State of Iowa

Department of Transportation

Request for Proposals

for

The Development of a Linear Referencing System

RFP# LT99022

December 11, 1998

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Section 1   General Information

1.1   Introduction

The Iowa Department of Transportation (Iowa DOT) is issuing this request for proposals (RFP) for the development and implementation of a linear referencing system (LRS) for all public streets and highways in the State.

1.2   Definition of Terms

See *Appendix A – Glossary* for a listing of definitions of acronyms and technical terms.

1.3   Project Scope

This project, to be called Project 1, consists of two phases and is to be followed by a future project, to be called Project 2, for full-scale implementation of the LRS.

The focus of Project 1-Phase 1 is the development and design of a LRS solution. Project 1-Phase 2 involves testing the proposed solution in a pilot implementation, followed by revising the LRS design based on lessons learned during the pilot. Full-scale implementation of the LRS shall be initiated in Project 2. Development of a plan for full-scale implementation is the final deliverable of Project 1.

Major work areas for the phases of the projects are as follows:

Project 1

Phase 1 - Linear Referencing System (LRS) Design
- Assess needs and establish benchmarks
- Develop LRS design

Phase 2 - Pilot LRS Implementation (summer 1999)
- Develop pilot plan
- Perform and document pilot
- Revise final LRS design and analyze benchmark criteria
- develop plan for full-scale implementation

Project 2 - Full scale LRS Implementation (spring/summer 2000)

1.4   Project Goals and Objectives

The goal of Project 1 is to design and develop a consistent and uniform system that references features or occurrences along Iowa roads. The system shall facilitate easy collection and location of features in the field, integrate data using multiple referencing methods, and simplify the data maintenance and access within all divisions of the Iowa DOT. The following objectives support this goal.

- Improve accuracy of the features referenced to the road network

- Minimize redundancy in the database systems

- Include all public roads in the state

- Minimize data maintenance needed due to changes in transportation network

- Provide improved data integration and access

1.5   Project Background

Over the years, the Iowa DOT has used, and is still using, several linear referencing methods (milepoint, milepost, stationing, latitude-longitude, Public Land Survey System (PLSS), link-node and others). In 1990, the Iowa DOT commissioned a study entitled "Highway Location Referencing Procedure Project," which resulted in the publication of a "Statement of Understanding of Current Conditions and Needs Assessment" and "Final Recommendations". In 1993, the Iowa DOT began the development of a Geographic Information System Strategic Plan (finalized April 1995). The plan provided guidelines for development of GIS to support transportation planning, design and management activities at the Iowa DOT. In early 1995, a GIS Coordinating Committee (GISCC) was formed. Several GIS pilot projects were then completed.

The GISCC recognized the integration potential of spatial information. In October 1996, a Location Referencing Issues Workshop was held, at the request of the Office of Transportation Data, to increase the knowledge of Iowa DOT personnel. The results of the workshop led to the formation of a Location Referencing System Team. The mission of the Location Referencing System Team was to develop a location referencing system for the Iowa DOT. During the Location Referencing System Team's efforts, the Iowa DOT hired a full-time GIS Coordinator. The Location Referencing System Team, with assistance from the GIS Coordinator, produced the Location Referencing System Team Report in January 1998, which was received and approved by the Iowa DOT Information Processing Steering Committee. The Location Referencing System Team report recommended the establishment of a linear datum, with rigorous rules allowing for the collection, management and integration of the data gathered by various referencing methods used in the Iowa DOT. The Team also recommended that the linear datum be evaluated in a pilot project at a scaled-down level (e.g., a single county) and then assessed with respect to cost and practicality. Most recently, the Iowa DOT has developed a GIS Implementation plan (finalized May 1998), in which LRS plays a significant role.

1.6   Existing Resources

A successful proposal shall include a preliminary, brief summary of past Iowa DOT efforts and studies that are pertinent to the development and implementation of a linear referencing system. Existing resources include the Location Referencing System Team Report (Iowa DOT), Highway Location Reference Procedure Project reports (C.W. Beilfuss and Associates), GIS Strategic Plan (Iowa DOT), and GIS Implementation Plan (Iowa DOT).

Section 2 Instructions for Potential Bidders

2.1 RFP Schedule

The following is a list of the activities relevant to the RFP process. The state reserves the right to change these dates and will notify vendors in such a case.

Activity	Time (CST)	Date
RFP released		12/11/98
Bidder's Conference Written Questions due	5:00pm	12/31/98
Bidder Conference	9:00am	1/8/99
Bidder's Written Question due	5:00pm	1/15/99
Response to Written Questions posted on Internet	5:00pm	1/22/99
Proposals due	5:00pm	1/29/99
Evaluations complete, finalists selected and notification sent	5:00pm	2/12/99
Finalists oral presentations start		3/1/99
Finalists oral presentations end		3/5/99
Contract award		3/17/99
Project begins		4/19/99

2.2 Submission of Proposals

Proposals are due January 29, 1999 by 5:00 p.m. (CST).

Proposals must be mailed to the address below:

Iowa Department of Transportation
Purchasing Section
Iowa Linear Referencing System RFP
800 Lincoln Way
Ames, Iowa 50010

Iowa DOT reserves the right to reject any or all proposals.

2.3   Bidders' Conference

Iowa DOT will hold a Bidders' Conference for this RFP. The purpose of the conference is to provide an overview of Project 1 and to answer specific questions concerning the RFP and RFP processes. Questions may be submitted prior to the conference in written format via email or fax (see Section 2.4 - Submission of Questions), and will be answered in writing, posted on the Internet site, and given to conference attendees. It is requested that bidders limit attendance to two people from each company. Attendance is not mandatory to respond to the RFP, but is strongly recommended. The conference will be held on January 8, 1999, and will start at 9:00 a.m. CST and end at approximately 3:00 p.m. CST.

The conference will be held at:

Iowa Department of Transportation
Commission Room
800 Lincoln Way
Ames, Iowa

2.4   Submission of Questions

Questions shall be submitted in writing by e-mail or fax. No telephone questions will be allowed. Bidders shall refer to the specific RFP section number and page, and shall quote the passage being questioned. Questions concerning the specifics of the finalist oral presentations will not be allowed until a bidder short list has been determined. All questions will be responded to as a group and posted on the Iowa DOT's Internet site, http://www.state.ia.us/government/dot/lrs.htm. Iowa DOT will edit out bidder names, but otherwise the questions will be posted as submitted.

The Bidders' Conference Written Questions, due on December 31, 1998, will be handed out to everyone at the Bidder's Conference and posted on the Internet site. The Written Questions received after December 31, 1998 will be posted on the Internet site no later than January 22, 1999.

All questions shall be directed to:

LRS RFP Questions
skadolp@max.state.ia.us
Fax (515) 239-1975

2.5   Proposal Costs

The Iowa DOT is not responsible for any costs incurred by the bidder in the preparation of the proposal or for participation in the Bidders' Conference.

2.6   Evaluation Criteria

The Iowa DOT is interested in obtaining a complete solution to the stated requirements. Incomplete solutions will be considered non-responsive and will not receive further consideration.

The Iowa DOT will evaluate proposals using a number of factors as described in Section 2.7 – Proposal Format. Proposals that are late, don't comply with proposal instructions, or take exceptions to requirements will be eliminated without further consideration. Proposals that meet the proposal instructions will be given a thorough and objective review, based on the following general factors.

2.7   Proposal Format

Bidders are requested to follow the proposal format provided in the RFP. This format provides a section layout for the proposal.

Section 1   <u>Executive Summary</u> – A five-page summary of Sections 2-7.

Section 2   <u>Introduction and Description of Problem</u> – This section shall describe the Bidder's understanding of the problem.

Section 3   <u>Project Approach</u> – This section shall include methodologies for project management and design.

Section 4   <u>Technical Approach</u> – This section shall contain a description of technical approach to the problem based on the Bidder's experience and knowledge. This shall include issues related to data collection, integration with existing systems (GIS, SAS, etc), issues surrounding LRS implementation (ramps, divided highways, equations, one-way road pairs, duplicate naming, referencing gaps, GPS, etc.), maintenance of the LRS, and the data modeling approach.

Section 5   <u>Project Management</u> – The Bidder shall provide an organizational chart for the project personnel, a Gantt chart for the project schedule, and a list of deliverables. Personnel proposed must be the same personnel that do 80% or more of the work on the project. Any proposed personnel can be switched only with Iowa DOT approval.

Section 6   <u>Qualifications and References</u> – This section shall contain references from two previous LRS contracts (on the enclosed form), a list of the project personnel and their resumes, and other pertinent information.

Section 7   <u>Financial Information</u> – Included audited financial statements as previously described.

Section 8   <u>Cost Proposal</u> – This section shall be marked as Section 8, but must be delivered in the bid envelope provided at the Bidders' Conference separate from Sections 1 through 7.

2.7.1   Executive Summary

Bidders shall provide an Executive Summary, to be written in non-technical language, to summarize the Bidder's overall capability and approaches for accomplishing the services specified. The Bidder is encouraged to limit the summary to no more than five (5) pages.

2.7.2   Technical Approach

The technical approach provided in the RFP responses will be reviewed not only on the technical knowledge (hardware, software and LRS theory) of the Bidder, but also on the functional knowledge (transportation business processes, total solution vision and experience with engineering information systems) shown in the proposals.

The following are factors in the functional and technical evaluation.

1. Understanding of the work to be performed

2. Technical approach and methodology to accomplish the work

3. Completeness and competence in addressing the scope of work

4. Discussion of the potential constraints or limitations of the proposed system with suggested approaches to resolving those issues

5. Integration with the Iowa DOT Geographic Information System (GIS). The GIS software selected by the department is Intergraph's Modular GIS Environment (MGE), GeoMedia, and Oracle Relational Database Management System.

6. Integration of linear and locational referencing methods within spatial modeling

7. Concepts related to development of a linear datum

8. Application of field procedures for information systems

9. Knowledge of data modeling

Any software that is needed by the Iowa DOT for the proposed technical approach should be listed in this section (i.e. case tools, project management software, etc.).

2.7.3   Project Management

Bidders will be evaluated on the completeness and responsiveness of their project plan and the project team assigned. Bidders shall list all subcontractors that will participate in the project. As part of the project plan, Bidders must demonstrate adequate experience in developing and implementing similar projects. The Iowa DOT's confidence in the Bidder's ability to meet deadlines and successfully manage long-term complex projects will be a primary consideration.

Special consideration will be given to Bidders who propose a detailed project plan with sufficient breakdown of tasks and steps to demonstrate a complete understanding of the project.

Bidders will also be evaluated on.

1. Experience with similar projects and technologies

2. Proposed communication strategies between the Iowa DOT and consultant

3. Demonstrated project management experience

4. Stability of assigned project team

As part of this section in the proposal, the Bidder must estimate the expected use of Iowa DOT resources for the duration of the project. This includes facility and office space, equipment use, and personnel needs. Minimal equipment and office space is available, so plans must assume very little use of Iowa DOT facilities and equipment.

2.7.4   Cost Proposal

The Iowa DOT will consider cost as part of the evaluation criteria. Low cost is not essential to win; however, large cost differentials between bidders will be carefully examined. Cost will be used as a final indicator for determining the bidder finalists when all other aspects and criteria are equal.

The Cost Proposal shall be itemized based on the deliverables that are described elsewhere in this RFP.

The Bidder is reminded that this section of its proposal must be submitted in the bid envelope provided at the bidders' conference, separate from the rest of the proposal.

2.7.5   Deliverables

The deliverables for the project are listed below. The Cost Proposal must be itemized based on these eight (8) deliverables. The deliverables are detailed in subsequent sections of the RFP.

- LRS Needs Assessment
- LRS Design
- LRS Pilot Project Plan
- LRS Pilot
- LRS Design (Revised)
- LRS Implementation Strategy
- LRS Benefits
- Project 2 Cost Estimate

2.7.5.1 Deliverable Submission

The successful Bidder shall be responsible for submitting six (6) copies of each deliverable in hardcopy and must submit one copy of each deliverable in softcopy on a standard floppy in either Microsoft Word or WordPerfect format.

2.7.5.2 Status Reports

Biweekly status reports must be submitted in writing to the Iowa DOT LRS Project Manager. These reports are not official deliverables for the project, but must be provided to inform the Iowa DOT of the project status and progress.

2.7.6   References

Bidder's references will be contacted by the Iowa DOT. References will be questioned on the bidder's technical capabilities and project management skills.

All references shall be listed on the Bidder Reference Form, Appendix B. To warrant consideration for the award of the contract, bidders and major subcontractor(s) must successfully pass reference checks. A major subcontractor is one that has 25 percent or more participation in the project by dollar amount. Work is defined as participating in the design, coding, integration, and support of the system application. An equipment supplier is not considered a subcontractor.

Bidders and major subcontractors must provide references for at least two implementations where the bidder has developed a LRS, where the work was similar in size, application and scope to the projects described herein. Bidders may substitute similar or alternate applications if no DOT systems have been implemented.

Each reference shall contain *at a minimum* the following information (See Appendix B):

- Name of references' organization
- Name of primary contact with experience on the referenced project (preferably the reference's Project Manager)
- Contact's Title

- Address of contact
- Phone number of contact
- Fax number of contact
- Actual project completion date (estimated if on-going)
- Total project cost
- Amount of total cost for which the bidder's firm is responsible

2.7.7   Financial Qualifications

To warrant consideration for this contract, bidders and all major subcontractors must submit financial information for the last two fiscal years and for the year to date, including an annual report or audited balance sheets and income statements. For the purposes of this section, "audited" shall mean that a certified public accountant has reviewed the financial reports and has expressed an opinion regarding the fairness of the information reviewed. Bidders will be evaluated on their long-term company stability.

2.7.8   Standards Compliance

The solution proposed must be in compliance with any standards used at the Iowa DOT. The most notable standards would be the operating system and GIS software standards, but the system must adhere to other national standards adopted at the Iowa DOT, such as the Federal Geographic Data Council Metadata Standards.

2.8   Notification

The Iowa DOT anticipates making a preliminary selection of bidders and developing a short list of finalists. All bidders, finalists or not, will be notified of their status in writing. After oral presentations and final evaluations, the winning bidder will be invited to negotiate a contract with the Iowa DOT and remaining bidders will be notified in writing of their selection status.

2.9   Finalist Oral Presentations

The Iowa DOT anticipates selecting a short list of finalists that will be invited to provide an oral presentation. The presentations will be conducted at the Iowa DOT in Ames, Iowa, and will be a test of bidders' capabilities and knowledge. The presentations will be used as part of the evaluation criteria for bidder selection. Bidders will have two weeks to prepare for the presentation. Failure to participate in the oral presentations will eliminate a bidder from further consideration for Project 1. The Iowa DOT is not responsible for any costs incurred by the bidder in preparation of, or participation in, the oral presentations.

2.10 Number and Size of Proposals

The proposal must be limited to sixty (60) pages, not including covers, section separators, financial reports, or table of contents. Bidders shall provide eight (8) copies of their proposals.

2.11 Supporting Documentation

There are documents available to bidders on the Iowa DOT Internet site. These documents are part of the original studies performed and convey useful information about this project. These documents are referenced throughout this RFP. The documents can be located at the following URL, which also includes links to relevant sites:

> http://www.state.ia.us/government/dot/lrs.htm

These documents are:

1. GIS Strategic Plan
2. GIS Implementation Plan
3. LRS Team Report
4. C. W. Beilfuss Reports

As these documents contain information that is needed to respond to requirements in this RFP, it is the bidder's responsibility to download and review these documents. The Iowa DOT does not intend to mail copies of these documents to RFP recipients unless extenuating circumstances require a separate mailing.

2.12 Ownership

All delivered proposals, documents, working notes shall become the property of Iowa DOT when they are delivered or when the project is completed. Computer equipment, software and non-disposable supplies purchased with project funds, specifically for use on Iowa DOT's LRS Project 1, shall become the property of the Iowa DOT when the project is completed.

Section 3   LRS Needs Assessment and Benchmarking

3.1   Goals and Objectives

The LRS needs assessment shall include a review of the Iowa DOT's needs identified in past studies as well as interviews with appropriate Iowa DOT staff, as needed (or directed). Benchmark processes shall be established to assess the effectiveness of the LRS solution. A successful proposal shall include a brief preliminary needs assessment.

3.2   Description

A needs assessment shall be developed by the consultant, but shall consider the needs identified in past studies, particularly the Location Referencing System Team Report (Iowa DOT). The consultant shall succinctly characterize the need for an Iowa DOT LRS, and demonstrate this need by providing several clear examples of business processes that will be enhanced, improved, streamlined, or otherwise made more efficient by the LRS. These examples shall be a limited set of well defined processes (including software and procedural) that shall be used to benchmark the effectiveness of the LRS pilot and full implementation. The set shall be representative of all Iowa DOT business spatial processing functions (cross-divisional). For similar functions (e.g., those that require similar location coordinate conversion or translation), only one example for benchmarking is required.

Benchmark processes must outline the procedures necessary to perform transformations among the various referencing methods used within the Iowa DOT, including milepost references, mile point (meter point), engineering stationing, projected and geographic coordinates, ALAS link-node references, and literal description. The benchmark processes shall demonstrate the use of these referencing methods to access data located in several cross-divisional databases (e.g., base record inventory, ALAS, and pavement management systems). It should be noted that various offices access the same database using different referencing methods. The benchmarks must also demonstrate that the use of field or office-based data referencing methods will work well with the design LRS.

3.3   Deliverables

The designated deliverable is the LRS Needs Assessment, which is a brief, formal document characterizing existing, and anticipated, Iowa DOT LRS needs and requirements as well as the list and details of the LRS benchmarking specifications. Benchmarking specifications must include documentation of existing procedures and processes that will be changed to utilize the LRS in the new system. The purpose of this documentation is to provide a method of verifying the benefits (or lack of benefits) with the implementation of a new LRS. In addition, approximate required staff and computation time for the existing procedures shall be documented to help determine if the new LRS procedures save time.

All participating Iowa DOT divisions must approve the LRS Needs Assessment deliverable.

Section 4   Propose a Linear Referencing System Solution

4.1   Overview

Several national and regional efforts related to the development of a LRS standard or implementation process have been undertaken. The NCHRP 20-27(2) study is one of the most notable, but the derived model could be implemented at any accuracy in a digital map or field process. For example, the anchor points could be locationally accurate to one meter or one mile. The NCHRP model does not require a stringently defined location for the anchor points. It is the desire of Iowa DOT to build a strong link between any new linear referencing system and the physical location in the field. Taking this into consideration, this section describes the information that shall be considered for, and the desired components of, the LRS Design. Two key areas shall be addressed in the LRS Design.

The first area of importance is the location portion of the LRS. Current thinking is that a series of anchor points, reference points, and anchor sections will be developed. For the purposes of this document, this series of points and sections will be called the reference datum. The reference datum physically ties down the location of control points in the field so they can be referenced back to the data model and map locations. For instance, it is not enough to simply drop the location of an anchor point in a digital map file for use as an established point. The point must be represented by a physical feature in the field that can be found in most weather, that does not move, and can be located at the accuracy defined in the Iowa DOT Location Referencing System Team Report. The diagram below shows how the integration between the field, the reference datum, and the map may be established.
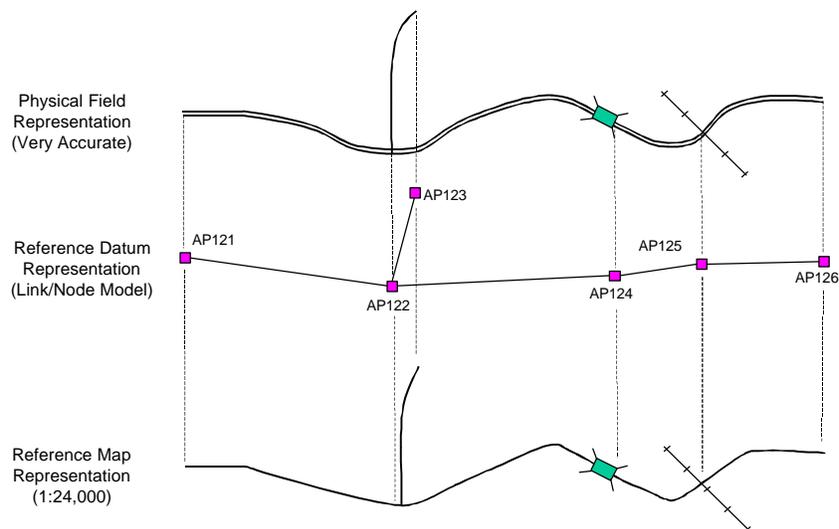
The second area that needs to be addressed is the design of a linear referencing model that will provide the data integration functionality desired in the system. This includes database models and processes that provide the integration of different linear referencing methods. This integration must allow for queries across multiple referencing methods and allow the user to define which referencing method to use for the output. For example, the user will be able to request a query on the base record data, the pavement data, and the accident locations, all of which use different referencing methods, and then request the results in yet a different referencing method.

4.2   Goals and Objectives

The goal of the LRS Design is to provide a complete functional and technical design for the development of the LRS at Iowa DOT. The design must be utilized in the Pilot Phase of the project and eventually be implemented into the Iowa DOT business processes, so the design must be practical and satisfy the integration goals.

The objectives of the design are numerous:

- The design shall include a complete review of the current best practices and of representative documentation available on the subject of LRS.

- The design must provide a LRS that is capable of integrating the many linear referencing methods that are utilized in the Iowa DOT.

- The design must be integrated with the GIS products and the Coordinated Transportation Analysis and Management System (CTAMS) so that they can query the data referenced to the new LRS.

- The design must consider the data collection processes and make sure that no process becomes burdensome for the field personnel who collect the data or the data input staff who maintain the databases.

- The design must enhance the efficiency of data access, input and maintenance.

- The design must accommodate all public roads in the state of Iowa. The Iowa DOT maintains data for all roads: state, county and municipal. This includes entrance and exit ramps. Consideration must also be given to how to model multiple lane highways, such as interstates.

- The design shall not be division specific, but shall be usable by all divisions for referencing data to the road network.

- The design must be able to provide processes to simplify the Iowa DOT's reporting requirements to the Federal government.

- The design must identify the processes that shall establish the linear referencing system datum in the field.

- The design must address the processes in which the referencing system shall be maintained.

- The design must propose a strategy for institutionalizing the new LRS and identify the areas where policy and procedure changes are necessary for successful implementation.

- The historic or temporal component of the linear data must be considered in the data model and LRS design.

- Integration of data external to the Iowa DOT must be considered, especially in relation to data that may not be formatted in the same methods related to divided or undivided roads.

4.3   Design Specifics

This section further explains the Iowa DOT's expectations for each of the objectives listed in the previous sections.

4.3.1   Reference Material

The following list of reference material must be considered as part of the design. If the design specifically contradicts any recommendation or suggestion from these documents, an explanation of why that variance occurred is required as part of the design. If the consultant is aware of other pertinent information, then that shall be utilized as well.

- Location Referencing System Team Report (Iowa DOT)
- Highway Performance Monitoring System Field Manual, Chapter 5 (FHWA)
- A Generic Data Model for Linear Referencing Systems (NCHRP 20-27[2])
- LRS recommendations, implementations, plans, or standards from other State DOTs
- Bureau of Transportation Statistics LRS/GIS CD ROM
- Any other documents as identified by the Consultant or Iowa DOT

4.3.2   Integration of Linear Referencing Methods

The list of linear referencing methods used at the Iowa DOT can be found in Appendix H of the Iowa DOT Location Referencing System Team Report. The list is not exhaustive, but does include the used or desired methods for the larger systems at the Iowa DOT.

The design must address how these different methods can be integrated, thus enabling the users of the GIS to perform cross-method queries, request results in any defined referencing method, and input data into the system by any referencing method.

4.3.3   Integration of the LRS into the GIS

The Iowa DOT has standardized on some key GIS products. Different products are identified for different functional uses, but the LRS Design must consider these products and must be compatible with them to allow full integration of the LRS into the GIS environment.

For GIS map creation and maintenance, Iowa DOT uses Intergraph's Modular GIS Environment (MGE) and MicroStation. The maps are linked to attribute information stored in an Oracle database. Oracle was selected as the relational database for GIS and is the standard that must be first considered for new applications before any other database can be considered. MGE Segment Manager (MGSM) is also used, but has not been fully implemented into the processes at Iowa DOT because a strong LRS has not been established. The design must also consider the use of this product and accommodate the use of dynamic segmentation processes.

The Iowa DOT utilizes Intergraph's GeoMedia software to access the MGE, MGSM and Oracle data. GeoMedia has also been used to integrate data from several other state, county and federal agencies that are not in MGE or MGSM format.

The Iowa DOT has established a concept called the GeoData Warehouse that is implemented as part of CTAMS. This is not a data warehouse in the truest of information system definitions, but is a collection of data spread throughout the Iowa DOT on several servers. These data are in many formats and the data are integrated through the data server capabilities in GeoMedia.

4.3.4   Data Collection Processes

The design must consider the numerous data collection workflows and processes in the development and documentation of the LRS.

Several offices in the Iowa DOT collect road data. These include, but are not limited to the following:

- Office of Transportation Data – This office is responsible for the cartography and base record data at the Iowa DOT. The office generates, and receives back, requests for construction updates from counties and cities, performs traffic surveys, physical inventories, video logging, and traffic counts.

- Maintenance Division – This division keeps information related to highway accesses, safety features, and highway maintenance locations.

- Office of Roadside Development – This office tracks environmental information such as wetland locations.

- Materials – This office tracks the locations of material tests for the purposes of integrating existing pavement conditions with material and construction information. This includes data for the Pavement Management Information System.

- Office of Drivers Services – This office collects locations for all crashes in the state.

The intent of the LRS Design is to accommodate as many of the existing linear referencing methods as possible. It is desired that major restructuring of the existing data collection processes be avoided.

Many of the managers in charge of Iowa DOT data collection processes have considered the use of GPS to locate data. The use of GPS is important in our collection of data, but the location of a feature by latitude and longitude may not always be the best method of location identification for non-mapping applications. For instance, it is difficult for a sign maintenance crew to use the latitude and longitude to locate a sign that needs replaced along the interstate. GPS might have been used to locate the sign originally, but the location must be processed into a meaningful description for the field crews, such as a route and milepost or a literal description. In many cases, the GIS software will help with this issue, but it must be addressed in the LRS Design.

4.3.5   Enhanced Efficiency

One of the key goals of implementing a common LRS is the increased efficiency in data maintenance, data accessibility, data collection and entry methods, and analytical process. The LRS Design must specify the most efficient way to collect, store, and analyze the data. Efficiency is provided, not only in the methods that data are stored on the computer, but also in the processes that are developed to utilize and access the data.

4.3.6   Road Classification Independent

The LRS Design must be able to locate linear features on all road classifications. If a milepost system, or any other method, is not established on a road, the LRS Design shall not preclude it from referencing the established LRS.

4.3.7   Department-wide Applicability

The goal of implementing a departmental LRS is to provide a single referencing system that all the current referencing methods can reference. This must include all divisions of the Iowa DOT. If a division's linear referencing methods can not be accommodated, then methods for migrating the division to a new referencing method must be addressed and approved by that division.

4.3.8   Simplify Federal Reporting Requirements

The Iowa DOT is responsible for numerous annual reports that describe the condition of the Iowa roads and the anticipated future needs. These reports include the Highway Performance Monitoring System (HPMS) data and the National Bridge Inventory (NBI).

One of the benefits of developing a common LRS for the Iowa DOT is that the reporting of locations for bridges, pavement conditions, traffic volumes and roadway characteristics could all be based on a common datum. If a common datum is established, the data can be more easily integrated, not only internally, but also in the systems used by FHWA.

4.3.9   Datum Location in the Field

The design must address the development of field procedures for establishing a linear datum that is identifiable in the field. A linear referencing system could be established in the office based on computer maps, but the accuracy of the maps will limit the accuracy of the actual geographic position of a feature. This is the purpose for the development of concepts such as anchor points, reference points, and anchor sections that can be located with the accuracy defined in the Iowa DOT Location Referencing System Team Report. The number of required anchor points and reference points is left to the design process, but must maintain Iowa DOT's desired accuracy.

4.3.10   LRS Maintenance

The design must address the processes that will be employed to maintain the LRS. This shall include the processes for updating the cartographic representation of the road network, adding new road alignments into the LRS, maintaining historical data, adding additional referencing methods, and enhancing the positional accuracy of the linear datum.

4.3.11   Institutionalizing the LRS

Maintenance and update procedures for the linear datum and linear referencing data model, including staffing and support, must be addressed in the LRS Design. This shall include identification of required database and technical computer staff, identification of field personnel necessary to locate the datum in the field, and training for the data collection crews.

The integration of both English and metric units shall also be addressed. Several offices have moved their operations to metric units of measure, but others continue to maintain English units since they use mileage-based location references (e.g., mileposts).

4.3.12 Historic and Temporal Information

The temporal component of the data must be considered in the design and development of the LRS and the associated data models. The system must be able to identify compatible data for comparison. For instance, the 1990 accidents may not be accurately located on the 1998 road network due to alignment changes, road name changes, etc. It may not be possible to correct all the inconsistencies for legacy data, but the new system must address the temporal component of the data.

4.3.13 Integration of External Data

Data may come into the Iowa DOT from sources external to the Iowa DOT. For instance, cities and counties may provide information about a road that may not be formatted as a divided highway, although the Iowa DOT tracks the road as a divided highway. The new system must be flexible enough to accommodate such inconsistencies.

4.4 Expected Deliverables for LRS Design

The deliverable for the LRS Design shall be a formal, detailed document that addresses the above mentioned topics and provides detailed procedures for the implementation of the LRS. Any reports obtained as part of the contract and used in the design shall also be turned in with the LRS Design.

All participating divisions of the Iowa DOT must approve the proposed solutions. This may require revisions to the initial document until consensus is reached.

Section 5   Plan Pilot

5.1   Goals and Objectives

The goal of the LRS Pilot Project Plan is to develop a strategy to demonstrate the implementation of the proposed and accepted LRS Design as described in Section 4. The pilot must satisfy the goals and objectives outlined for the LRS Design and test each of the benchmark processes defined in Section 3. The plan itself shall detail the manner in which the pilot will be executed.

5.2   Requirements

The consultant shall develop a plan that addresses the scope of the project and the methodology to be employed during the pilot.

5.2.1   Scope

The pilot scope includes establishing a linear datum in the field, given Section 4 specifications and the LRS Design. The scope also includes, collecting sample data in the field using various referencing methods, integrating the linear reference methods currently used in the Iowa DOT, and testing the LRS benchmark processes. The consultant shall effectively outline specific tasks and subtasks within this scope.

5.2.2   Methodology

The consultant shall describe the manner in which all pilot tasks and subtasks will be conducted. Specific aspects of the pilot that must be addressed include:

- Location and extent of the roadway system to be used for the linear datum and sample data collection

- Method used to establish the linear datum control (e.g., GPS, Digital Orthorectified Quadrangles, field survey, or other)

- Staff roles and responsibilities of each organization, particularly the split between consultant and Iowa DOT staff responsibilities

- Equipment and space requirements, consultant/Iowa DOT responsibilities for the field test (establishing the linear datum and collecting sample data), integrating the various referencing methods, and testing the benchmark processes

- Statistical quality control checks on the positional accuracy of the LRS

5.2.3   Timeline

The pilot plan timeline shall note the anticipated date for completion of each plan task. Iowa's late fall, winter, and early spring weather shall be considered when developing a timeline for the pilot work. Outdoor activities during those seasons can be difficult. If the DOT requires new software for the pilot, ample notice must be provided to allow Iowa DOT the time needed to obtain the software.

5.3   Deliverables

The deliverable of this project task is a formal LRS Pilot Project Plan document. The plan shall clearly define the project scope and thoroughly outline all project tasks and methodologies. All participating Iowa DOT divisions must approve the LRS Pilot Project Plan.

Section 6   Perform Pilot

6.1   Goals and Objectives

The goal of the pilot project is to demonstrate the implementation of the LRS Design, following the LRS Pilot Project Plan developed and approved in Section 5.

6.2   Description

The pilot project shall be performed following the LRS Pilot Project Plan approved by the participating Iowa DOT divisions. The consultant and appropriate Iowa DOT staff shall perform the pilot given their respective responsibilities defined in the pilot plan. The consultant shall provide bi-weekly, electronic written status reports to the project monitor(s) (the consultant may choose to develop and maintain a web page so that Iowa DOT personnel from various divisions can monitor progress). The project updates shall address the status of specific tasks, anticipated completion dates, and future efforts. Periodic meetings between the consultant, project monitor(s), and participating Iowa DOT divisions shall be held to discuss the status of the project. All significant deviations from the plan must first be approved by the project monitor(s). All benchmarking processes shall be conducted within the pilot effort.

The consultant shall thoroughly document all procedures, equipment, staffing, and other resources utilized to perform each pilot project task. All deviations from the initial plan shall be recorded and the actual procedures and resources documented.

All project documentation shall be provided to the Iowa DOT at the completion of the project and upon request. The consultant shall also document problems and inefficiencies of the pilot efforts and provide initial suggestions regarding potential alternate workflows.

6.3   Deliverables

The primary deliverable for this task is performing the pilot project and documentation of completed pilot. Pilot success will be evaluated based on demonstration of the LRS Design and completion of all tasks outlined in the LRS Pilot Project Plan. Completion of the pilot will be determined by the achievement of the tasks listed above and when the identified problems encountered during the LRS pilot project have been addressed and documented by adjusting the pilot implementation strategy to show that the LRS can be successfully implemented. Revision of the LRS Design is described in the next section of this document.

Section 7   Revise Final LRS Design

7.1   Goals and Objectives

The goal of this task is to incorporate lessons learned in the pilot project into a final LRS design. Objectives that support this goal include identifying and addressing problems encountered during the LRS pilot project, proposing solutions to the problems, and revising the LRS Design accordingly.

7.2   Description

The consultant shall revise the LRS Design per pilot experience. The consultant, project monitor(s), and participating Iowa DOT divisions shall collaborate to identify the problems and inefficiencies of the pilot effort, expanding on those documented per Section 6. These problems and inefficiencies will be identified by evaluating the requirements of the LRS Design and benchmark criteria. All areas of necessary or potential improvement shall be clearly identified and addressed independently by the consultant. Where applicable, several potential solutions shall be proposed for each problem area. The project monitor(s) and participating Iowa DOT divisions will ultimately select the optimal solutions. Upon selection and approval of the proposed solutions, the consultant shall develop a new, revised LRS Design based on these solutions.

The consultant shall also prepare a formal LRS Implementation Strategy document, applying the newly revised LRS Design and the findings from the Pilot Project. The purpose of the Implementation Strategy is to document the revisions to demonstrate a potential workflow for full-scale LRS implementation. The consultant is not required to repeat the pilot.

The consultant shall create a formal document describing the benefits of the LRS, called LRS Benefits, that describes the results from each of the benchmark processes. Benefits of full-scale implementation of the LRS shall be extrapolated from these benefits. The estimation of these benefits is nontrivial and is of utmost importance to the eventual success of the full-scale LRS. The document shall include a full description of the method used to estimate the benefits. Costs of LRS implementation are to be estimated as described in Section 8.

7.3   Deliverables

The deliverables for this effort include three formal documents: the LRS Design (Revised), LRS Implementation Strategy, and LRS Benefits. All participating Iowa DOT divisions must approve the LRS Design (Revised), LRS Implementation Strategy, and LRS Benefits.

Section 8   Develop Scope and Plan for Full Scale Implementation

8.1   Description

The goal of this task is to create continuity between Project 1 and Project 2, and to aid the Iowa DOT in the development of the contracts for Project 2.

8.2   Scope

If the benchmarking criteria confirm that the development and full implementation of a LRS will enhance the maintenance, access and integration of data at Iowa DOT, Project 2 will be initiated. Project 2, which will entail full-scale implementation of the designed and piloted LRS, will follow the current project. A second, separate contract will be initiated, and if necessary, a second RFP released. If both the Iowa DOT and the consultant from Project 1 agree to move forward, and an acceptable cost can be negotiated, it is hoped that the consultant selected for Project 1 will continue work on Project 2 to achieve project continuity.

Project 2 will include the implementation of the LRS into the offices collecting data for the Iowa DOT, final integration of the LRS into the production GIS, and training of all the staff that utilize the LRS. Project 2 also includes tasks for developing all documentation for the LRS and working with the divisions of the Iowa DOT to identify Policy and Procedure changes that need to be addressed to use the new LRS. Project 2 may also contain GIS database design and development, graphical user interface development, and other software development components.

8.3   Deliverables

The successful bidder shall be required to prepare a document detailing an estimate of the cost, based on the LRS Implementation Strategy, for the full-scale implementation of Project 2. The cost estimate shall include the project plan from the LRS Implementation Strategy with a cost breakdown for the primary deliverables identified in that plan. This document shall be called the Project 2 Cost Estimate and is the final deliverable for Project 1.

Appendix A – Glossary

ALAS - The Iowa DOT's mainframe Accident Location and Analysis System. Its PC version is known as PC-ALAS, a non-geographic, menu driven application written in Turbo Pascal. The system is being replaced by ACCESS-ALAS (programmed in Microsoft Access). A third system, GIS-ALAS, is currently being programmed in ArcView GIS.

Coordinated Transportation Analysis and Management Systems (CTAMS) – CTAMS is a collection of geographic data and tools into a single system that provide GIS and integrated data systems to the Iowa DOT.

Geographic Information System (GIS) – GIS, in general, can be defined as a computer-based tool for mapping and analyzing things that exist and events that happen on earth. In addition, GIS allows for the integration of data, specifically spatial data, and gives the user the ability to provide quicker and better decisions.

Linear Referencing Method (LRM) – the means by which the location of any unknown point along a linear feature can be determined by specifying the direction and distance from any known point to the unknown point. For example, milepoint, reference post, literal descriptions, coordinate locations and engineering stationing are all linear referencing methods.

Linear Referencing System (LRS) - set of office and field procedures that includes a linear referencing method and a means for transformation among various methods.

Linear Datum - "The complete set of anchor sections and anchor points, constituting a mutually exclusive, totally exhaustive, ordered set of linear locations." "…relates the database representation to the real world and provides the domain for transformations among linear referencing methods and among cartographic representations." (from NCHRP Research Results Digest, Number 218, September 1997.)

Appendix B – Bidder References

The Bidder, and each subcontractor that will perform twenty-five percent (25%) or more of the work on the project, must complete the following page and must provide at least two references.

Bidder's Reference Form

Bidder's or Subcontractor's Name: _____

Information Requested	Reference 1	Reference 2
Name of reference's organization		
Name of Primary Contact on project (References Project Manager)		
Contact's title		
Contact's address		
Contact's phone number		
Contact's FAX number		
Completion date of project being referenced		
Total project cost		
Amount of cost for which the reference's firm was responsible		