SIMPLIFIED STREAM SIMULATION (SSS)

also known by Minimally Engineered Aquatic Organism Passage (MEAOP)

Forest Service, Engineering
October, 2015

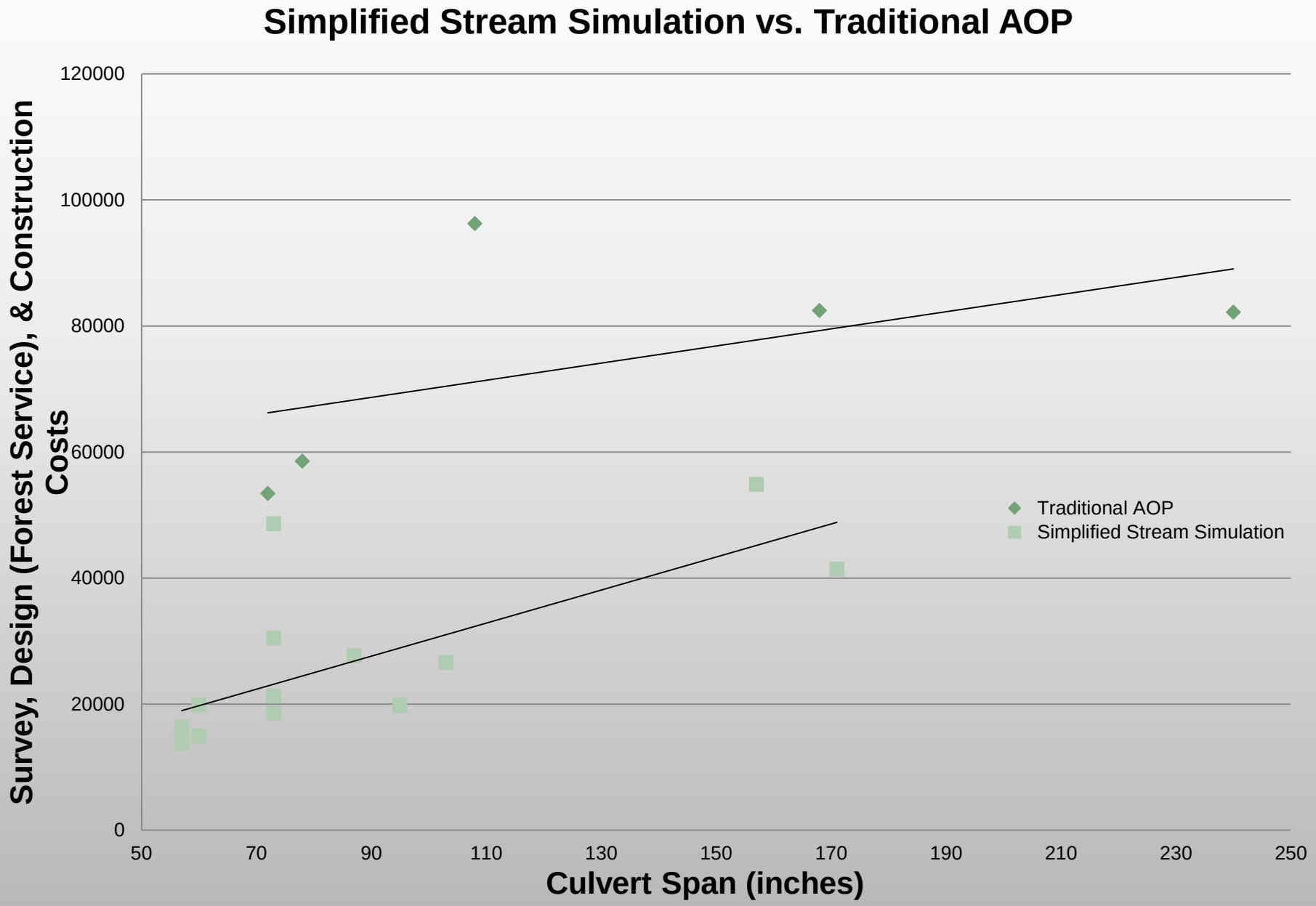
Simplified Stream Simulation Goals

- Create conditions that will allow for aquatic organism passage.
- Reduce the overall costs, as compared to the geomorphological design.
- Be able to extend our funding further to address more road/stream crossing issues.

Differences between the simplified approach and a geomorphological design approach to stream simulation

- Costs
  - Assuming survey and design is done in-house, traditional AOP culverts cost an average of approximately $50,000* more.
  - Each year we've seen the Simplified Stream Simulation costs trend downward.

* A recent construction contract was excluded from this comparison due to the AOP culverts being part of an abnormally large, multimillion dollar road contract which may have skewed the data.

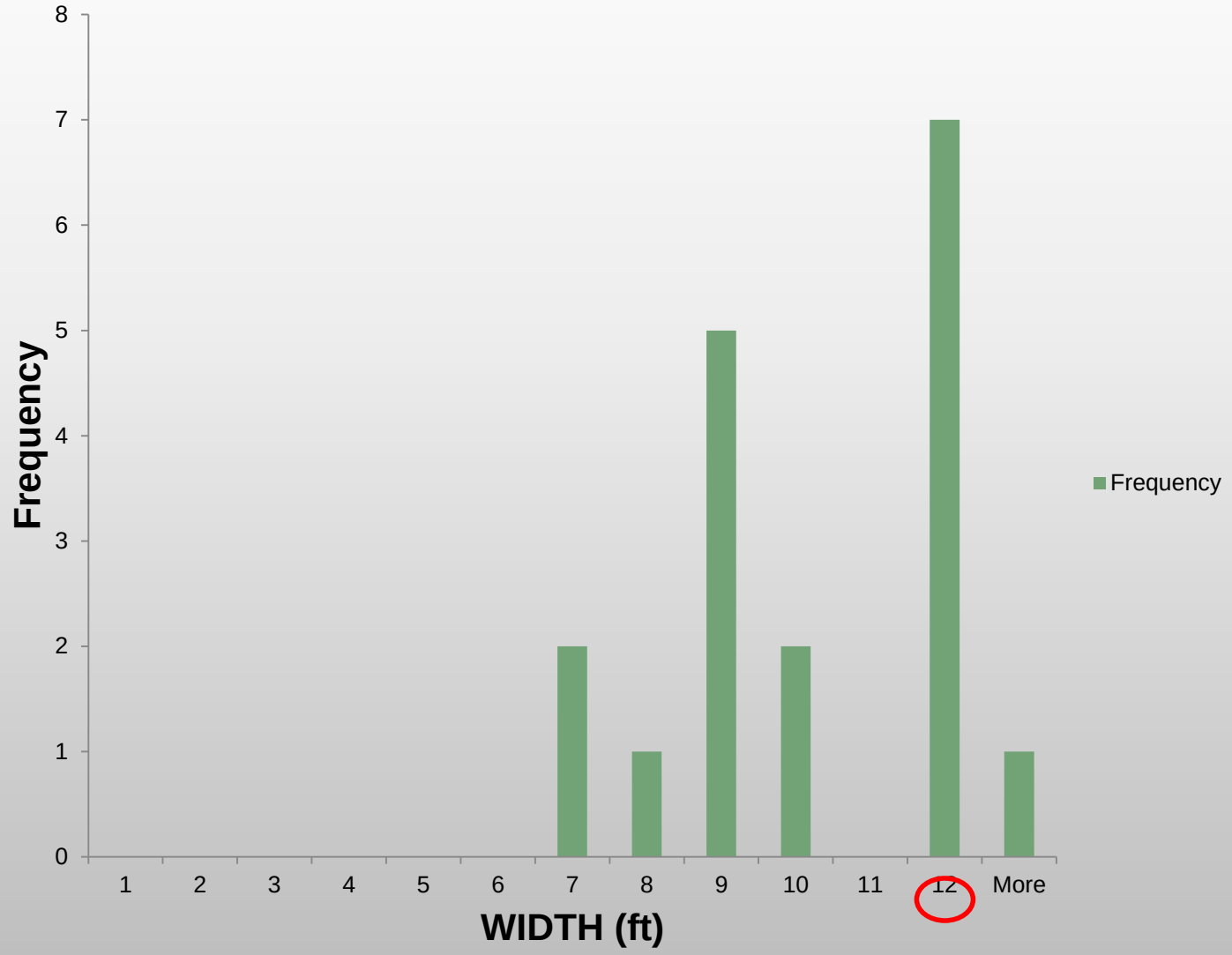

Simplified Stream Simulation vs. Traditional AOP
Survey, Design (Forest Service), & Construction Costs
120000
100000
80000
60000
40000
20000
0
50
70
90
110
130
150
170
190
210
230
250
Culvert Span (inches)
Traditional AOP
Simplified Stream Simulation

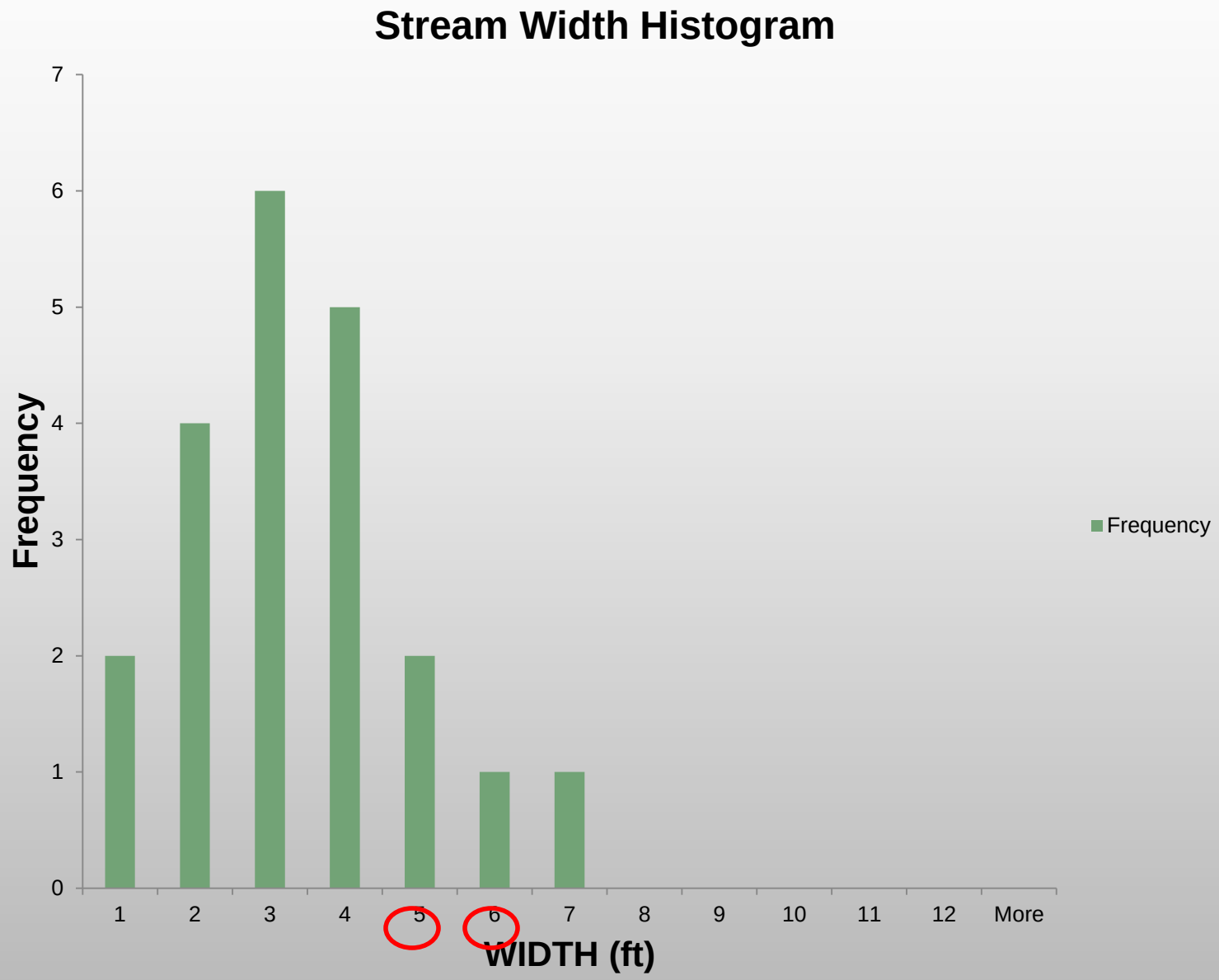
Culvert Sizing

- **Traditional AOP**
  - Relies on a maximum width measurement from a “representative” reference reach.
  - Other considerations (woody debris, grade control, bank transition, baffles, etc.).

- **Simplified Stream Simulation**
  - Sampling stream width measurements from the whole survey, excluding portions affected by the old culvert.
  - Sample measurements are plotted in a histogram.
  - Culvert is then sized based on the maximum, or near maximum, width measurement- evaluate the 66^{th} percentile width.
  - Other considerations (woody debris, grade control, bank transition, baffles, etc.).

Stream Width Histogram

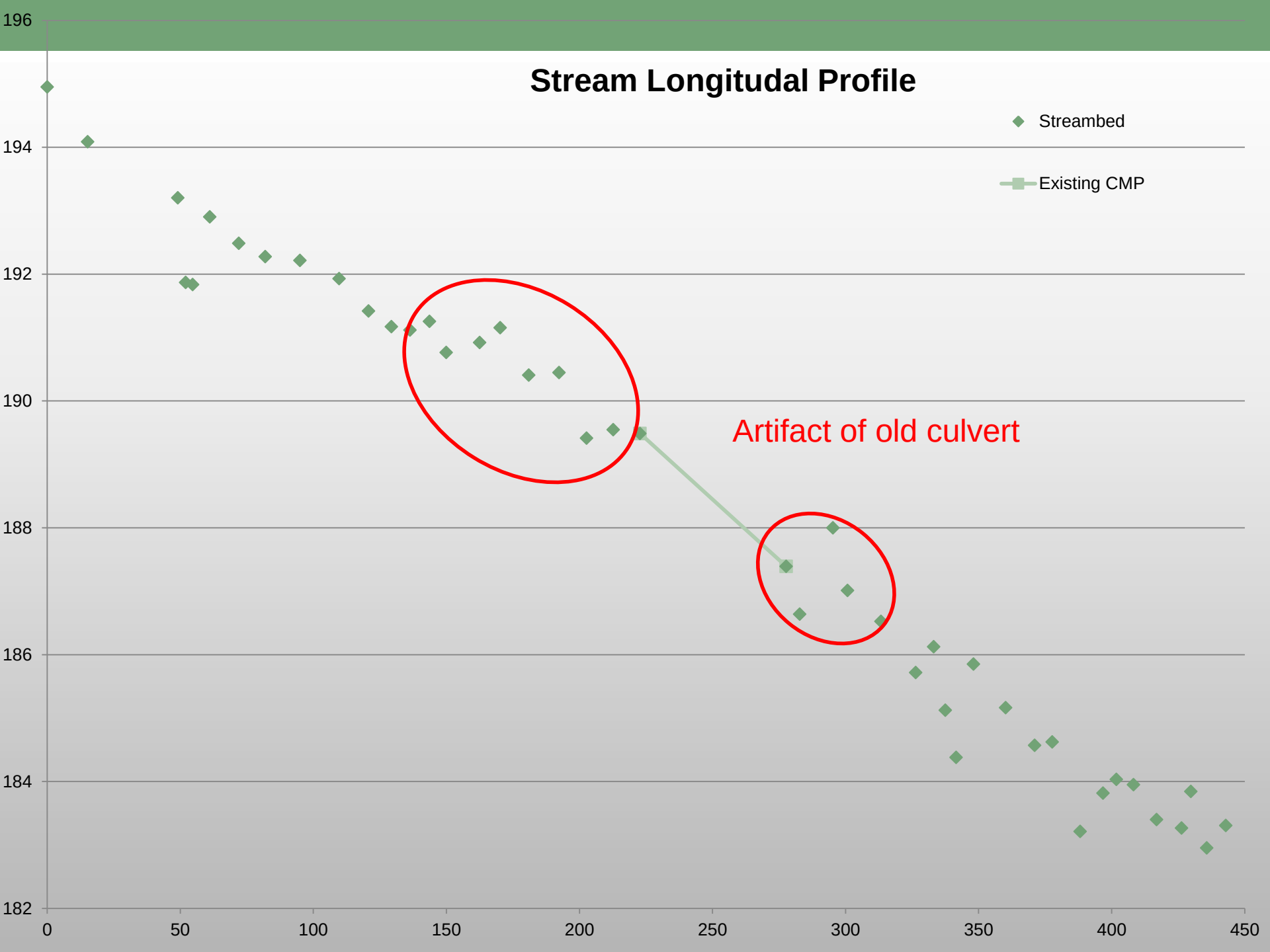


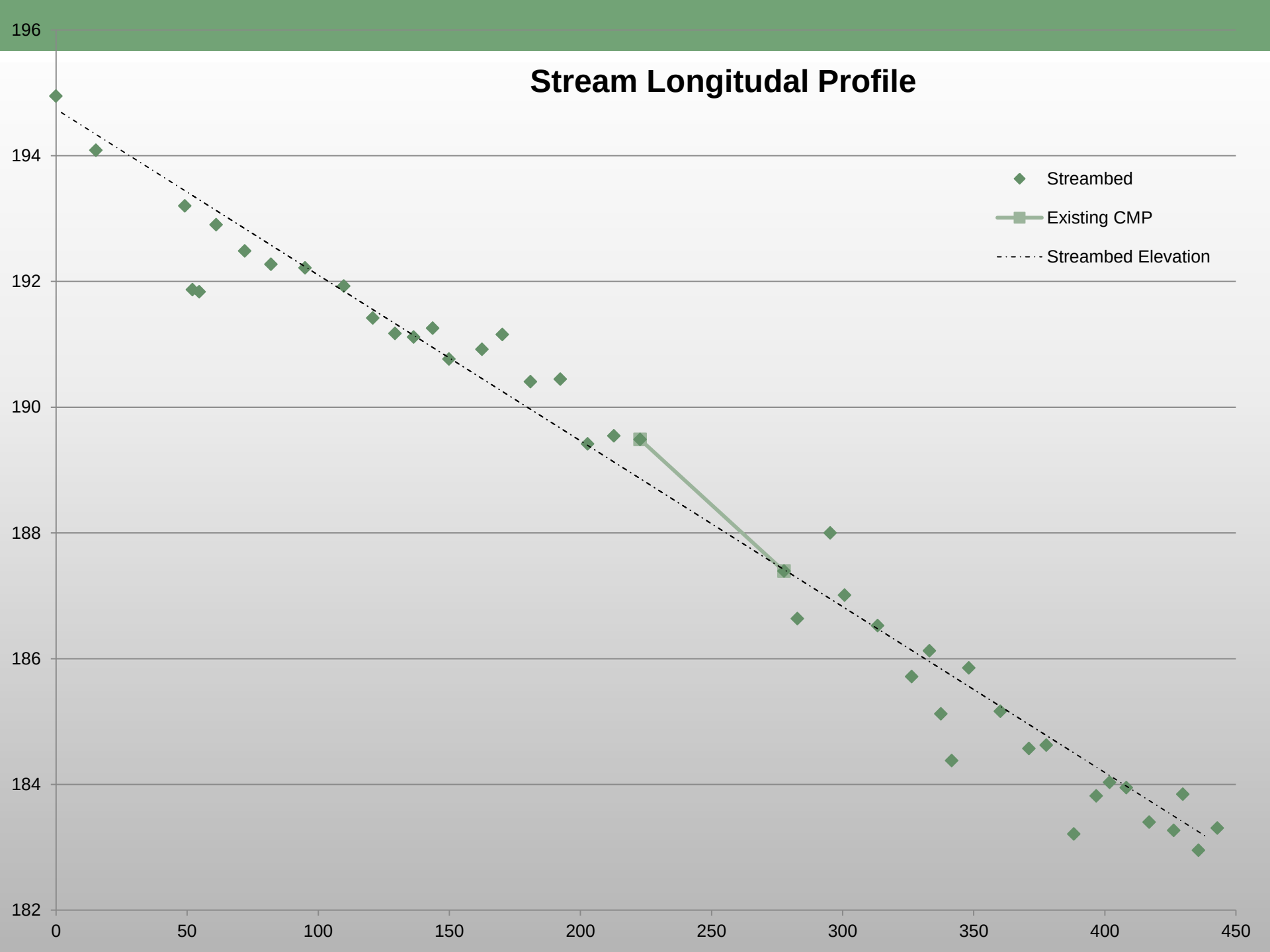

Stream Width Histogram
Frequency
0
1
2
3
4
5
6
7
1
2
3
4
5
6
7
8
9
10
11
12
More
WIDTH (ft)
Frequency

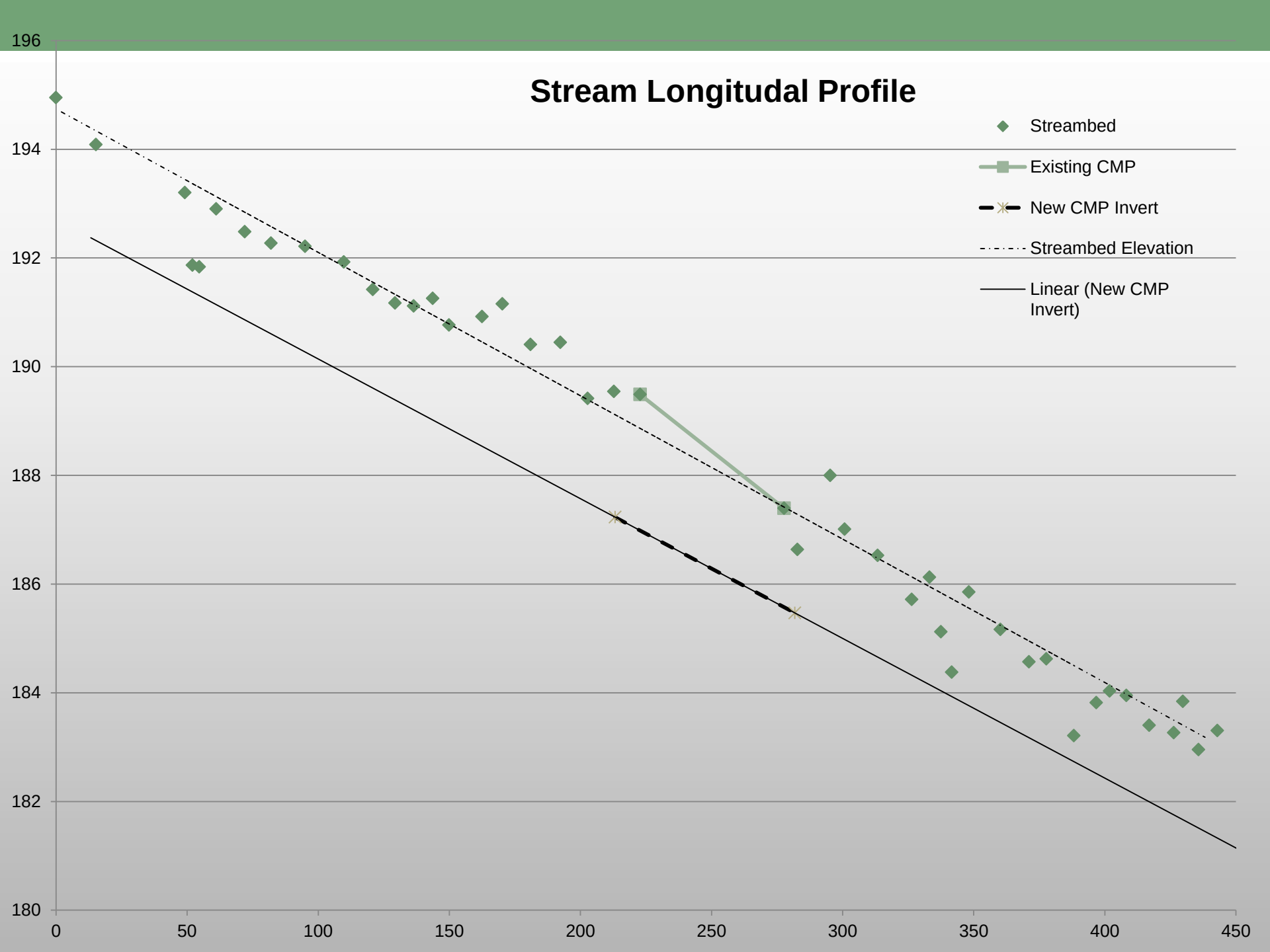
Culvert Gradient

- **Traditional AOP**
  - Obtained from two grade controls within the reference reach.

- **Simplified Stream Simulation**
  - Because streams are dynamic, we try to match the overall gradient of the stream.
    - This is not always possible to use the overall gradient as some streams are convex, concave, or benched.
    - Consider the specific stream configuration, inlet and outlet bank transition, natural stream gradient, depth to bedrock.
  - Consider location of gradient controls- upstream- as well as downstream- to minimize head cutting and increase backwater effect for substrate/ bedload retention in the structure.


Stream Longitudal Profile
Streambed
Existing CMP
Artifact of old culvert
196
194
192
190
188
186
184
182
0
50
100
150
200
250
300
350
400
450


Stream Longitudal Profile
196
194
192
190
188
186
184
182
0
50
100
150
200
250
300
350
400
450
Streambed
Existing CMP
Streambed Elevation


Stream Longitudal Profile
Streambed
Existing CMP
New CMP Invert
Streambed Elevation
Linear (New CMP Invert)
196
194
192
190
188
186
184
182
180
0
50
100
150
200
250
300
350
400
450

Bedload Material

- Traditional AOP
  - Hand placed and constructed pools and riffles.

- Simplified Stream Simulation
  - At sites where bedload is desired, surcharge material is placed upstream and washed into the culvert by the stream.
  - At some sites machine place bedload into initial 10 feet of culvert.
  - Baffles can be used to retain bedload as well as create roughness in the culvert.
  - Effective baffle design coupled with stream strata in the culvert can create a thalweg toward the center of the culvert.

Results

- Bedload surcharge
  - Most sites have been small streams and lack the space for the specified amount of material.
  - The lack of space has led to material being placed above bankfull where it is unlikely to be transported into the culvert.
  - The narrowing of the stream with the surcharge, combined with an inadequate amount, may have led to head cutting at some of sites.
  - At sites where material has been placed inside the inlet of the culverts, the bedload is distributed in the structure.
- Construction
  - Installation of culvert at improper elevations or gradients or without upstream and downstream grade control have led to a site remaining a barrier for some aquatic organisms at some flows.


Before:
87”x63” pipe-arch


After:
171”x110” pipe-arch


After:
Backwatered conditions
and bedload

Before:
Inlet of 48” and 18” overflow culvert with beaver activity


Before:
Looking upstream at sediment and woody debris accumulation due to beaver issues


Before:
Looking at outlets


After:
157”x101” pipe-arch, outlet


After:
Outlet looking upstream


After:
Looking upstream. Surcharge that will likely not be mobilized.