Project ID & Status

Project Name/Number: **East Prong of Roaring River Stone Mountain State Park**
EEP ID: 364
Project Type: Stream Restoration and Wetland Enhancement
Current Status: 8 Years of monitoring complete

Project Setting & Background

Physiographic Region:	Mountain
County:	Wilkes
Basin:	Neuse
Drainage Area:	22 SM
Impervious cover	<5%
USGS Hydro Unit:	03040101
NCDWQ Subbasin:	03-07-01
Thermal Regime:	Cold
Trout Water:	Yes
Designer:	NCSU

Project Timeline

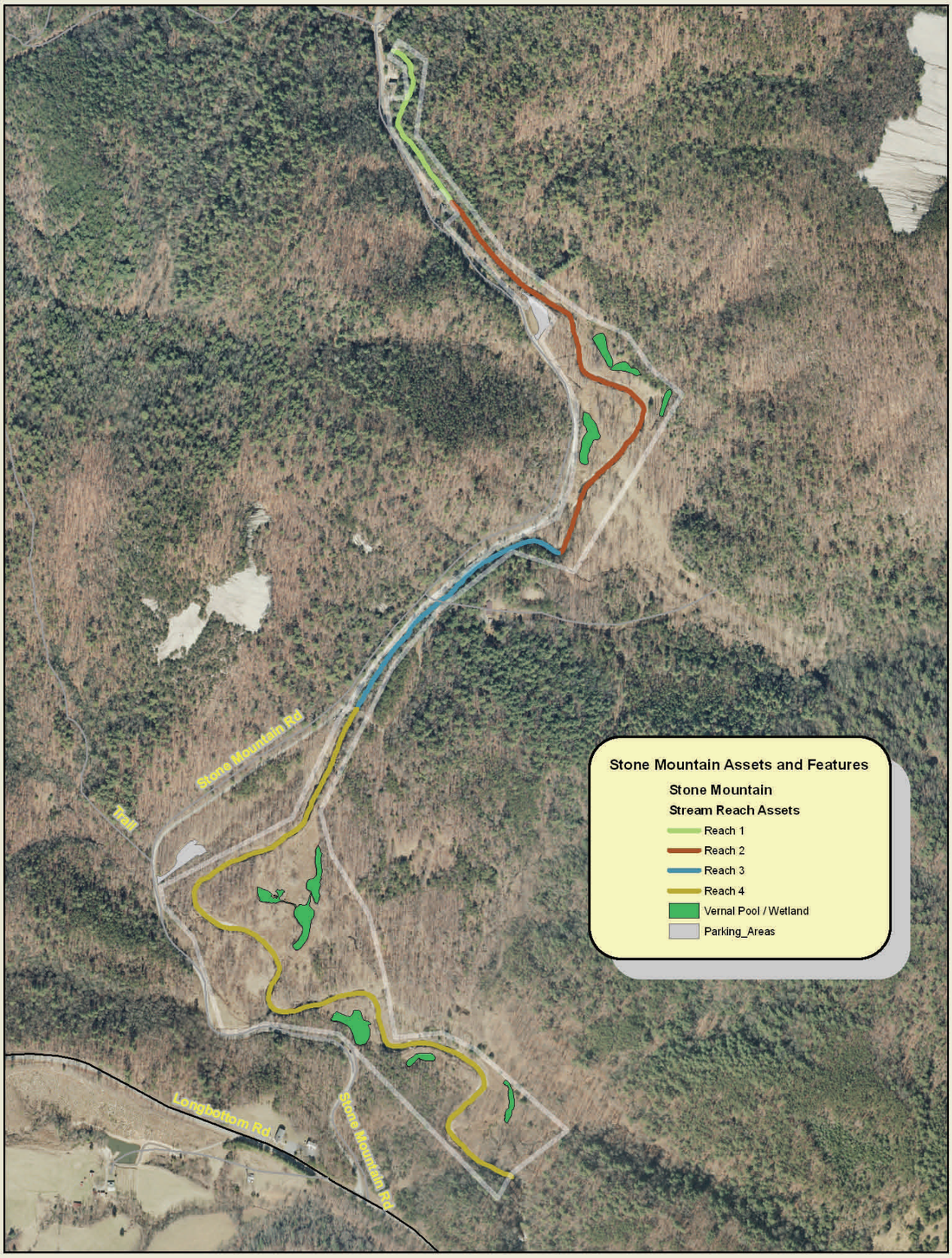
Milestone	Date
Permit Date	1999
Construction Completed	2000
Monitoring Year-1	2001
Monitoring Year-2	2002
Monitoring Year-3	2003
Monitoring Year-4	2004
Monitoring Year-5	2005
Monitoring Year-6	2006
Structural Repairs	2006/2007
Monitoring Year-7	2007
Monitoring Year-8	2008

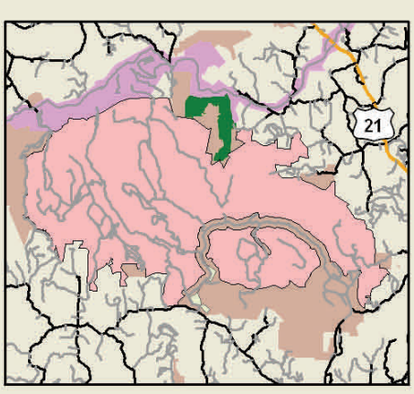
Table 1. Stone Mountain (East Prong of the Roaring River) Project Restoration Components and Mitigation Assets

Stream		Asset Data								
	Drainage/Hydrology Component	Asset				Ratio				
		Map #	Approach	Level	Ratio	Multip	Feet	SMU	Acres	WMU
	Upper extent at Garden Creek Confluence near Culvert	1	Enh	EII	2.50	0.40	984	394	-	-
	500 feet above pedestrian bridge to confluence with trib	2	P1	R	1.00	1.00	2422	2422	-	-
	Confluence with trib to Ranger bridge	3	-	P	5.00	0.20	1445	289	-	-
	Ranger bridge to bottom of project	4	P1	R	1.00	1.00	4332	4332	-	-
Wetland	Vernal pools and pocket features created in pre-existing align	Green Poly	-	C	3	0.33	-	-	2.09	0.70

Asset Summary

Level	Feet	SMU	Acres	WMU
R	6754	6754		
E				
EI				
EII	984	394		
C			2.09	0.70
P	1445	289		
	9183	**7437**	**2.09**	**0.70**





1,000 500 0 1,000 Feet

Stone Mountain Asset Map

N

Figure 1

Project Background and Summary

The **Stone Mountain** restoration project on the East Prong of the Roaring River is located in Stone Mountain State Park in Wilkes County near the headwaters of the Yadkin Pee-Dee River basin and was a collaborative effort between the Ecosystem Enhancement Program (NCEEP formerly - NCWRP), NC Division of Parks and Recreation, and the project designer, the NCSU Stream Restoration Institute. The project resides within a 22 SM drainage and includes approximately 9200 feet comprising restoration and enhancement. The park was purchased by the state of North Carolina in the 1960s. Prior to this, the alluvial valley sections (Reaches 2 and 4—Figure 1) were straightened and significantly modified to facilitate agriculture. A section of reach 4 was also subjected to gravel mining. Reaches 1 and 3 (Figure 1) exist in confined valleys and were characterized a B stream types that were somewhat incised, but generally more stable than the other project reaches with localized areas of instability and some sections lacking well defined pool features. These reaches were treated with some bioengineering, supplemental seeding and plantings in local areas where there was need and small floodplain features that would accommodate it. These reaches also included the installation of some habitat and grade control structures. Reach 2 was straightened in some areas and was incised with a significant proportion of eroding banks. Reach 4 was moderately incised and exhibiting significant widening with W/D ratios as high as 50, progressing from an F towards a braided D channel type. These 2 reaches were the subject of priority 1 restoration, raising the bed in sections and addressing dimension pattern and profile. The efforts on these reaches also included instream structures, supplemental planting, and the creation of vernal pools/wetland features in the abandoned channel corridors of the floodplain. This project was implemented in the earliest stages of stream restoration practice in North Carolina and was implemented in a large mountain drainage. Some structures on reaches 2 and 4 exhibited stress and partial failures beginning in year 3 associated with very wet years (2003-2004), with the full extent realized by 2006 (year 6). Repairs were implemented in late 2006/2007. These structures we either repositioned or re-designed more in keeping with current understanding and practice and additional habitat features were incorporated. 2008 represents the 8th year of monitoring.

Goals and Objectives

- Improve water quality degraded by sedimentation by returning the East Prong of the Roaring River to a stable dimension, pattern and profile.
- Restore the aquatic and terrestrial habitat of the stream corridor.
- Restore floodplain and wetland functionality.
- Improve the aesthetics of the river corridor.

Success Criteria

Criteria	**Met?**	
Morphological	**Y**	**N**
Dimension—Channel cross-sections demonstrate little change or change that indicates stabilization	X	
Profile - Channel not demonstrating trends of aggradation or degradation. Pools maintain flat and deep, riffles step and shallow	X	
Substrate—General coarsening	X	
Bank Stability— Banks should exhibit stability	X	
Vegetation		
320 stems/acre after 3 years	Volunteer	Planted

See narrative sections for context

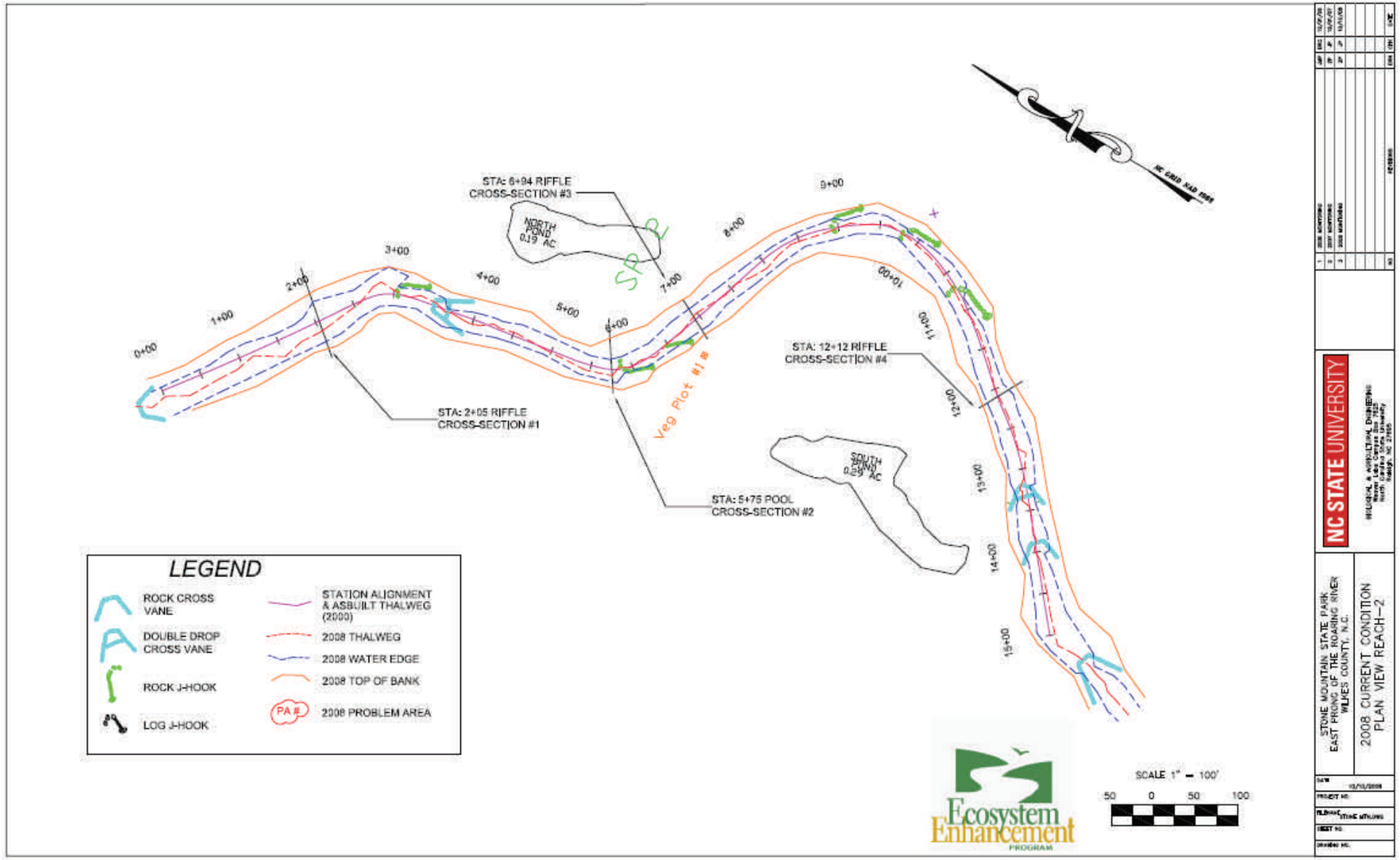
Pre-Construction Condition Photos—Reach 2

2008—Reach 2 Photos

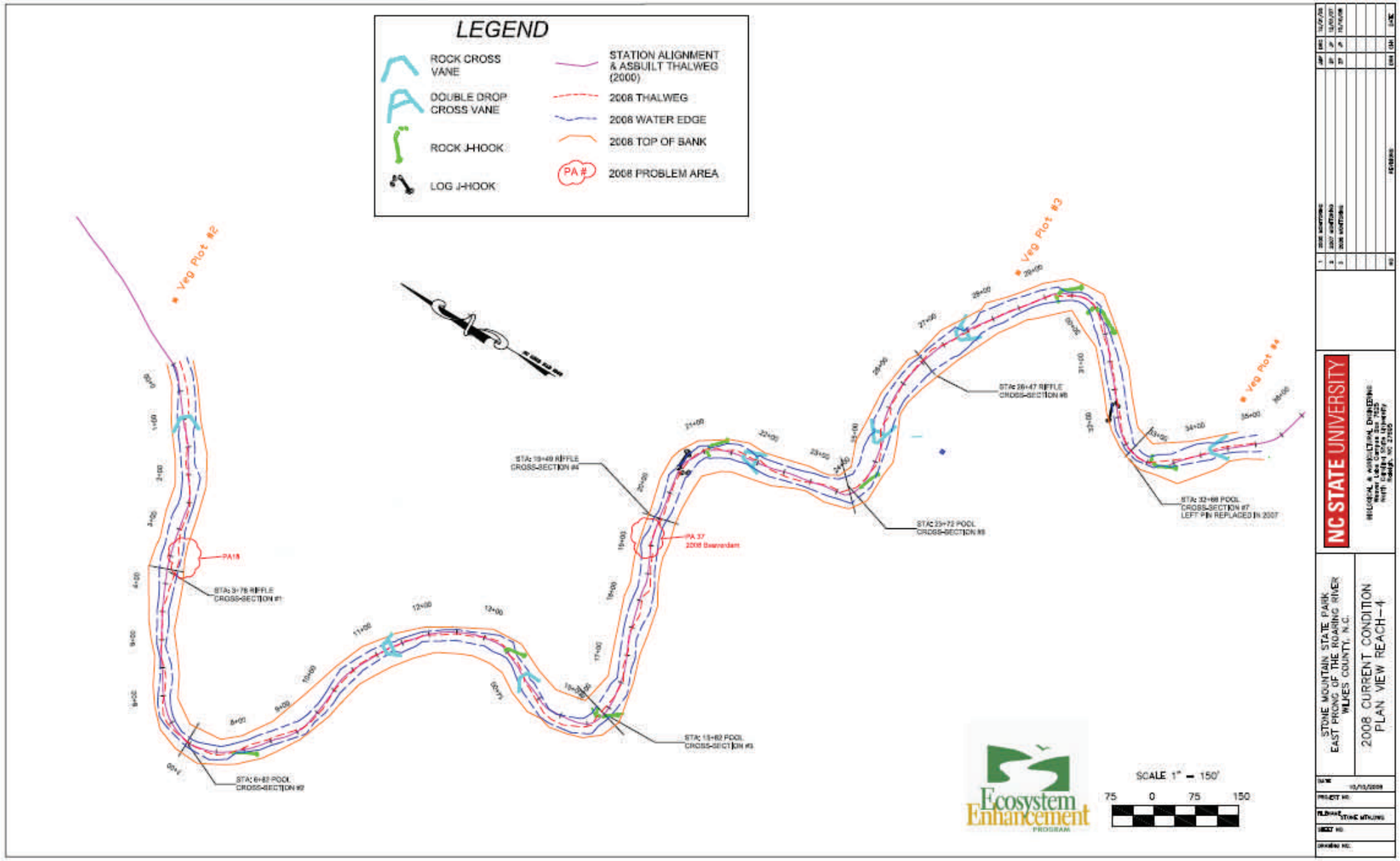
Pre-Construction Condition Photos—Reach 4

2008 Reach 4 Photos

Plan View—Reach 2



Plan View—Reach 4



Vegetation Condition

Deer browse on stems and recreational foot traffic in the near channel areas has been intense over the project's history and has reduced the survival and size of planted stems (40/acre) and smaller volunteers significantly , but the restoration effort accommodated a large number of mature trees throughout the site such that the rate of germination and overall density of volunteer stems combined with mature stems results in densities averaging in the thousands (4000 calculated) per acre over the site based on the vegetation plots. This community includes sycamore, tulip poplar, river birch, Virginia pine, sweet gum, black cherry, and tag alder. Herbaceous cover exceeds 90% over the site outside of mature stands Switchgrasses, rushes, and sedges are plentiful in the wet areas. Kudzu and oriental bittersweet were found in several locations.

Morphology and Substrate Data

Channel Dimension

The cross-section data indicated general lateral stability for the site. Some cross-sections exhibited lateral oscillations at various points over the 8 years of assessment, but generally demonstrated maintenance of the cross-section. The riffle cross-sections of reach 2 did not exhibit widening at the bankfull elevation, but one (XS3-see page 12 for cross-section overlays) did widen somewhat below the bankfull elevation without concurrent building on the opposing bank. This occurred between 2003 and 2004, but has since arrested. Riffle cross-sections for reach 4 demonstrated maintenance of the cross-sectional area and W/D ratios. Pools for both reaches generally maintained or increased their max depths in relation to their As-built levels. Both reaches did develop some scour and erosion locally in relation to stressed structures from 2003 to 2006. In the period since the aforementioned maintenance in late 2006/early 2007, the site has exhibited stability in these areas with the exception of one structural cut-around on reach 4, which is scheduled for follow-up repairs. The proportions of bank footage exhibiting stability was reported as 100% and 98% for Reaches 2 and 4, respectively in 2008.

Channel Profile

The comparison between the As-built profile and that of 2008 does indicate some downcutting did occur (Pages 14-17). This appeared to occur primarily between years 3 and 4 (2003-2004). This was prominent in the lower part of reach 4 where a foot or more of downcut was evident based on the overlays. However, this was not necessarily corroborated by the cross-sectional overlays as little substantial or sustained downcut was evident. The profile overlays since 2004 have demonstrated that this has since arrested (page17) and the bed has generally remained faceted with distinctive bedforms.

Substrate data

The riffle substrate distributions for the last few years were generally within the classes intended by the design (medium to coarse gravel for the d50), although some of the riffle cross-sections exhibited fining in the last year (2008). The source of this is uncertain. It is possible this is related to the aforementioned repairs in 2006/2007, but with the exception of cross-section 6, this fining was not prevalent in the 2007 data record. Beaver did beginning building dams in this lower section in late 2007 and did create some backwater before their removal. Moreover, XS-1 near the upper part of reach 2, where no upstream repair work was conducted exhibited this in 2008 as well, indicating the potential influx from above reach 1, but no sources are evident along the East Prong above the project. Several tributaries along the projects extent have been observed to supply significant amounts of sand at various times. One is in close proximity to XS6 in reach 4, which demonstrated fining in 2007 and was maintained in 2008.

Hydrological Data

A crest gauge was installed in late 2005 and 2 bankfull events were recorded, one in spring/summer of 2006 one and summer/fall 2008. In an attempt to get some indication of other hydrologic events that the site may have experienced over the 8 years of monitoring, precipitation data from surrounding gauge sites was examined. The availability of discharge data was inconsistent from these sites. Although this is not a definitive substitute for on-site gauging, the intent was to catalog widespread regional rain events of some significance. In order to be included in the summary the date had to exhibit significant precipitation at all three stations. Any given daily total had to be greater than 1.3 inches and exhibit an average of daily totals across the three sites in the ranges indicated in the table column headers. Again, this does not provide additional verification of an actual stage of the project site, but can provide an understanding of the variation in the regional precipitation events of potential significance over the monitoring period to see which periods were wetter than others and which time periods may have challenged the project channel more than others. Examining the data it is evident that 2000-2002 was dry, but 2003 and 2004 saw significant regional precipitation and probably included multiple events that tested the restored channel. 2003 saw 7 widespread precipitation events, 6 of which exhibited inter-station averages over 2 inches. 2004 included 5 events with inter-station averages between 1.5 and 2.0 inches and 3 over 2 inches. The latter was a sustained 3 day event that exhibited 2 inch averages for each day of the 3 day event and this was associated with the hurricane remnants that went through the mountain region in fall 2004. It is likely that the hurricane event exceeded the bankfull elevation. Although 2007 was a drought year and base flow was likely reduced it did experience 5 widespread events, 4 of which exhibited inter-station averages ≥2 inches. Two of those were consecutive days as part of a sustained event with 2 inch regional averages each day.

Tallies of Widespread Regional Precipitation Events of Interest Surrounding Stone Mountian State Park

	Total Events of Interest	Events of Note ~ ≥1.5 - 2.0	Events of Potential Significance ~ ≥2.0	Sustained Moderate 2-3 day events ~ ≥1.5 - 2.0	Sustained Heavy 2-3 day events ~ ≥2.0
2009	2		2	0	0
2008	4	1	3	0	1
2007	5	1	4	1	0
2006	8	6	2	1	0
2005	4	1	3	0	0
2004	8	5	3	0	1
2003	7	1	6	0	0
2002	2	2	0	0	0
2001	2	2	0	0	0
2000	3	2	1	0	0

The 3 precipitation gauging sites utilized surrounded Stone Mountain State Park are within a 20 mile radius. They are as follows:

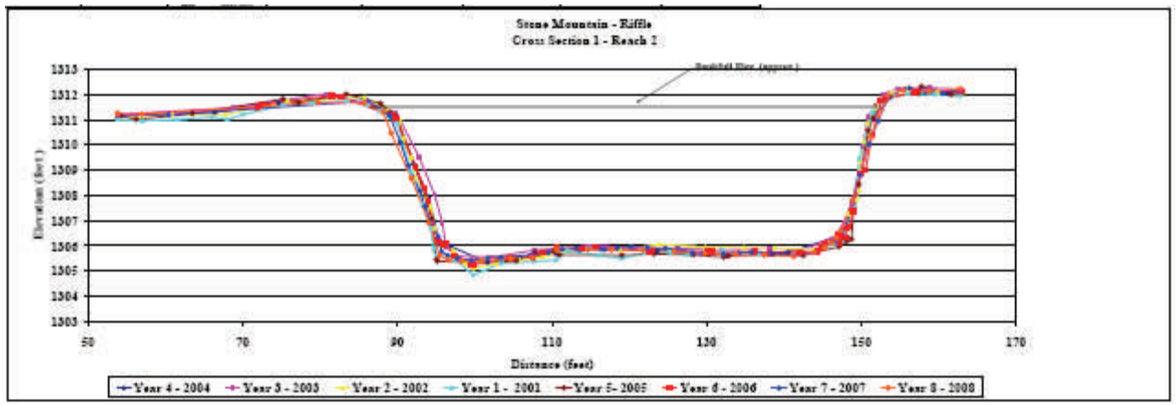
Roaring River Gauging station (USGS 02112120)
Wilbar, NC (USGS 361554081191701)
Kerr Scott Station (USGS 02111391)

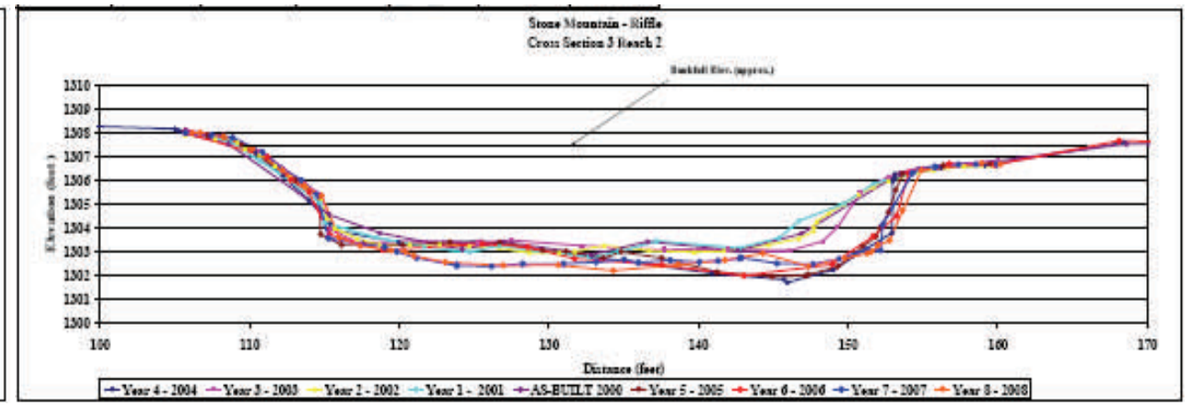
-A qualifying event had to yield precip in the ranges indicated as an average across all three sites. No single event inclued in the average from a given station was less than 1.3 inches. Years in red indicate bankfull events have been confirmed.

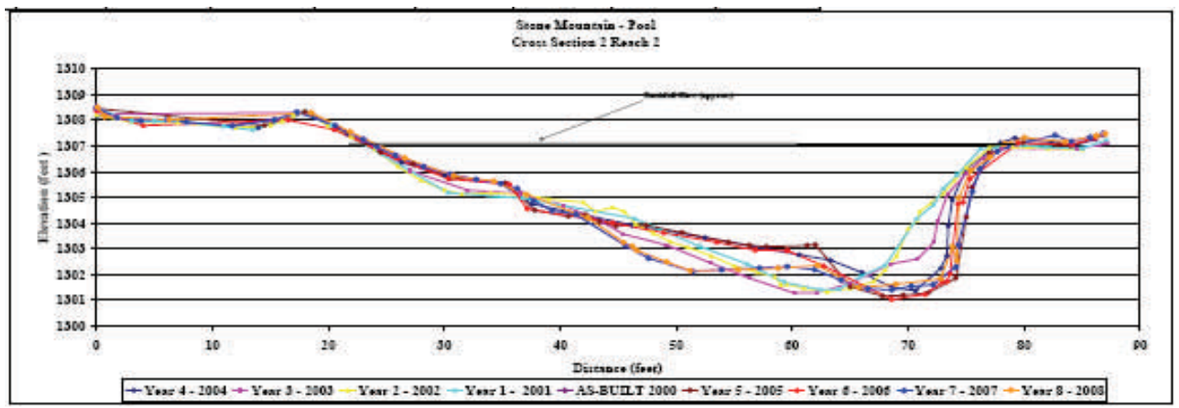
Morphology and Channel Stability Summary

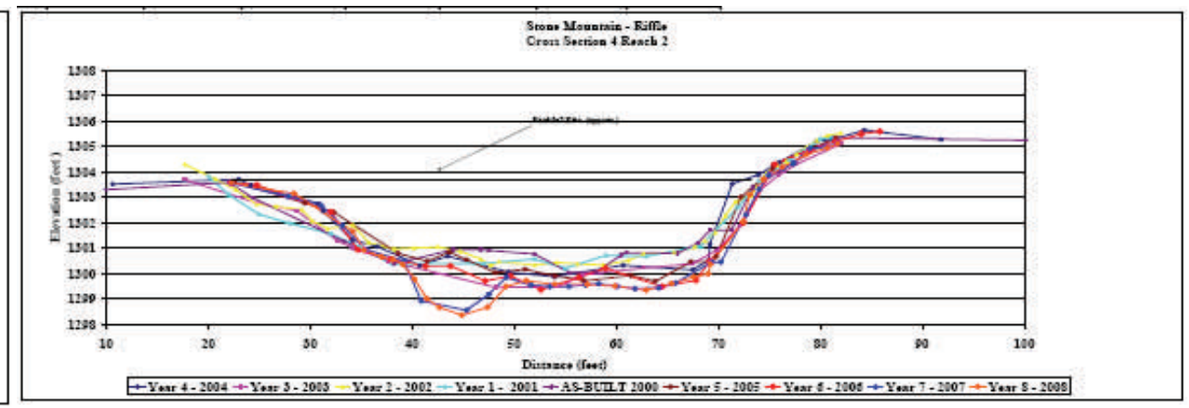
Communication with the projects lead designers, Dr. Greg Jennings with the NCSU Stream Restoration Institute and Will Harman, P.G. the co-designer with NCSU at the time indicated that after assessing/observing the project over the monitoring period, sections of the channel may have been built somewhat oversized leading to greater than intended shear. In addition, the one long riffle/run section where this was most prominent near the bottom of reach 4 is directly parallel to the fall of the valley, which based on subsequent experiences with other projects was described as a risk factor by one of the designers for greater likelihood of downcut. Their designs today avoid a highly parallel orientation and emphasize riffles at angles to the fall of the valley. In addition, the restoration involved raising the bed without the inclusion of constructed riffle features as is more commonly practiced today. Raising the bed in its new alignment amidst the large amounts of gravel mining legacy sediments (dredgings) in the banks/floodplain did not permit the designers to situate the bed from the outset on the truly coarse bed material of the pre-disturbance channel. Collectively, it is believed these factors with the very wet years in 2003 and 2004 led the channel in this area (lower reach 4) to downcut and to the other aforementioned channel responses. It was also pointed out that these areas have since exhibited stabilization. Additional downcutting or widening is not occurring even when challenged with other bankfull events and sections of the project appear to be building stable benches between the inner berm and the bankfull elevation. This is evident in riffle cross-sections 1 and 4 in reach 4, stream right and left, respectively (Page 13). These observations in combination with the performance of the projects instream structures since the repairs/modification in 2006/2007 indicates that the site has probably now stabilized. Continued lateral building of the cross-section will further enhance floodplain access and the entire site continues to exhibit healthy entrenchment ratios.

Cross-Section Data —Reach 2

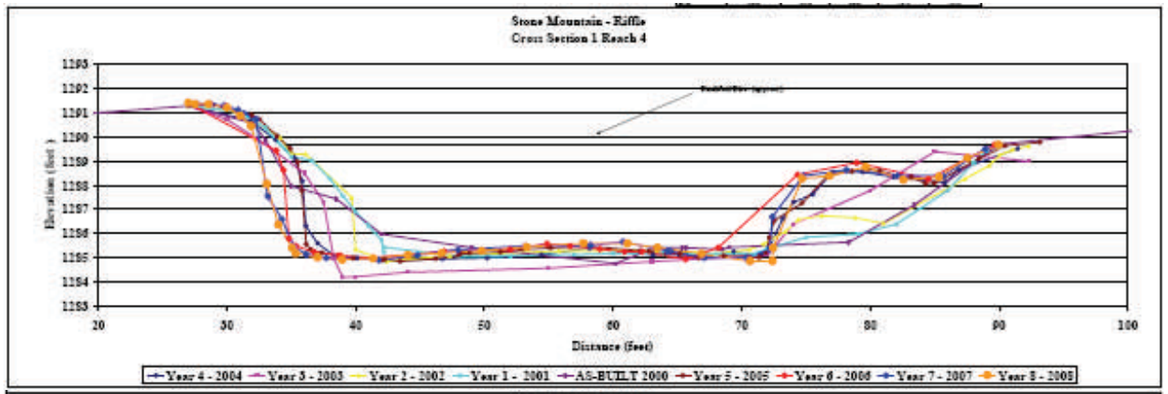


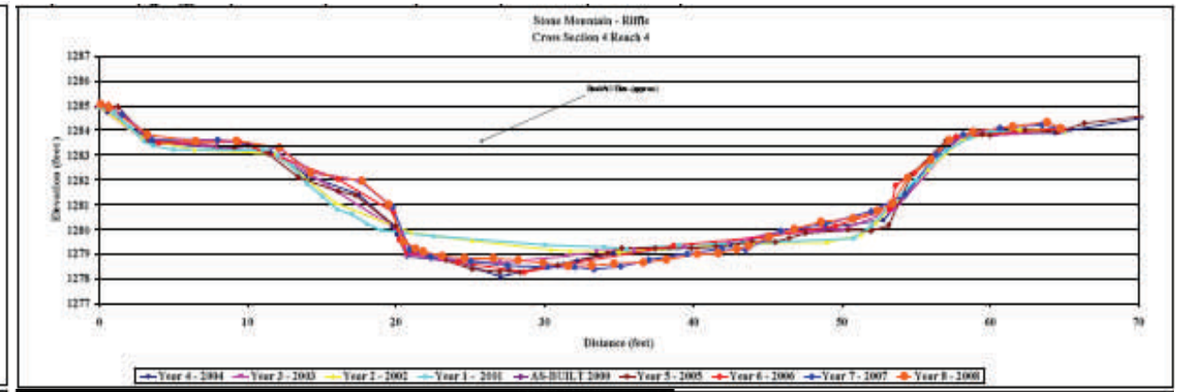


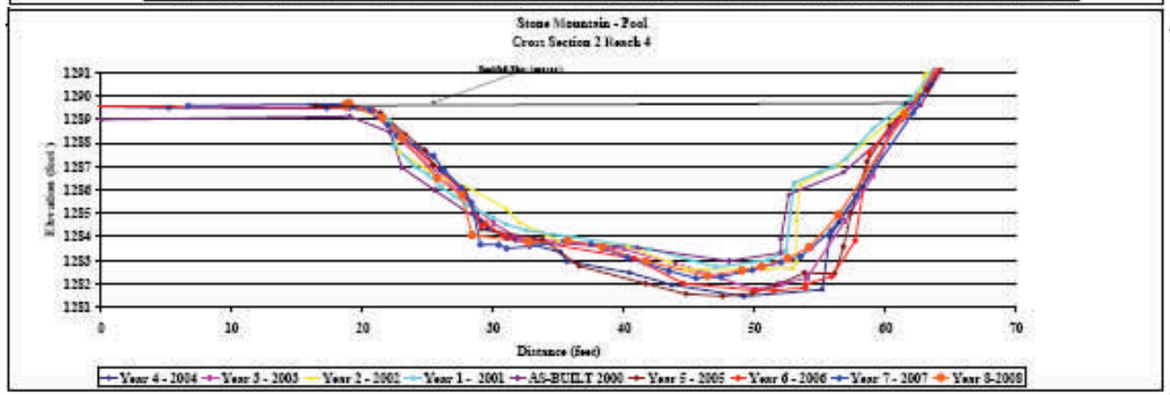


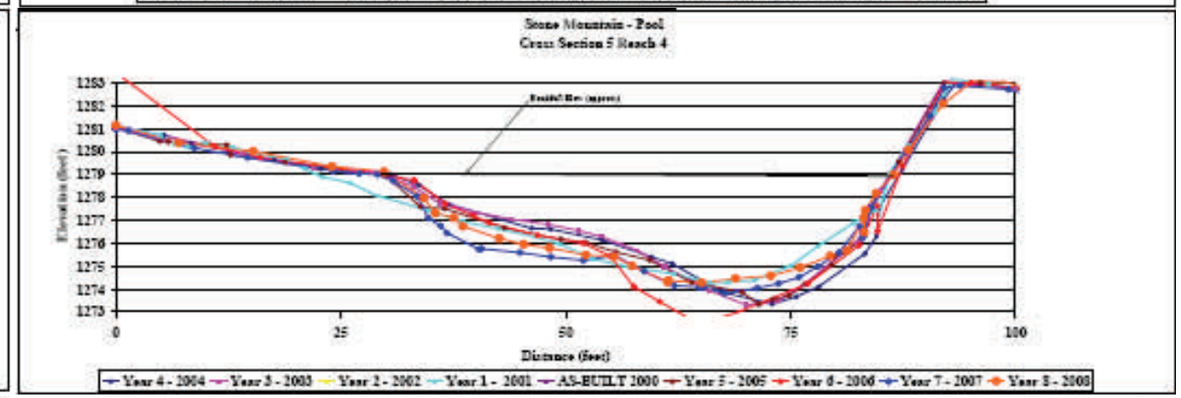


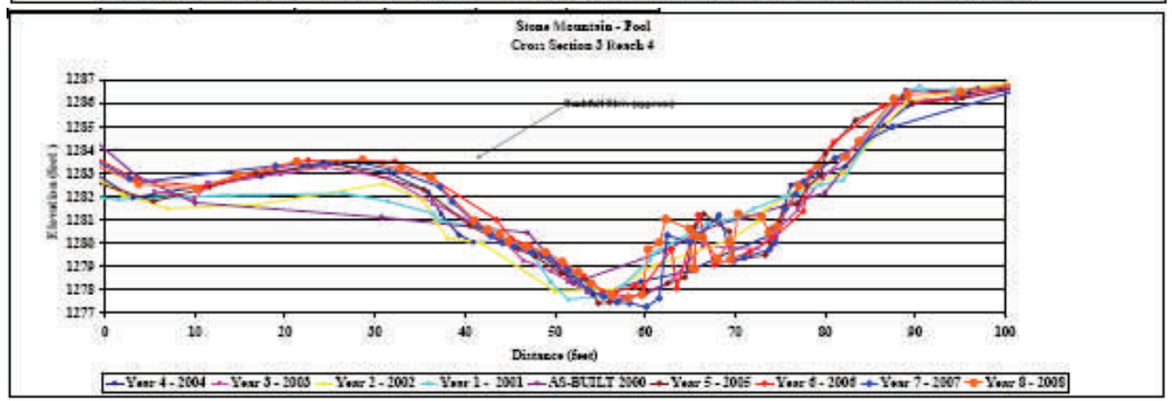
Cross-Section Data —Reach 4

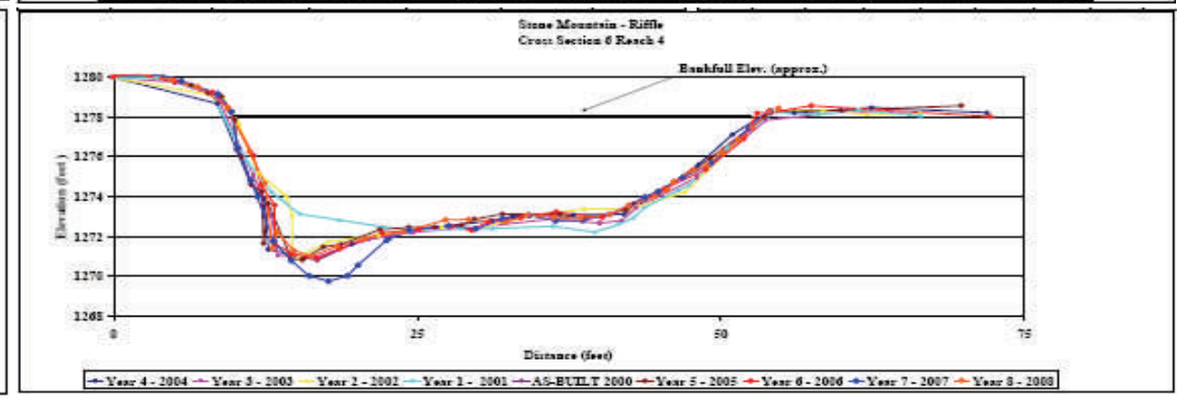




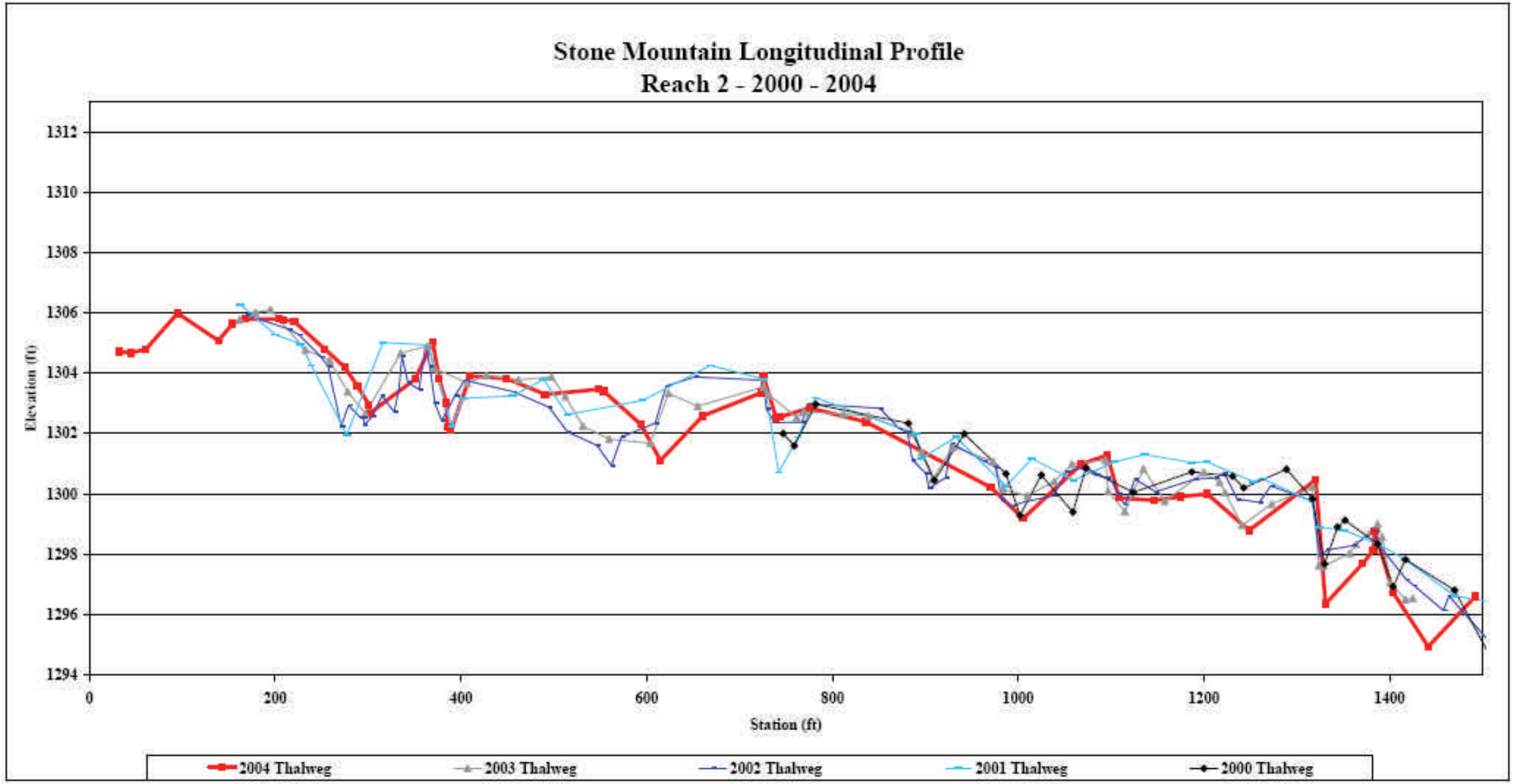




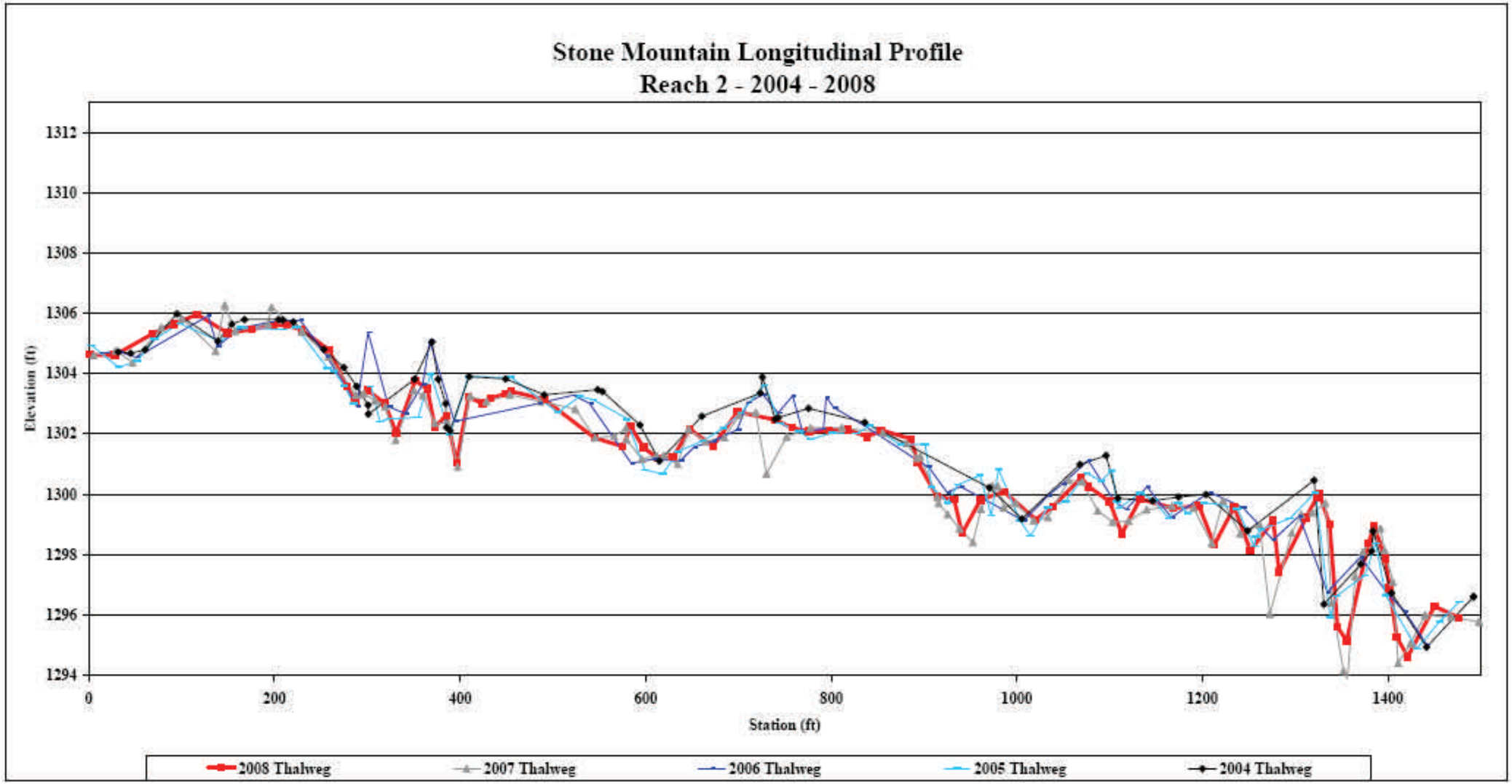




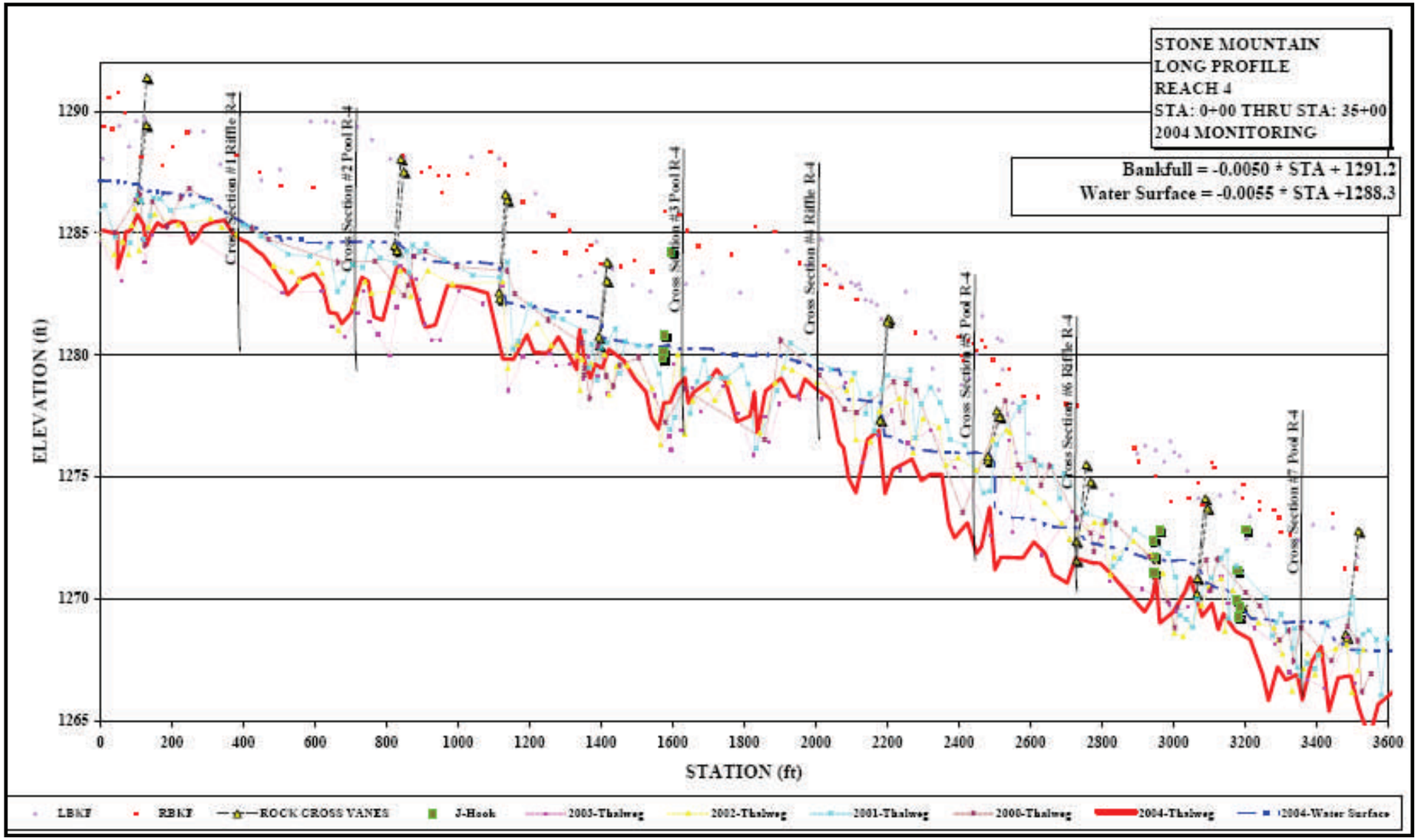
Profile Data — 2000-2004 Reach 2



Profile Data — 2004-2008 Reach 2



Profile Data — 2000-2004 Reach 4



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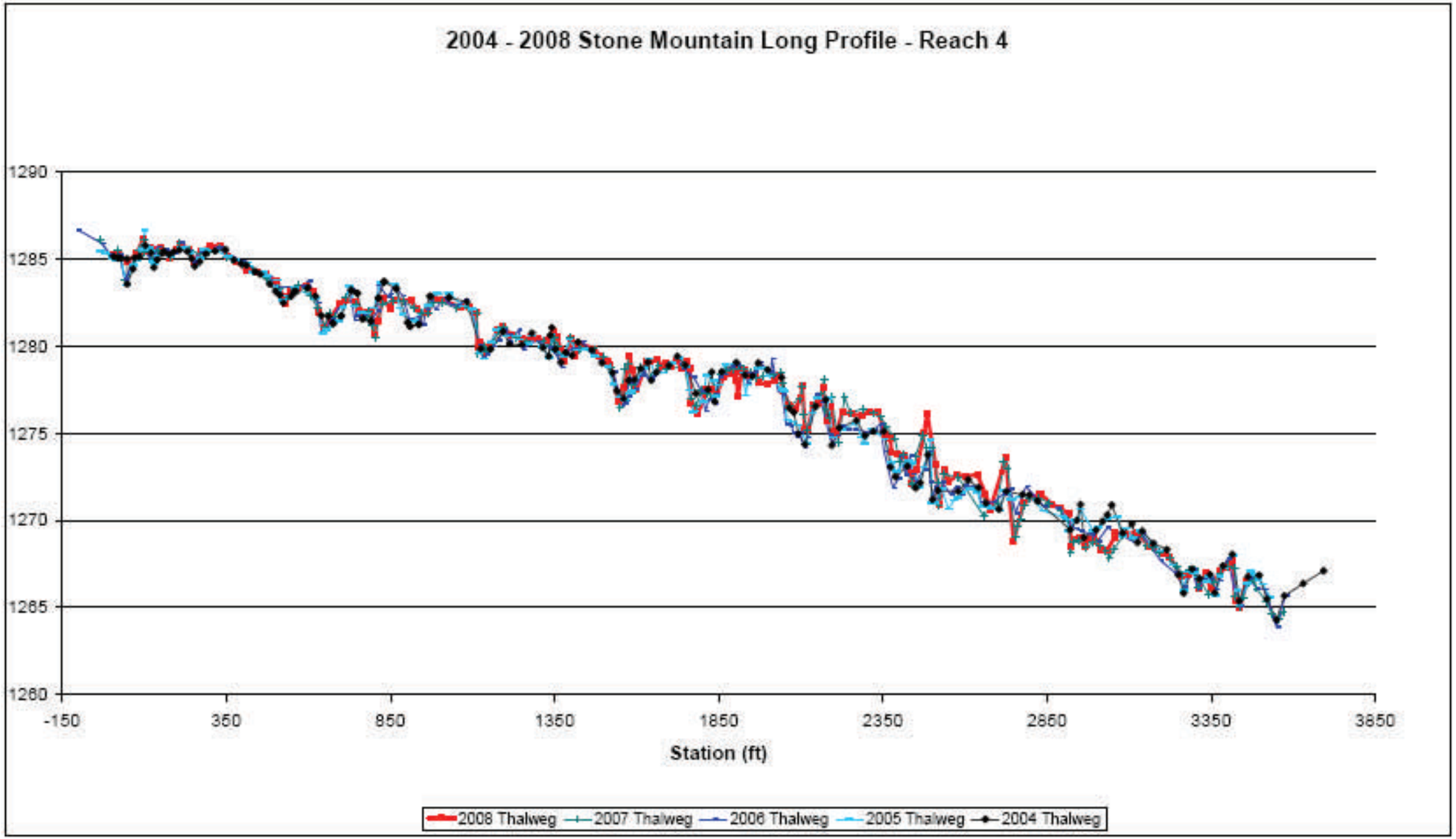

Summary

The channel has exhibited some stress and adjustments over its history due to the aforementioned factors in the morphology summary with modest proportions of localized bank instability, some structural instability and degradation of the profile in certain areas. However, the combination of the repairs/rework implemented upon the projects structures and the indications of bench building in certain cross-sections with stabilization of its profile (Page 17) indicates that the project has likely stabilized. The projects cross-sections all indicate healthy entrenchment ratios and the system has demonstrated overbank events. The projects profile maintains a faceted bed with distinct/diverse bedforms and although 2008 saw some influx of finer material, the site had demonstrated coarsening prior to that. Large amounts of coarse material exists and is evident throughout the site.

The bank stability proportions over the last 2 years have been near 100% subsequent to the repairs, even when challenged with flows near bankfull and one that was confirmed bankfull. This represents a significant improvement over the amount of wasting described for the pre-existing condition (see page 4, 6). However, one structure did subsequently cut around on reach 4 in early 2009. (Reach 4 - station 27+50). Between 2008 and 2009 beaver half constructed a dam on this structure (see photo in upper left on page 7), which seemed to be diverting some flow to the backside of the vane arm and the vane arm itself appeared to settle to a greater extent than expected. Collectively these factors resulted in this one failure, which is scheduled for repair. Normally a single structural failure would not dictate the re-introduction of equipment given typical structural redundancies, but due to the head these structures are required to negotiate in this section and it's proximity to the bottom of the project it is prudent to make this repair. Reach 1 has several structures for habitat enhancement and local stabilization. Reach 3 had a similar structure near its lower extent and some localized bioengineering, but was primarily preservation. All of these structures have remained stable.

Planted stems were subject to intense browsing by the very large unmanaged deer population in the park and as a result the planted stem densities were low, however, the design was able to accommodate a large number of mature trees over much of the projects extent providing an existing stands of significance with high amounts of volunteer stems to combine for high tree densities overall. While the browsing has been heavy on volunteer stems as well, the numbers from the abundant seed source is permitting the development of stems of size. Given the size of the channel, many sections of reaches 2 and 4 could not be expected to develop a dense overhanging canopy similar to that observed in Reaches 1 and 3 in these timeframes.

The channel appears to be stabilizing with a dimension, pattern and profile that represents a substantial improvement over the pre-existing condition and the floodplain is being accessed. The proportions of eroding banks have been significantly reduced. The structures are maintaining deep, expansive pool habitat, providing a great deal of oxygenation and now include additional habitat features such as cover logs that are often seen to be holding trout. The vernal pools/wetland features created in the abandoned corridor of the impaired channel are providing good floodplain habitat diversity and aesthetics to the valley. While the project has experienced some stability issues over its history, collectively the features and factors discussed in this report indicate the project has demonstrated uplift and is on a trajectory for additional uplift/improvement. The area designated in Figure 1 on Page 2 is being incorporated into the Parks overall management plan such that expansion of any recreational facilities will not be permitted in the valley bottom. The project has largely met its goals and is proposed for regulatory closeout.