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Pump Stations Design

Reducing Existing Pump Station Power Consumption

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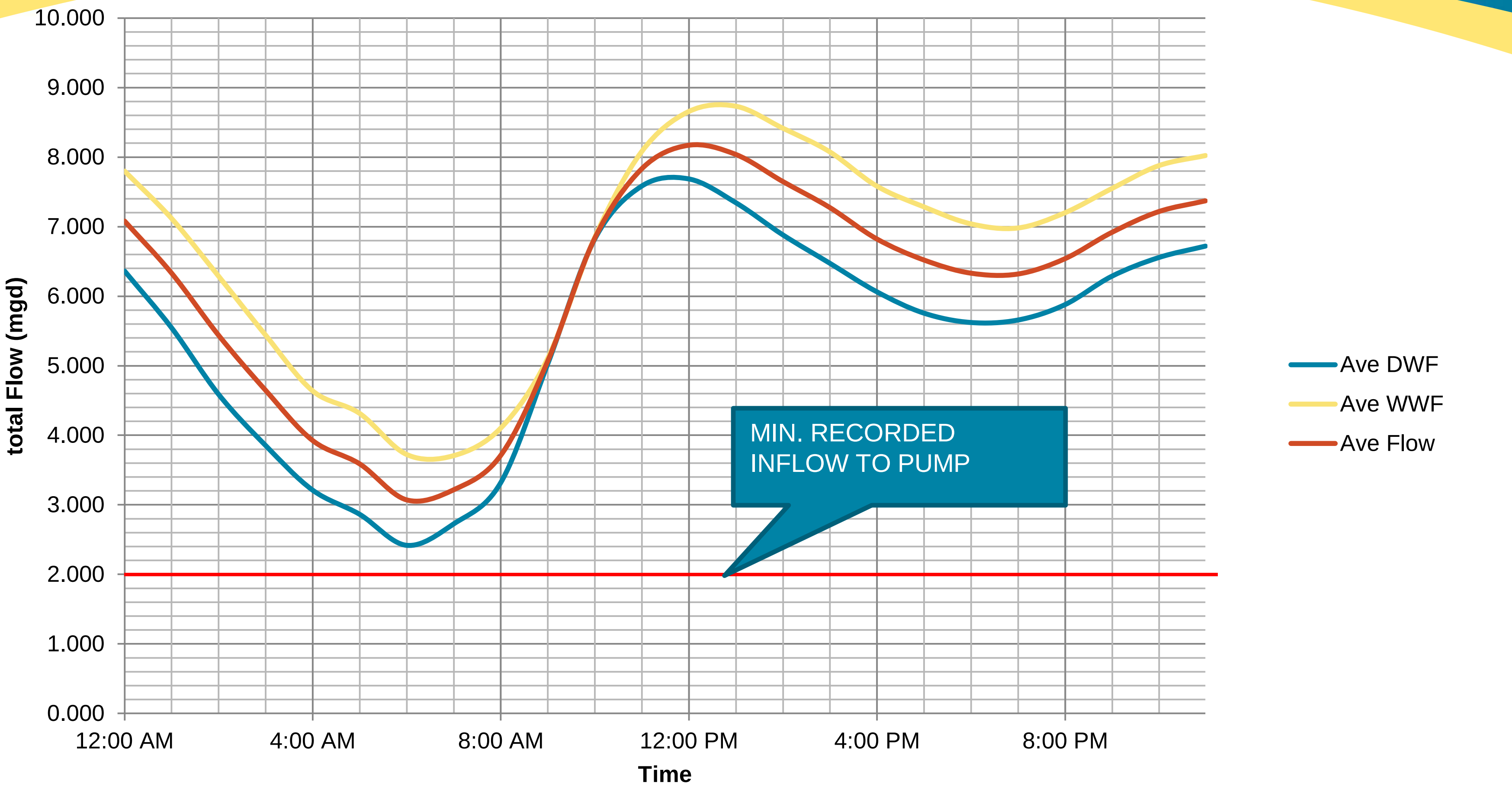
The project

- Existing is 30 years old pump station station
  - Existing capacity is 18 mgd with all 4-pumps in operation
  - Existing 12 and 24 inch force mains
  - Existing pumps are VFD driven
- Project Scope: Expansion and Rehabilitation
- Expand the pump station to:
  - Firm Capacity = 26 mgd with 3 pumps in operation @8.66 mgd each
  - Peak Capacity =30 mgd with all 4 pumps in operation
- Rehabilitation
  - Replace all pumps, motors and VFD
  - Replace existing 12 inch FM

How to reduce energy consumption of existing pump station

- Optimizing pump efficiency by selecting pumps with BEP at or near the point where the pump operates most of the time.
- Determine force main diameter with least LCC.
- Replacing pumps, motors and VFD with higher efficiency equipment.
- Configuration of controls so that pumps operate at speed and number of units where specific energy consumption is the lowest.

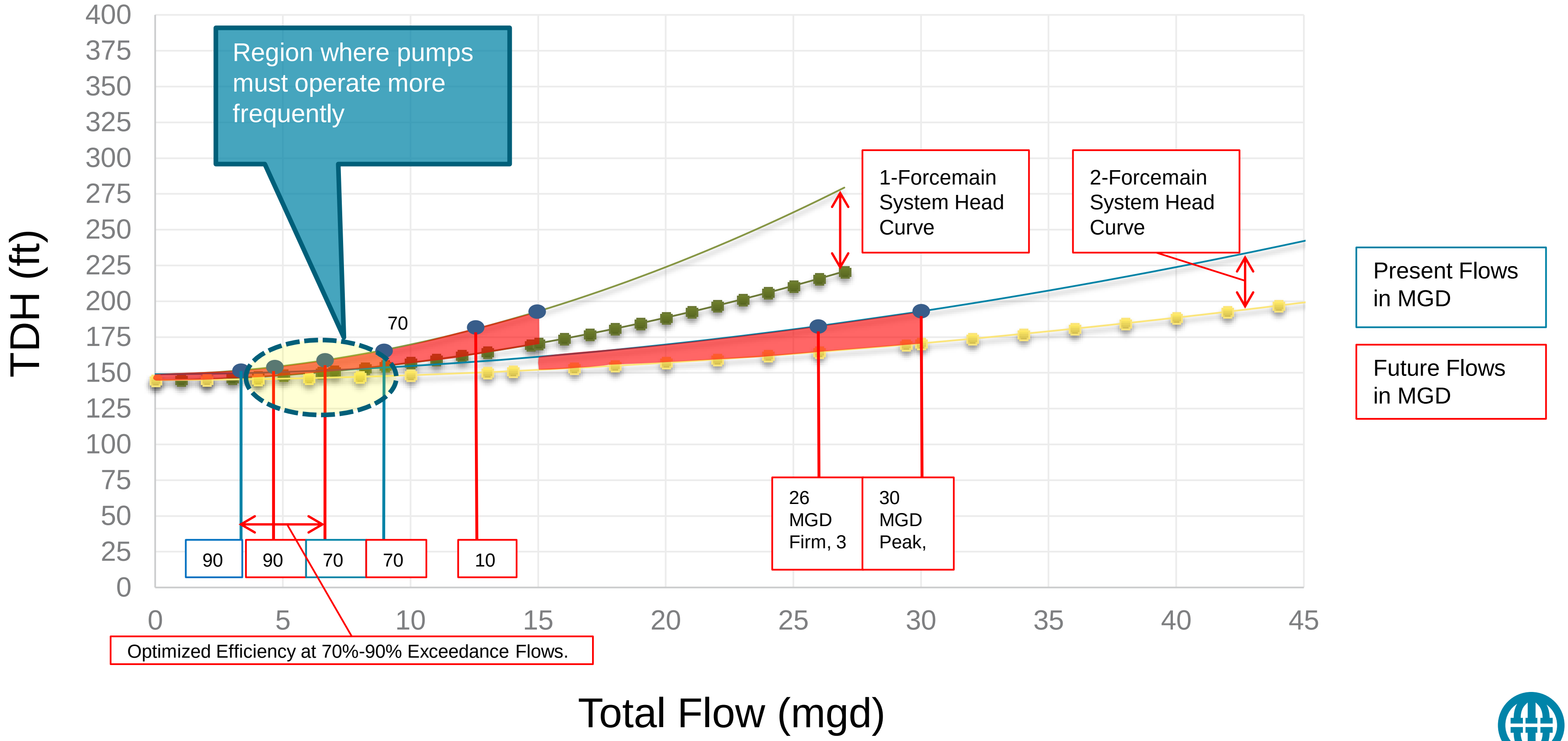
Step 1. Review Diurnal Inflow to PS



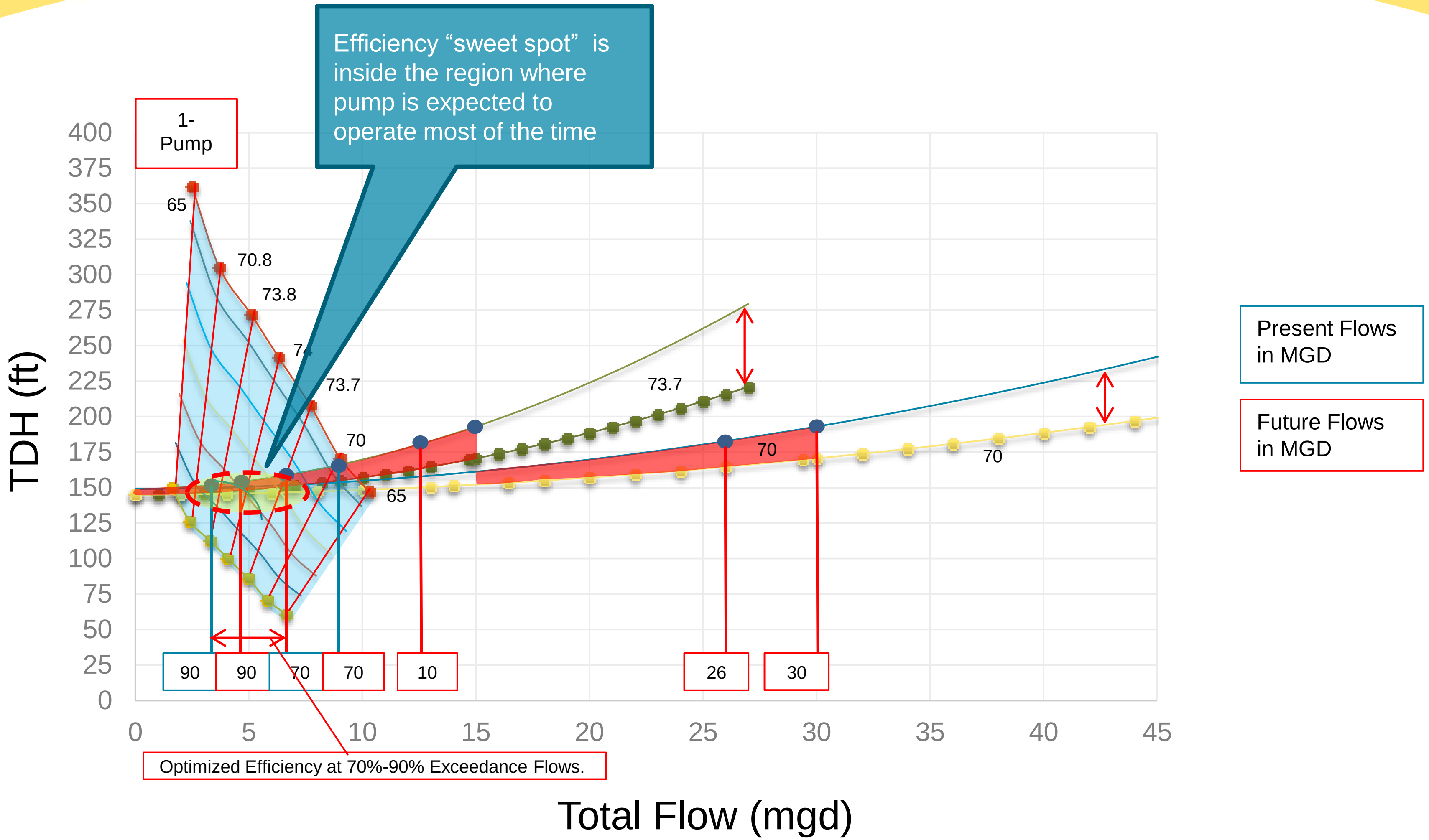
Step 2. Determine operating region where pumps operate most frequently of the time

- Plot exceedance flow curve.
- Determine 10, 70, 80, 90 flow percent of exceedance

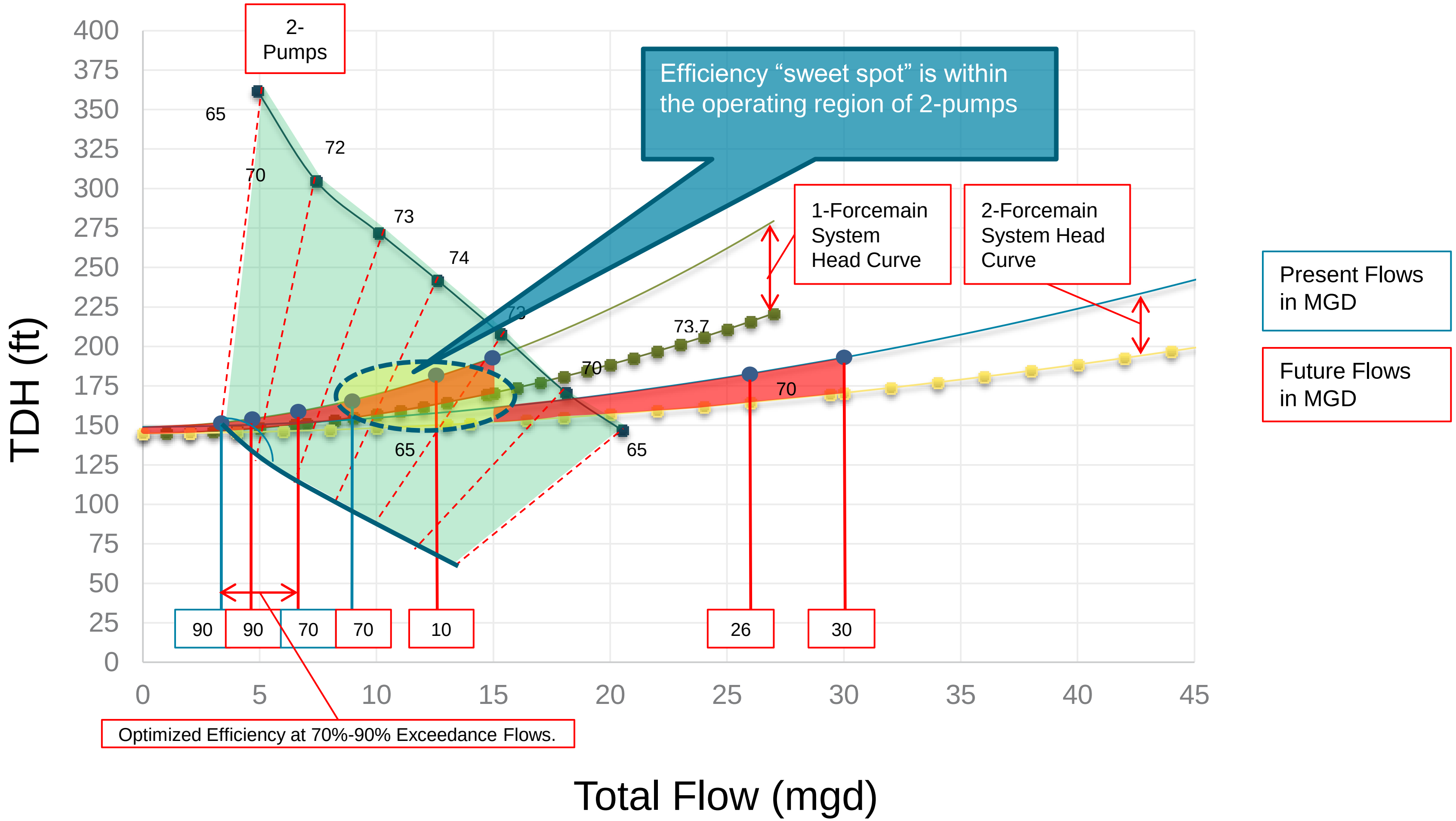
Step 3a. Plot System Head Curve - Operating Region and Indicate % exceedance



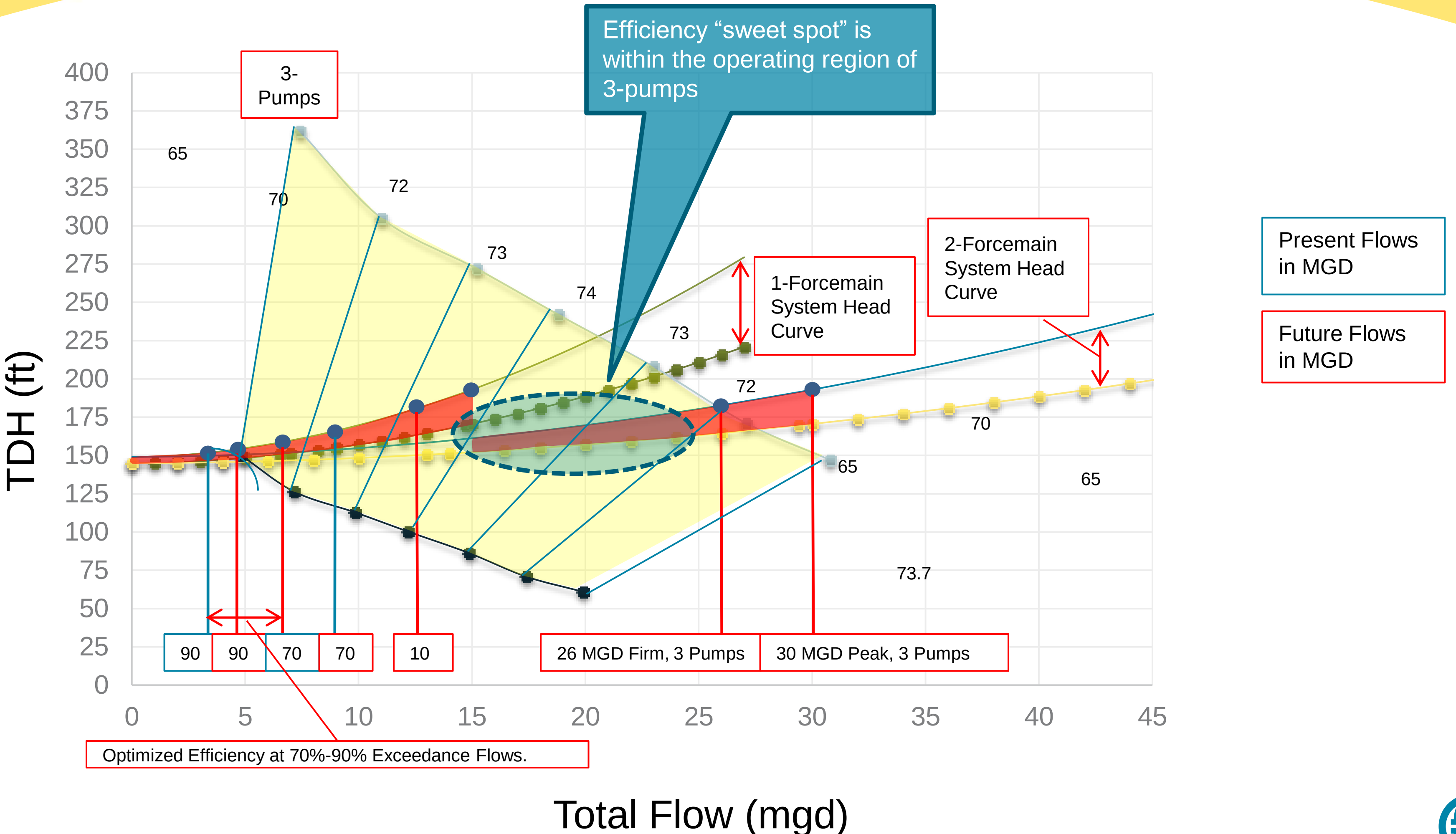
Step 4. Select Pumps and Plot Pump Operating Envelope One Pump Operating



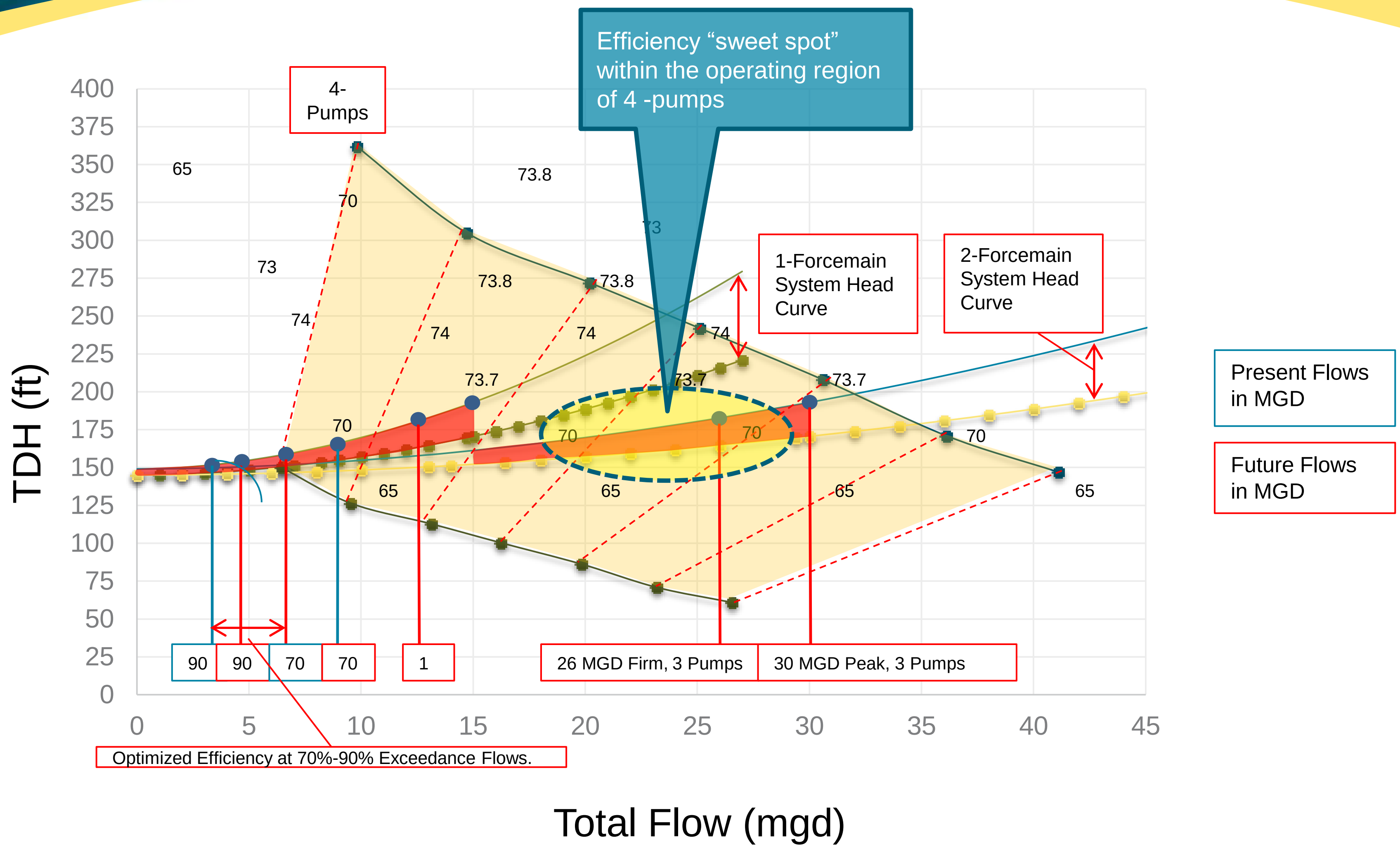
Step 4b. Select Pumps and Plot Pump Operating Envelope Two Pumps Operating



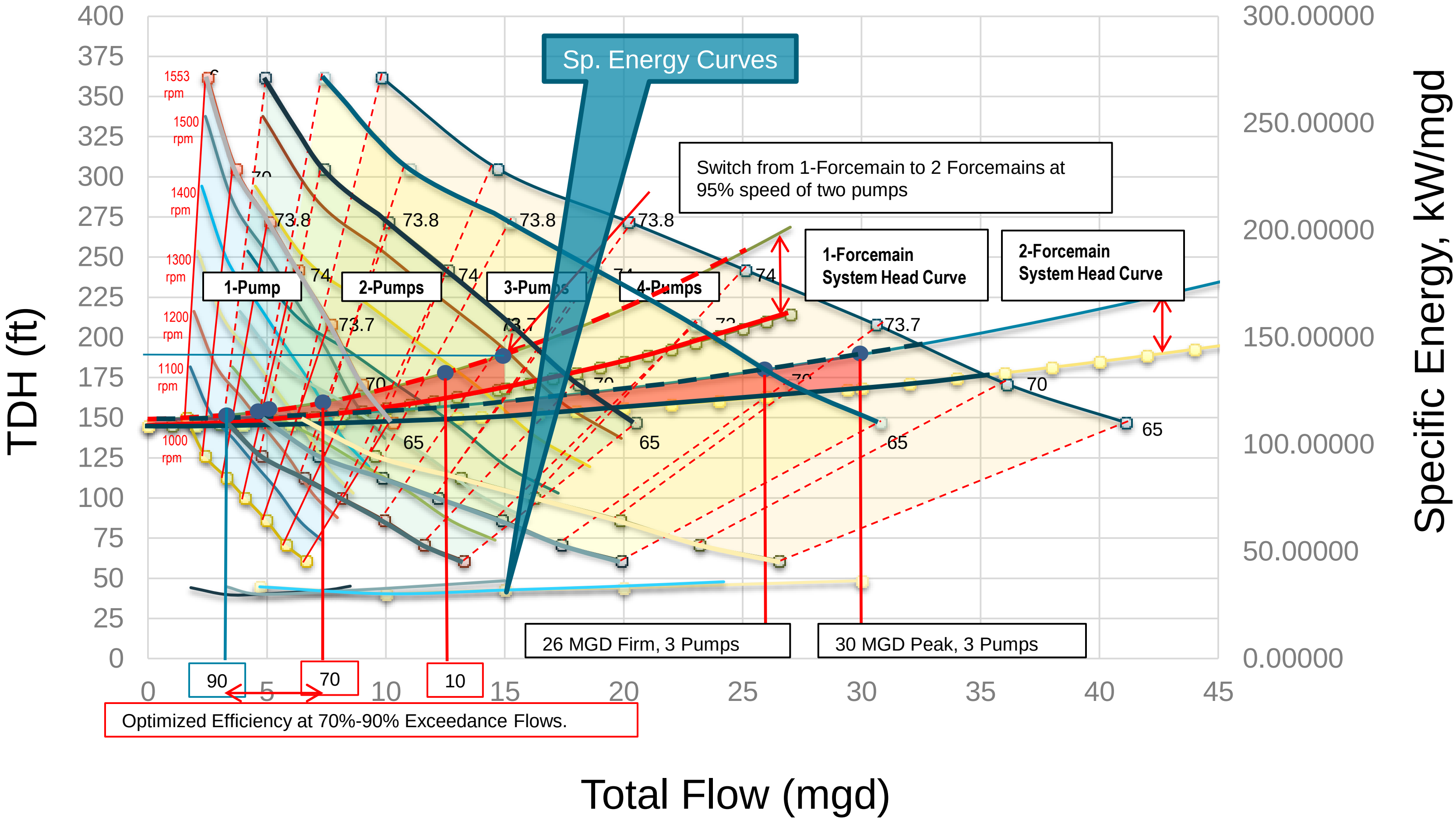
Step 4c. Select Pumps and Plot Pump Operating Envelope Three Pumps Operating



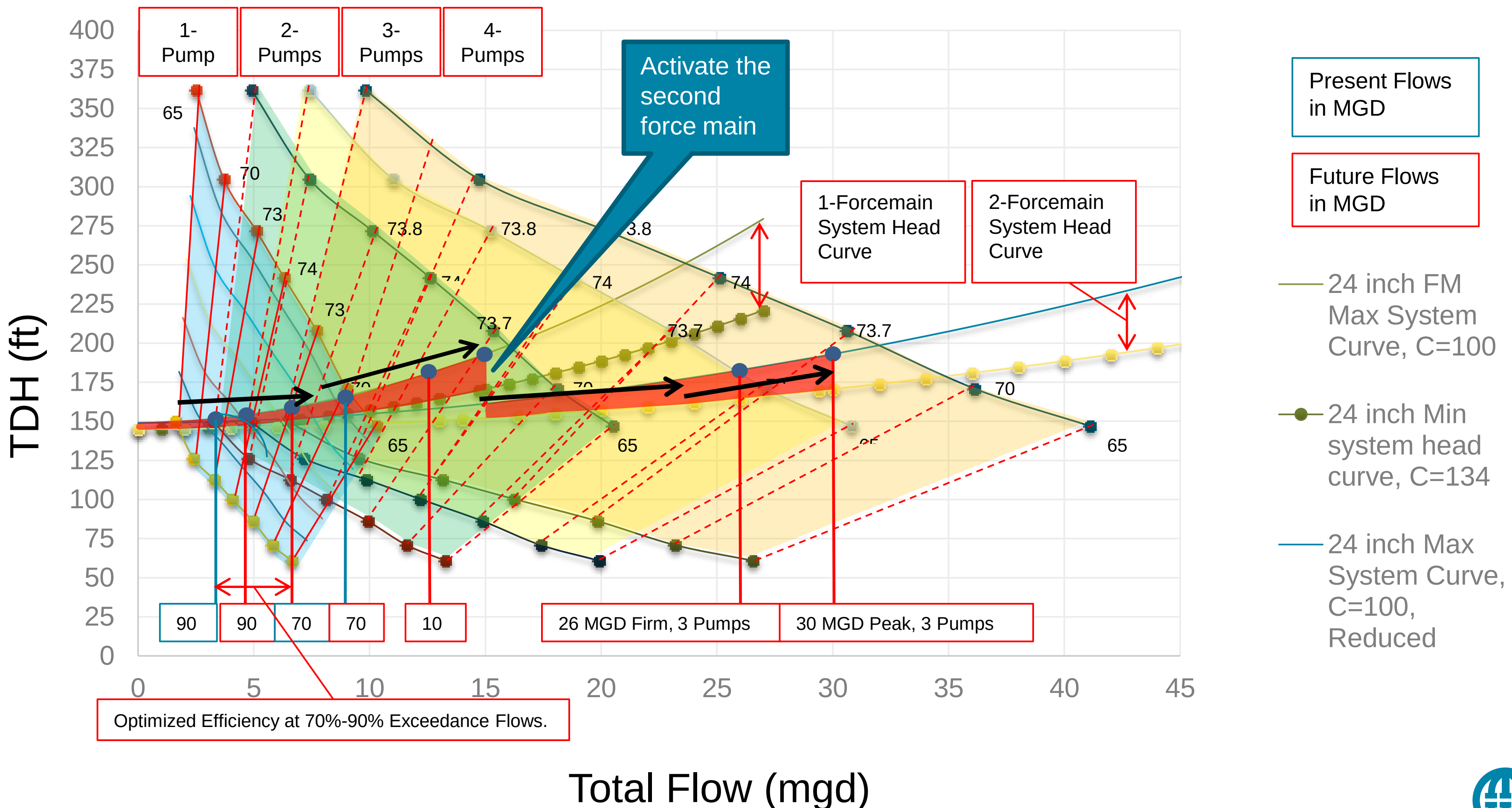
Step 4d. Select Pumps and Plot Pump Operating Envelope Four Pumps Operating



Step 5a. Check Specific Energy Consumption - Range 30-36 kW/mgd



Step 6a. Pump Sequencing Control



Step 6b. Design Pump Sequencing and Control

- Lead pump runs from 75 to 95% speed
  - Upon reaching 95%, controller calls 1st lag pump to start.
- Both pumps adjust speeds to share load until their speed reaches 95%
  - Upon reaching 95% speed, controller calls the 2nd lag to start.
  - Activate both force mains
- Three pumps adjust speeds to share load until the firm capacity of 26 mgd is achieved. Increase in inflow will cause the pumps to run up to 95%.
  - Upon reaching 95% speed, controller calls the 3rd lag to start.
- Four pumps will adjust to share loads until 30 mgd is achieved.
- Decrease in inflow will cause the pumps to slow down and shutdown in reverse sequence accordingly.
- Final energy optimization by fine tuning of controls after startup and commissioning.

Step 7. Check Power Consumption Comparison among other candidate pumps

Pump "A" (featured in this case study)

- BEP intersects the region where one pump operate most of the time
- Pumps operate near the "sweet spot" of BEP
- Present Flows - $72,438
- Future Flows - $100,235
- Yearly energy savings is lower by $4k (5%) during the yearly years and $2,000 (2%) during the future years.

Pump "B" (Alternate Pump)

- BEP was slightly to the right of the region where one pump operate most of the time
- Pumps operate away from the "sweet spot" of BEP
- Present Flows - $76,445
- Future Flows - $102,331
- Yearly energy savings is higher by $4k during the yearly years and $2,000 during the future years.

Lessons Learned on this Case Study

- **Largest Energy Savings** is by knowing the region in the system head curve where the pumps are expected most of the time, pumps can be selected so that the pumps efficiency "sweet spot" will intersect that operating region.
- **Efficiency can be further optimized** by using the "specific energy consumption" to determine the least energy consumption throughout the range of pump operation will further define how the pump can be configured so that the pump station operate with the least energy consumption.
- Switching from single to dual force main at the right flow will save energy while maintaining the right solids transport based on pipe velocity.
- Other energy savings tips
  - Specifying high efficiency pumps, motors and VFDs
  - Designing controls so that pumps operate at speed and number of units where specific energy consumption is the lowest.

Questions and Answers