LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

GROUNDWATER RESOURCES
HYDROLOGY · DEVELOPMENT · MANAGEMENT

MEMORANDUM

DATE: March 13, 2018 PROJECT: 17-5-018

TO: Beth Gabor
Manager of Operations and Strategy
County of Yolo

FROM: William Gustavson, Principal Project Manager
Philip L'Amoreaux, Staff Engineer

SUBJECT: **RECOMMISSIONING OF THE CANVAS BACK AND PINTAIL PUMP STATIONS PERFORMANCE TESTING – WILD WINGS CSA**

BACKGROUND

This report summarizes findings of the performance testing conducted at the Canvas Back and Pintail pump stations located in Wild Wings Community Service Area (CSA). The testing was performed to determine the operational status of each of the well and pump stations as part of the process to develop updated operational and needed capital projects.

The Canvas Back pump station has been off-line for domestic water service duty due to water quality issues (exceedance of the Arsenic maximum contaminant level). The well has been utilized however to supplement treated water from the waste water treatment plant to irrigate the golf course. Though designed to be utilized independent of the well pump, the booster pumps and storage tank at Canvas Back have been off-line and fallen into disrepair.

Since the date Canvas Back was removed from the system, the Pintail well and pump station has been utilized to provide all of the potable drinking water for the system and to provide standby fire suppression service. This operational scenario has resulted in the lack of immediate system redundancy should the Pintail source suffer an operational failure and has lessened the fire suppression storage available that might be needed during a fire event.

In recognition of these issues, the County of Yolo engaged the services of Luhdorff and Scalmanini Consulting Engineers (LSCE) of Woodland to review the operation of the system, evaluate the physical condition of the system, develop a list of deficiencies, and assist the system operators in the correction of those deficiencies and recommissioning of the system. As part of the evaluation of the physical condition of the system all of the pumping equipment was performance and efficiency tested.

In an effort to bring the Canvas Back pump station back online, LSCE conducted a site evaluation of both the Canvas Back and the Pintail pump stations. From that evaluation, LSCE developed a list of items that needed correction, replacement and/or adjustment and provided recommendations for various improvements or the necessary steps required to place the equipment back into service. To that end, the services of Primex and Telstar were engaged to remedy issues with the SCADA system, replace a failed PLC at the Canvas Back pumping station and to calibrate the flow meters, pressure transducers and water level measuring equipment at both sites. The services of CorrPro were engaged to address the cathodic protection at both storage tanks and Kirby Pump and Mechanical was hired to service Booster No. 1 at the Canvas Back site (the pump was found to be in a frozen state) and to replace piping and service air compressors on both hydropneumatic tanks. All of the work was supervised and the performance testing of the well pumps and booster pumps at both the Canvas Back and Pintail sites was performed by LSCE.

In order to test the Pintail site, it was necessary to have the Canvas Back well and pumping station on line. The pumping station was recommissioned and tested prior to placing the station on-line. Current DDW regulation allow for a "standby" well to be utilized for a total of 15 days per year and no more than 5 consecutive days. The Canvas Back well was placed into temporary service on January 18 and pumped for 4 days, allowing the testing of the Pintail station to be completed. The use of the Canvas Back well and pumping station was closely monitored by the California State Water Board Division of Drinking Water (DDW).

The Canvas Back well pump performance testing was conducted on December 12, 2017. The following individuals were present for the testing: John Honea with National O&M, Inc., Lachi Richards (a Wild Wings resident and CSA board member), and Philip L'Amoreaux and Allison Cronk of LSCE. The Canvas Back booster pumps were performance tested on December 18, 2017. The following individuals were present for the booster testing: John Honea with National O&M, Inc., Jay and Matt with Kirby Pump and Mechanical, and Philip L'Amoreaux of LSCE.

The Pintail well pump and booster pumps were performance tested on January 19, 2018. The following individuals were present for the testing: John Honea with National O&M, and Philip L'Amoreaux with LSCE. Due to an issue with the small utility booster pump electrical, a performance test of that unit was not performed.

CANVAS BACK – WELL PUMP TESTING

The performance test was conducted at three flow rates to evaluate the hydraulic performance and overall pump efficiency. The flow rate was throttled using the gate valve located on the station piping downstream of the overboard lateral. Three flow rates were targeted to determine whether the field data matched the pump curve. The pump station instrumentation, a water level sounder, and the PGE meter were used to collect data for the performance test.

The hydraulic performance of the pump was evaluated from the flow rate and total dynamic head. The flow rate was read from the Siemens electromagnetic flow meter installed on the station piping. The total dynamic head was determined from the summation of the pumping water level, discharge pressure and calculated hydraulic losses (hydraulic losses were calculated using the Hazen Williams headloss formula).

The pumping water level water was manually measured using the well level sounder lowered through the sounding pipe located on the pedestal. The discharge pressure was determined from a pressure gauge installed on the station piping downstream of the flow meter and upstream of the gate valve.

Input horsepower was determined from the PGE meter kilowatt readings. The PGE meter represents the entire electrical load for the pump station. Thus, parasitic loads (i.e. building lighting, etc), were eliminated as practical so that the PGE meter represented the true electrical demand associated with the well pump. However, not all parasitic loads could be eliminated (e.g. the chemical feed pump). A summary of the testing is as follows:

Hydraulic Calculations Assumptions, and Pump and Motor Information:

- Pump model: Floway 12JKH, 3 stage, 1,400 gpm, 205 feet, Serial No. 53529-1-1; The pump bowl information obtained from the discharge head nameplate; The impeller trim was assumed to be the full trim of 9.056 inches.
- Motor: US Motors, 100 hp, 1785 rpm, 60 Hz, 460 volts, Model No. BF66, Catalog No. H0100V2SL6, Serial No. G06-BF66-M C5
- Pump Setting Depth: 220 feet below ground surface
- Suction Pipe Length: 200 feet below pump bowls
- Bowl Assembly Length: 3 feet and 9.5 inches
- Column and Suction Pipe Diameter: 10 inch
- Lineshaft Diameter: 1.5 inch
- Assumed Hazen Williams C-factor for the column piping = 120

Performance Testing Results

Hydraulic Performance Testing

Gallons Per Minute	Pumping Water Level (feet below groundsurface)	Discharge Pressure (pounds per square inch)	Hydraulic Losses (feet)	Total Dynamic Head (feet)
880	169	40	4	215
1,120	177	26	6	242
1,300	178	13	7	265

Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
880	59	60	80	73%
1,120	68	67	90	76%
1,300	70	70	93	76%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Pressure Transducer Calibration Verification

	Sounder (feet)	Pressure Transducer (feet)	Difference (feet)
SWL	130	178	48
PWL at 880 gpm	167	214	47
PWL at 1,120 gpm	175	221	46
PWL at 1,300 gpm	178	-	-

Note: A new pressure transducer was installed in the well to monitor well water levels. During the performance testing, the water levels were checked using an electric sounder with a higher difference of 47 feet in readings observed.

Findings and Recommendations for the Canvas Back Well and Pump

The well pump was observed to be running smoothly with no unusual noises noted. The performance tests indicated a performance that was matched closely to the original pump performance parameters. The findings include:

- The field total dynamic head at the lowest test flow rate of 880 gpm matched the head of the catalog curve. At highest test flow rate of 1,300 gpm the total dynamic head was about 15 feet lower than the catalog curve, less than 10% difference. In accordance with Hydraulic Institute Standards this is acceptable.
- The overall plant efficiency for the tested flow rates was calculated at the range of flow at 73% to 76%. This is considered excellent and no change in pumping equipment is recommended at this time.
- A comparison of the factory curve and the collected field data is attached as **Figure 1**.

It should be noted that water levels collected from SCADA and levels recently collected utilizing the well transducer have been suspect as to accuracy. This was confirmed by the use of a manual electric sounder. The measured difference was found to be 47 feet so earlier readings have been discounted as inaccurate as the transducer has been removed from the well in the past and it is obvious that no attempt at re-calibration of the depth was made. Reportedly, the operators have had issues with obtaining accurate water level readings in the past and has resulted in the transducers removed from the wells with no attempt to recalibrate the water level readings. It is always recommended the transducer be re-calibrated using an electric sounding as the baseline after replacement or annually to verify water levels. Given the observed inaccuracies of water level readings, all recorded long term trends are now suspect. It is in this light that we strongly recommend manual soundings be made on a bi-annual basis with an electric sounder and compared with recorded SCADA readings. From other work in the area performed by LSCE, a general lowering of the ground water basin in the area of Wild Wings has been observed possibly as a result of the drought and it is imperative that the water level be closely monitored to ensure the pump always has adequate submergence for proper operation.

Well water levels collected during the performance testing were projected to the 24-hour pumping water level and the specific capacity calculated for comparison to tests performed immediately after well construction. It should be noted that the specific capacity of the well has not changed since well construction indicating the well structure has maintained intake efficiency. The specific capacity data from the test was plotted and is shown on the attached **Figure 2**.

At a flow rate of about 1,310 gpm, the water level declined from a static of 133 feet below ground surface (bgs) to pumping level of 180 ft bgs after 30 minutes of pumping. The projected 24 hour pumping water level is 190 ft bgs though a scenario of the well running continuously for 24 hours has been and will continue to be a rare circumstance. The pump setting depth is 220 ft bgs, 30 feet lower than the projected 24-hour pumping water level, which is adequate for continued operation during the winter months, when area water levels are highest.

However, it is reported that prolong operation during the summer months (or higher demand periods) has resulted in water levels dropping by as much as an additional 35 to 40 feet. In order to keep the well pump from "breaking suction" the operators throttled the pumps to a lower capacity. The well pump may need to be lowered in the future to address the slow decline of static water levels throughout the area.

LSCE has analyzed the water demand for the community and the golf course. The demand appears to have increased over time. The basic premise in water works design is that given adequate storage, source capacity must equal the maximum day demand with storage providing resident storage for daily "peaking" demands. In that light it appears the Canvas Back well has adequate capacity to provide backup water for the golf course and can be a reliable source once the Arsenic removal issue is addressed. Since there may be changes in the hydraulic conditions with the installation of an arsenic system, it is recommended changes to the well pumping equipment be re-visited at that time.

CANVAS BACK - BOOSTER PUMP TESTING

There are two booster pumps located at the Canvas Back pump station. The pumps have identical design points producing 1,900 gpm at 165 feet (i.e. about 72 psi). During normal operation, the pump is supplied water through a 20-inch suction manifold from the storage tank. The booster pumps discharge water into a 12-inch manifold, connected to the hydropneumatic tank, which provides pump cycle control before water is introduced into the distribution system.

During the performance testing, the water was discharged to the storage tank (i.e. circulating flow), the storm sewer system through a 4-inch line, and by opening the fire hydrant located in Canvas Back court. The flow rate was regulated using the 10-inch gate valve, located immediately downstream of the discharge head. A 200 psi pressure gauge was installed on the discharge head to monitor the discharge pressure. The suction line pressure was estimated from the storage tank level (about 20 feet) and the calculated hydraulic head loss through the suction line. A summary of the testing is as follows:

Hydraulic Calculations Assumptions, and Pump and Motor Information:

- Pump Information for both booster pumps:
  - Model: Floway 14DHK, 3 stage, 7.878-inch impeller trim
  - Discharge Head Nameplate: 1,900 gpm, 165 feet
  - Best Efficiency Point: 1,700 gpm, 187 feet, 86% efficient
  - Booster Pump #1 (Right): Serial No. 55154-3-2
  - Booster Pump #2 (Left): Serial No. 55154-3-3
- Motor: US Motors, 100 hp, 1785 rpm, 60 Hz, 460 volts, Model No. 7222-BEM
- For determination of system head losses due to friction, a Hazen Williams C-factor of 120 was utilized in head-loss calculations.

CANVAS BACK BOOSTER PUMPS

A summary of the test results is as follows:

Booster Pump #1 (Right) - Hydraulic Performance Testing

Gallons Per Minute	Suction Head (feet)	Discharge Pressure (pounds per square inch)	Total Dynamic Head (feet)
1,050	20	108	229
1,400	20	100	211
1,700	20	90	188

Note: The estimated hydraulic losses were less than 1 foot and therefore not included in the total dynamic head calculations.

Booster Pump #1 (Right) – Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
1,050	61	67	90	67%
1,400	74	77	103	72%
1,700	81	76	101	79%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Booster Pump #2 (Left) – Hydraulic Performance Testing

Gallons Per Minute	Suction Head (feet)	Discharge Pressure (pounds per square inch)	Total Dynamic Head (feet)
1,725	20	90	188
1,900	20	81	167
2,140	20	70	141

Note: The estimated hydraulic losses were less than 1 foot and therefore not included in the total dynamic head calculations.

Booster Pump #2 (Left) – Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
1,725	82	76	101	81%
1,900	80	77	103	78%
2,140	76	77	103	74%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Findings and Recommendations for the Canvas Back Booster Pumps

Both the booster pumps were observed to be running smoothly with no unusual noises noted. The performance tests indicated a performance that was matched closely to the original pump performance parameters. Booster pumps are designed to produce the greater of either the peak hour demand or the maximum day demand plus the fire flow. For Wild Wings the pumps were designed to provide adequate system flow and pressure during the maximum day plus fire flow (or 1,500 gpm for fire flow plus 376 gpm for maximum day demand) and maintain a minimum residual system pressure of 20 psig. Both pumps have been found to be capable of providing the originally defined flows. Of interest is that the pumps, as tested, are also capable of producing the currently calculated maximum day demand of 376 gallons per minute plus the fire flow of 1,500 gpm. This is accomplished as one booster pump from one site would be supplemented from one booster pump from the other site (operation initiated with dropping pressure).

The overall plant efficiency for both pumps is excellent, and no recommendations are made at this time to make any modifications to the boosters. The performance data for the booster pumps was plotted and is illustrated on **Figures 3** and **4**.

Having said that, an alternate operational scenario can be pursued by the County; consisting of removing one of the booster pumps at Canvas Back and replacing it with a smaller pump installed in the vacant can. The booster would be controlled by a variable frequency drive unit to maintain a fairly constant pressure in the system, eliminate pump cycling and offering a power savings over time. A small booster pump would be sized to provide water during normal periods of higher demand and supplemented by the larger boosters during the maximum day plus fire or peak hour demand, whichever is greater. The existing booster would be stored as a spare to replace the other units. This would provide redundancy for the small booster at the Pintail site. Though not included in the Capital Improvement Plan the estimated cost for this option is approximately $35,000 to $40,000.

PINTAIL – WELL PUMP TESTING

The Pintail well pump performance testing was conducted in a similar fashion to the Canvas Back well pump. Data was collected at three flow rates to evaluate the hydraulic performance and overall pump efficiency. The pump station instrumentation, a water level sounder, and the PGE meter were used to collect data for the performance test.

The hydraulic performance of the pump was evaluated from the flow rate and total dynamic head. The flow rate was read from the Siemens electromagnetic flow meter installed on the station piping. The total dynamic head was determined from the pumping water level, discharge pressure and calculated hydraulic losses (hydraulic losses were calculated using the Hazen Williams headloss formula).

The pumping water level water was manually measured using the well level sounder lowered through the sounding pipe located on the pedestal. The discharge pressure was determined from a pressure gauge installed on the station piping downstream of the flow meter and upstream of the gate valve.

Input horsepower was determined from the PGE meter kilowatt readings. The PGE meter represents the entire electrical load for the pump station, and while parasitic loads were eliminated as much as possible and thus parasitic loads were included in the kilowatt readings. The overall plant efficiency has some minor inaccuracies. A summary of the testing findings is as follows:

- Pump model: Floway 12DKH, 5 stage, 1,200 gpm, 245 feet, Serial No. 55154-1-1
- The pump bowl information obtained from the discharge head nameplate. The impeller trim was assumed to be the full trim of 7.451 inches.
- Motor: US Motors, 100 hp, 1785 rpm, 60 Hz, 460 volts, Serial No. H07-03046040-100R-01
- Pump Setting Depth (length to top of bowls): 270 feet below groundsurface
- Suction Pipe and Strainer Length: 12 feet and 4.5 inches
- Suction Inlet Depth: 287.25 feet below groundsurface
- Bowl Assembly Length: 4 feet and 10.25 inches
- Column and Suction Pipe Diameter: 10 inch
- Lineshaft Diameter: 1.5 inch
- To calculate head losses due to friction, a Hazen Williams C-factor of 120 was utilized.
- The field total dynamic head at the three tested flow rates matched the factory pump curve within 5%. This is acceptable under the guidelines of the Hydraulic Institute.
- The overall plant efficiency for the tested flow rates was estimated at 70% to 72%. This is also acceptable.
- Refer to the following tables and the attached **Figure 5** for a comparison of the factory curve and the field data.

Hydraulic Performance Testing

Gallons Per Minute	Pumping Water Level (feet below groundsurface)	Discharge Pressure (pounds per square inch)	Hydraulic Losses (feet)	Total Dynamic Head (feet)
1,025	191	34	5	274
1,130	194	26	6	260
1,250	194	14	7	233

Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
1,025	71	76	101	70%
1,130	74	77	103	72%
1,250	74	77	103	71%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Findings and Recommendations for the Pintail Well Pump

All of the pumping equipment was observed to be operating smoothly with no unusual noises noted. The well water levels were monitored to evaluate the long term pumping effects. The static level was recorded prior to turning on the well pump, and pumping water levels were recorded for 20 minutes thereafter. The water levels were projected to estimate the 24-hour specific capacity. At a flow rate of 1,250 gpm, the 24-hour specific capacity was estimated at 15.6 gallon per minute per foot of drawdown. In 2003, the projected 24-hour specific capacity was 16.9 gpm per foot of drawdown at a flow rate of 1,117 gpm. The specific capacity of the well is shown on the attached **Figure 6**.

While the 24-hour specific capacity has not declined since the well was constructed in 2003, the static and pumping water levels have declined. In September 2003, the static water level was measured at 103 feet below ground surface, and at a flow rate of 1,117 gpm the projected 24-hour pumping water level was 170 feet. In January 2018, the static water level was measured at 138 feet below ground surface, and at a flow rate of 1,250 the project 24-hour pumping water level was 218 feet. Even though the projected pumping water level has declined, there is about 69 feet above the suction inlet. However, this testing occurred during the winter months. During the summer months (especially during September and October), the water levels have been measure to be only 20 feet above the bowl.

Though the well pump is operating properly and very efficiently, given the uncertainty of long term water levels within the county and with drier spells predicted due to climate change, it is recommended the pump setting depth be extended to 300 feet bgs.

PINTAIL – BOOSTER PUMP TESTING

There are two booster pumps located at the Pintail pump station. For redundancy, these pumps are identical to the booster pumps located at the Canvas Back site. A smaller booster pump was installed a few years ago to eliminate pump cycling and save on pumping costs. It was not possible to test this pump as there were apparently some electrical issues which have not been resolved as of this writing.

The performance test data was collected using the pump station instrumentation. The flow rate was recorded using the Siemens flow meter installed on the inlet piping to the hydropneumatic tank, the discharge pressure was determined from a pressure gauge installed on the discharge head, and the suction pressure was determined from the storage tank level and hydraulic losses through the suction line. The flow rate was throttled using the gate valve located downstream of the discharge head. The findings are as follows:

- Pump Information for both booster pumps:
  - Model: Floway 14DHK, 3 stage, 7.878-inch impeller trim
  - Discharge Head Nameplate: 1,900 gpm, 165 feet
  - Best Efficiency Point: 1,800 gpm, 176 feet, 86% efficient
  - Booster Pump #1 (Right): Serial No. 55154-3-1
  - Booster Pump #2 (Left): Serial No. 55154-3-4
- Motor: US Motors, 100 hp, 1785 rpm, 60 Hz, 460 volts, Model No. 7222-BEM
- For the purpose of determining head losses due to friction, a Hazen Williams C-factor of 120 was utilized in friction loss calculations.
- Booster Pump #1 (Right), the field total dynamic head was about 7 to 13 feet lower than the factory pump curve. This is about 4% to 7% difference.

- The overall plant efficiency for Booster Pump #1 (right) ranged from 63% to 77% at the tested flow rates.
- Booster Pump #2 (Left), the field total dynamic head was about 2 to 13 feet lower than the factory pump curve. This is about 1% to 7% difference.
- The overall plant efficiency for Booster Pump #2 (left) ranged from 62% to 77% at the tested flow rates.
- See following tables and the attached curves compare the factory curve and the obtained field data.

PINTAIL BOOSTER PUMPS

Booster Pump #1 (Right) - Hydraulic Performance Testing

Gallons Per Minute	Suction Head (feet)	Discharge Pressure (pounds per square inch)	Total Dynamic Head (feet)
1,130	23.5	100	207
1,350	23.6	95	196
1,730	23.7	85	172

Note: The estimated hydraulic losses were less than 1 foot and therefore not included in the total dynamic head calculations.

Booster Pump #1 (Right) – Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
1,130	59	70	93	63%
1,350	67	74	100	67%
1,730	75	77	103	73%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Booster Pump #2 (Left) – Hydraulic Performance Testing

Gallons Per Minute	Suction Head (feet)	Discharge Pressure (pounds per square inch)	Total Dynamic Head (feet)
1,060	23.1	102	212
1,620	23.2	90	184
1,780	23.4	85	173

Note: The estimated hydraulic losses were less than 1 foot and therefore not included in the total dynamic head calculations.

Booster Pump #2 (Left) – Overall Plant Efficiency

Gallons Per Minute	Water Horsepower	Plant Total Input kW	Plant Total Input HP	Overall Plant Efficiency
1,060	57	68	92	62%
1,620	75	74	100	76%
1,780	78	76	101	77%

Note: The plant total input kW was determined from the PGE meter. Thus, the input kW represents the electrical demand of the entire pump station. While the lights and AC units were turned off, not all parasitic loads could be eliminated.

Findings and Recommendations for the Pintail Site Booster Pumps

The booster pump performance testing indicated the field total dynamic head was lower than the factory curve (See **Figures 7** and **8**), and the overall plant efficiencies were lower than expected and reflect continued operation since the Canvas Back well station was taken off-line. In other words, the performance has decreased due to not sharing the operational load with Canvas Back. However, the efficiencies are still considered good, but the pumps will need to be serviced in the next few years.

It is recommended that annual testing of the boosters be performed, and an annual evaluation/analysis be performed to ascertain an acceptable payback period for the anticipated repair costs.

The small booster pump variable frequency drive requires servicing and the pump speed should be reprogrammed to 60 Hz from the current 55 Hz. During periods of higher demand, the small booster is not able to keep up with the demand, resulting in the water level dropping to below the tank air release valve port and releasing air. Compounding this issue is that the continued dropping of the level (and corresponding drop in system pressure) causes the larger booster pump to cycle. This mode of operation is very inefficient. With the proper speed adjustment of the small booster pump, the water level should be maintained in the tank with no resulting discharge of air nor cycling of the larger booster pump.

FIGURES

Figure 1

Canvas Back Well Pump Performance Curve

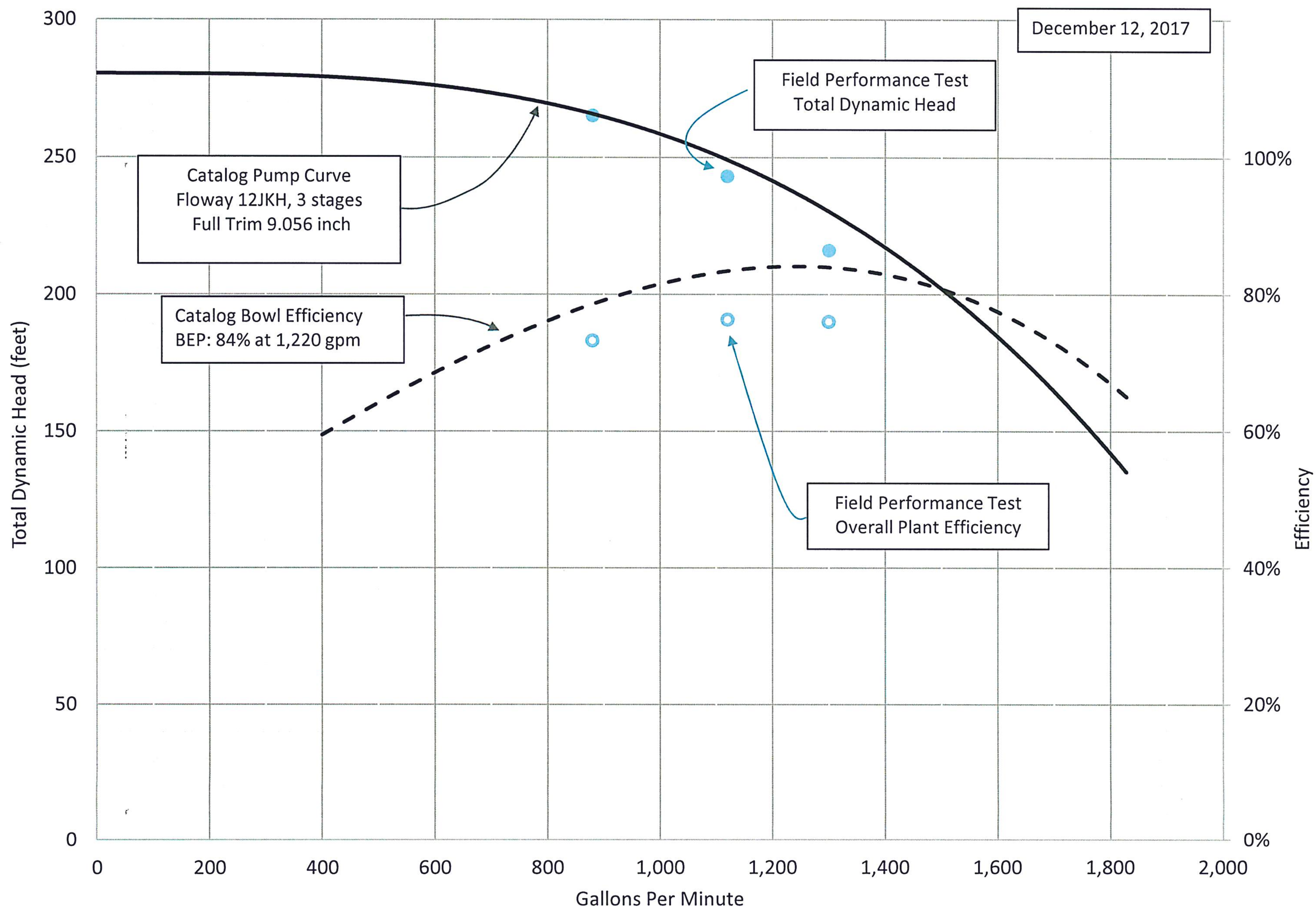


Figure 2

Canvas Back Well Specific Capacity

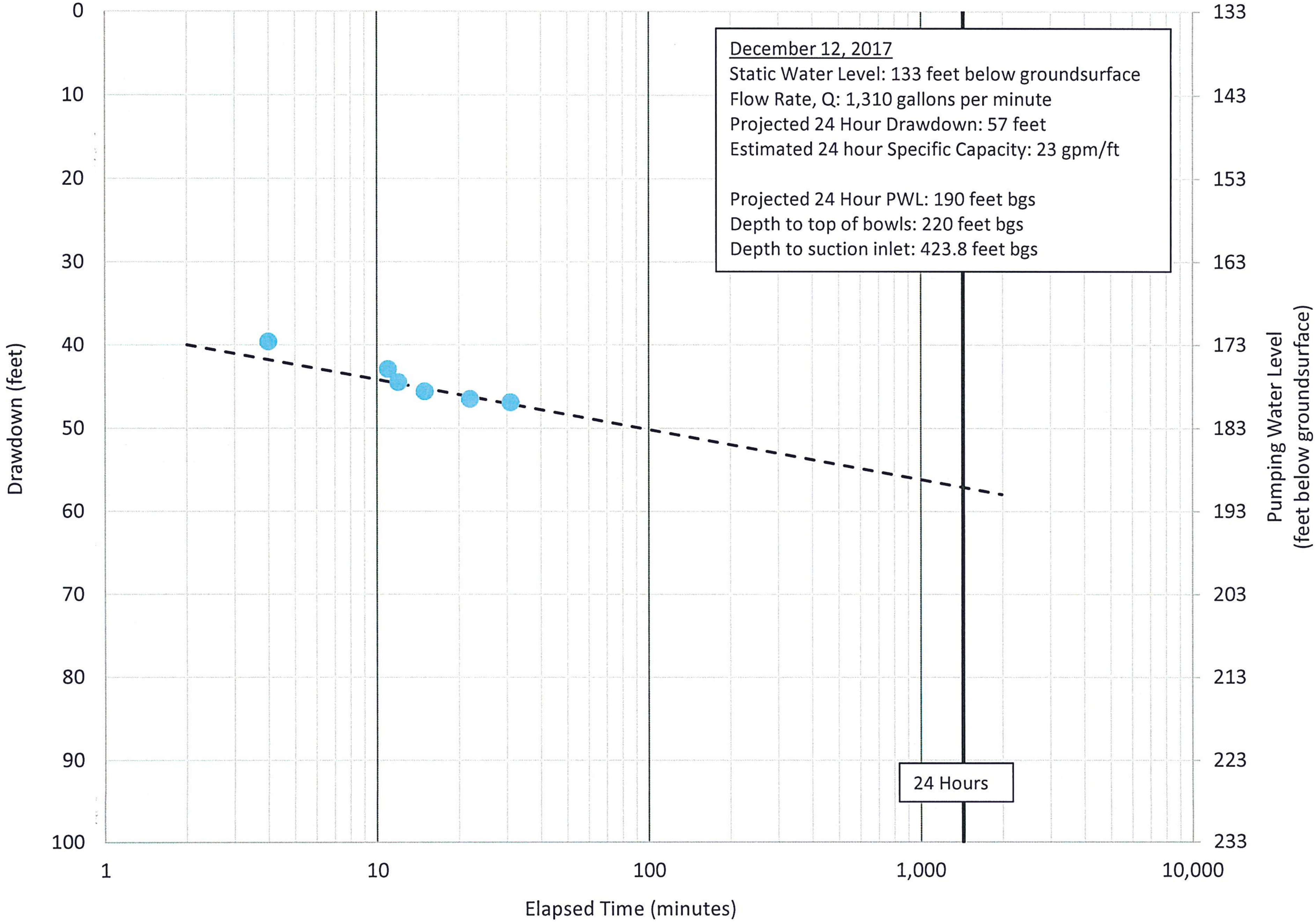
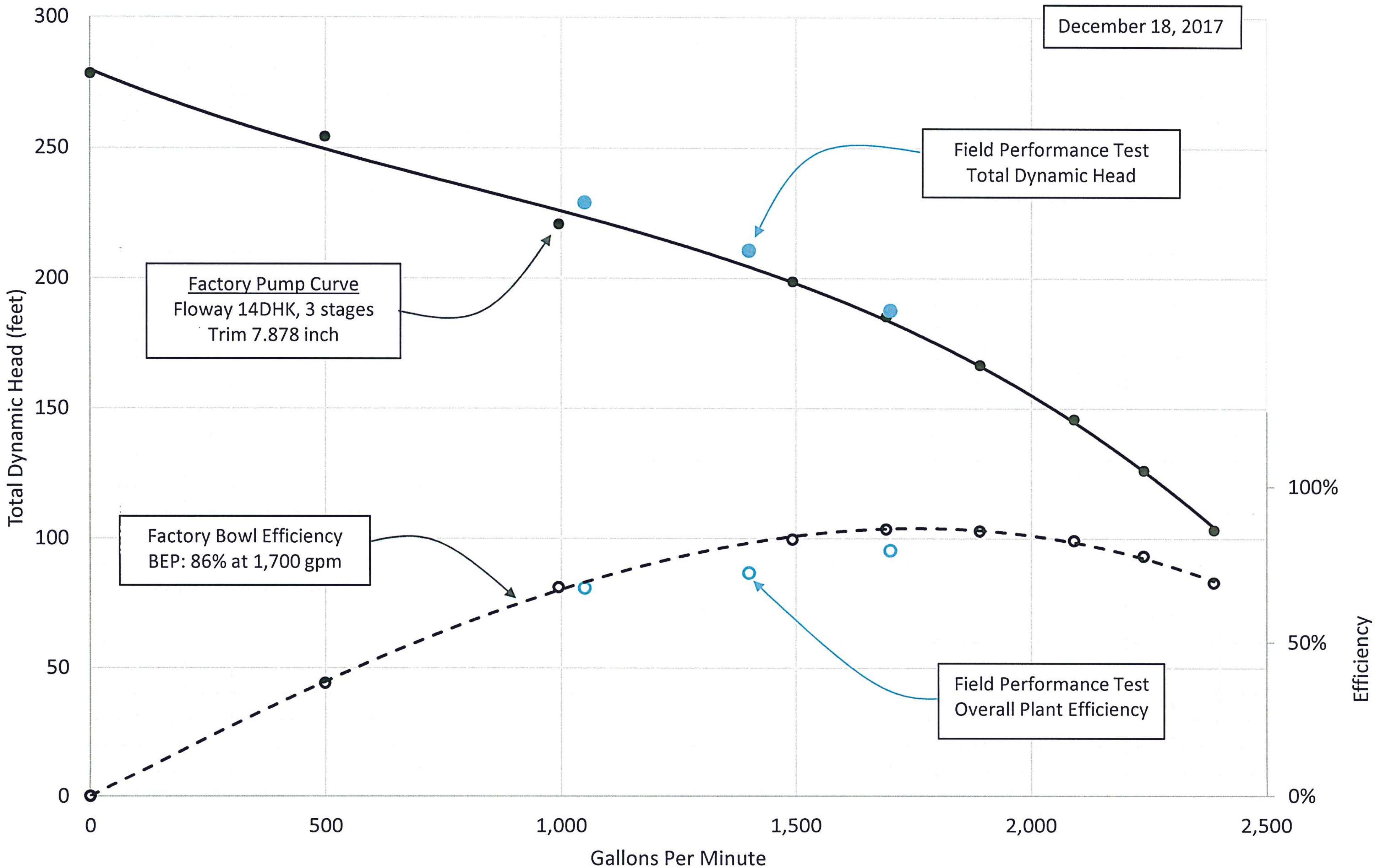


Figure 3

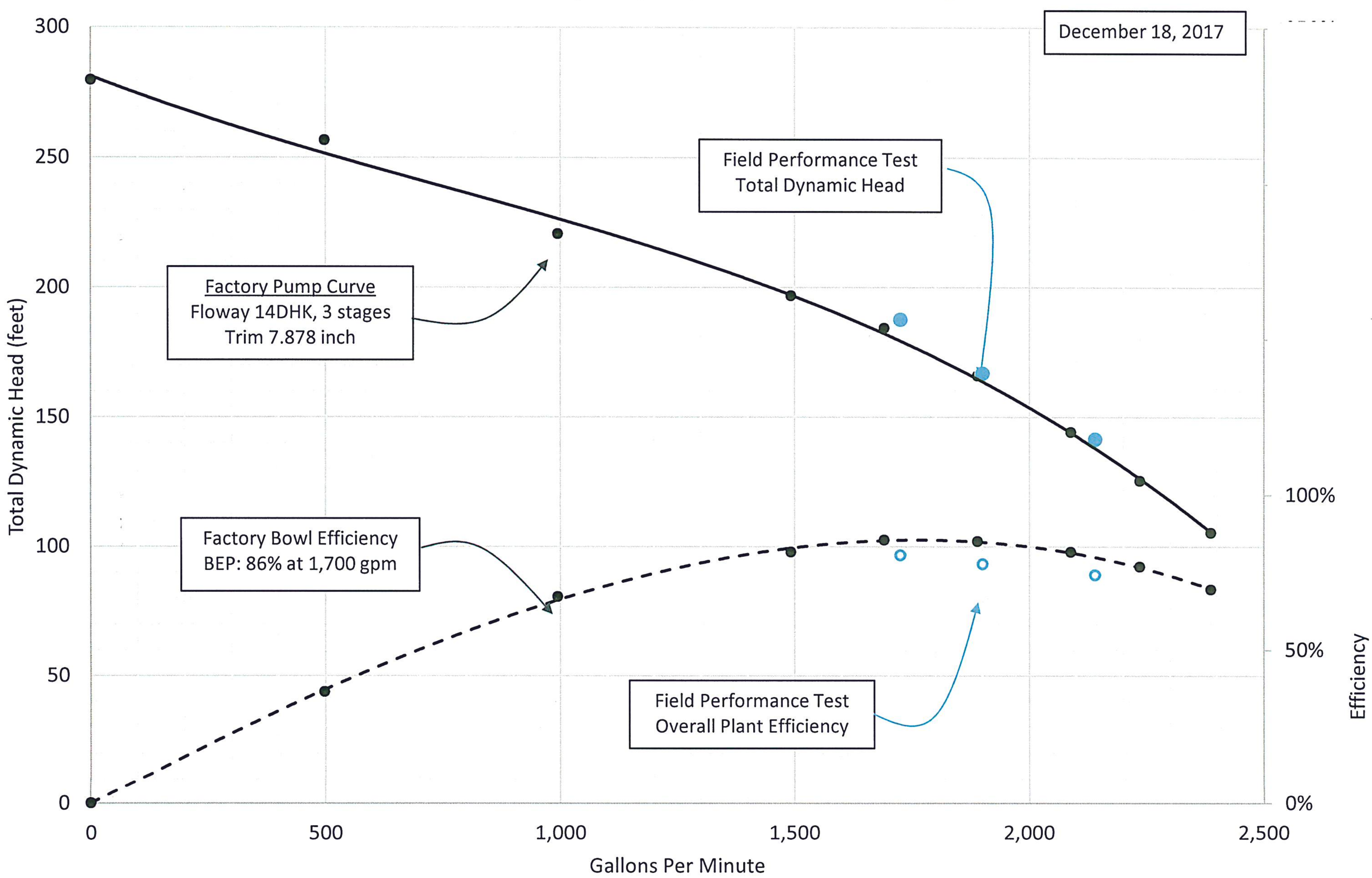
Canvas Back Pump Station

Booster Pump #1 (Right) Performance Testing



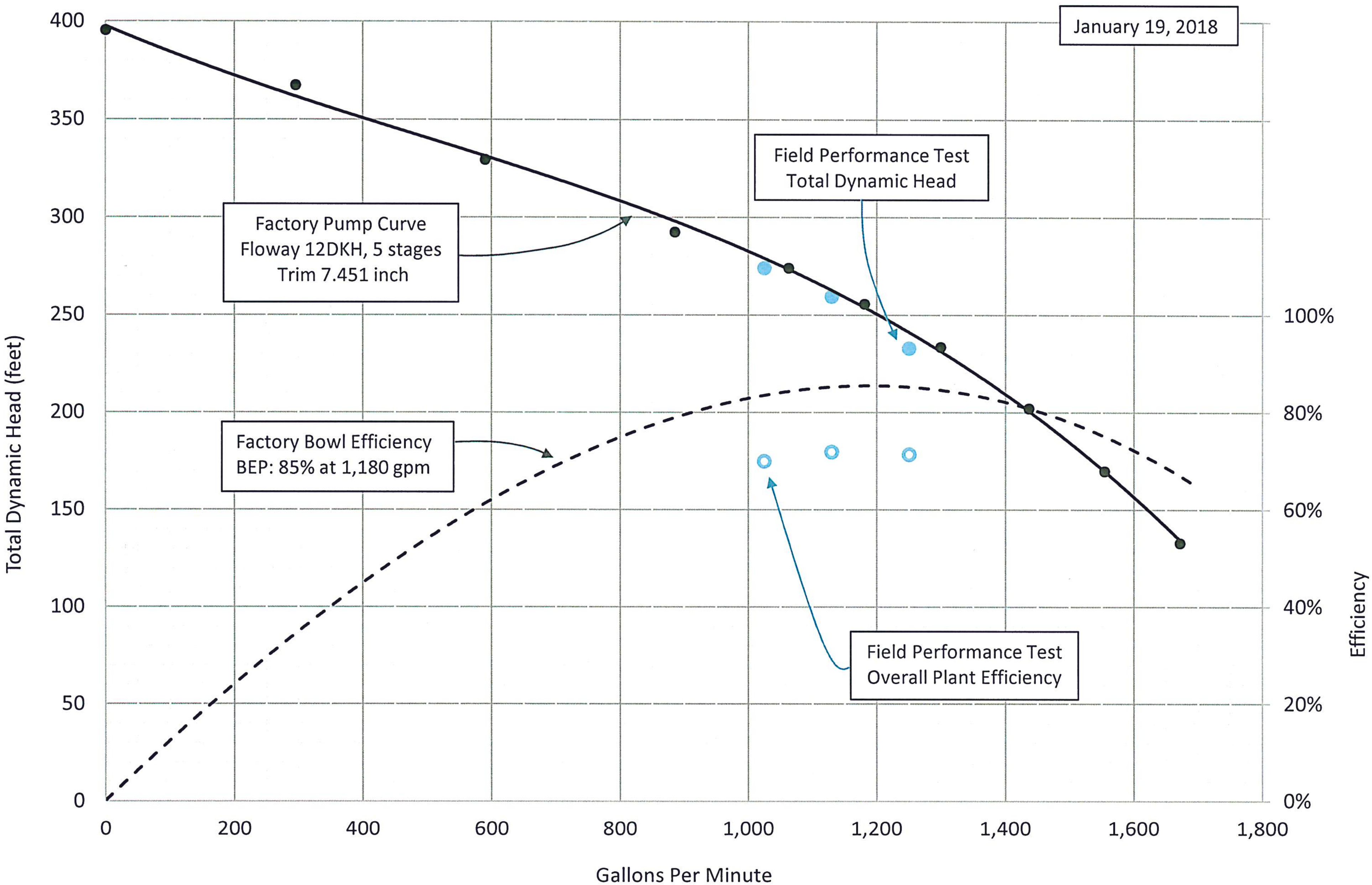
Note: the overall plant efficiency includes the bowl efficiency, motor efficiency and a handful of parasitic loads.

Figure 4
Canvas Back Pump Station
Booster Pump #2 (Left) Performance Testing



Note: the overall plant efficiency includes the bowl efficiency, motor efficiency and a handful of parasitic loads.

Figure 5
Pintail Well Pump Performance Curve



Note: the overall plant efficiency includes the bowl efficiency, motor efficiency and a handful of parasitic loads.

Figure 6

Pintail Well Specific Capacity

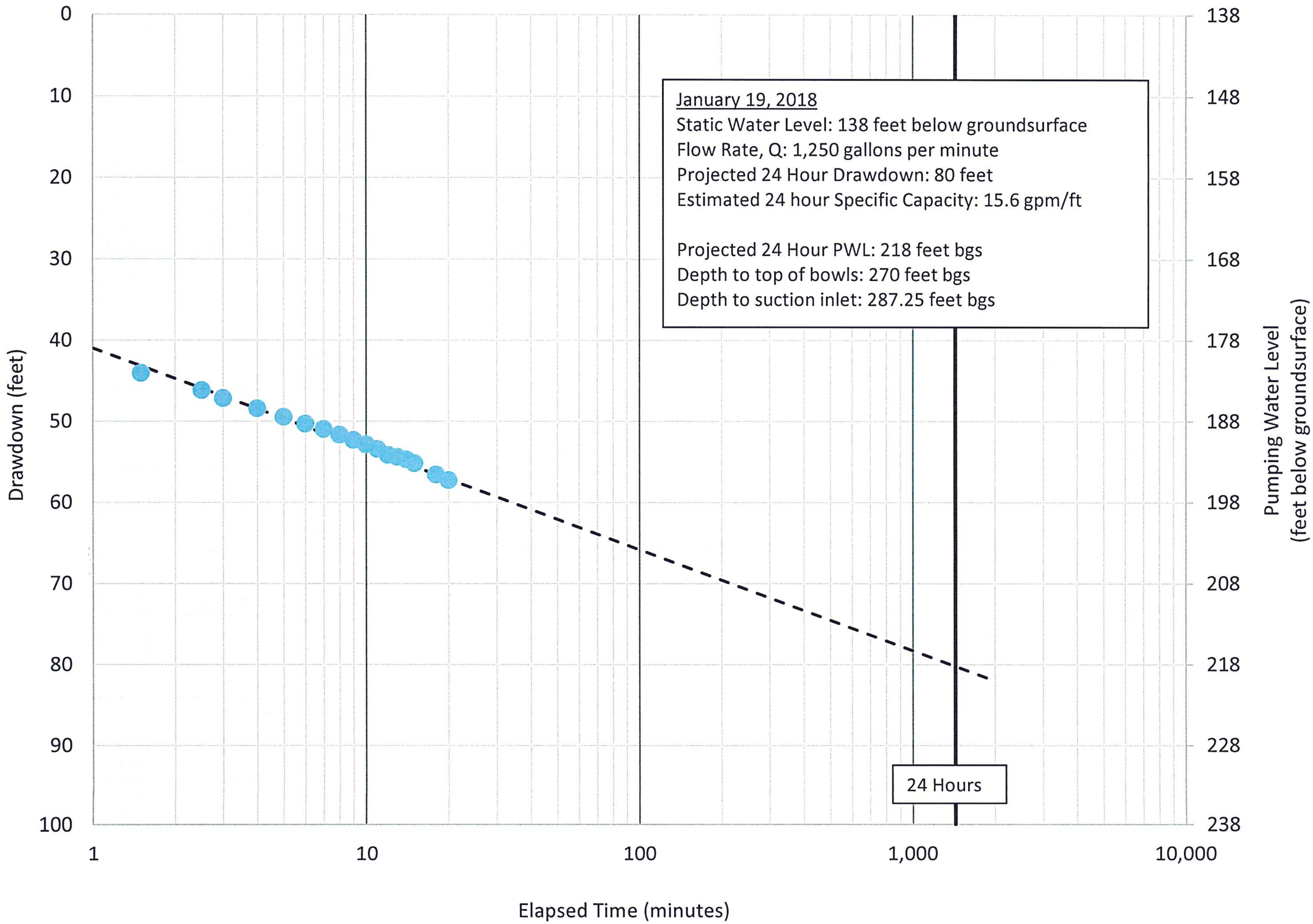
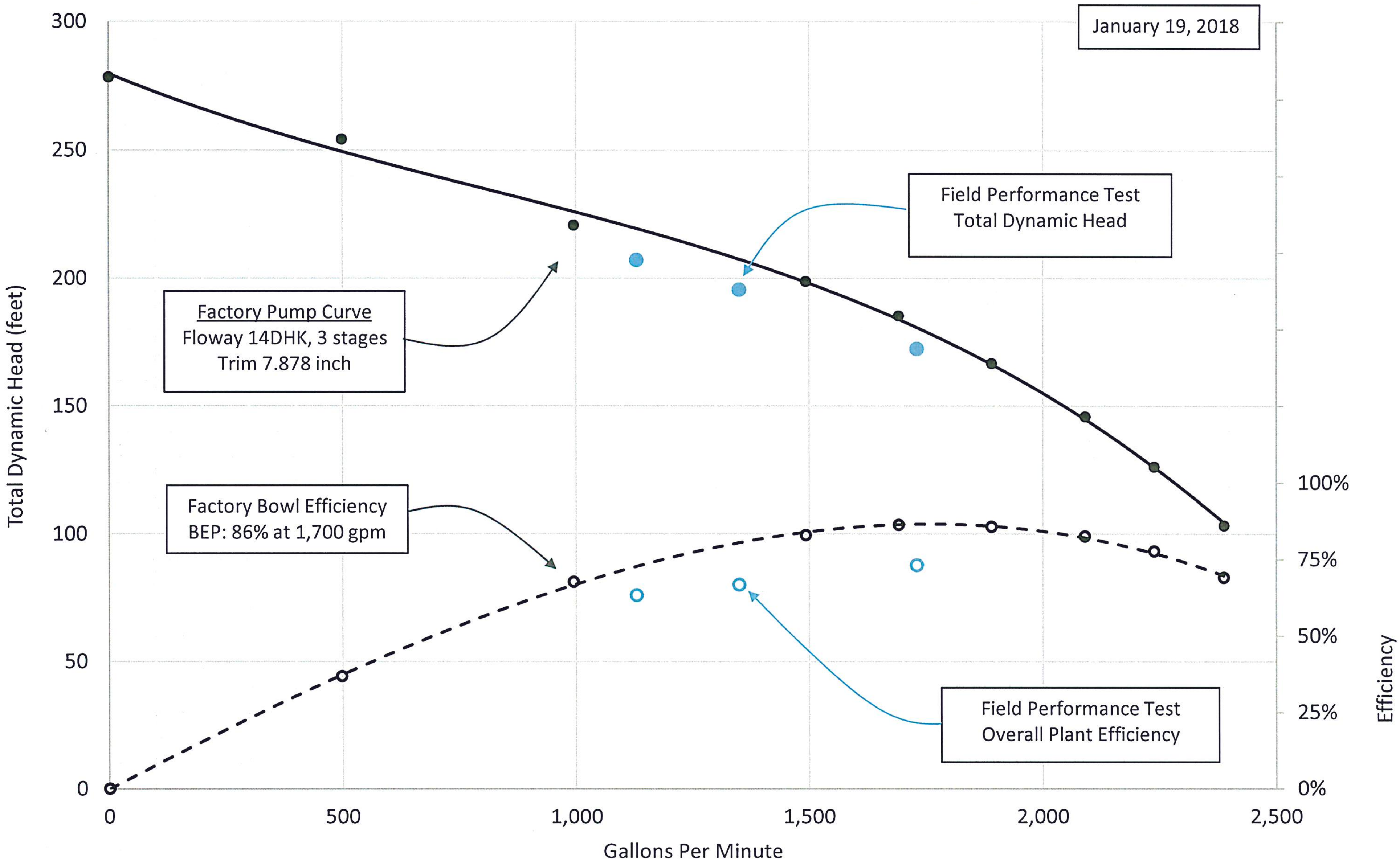


Figure 7

Pintail Pump Station

Booster Pump #1 (Right) Performance Testing

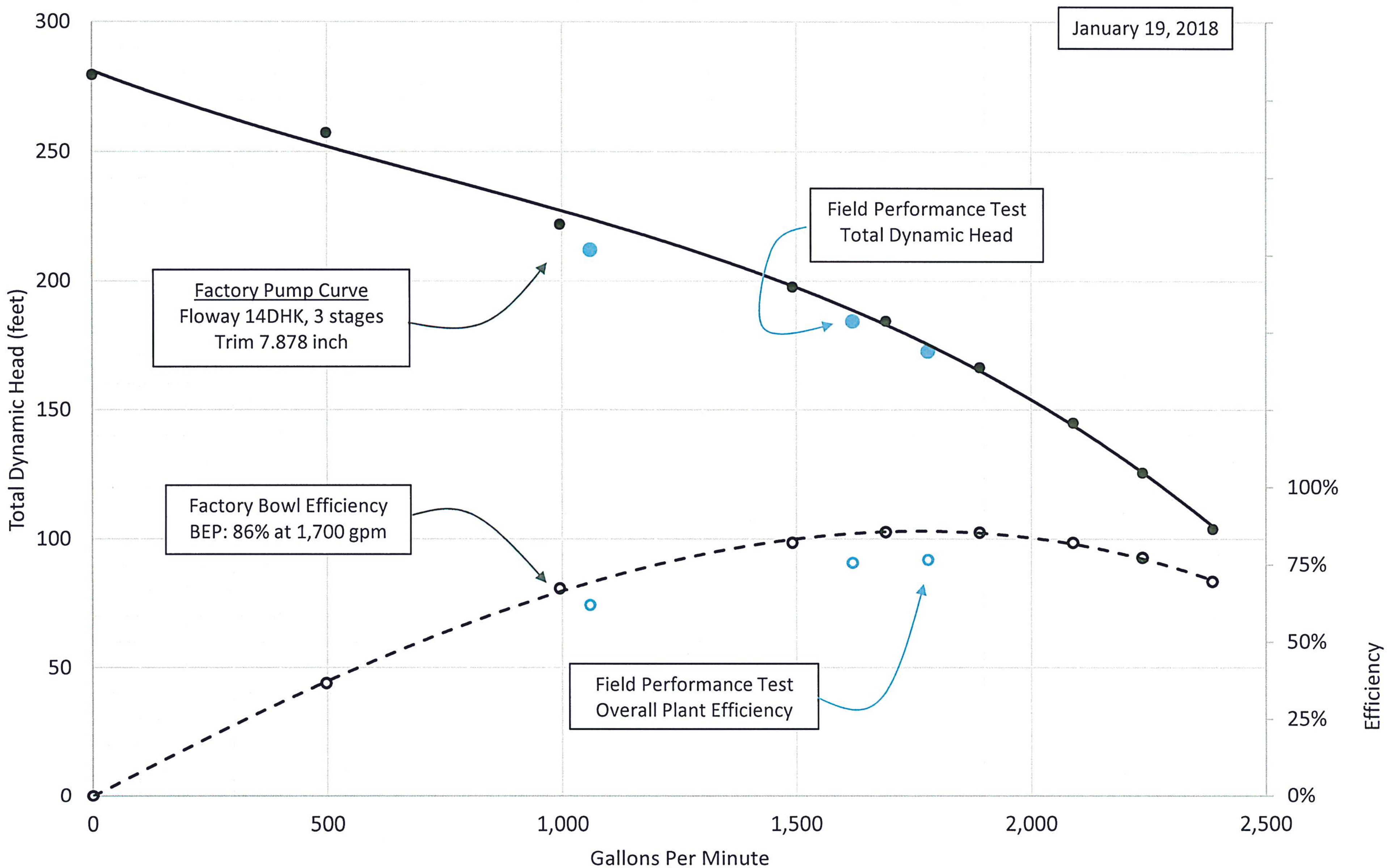


Note: the overall plant efficiency includes the bowl efficiency, motor efficiency and a handful of parasitic loads.

Figure 8

Pintail Pump Station

Booster Pump #2 (Left) Performance Testing



Note: the overall plant efficiency includes the bowl efficiency, motor efficiency and a handful of parasitic loads.