Evaluation of Energy Saving Alternatives at Madison Water Utility

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5/26/2015

Outline

Research Objectives

Background

Methods

Results

- VFD Study

Conclusions and Recommendations

Research Objectives

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A system-wide variable frequency drive (VFD) study aimed at determining which wells in MWU's system have characteristics that are best suited for future VFD installations.

A system demand study in Pressure Zone 4, to characterize the impacts of peak demand periods on annual energy use.

A hydraulic modeling study of Pressure Zone 4, aimed at estimating the energy savings produced by capital improvements and modifications to hydraulic operations within the zone.

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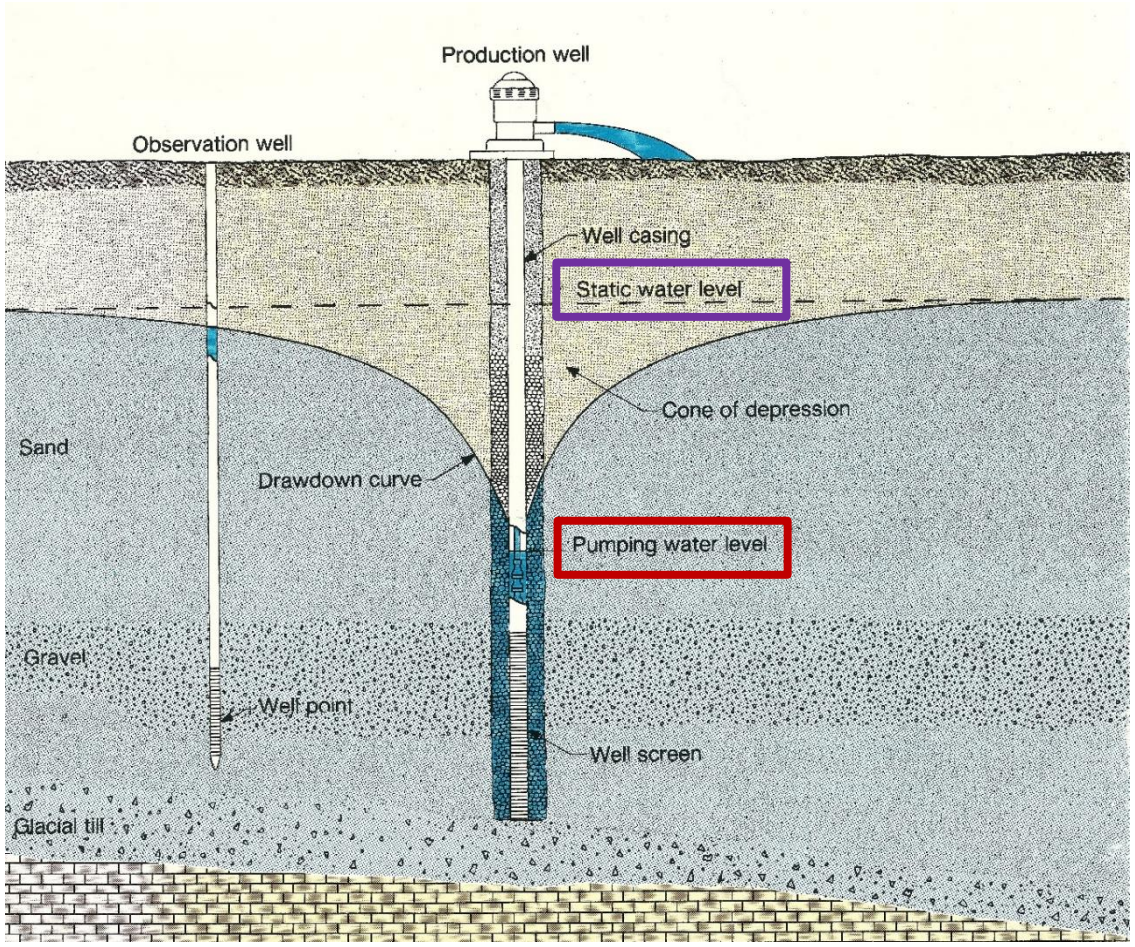
Background

Ground Water and Wells

Drawdown:

pumping water level – static water level

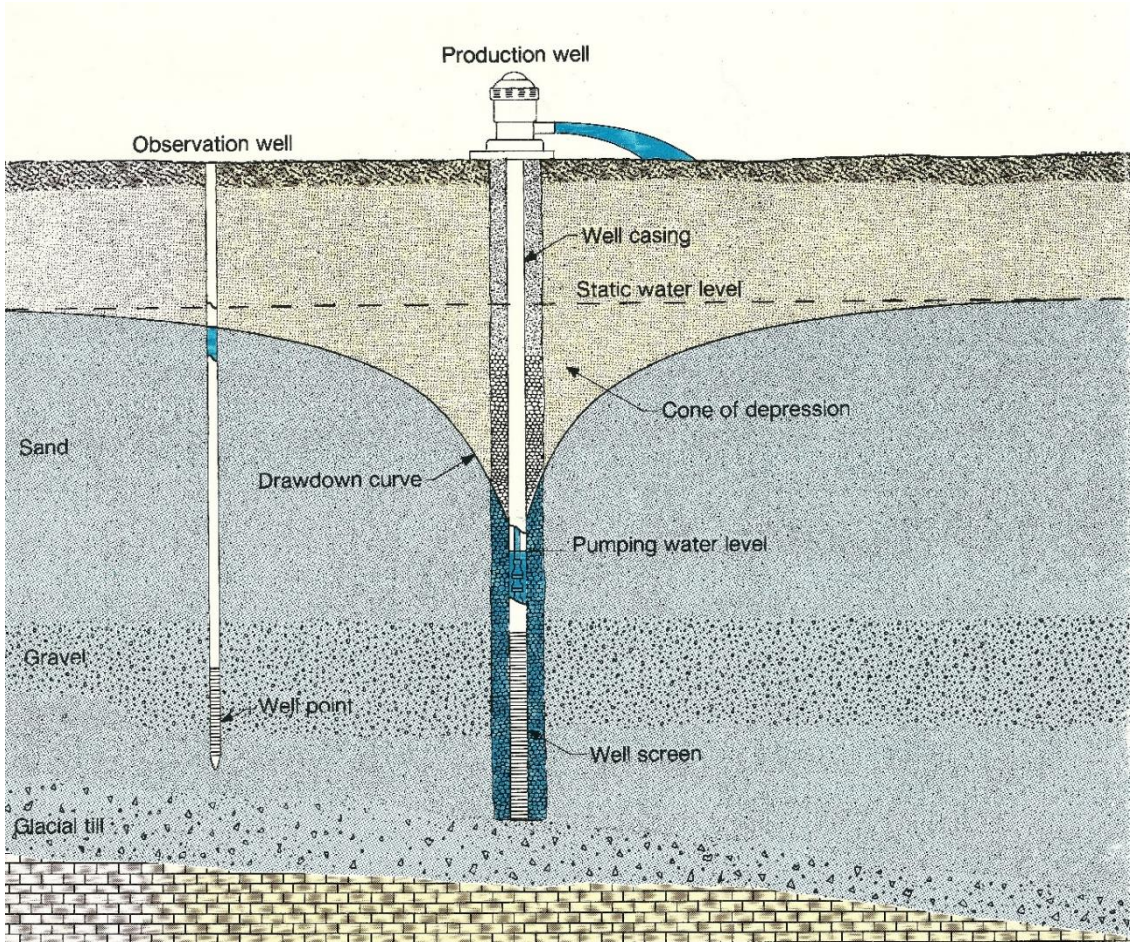
Measured as feet below ground surface



Ground Water and Wells

Specific capacity defined by well properties

- Measured in gallons per minute per foot of drawdown (gpm/ft)
- MWU specific capacity ranges from 10-100 gpm/ft
- MWU average specific capacity = 17.5 gpm/ft



Methods

VFD STUDY

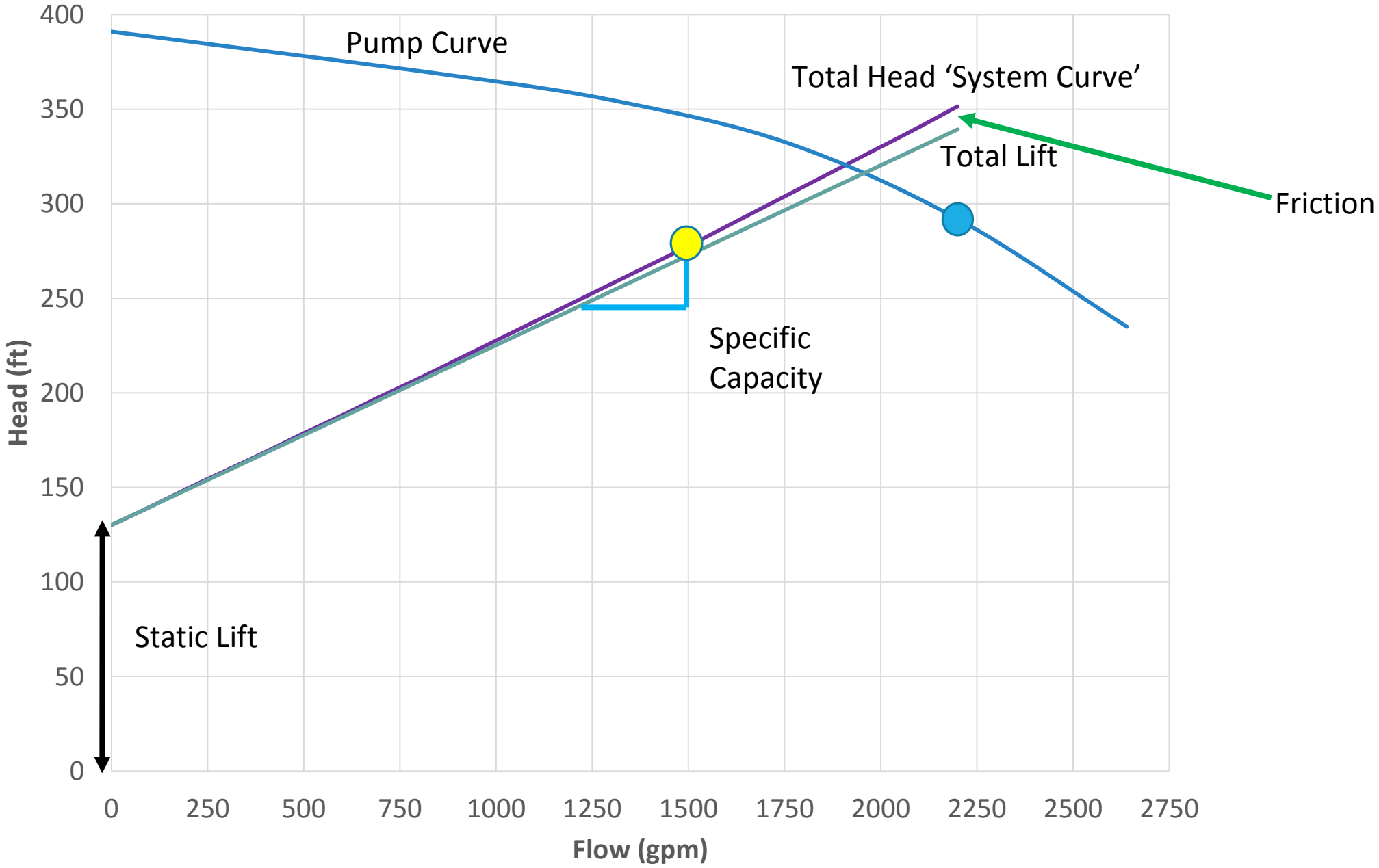
VFD Study

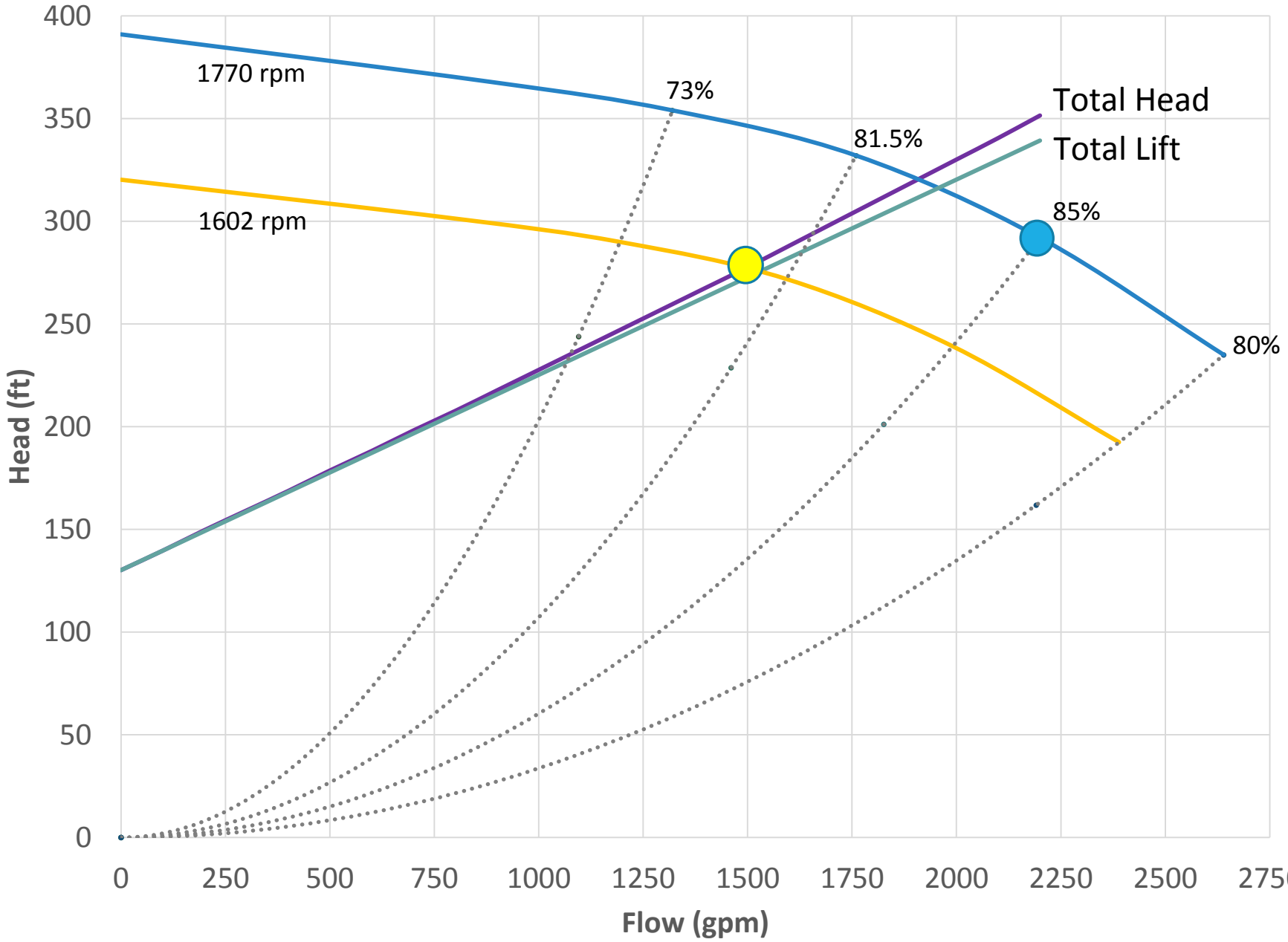
Objective: determine which pumps in the MWU system are best suited for VFD installations in the future and the speed at which to operate the pumps

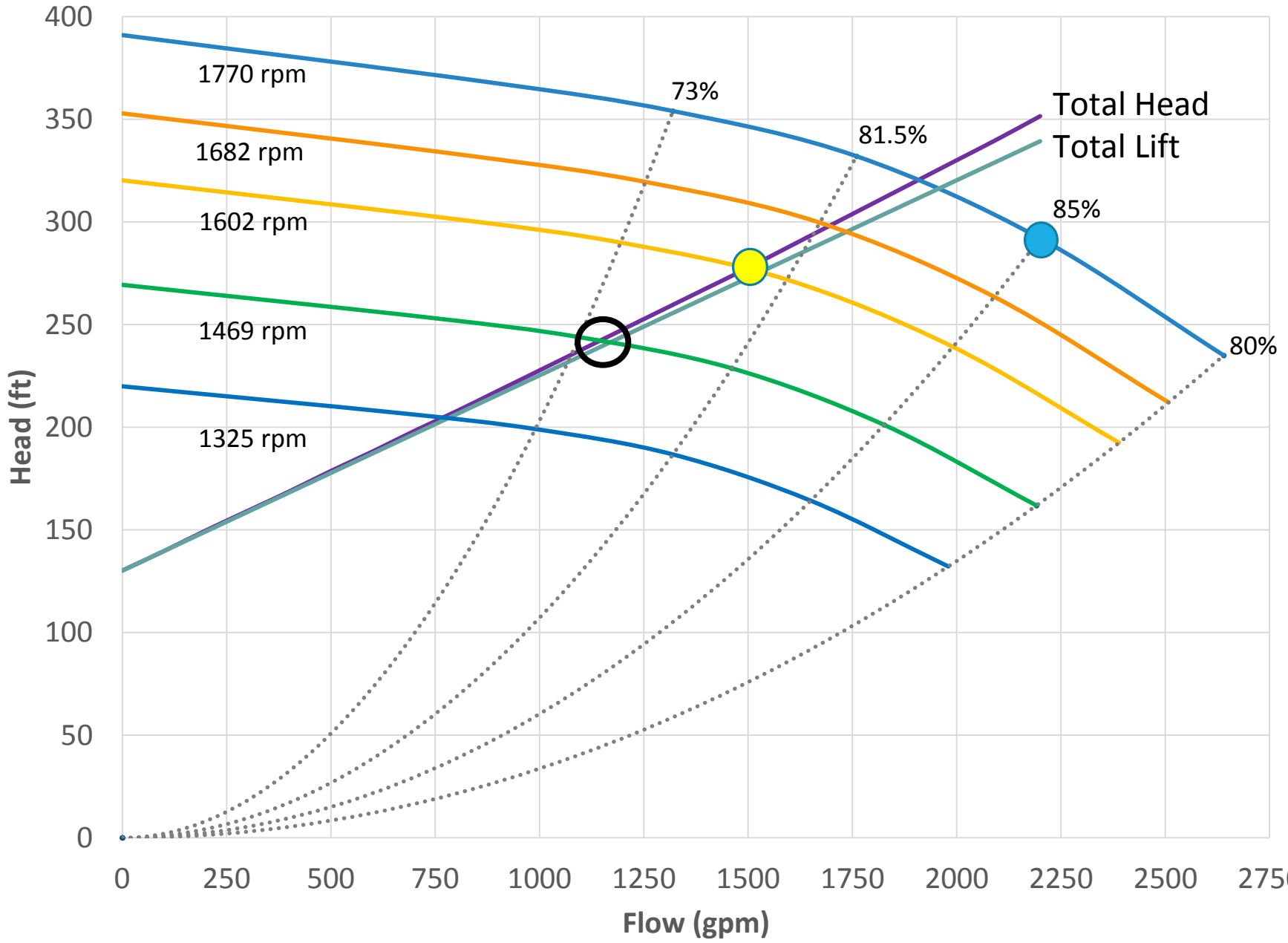
Used energy data collected from Nick Baniel in 2013

Group wells in terms of specific capacity

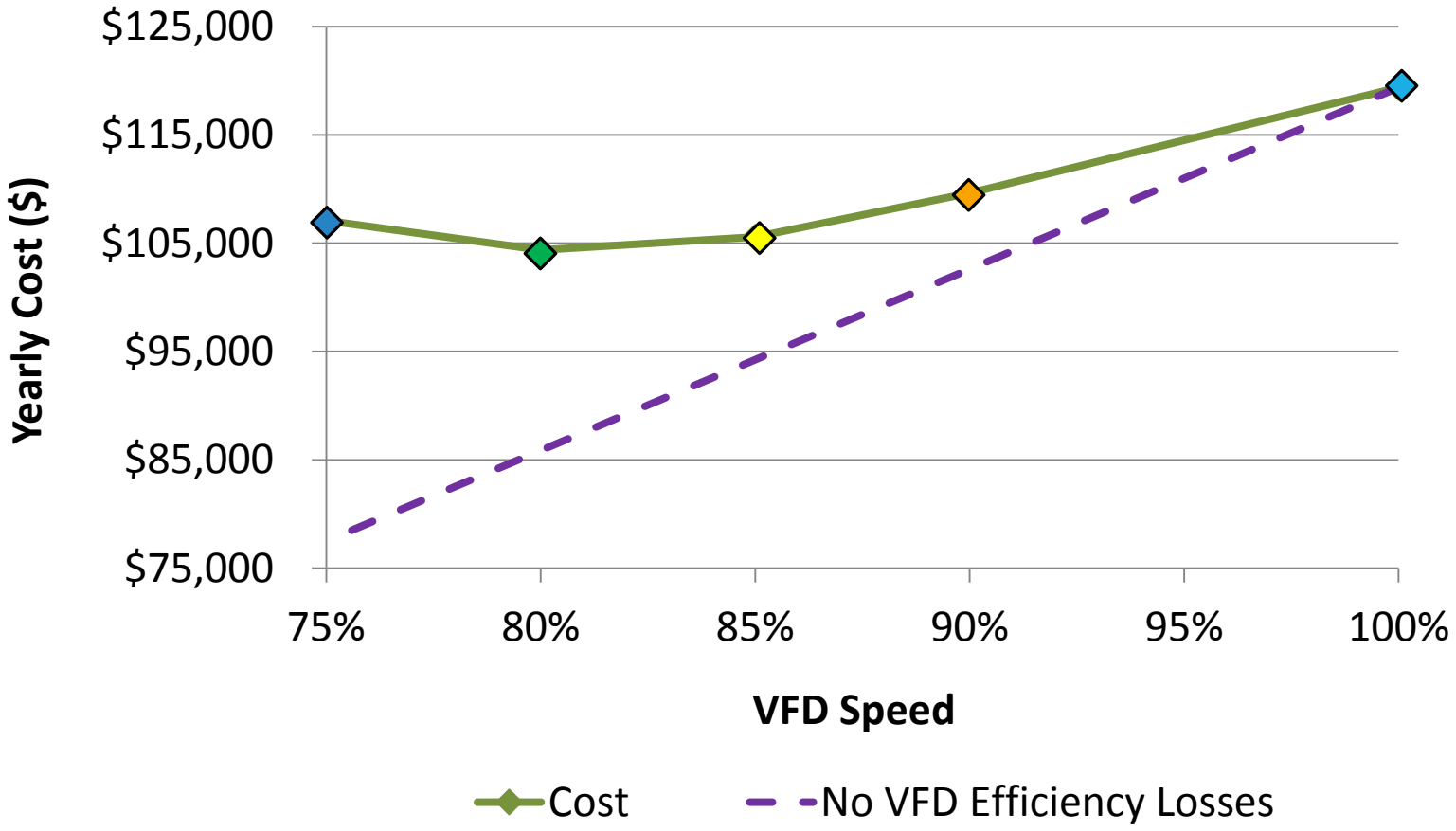
High Specific Capacity > 21.2 gpm/ft	(6 wells)
Medium Specific Capacity = 13.8 – 21.2 gpm/ft	(10 wells)
Low Specific Capacity < 13.8 gpm/ft	(6 wells)


Pump Curve
Total Head 'System Curve'
Total Lift
Friction
Specific
Capacity
Static Lift
Head (ft)
Flow (gpm)
400
350
300
250
200
150
100
50
0
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750


400
350
300
250
200
150
100
50
0
Head (ft)
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
Flow (gpm)
1770 rpm
1602 rpm
73%
81.5%
85%
80%
Total Head
Total Lift


400
350
300
250
200
150
100
50
0
Head (ft)
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
Flow (gpm)
1770 rpm
1682 rpm
1602 rpm
1469 rpm
1325 rpm
73%
81.5%
85%
80%
Total Head
Total Lift

VFD Speed Optimization

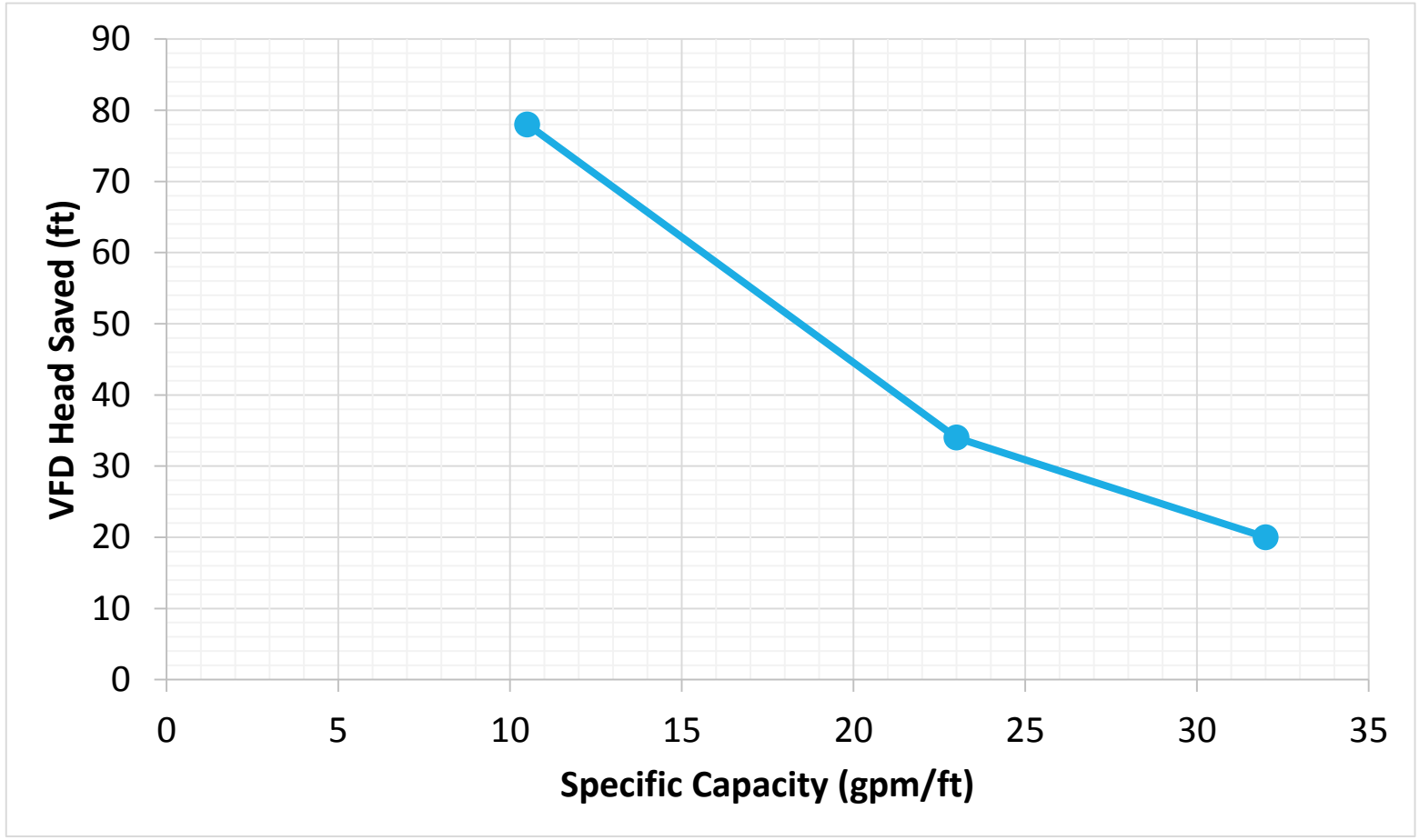


Results

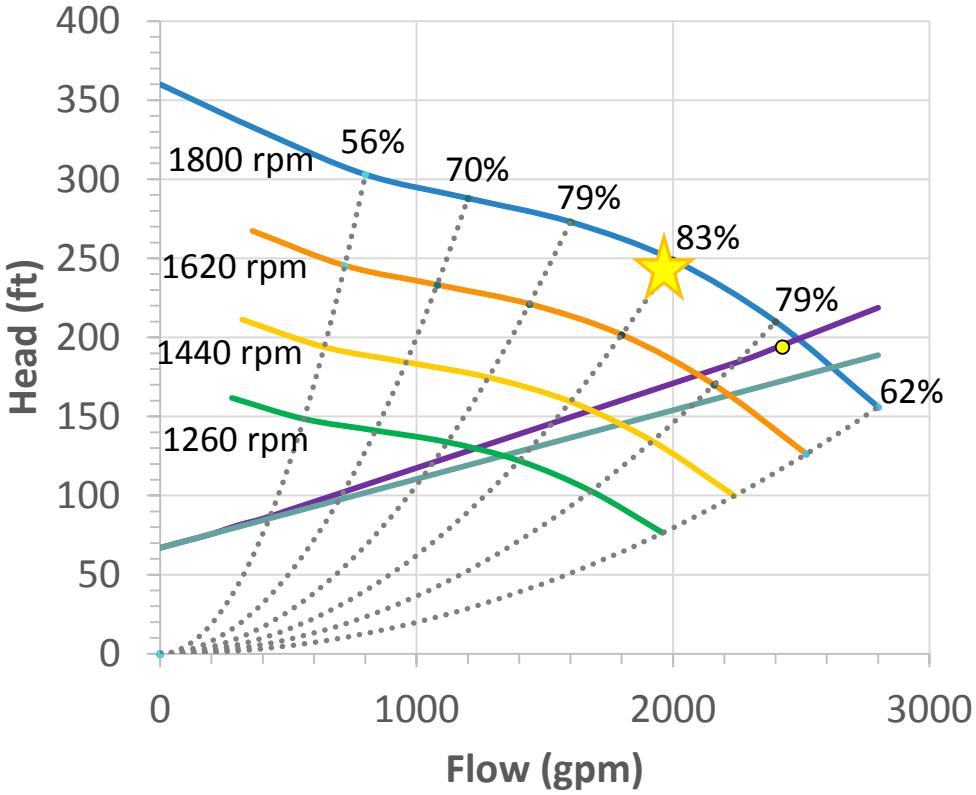
VFD Savings by Specific Capacity

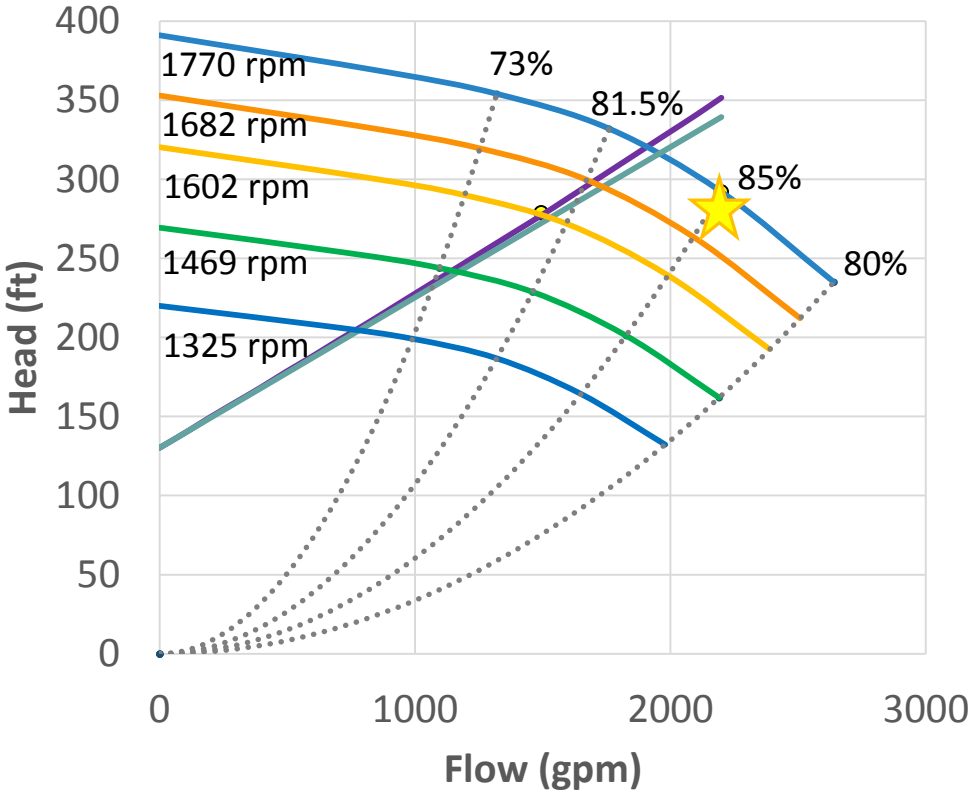
High specific capacity well (UW9)	Payback: 24 years
Specific Capacity = 32 gpm/ft	Energy Savings: 36,000 kWh/year
Medium specific capacity well (UW6)	Payback: 7 years
Specific Capacity = 17-23 gpm/ft	Energy Savings: 125,000 kWh/year
Low specific capacity well (UW25)	Payback: 8 years
Specific Capacity = 10 gpm/ft	Energy Savings: 110,000 kWh/year

Energy Use Dependence on Specific Capacity



Pump Selection Impacts





Conclusions and Recommendations

VFD STUDY

Low specific capacity sites have the greatest potential for energy savings.

Medium and high specific capacity sites have potential to be economically feasible if sized appropriately at installation

Low specific capacity sites tend to have higher efficiency values at reduced VFD speeds

Application of VFDs to all low specific capacity sites is estimated to save approximately 778,000 kWh/year of the near 20,000,000 kWh/year consumed by MWU

- Projected savings calculated by applying predicted energy savings from tested well to all other wells in system.
- Further sampling could improve prediction

Variable Frequency Drive Study Recommendations

Do not install VFDs on high specific capacity wells for energy savings.

Install VFDs on medium specific capacity wells if specific capacity and pump sizing are conducive.

- UW 11, 13, 16, 20 most favorable

Install VFDs on low specific capacity wells.

- UW 18, 19, 24, 27 prioritized

Size future high specific capacity deep well pumps at the BEP, and low/medium specific capacity deep well pumps to operate at higher flow and lower head conditions.

VFD Case Study

Unit Well 13 was predicted to have favorable conditions for VFD installation and energy savings.

- 5th highest yearly flow rate
- 7th lowest specific capacity
- 5th highest energy use

Head savings of approximately 65 feet could result, saving over 100,000 kWh/year.

Excellent project for future graduate student to test and validate projected savings.

Questions