The Work Plan for the first year of the project (ending March 7, 2001) as stated in the subcontract is as follows:

*Needs Assessment:* Survey Highway Officials in the Southeastern United States to determine data requirements for environmental assessment studies. Attempt to determine quality, scale and resolution of data that might be supplied from remote sensing sources.

Conduct a search of southeastern highway corridors with sufficient maturity such that they might be suitable for further study of environmental impacts of highway construction. Focus on hydrologic and geomorphological impacts such as changes in normal water levels, frequency of extreme events (flooding) and erosion potential.

*Perform initial evaluation of a site in the Atlanta metropolitan area.* Correlate changes in environmental indicators (water levels, flooding, erosion, etc.) with land use changes coincident with highway construction. Use existing land cover data from the ongoing ATLANTA project, with some supplemental data (probably TM) to be acquired for this project. Coordinate with other investigators on the land cover change portion of the study.

In order to facilitate the work plan outlined above, the following objectives were articulated for the first milestone period (September 8, 2000):

1. Select suitable study sites
2. Collect Data and Begin GIS Database

Following up on this, the milestones articulated to be met at the end of the first project year (March 6, 2001) were the following:

1. Initial evaluation of environmental impacts
2. Completion of database
3. Initial evaluation of the study sites

The milestones listed above have been fully met in the first two bi-annual project periods, and in fact, considerable additional progress has been made toward fulfillment of the overall work plan. Progress made during the first year of the project include:

1. **Needs Assessment:** Meetings have been held with individuals involved in Environmental Impact Assessment for highway construction in order to discuss methodology and data requirements. At this time discussions have been held with
Mr. Tim Barnett (City of Huntsville Transportation Department) and Ms. Jacquelyn Byrne (Johnson & Associates). In addition, three completed Environmental Impact Assessment reports have been obtained and studied to help determine methodologies and data sources and quality requirements.

2. **Selection of Study Sites**: An overall assessment region has been delineated for the southeastern United States and a number of individual study sites have been selected within this region. The study region essentially runs from Atlanta, GA west along the I-20 corridor over to Birmingham, AL, and then north along the I-65 corridor to Decatur, AL, thence east along the US 72 corridor to an area just south of Chattanooga, TN and then south along the I-75 corridor back to Atlanta. At this time, eight (8) individual study sites have been selected within this region for hydrologic analysis. These sites represent drainage basins which may have been altered as a result of major highway construction. The test sites include six mid-size (200-400 mi²) basins to provide general coverage of the entire region and two additional intensive study sites in the Metropolitan Atlanta area (Sope Creek and Big Creek). Climatological and hydrologic data have been collected for all sites and land use classification is underway by the cooperating group at USRA. Considerable additional data (demographics, water quality, hydrology, climatology, drainage structures, etc) have been collected for the two smaller, intensive study sites.

3. **Preliminary Analysis**: Preliminary statistical testing has been conducted on streamflow data for all sites, with additional testing completed on the data at the intensive study sites. Relevant hydrologic variables under consideration include mean annual discharge, variability of annual discharge, and frequency and duration of discharges above given thresholds. These hydrologic variables have been identified as playing a significant role in ecosystem viability and sustainability. Significant trends in annual discharge and frequency of recurrence have been identified at a number of the sites, including both of the intensive study sites in the Atlanta metropolitan area. Results for the Sope Creek watershed were shown in the last progress report, so for the present report the results obtained for the Big Creek watershed will be demonstrated. The location of the basin, together with some of the demographic data (spatial location of population and business activity) are shown in Figures 1 and 2. Data such as that shown on the figures are available from census records starting in 1970 for the case of population figures and since 1984 in the case of business activity. These data are shown graphically in Figures 3 and 4, with estimated census data used to interpolate between the actual 10 year census results. It is felt that business and population indices will be well related to construction of transportation facilities over these time periods. Scanned transportation maps of each of the counties in the study area have been obtained and algorithms are under development at GHCC to derive relevant information (i.e., miles of highway, type of highway, etc.) from these maps. Once obtained, the transportation data can be correlated with the demographic data shown in Figures 1-4.
Changes in watershed demographics are also well correlated to observed trends in hydrologic variables. Figure 5 shows the average annual streamflow of the Big Creek watershed for the period 1960-98. The annual values have been filtered by applying a 3 year moving average to make comparison with the 3 year census estimates possible. The time intervals between recurrences of streamflow events above 2000 cfs are depicted graphically in Figure 6. The figure shows the log of the time interval on the y-axis plotted against cumulative time in days on the x-axis beginning in 1960.

Comparisons of Figures 3-6 dramatically illustrate the relationships between business activity, population, mean streamflow (and by extension, water levels) and frequency of inundation above specified levels. Figures 3 and 4 clearly demonstrate the sharp increase in economic activity and population that began around 1985 and are continuing to the present at an accelerated pace. Then, Figures 5 and 6 illustrate that the hydrology of the watershed reacted in a very positive fashion to these increases in demographic activity. Mean annual streamflow doubled over this roughly 15 year period, while frequency of inundation decreased by two orders of magnitude. Statistical testing has revealed that the trends evident in Figures 5 and 6 are significant. The mean streamflow for the decade of the 1990’s was found to be significantly different from that of the 1970’s (p = .029) and the 1980’s (p = 0.006). This increasing trend of mean streamflow could not be attributed to increasing precipitation of this decade since no significant trend in precipitation was evident. Likewise, the recent trend in increasing frequencies of inundation that is evident in Figure 6 was also found to be significant at the 10% level.

Correlation analyses revealed significant relationships between mean annual streamflow and both population (r = 0.736, p = 0.002) and number of businesses (r = 0.741, p = 0.002). Lastly, regression analyses revealed that population and business numbers can be used as explanatory variables in the trend in mean annual flow as shown in Figure 5 ($R^2 = 0.542$, p value of regression = 0.002 for population and $R^2 = 0.55$, p value of regression $= 0.002$ for business numbers).

The hydrologic analyses of both intensive study sites (Sope and Big Creeks) have been completed at this time. As the needs assessment continues it is possible that other relevant variables will be identified. In addition, when the remotely sensed data are processed by the USRA team, further analyses will be conducted to relate hydrologic impacts to specific land use/cover variables associated with transportation (e.g., miles of road).

Preliminary hydrologic analyses have also been completed on the six general study sites. These are Tallapoosa River nr. Heflin, AL; Big Canoe Creek @Ashville, AL; Sweetwater Creek nr. Austell, GA; Paint Rock River nr. Woodville, AL; Mulberry Fork nr. Garden City, AL; and Chattooga River @Summerville, GA. Of these, only two (Tallapoosa and Paint Rock) have shown significant trends in streamflow variables over time. When the USRA group has completed the land use classification and the economic and demographic databases of the study region,
additional analyses will be performed to relate observed hydrologic trends to these data. It is also possible that additional study sites will be selected for analysis at this time.

4. Project Coordination: Three project meetings of the entire NCRST-E team have been held in Starkville, MS during the first year of the project. This investigator participated in two of these meetings. In addition, a number of project meetings have been held locally to coordinate the activities of the GHCC portion of the project.

Conclusions:

Enumerated tasks related to the subject project are being completed in a satisfactory manner. Needs assessment is underway and will continue over the next few months in order to further refine relevant variables and data sources and requirements for environmental assessments. As remotely sensed data become available, the general study area will be re-examined to determine additional study sites that may be impacted by highway development. Additional variables may also be identified as important in environmental assessment. Statistical testing of relevant hydrologic variables will continue and results will be directly correlated to transportation-related variables such as miles of highway within a watershed.

The project will be expanded in the next year to begin analysis of remotely sensed data to determine the accuracy of derived products that might be useful in environmental analysis of transportation projects. The selection of remotely derived products will depend on the results of the needs assessment that will be completed in the summer of 2001. From current discussions with professionals involved in the field, it appears that relevant variables might include wetland and flood plain areas as well as stream sinuosity. The work plan and milestones, along with associated costs, are given below. A detailed budget for Year 2 is also attached.

Year 2 Work Plan – Hydrologic Analyses

1. Continue needs assessment (September 2001): Define relevant physical variables associated with hydrologic impacts that might be detected through remotely sensed data (e.g., flood plain delineation, mean water level, stream width and sinuosity, etc.) Cost: $7166

2. Complete all testing of hydrologic variables for two intensive study sites (September 2001). Correlate observed trends in hydrologic and water quality variables to transportation-related development variables (e.g., land cover/use, miles of highway, type of highway, etc.) Cost: $7167
3. Complete testing of the six general sites (or other selected basins) within the Alabama/Georgia study area to determine if trends in hydrologic and/or water quality variables might be related to demographic and economic data (September 2001). Cost: $7166

4. Use the remotely sensed data base collected in year 1 to correlate any trends observed in #3 above to land cover/use classes that might be related to transportation development in the test basins (March 2002). Cost: $7167

5. Participate in analysis to determine the accuracy of derived physical variables from remotely sensed data compared to traditional (e.g., paper or field) sources. Preliminary report on results of these analyses (March 2002). Cost: $7167

6. Participate in meetings with experts from regulatory agencies (e.g., US Army Corps of Engineers, US Fish & Wildlife, EPA) to determine level of acceptable accuracy in derived physical variables such as flood plain geometry, stream width, sinuosity, wetland delineation, etc. Report on results of findings (March 2002). Cost: $7167
Figure 1. Population Centers of Big Creek Watershed
Figure 2. Business Locations in Big Creek Watershed
Figure 3. Population increase in Big Creek watershed (1965-98)
Figure 4. Established Businesses in Big Creek Watershed (1986-98)
Figure 5. Running Three Year Average flow for Big Creek Watershed (1960-98)
Figure 6. Interarrival Times of Events Above 2000 CFS