How Much Load Reduction is Necessary? An Introduction to Load Duration Curves

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Water Quality Conditions

- Geronimo Creek first listed on the 2006 303(d) list for not supporting its contact recreation use
  - Listed again in 2008 and 2010
- Geronimo Creek first identified in 2000 for concern for nutrient enrichment
  - 2008 assessment, all 60 samples exceeded 1.95 mg/L nitrate-nitrogen

TSSWCB

GBRA

AgriLIFE EXTENSION
Texas A&M System

Our Goal

- Reduce loading of bacteria to meet the water quality standard for contact recreation
  - 126 cfu/100 mL *E. coli*
- Reduce loading of nitrate-nitrogen to meet the water quality screening criterion for nitrate-nitrogen
  - 1.95 mg/L nitrate-nitrogen

How can we estimate the reduction that is needed to achieve our water quality goals?

- Simple math equation
- Load Duration Curve

Simple Math

- Example: Geomean for our creek is at 165 cfu/100ml
  - Water quality standard is a geomean of 126cfu/100ml
  - 165 – 126 = 39
- 39/165 = 23.6% Overall reduction

Simple Math Pros and Cons

- Pros
  - Quick and simple
- Cons
  - Does not look at full range of flow conditions
  - May oversimplify a complex situation
  - May be misleading
  - May not result in achieving goal, because loading may be greater (or lesser) at different flow conditions
  - Provides no insight into pollutant sources

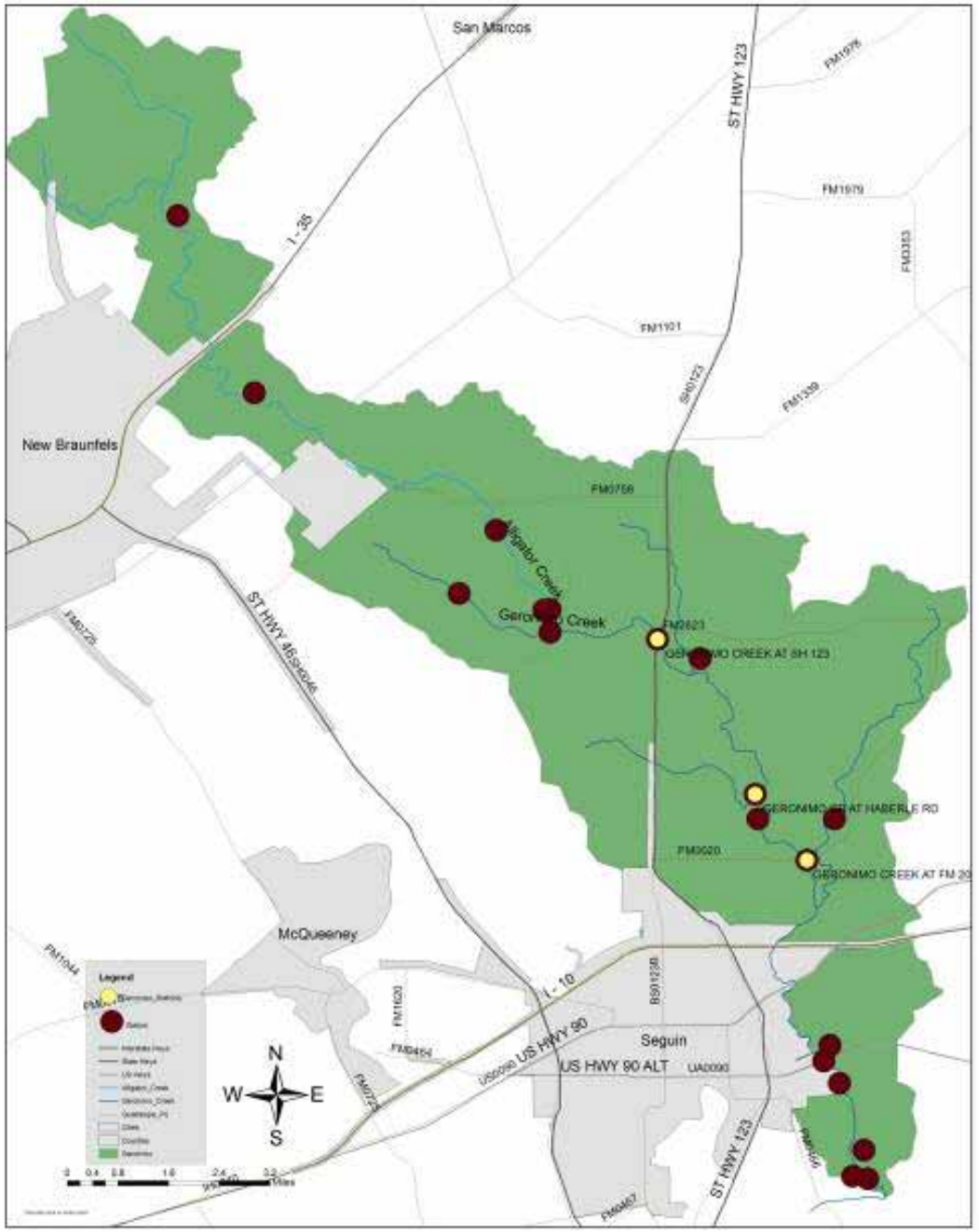
Load Duration Curves

- A good combination of moderately complex calculations, with a somewhat easy to understand output
- Recommended by EPA as a valid tool
- An improvement over the simple math approach
  - Looks at water quality over the full range of flows that a creek experiences
- Identifies the flow at which impairments occur most frequently

LDC Introduction

- Begin with constructing a Flow Duration Curve
  - The curved line demonstrates the frequency of flows in a stream over time
    - Highest volume flows are on the left
    - Lowest volume flows are on the right
    - Frequency of the flows is given along the X axis

Water Quality Sites on Geronimo and Alligator Creeks



Geronimo Creek at SH 123 Flow Duration Curve

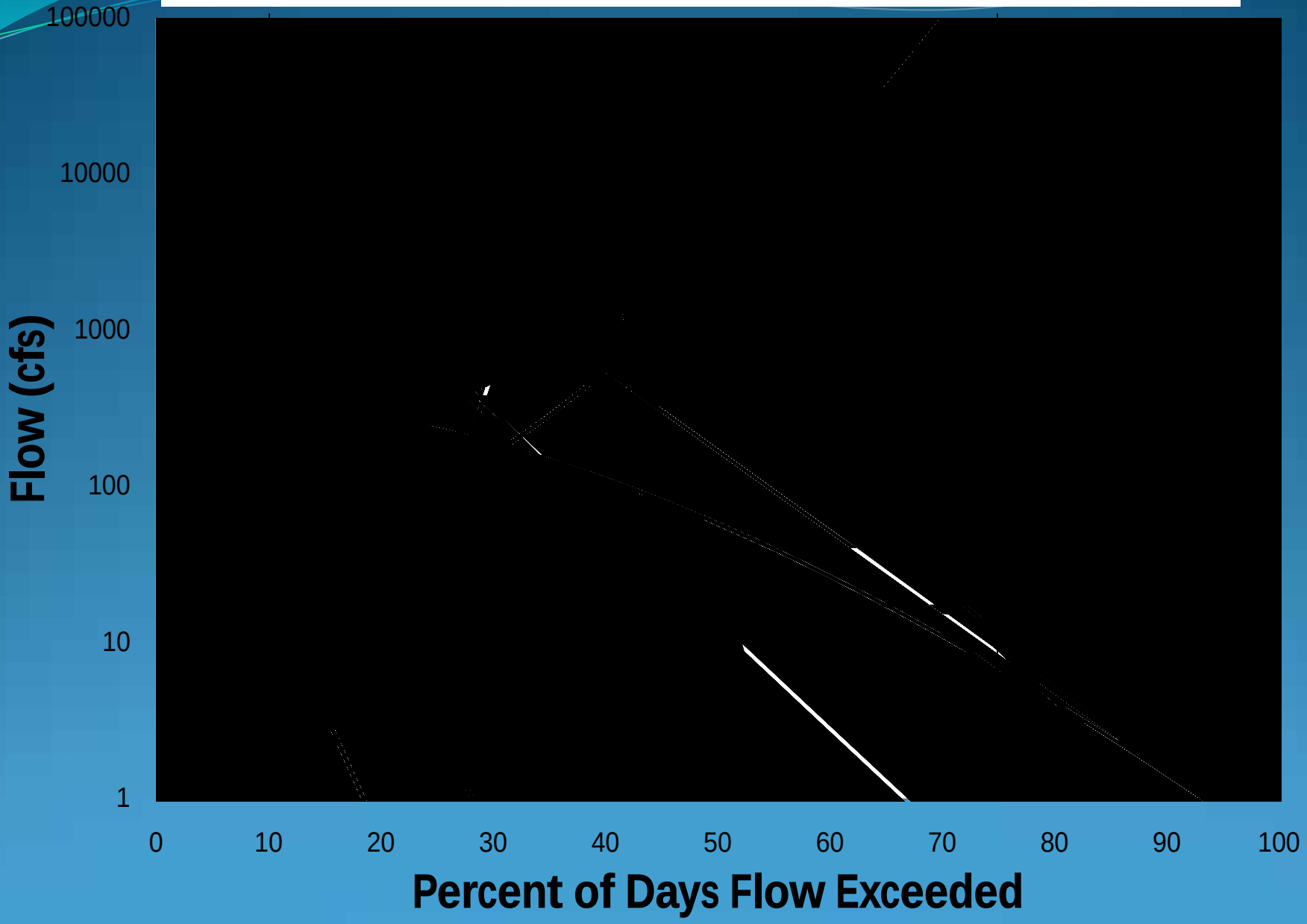
Flow (cfs)

10000
1000
100
10
Hi
1

0 10 20 30 40 50 60 70 80 90 100

Percent of Days Flow Exceeded

Geronimo Creek at Haberle Road Flow Duration Curve



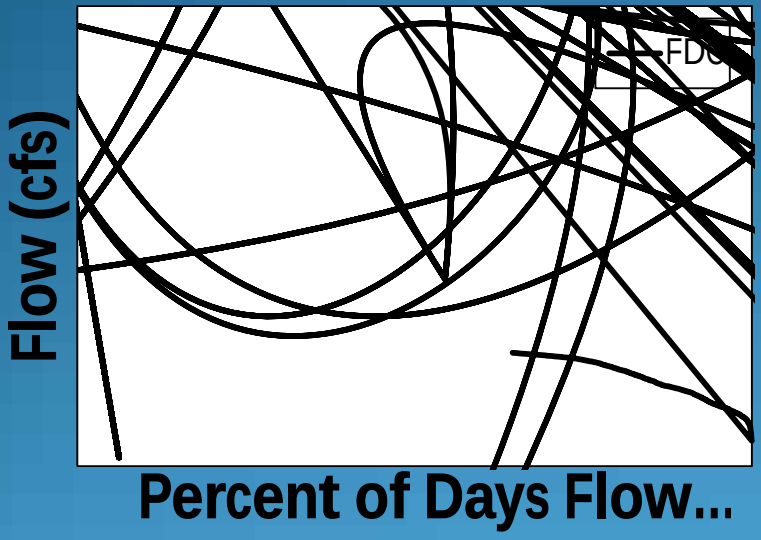
Flow Duration Curves then Converted to Load Duration Curves

- This is what allows us to see what reduction is necessary
- Load duration curves are simply flow duration curves converted to show a concentration (load) of a given constituent
- To convert a FDC to a LDC, simply multiply the FDC by the concentration of the parameter of concern

Conversion from FDC to LDC

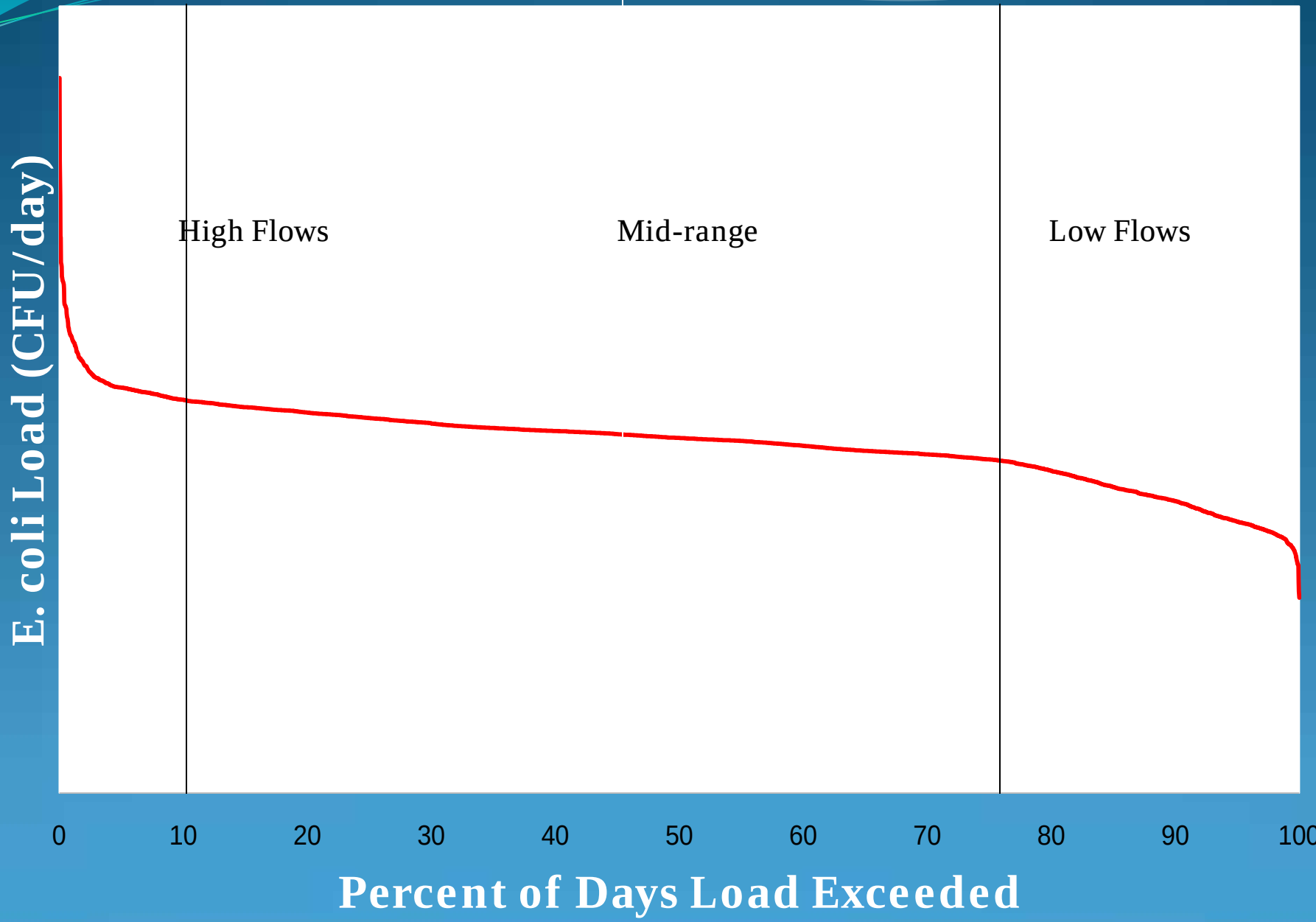
- To create a bacteria LDC, multiply the FDC by the water quality standard
  - Geomean of 126 cfu/100mL
  - At this time, you build in a Margin of Safety
    - Typically 10% less than the water quality standard
- The line now demonstrates how much bacteria can be in the stream at any given flow, and still meet the water quality standard

Creating LDCs from FDCs

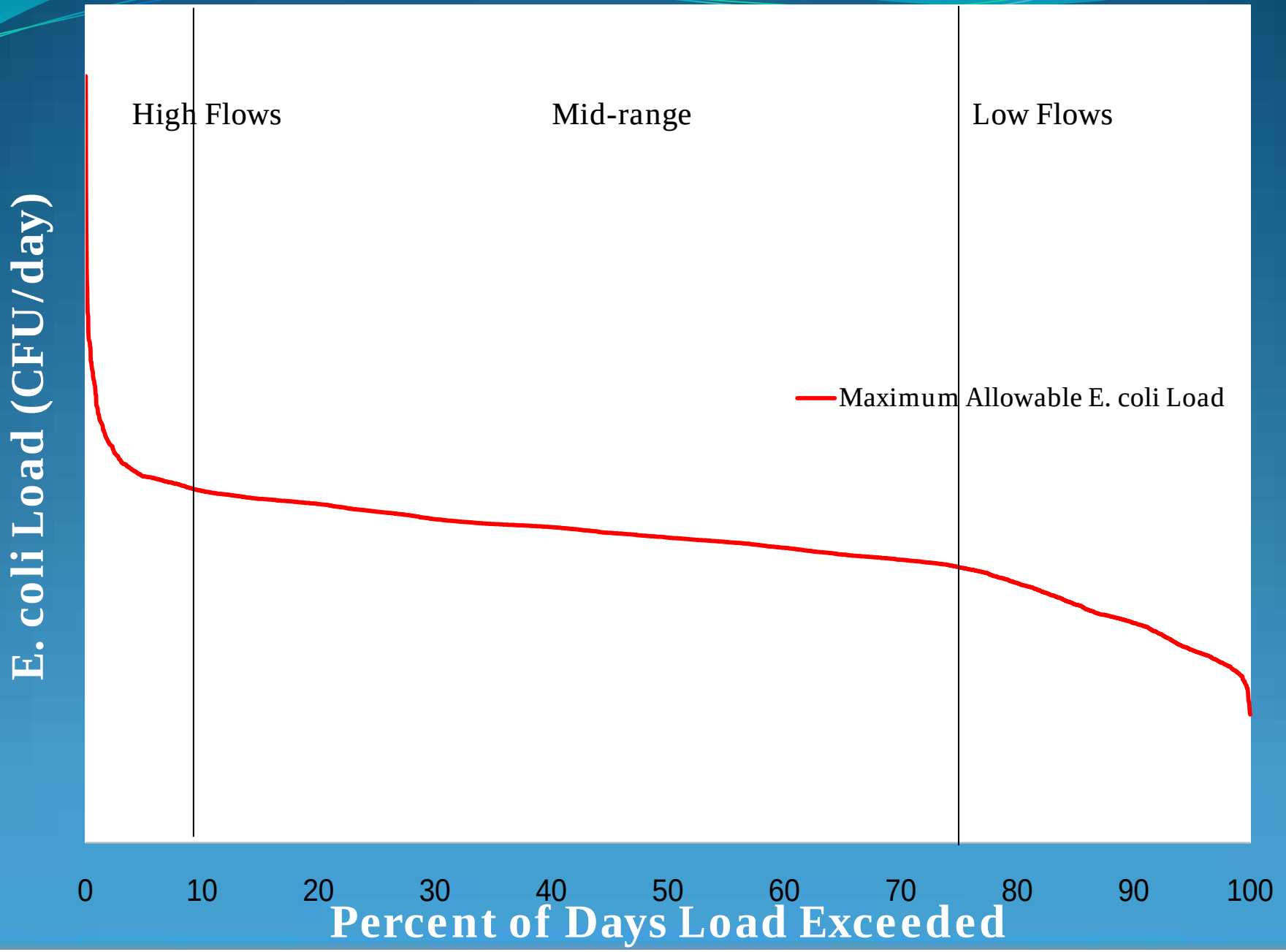


X **Contact Recreation Standard**

Geronimo Creek at SH 123 Load Duration Curve



Geronimo Creek at Haberle Road Load Duration



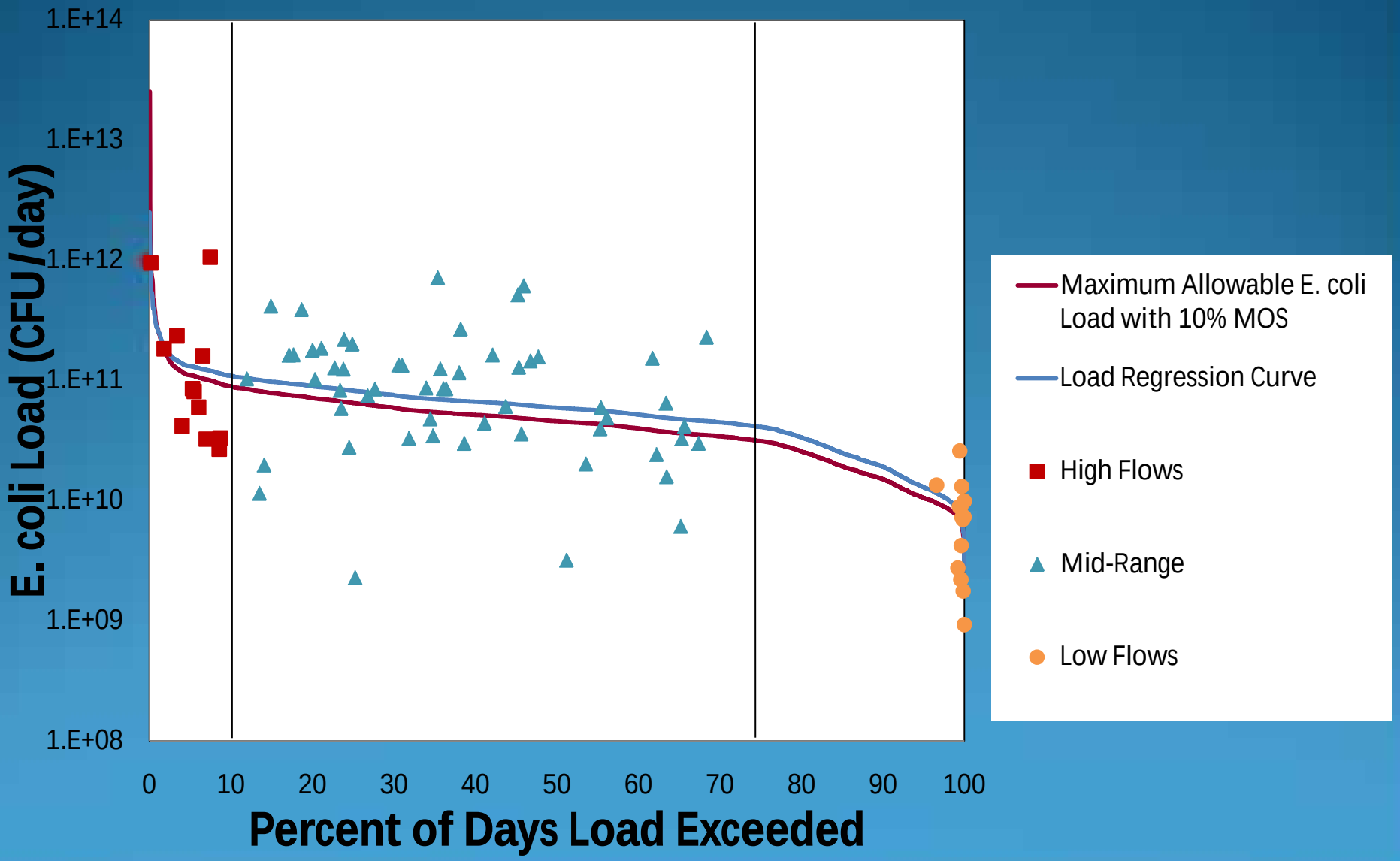
Next…

- Plot the data collected from the creek
- These individual data points will be scattered on the graph
- A “best fit” line will be on the graph to demonstrate the trend of the collected data

How do you read a LDC?

- Data points above the red line (Maximum allowable load) are above the standard
- Data points below the line are below the water quality standard
  - The “best fit” blue line demonstrates where our data are falling

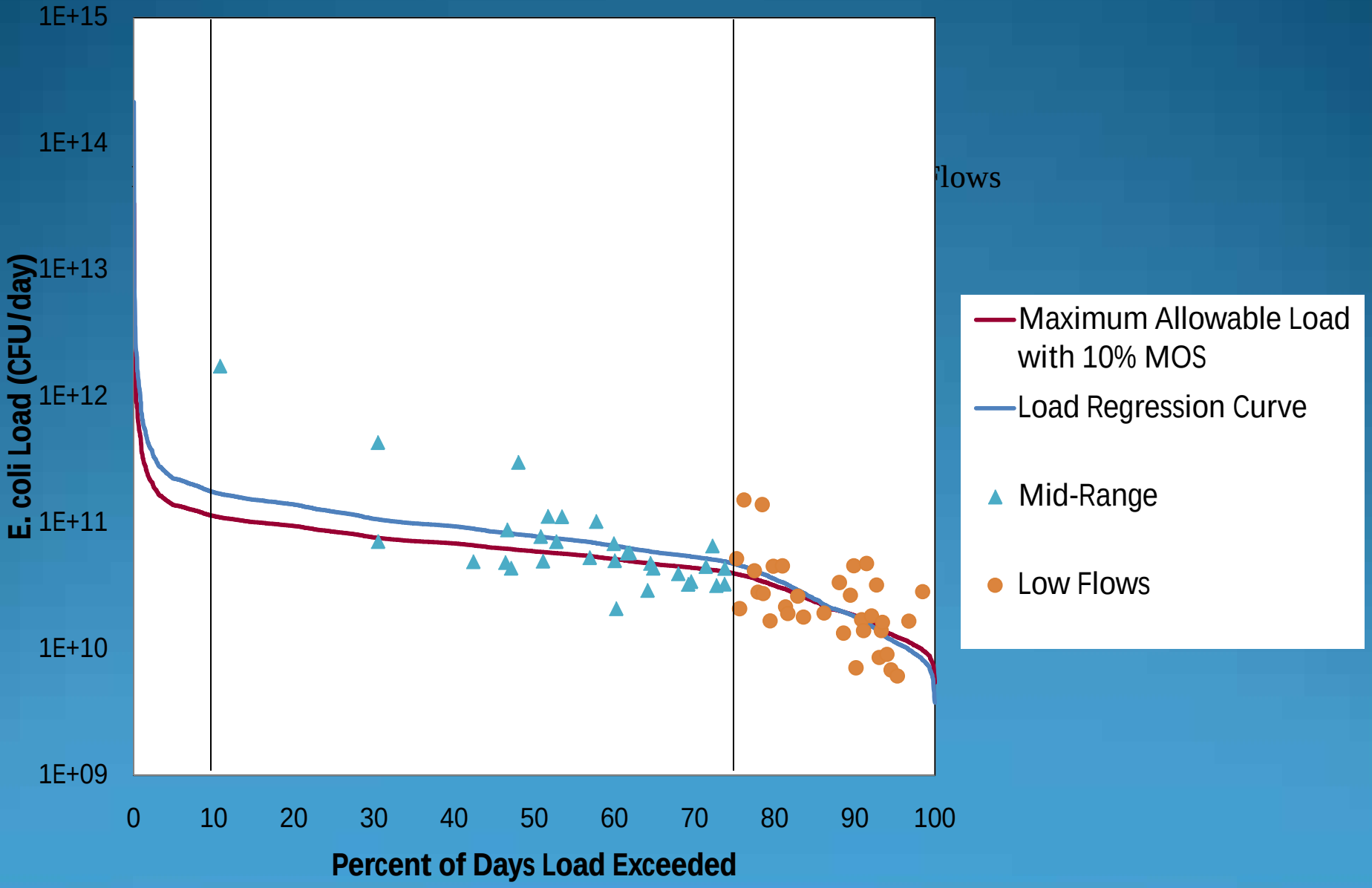
LDC for Bacteria for Geronimo Creek at SH 123



Geronimo Creek at SH 123 Bacteria Reductions

Flow Condition	Percent Reduction
High Flows	8%
Mid-Range	22%
Low Flows	21%

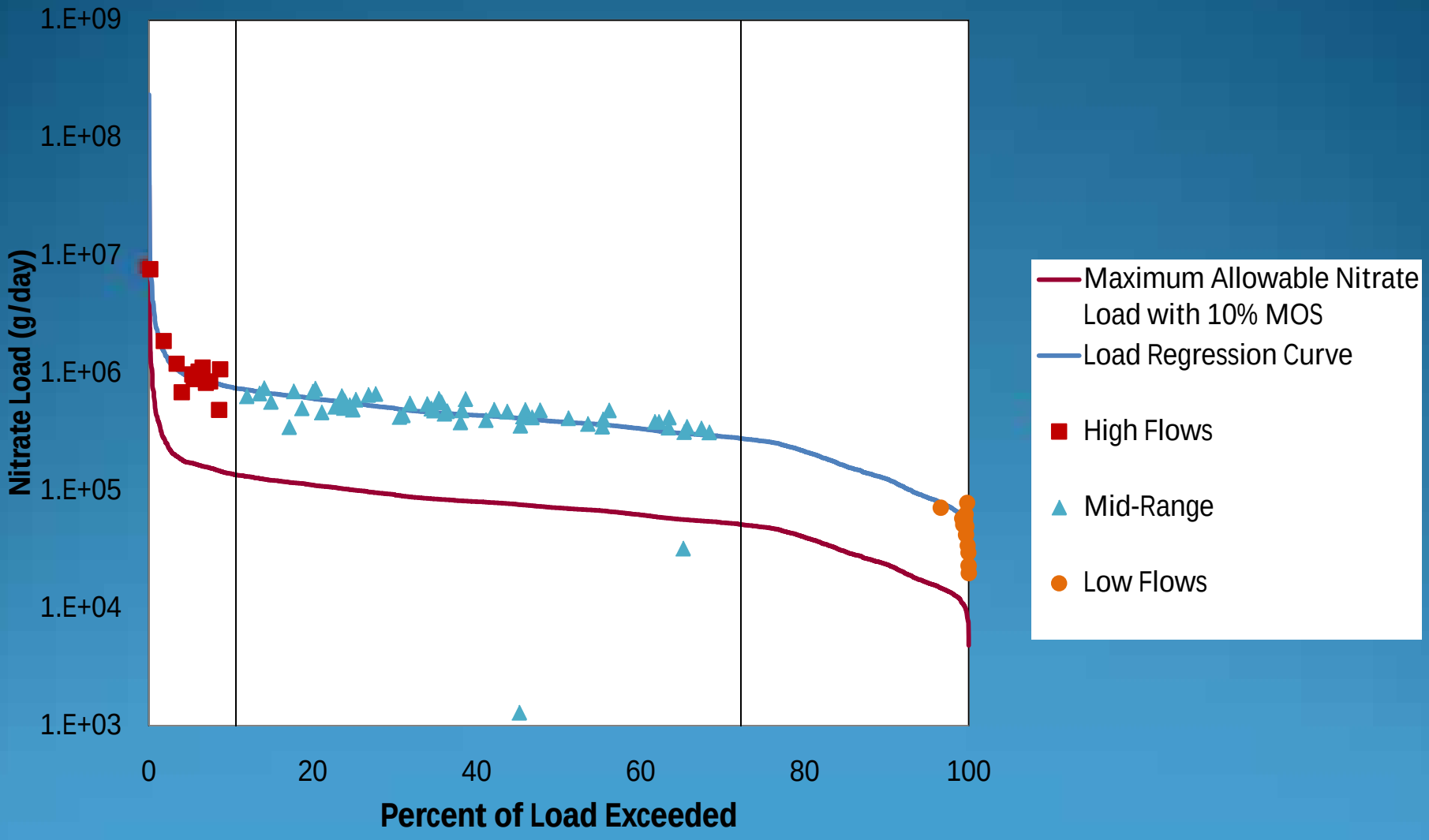
LDC for Bacteria for Geronimo Creek at Haberle Road



Geronimo Creek at Haberle Road Bacteria Reductions

Flow Condition	Percent Reduction
High Flows	42%
Mid-Range	26%
Low Flows	0%

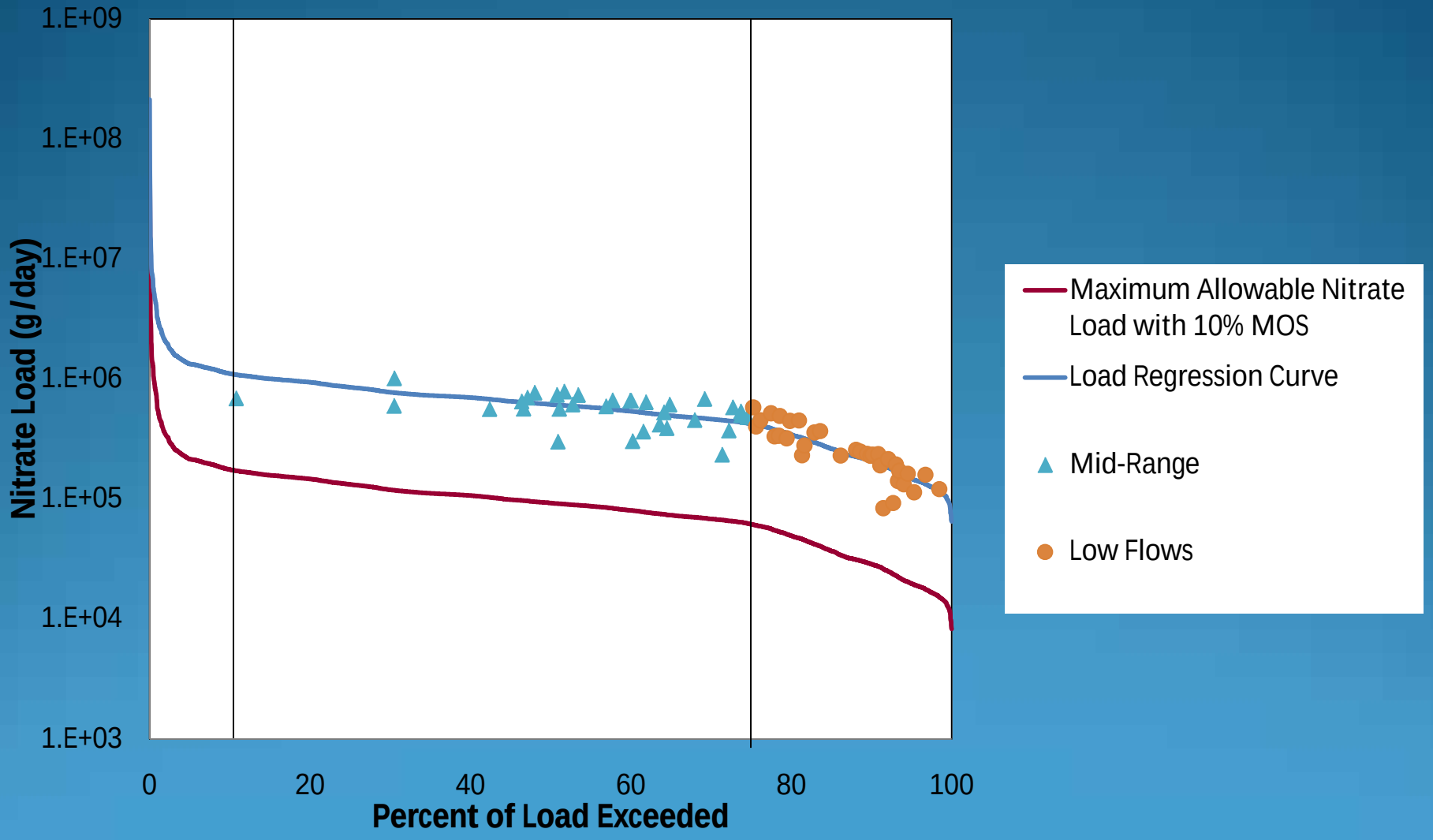
Geronimo Creek at SH 123 Nitrate Concentrations



Geronimo Creek at SH 123 Nitrate Reductions

Flow Condition	Percent Reduction
High Flows	82
Mid-Range	82
Low Flows	81

Geronimo Creek at Haberle Rd Nitrate Concentrations



Geronimo Creek at Haberle Rd Nitrate Reductions

Flow Conditions	Percent Reduction
High Flows	84
Mid-Range	85
Low Flows	86

Geronimo at SH 123 Summary

- Bacteria
  - Exceedances occur during all flows
  - Required reductions are reasonable and achievable
- Nitrates
  - Exceedances occur during all flows
  - Further investigation may be required

Geronimo at Haberle Road Summary

- Bacteria
  - Exceedances occur during high and mid range flows
  - Required reductions are reasonable and achievable
- Nitrates
  - Exceedances occur across all flows
  - Further investigation may be required

Questions?