Mitigation Plan

Hominy Swamp Creek, City Recreation Park
Wilson, North Carolina

N.C. Wetlands Restoration Program

NCDENR

January 2003

KCI

KCI Associates of North Carolina, P.A.
Landmark Center I, Suite 200
4601 Six Forks Road
Raleigh, North Carolina 27609

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1.0 Introduction

Project planning was initiated in 1999 for the implementation of an urban stream restoration project in Wilson, North Carolina (Figure 1). The project included a detailed analysis of watershed conditions, an evaluation of the existing stream utilizing Rosgen assessment/classification methodologies, the identification and assessment of an appropriate reference reach, data analysis, preparation of complete design plans and specifications, permitting, local government and stakeholder coordination, and implementation.

Phase I of the project consisted of the detailed analysis of the 5.4 square mile portion of the Hominy Swamp Creek watershed (located within USGS 14-digit Hydrologic Unit Code 03020203020040, NCDWQ Subbasin 03-04-07 of the Neuse River Basin) that contributes drainage to the project site. The watershed analysis, including the assessment of over 7 miles of stream channel, was conducted for the purpose of developing a clear understanding of existing system characteristics. The resulting Watershed Management Plan identified opportunities to improve water quality and overall system functions including targeted strategies such as wetland/riparian buffer preservation, stormwater BMP development/retrofitting, stream restoration, and community education.

Following coordination with local leaders and citizens groups, Phase II of the project was initiated and focused on the restoration of approximately 2,000 linear feet of degraded stream within the Wilson Recreation Park (Figure 2). Detailed environmental assessments and engineering studies were conducted and design plans and documents were prepared to facilitate the stream and riparian buffer restoration. Implementation of the project was completed in September 2001.

2.0 Project Summary

The restoration of the portion of Hominy Swamp Creek located within the Wilson City Recreational Park was conducted to correct identified system deficiencies including severe bank erosion, channel widening, and the loss of aquatic habitat resulting from stream channelization, the loss of riparian vegetation, and watershed development. The goal of the project was to develop a stable stream channel with reduced bank erosion, efficient sediment transport, enhanced warm water fisheries, and improved overall stream habitat and site aesthetics.

A Rosgen Level II Morphological Assessment and Classification of the project reach was conducted in accordance with the methodologies presented in "A Classification of Natural River Systems" (Rosgen, 1994). As part of this assessment, detailed stream morphologic characteristics and dimensions were field surveyed and analyzed. During the geomorphic analysis, observed bankfull indicators were identified and surveyed both in section and profile. Estimates of bankfull discharge were determined based on bankfull geometry, channel roughness, and bed slope using Manning's open channel flow equation. Hydraulic parameters such as discharge, flow area, wetted perimeter, slope and velocity were calculated to further analyze existing conditions and to provide a means for evaluating potential responses during the restoration design phase. Collected data were correlated with USGS gauge data to verify field determinations and an evaluation of stream competence was conducted utilizing critical shear stress and depth calculations to assess existing sediment transport characteristics.

Due to the nature of the site as an urban park, the presence of utilities, buildings and other infrastructure were a concern throughout project assessment, design and implementation. The site assessment included the meticulous location and evaluation of these features. Detailed criteria were developed during the preliminary design phase that established guidelines regarding the avoidance and incorporation of these constraints in the restoration design (Table 1). Stipulations regarding allowable restored stream encroachment into park open space and recreational areas placed further constraints on the restoration design.

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Hominy Swamp Creek
Stream Restoration Project
Wilson, North Carolina

Project Reach

North
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Figure 1. Vicinity Map

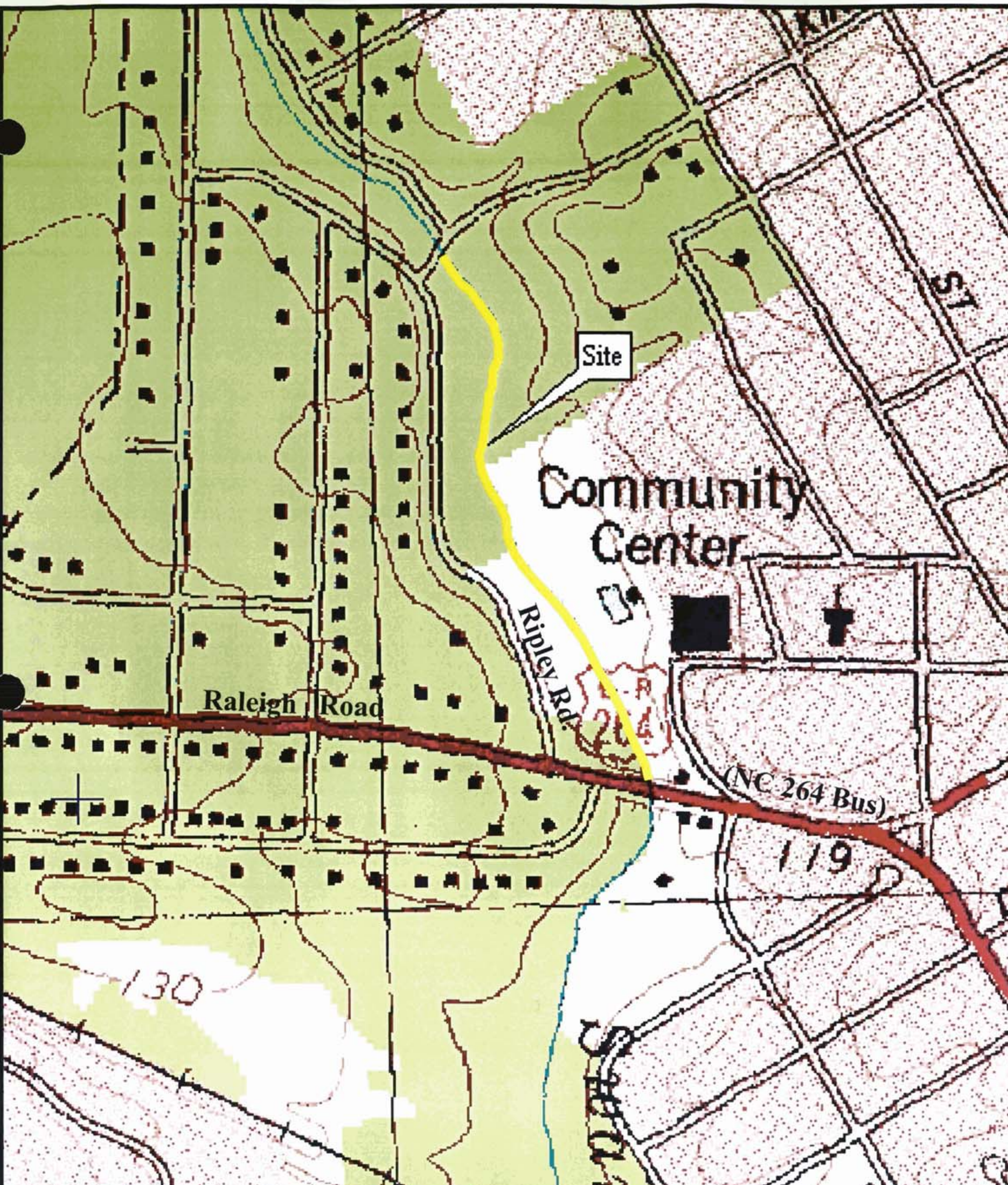

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Figure 2. Location Map

Table 1. Site Constraints

Constraint	*Impact on Design*	*Required Action/Treatment*
15" RCP	Lateral Confinement	Cutback Pipe and stabilize outfall as necessary.
Existing Trees	Lateral Confinement	Avoid all trees when possible.
48" RCP	Lateral Confinement	Stabilize outfall as necessary.
SS Line	Lateral Confinement	Avoid sanitary sewer. Do not encroach within 10 feet.
Watson Drive	Lateral Confinement	Avoidance, change stream plan, and stabilize.
15" RCP	Lateral Confinement	Cutback Pipe and stabilize outfall as necessary.
SS Line	Lateral Confinement	Avoid sanitary sewer. Do not encroach within 10 feet.
15" RCP	Lateral Confinement	Cutback Pipe and stabilize outfall as necessary.
36" RCP	Lateral Confinement	Stabilize outfall as necessary.
Lateral SS x-ing	Profile/Grading limitations	Stabilize the channel bed and pipe with grade control and/or instream pipe protection if necessary.
Play Area	Lateral Confinement	Treat as sensitive area. Avoid during all site operations.
Pedestrian Bridge	Planform and cross sectional limitations.	Bridge to remain. Incorporate into planform and dimensional modifications.
SS Line	Lateral Confinement	Avoid sanitary sewer. Do not encroach within 10 feet.
Gravel Path	Lateral Confinement	Avoid gravel path. Do not encroach within 10 feet.
Lateral SS Line crossing	Profile/Grading limitations	Stabilize the channel bed and pipe with grade control and/or instream pipe protection if necessary.
Pedestrian Bridge	Planform/X-section limitations	Bridge will be removed during construction.
Parking Lot	Lateral Confinement	Avoidance where possible. Structural protection if necessary.
2 Pipes	Lateral Confinement	Cutback Pipes and stabilize outfalls as necessary.
SS Line	Lateral Confinement	Avoid sanitary sewer. Do not encroach within 10 feet.
Lateral SS x-ing	Profile/grading limitations	Stabilize the channel bed and pipe with grade control and/or instream pipe protection if necessary.
Recreational train bridges	Planform and cross sectional limitations.	Structural protection utilizing traditional geo-technical methods (i.e., riprap) to be applied as necessary.
Culverts	Profile/X-section limitations	Incorporate into planform, profile and dimensional changes.

In addition, the project reach is located within a FEMA detailed flood study area. Activities within this area, including the stream restoration strategies implemented, are subject to a "no rise" certification that requires that the 100-year flood elevation not be increased from its current level. Therefore, the assessment and design process incorporated the use of a HEC-RAS hydrologic/hydraulic model of existing and proposed conditions to further evaluate channel discharge parameters and to verify design components.

The restoration of the project reach was based upon the use of an analog design or reference reach methodology. A Rosgen Level II Morphological Assessment and Classification was completed of the selected reference reach – a portion of Hominy Swamp Creek located northwest of Airport Road and south of the Wilson Airport (Figure 3).

Selection of this site was appropriate due to its close proximity to the subject site, location within the same watershed as the project site, and similarity of physiographic characteristics (i.e., geology, landscape position, topographic relief, and watershed land use/land cover) to the project site. Channel dimensions, pattern and profile were measured at the stable reference site and used to develop quantitative dimensionless ratios on which the restoration design was based (Table 2).

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Hominy Swamp Creek Stream Restoration Project
Wilson, North Carolina

Project Reach Reference Reach

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Figure 3. Reference Site Location

Table 2. Morphological Design Criteria

	Parameters	*Project Site Existing Channel*	*Reference Reach*	*Project Site Restored Reach*
Stream Type		E5 (Modified)	E5	E5
Drainage Area (mi^2)		5.4	1.03	5.4
Bankfull Width (W_{bkf})		25.5'	11.9'	20.2'
Bankfull Mean Depth (d_{bkf})		2.74'	1.61'	2.73'
Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)		70	19.2	55
Width/Depth Ratio (W_{bkf}/d_{bkf})		9.3	7.4	7.4
Bankfull Max Depth (d_{mbkf})		4.68'	2.11'	4.30'
Width of Floodprone Area (W_{fpa})		> 100'	>45'	> 100'
Entrenchment Ratio (ER)		> 4.0	>2.2	> 5.0
Channel Materials (D50) (mm)		Fine Sand	V. Fine Sand	Fine Sand
Water Surface Slope (S)		0.0015	0.0015	0.0014
Sinuosity (K)		1.1	1.41	1.2
Dimension	Pool Depth (dp)	5.18 – 6.78'	2.46' – 3.55'	5.4 – 6.6
	Riffle Depth (dr)	3.88 – 5.08'	1.55' – 2.18'	3.9 – 4.7
	Ratio - Max. Pool Depth:Mean Bkf. Depth	2.47	2.2	2.2
	Bankfull mean velocity (u) (ft./sec.)	2.94	2.43	3.38
	Bankfull discharge (Q) (CFS)	205.5	46.6	200
Pattern	Meander Length (L_m)	114 – 170'	107 – 150'	182 – 255'
	Radius of Curvature (R_c)	43' - 135'	27.35' - 36.9'	46.5 – 62.6'
	Belt Width (W_{blt})	92'	92'	85'
	Meander Width Ratio (MWR)	3.6	7.7	4.2
	Ratio- Rad. of Curv.:Bkf Width (R_c/W_{bkf})	1.9 – 5.9	2.3 – 3.1	2.3 – 3.1
	Ratio- Meander Length:Bkf Width (L_m/W_{bkf})	4.5 – 6.7	9.0 – 12.6	9.0 – 12.6
Profile	Valley Slope (ft./ft.)	0.0017	0.0021	0.0017
	Water Surface Slope (ft./ft.)	0.0015	0.0015	0.0014
	Riffle Slope (ft./ft.)	0.0016	0.0018	0.0015
	Pool Slope (ft./ft.)	0.0003	0.0007	0.0007
	Pool to Pool Spacing (ft.)	167.0'	69.56'	91.0 – 127.5
	Pool Length (ft.)	26 – 38'	20' – 29'	35 – 49'
	Ratio - Pool Slope:Water Surface Slope	0.20	0.47	0.47
	Ratio - Pool to Pool Spacing:Bkf width	6.55	5.9	4.5 – 6.3

Following the analysis of the watershed, site and reference reach data, potential stream restoration strategies were evaluated based upon the four priorities of incised river restoration developed by Dave Rosgen (Rosgen, 1997). For clarity and convenience, descriptions of these "Priorities" and their associated methods, advantages and disadvantages are provided in Table 3.

The stream design specified the implementation of Priority 1 stream restoration methodologies consisting of the use of natural channel restoration techniques, such as planform modifications, riffle/pool sequence reestablishment, and bank stabilization using bioengineering-based techniques. Reestablishment of a vegetated buffer consisting of native plant species was also integral to the project.

Table 3. Priorities for incised river restoration.

Description	*Methods*	*Advantages*	*Disadvantages*
Priority 1 Convert G and/or F stream types to C or E at previous elevation with floodplain.	Re-establish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design new channel for dimension, pattern, and profile characteristic of stable form. Fill in existing incised channel or with discontinuous oxbow lakes level with new floodplain elevation.	Re-establishment of floodplain and stable channel: 1) reduces bank height and streambank erosion, 2) reduces land loss, 3) raises water table, 4) decreases sediment, 5) improves aquatic and terrestrial habitats, 6) improves land productivity, and 7) improves aesthetics.	1) Floodplain re-establishment could cause flood damage to urban, agricultural, and industrial development. 2) Downstream end of project could require grade control from new to previous channel to prevent head-cutting.
Priority 2 Convert F and/or G stream types to C or E. Re-establishment of floodplain at existing level or higher, but not at original level.	If belt width provides for the minimum meander width ratio for C or E stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank halls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	1) Decreases bank height and streambank erosion, 2) Allows for riparian vegetation to help stabilize banks, 3) Establishes floodplain to help take stress off of channel during flood, 4) Improves aquatic habitat, 5) Prevents wide-scale flooding of original land surface, 6) Reduces sediment, 7) Downstream grade transition for grade control is easier.	1) Does not raise water table back to previous elevation. 2) Shear stress and velocity higher during flood due to narrower floodplain. 3) Upper banks need to be sloped and stabilized to reduce erosion during flood.
Priority 3 Convert to a new stream type without an active floodplain, but containing a floodprone area. Convert G to B stream type, or F to Bc.	Excavation of channel to change stream type involves establishing proper dimension, pattern, and profile. To convert a G to B stream involves an increase in width/depth and entrenchment ratio, shaping upper slopes and stabilizing both bed and banks. A conversion from F to Bc stream type involves a decrease in width/depth ratio and an increase in entrenchment ratio.	1) Reduces the amount of land needed to return the river to a stable form. 2) Developments next to river need not be relocated due to flooding potential. 3) Decreases flood stage for same magnitude flood. 4) Improves aquatic habitat.	1) High cost of materials for bed and streambank stabilization. 2) Does not create the diversity of aquatic habitat. 3) Does not raise water table to previous levels.
Priority 4 Stabilize channel in place.	A long list of stabilization materials and methods have been used to decrease streambed and streambank erosion, including concrete, gabions, boulders, and bioengineering methods.	1) Excavation volumes are reduced. 2) Land needed for restoration is minimal.	1) High cost for stabilization. 2) High risk due to excessive shear stress and velocity. 3) Limited aquatic habitat depending on nature of stabilization methods used.

Source: Rosgen, 1997, "A Geomorphological Approach to Restoration of Incised Rivers".

3.0 Success Criteria

The success of stream channel restoration, erosion control, and vegetation planting/seeding will be evaluated in accordance with the following guidelines.

Annual cross-sectional measurements should show little change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increased stability or whether they indicate movement toward an unstable condition. Bed material measurements (d_{50} and d_{84}) should indicate maintenance of the coarseness in riffles and fineness in pools.

Profile measurements should indicate stable bedform features with little change from the as-built survey. The bank height ratio (low bank height/max. bankfull depth) should remain near 1.0. The pools should maintain their depth with lower water surface slopes, while the riffles should remain shallower and steeper.

Planted riparian and bank vegetation must meet a minimum survival success rate of 320 stems/acre after five years.

Successive annual photographs taken at cross-section and permanent photo reference point locations should point to increasing overall site stability. The photographs should indicate an absence of channel aggradation/degradation and bank erosion while also indicating the continued maturation of established vegetation.

4.0 Monitoring Schedule

Monitoring of stream stability and vegetation survival will be conducted annually for a period of five (5) years following the completion of all restoration activities, to include both channel construction and vegetation planting.

Annual monitoring reports will be submitted to the U.S. Army Corps of Engineers – Wilmington District Regulatory Division and the North Carolina Division of Water Quality – 401/Wetlands Group at the end of each yearly monitoring period.

5.0 Mitigation

Based upon the assessment of the existing stream characteristics, the site constraints and the morphological parameters obtained from the reference site, Priority-1 restoration of 2,232 linear feet of stream within the project site was designed and implemented (Figure 4).

The degraded stream section was restored to a stable state by reestablishing appropriate cross-sectional dimension, increasing sinuosity through the establishment of a meandering stream planform, and adjusting the base elevation of the stream to eliminate headcuts and maintain connectivity with the floodplain during bankfull flow events. Site problems were addressed and natural stream system functions and values were restored in a morphologically appropriate manner that was compatible with and complementary to the continued use of the site as an urban recreational park.

The restoration of Hominy Swamp Creek within the Wilson City Recreation Park was a classic example of the requirements and restrictions encountered in an urban setting.

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Hominy Swamp Creek
Stream Restoration Project
Wilson, North Carolina

Priority 1 Restoration: 2,232 lf

North
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Figure 4. Mitigation Type and Extent

6.0 Contingency and Maintenance Plans

Contingency and maintenance plans were developed to help ensure the proper maintenance of the restored channel and adjacent riparian buffers, in order to promote the long-term success of the stream restoration project. Corrective actions, as detailed in Table 4, will be taken to rectify identified site problems as well as to address monitoring findings that indicate a failure to meet established success criteria.

Table 4. Contingency Plans.

	Identified Problem	*Corrective Action*	*Timeframe*
Stream	1. Localized bank erosion	Reestablish eroded bank section in accordance with design cross-section, reseed with appropriate mix, and apply coir matting to stabilize.	Immediate.
Stream	2. Excessive debris creating obstruction or diversion of stream flow.	Remove obstruction, by hand if possible. If needed, correct erosion problem i.a.w. #1.	Immediate.
Stream	3. Severe scour/erosion adjacent to rootwads and log vanes.	Divert flow, repair or replace degraded structure. Repair bank i.a.w. #1, above.	Immediate.
Stream	4. Severe scour or headcut compromising rock or log cross vane.	Divert flow, repair or replace degraded structure. Repair bank i.a.w. #1, above.	Immediate.
Vegetation	5. Riparian or bank woody vegetation not meeting success criteria	Determine reason for failure, determine quantity of plantings required to replant, develop list of species to be utilized, and install in accordance with original design specifications.	Seasonally (during dormancy)
Vegetation	6. Barren areas void of herbaceous vegetation.	Determine reason for failure, prepare area applying topsoil and amendments as necessary, and reseed with appropriate mix.	Immediate.
Vegetation	7. Invasive Species	Hand removal of or herbicide application to invasive plants. Herbicide application should be done by a licensed practitioner only. Broadcast herbicide application should NOT be allowed.	Immediate.

In addition:

- All work within the riparian buffer and stream shall be conducted in accordance with the provisions established in the protective conservation easement. No work within the conservation easement area will be conducted without prior coordination with and approval by the NCWRP. Upon the completion of approved work activities, the impacted area shall be put back to the original design grade, stabilized and re-vegetated.
- The deposition of material, such as soil, rock, wood, and grass clippings, into the stream and/or along the banks is prohibited. The unnecessary deposition in-stream and along the banks may cause channel instability, reduce the ability of bank vegetation to establish, and/or adversely impact instream habitat.
- Pumping water out of the stream should be avoided except when done in conjunction with appropriate channel maintenance activities or under emergency situations (i.e.. fire).
- Pedestrian access should be limited to areas outside of the top of bank and to designated stream access points only. Conservation easement boundary markers with educational information have been installed throughout the project site to promote stream/riparian buffer restoration awareness.

Guidelines regarding appropriate methods, frequency, and time of year for vegetation maintenance activities within the restored stream and riparian zones are provided in Table 5. Vegetation maintenance may be performed on a *less* frequent and/or intensive basis than indicated in the guidelines. However, vegetation maintenance may not be done on a *more* frequent or intensive basis than indicated. Likewise, guidance related to the approved seed mixture to be used in the event any reseeding activities are necessary is provided in Table 6.

Table 5. Scheduled Vegetation Maintenance Guidelines

Project Zone	***Vegetation Type***	***Maintenance***		
		Method	***Frequency***	***Occurrence***
Unmowed Herbaceous Buffer *(location as indicated on Plans)*	Grasses	Mechanically with a mower to a minimum height of 6 inches.	Twice a year.	Between May 1 and October 1.
Forested Buffer *(location as indicated on Plans)*	Grasses	Mechanically with a mower to a minimum height of 6 inches.	Twice a year.	Between May 1 and October 1.
	Shrubs	Pruning by hand of all dead wood and up to 20% of new growth.	Once a year after one (1) full calendar year.	December through February.
	Trees	Pruning by hand of all dead wood.	Once a year after one (1) full calendar year.	December through February.
		Removal of all dead or diseased vegetation.	As needed.	N/A
Stream Zone *(all areas inside the top of banks)*	Grasses	By hand with a string trimmer to a minimum height of 6 inches.	Twice a year.	Between May 1 and October 1.
	Live stakes	Pruning by hand to a minimum plant height of 3' and aerial coverage of 60 percent.	Once a year after two (2) full calendar years.	December through February.

Table 6. Re-seeding Specifications.

Riparian Buffer (All areas outside top of stream banks):

Summer Mix (April 15 – October 15)

Species		Application Rate (in Mix) % of Mix	lbs./acre
Redtop	*Agrostis alba*	5	1.5
Purple Lovegrass	*Eragrostis spectabilis*	5	1.5
Gama grass	*Tripsacum dactyloides*	35	10.5
Switchgrass	*Panicum virgatum*	30	9.0
Brown Top Millet	*Pennisetum glaucoma*	25	7.5
	TOTALS	100	30.0

Winter Mix (October 15 – April 15)
Same as above except substitute Rye Grain (*Secale cereale*) for Brown Top Millet.

Stream zone (All areas within the top of stream banks):

Summer Mix (April 15 – October 15)

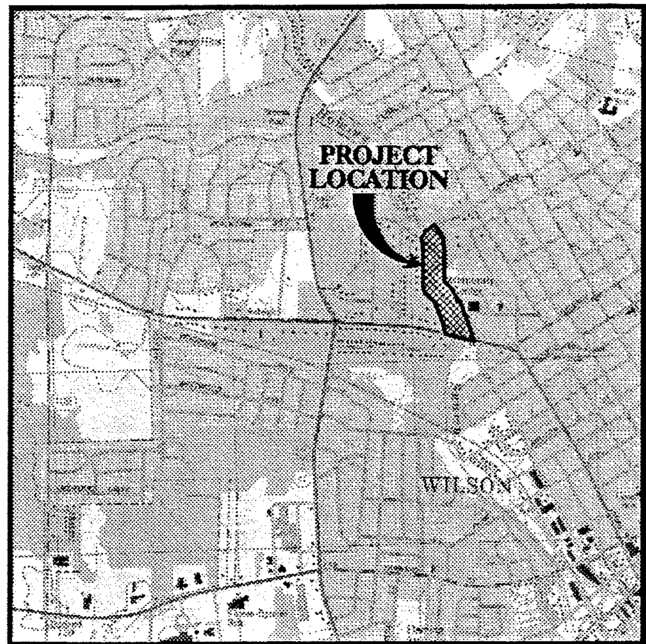
Species		Application Rate (in Mix) % of Mix	lbs./acre
Tussock Sedge	*Carex stricta*	5	1.5
Redtop	*Agrostis alba*	5	1.5
Purple Lovegrass	*Eragrostis spectabilis*	5	1.5
Gama grass	*Tripsacum dactyloides*	30	9.0
Switchgrass	*Panicum virgatum*	30	9.0
Brown Top Millet	*Pennisetum glaucoma*	25	7.5
	TOTALS	100	30.0

Winter Mix (October 15 – April 15)
Same as above except substitute Rye Grain (*Secale cereale*) for Brown Top Millet.

7.0 References

Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena 22 (1994): 169-199.

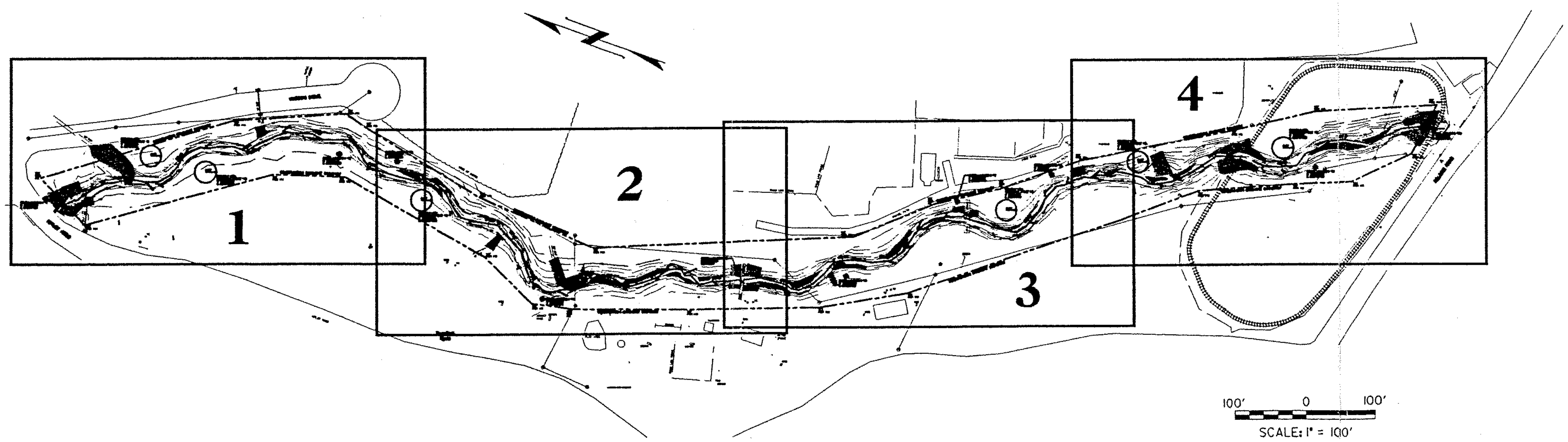
Rosgen, D.L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. In: Management of Landscapes Disturbed by Channel Incision, Univ. Miss., Oxford, MS. Pg. 3-22.



VICINITY MAP

HOMINY SWAMP CREEK STREAM RESTORATION PROJECT

WILSON, NORTH CAROLINA



AS-BUILT SURVEY

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REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

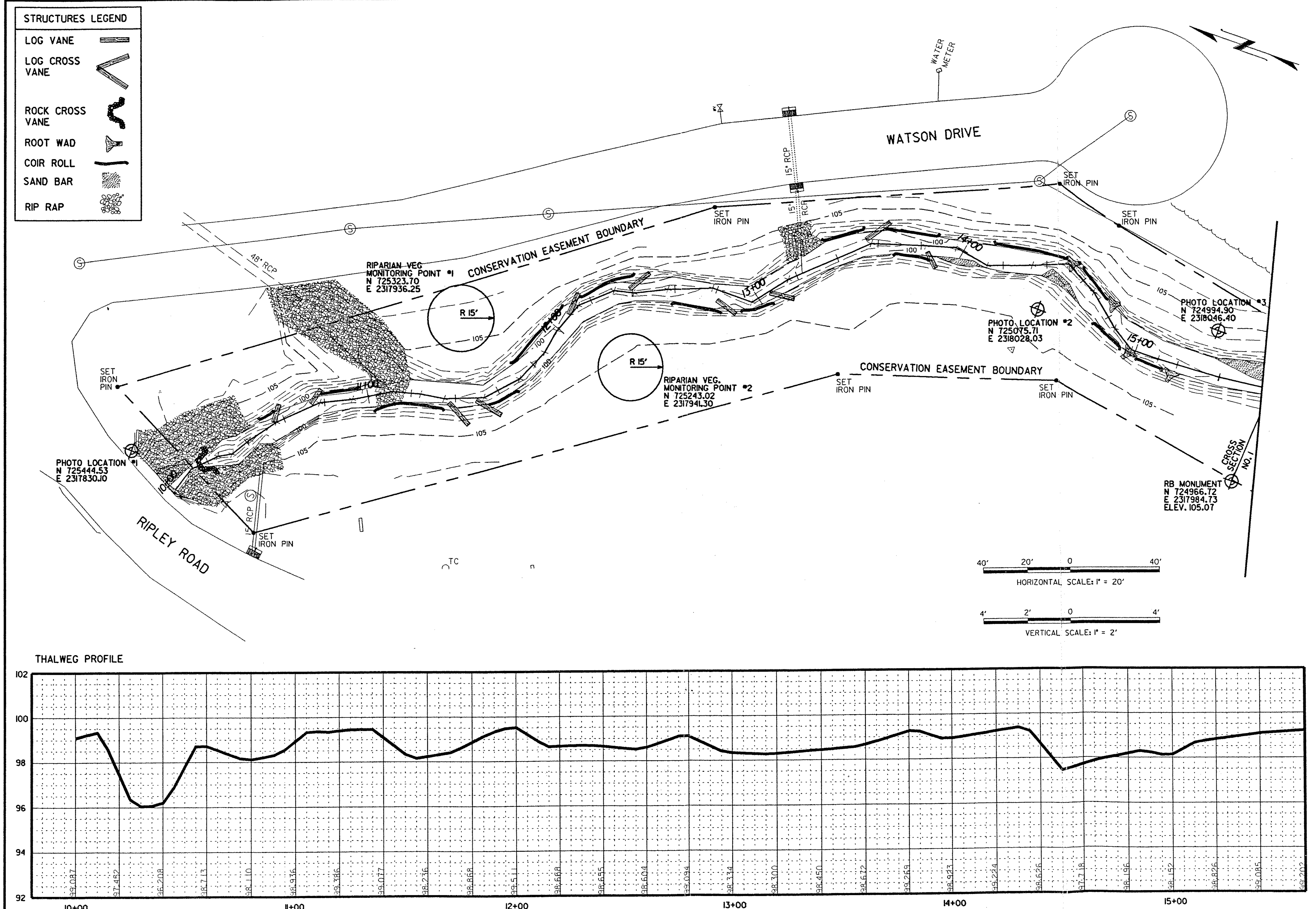
KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

HOMINY SWAMP CREEK
STREAM RESTORATION PROJECT
WILSON, NORTH CAROLINA

DATE: JUNE 24, 2002
SCALE: GRAPHIC

TITLE SHEET

SHEET 1 OF 5



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HOMINY SWAMP CREEK STREAM RESTORATION PROJECT

WILSON, NORTH CAROLINA

STA. 10+00.00 TO STA. 15+60.00

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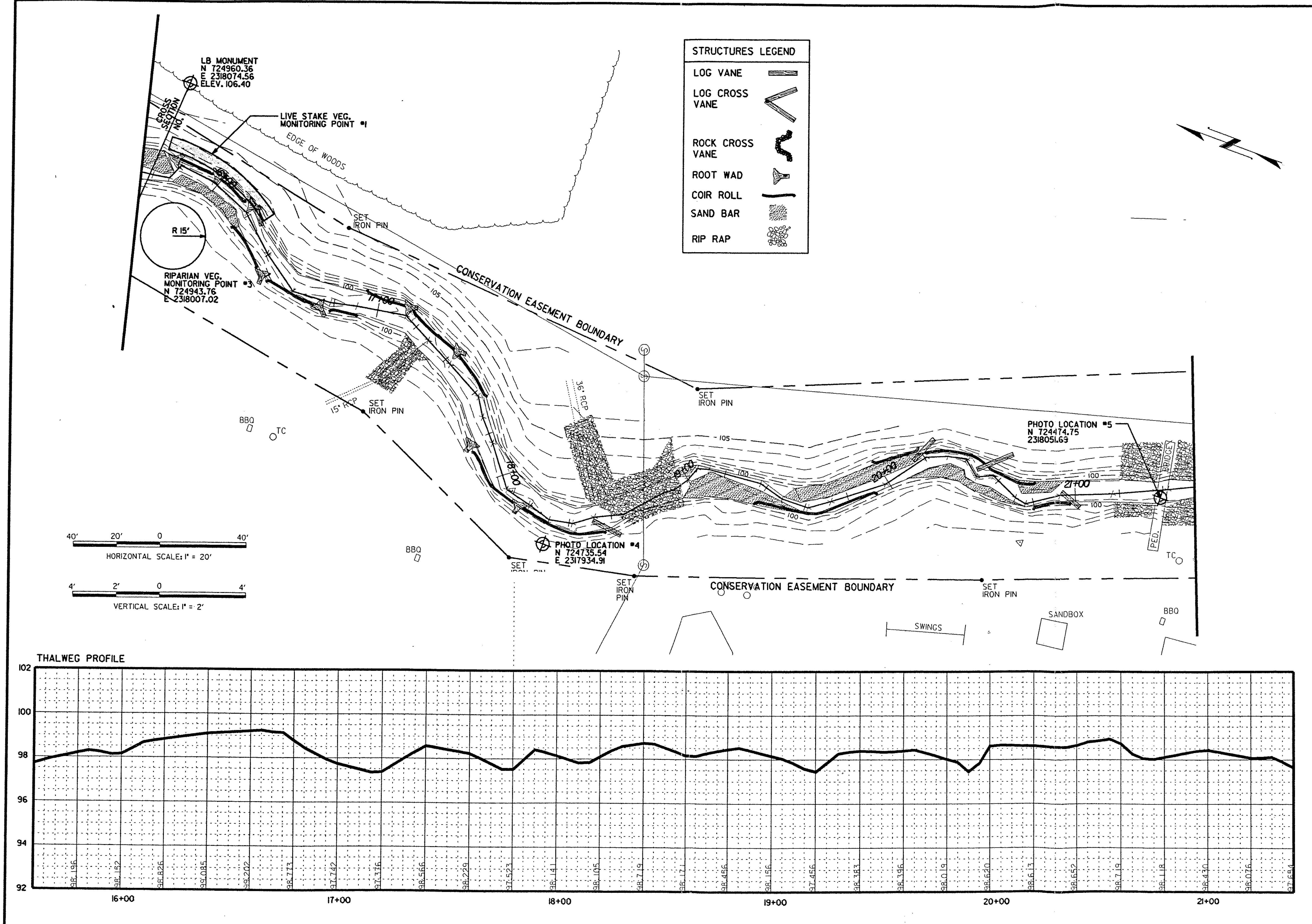
ASBUILT PLAN

SHEET 2 OF 5



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WILSON, NORTH CAROLINA
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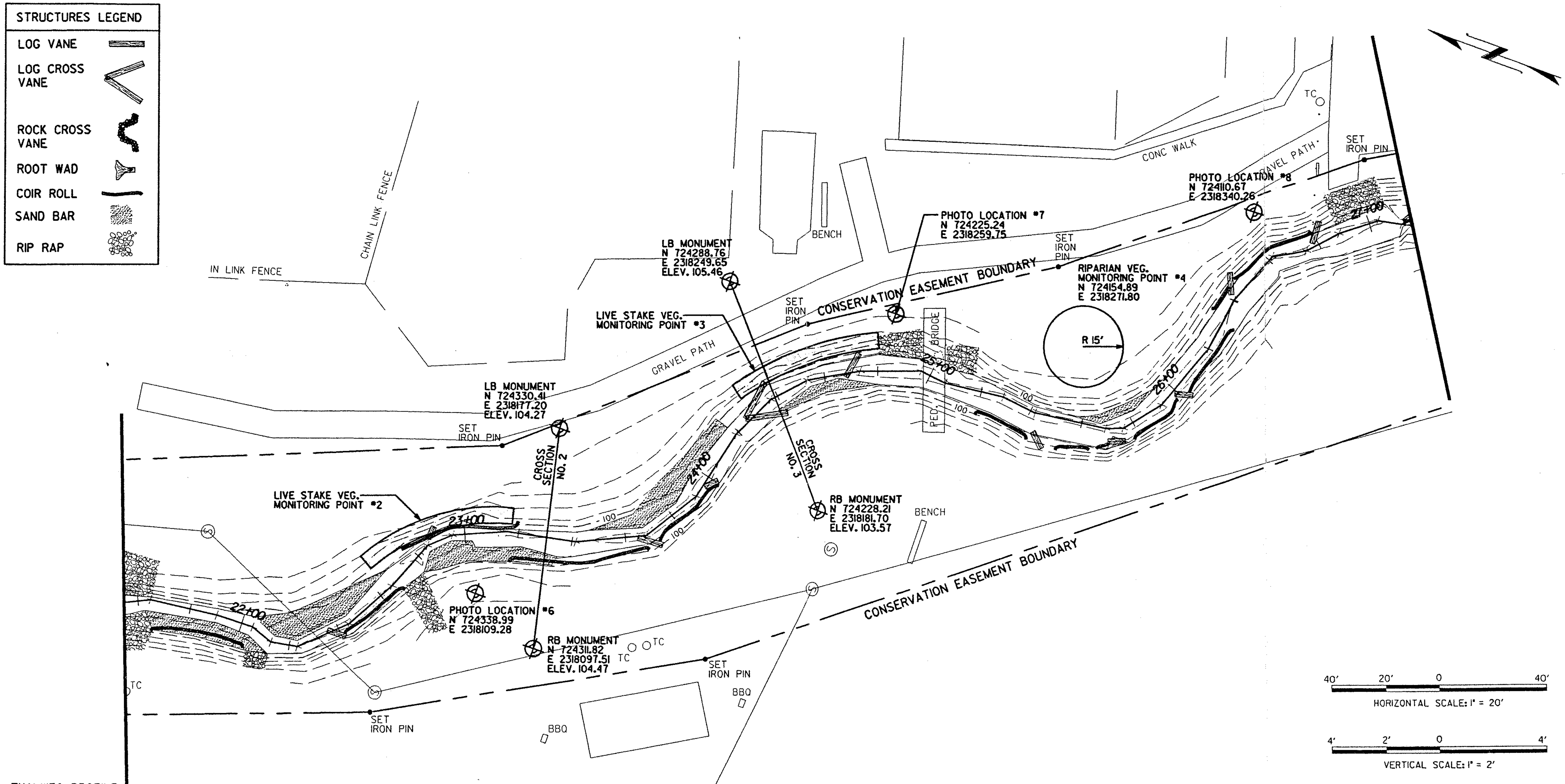
ASBUILT PLAN

SHEET 3 OF 5



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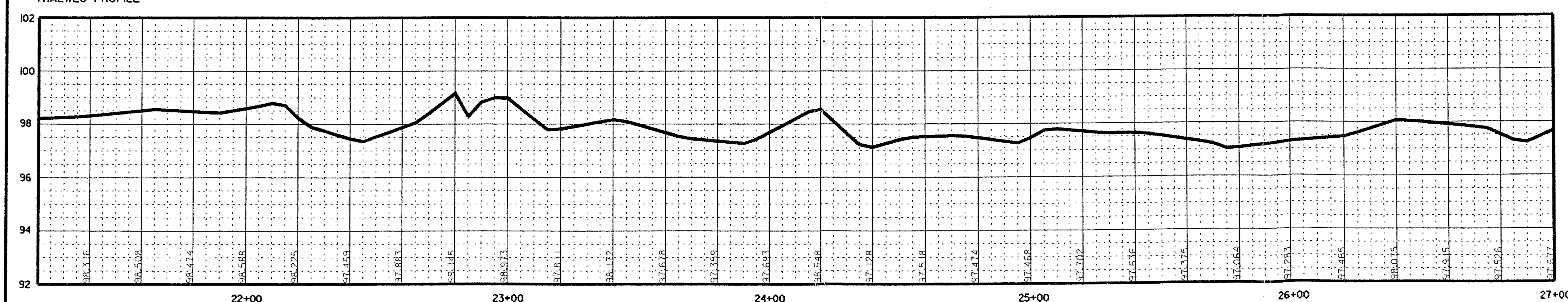

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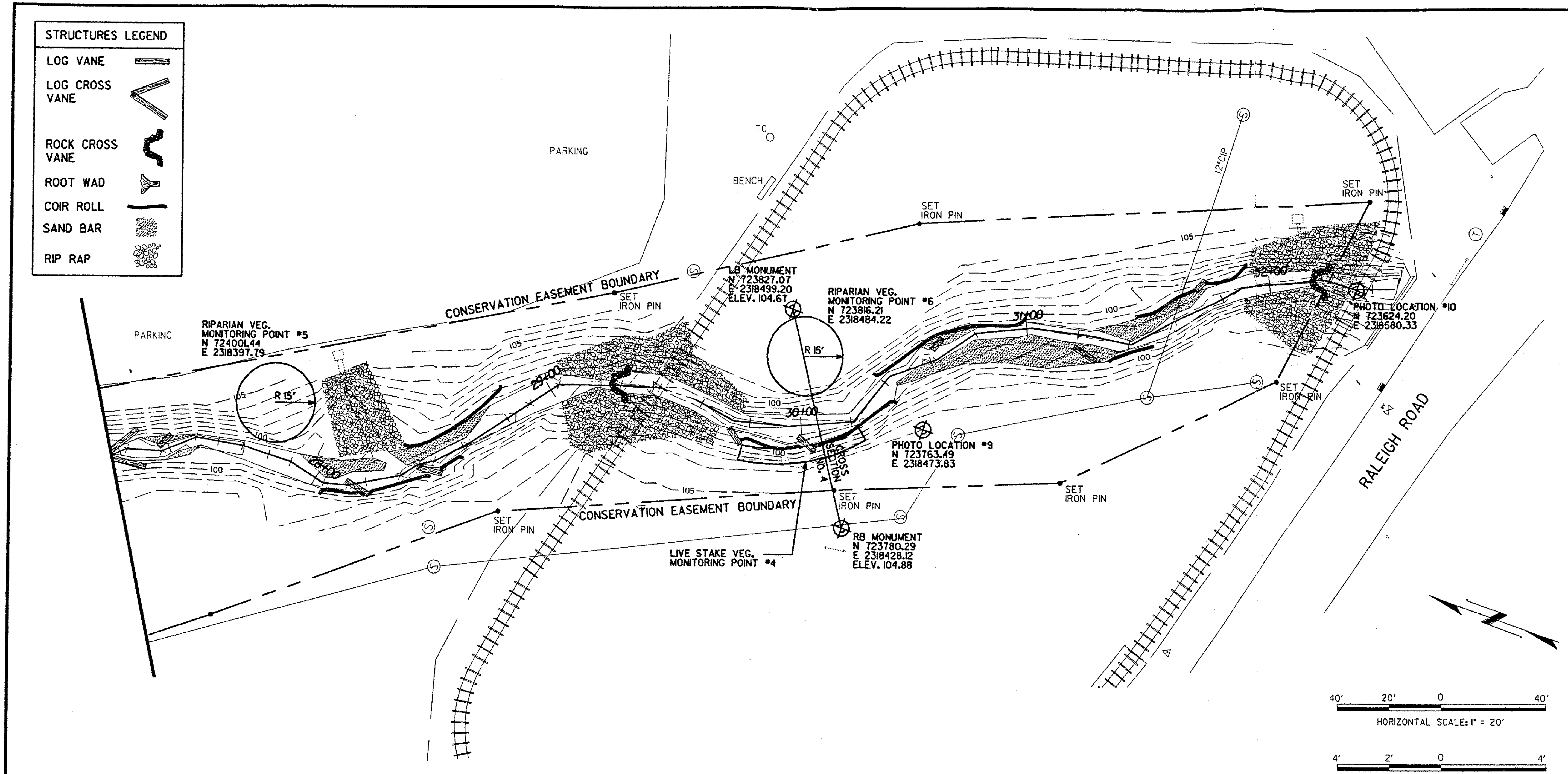
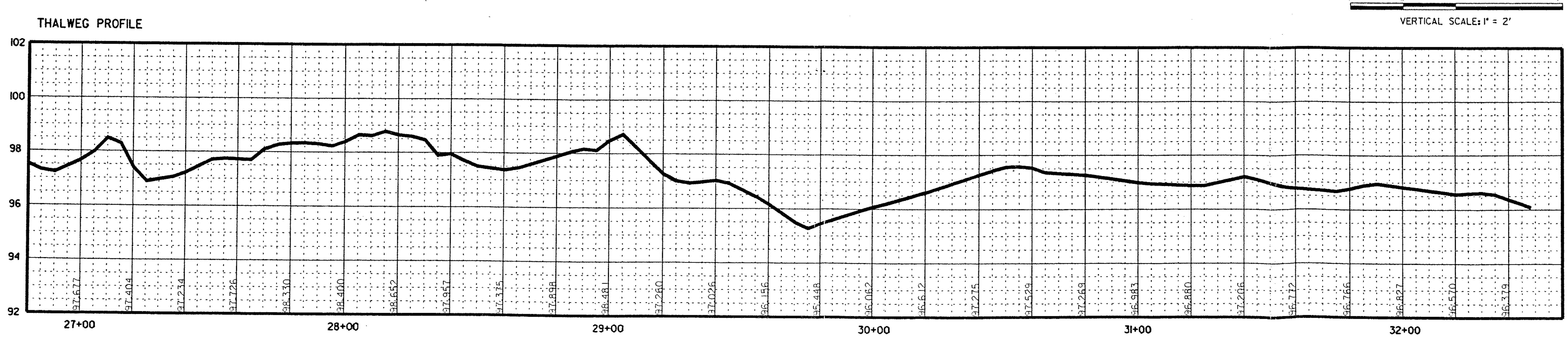
ASBUILT PLAN

SHEET 4 OF 5





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HOMINY SWAMP CREEK STREAM RESTORATION PROJECT

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ASBUILT PLAN

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