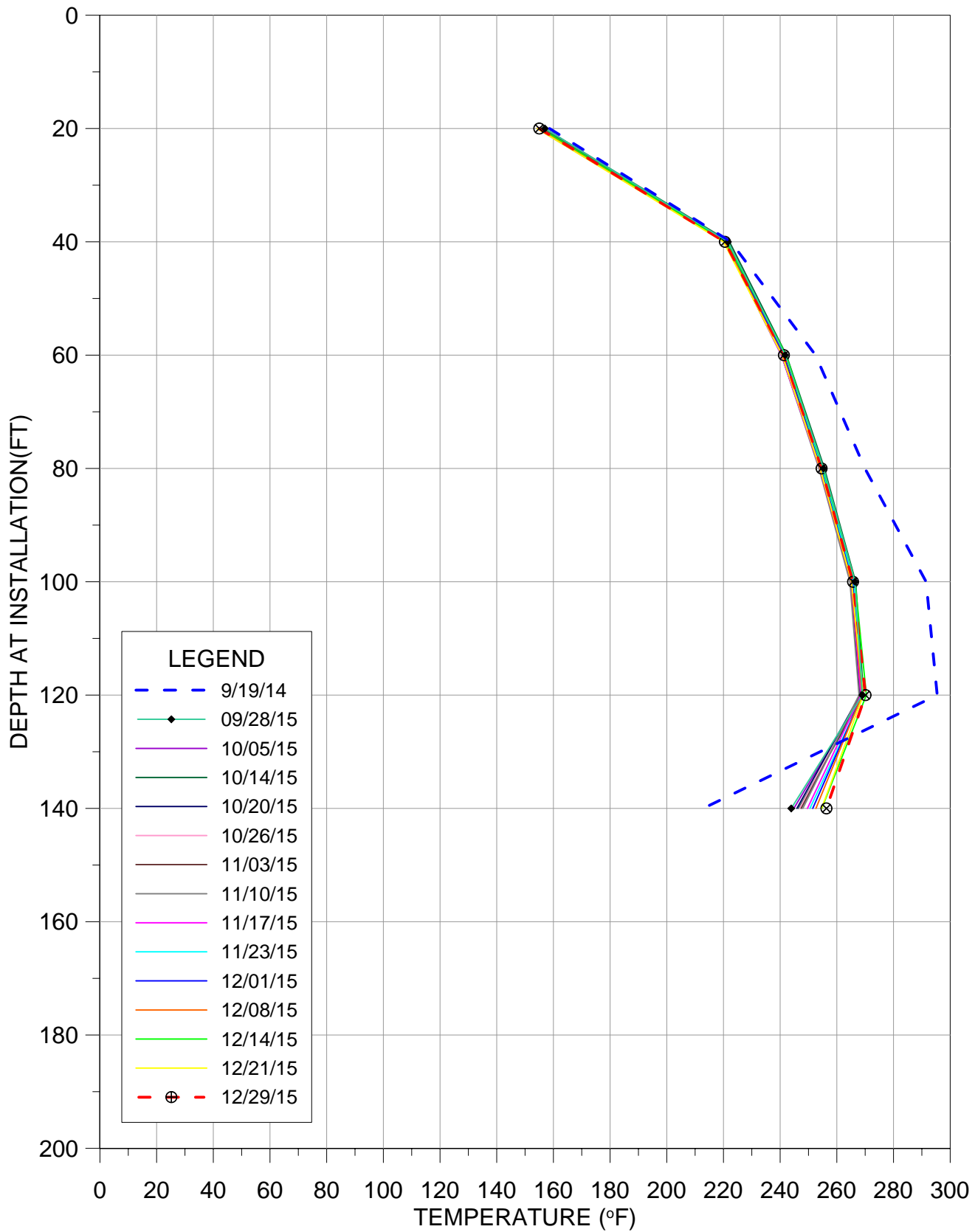
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-19



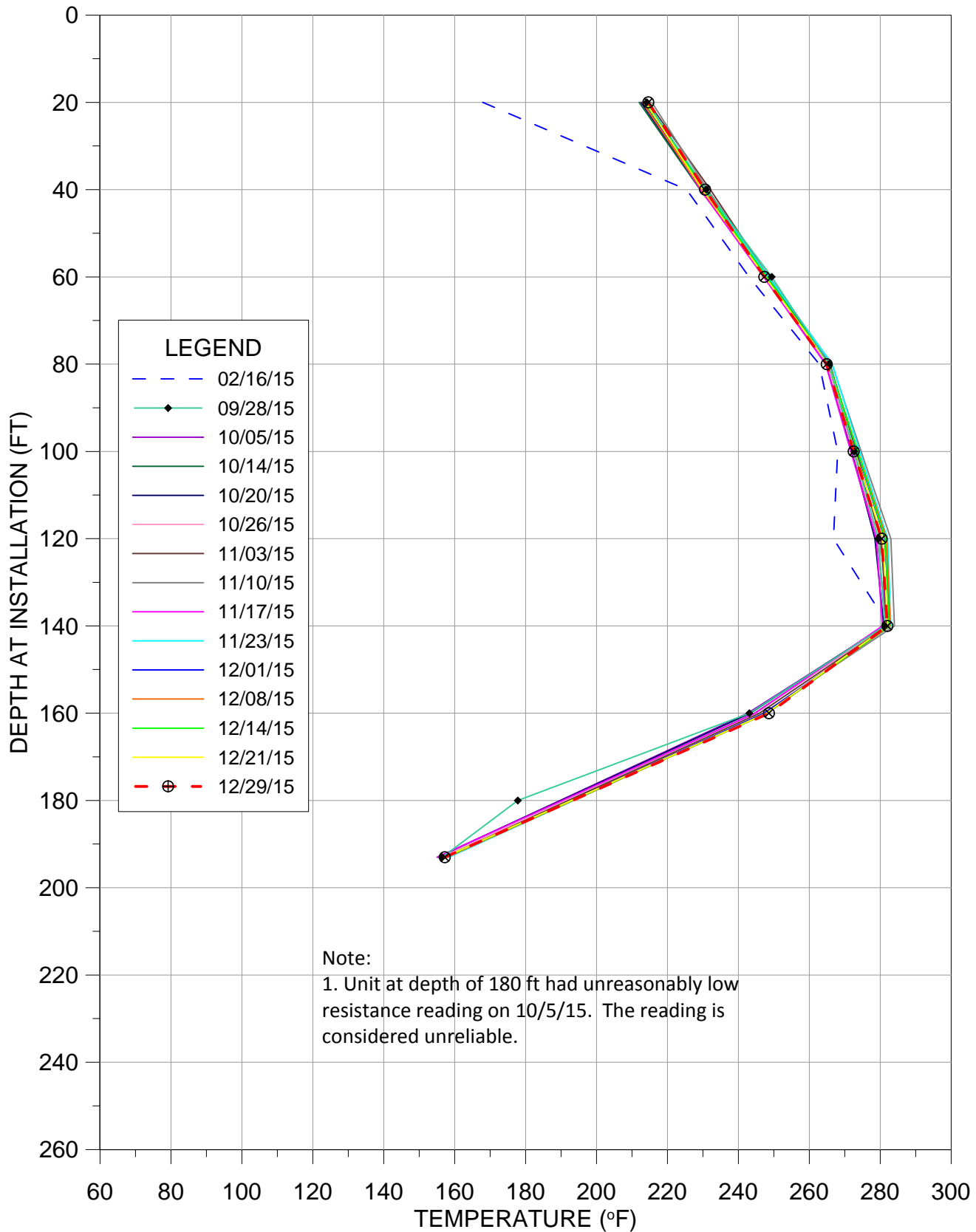
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-20



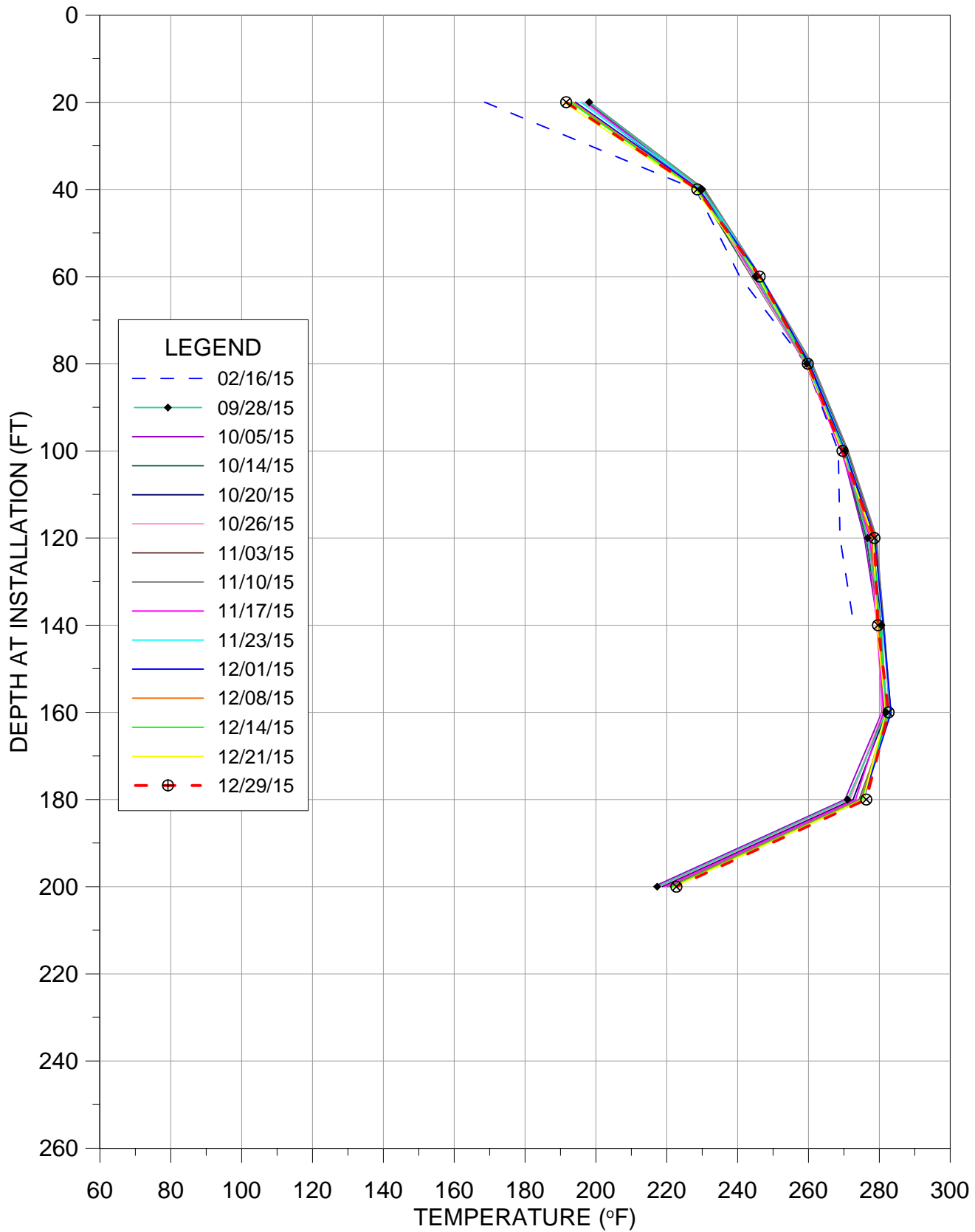
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-31



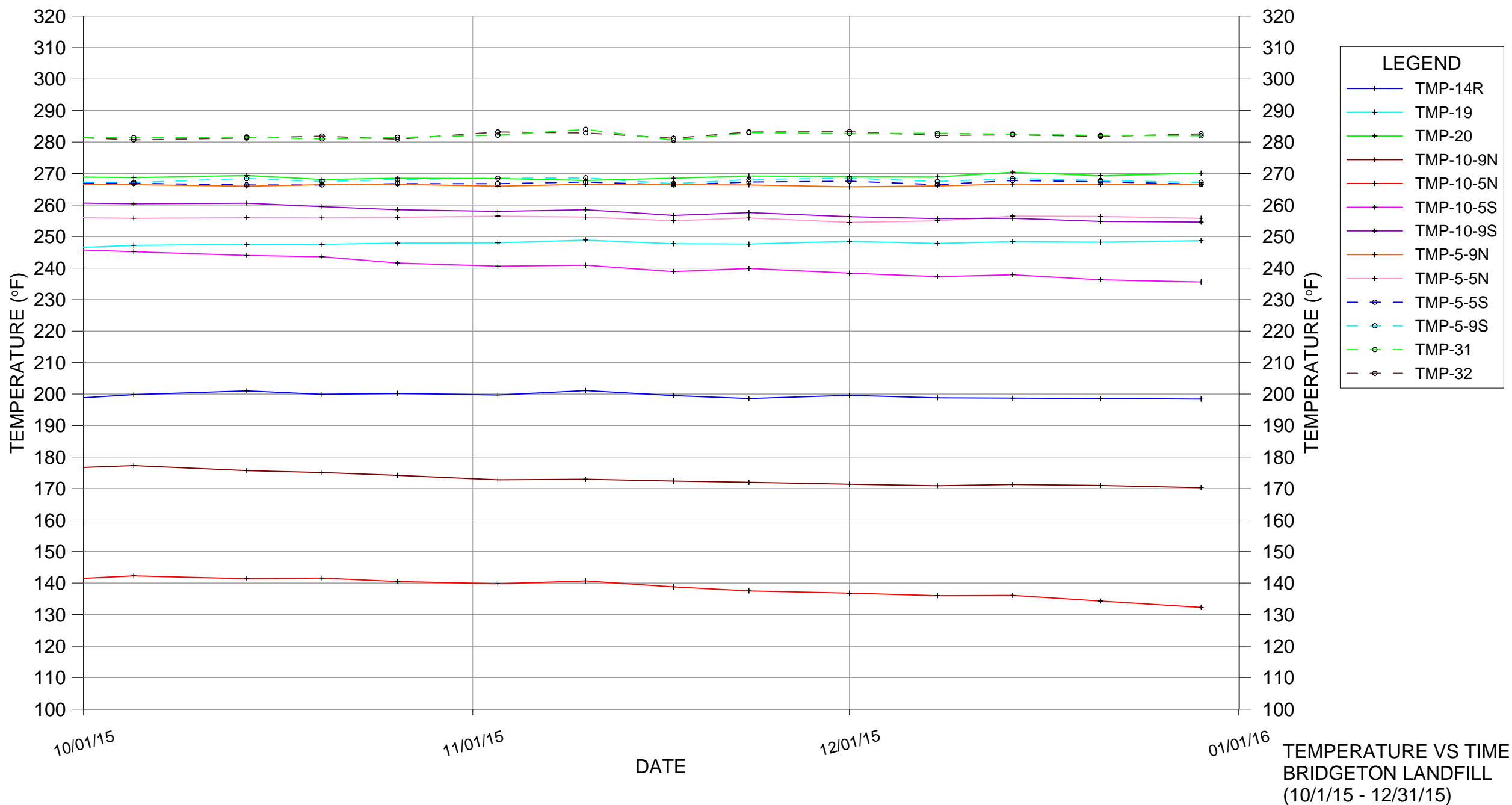
TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

TMP-32

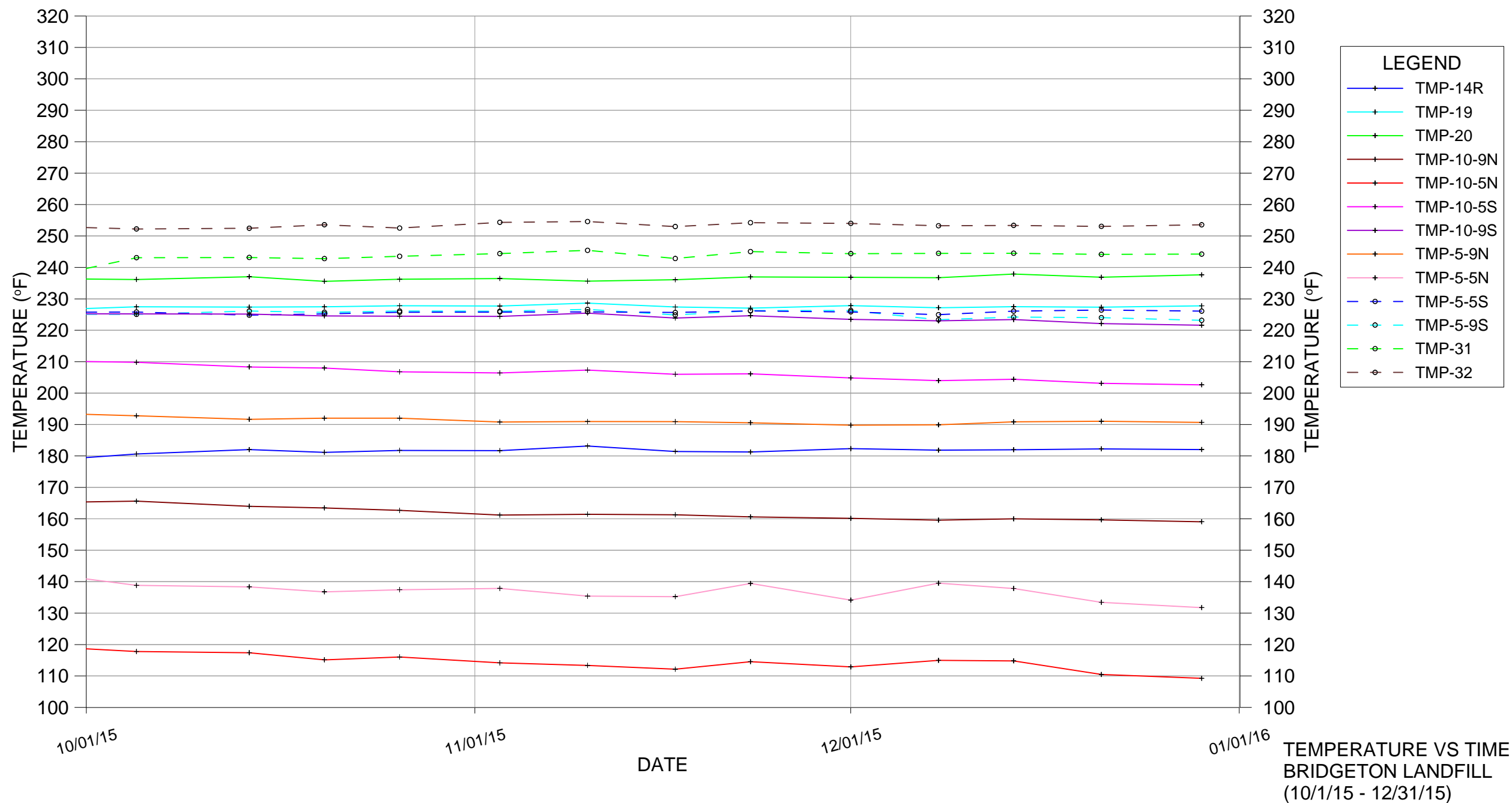


TEMPERATURE VS DEPTH
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

MAXIMUM TEMPERATURES

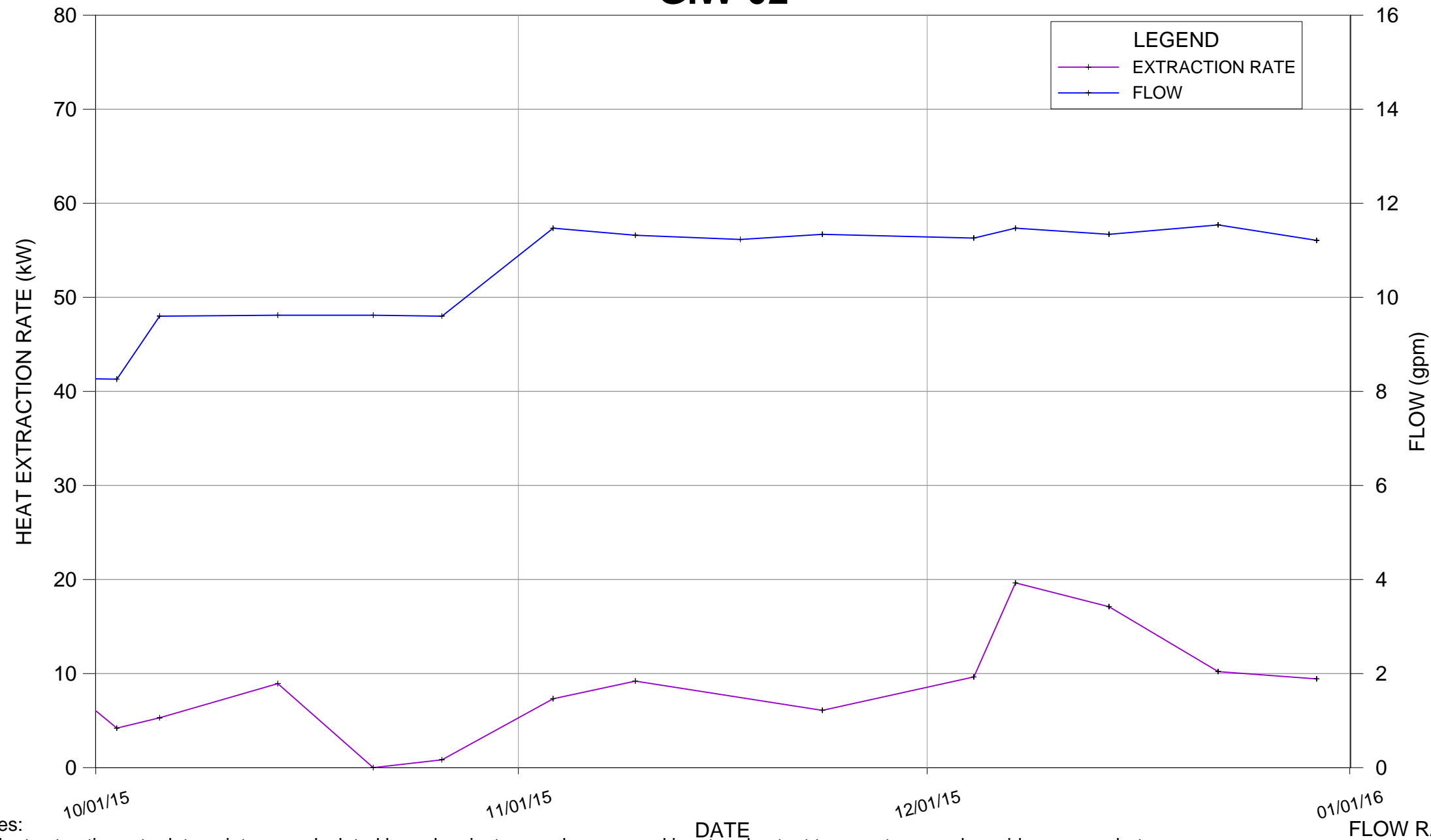


AVERAGE TEMPERATURES



Appendix B – Heat Removal Point Data Graphs (Fourth Quarter)

GIW-02

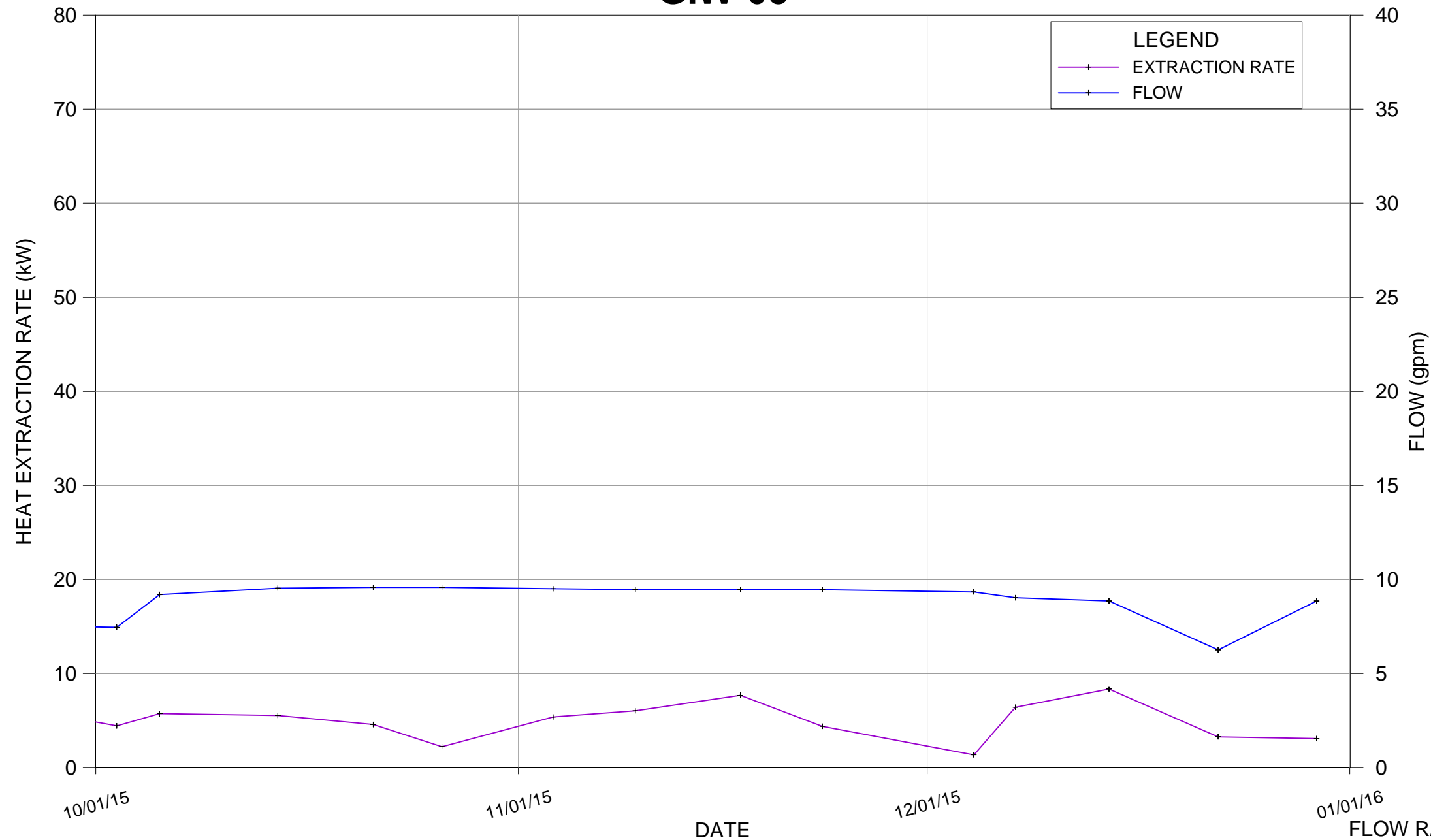


Notes:

- 1. Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.
- 2. The temperature reading for GIW-2 on 11/17/2015 was deemed unreliable based Feezor Engineering's review and comparison of prior and subsequent readings. Therefore, the heat extration rate for 11/17/15 was removed.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

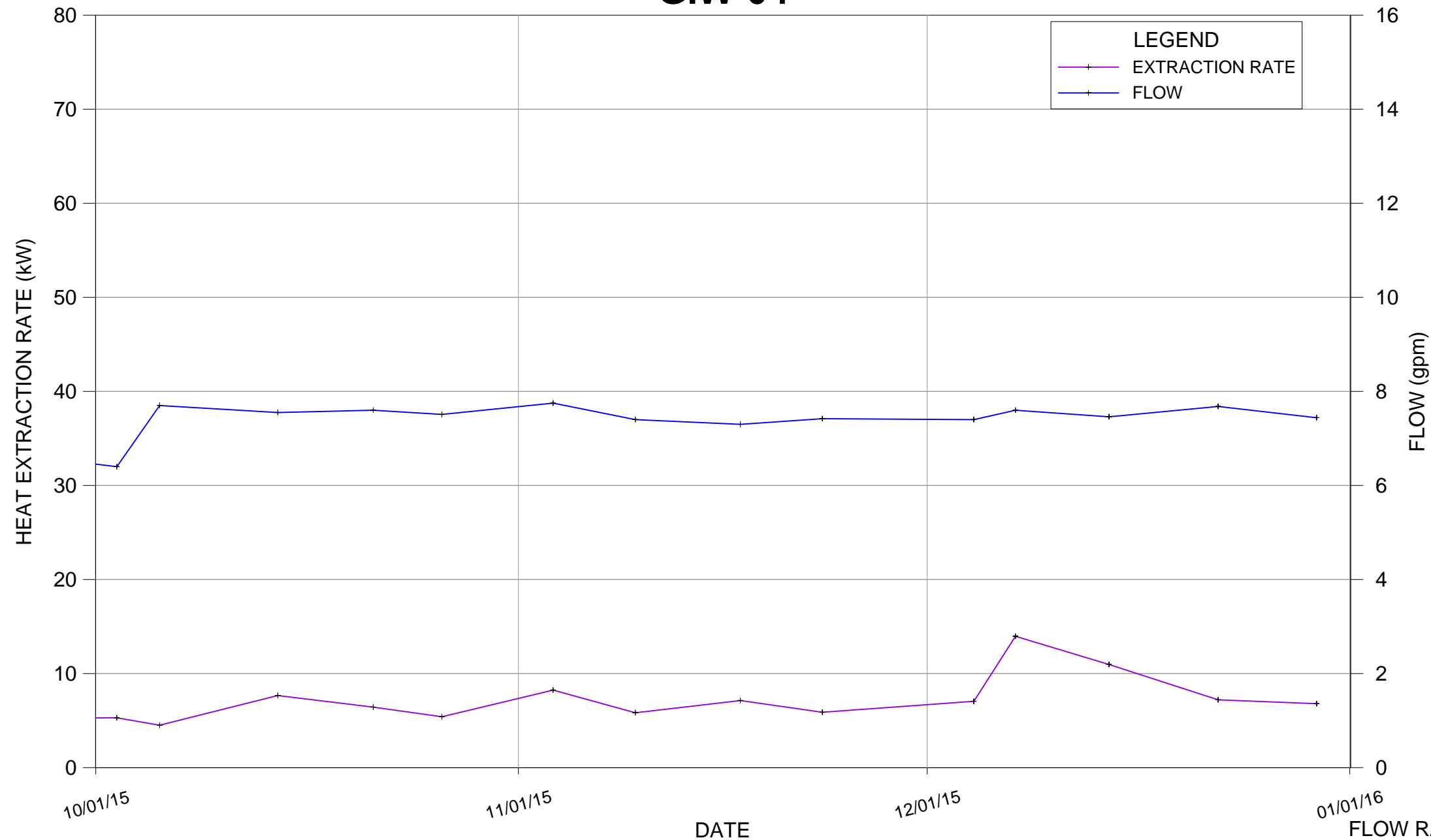
GIW-03



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

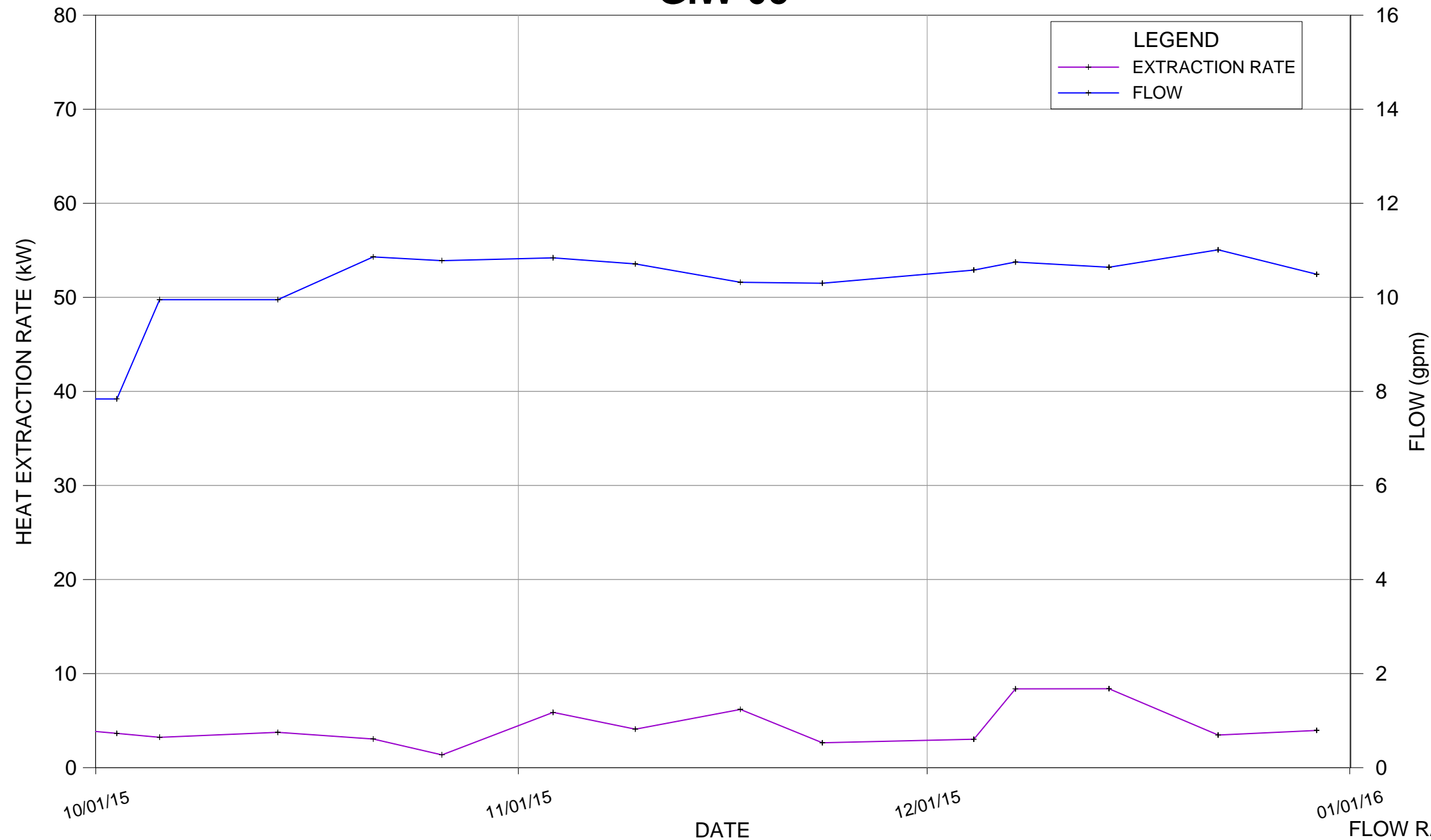
GIW-04



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

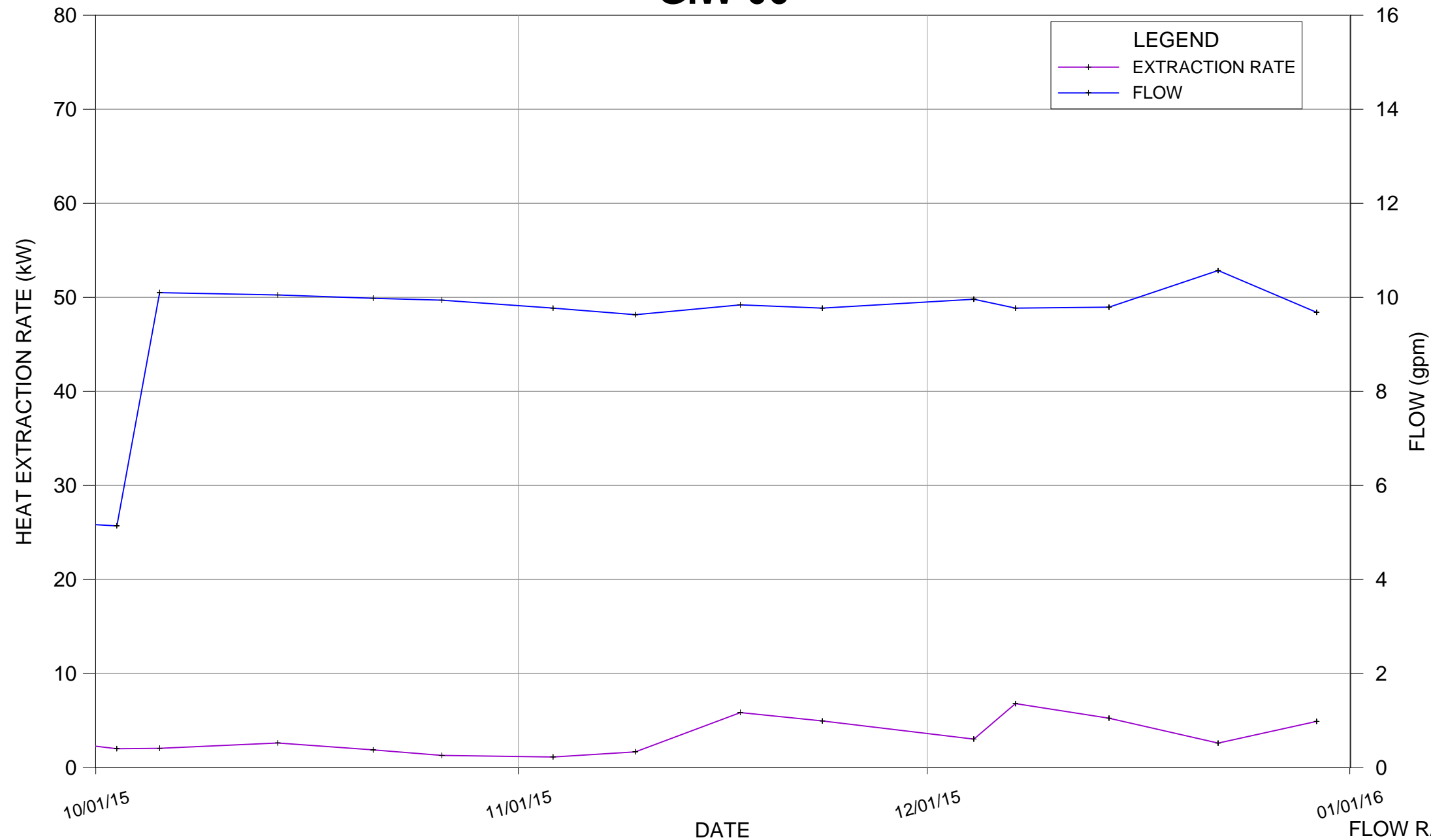
GIW-05



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

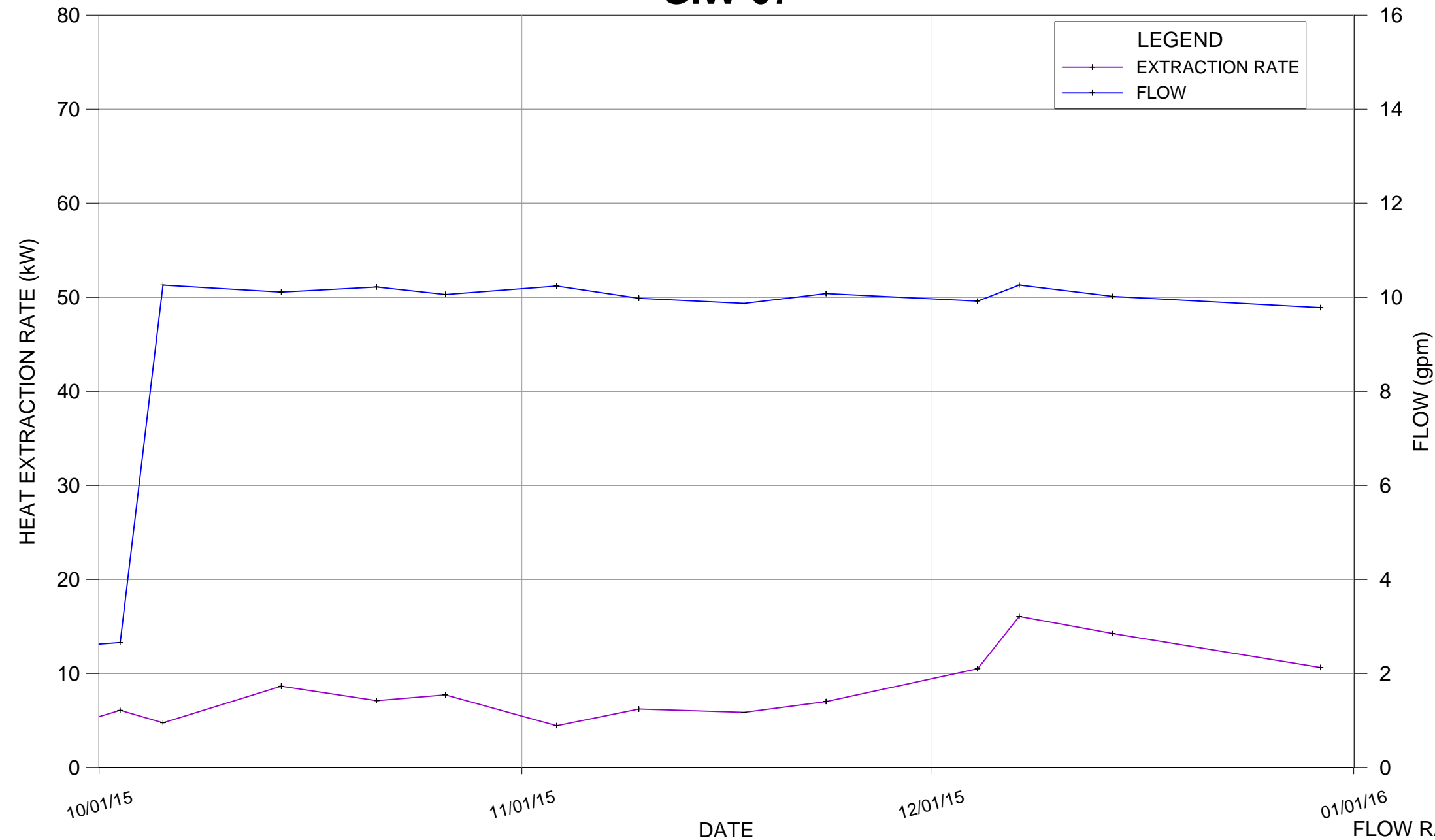
GIW-06



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

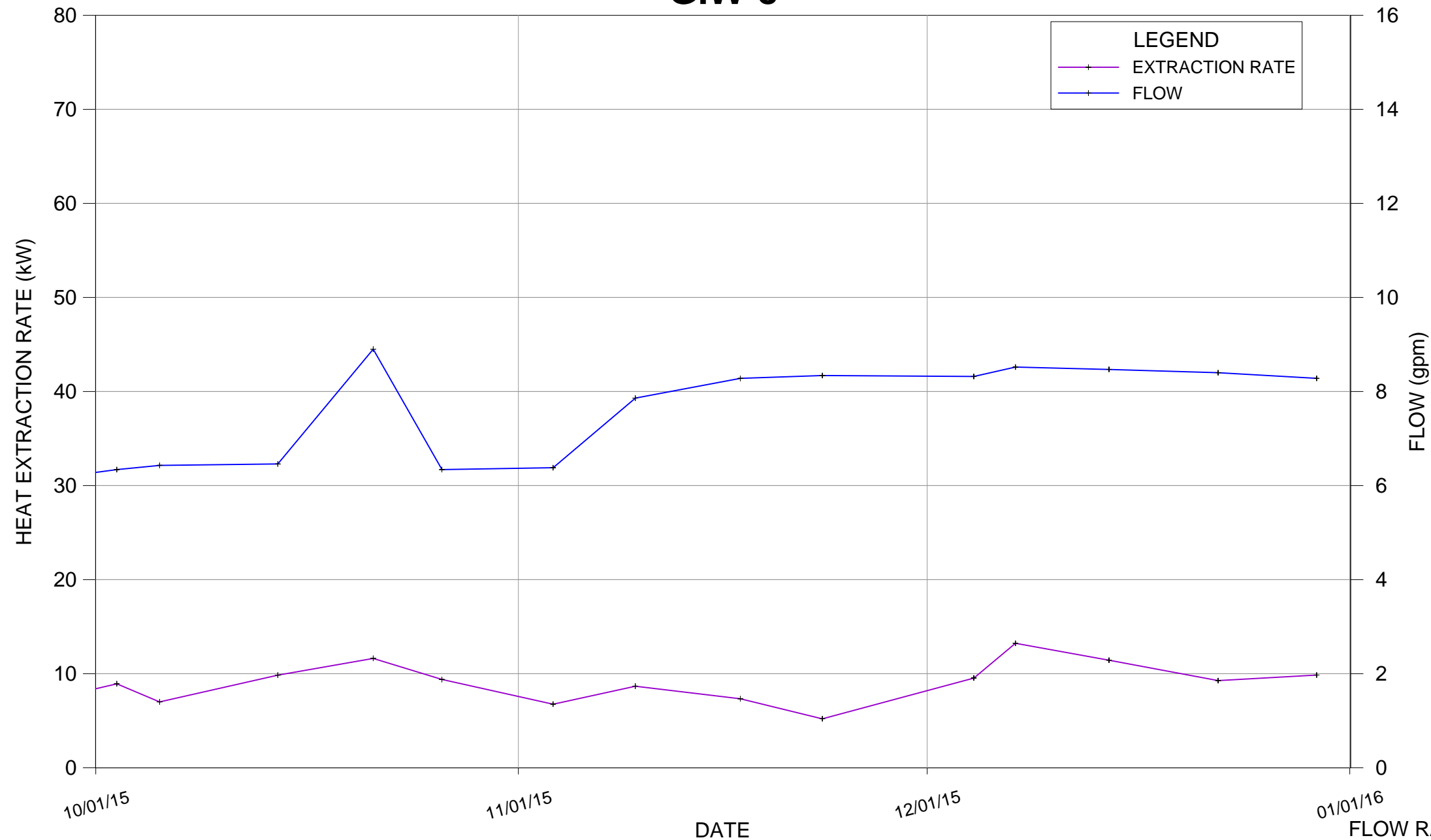
GIW-07



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

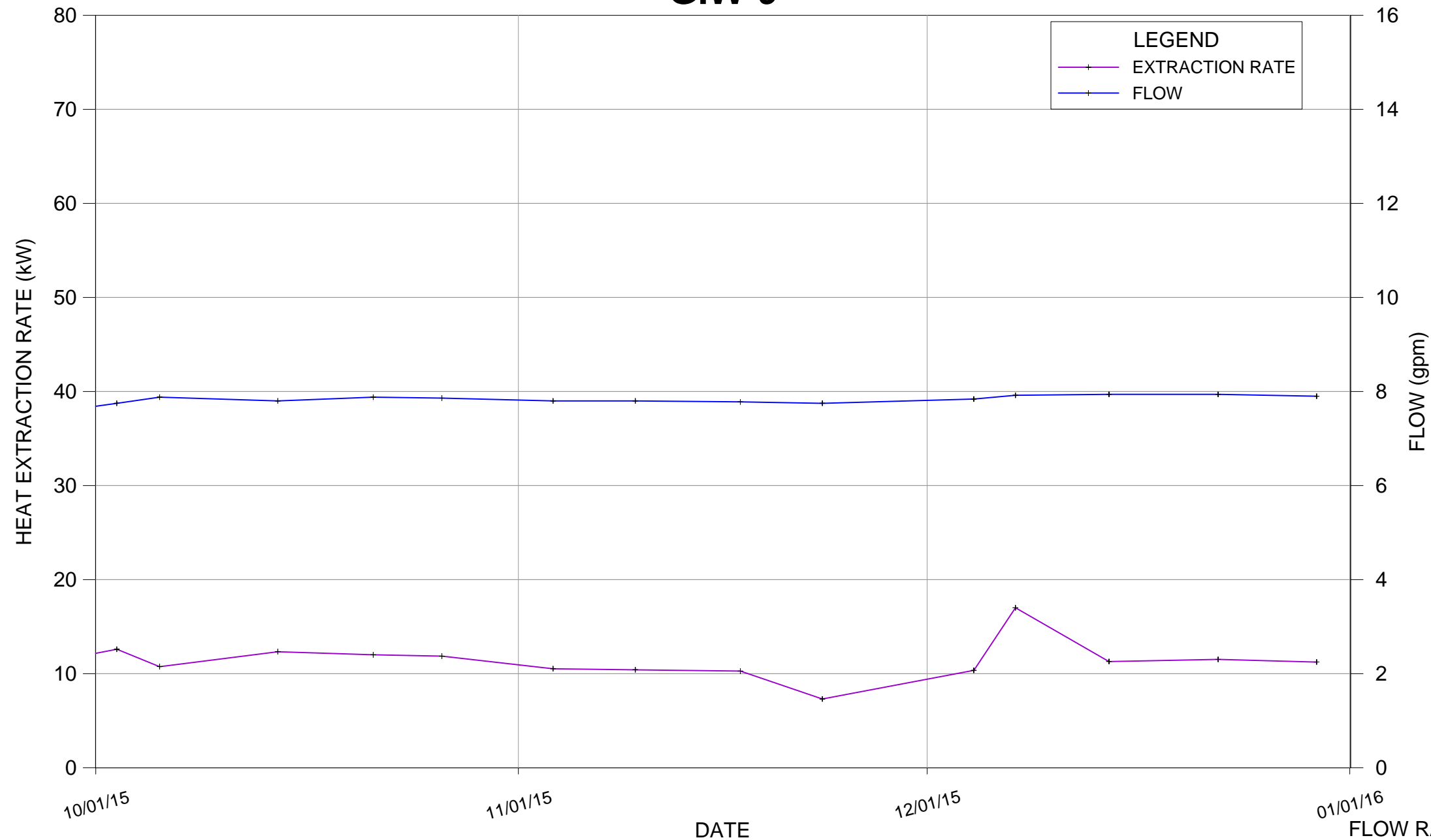
GIW-8



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

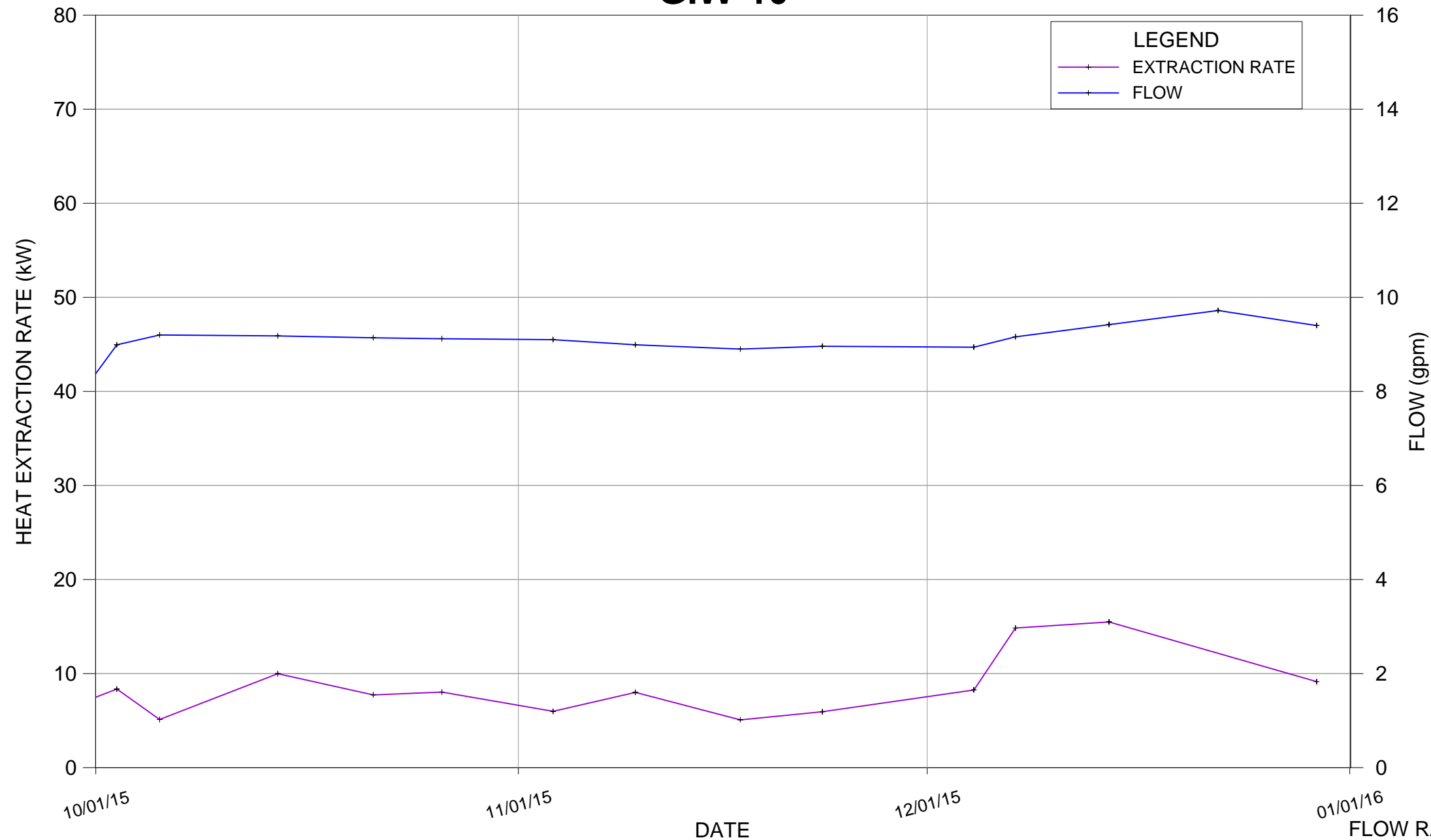
GIW-9



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT
EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

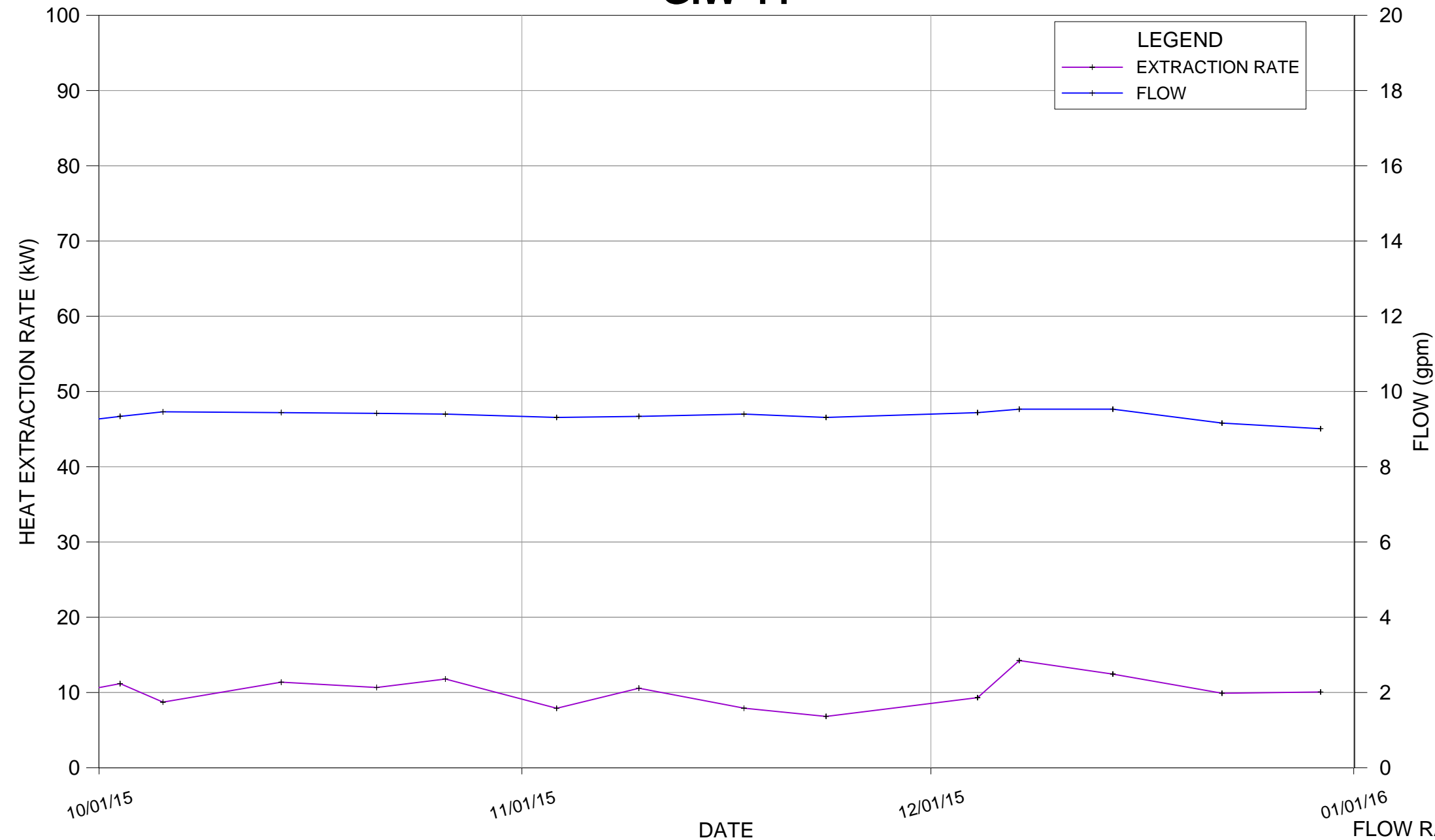
GIW-10



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

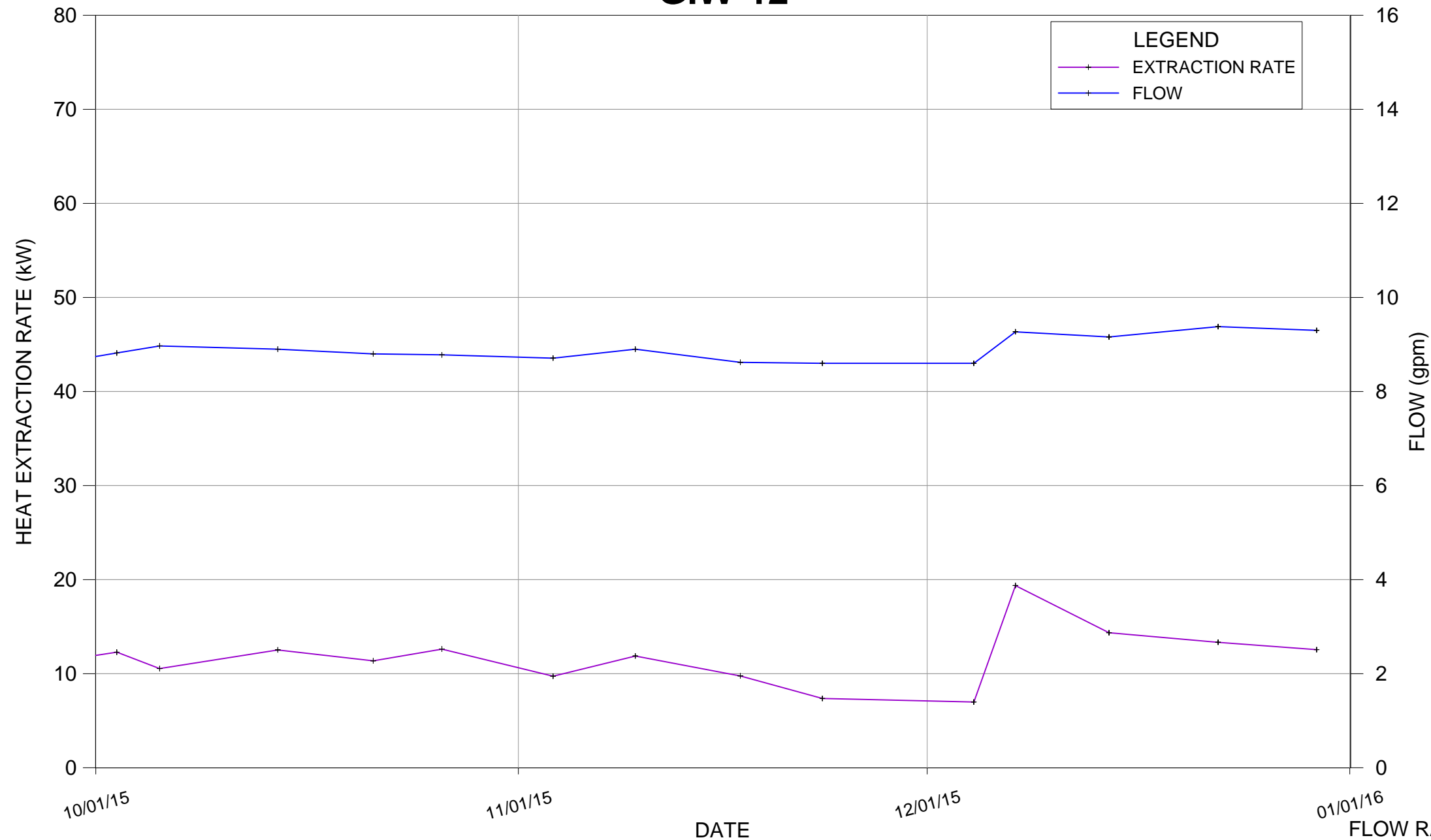
GIW-11



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

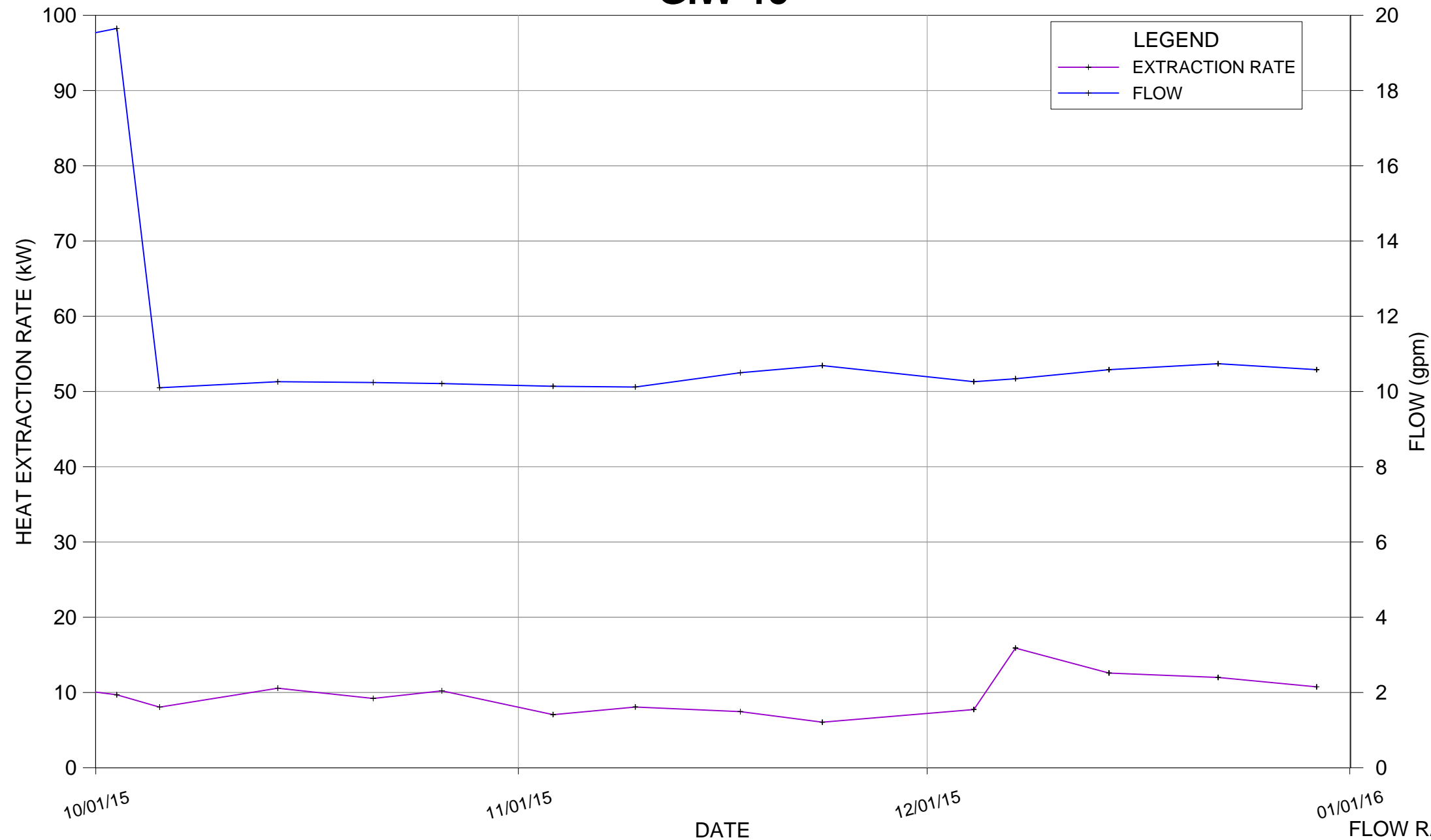
GIW-12



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

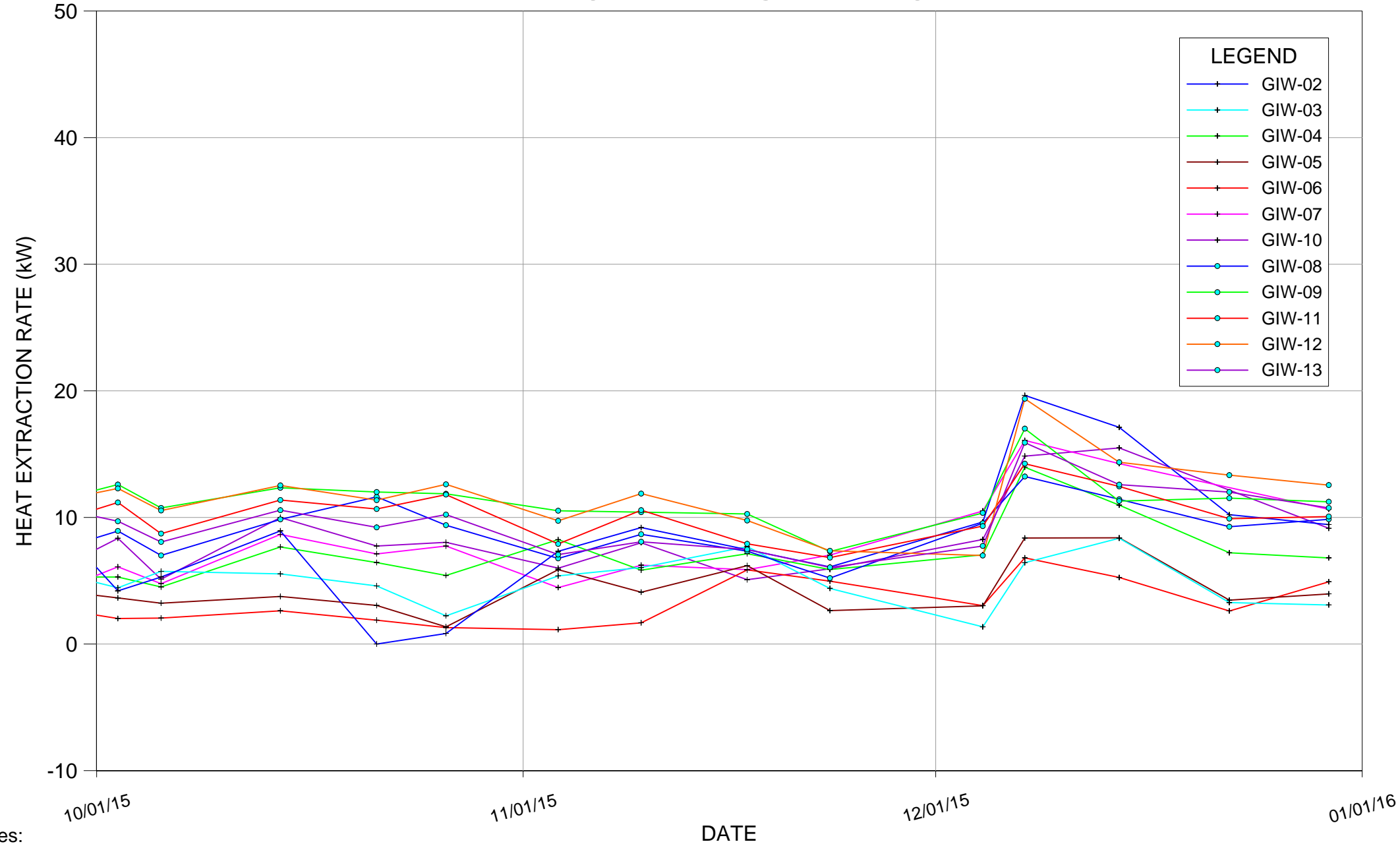
GIW-13



Note: Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.

FLOW RATE AND HEAT EXTRACTION VS TIME
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

RATE OF ENERGY REMOVAL

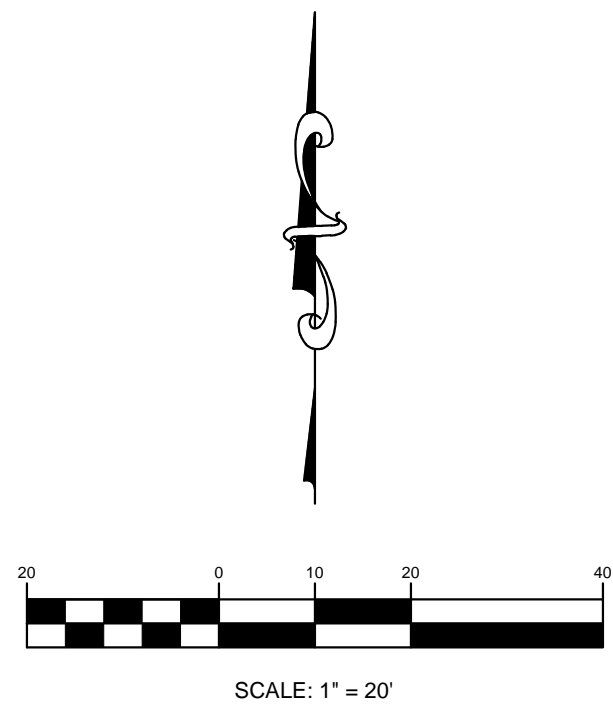
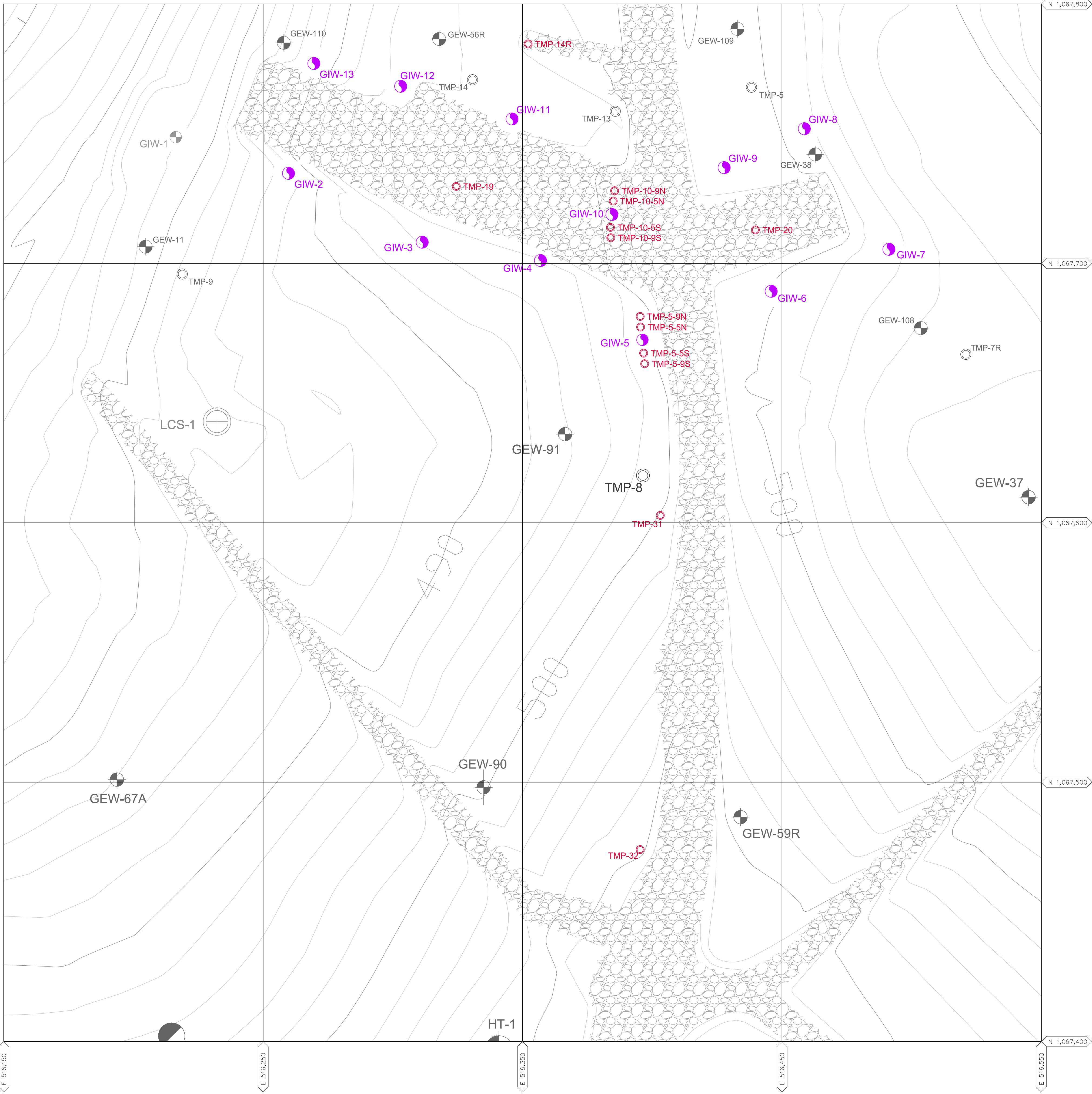


Notes:

1. Heat extraction rate data points are calculated based on instantaneously measured input and output temperatures and provide an snapshot. Input and output temperatures fluctuate and the heat extraction rate varies inbetween data points from the connecting lines shown.
2. The temperature reading for GIW-2 on 11/17/2015 was deemed unreliable based Feezor Engineering's review and comparison of prior and subsequent readings. Therefore, the heat extration rate for 11/17/15 was removed.

ENERGY REMOVAL RATE
BRIDGETON LANDFILL
(10/1/15 - 12/31/15)

Appendix C – Temperature Monitoring Probe Layout



LEGEND

- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- EXISTING GAS EXTRACTION WELL
- EXISTING GAS INTERCEPTOR WELL
- EXISTING TEMPERATURE MONITORING PROBE
- HEAT REMOVAL POINT WITHIN GAS INTERCEPTOR WELL
- PILOT STUDY TEMPERATURE MONITORING PROBE

TMP INSTALLATION			
ID	Northing	Easting	Depth (ft)
TMP-19	1067729.43	516324.34	140
TMP-14R	1067784.62	516352.17	140
TMP-20	1067712.59	516439.87	140
TMP-5-9S	1067661.16	516397.18	100
TMP-5-5S	1067665.2	516396.79	100
TMP-5-5N	1067675.28	516395.69	100
TMP-5-9N	1067679.41	516395.37	100
TMP-10-9S	1067709.77	516384.13	100
TMP-10-5S	1067713.85	516384	100
TMP-10-5N	1067723.9	516384.95	100
TMP-10-9N	1067727.77	516385.53	100
TMP-31	1067602.84	516403.11	192.96
TMP-32	1067474.00	516395.36	205.2

NOTES:
1.) AERIAL TOPOGRAPHY WAS PROVIDED BY COOPER AERIAL SURVEYS CO. AND IS DATED MARCH 20, 2014.

BRIDGETON LANDFILL, LLC
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

TEMPERATURE MONITORING PROBE
LAYOUT

FEEZOR
ENGINEERING, INC.
Engineering for a Better World

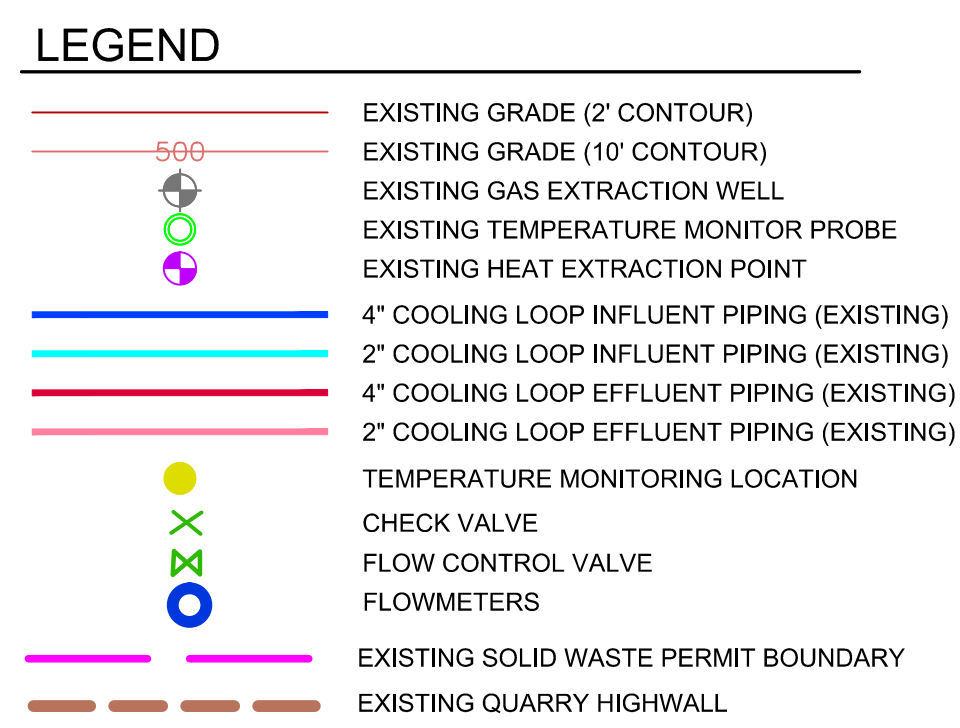
OCTOBER 2015
DESIGNED BY: AMR
APPROVED BY: ALK

REVISION
DATE

DRAWING NO.:
001

PROJECT NUMBER: BT-045 | FILE PATH:

Appendix D – Heat Removal System Plan View



Appendix E – Heat Extraction System Operating Log (Fourth Quarter)

BRIDGETON LANDFILL

Heat Extraction System Operating Log

Name: Arron Weber

Date: 10-2-15

Time: 14:00

Actions Taken or Observations:

GiW 13 tuned to 106pm from 206pm due to
a drop in temp since it was restarted

South Line back pressure valve was full open
& flows were low on the south line. I shut
the valve 3/4 to increase flow to the Wells.

BRIDGETON LANDFILL

Heat Extraction System Operating Log

Name: Arnon Weber

Date: 11-12-15

Time: 7:30

Actions Taken or Observations:

A power outage last night shut the
pump off. It was turned back on at
7:30