US Army Corps of Engineers

Portland District

Tri-Services Infrastructure Systems Conference

Monitoring the Effects of Sedimentation from Mount St Helens 4 August 2005

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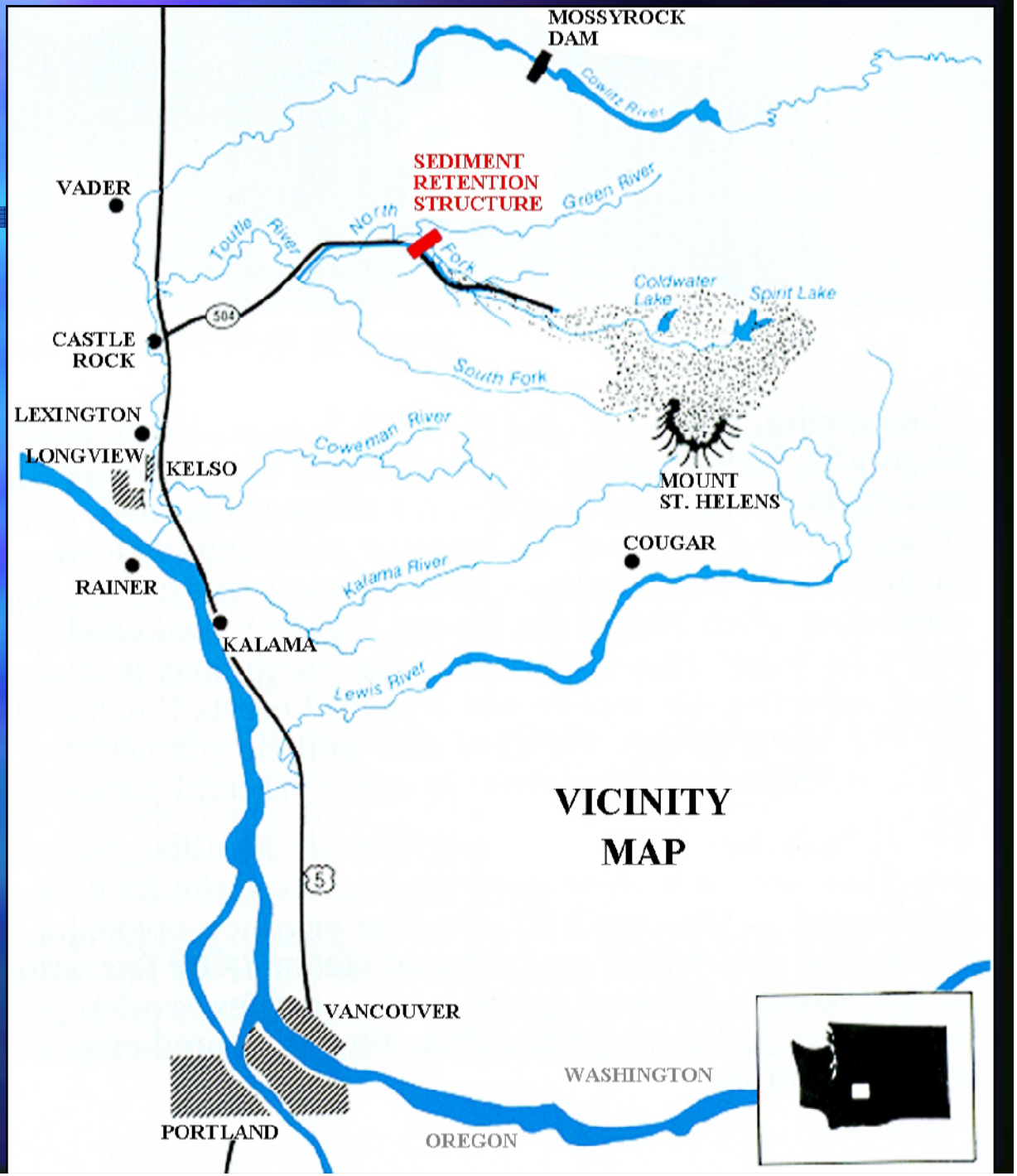
The Area

- Cowlitz below Mayfield Dam – 1400 SqMi
- Sediment Retention Structure – 143 SqMi
- Toutle at Tower Road – 496 SqMi
- Toutle at Mouth – 510 SqMi
- Cowlitz at Castle Rock – 2238 SqMi
- Cowlitz at Mouth – 2480 SqMi



Mount St Helens

18 May 1980

- Eruption removes estimated 0.67 mi^3 (3.7 billion cy) of material from volcano
- Pre-eruption elevation- 9,677 feet
- Post eruption elevation- 8,363 feet

18 May 1980

- Earthquake - 5.1
- Debris Avalanche - 3,700 MCY
- Ash Coverage – 22,000 Square Miles
- Lahars
  - Toutle Damage
  - Cowlitz Channel Capacity
  - Columbia Navigation Channel

Immediate Actions after 1980 Eruption

- Dredge Columbia River navigation channel
- Dredge Cowlitz River channel
- Toutle River sumps
- Additional FC Storage U/S on Cowlitz River
- Levee raises on Cowlitz River

The Area

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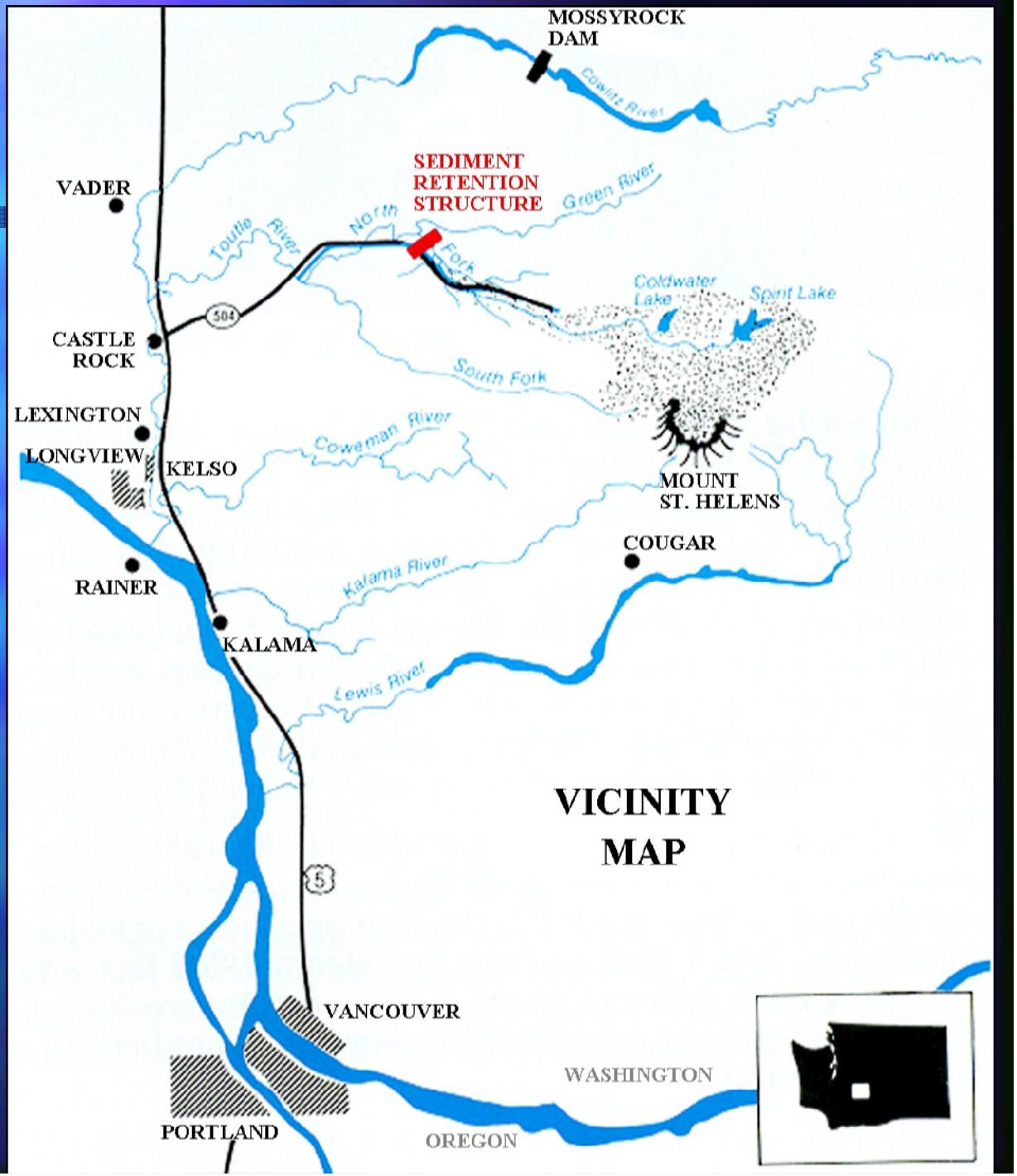


Immediate Actions after 1980 Eruption
(continued)

- Pumping plants for interior flooding
- Outlet channels for Coldwater and Castle Lakes
- Pumping of Spirit Lake
- N1 & S1 Small Retention Structures

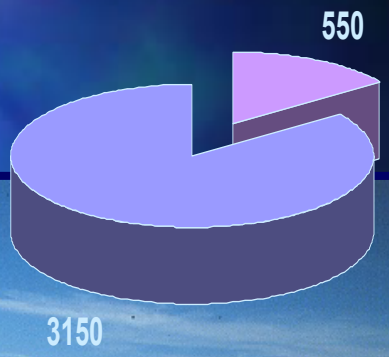
The MSH Project Goal

- To manage sediments eroded from the MSH debris avalanche and downstream bank deposits
  - to maintain authorized levels of flood protection on the Cowlitz River and
  - to maintain full navigation depths on the Columbia River

Areas of Concern

- Flood Damage Reduction - Cowlitz River
  - Kelso
  - Longview
  - Lexington
  - Castle Rock
- Navigation - Columbia River

Debris Avalanche



Selected Alternative

- Three Part Plan
  - Large Sediment Retention Structure
  - Base Plus Dredging
  - Levee Improvement
- And…
  - Monitor
  - Re-evaluate flood risk when the SRS starts passing medium/course sand
  - Identify and evaluate remedial actions if needed

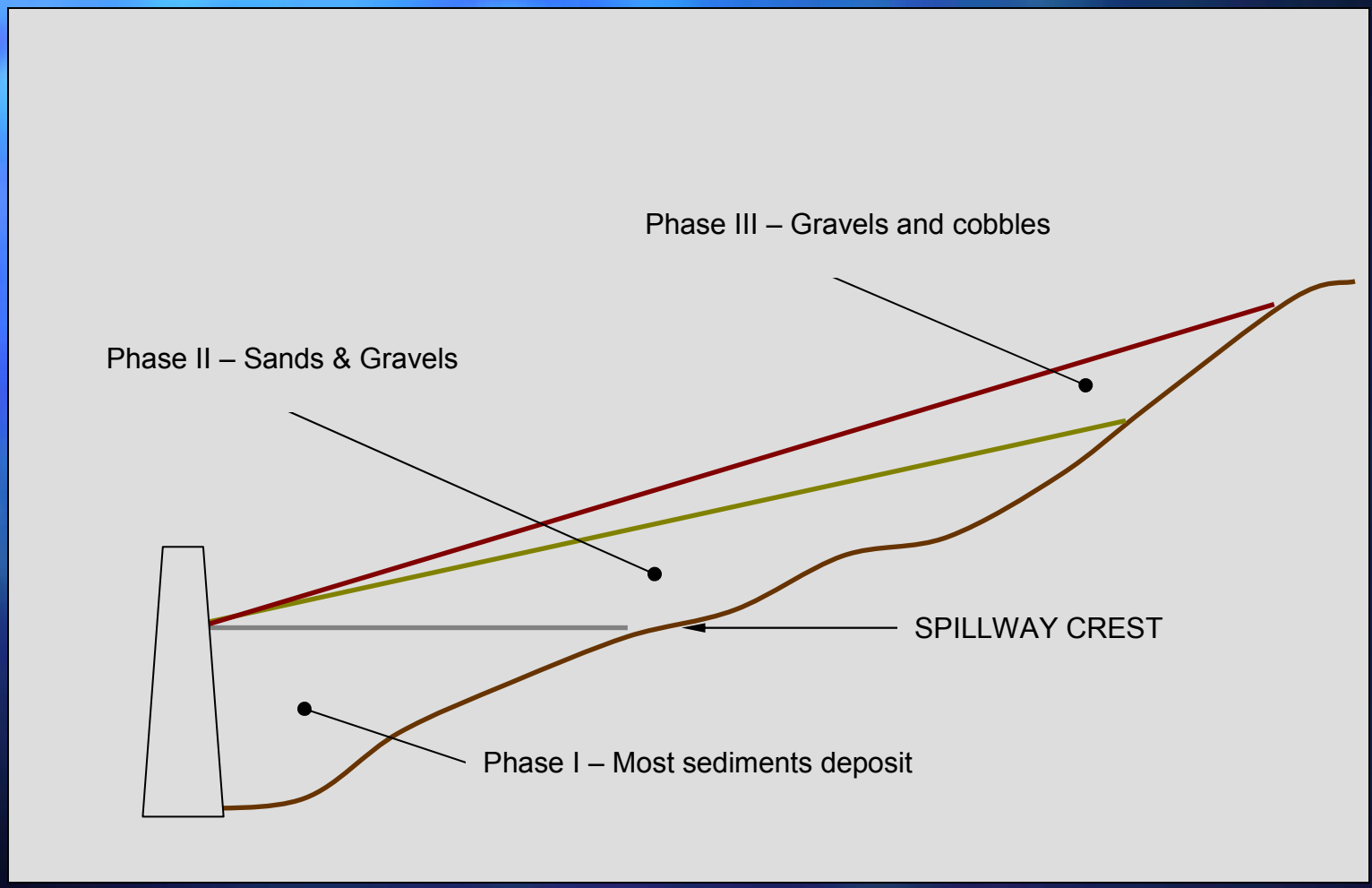
Cowlitz River Levels of Protection

- Pre-eruption
  - All Locations 100 - year+
- Post-eruption
  - All Locations < 2 - year
- Project Authorized LoP (= 106 kcfs - 117 kcfs)
  - Kelso 143 - year
  - Longview 167 - year
  - Lexington 167 - year
  - Castle Rock 118 - year

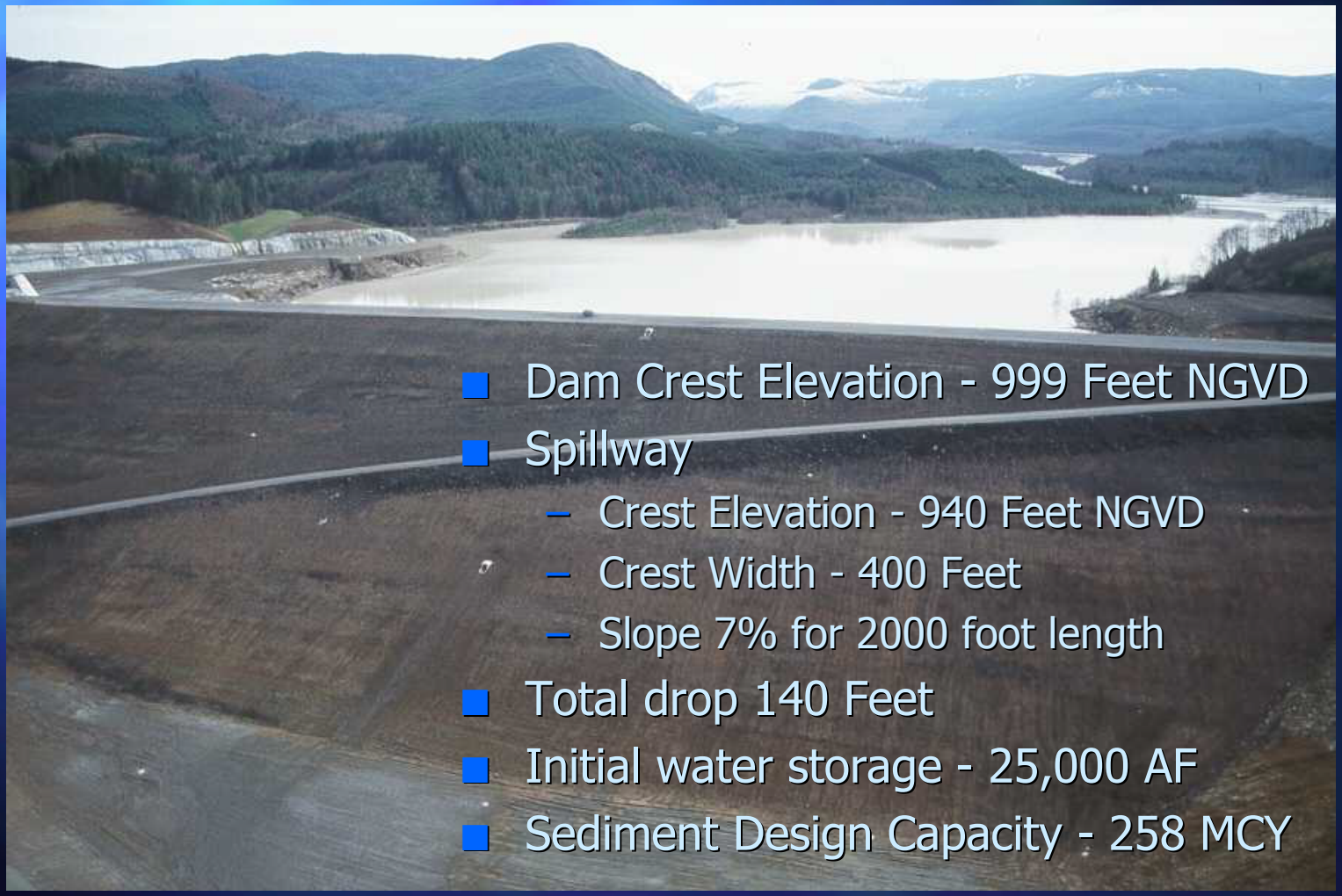
SRS Design Considerations

- Minimal pondage
  - Water Quality
  - Debris Flow
- Pass the PMF - 213,000 cfs
- Pass the OBM - 228,000 cfs
- Sediment Yield and Deposition
- Fish friendly spillway

The SRS Concept



Sediment Retention Structure - 1989

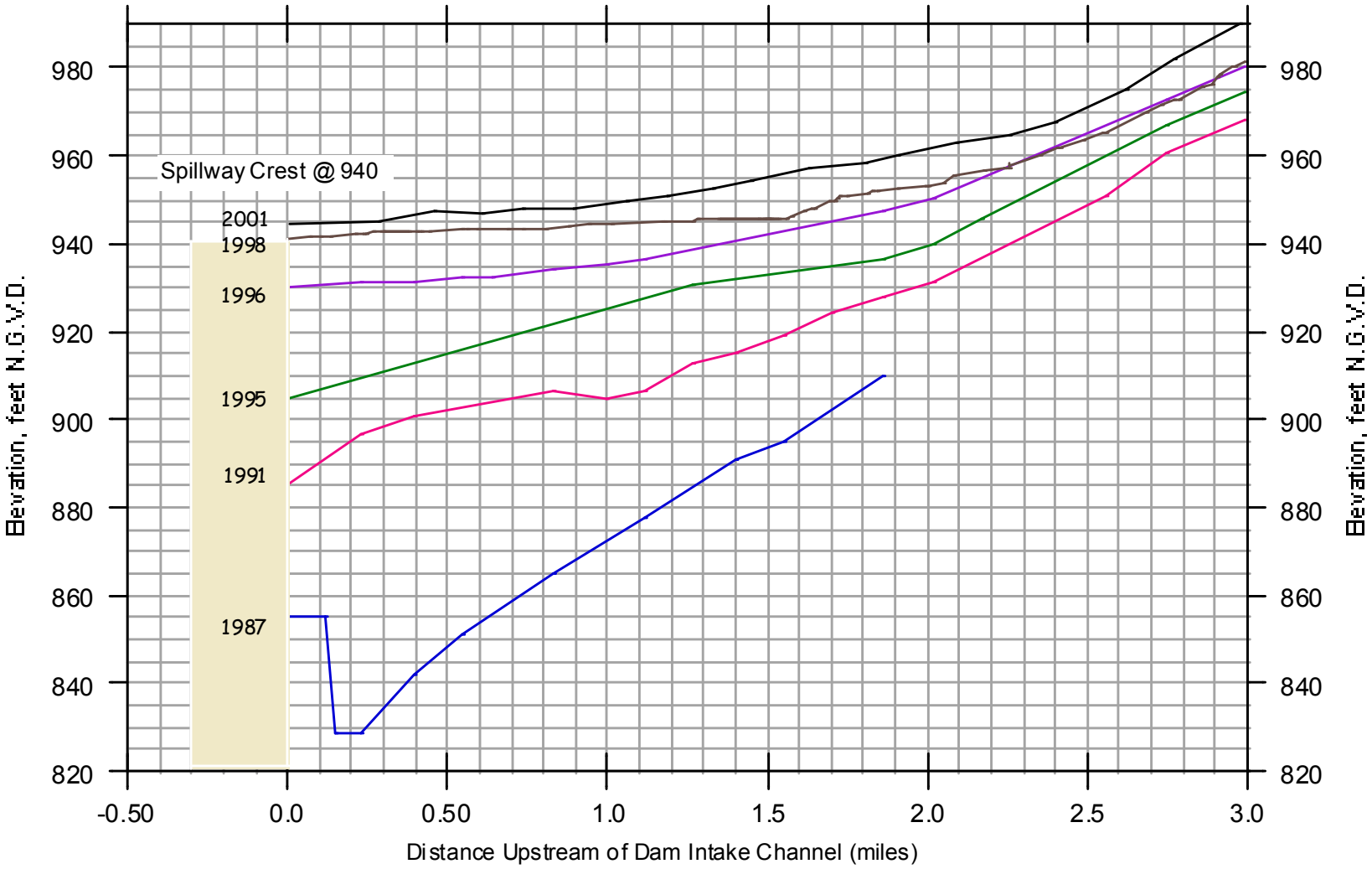


- Dam Crest Elevation - 999 Feet NGVD
- Spillway
  - Crest Elevation - 940 Feet NGVD
  - Crest Width - 400 Feet
  - Slope 7% for 2000 foot length
- Total drop 140 Feet
- Initial water storage - 25,000 AF
- Sediment Design Capacity - 258 MCY

1998

- Issues
  - Top row of outlets closed
  - Sediment reached Spillway Crest
  - Required Cowlitz Level of Protection at issue (FEMA Flood Hazard Study)
- Actions
  - Update Engineering Data
  - Evaluate Conditions • Estimate Potential
  - Recommend Next Action

SRS Sediment Profiles



Sediment Change 2003 to 2005

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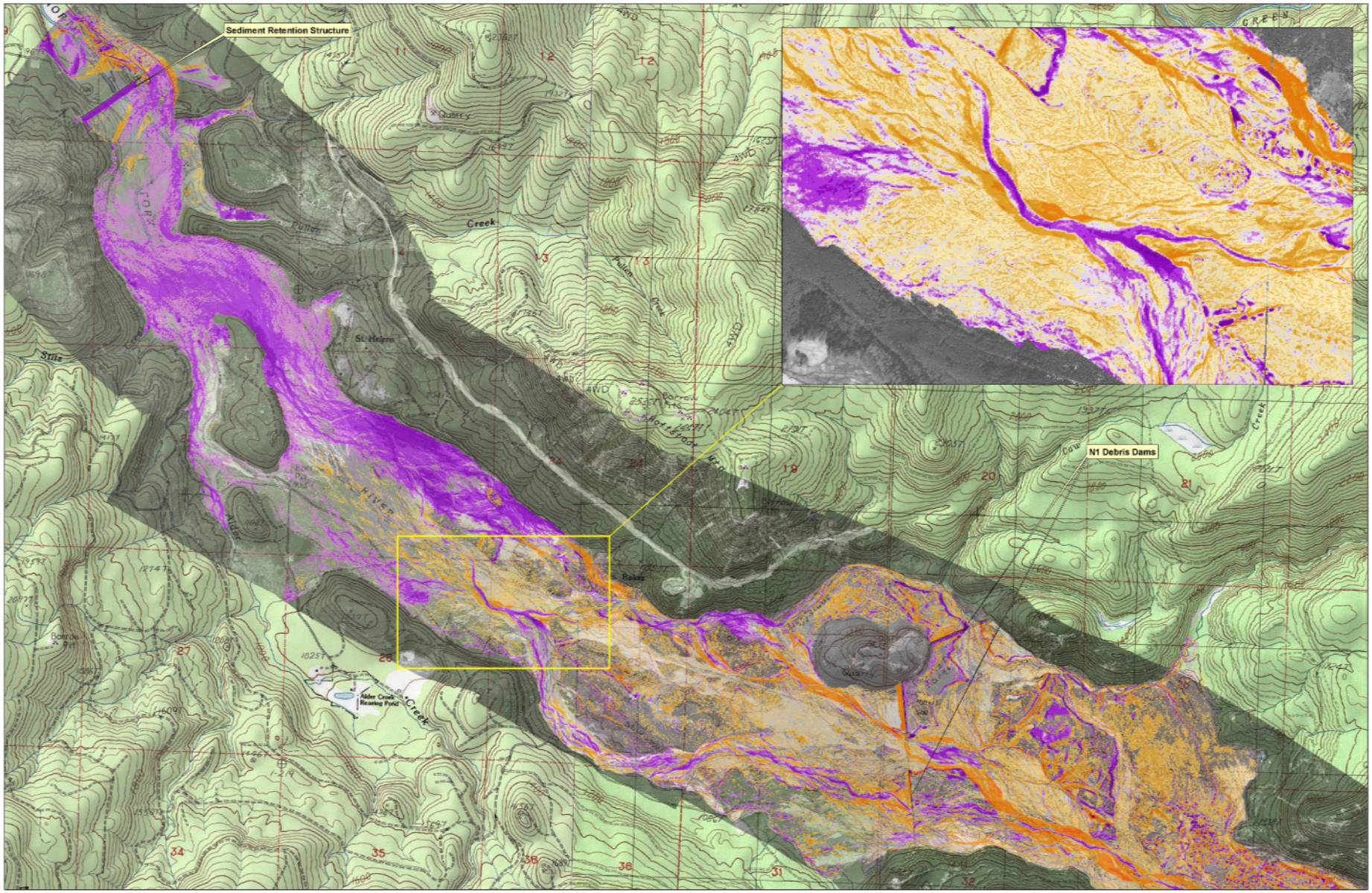


Sediment Yield Reanalysis - 2002

- Changed Conditions
  - Re-vegetation
  - Channel geometry and armouring
  - Channel roughness
  - SRS Filling
- Sediment at SRS spillway crest
- Cowlitz bed material
- Risk evaluation

Engineering Re-Analysis - Products

- Update Sediment Yield
  - DTM of Debris Avalanche - 1998
  - DTM of Debris Avalanche - 2000
  - other methods
- Update Hydrologic Data
- Re-evaluate Future Flood Risk - Cowlitz
  - HEC6
  - FDA
- Recommendations for Future Action

Mount St Helens Engineering Reanalysis (2002) Recommendations

- Periodic aerial photography of NF Toutle Basin
- Sediment sampling Toutle Basin and Cowlitz River
- Channel surveys NF Toutle River (SRS), Cowlitz River
- Monitoring gages on Cowlitz River

Current Levels of Protection

LOCATION	Authorized LoP (Years)	Nov 2004 Update (Years)
Kelso	143	259
Longview	167	277
Lexington	167	230
Castle Rock	118	209

- Monitoring
- Assessment
- Action

Monitoring/Assessment/Action

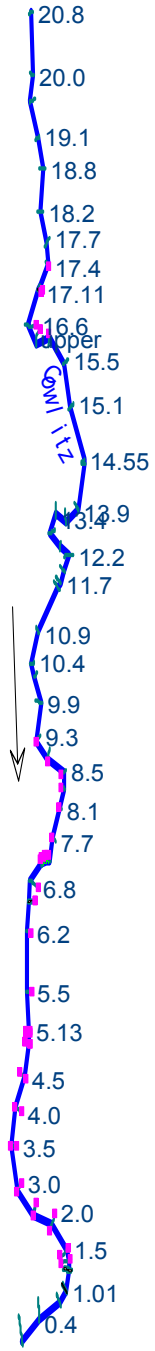
- Monitoring – data collection and field observations
- Assessment – qualitative analysis of data collected
  - Specific gage analysis from monitoring gages
  - Geomorphic assessment = field observations + bed material samples + USGS suspended sediment data
  - SIAM model uses data collected. The model should confirm and support observed geomorphic trend.

Monitoring/Assessment/Action

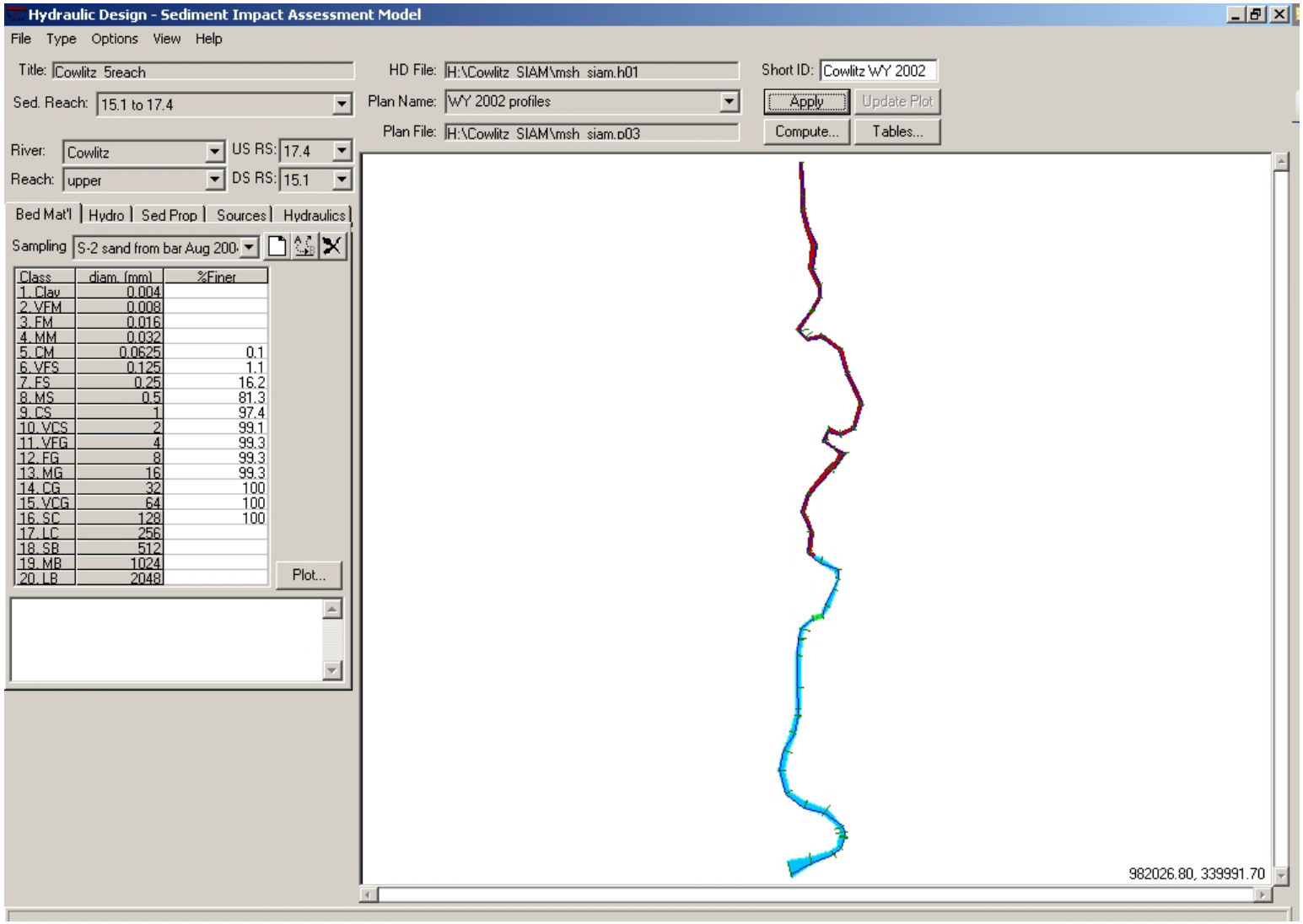
- Action - 2 possible outcomes
  - Assessment concludes aggradational trend in Cowlitz threatens authorized level of flood protection provided by levees. **Action – immediate measures, followed by alternative study**
  - Assessment concludes that channel is stable or aggradation/degradational trends do not threaten authorized level of flood protection provided by levees. **Action – Continue monitoring**

Data

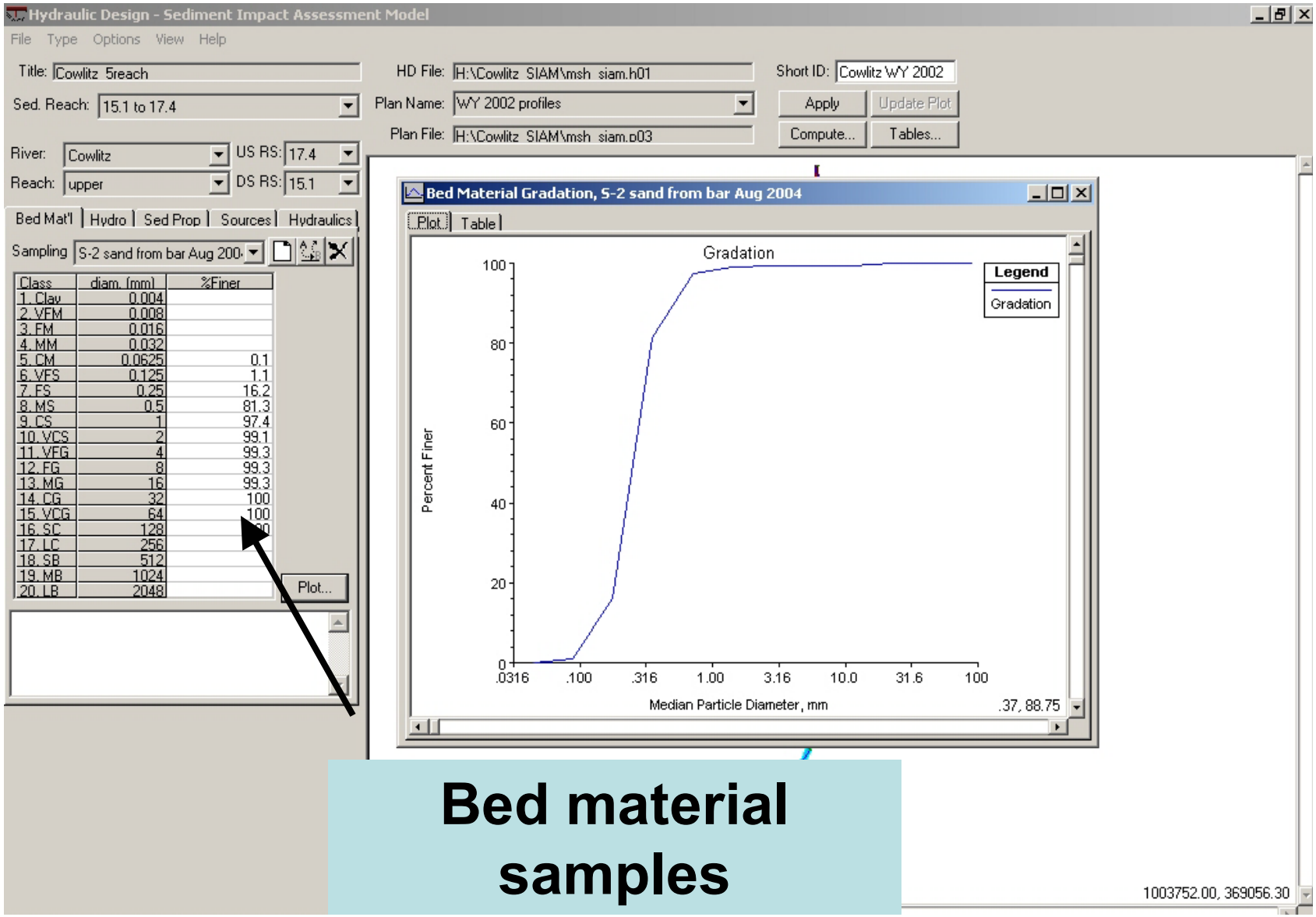
- Bed material samples
- Suspended sediment data
- Monitoring gage data
- Hydrosurvey data
- Bottom sediment classification mapping



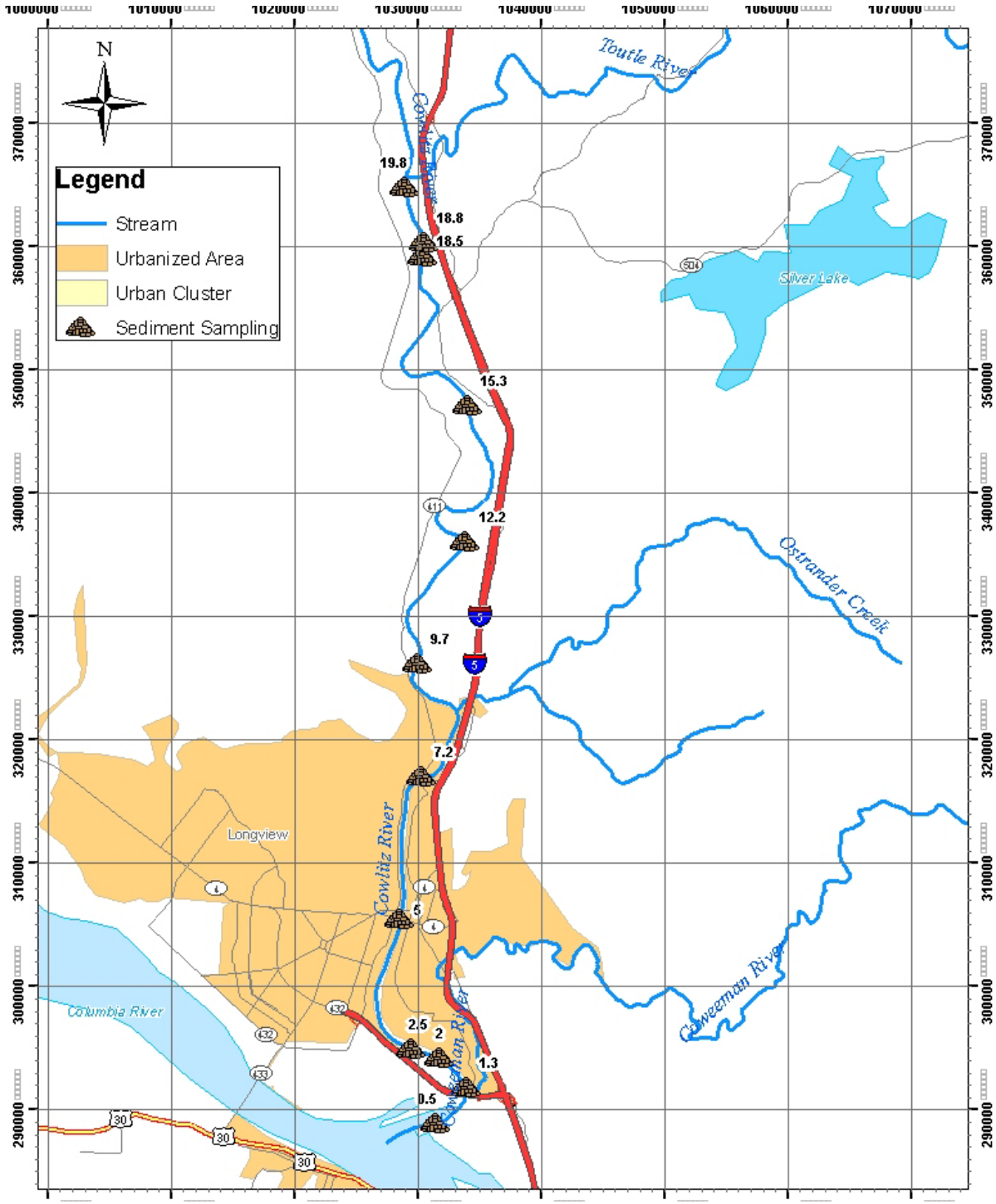
Sediment Impact Assessment Module



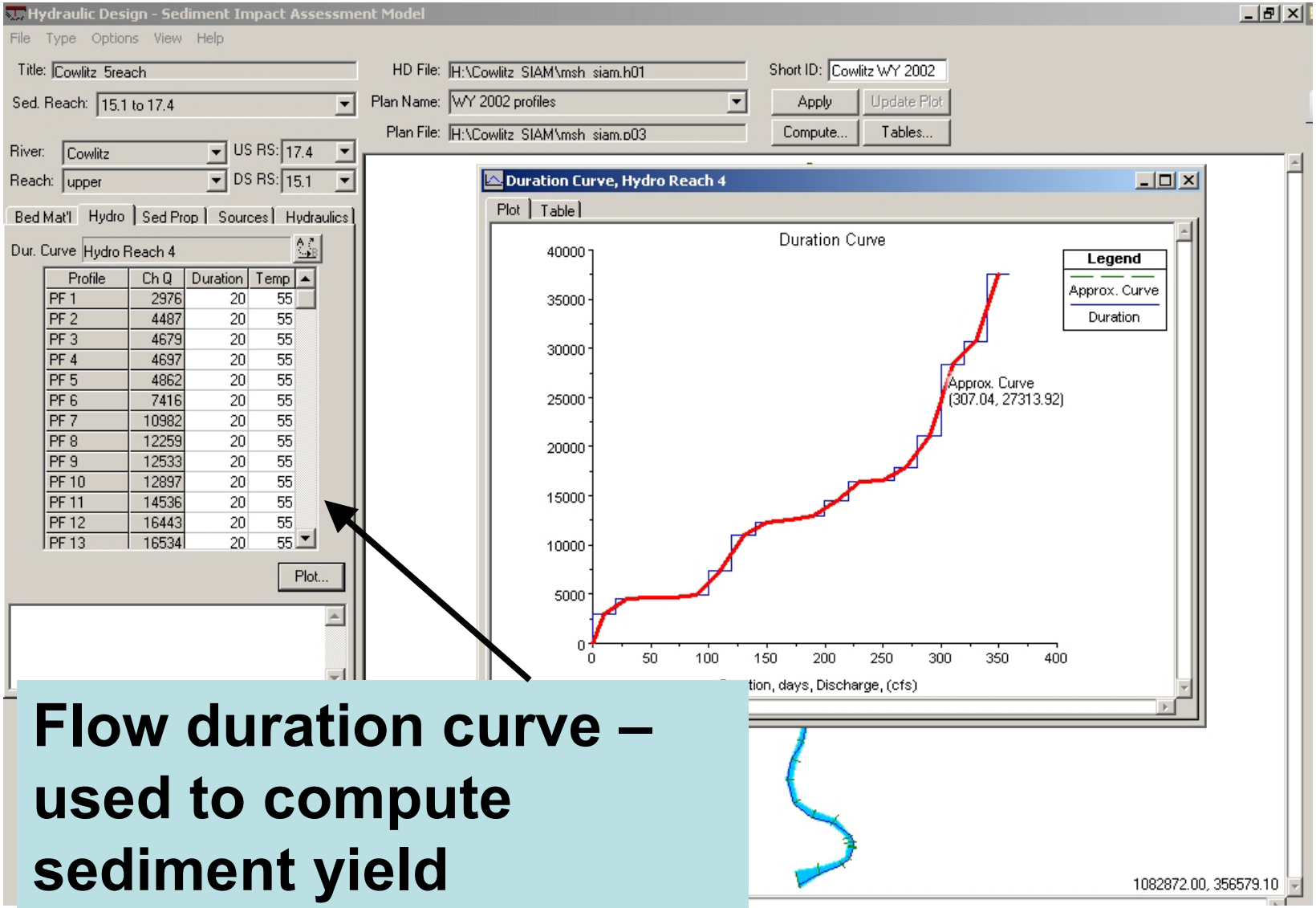
SIAM inputs



Bed material samples

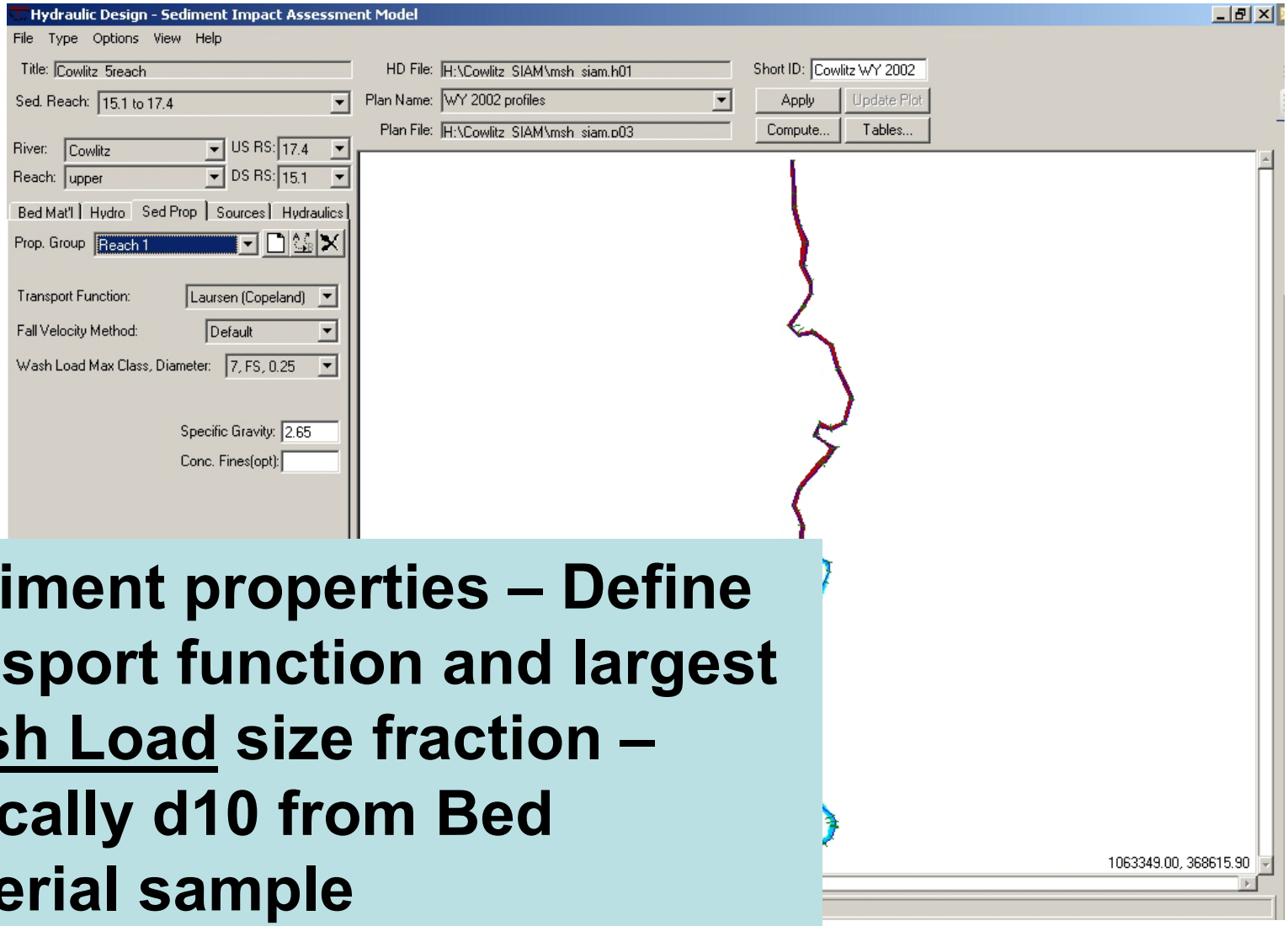

N
Legend
Stream
Urbanized Area
Urban Cluster
Sediment Sampling
19.8
18.8
18.5
15.3
12.2
9.7
7.2
5
2.5
2
1.3
0.5
Toutle River
Silver Lake
Ostrander Creek
Longview
Cowlitz River
Columbia River
Coweeman River
504
411
5
4
432
433
30

SIAM inputs



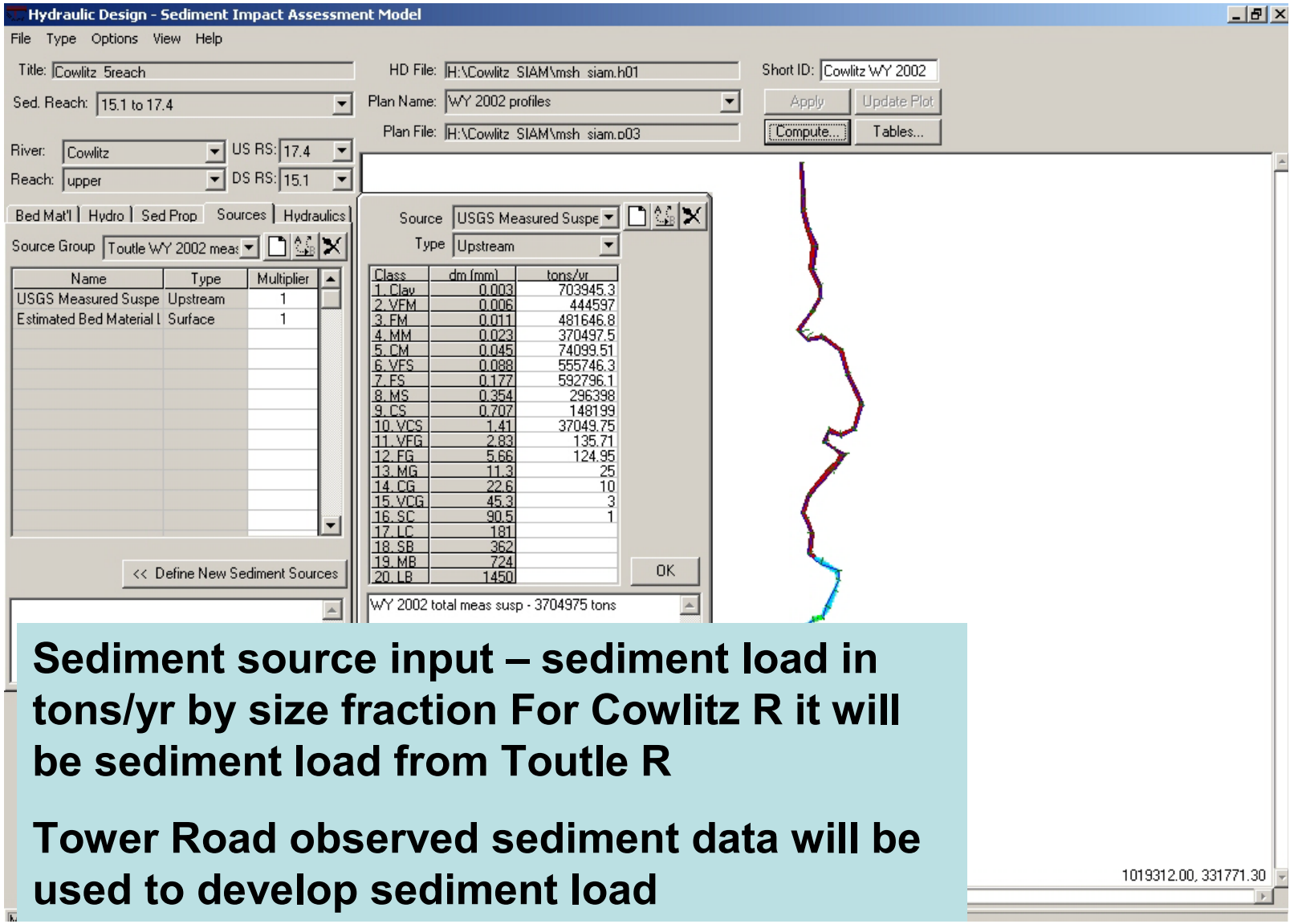
Flow duration curve – used to compute sediment yield

SIAM inputs



Sediment properties – Define transport function and largest <u>Wash Load</u> size fraction – typically d10 from Bed Material sample

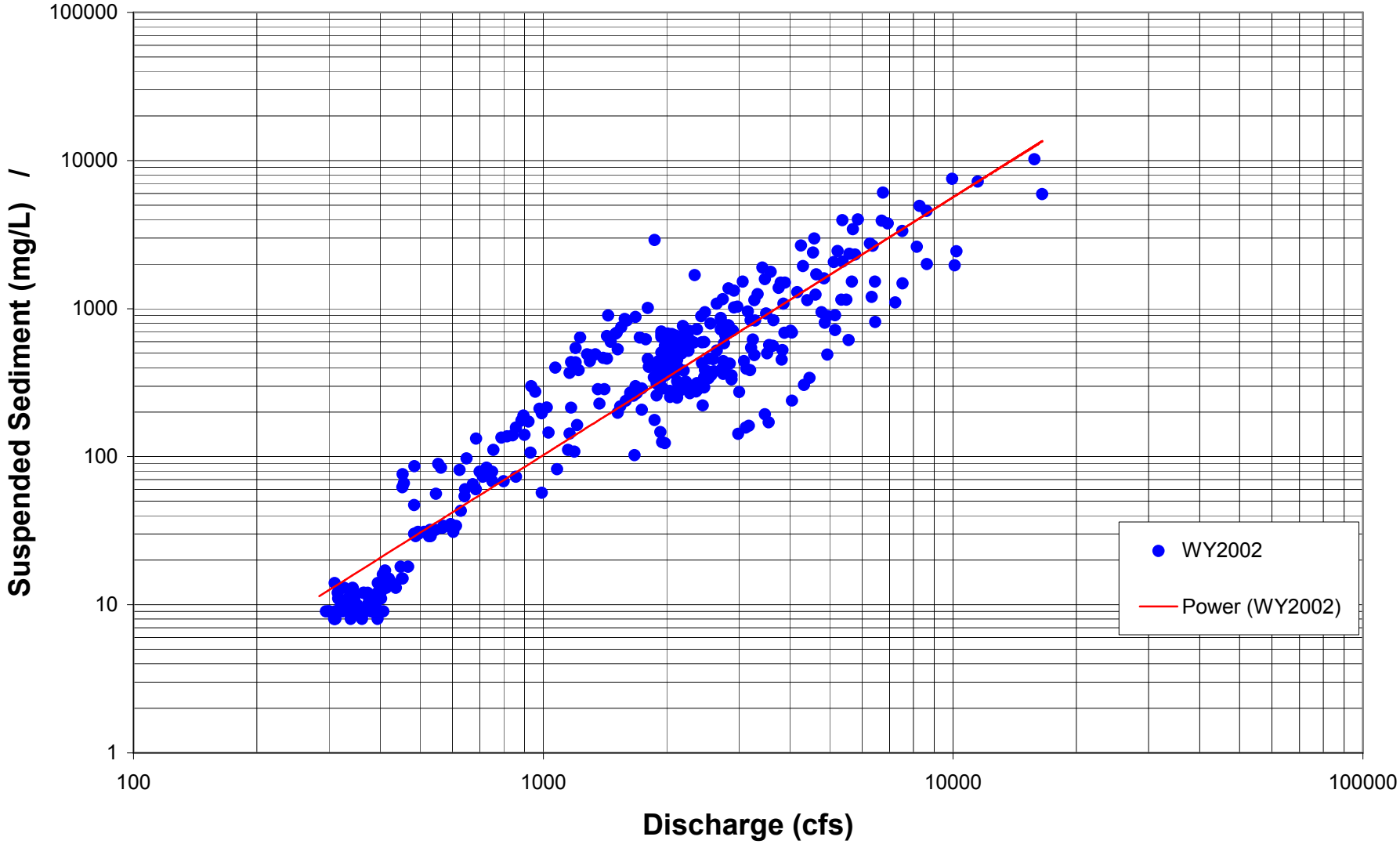
SIAM inputs



Sediment source input – sediment load in tons/yr by size fraction For Cowlitz R it will be sediment load from Toutle R

Tower Road observed sediment data will be used to develop sediment load

USGS observed suspended sediment data – Toutle R @ Tower Road



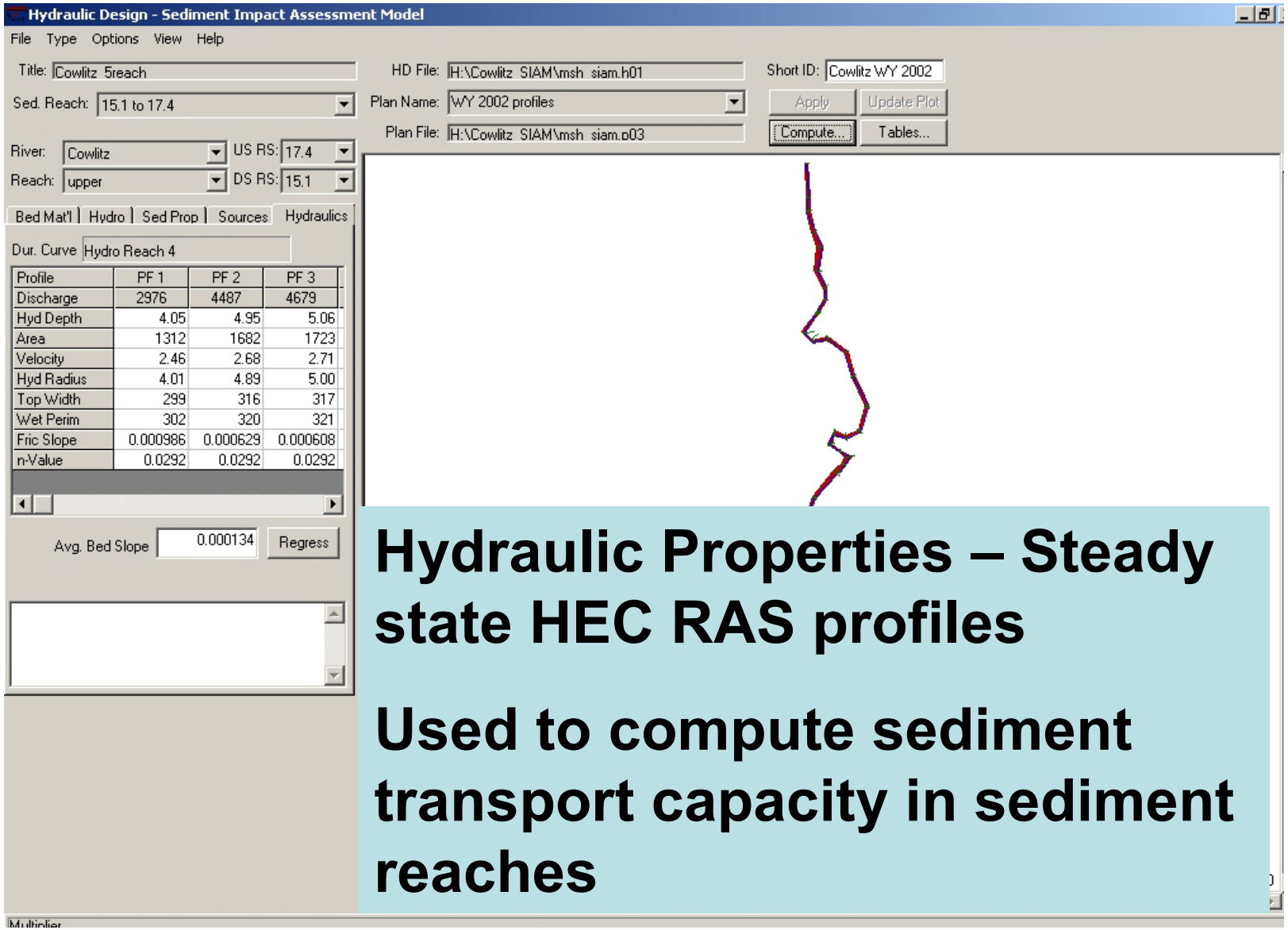
Toutle River source load

Wash load = suspended sediment data = measured load (USGS observed data)

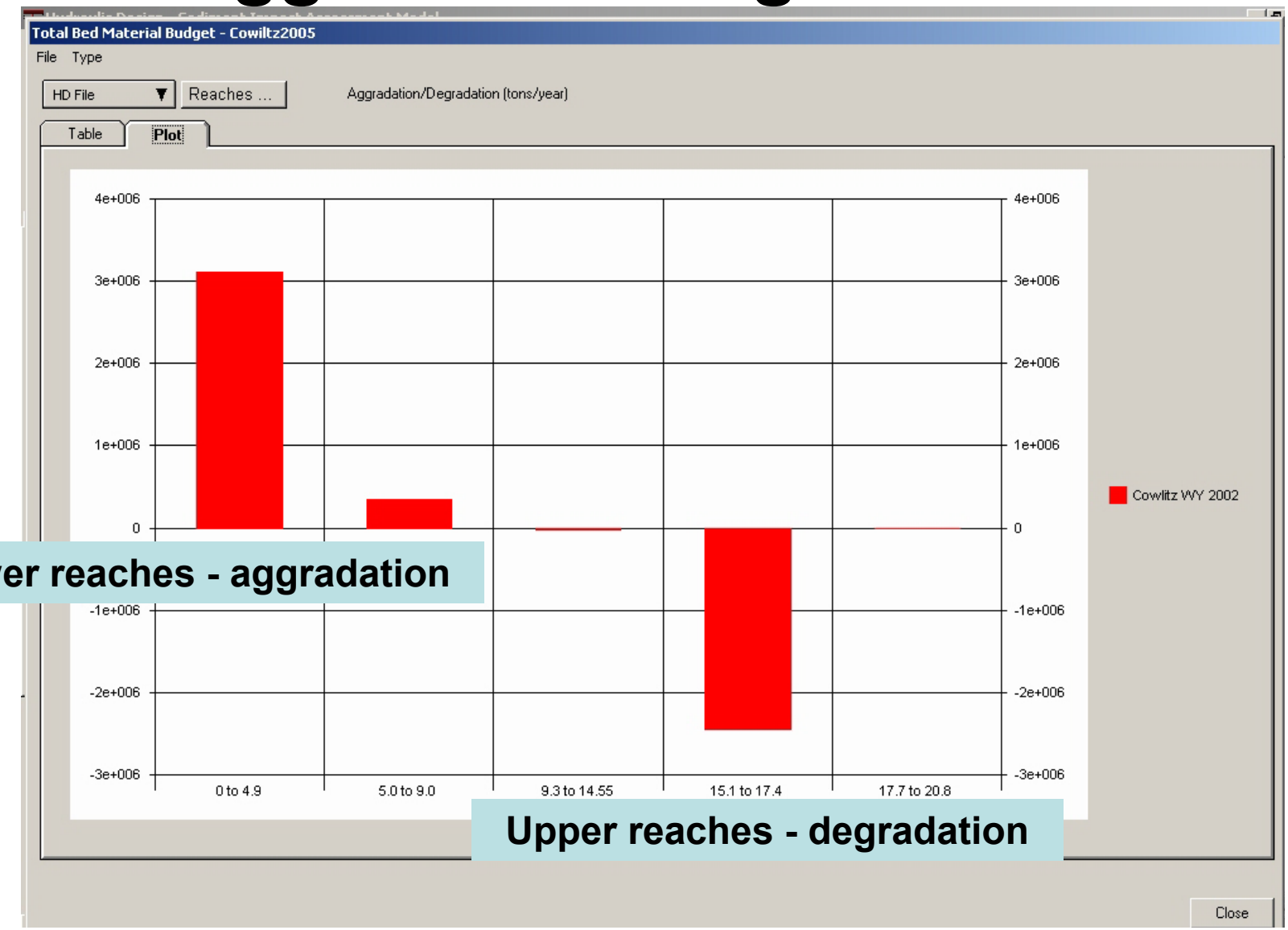
Bed material load = unmeasured load estimated using data from sampling (Modified Einstein)

Total Load (tons/yr) = measured + unmeasured by grain size class

SIAM inputs


Hydraulic Design - Sediment Impact Assessment Model
File Type Options View Help
Title: Cowlitz 5reach
Sed. Reach: 15.1 to 17.4
River: Cowlitz
US RS: 17.4
Reach: upper
DS RS: 15.1
Bed Mat'l Hydro Sed Prop Sources Hydraulics
Dur. Curve Hydro Reach 4
Profile PF 1 PF 2 PF 3
Discharge 2976 4487 4679
Hyd Depth 4.05 4.95 5.06
Area 1312 1682 1723
Velocity 2.46 2.68 2.71
Hyd Radius 4.01 4.89 5.00
Top Width 299 316 317
Wet Perim 302 320 321
Fric Slope 0.000986 0.000629 0.000608
n-Value 0.0292 0.0292 0.0292
Avg. Bed Slope 0.000134
Regress
HD File: H:\Cowlitz SIAM\msh siam.h01
Plan Name: WY 2002 profiles
Plan File: H:\Cowlitz SIAM\msh siam.p03
Short ID: Cowlitz WY 2002
Apply
Update Plot
Compute...
Tables...
Hydraulic Properties – Steady state HEC RAS profiles
Used to compute sediment transport capacity in sediment reaches

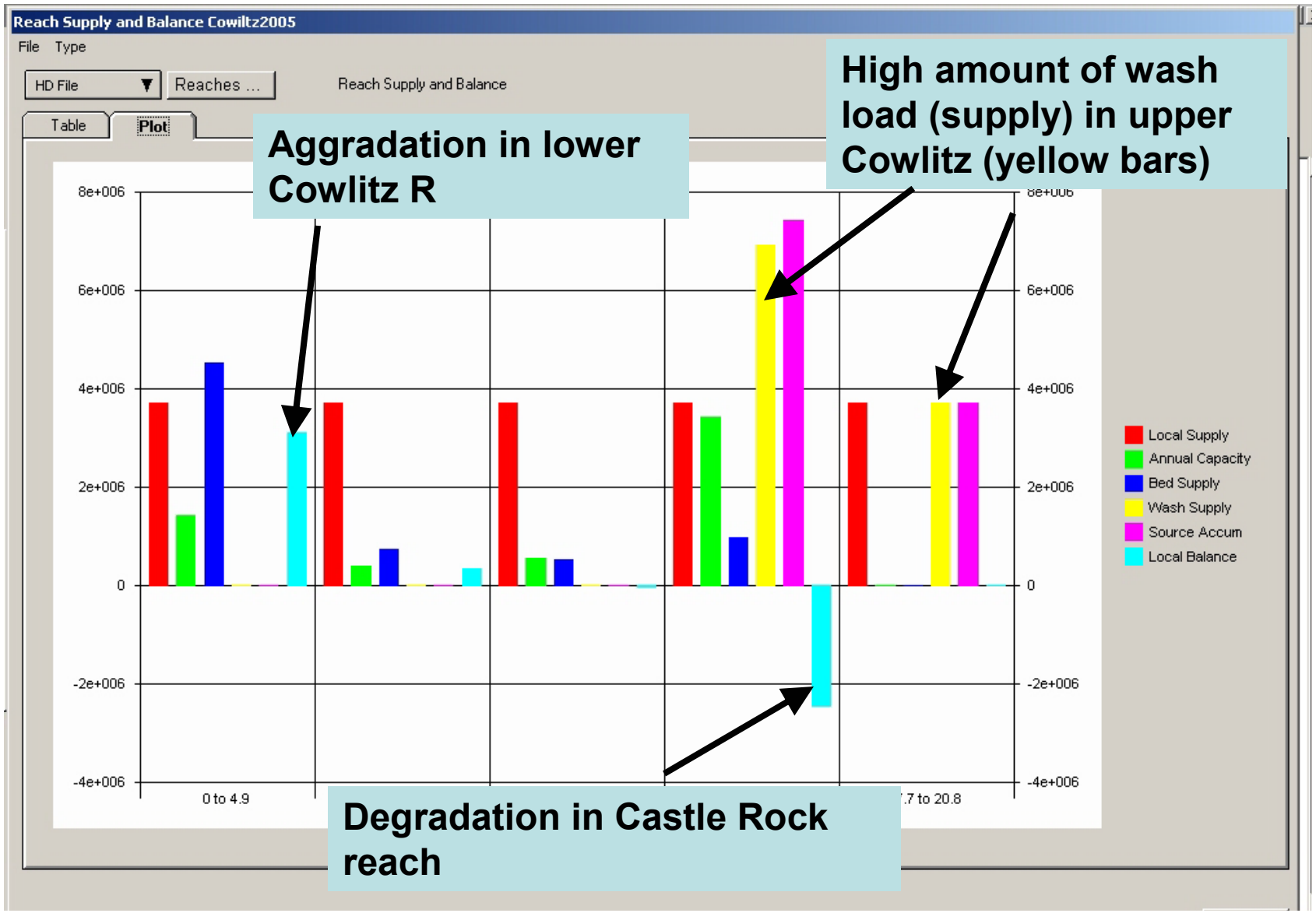
SIAM outputs – Aggradation/Degradation



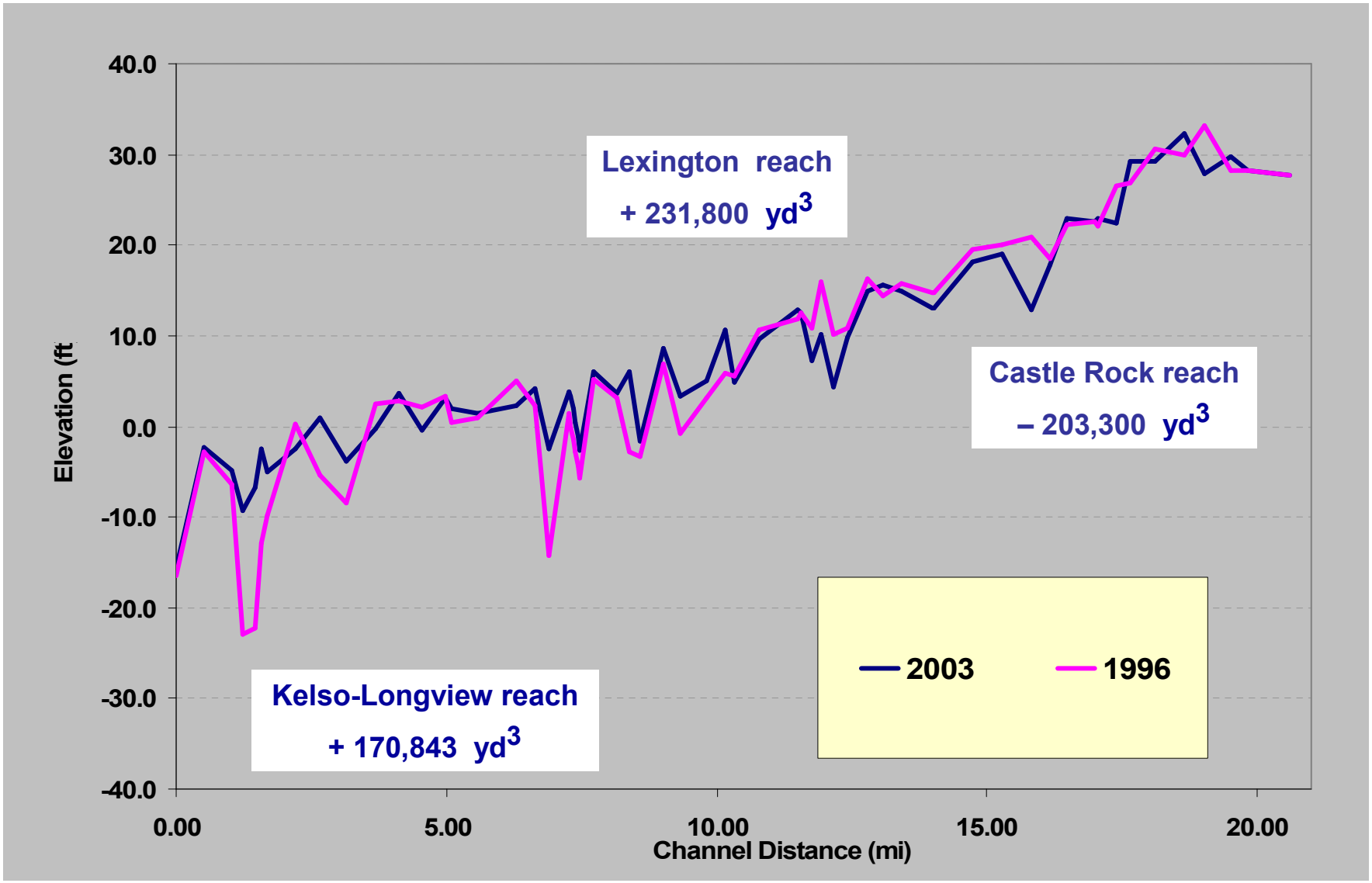
Lower reaches - aggradation

Upper reaches - degradation

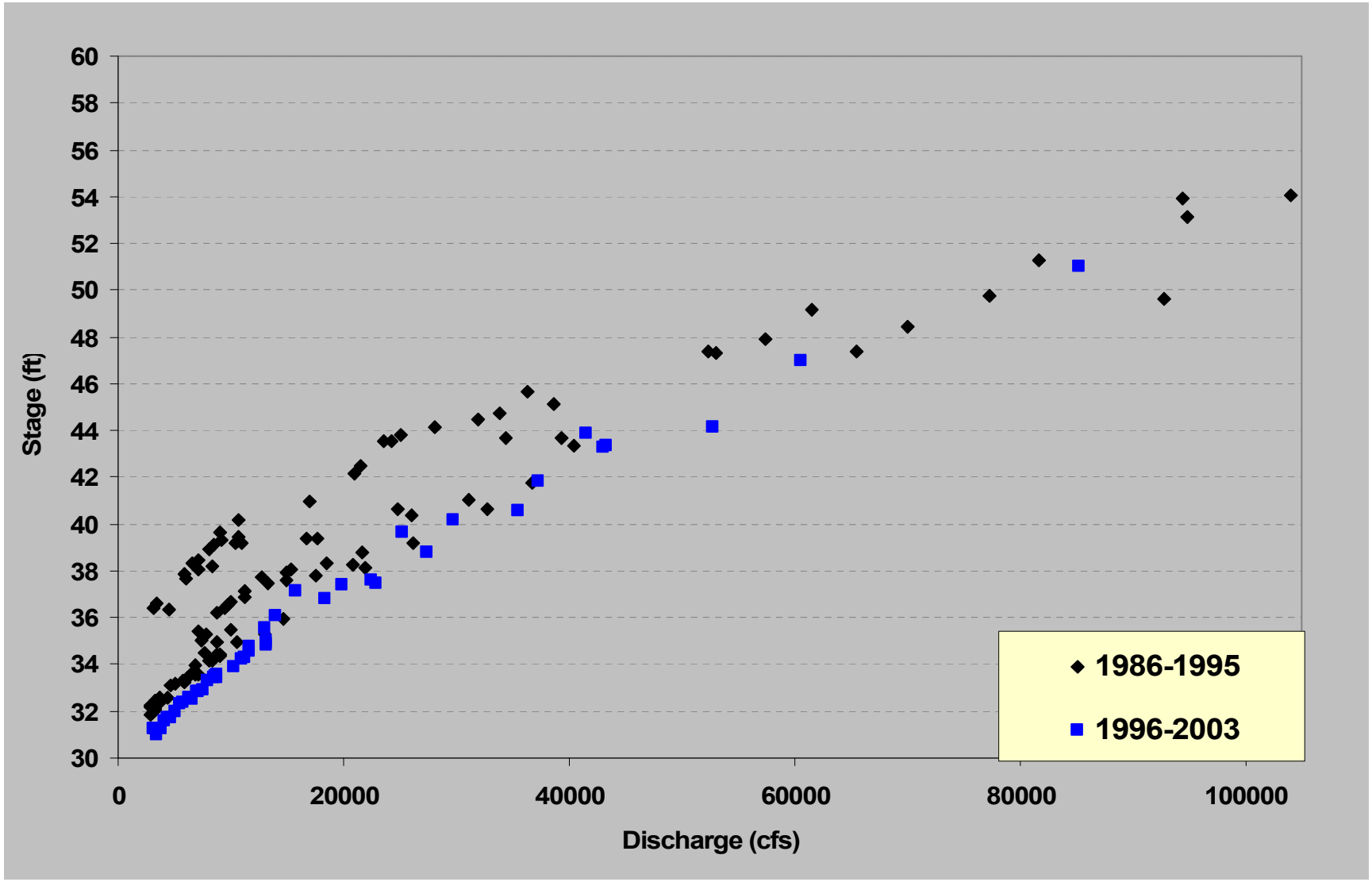
SIAM outputs – Local Balance



Cowlitz R Bed Profiles – 1996 vs 2003 (from HEC RAS models)



Cowlitz River at Castle Rock (USGS gage)



Potential Actions

- Additional Flood Control Storage (Mossy Rock)
- Flushing Flows (Mossy Rock)
- Levee Improvements
- Dredging
- Raise SRS