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THREE-YEAR COMPREHENSIVE MONITORING REPORT

Coast 2050 Region 4

CAMERON PRAIRIE REFUGE PROTECTION ME-09

First Priority List Shoreline Protection Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

We would like to acknowledge and extend our appreciation to the U.S. Geological Survey, National Wetlands Research Center (NWRC), particularly William Jones, Robert Greco, and Holly Gaudet, for conducting habitat analysis and assisting in the preparation of this monitoring report; and John Barras and Christina Saltus for preparing the SPOT image map included in this report. Mike Miller, Chad Courville, and Ralph Libersat of LDNR/CRD; Paul Yakupzack of the U.S. Fish and Wildlife Service (USFWS); and Robert Greco of NWRC participated in the monitoring fieldwork. Critical reviews were provided by Greg Steyer, Ralph Libersat, and Rick Raynie of LDNR/CRD; Jimmy Johnston of NWRC; and John A. Nyman of the Department of Biology, University of Southwestern Louisiana.

ABSTRACT

The Cameron Prairie Refuge Protection project is a 13,200 ft (4,023 m) shoreline protection project in Cameron Parish, Louisiana, within the Cameron Prairie National Wildlife Refuge (NWR). This project is designed to protect 247 ac (100 ha) of marsh by preventing the widening of the Gulf Intracoastal Waterway (GIWW) into emergent wetlands of the NWR where the spoil bank has almost completely eroded.

Since project construction, shoreline erosion in the project area has ceased, but the spoil bank in the reference area eroded at 3.76 ft/yr (1.15 m/yr). The rock dike in the project area has protected 1.14 acres/yr (0.46 ha/yr), assuming an erosion rate equivalent to the reference area. The area of vegetated wetlands protected from erosion cannot be accurately estimated until the spoil bank in the reference area is fully eroded and wetland soils begin to erode. This is because wetland soils probably erode much faster than spoil bank soils. Benefits resulting from erosion protection are expected to accrue throughout the life of the project for a net protection of at least 22.8 ac (9.23 ha). This estimate is likely an underestimate of the area of wetlands protected because it assumes that wetland soils erode at the same rate as spoil bank soils.

In addition to protecting existing wetlands from erosion, the project also created 3.03 ac (1.23 ha) of vegetated wetland. Creation is proceeding at 1.40 ac/yr (0.57 ha/yr) but is expected to continue only until the area between the existing shoreline and the rock dike is filled by vegetated wetland. This result indicates that low sediment availability does not prohibit wetland creation behind rock dikes on navigation channels.

The benefits of preventing exposure of the interior marsh soils to ebb and flow in the GIWW (i.e., blowout) cannot be directly quantified but may result in the safeguard of several hundred acres of delicate wetland habitat. The area protected from blowout is a wildlife trail within the Cameron Prairie NWR, and is utilized heavily as a recreational and educational area.

INTRODUCTION

Coastal navigation channels have played a major role in wetland loss in Louisiana. The losses resulting from channels are categorized as either primary losses (i.e., those resulting directly from construction) or secondary losses (i.e., those long term losses induced by presence of the channels). Primary losses include the impacts resulting from the excavation of the channel and the placement of the resulting dredge material, while secondary wetland losses are caused by 1) hydrologic modifications resulting from the physical channel (e.g., saltwater intrusion and disruption of natural sheet flow, and 2) erosion of the channel bank resulting from vessel-generated wave wash (Good et al. 1995).

Erosion of the banks of navigation channels results primarily from the wakes and wave washes of vessels using the channels. Passing vessels create “boat wakes” which break along channel banks, eroding fragile wetland soils and adversely impacting the vegetative communities. Vessels may also displace significant quantities of water from the channel, pushing the water into adjacent wetland areas which causes severe and rapid changes in water levels and scour soil and vegetation substrate. As erosion progresses beyond channel or spoil banks and into interior, more fragile wetland areas, erosion accelerates dramatically (Good et al. 1995). "Blowouts" result when shoreline erosion reaches the point where connections between a channel and an inland water body form, maximizing exchange of water and sediments (Good et al. 1995).

Construction of the Gulf Intracoastal Waterway (GIWW) was authorized by the Rivers and Harbors Act of 1925. Vessel traffic on the GIWW is a major source of erosion of the primarily fresh and intermediate marshes adjacent to the GIWW. Shoreline erosion and subsequent “blowouts” are commonly observed along the banks of the GIWW. Although it only had an authorized bank width of between 150 and 200 ft (45.72 and 60.96 m) (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 1993), erosion has resulted in a current bank width ranging from 500–600 ft (152.4–182.88 m), and up to 775 ft (236.22 m) wide in some areas (Louisiana Department of Natural Resources [LDNR] 1995). As channel erosion continues, the potential for blowouts is increased.

The shoreline erosion rate for the Cameron Prairie Refuge Protection project area was estimated by U.S. Fish and Wildlife Service personnel to be 2.5 ft/yr (0.76 m/yr) before the project was constructed (U.S. Fish and Wildlife Service [USFWS] 1991). That estimate was based on observations of the bank line relative to the refuge boundary signs placed along the waterway, and applies to critical areas where the bank was almost completely deteriorated. The shoreline erosion rate just west of the project area was calculated to be 6.56 ft/yr (2.0 m/yr) in the Sweet Lake area along the GIWW (Adams et al. 1978).

Rock dikes have been designed to prevent boat wakes from eroding shorelines, but also to allow wave overtopping, resulting in sediment accretion behind the dike. In September 1989, a 2,339 ft (713 m) rock dike was constructed adjacent to Blind Lake, located in Cameron Parish, in order to prevent the GIWW from breaching into the lake. In addition to a rock dike, 400 *Zizaniopsis miliacea*

(giant cutgrass) plants were installed behind the dike to stabilize the accreting sediment. Two and a half years after the plantings, there was an average elevational increase of 0.32 ft (0.1 m) (Louisiana Department of Natural Resources/ Coastal Restoration Division [LDNR/CRD] 1993). Another rock dike project with similar features to Blind Lake and Cameron Prairie Refuge Protection is Freshwater Bayou Wetlands (ME-04).

The Cameron Prairie Refuge Protection (ME-09) project is located in north-central Cameron Parish within the Cameron Prairie National Wildlife Refuge (figure 1) and encompasses 350 ac (140 ha) of highly organic freshwater wetlands (USFWS 1991). The GIWW borders the project area to the south and threatens to breach into the refuge. Wave action caused by boat traffic within the GIWW has eroded most of the spoil banks that protect the refuge, allowing the high energy saline waters of the GIWW to enter the project area. The resulting wave energy and saltwater intrusion has impacted the fragile interior freshwater wetlands, and could potentially result in a "blowout", causing considerable wetland loss (Cameron Prairie National Wildlife Refuge 1991).

The project design consists of installing a rock dike (breakwater) to protect the remaining shoreline. In August 1994, a 13,200 ft (4,023 m) rock breakwater was constructed 0-50 ft (0-15.24 m) from, and parallel to, the northern bank of the GIWW in 3 to 4 ft (0.9 to 1.2 m) of water. The purpose of the breakwater is to prevent the encroachment of the GIWW into the project area by preventing the waves caused by boat traffic from eroding the remaining spoil bank.

The project objectives are to prevent the loss of 247 ac (100 ha) of emergent wetlands of the Cameron Prairie NWR adjacent to the GIWW and to prevent the widening of the GIWW into the NWR. The following goals will contribute to the evaluation of the above objective:

1. Decrease the rate of spoil bank erosion along the south boundary of the 247 ac (100 ha) area adjacent to the GIWW within the Cameron Prairie NWR management unit; and

2. restore and maintain approximately 2 mi (3.2 km) of levee along the north bank of the GIWW by constructing a rock dike along the refuge boundary.

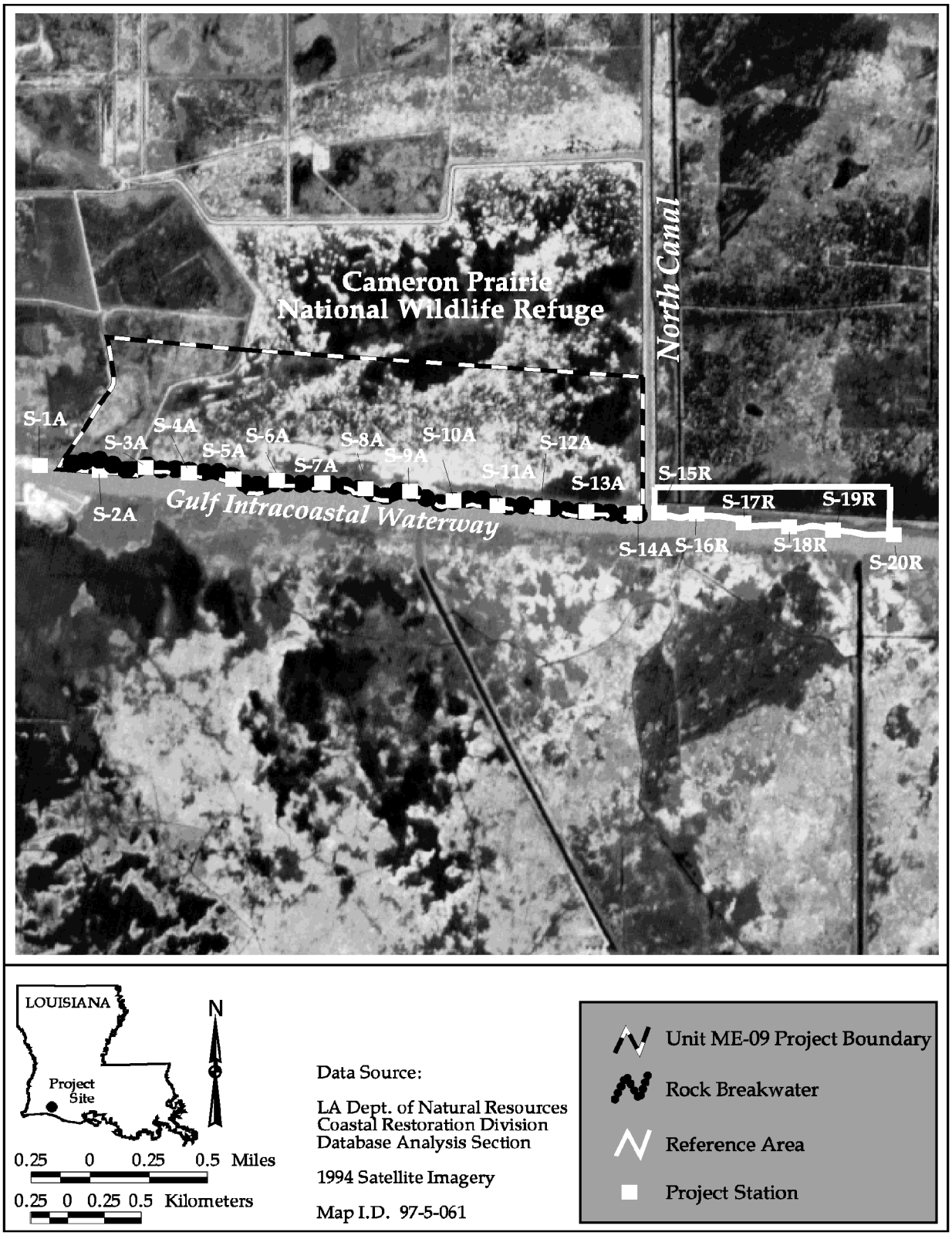

Figure 1. Cameron Prairie Refuge Protection (ME-09) project boundaries and features.

METHODS

A detailed description of the monitoring design for the entire life of the project can be found in Miller (1994).

Color-infrared aerial photography for the project and reference area was flown for preconstruction on November 1, 1993 and postconstruction on January 11, 1997. Upon completion of the flights, the photography was checked for flight accuracy, color correctness, and cloudiness. Duplicate photography was prepared for scanning and analysis and the original film was archived.

A digital .tif file with a resolution of 300 dots per inch (dpi) was created from the photography. Using PCI, an image processing software, the photography was mosaicked and used to generate a base map. Optimal global positioning system (GPS) points were collected in the field in order to georeference the base map with the proper Universal Transverse Mercator (UTM) coordinate system. The resulting preconstruction and postconstruction maps were then analyzed with ERDAS Imagine, a geographic information system (GIS), to determine temporal change.

On July 20, 1994, the first survey of the rock breakwater using GPS equipment was conducted. The NWRC mapped the position of the rock breakwater, the shoreline behind the breakwater, and the shoreline of the reference area. NWRC's GPS equipment at that time was accurate to within 2-5 meters. After comparison of this survey with georeferenced photography of the site, it was determined that the 1994 shoreline position could be more accurately delineated using aerial photography. NWRC's current GPS technology will allow future surveys to be conducted with sub-meter accuracy.

Cross-sectional surveys of the breakwater were completed in March 1995 and May 1997 (figure 2). The surveys delineated the vegetation edge, which will serve as our measure of shoreline position, and channel profile. This survey consisted of 20 cross-sections: 15 in the project area and 5 in the reference area. In the project area, the original brass hubs were all recovered in good condition. Due to erosion of the GIWW canal bank, the reference area brass hubs had to be reset on the proper azimuth away from the existing canal bank.

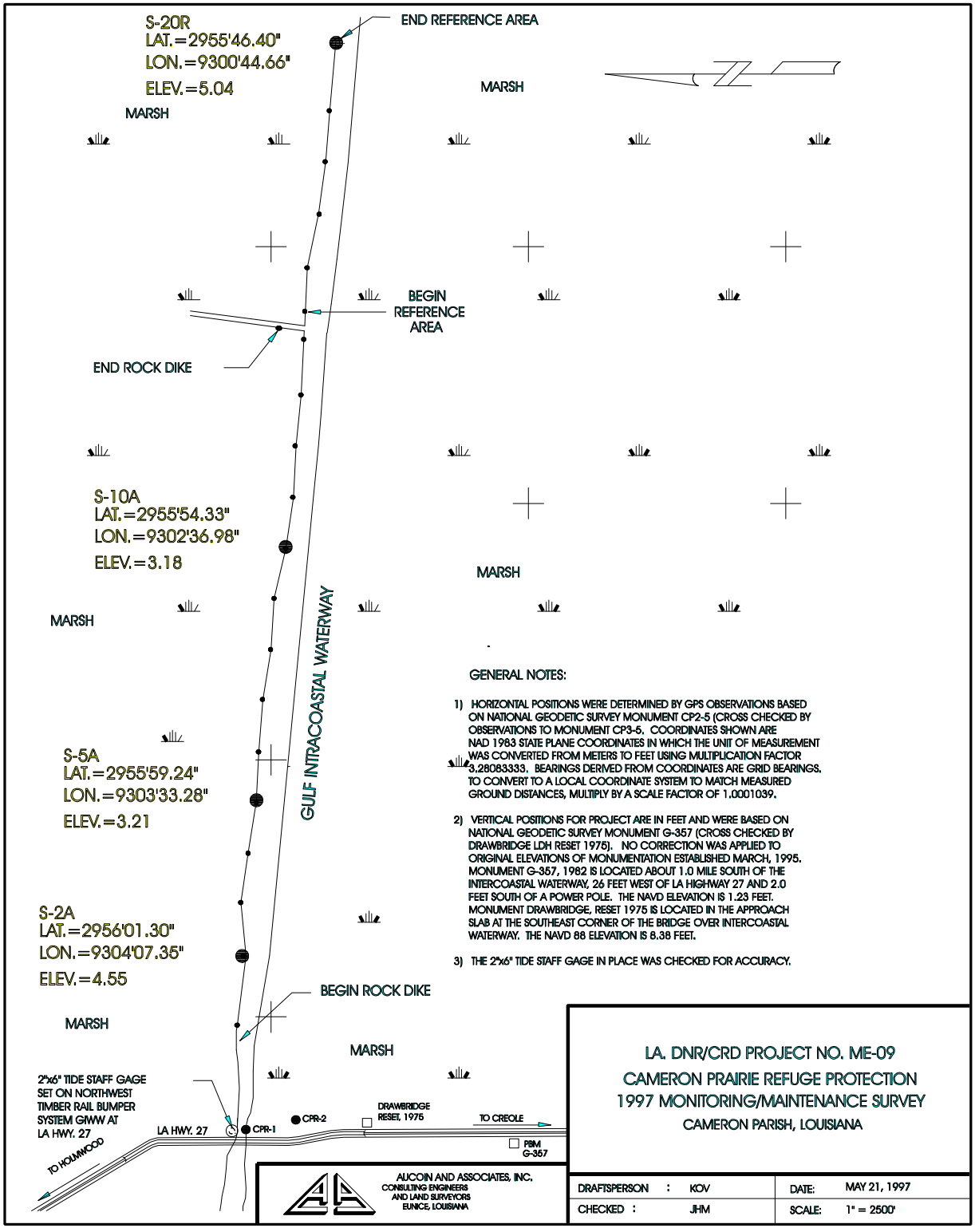

Figure 2. Cameron Prairie Refuge Protection (ME-09) plan view conducted by Aucoin and Associates, Inc. in 1997 showing each station in the project and reference area.

RESULTS

The GIS analysis revealed noticeable new vegetation present in the central portion of the project area, between the rock breakwater and the shoreline (figure 3). Overall, however, the 778 ac (315 ha) project area showed a 9.91% increase in water; by comparison, the 106 ac (43 ha) reference area experienced a 1.58% increase in water (table 1).

Spoil bank erosion along the shoreline was significantly different between the project and reference areas ($F_{1, 18} = 23.13$, $P < 0.0001$). Shoreline movement averaged a gain of +10.00 ft ± 8.25 (SD) (3.05 m ± 2.51) in the project area but eroded at a loss of -8.17 ft ± 6.24 (-2.49 m ± 1.90) in the reference area. Erosion was indicated at all reference area stations, but only at one station in the project area, station S-11A. Excluding station S-11A, the change in shoreline position in the project area ranged from +23 ft (7.0 m) at cross section S-5A to +2 ft (0.6 m) at cross section S-8A (table 2). In the reference area, the change in shoreline position ranged from -19 ft (-5.8 m) at cross section 17 R to -3 ft (-0.9 m) at cross sections 18 and 19 R (table 3). Appendix A contains all cross sections representing shoreline position and channel profile.

The spoil bank erosion rate was determined to be -3.76 ft/yr (1.15 m/yr) between March 1995 and May 1997 in the reference area which is located directly east of the project area. The shoreline in the project area prograded at a rate of +4.61 ft/yr (1.41 m/yr). This rate is not indefinite because of the limits of the rock dike.

Based on the as-built length of 13,200 ft (4,023 m) and spoil bank erosion rates of -3.76 ft/yr (1.15 m/yr) the Cameron Prairie Refuge Protection (ME-09) project has protected 1.14 acres/yr (0.46 ha/yr). The creation rate for the project area is 1.40 ac/yr (0.57 ha/yr) but is confined to the boundaries of the rock dike.

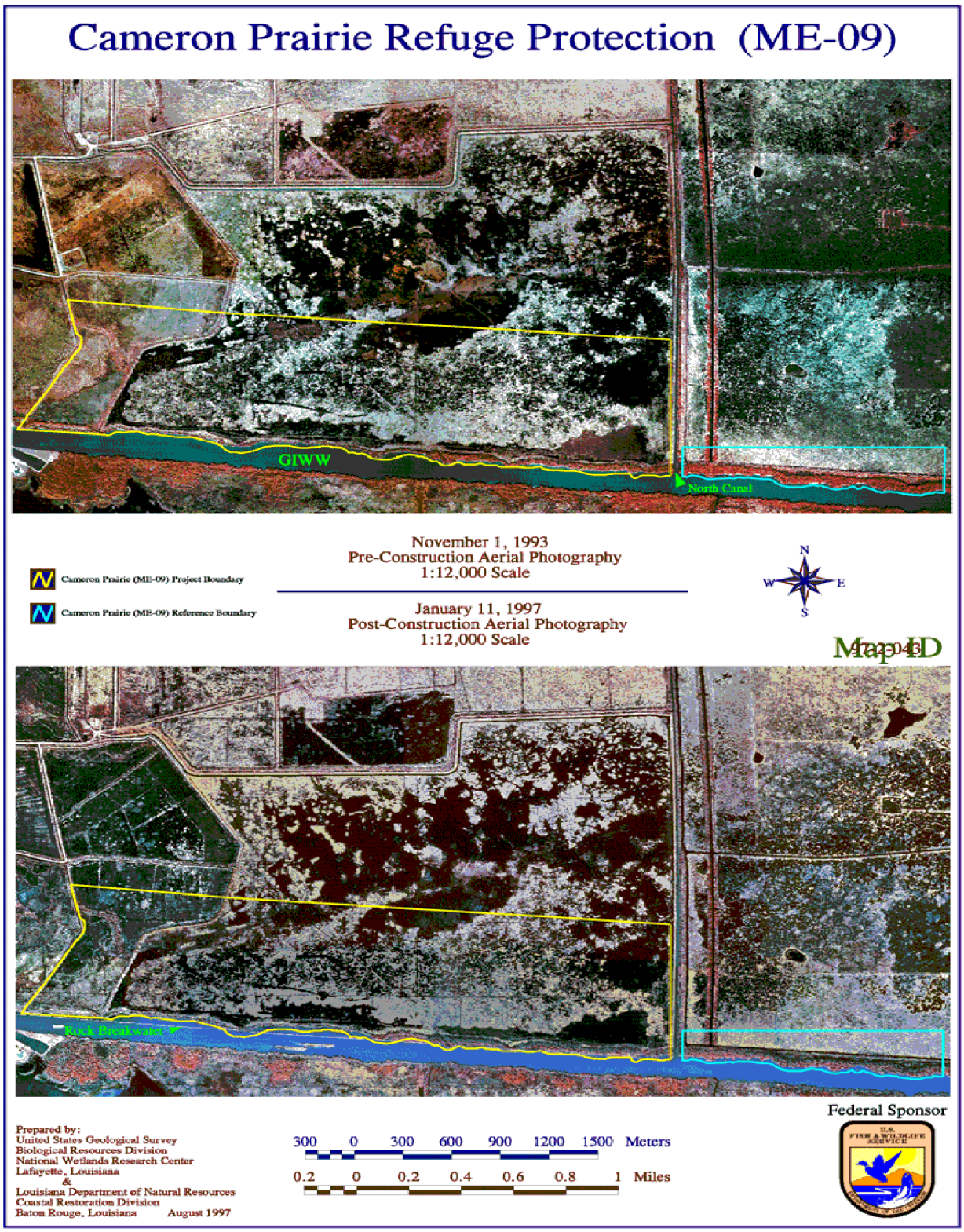

Figure 3. Cameron Prairie Refuge Protection (ME-09) pre- and post-construction aerial photography.

Table 1. Land/water analysis of the Cameron Prairie Refuge Protection (ME-09) project and reference areas during the preconstruction (November 1, 1993) and post-construction (January 11, 1997) time period.

	Project Area Water	Project Area Land	Reference Area Water	Reference Area Land
Preconstruction	46.65%	53.35%	8.08%	91.92%
Post-construction	56.56%	43.44%	9.66%	90.34%

Table 2. Shoreline position (ft) at Cameron Prairie Refuge Protection (ME-09) project area comparing surveys conducted by Pyburn and Odum, Inc. in 1995 and Aucoin and Associates, Inc. in 1997. Shoreline position represents net gain or net loss between the two surveys.

Cross-section	P. & O. 1995 vegetated edge	A. & A. 1997 vegetated edge	Shoreline Position (ft)
S-1A	station 10+04	station 10+21	+17
S-2A	station 10+06	station 10+10	+4
S-3A	station 10+03	station 10+21	+18
S-4A	station 10+01	station 10+09	+8
S-5A	station 10+04	station 10+27	+23
S-6A	station 10+03	station 10+23	+20
S-7A	station 10+01	station 10+06	+5
S-8A	station 10+09	station 10+11	+2
S-9A	station 10+06	station 10+09	+3
S-10A	station 10+08	station 10+26	+18
S-11A	station 10+14	station 10+08	-6
S-12A	station 10+10	station 10+20	+10
S-13A	station 10+16	station 10+26	+10
S-14A	station 10+00	station 10+08	+8
Mean			**+10.00** (SD[a]±8.25)

[a] SD=Standard Deviation

Table 3. Shoreline position (ft) at Cameron Prairie Refuge Protection (ME-09) reference area comparing surveys conducted by Pyburn and Odum, Inc. in 1995 and Aucoin and Associates, Inc. in 1997. Shoreline position represents net gain or net loss between the two surveys.

Cross-section	P. & O. 1995 vegetated edge	A. & A. 1997 vegetated edge	Shoreline Position(ft)
15R	10+07	9+97	-10
16R	10+04	10+00	-4
17R	10+03	9+84	-19
18R	10+09	10+06	-3
19R	10+08	10+05	-3
20R	10+04	9+94	-10
Mean			**-8.17** (SD[a]± 6.24)

[a] SD=Standard Deviation

DISCUSSION

GIS land/water analysis comparing pre-construction and post-construction photography revealed only small changes in the reference area; whereas, the project area showed a marked increase in the ratio of water to land. However, four principal difficulties were associated with the interpretation of this photography. First, the western expansion section of the project area was eliminated from analysis due to standing water conditions and submersion of vegetation. Similar conditions may have contributed to the apparent increase in water in the analyzed portion of the project area as well. Second, the preconstruction photography, flown in November, showed trees and extremely high vegetation along the GIWW shoreline. This vegetation casts shadows which visually appear as open water on the photography. Third, the pre-construction photography showed large sections of floating vegetation throughout the project area and in canals in the reference area. On the photography, floating vegetation visually appears to be land. Finally, because the post-construction flight was conducted in January 1997, due to unsatisfactory weather conditions in November 1996, apparent differences in preconstruction and post-construction vegetation may be a reflection of time of year rather than project effects.

Erosion was indicated at only one station in the project area at station S-11A (figure 14). Apparently, the 1995 surveyors interpreted the vegetated edge to be on the GIWW side of the rock dike while the 1997 surveyors interpreted the vegetated edge to be on the marsh side of the rock dike. At this station the dike meets the existing spoil bank and vegetation is coming up through the dike. The 1995 and 1997 surveys show the vegetated edge on the rock dike itself.

In the reference area, erosion was indicated at all stations. The erosion was so severe in some areas that the brass survey hubs, initially located in the marsh interior, had to be reset as far as an additional 40 ft (12.2 m) landward. At the current rate of spoil bank erosion, it is envisioned that these markers will have to be reset again in 12 years. Boat wakes from vessels traveling along the GIWW are assumed to be the main source of energy eroding the spoil bank.

The 3.76 ft/yr (1.15 m/yr) spoil bank erosion rate observed in the reference area in this study falls within the range observed on the GIWW of 2.50 ft/yr (0.76 m/yr) – 6.56 ft/yr (2.0 m/yr) (USFWS 1991; Adams et al. 1978). Other highly navigable waterways such as Freshwater Bayou have experienced similar erosion rates of 6.56 ft/yr (2.0 m/yr) (Vincent 1997).

Since project construction, approximately 2.47 ac (1.0 ha) have been protected to date and 3.03 ac (1.23 ha) have been created. Assuming the spoil bank erosion rate remains constant, we can anticipate that approximately 22.8 ac (9.23 ha) will be protected over the 20 year life of this project. However, this is an underestimate because marsh soils are likely to erode much faster than the spoil bank.

The estimated area of wetland protected from direct erosion is surely underestimated because wetland soils in the reference area are not yet exposed to hydraulic energy of the boat wakes in the GIWW. Once the spoil bank in the reference area is fully eroded, then erosion rates determined on wetland soils can be used to more accurately estimate the wetland area protected by the project. If the project

had not been constructed, it is possible that wetland soils in the project area would be exposed to the GIWW because the spoil bank in this area was already greatly eroded. The wetland area protected by avoiding a "blowout" cannot be quantified because there are no data available to document either the probability of a blowout or the marsh loss resulting from a "blowout."

In addition to protecting acres, this project is reclaiming approximately 1.40 ac/yr (0.57 m/yr). However, this rate is constrained by the limits of the rock dike. The area remaining available for wetland creation (the area between the rock dike and the existing shoreline) was not quantified.

In some areas vegetation is bordering the rock dike. However, in the areas where the rock dike is approximately 200 ft (60.96 m) away from the shoreline, progradation of the shoreline will require more time because the amount of sediment needed to fill this area is great. There are signs that sediment is building up directly behind the rock dike at all stations as observed by CRD personnel and illustrated by cross sections S-1A through S-14A. During the summer months, *Eichhornia crassipes* (Mart.) Solms (water hyacinth) fill these large open water areas which further reduces the amount of wave action reaching the shoreline.

The project has resulted in marsh creation as well as protection of fragile interior marsh which serves as valuable waterfowl habitat. The ancillary data collected by the Cameron Prairie NWR personnel reflect the importance of this area to wintering waterfowl. Surveys were conducted in November during years 1993 through 1996 showing a variety of species present and an overall increase in waterfowl usage. Mottled duck (*Anus fulvigula*), Mallard (*Anus platyrhynchos*), Gadwall (*Anas strepera*), Pintail (*Anas acuta*), Green-winged Teal (*Anas crecca*), Blue-winged Teal (*Anas discors*), American Wigeon (*Anas americana*), Northern Shoveler (*Anas clypeata*), Wood duck (*Aix sponsa*), Ring-necked (*Aythya collaris*), and Fulvous Whislting (*Dendrocygna bicolor*) ducks were observed in the area. White-fronted (*Anser albifrons*) and Snow geese (*Chen caerulescens*) along with American Coot (*Filica americana*) use this area also. In November 1993, prior to construction 19,488 total waterfowl were in the area. In November 1994, 1995, and 1996 an average of 28,710 total waterfowl were using the area. As important as the summer breeding grounds are to waterfowl in the north, the wintering grounds are equally as important.

CONCLUSION

The results presented in this report indicate that the Cameron Prairie Refuge (ME-09) Protection project has protected 13,200 ft (4,023 m) of shoreline along with 247 ac (100 ha) of marsh north of the rock dike. This protection is expected to accrue throughout the life of the project for a net protection of at least 22.8 ac (9.12 ha). The actual wetland area protected is much greater because this estimate assumes that wetland soils erode at the same rate as that measured on a spoil bank. In addition to protecting the existing shoreline, the project reversed erosion and created 3.03 ac (1.23 ha) of vegetated wetland to date of an average rate of 1.40 ac/yr (0.57 ha/yr). This wetland creation is expected to continue only until the area between the existing shoreline and the rock dike is filled by vegetated wetland. These results indicate that low sediment availability does not prohibit wetland creation behind rock dikes on navigation channels.

To date, the Cameron Prairie Refuge (ME-09) Protection project has had limited success. It is expected that this project area will continue to accrete new wetland area between the spoil bank and rock dike, which will further safeguard the adjacent fragile wetland area from encroachment of the GIWW. Future photography will have to be conducted during the same month and water level condition as the preconstruction flight, and more detailed ground-truthing is necessary, to delineate small scale changes in the project and reference areas.

REFERENCES

Adams, R. D., P. J. Banas, R. H. Baumann, J. H. Blackmon, and W. G. McIntire 1978. Shoreline erosion in coastal Louisiana: inventory and assessment. Baton Rouge: Louisiana Department of Transportation and Development, Coastal Resources Program. 139 pp.

Cameron Prairie National Wildlife Refuge 1991. Project information fact sheet. Gibbstown, Louisiana: U.S. Fish and Wildlife Service, Cameron Prairie National Wildlife Refuge. 7 pp.

Good, B., J. Buchtel, D. Meffert, J. Radford, K. Rhinehart, and R. Wilson, eds. 1995. Louisiana's major coastal navigation channels. Unpublished report. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 57 pp.

Louisiana Coastal Wetlands Conservation and Restoration Task Force (LCWCRTF) 1993. Coastal Wetlands Planning, Protection and Restoration Act, Louisiana Coastal Wetlands Restoration Plan: Main Report, Environmental Impact Statement and Appendices. Baton Rouge, La: U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Natural Resource Conservation Service, and Louisiana Department of Natural Resources.

Louisiana Department of Natural Resources 1993. Annual Monitoring Report: Intracoastal Waterway Bank Stabilization and Cutgrass Planting Project at Blind Lake. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division, Biological Analysis Section. 18 pp.

Louisiana Department of Natural Resources 1995. Summary of Completed State Funded Coastal Wetlands Conservation and Restoration Projects 1986-1994. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division. 53 pp.

Miller, M. 1994. Cameron Prairie Refuge Protection (ME-09) Monitoring Plan. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

Steele, R. G. D., and J. H. Torrie 1980. Principles and procedures of statistics. A biometrical approach. Second Edition. McGraw-Hill, Inc. New York. 633 pp.

U.S. Fish and Wildlife Service 1991. Cameron Prairie National Wildlife Refuge Erosion Protection and Marsh Management Design Memorandum. Gibbstown, Louisiana: U.S. Fish and Wildlife Service, Cameron Prairie National Wildlife Refuge. 7 pp.

Vincent, K. 1997. Freshwater Bayou Wetlands (ME-04) Phase 1, Progress Report No. 3. Open-file monitoring series ME-04-MSPR-0197-3, for the period January 31, 1995 to January 6, 1997, Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

APPENDIX A

Elevational Data

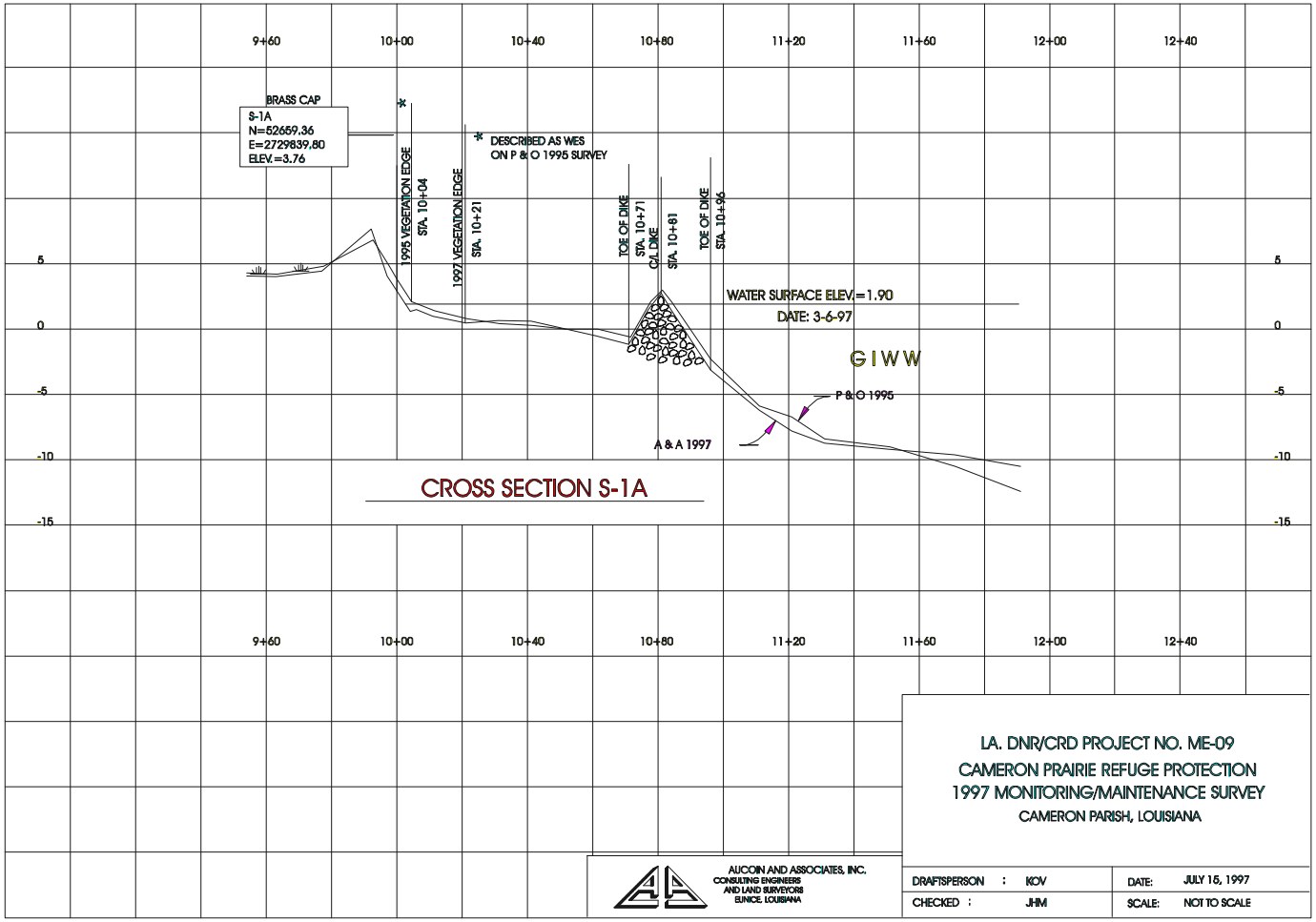

Figure 4. Cameron Prairie Refuge Protection (ME-09) cross section S-1A in the project area showing the survey lines, vegetation edge, and channel profile.

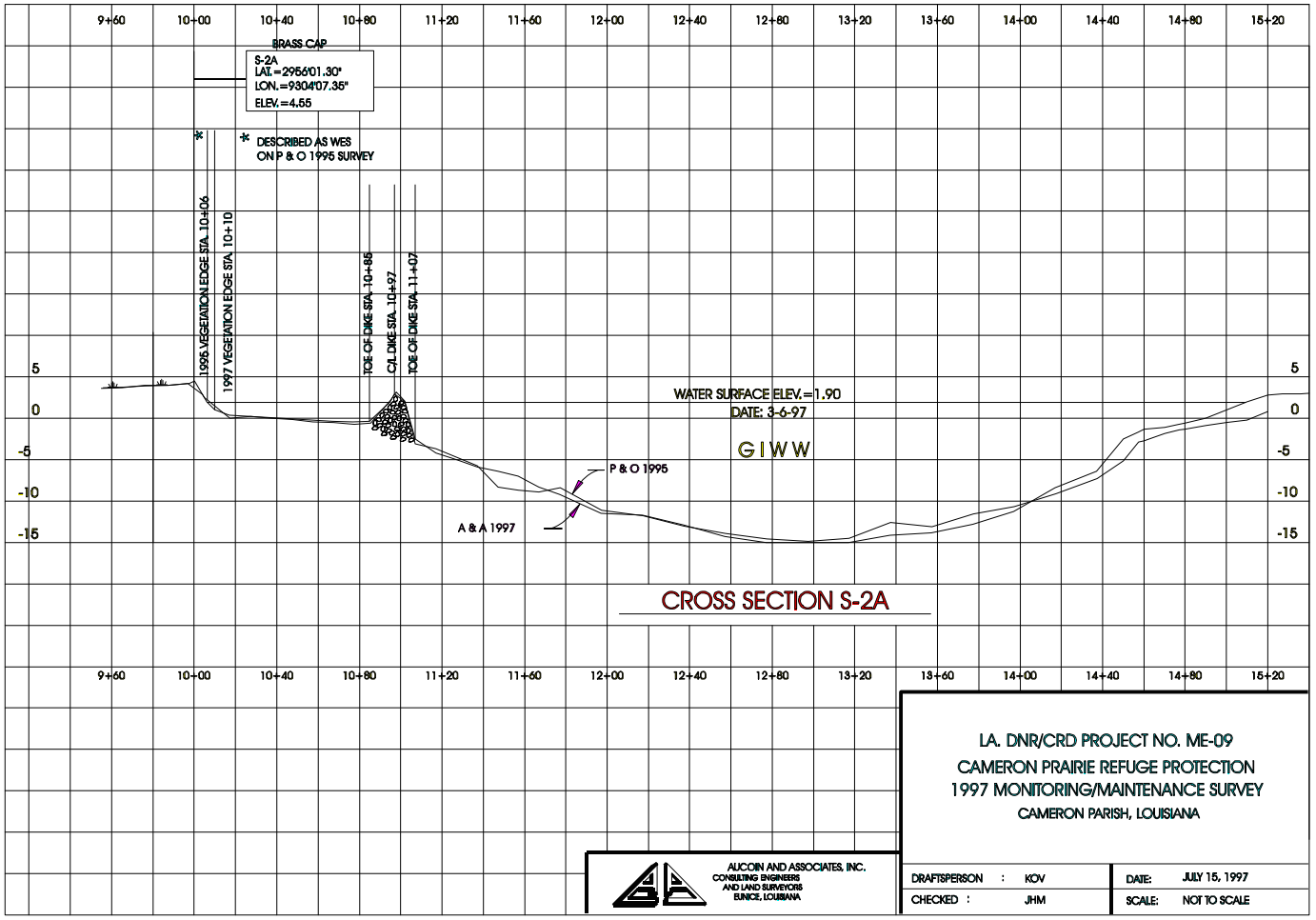

Figure 5. Cameron Prairie Refuge Protection (ME-09) cross section S-2A in the project area showing the survey lines, vegetation edge, and channel profile.

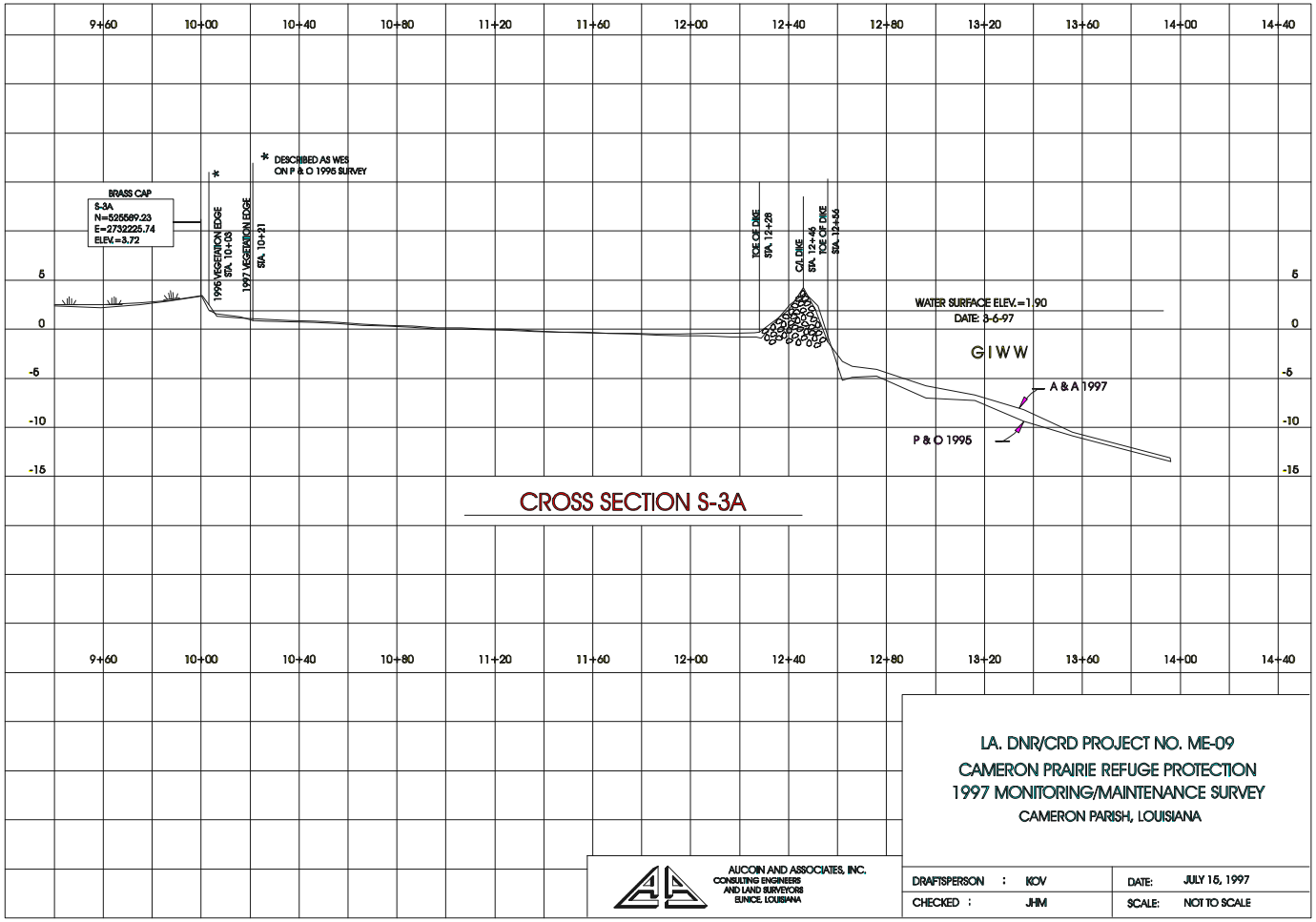

Figure 6. Cameron Prairie Refuge Protection (ME-09) cross section S-3A in the project area showing the survey lines, vegetation edge, and channel profile.

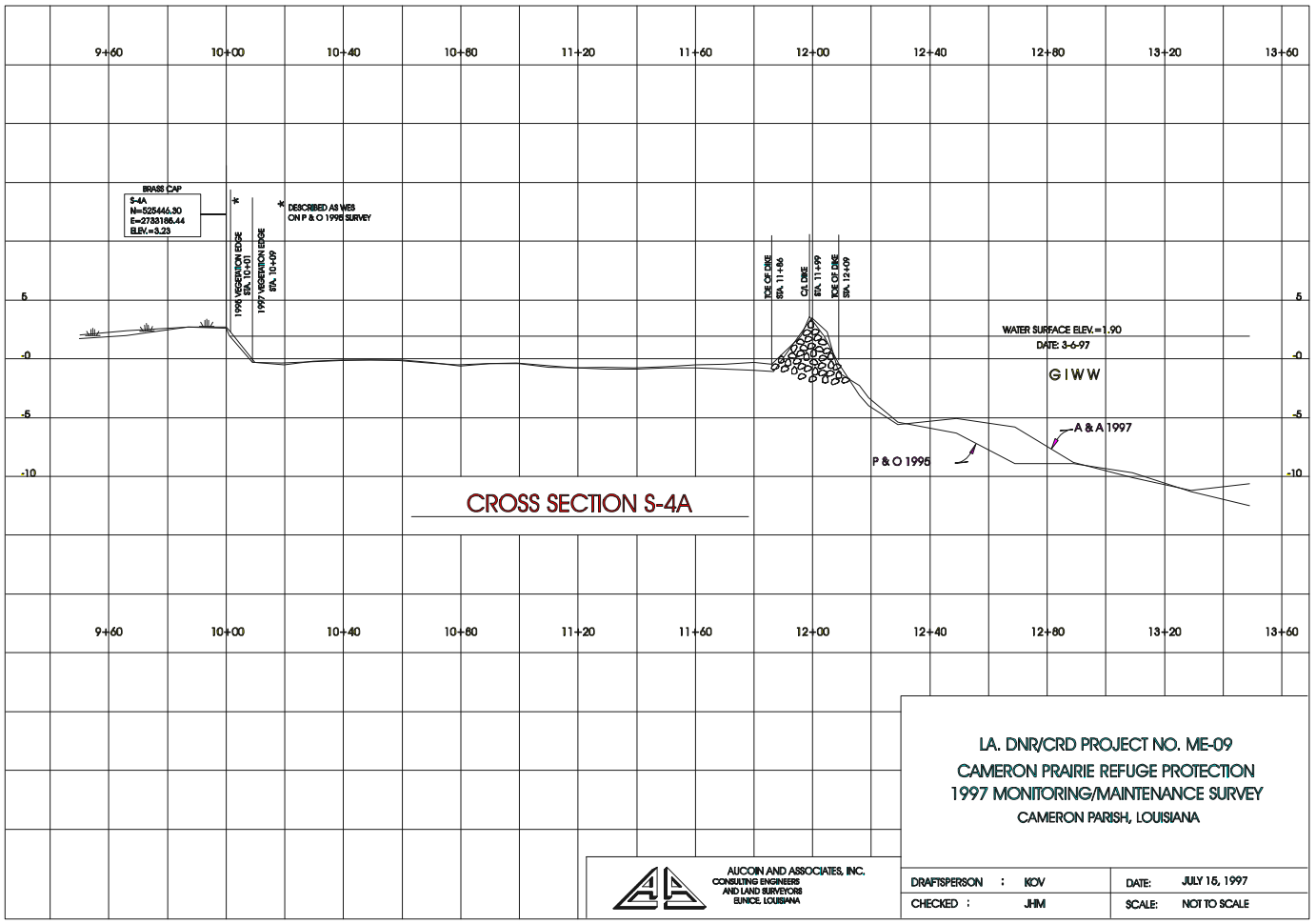

Figure 7. Cameron Prairie Refuge Protection (ME-09) cross section S-4A in the project area showing the survey lines, vegetation edge, and channel profile.

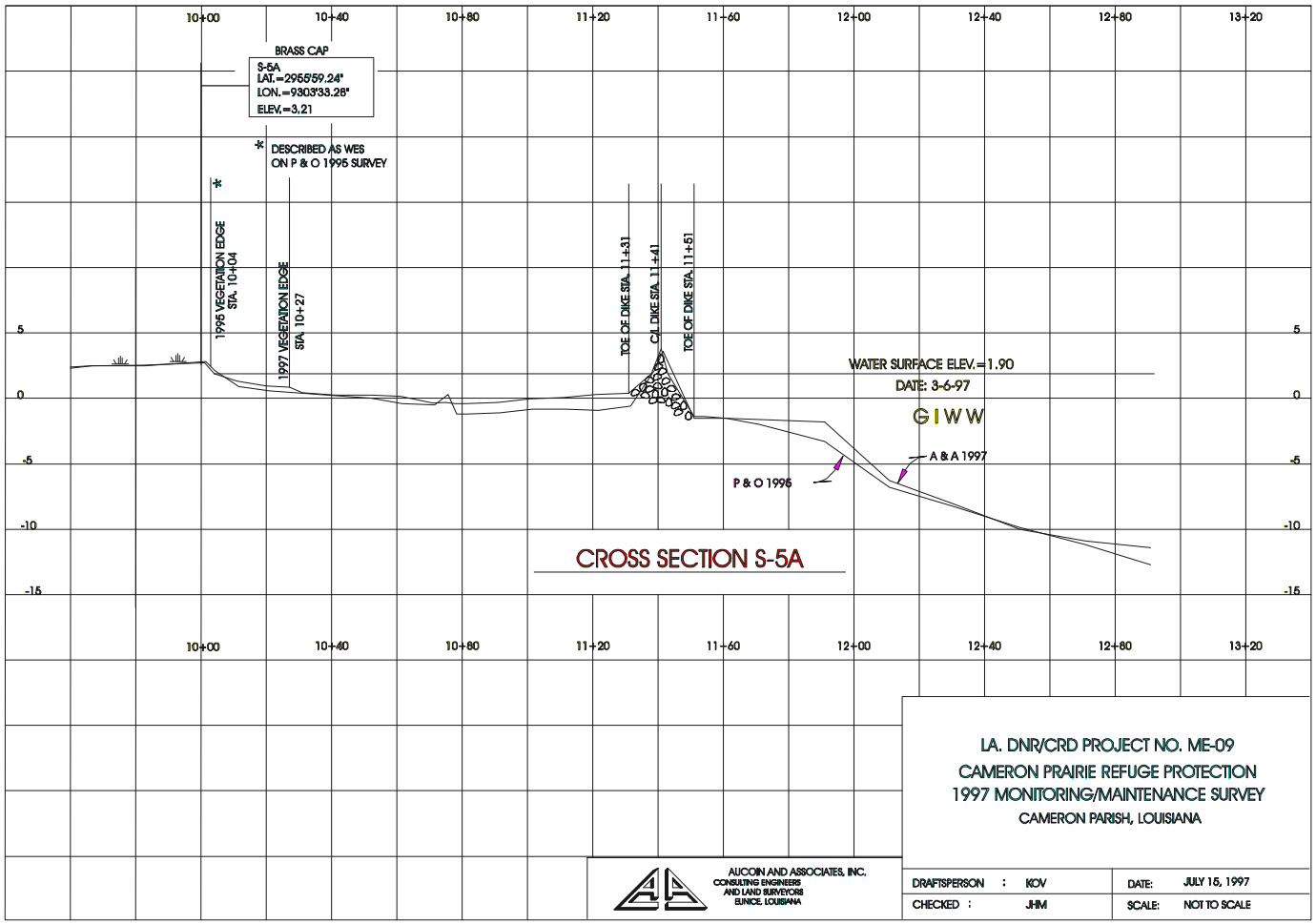

Figure 8. Cameron Prairie Refuge Protection (ME-09) cross section S-5A in the project area showing the survey lines, vegetation edge, and channel profile.

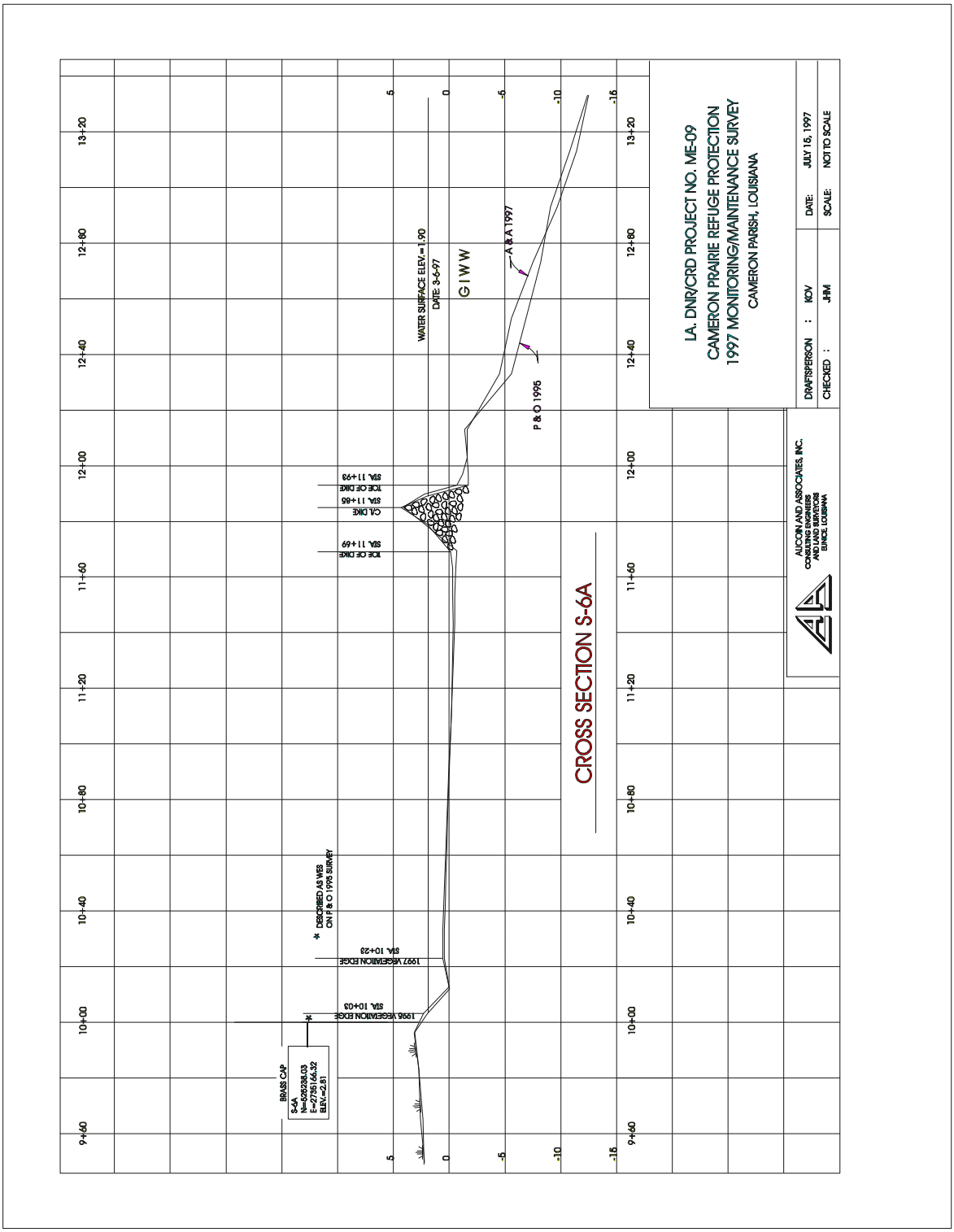

Figure 9. Cameron Prairie Refuge Protection (ME-09) cross section S-6A in the project area showing the survey lines, vegetation edge, and channel profile.

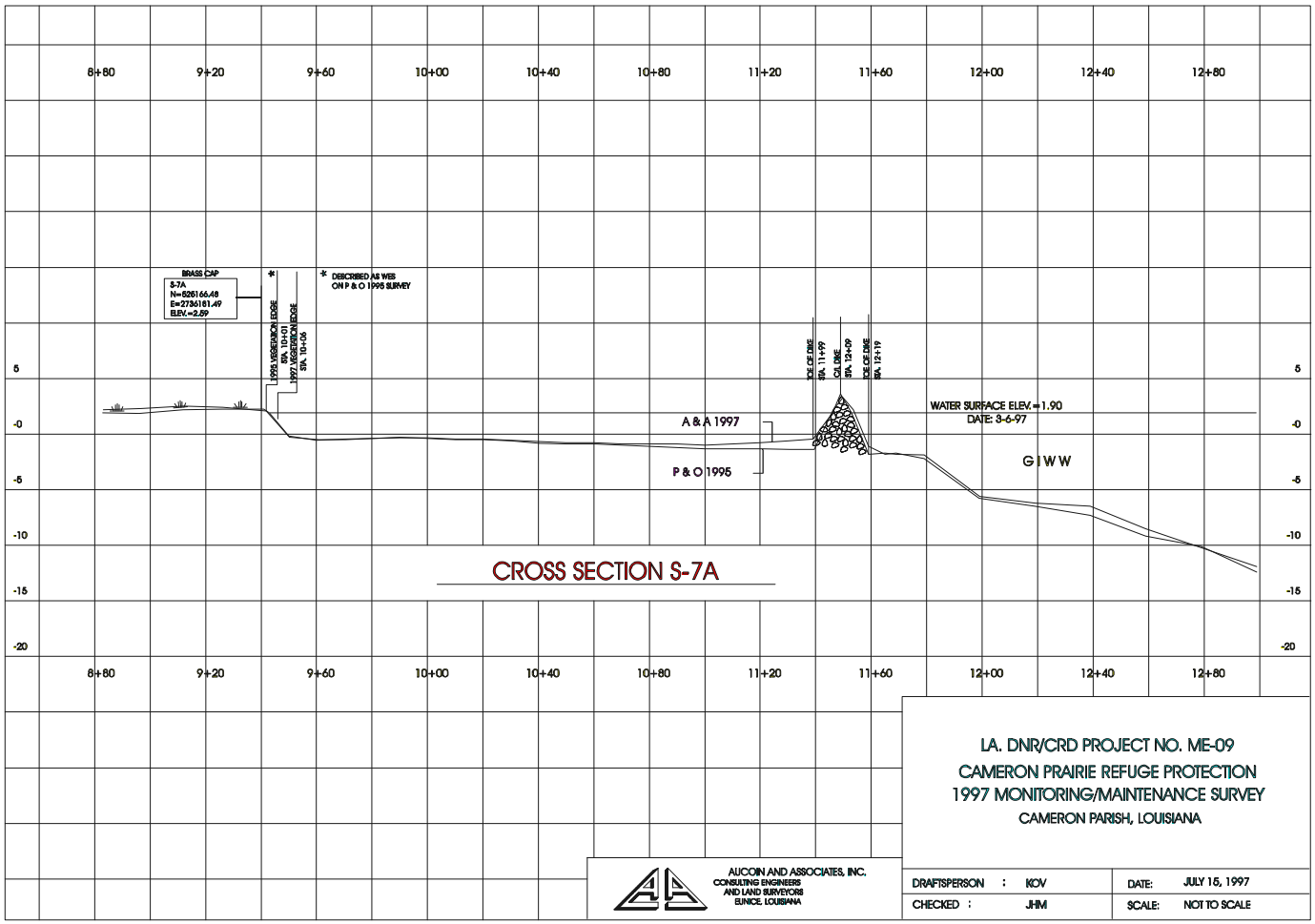

Figure 10. Cameron Prairie Refuge Protection (ME-09) cross section S-7A in the project area showing the survey lines, vegetation edge, and channel profile.

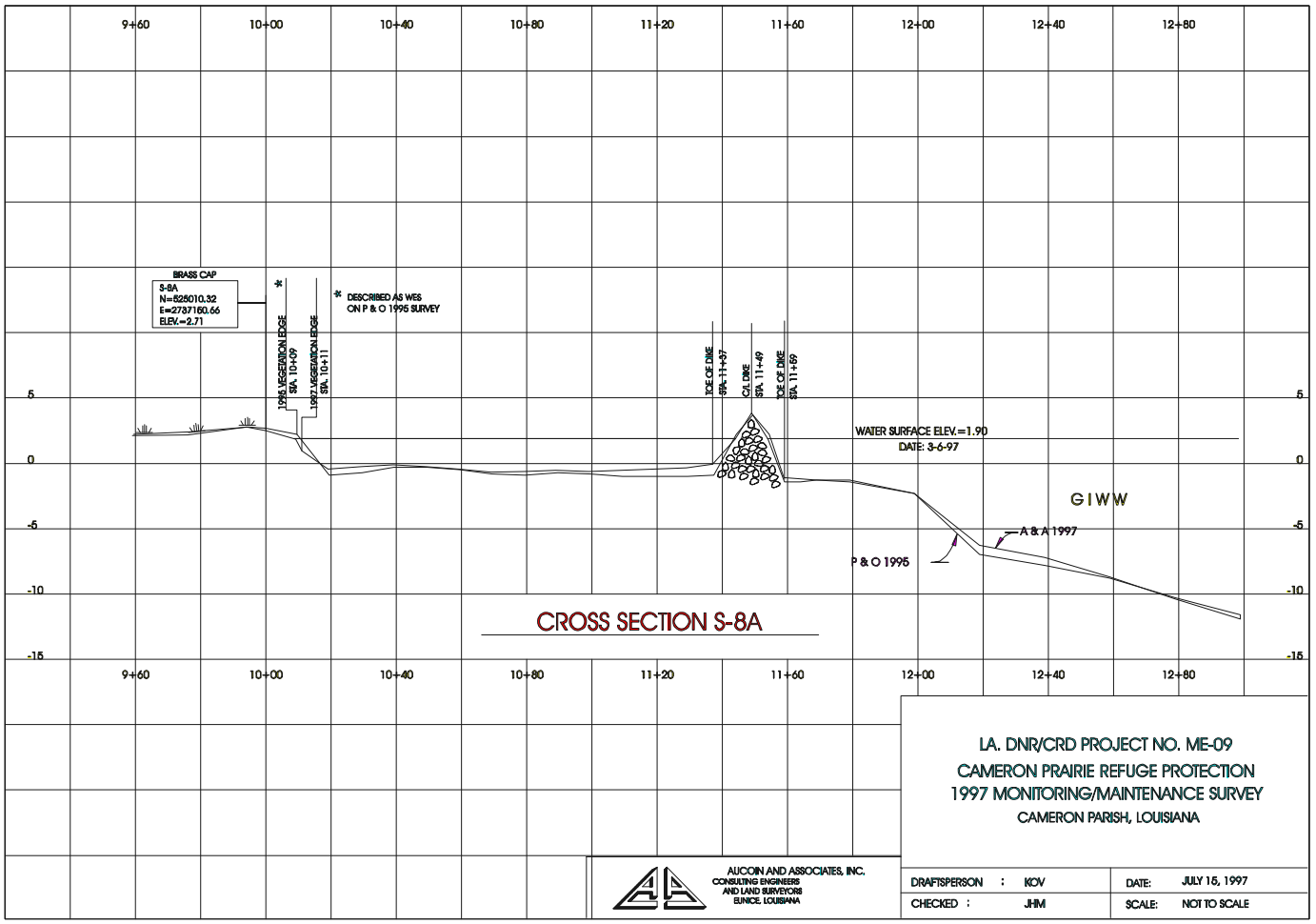

Figure 11. Cameron Prairie Refuge Protection (ME-09) cross section S-8A in the project area showing the survey lines, vegetation edge, and channel profile.

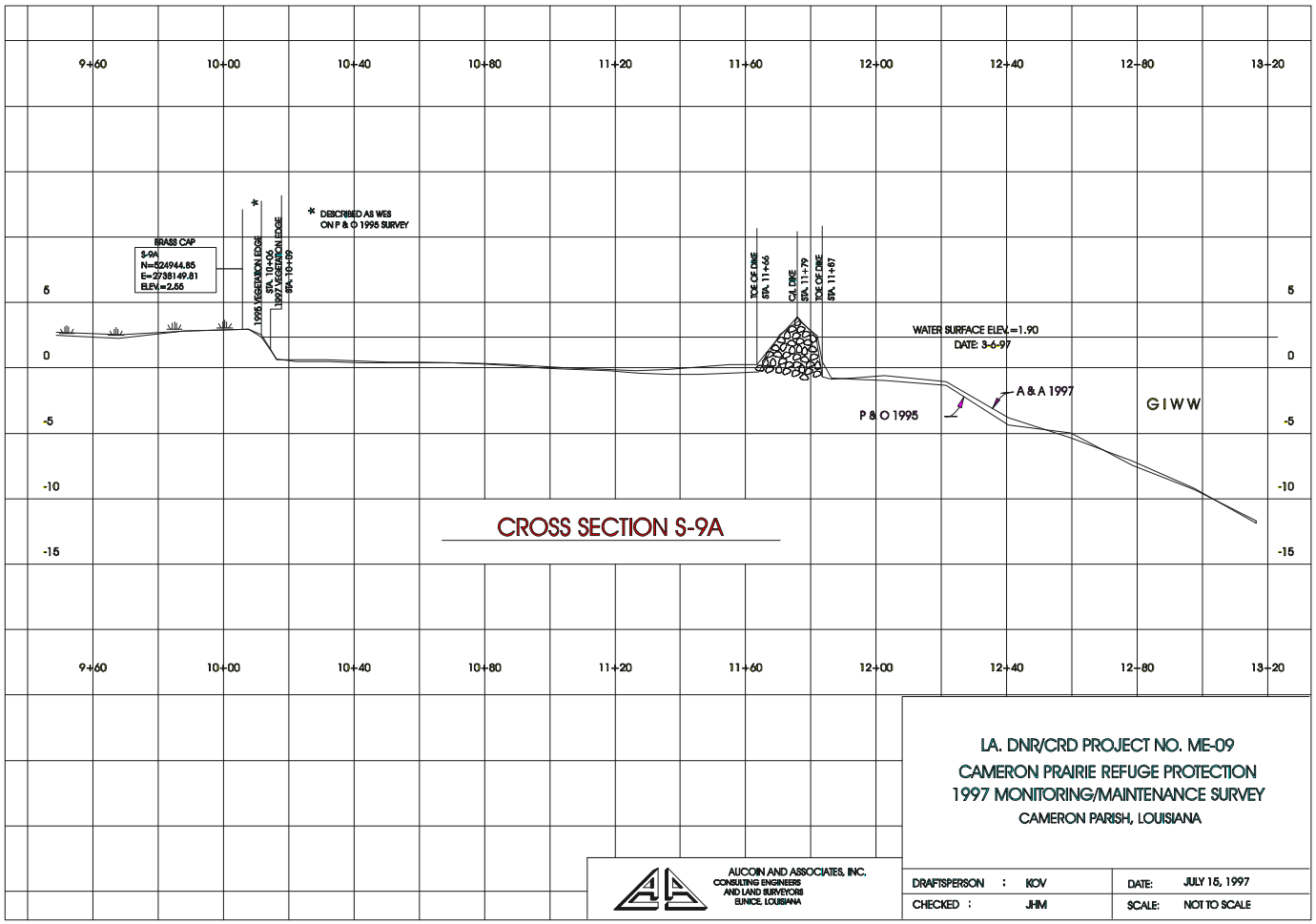

Figure 12. Cameron Prairie Refuge Protection (ME-09) cross section S-9A in the project area showing the survey lines, vegetation edge, and channel profile.

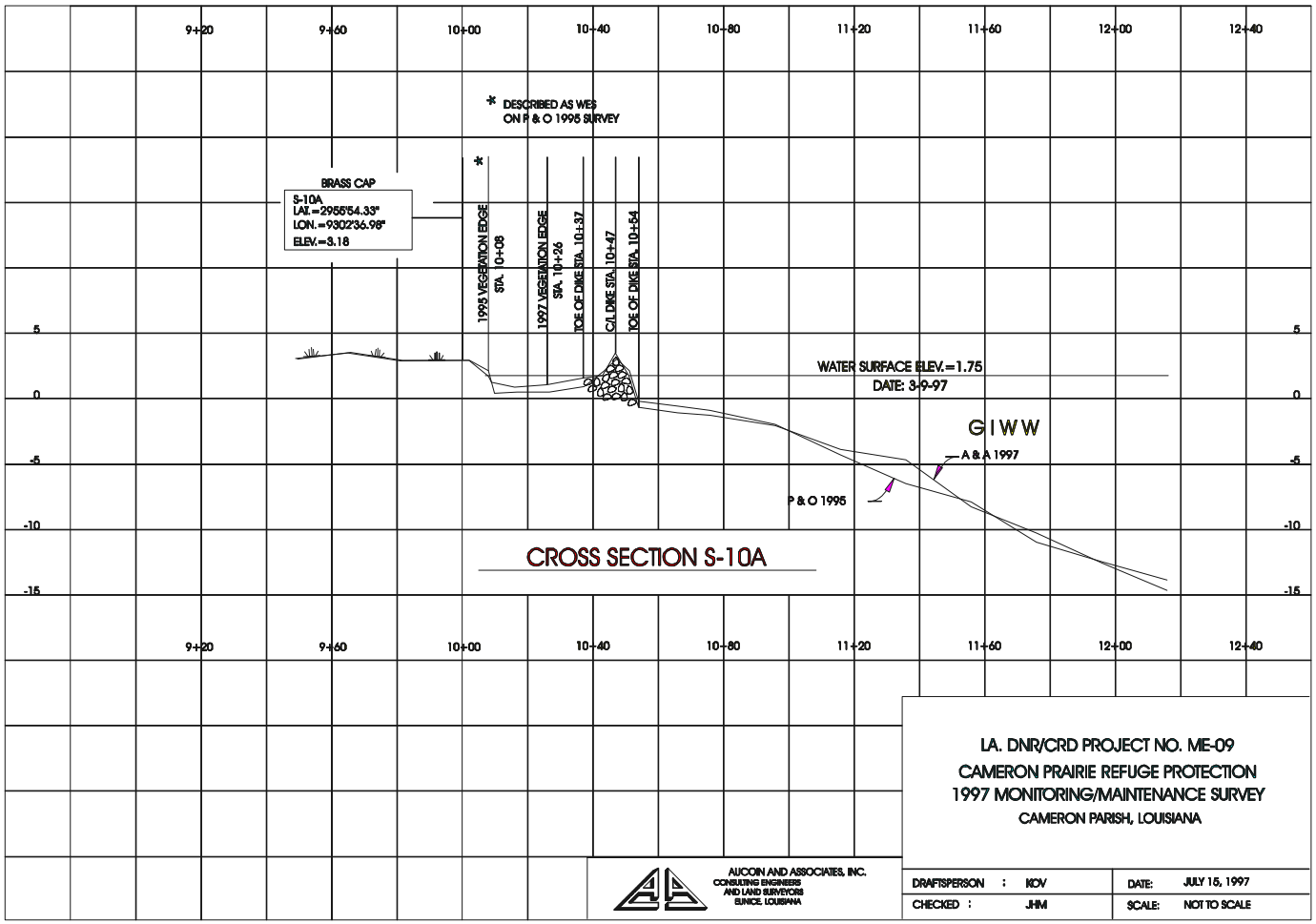

Figure 13. Cameron Prairie Refuge Protection (ME-09) cross section S-10A in the project area showing the survey lines, vegetation edge, and channel profile.

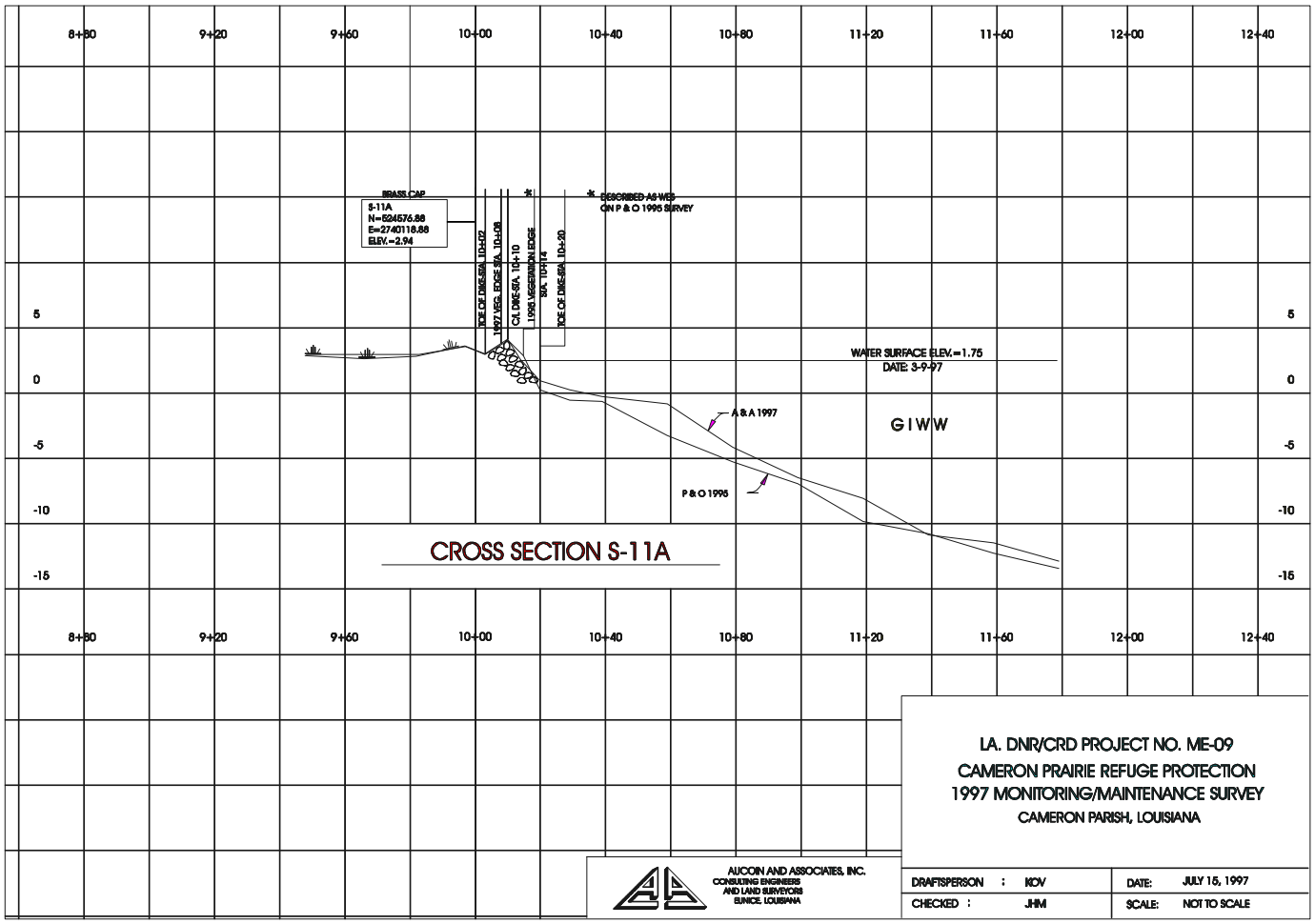

Figure 14. Cameron Prairie Refuge Protection (ME-09) cross section S-11A in the project area showing the survey lines, vegetation edge, and channel profile.

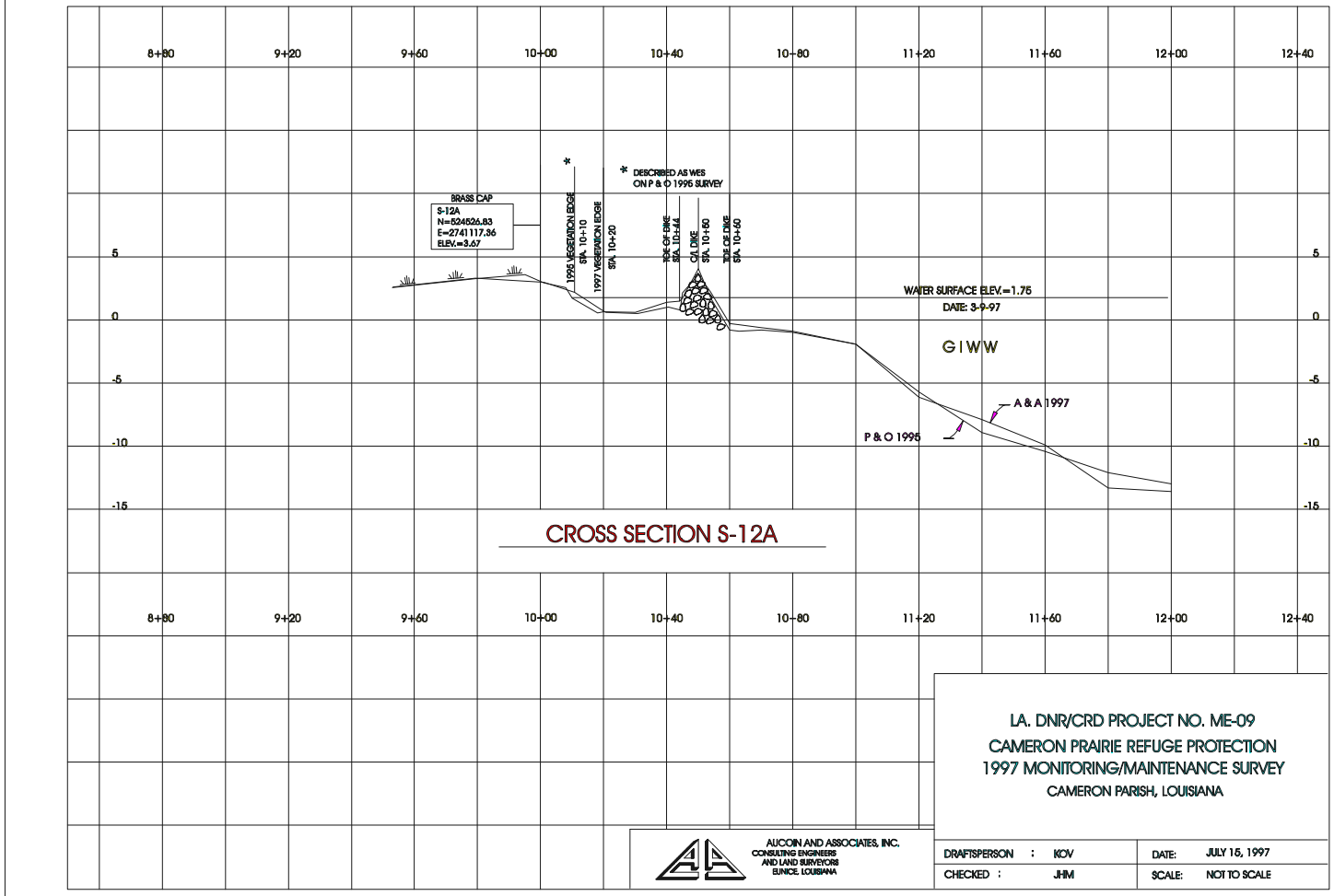

Figure 15. Cameron Prairie Refuge Protection (ME-09) cross section S-12A in the project area showing the survey lines, vegetation edge, and channel profile.

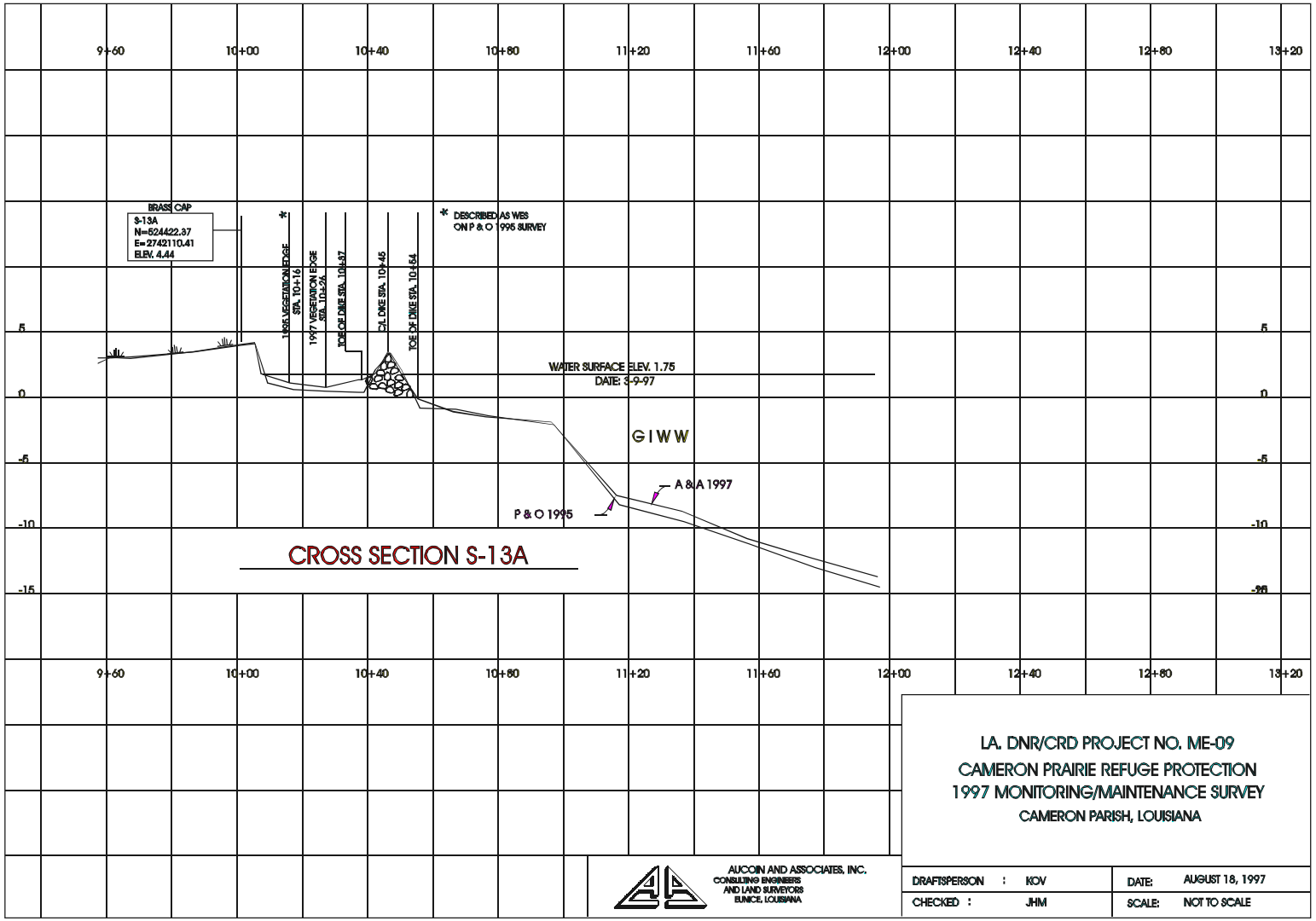

Figure 16. Cameron Prairie Refuge Protection (ME-09) cross section S-13A in the project area showing the survey lines, vegetation edge, and channel profile.

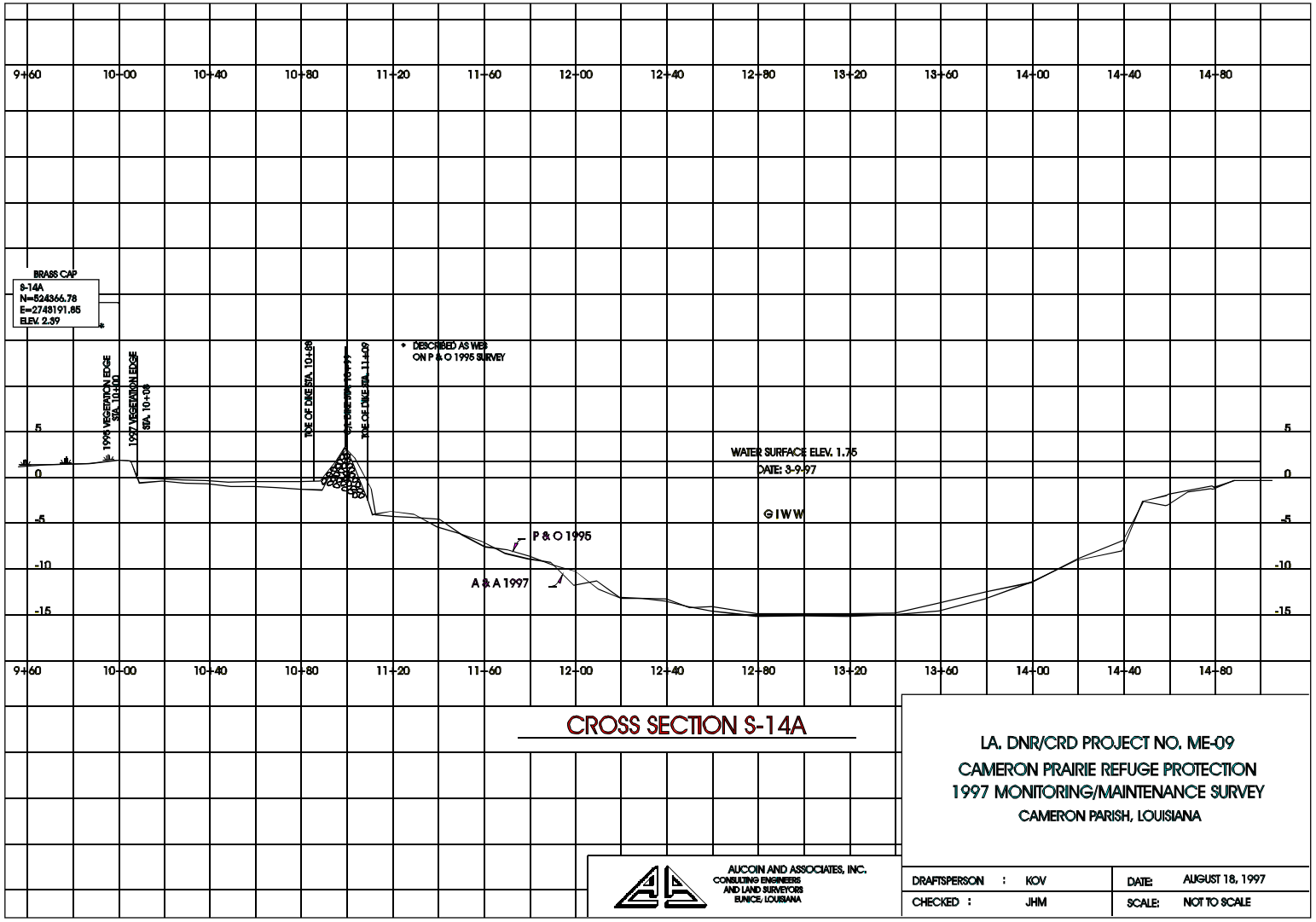

Figure 17. Cameron Prairie Refuge Protection (ME-09) cross section S-14A in the project area showing the survey lines, vegetation edge, and channel profile.

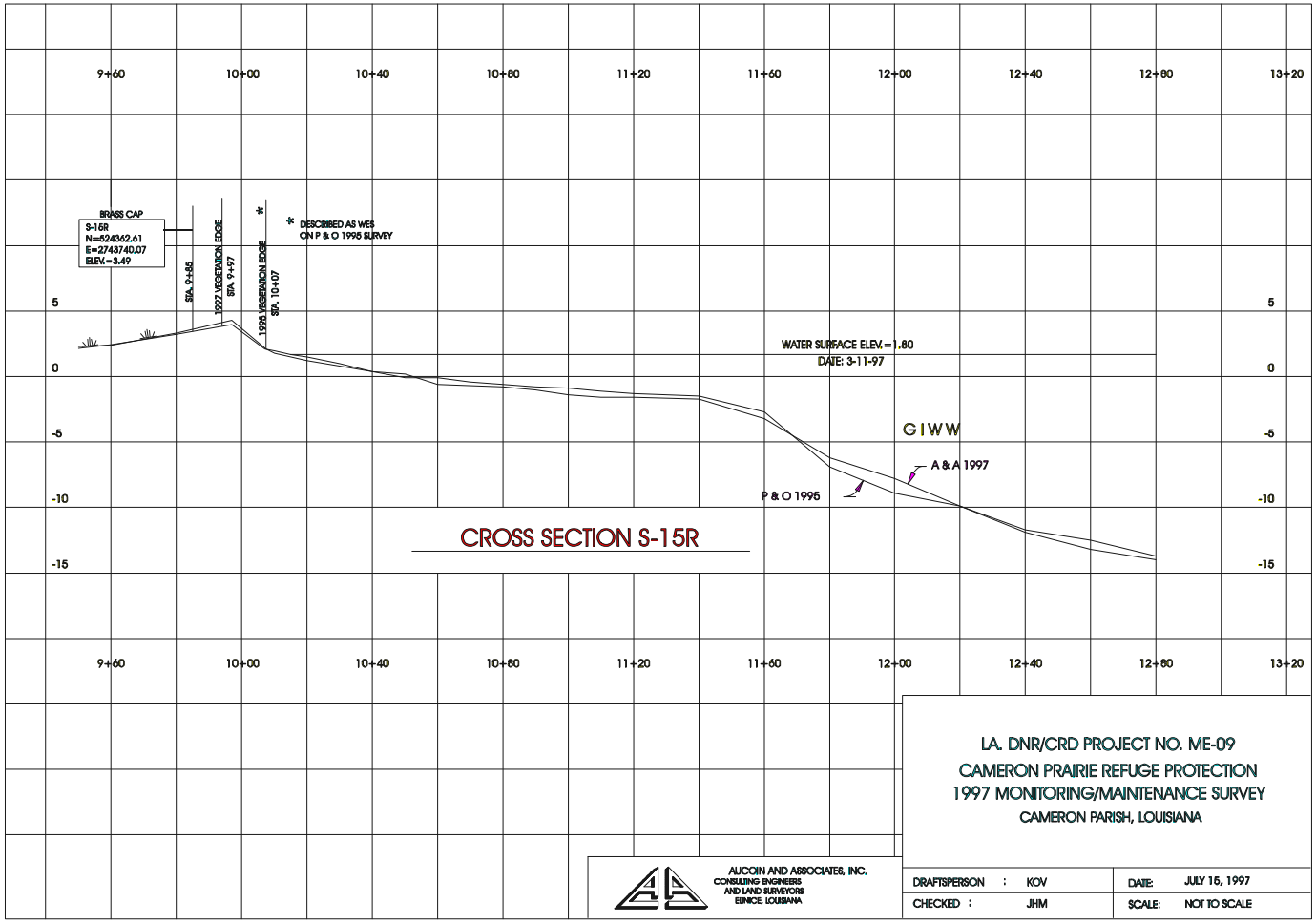

Figure 18. Cameron Prairie Refuge Protection (ME-09) cross section S-15R in the project area showing the survey lines, vegetation edge, and channel profile.

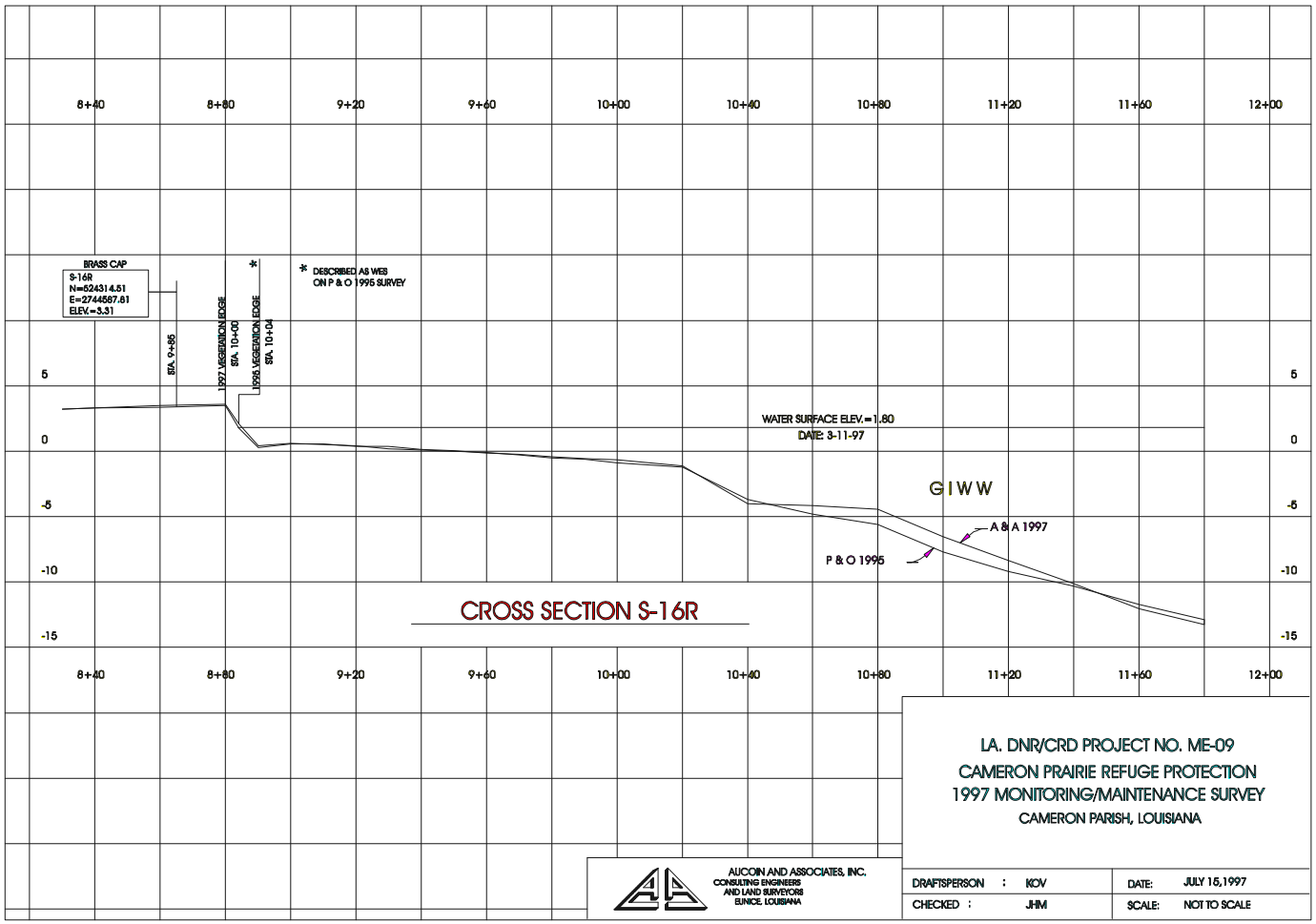

Figure 19. Cameron Prairie Refuge Protection (ME-09) cross section S-16R in the project area showing the survey lines, vegetation edge, and channel profile.

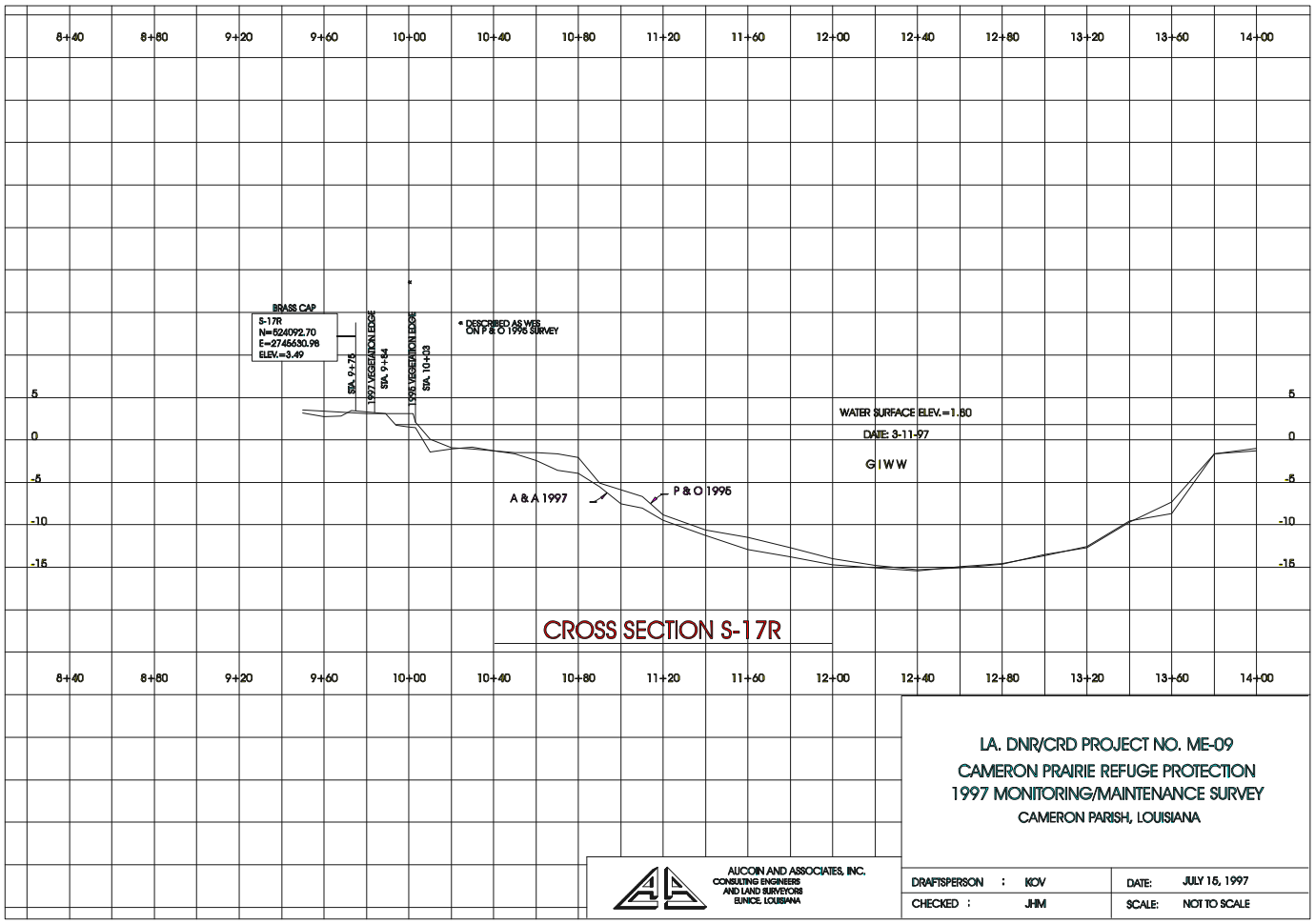

Figure 20. Cameron Prairie Refuge Protection (ME-09) cross section S-17R in the project area showing the survey lines, vegetation edge, and channel profile.

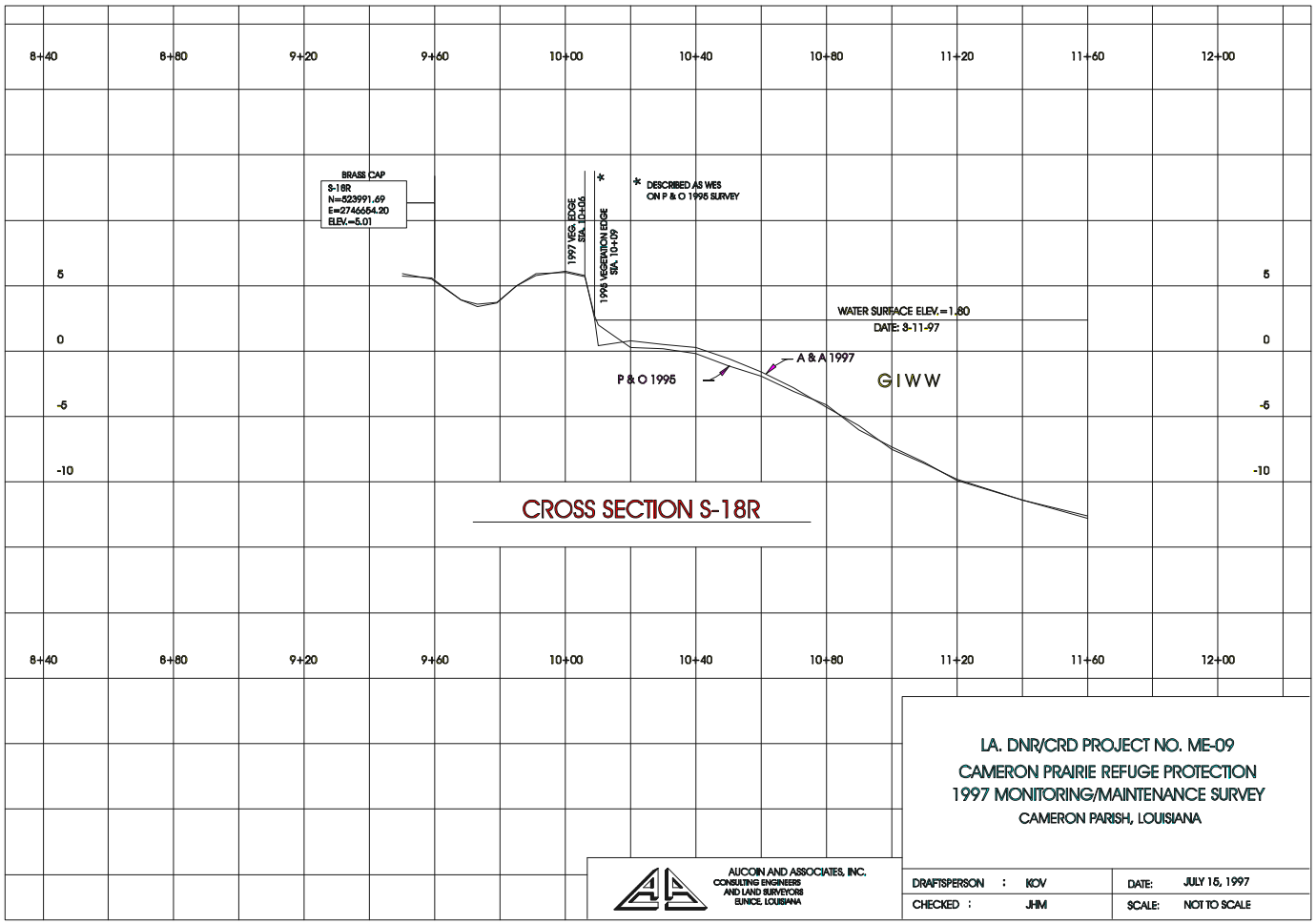

Figure 21. Cameron Prairie Refuge Protection (ME-09) cross section S-18R in the project area showing the survey lines, vegetation edge, and channel profile.

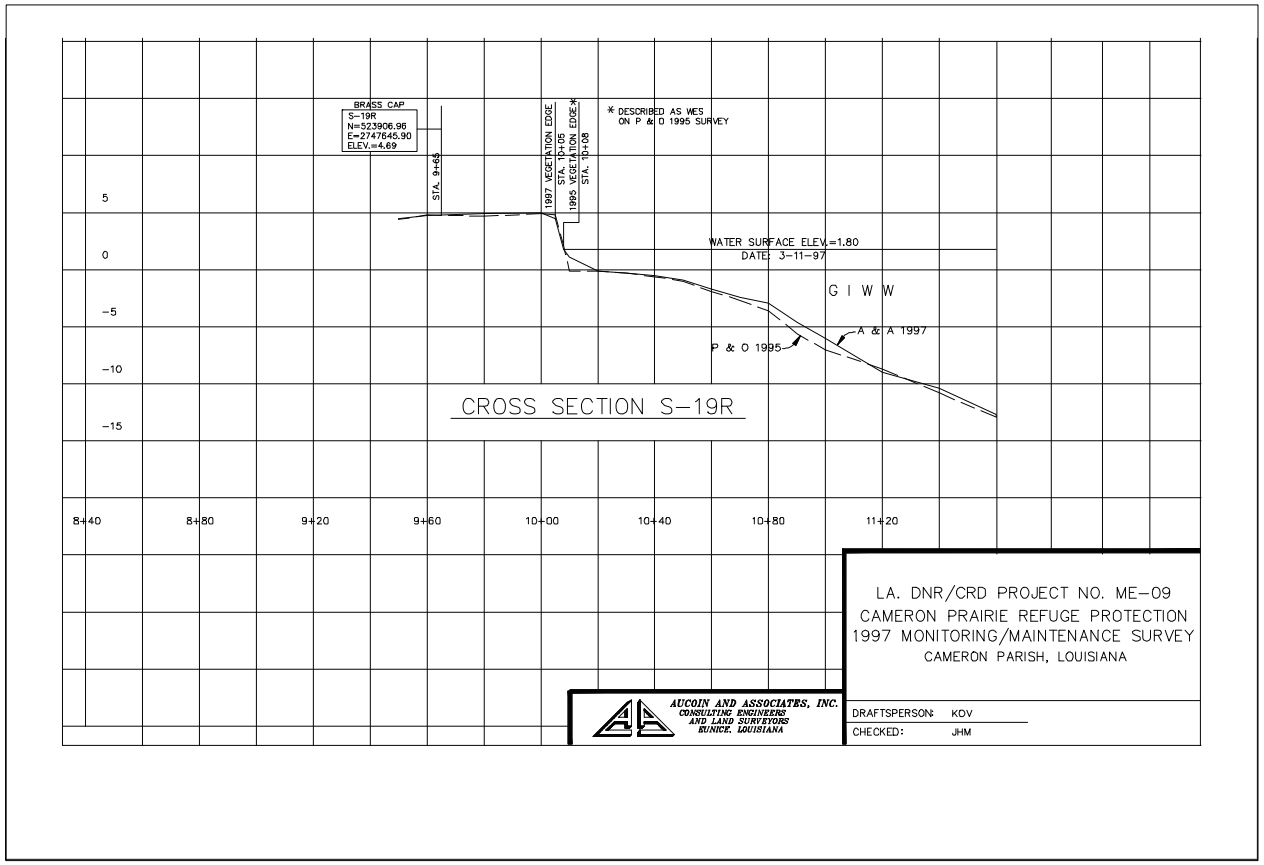

Figure 22. Cameron Prairie Refuge Protection (ME-09) cross section S-19R in the project area showing the survey lines, vegetation edge, and channel profile.

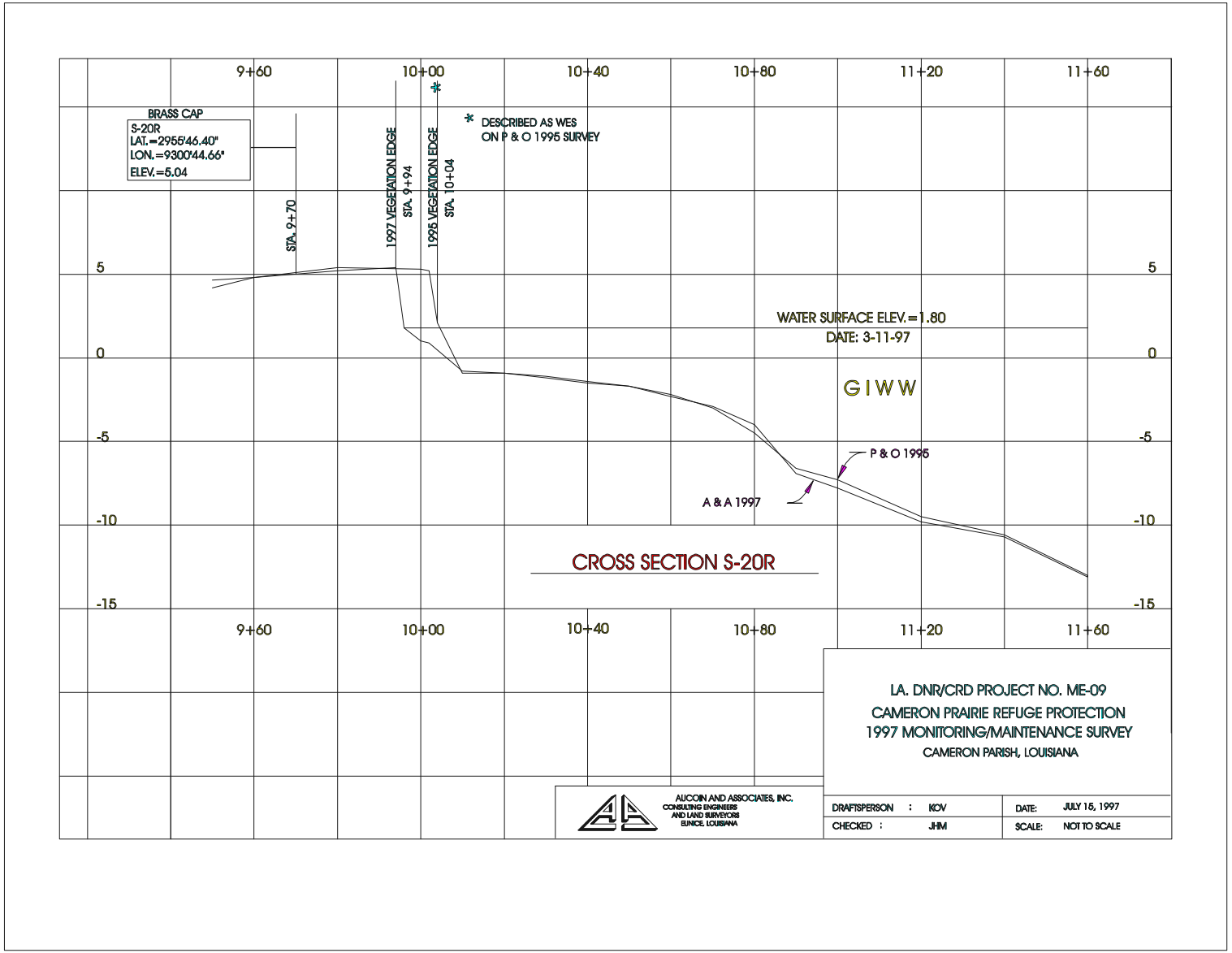

Figure 23. Cameron Prairie Refuge Protection (ME-09) cross section S-20R in the project area showing the survey lines, vegetation edge, and channel profile.