KYTC Highway Design

Chapter

SURVEYING

Subject

Survey Control

OVERVIEW: The establishment of the survey control of an area for the location and design of a roadway is to be performed by Global Positioning System (GPS) and/or conventional survey methods. Accuracy and completeness of information are of prime importance.

It should be noted that this chapter presents a change in survey methodology, from traditional route surveying techniques to planimetric topographic data collection methods. All aspects of the design and construction phases can be staked from traverse control. The centerline is not necessarily the controlling feature for survey purposes. Although State Plane coordinates and digital terrain models are utilized in the design process, centerlines can be a means of location utilizing station and offset. For current information and additional references on survey-related items, see the Division of Highway Design Survey Coordination Web page.

FIELD CONTROL RECONNAISSANCE: The surveyor should make every effort to obtain information for any existing control of the project area. If any primary control exists from National Geodetic Survey (NGS) or from others that may have set control for the Department of Highways, it is highly recommended that this control be used for further densification of the project. Recovered control monumentation must be evaluated before being used as a basis for new control surveys.

Recovered NGS monumentation will be reported by using the NGS online *Mark Recovery* form. Destroyed monumentation will be reported to the NGS Kentucky Geodetic Advisor.

The initial horizontal and vertical control should be established for use in design, right-of-way, and construction phases of the project.

GPS PROCEDURES FOR PRIMARY CONTROL:

Horizontal Control

All horizontal control for primary control shall utilize the Kentucky Federal Baseline Network (FBN). A minimum of two FBN monuments shall be used as fixed control for a project. Any existing NGS horizontal control stations (first or second order only) may be included in the control network for quality checks but will not supersede any Kentucky FBN monument.

CONT.

GPS PROCEDURES FOR PRIMARY CONTROL (cont.):

All horizontal control shall be tied to the NAD83/1994 Kentucky State Plane Coordinate System, Lambert Projection. Kentucky uses the North Zone, the South Zone, and the Single Zone. Final coordinates shall be Project Datum Coordinates (see **Exhibit 300-01**). All coordinates, distances, and elevations shall be based on the U.S. survey foot definition, as defined by NGS.

Horizontal coordinates for primary control that utilize GPS methods shall comply with the *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques,* published by the Federal Geodetic Subcommittee.

Allowable GPS methods will be static or fast static. RTK (Real Time Kinematic) methods will not be allowed for primary control. Dual frequency receivers are recommended, and the occupation times will be such that a minimum of second-order specifications is obtained as specified by *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques.*

Vertical Control

All vertical control obtained from GPS shall comply with the *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques.* GPS control is also to comply with any additional specifications as outlined below.

Elevations obtained from GPS are to originate from NGS benchmarks of second- or higher-order accuracy. If vertical control is established by GPS, the number of existing vertical control monuments from which to originate depends on the accuracy required, but in no case is the number to be fewer than four. The surveyor should distribute the four or more monuments equally, covering the entire project area. Control extended from GPS shall use differential positioning techniques, with a minimum of three receivers observing no fewer than four satellites for a minimum of 60 minutes in 15-second epochs or less. GPS-derived elevations shall be referenced to the North American Vertical Datum of 1988 (NAVD88) and shall utilize the most current geoid model. All elevations shall be based on the U.S. survey foot definition.

CONVENTIONAL SURVEYS FOR PRIMARY CONTROL:

Horizontal Control

Accuracy—All survey work for conventional methods shall meet or exceed the minimum "Standards of Practice" as specified by the Commonwealth of Kentucky, State Board of Licensure for Professional Engineers and Land Surveyors (201 KAR 18:150).

CONT.

CONVENTIONAL SURVEYS FOR PRIMARY CONTROL (cont.):

All horizontal control set using conventional equipment (e.g., Total Stations) shall be done to second-order specifications, Class 1 or better (see **Exhibit 300-02**). The horizontal distance accuracy is based on the relationship of the distances between two points and the standard deviation of that distance.

Vertical Control

Accuracy—All survey work for conventional methods shall meet or exceed the minimum "Standards of Practice" as specified by the Commonwealth of Kentucky, State Board of Licensure for Professional Engineers and Land Surveyors (201 KAR 18:150).

When elevations are obtained by differential leveling procedures, levels shall originate from NGS benchmarks of second- or higher-order accuracy. Reference all elevations to the North American Vertical Datum of 1988 (NAVD88).

All level runs for vertical control shall meet Second-Order, Class I, Specifications as shown in **Exhibit 300-02**.

PHOTOGRAMMETRIC CONTROL:

All control set for KYTC mapping using photogrammetric techniques shall be classified as primary control and set in accordance with procedures described above.

All horizontal control set for photogrammetric purposes shall utilize GPS methods and comply with the *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques*.

Elevations for photogrammetry may be derived by GPS as long as the methodology from **GPS Procedures for Primary Control** on the previous pages is followed. If differential (conventional) levels are used, the vertical control methods in **Conventional Surveys for Primary Control** described above are used.

Monumentation for photogrammetric control shall be set as described in **Primary Monumentation** on the following page**.**

CONT.

PRIMARY MONUMENTATION: Primary monumentation shall be as prescribed by the Federal Geodetic Control Subcommittee (FGCS). FGCS requires that all First- and Second-Order Class II horizontal and vertical control be monumented and described. It may be advantageous to utilize the same monument for both horizontal and vertical control.

The Department requires that all projects have pairs of permanent intervisible monumentation spaced along the project not more than 2,000 feet apart. If possible, the surveyor should locate the monuments to avoid destroying or disturbing them during construction.

The monuments shall be concrete and either 5 inches x 5 inches square or 6 inches in diameter (minimum dimensions) and not less than 2.5 feet deep. The monuments shall contain a rebar not less than 5/8-inch in diameter driven 2 feet below the bottom of the hole. The top of the rebar shall be approximately 2 inches below the top of the monument.

The monuments shall have aluminum or bronze identifier caps with the description of the agency that set the monument and the year the monument was set. All monuments shall be marked "KYTC Survey Control."

If good, sound (permanent) rock is encountered, drill a minimum of 12 inches and countersink and concrete the disks in the drilled hole. For primary control, use a rebar of at least 5/8-inch diameter driven 2 feet below the bottom of a 2-foot-deep hole. Fill the hole with concrete with the top of the rebar no greater than 1 inch above ground elevation.

A 48-inch minimum carsonite witness post will witness each monument, with a label recognizing the point as a KYTC Survey Control point. It is important to note that the continued value of a control survey is dependent on the permanence of the monuments placed.

The Department may also approve alternate monumentation (see **Exhibit 300-04**).

As with all field activities, ground survey crews establishing primary control should respect the rights of individual property owners and ask for permission before entering their property. For more information, see **HD-304**, "Other Survey Activities."

CONT.

SUPPLEMENTAL CONTROL: Supplemental control can be defined as additional points set when further densification of primary control is needed. Supplemental control may be set using conventional methods or Real Time Kinematic (RTK) methods. Horizontal coordinates and elevations for supplemental control shall begin from the primary control and check back in to the primary control. All supplemental control (horizontal and vertical) shall be set using Second-Order, Class II or better, Specifications (see **Exhibit 300-02**).

Monumentation for supplemental horizontal control shall be a minimum of 24-inch rebar (#4 or larger) with a plastic or aluminum cap. The cap shall contain the "KYTC" text.

Supplemental vertical control should be conveniently located and accessible and of a stable, permanent nature.

SURVEY REPORT: The final survey report shall contain:

- Purpose of the survey
- Number of intervisible monuments set and any supplemental physical feature points
- A map to scale of the project area, showing all primary and supplemental (horizontal and vertical) control monumentation established with appropriate designation
- Type of equipment used in the survey
- Description of all NGS control points used in the project
- Closures of all traverses
- Unadjusted and adjusted information of traverses
- Project datum factor that relates to the Kentucky State Plane Coordinates

Additionally, when using GPS, the report shall contain:

- Type of receivers used
- Date of observations
- Time interval of each observation
- Number of times occupying each control point

Submit the report as a .pdf document to the Survey Coordinator.

Document all pertinent information of all control on a Department control monument information sheet (available from Department) and submit it with the final control survey report. The survey report will not be accepted unless signed, dated, and stamped by a registered land surveyor for the State of Kentucky, certifying the accuracy of the report submitted and the accuracy of all control monuments set for the Department, unless otherwise authorized by the Division of Highway Design.

KYTC Highway Design	*Chapter* SURVEYING
	Subject Photogrammetry

PHOTOGRAMMETRY: Final Map accuracy for KYTC projects shall conform to the National Map Accuracy Standards as published by the United States Geological Survey (USGS). Refer to **Exhibit 300-03** for details.

The default KYTC standard for design mapping is a scale of 1 inch = 50 feet with 2-foot contours. Other scales and intervals may be acceptable based on the request of the project manager and the design team.

Submit requests for aerial surveys to the Survey Coordinator, Division of Highway Design. Uncontrolled photographic coverage of the entire state and reproductions, including enlargement or reduction of scale, are available to the designer. They can be obtained from the Phototechnical Section of the Division of Highway Design.

All aerial photography and photogrammetry services are to comply with the conditions and specifications described in the *Reference Guide Outline, Specifications for Aerial Surveys and Mapping by Photogrammetric Methods for Highways.* They are also to comply with the U.S. Department of Transportation, Federal Highway Administration, and the terms and conditions of the contract agreement between the Department of Highways and the company furnishing the aerial and photogrammetric services.

PHOTOGRAMMETRY DELIVERABLES: Deliverables from KYTC Consultants shall be MicroStation (DGN) files with all graphics being submitted to the current KYTC graphic standards and ASCII files containing breakline and random-point data that will produce a DTM of the mapped area. It is also acceptable if this information is submitted in an approved DTM file (built by consultant) or graphical format in a DGN file.

A survey report as described in the “Survey Report” section must be submitted.

Three copies of all information are to be delivered as follows:

- One copy to the Survey Coordinator, Division of Highway Design
- Two copies to the KYTC District Office

CONT.

LIGHT DETECTION & RANGING (LIDAR):

Light Detection and Ranging (LIDAR) data may be used for certain KYTC projects. The use of LIDAR may provide a faster delivery of data than conventional photogrammetry and survey methods. KYTC does not have LIDAR capabilities and relies on the consultant community for all LIDAR services.

LIDAR data is not to be used for any location survey unless written approval is obtained from the director of the Division of Highway Design.

KYTC Highway Design	***Chapter*** SURVEYING
	Subject Data Collection

OVERVIEW: Determine the degree of precision of all surveys by the final intended use of the data. Generally, a preliminary survey should be to the same order as that required for the final survey. In some situations, a preliminary survey for mapping or reconnaissance studies may be to a lesser order with approval of the director of the Division of Highway Design.

SURVEY FIELD CREW RESPONSIBILITIES:

For all KYTC projects, survey field crews are responsible for processing their data and delivering a design (.dgn) file, digital terrain model (.dtm) file, and geometry (.alg) file. Field crews are responsible for final checking and the assurance of the accuracy of all survey products delivered to the design office.

ELECTRONIC DATA COLLECTORS: The electronic data collectors (electronic field books) selected for use in the Cabinet shall not allow the data to be deleted until it has been sent to a printer or a computer. If an error is made in the field, the data collector retains both the error and the correction.

As standard procedure to ensure that a permanent record of the original fieldwork is available, any agent of the Cabinet using electronic data collectors should comply with the following practices:

1. Download the original data into a computer and copy (unedited) to a permanent medium.

2. Produce a hard-copy printout of the data before any editing takes place.

3. Do any editing or subsequent changes to the data on copies of the original data. Never alter the original data.

4. In any subsequent submittals of project information, treat the permanent medium and the hardcopy printout, cited before, as a traditional field book.

CONT.

ELECTRONIC DATA COLLECTORS (cont.):

Electronic data files submitted should be in the approved KYTC format. If it is submitted in a text file, the following format shall be used: point number, Northing, Easting, elevation, feature code.

FEATURE CODING: All survey and DTM information for KYTC projects shall utilize the KYTC feature codes list. The current feature codes list can be found on the KYTC Highway Design Web site under "Survey Coordination."

DIGITAL TERRAIN MODELING: A Digital Terrain Model (DTM) is a three-dimensional representation of the surface of the earth. The accuracy of the DTM should reflect its intended use.

Cross-sections and profiles needed for plan development and documentation shall be derived from the DTMs.

DTMs are created from breaklines and random points. Breaklines are linear features that locate "breaks" (changes) in the earth's surface such as changes in slope. Examples of breaklines are the crown of pavement, edge of pavement, edge of shoulder, flow line, top of curb, bottom of slope, top of slope, bottom of ditch, and top of ridge.

Random points are used to define the surface between breaklines. These points are spot elevations at various or key locations. Random points are generally collected in a gridded manner with a nominal spacing of 25 to 50 feet. This spacing can vary widely depending on the regularity of the surface being surveyed.

The surveyor shall be responsible for adequate breaklines and random points to ensure that the DTM accurately reflects the surface. Additional care shall be taken in the collection of breaklines in areas around bridges, other structures, streams, and other sensitive locations. At bridge abutments, wing walls, ends of pipes and culverts, curbs, retaining walls, and any other vertical-type situation, breaklines at both the top and bottom of the feature are necessary for the definition of the surface.

Take breakline data in a directional sequence and do not jump back and forth on the same breakline.

The rodman should be knowledgeable of the data collection process and how the collected data influences the quality of the DTM. Thus the rodman is key to the collection process.

. The surveyor is responsible for the processing, final checking, and validating of the DTM.

CONT.

TOPOGRAPHIC FEATURES:

Topography is defined as the graphic delineation of all natural and manmade features of an area. Collect all topographic feature data within the project area. Where appropriate, elevations should be collected. For overhead utilities, identify the ownership, pole number(s), and low wire elevation(s). Collect the major topographic features of the area such as buildings, septic systems, existing roads, drainage structures, and utilities. The types of construction and descriptions for all buildings and existing roadway surfaces shall be noted. In addition, collect any item that may influence project decisions.

UTILITY LOCATION:

The relocation of underground utilities is a primary concern during project development. Complete and concise locations of existing utilities shall be obtained early in the design process. Utility company archives may not be sufficient to identify all utilities within the project corridor.

Locating existing utilities to a certain level should occur even during the Planning phase and/or Phase I Design of a project, whenever there are either large concentrations of utilities or the existence of a major utility facility. At any stage of design, the utility companies should be an integral part of the design process and should be invited to key meetings to be advised of and consulted about impacts of the roadway to their facilities. Invitations to utility companies should be extended for public involvement meetings as well, to afford the companies the opportunity to give input. The choice of alternatives for the proposed roadway should reflect this information in an effort to first avoid the utility conflict, secondarily minimize the effect, and thirdly mitigate the conflict.

The quality level that is utilized in the location of existing utilities should be based on the stage of development for a roadway project. During the corridor study to determine potential alternatives, the use of existing records or verbal information from utility companies typically will suffice. The quality level utilized in locating existing utilities should improve as alternatives are developed and their subsequent location refined. Location of utilities should include the horizontal position (and vertical position when appropriate) of the utility, the material of which it is composed, the size, and any other pertinent data concerning the facility. The following is a description of the differing quality levels of utility location:

- **Quality Level D (QL D)**: Information derived solely from existing records or verbal recollections

- **Quality Level C (QL C)**: Information obtained by surveying and plotting visible aboveground utility features and by using professional judgment in correlating this information to Quality Level D information

CONT.

UTILITY LOCATION (cont.):

- **Quality Level B (QL B)**: Information obtained through the application of appropriate surface geophysical methods to identify the existence and approximate horizontal position of subsurface utilities

  Quality Level B data should be reproducible by surface geophysics at any point of the utility's depiction. This information is surveyed to applicable tolerances and reduced onto plan documents.

- **Quality Level A (QL A)**: Information obtained by the actual exposure (or verification of previously exposed and surveyed utilities) of subsurface utilities, using (typically) minimally intrusive excavation equipment to determine their precise horizontal and vertical positions, as well as their other utility attributes

  This information is surveyed and reduced onto plan documents. Accuracy should be to applicable horizontal survey and mapping accuracy and should be within $\pm$ 0.05 foot vertical.

All of the above quality level work shall be completed in accordance with Section 5: Utility Quality Level Attributes as documented in CI/ASCE 38-02, the *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data* by the American Society of Civil Engineers.

The project team shall determine the quality level (QL) of utility locations for the various stages of project development. The appropriate level D, C, or B should coincide with the surveying during Phase 1 design. QL A will be done as needed, based on potential conflicts. The utilities must be identified and located on plan documents. All underground utilities depicted shall be QL B unless the particular utility is labeled "QL C" or "QL D" (See **Exhibit 300-05.**) QL A is applicable only where direct observations of the exposed utility are made. A summary sheet will be included to document in the plans the QL A horizontal and vertical locations noted. The QL A data shall be documented by station, offset, northing, easting, and elevation. (See **Exhibit 300-06.**)

The following are areas where emphasis and care should be given to establish complete and accurate location of underground utilities:

- The urban highway construction project with high potential for anticipated utility conflicts
- Projects with complex utility networks, either aged or of significantly high potential for expensive utility relocations
- Limited, narrow, and congested existing rights of way
- High-profile highway projects that have critical schedule

CONT.

UTILITY LOCATION (cont.):

It may appear to be fiscally advantageous to place the brunt of relocation costs on private companies, while avoiding publicly owned utilities simply to avoid the direct cost of utility relocation by the Cabinet. The ultimate cost in time and money to the public should compel the designer to consider all the impacts of utility relocation whenever decisions are made as to the location of a roadway.

To more adequately and expeditiously effect the location of utilities, the project team should specify in the advertisement for consultant services that the consultant will be required to locate utilities to the differing levels dictated by the project development stages.

EXISTING STRUCTURES:

Accurate depiction of existing structures is particularly important to the design process. Field information should completely define the structure and surrounding terrain. Additional information should be collected to describe the components of the structure (beam depths, pier heights, bridge seats, headwalls, abutments, wingwalls, etc.). A written description of the structure should also be documented.

PROPERTY LINE FEATURES:

All property lines, easement lines, lease lines, and special agreement lines, etc., within the limits of the project and in some instances in the general proximity must be identified (including KYTC's permits and agreements). All monuments and features that can aid in the description of property lines should be located.

Other information to be collected to help establish property lines may include deed descriptions, PVA maps, plats, and subdivision plans.

The names of all property owners are to be collected as recorded in the deed book, along with the deed book and page numbers and acreage or square footage.

KYTC Highway Design	*Chapter* SURVEYING
	Subject Other Survey Activities

PROPERTY BOUNDARY SURVEYS:

Occasionally, it becomes necessary to perform a property boundary survey. Boundary surveys are to be conducted in accordance with requirements defined by the Commonwealth of Kentucky, State Board of Licensure for Professional Engineers and Land Surveyors—normally, the closed traverse method with an error of closure within the limits for the particular type of survey. When practical, the boundary survey is to be tied to the roadway centerline on active design projects and to either the centerline or right-of-way line on existing highway.

All boundary surveys and gravesite location work are to be performed under the supervision of a registered land surveyor. Consultant contracts are available to accomplish this work, if needed.

All survey work for these types of surveys shall meet or exceed the "minimum standards of practice" as specified by the Commonwealth of Kentucky, State Board of Licensure for Professional Engineers and Land Surveyors (201 KAR 18:150).

GENERAL ORDER SURVEYS:

Once the Primary and Supplemental Control has been established, a General Order Survey can be done. These types of surveys can be done to Third-Order Specifications (see **Exhibit 300-02**). The types of applications for these types of surveys may be additional topographic points, staking points from a radial method, GIS surveys, and environmental surveys.

CEMETERY:

Cemetery relocation requires a boundary survey, and any gravesites within the right of way must be located in relation to the roadway centerline or boundary-survey base line.

All gravesite locations and boundary surveys of cemeteries are to be performed under the supervision of a registered land surveyor. All survey work for these types of surveys shall meet or exceed the "minimum standards of practice" as specified by the Kentucky Board of Engineers and Surveyors (201 KAR 18:150).

CONT.

DRAINAGE: Major drainage situations that will have an impact on roadway location require sufficient fieldwork for a hydraulic analysis. Methods and procedures to follow for different types of situations can be found in the *Drainage Design Guidance Manual*.

Situation surveys are required for all bridges, box culverts, and structures 54 inches or greater in diameter (or equivalent). Additional fieldwork may be necessary for other drainage features. Complete details for the requirements for situation surveys are contained in the *Drainage Design Guidance Manual.*

The necessary drainage sections and profiles (and flood plain cross sections when practical) should be extracted from the DTM. Densification and/or additional data will most likely be needed.

In order for hydraulic analysis to be completed, key information is to be obtained. This information shall include all pertinent information on existing stream, i.e., top of bank, bottom of bank, flow line, edge of water. This includes sufficient terrain data to accurately describe bridge and culvert ends. DTM data shall be taken at regular intervals (depending on the size and the uniformity of the stream) and at any point the water velocity changes. The type of material in the streambed shall be described, and it shall be noted if banks are subject to scour.

When collecting field data for the situation survey, a reach of two flood plain widths up and down stream is to be included. Surveyors should obtain information about the flood plain from available mapping, such as FEMA.

High and normal water information shall be collected and recorded with a description of how these levels were determined (include event date, if possible). If the high-water level is a result of backwater, then the source should be identified.

RAILROADS: Typically the location and topography of a railroad can be obtained from project mapping. When the location of the rail is critical, densification and/or additional survey data may be needed. In order to index the railroad mapping to the project mapping, the distance to the nearest railroad milepost on each side of the highway centerline will be measured and the information on the mileposts recorded.

When the location of the rail is critical, the surveyor shall be responsible for adequate breaklines and random points to ensure that the DTM accurately reflects the railroad in the project area. When collecting the additional data**,** all topography for 500 feet on each side of the highway centerline is to be located.

CONT.

RAILROADS (cont.):

If a highway underpass is considered, topography is typically needed a minimum of 1,500 feet on each side of the centerline for use in railroad detour plans. The topographic features include:

- Railroad switches
- Signal equipment
- Flashers
- Gates
- Pole lines (with number of wires)
- Switch-points
- Right-of-way limits
- Drainage features
- Size and type of all structures

Additionally, each rail of the tracks shall be located with the elevations taken at 50-foot intervals. In the event that drainage is to be diverted toward railroad right of way, additional data may be needed through the affected area.

All survey stakes within 15 feet of the centerline of the tracks shall be driven flush to the existing grade to avoid interference with railroad train traffic; guard stakes are not to be used within this area.

KYTC Highway Design

Chapter

SURVEYING

Subject

Property Entry

OVERVIEW: In order to complete a survey, it may be necessary to enter onto private property. In such cases, there are several actions that need to occur before accessing the property. It is also important to know who is responsible for compensating for any damages incurred while gaining access and performing the necessary operations.

PRECONSTRUCTION ACTIVITY ON PRIVATE PROPERTY: The development of roadway plans necessitates studies, surveys, tests, soundings, and appraisals of property held privately by individual property owners.

The Cabinet's intent is that all property owners be contacted and informed about any need to access their property. During the survey function, it is the surveyors' responsibility to assure that property owners are advised of when, where, and why their property will be accessed.

It is essential to respect the rights of private property ownership while recognizing the need for expeditious development of project details. The property owner's permission is to be requested before entering upon private property for necessary fieldwork. Property owners are more likely to grant permission for entry if they receive a complete explanation, a promise not to cause undue damage, and an assurance to repair damages caused by the activity.

If the property owner refuses permission for entry, the state has the right to enter upon private property for studies and related activities and may exercise its rights over refusal by the owner. The statute describing this right is KRS 416.560(4) and reads as follows:

CONT.

PRECONSTRUCTION ACTIVITY ON PRIVATE PROPERTY (cont.):

> "(4) Prior to the filing of the petition to condemn, the condemnor or its employees or agents shall have the right to enter upon any land or improvement which it has the power to condemn in order to make studies, surveys, tests, soundings, and appraisals, provided that the owner of the land or the party in whose name the property is assessed has been notified ten (10) days prior to entry on the property. Any actual damages sustained by the owner of a property interest in the property entered upon by the condemnor shall be paid by the condemnor and shall be assessed by the court or the court may refer the matter to commissioners to ascertain and assess the damages sustained by the condemned, which award shall be subject to appeal."

PROCEDURE: The individual property owners are to be contacted before entry upon their property. Contact should be made face-to-face, via phone, and/or by certified mail. The District Preconstruction Engineer is responsible for determining how and when this contact is made and who will make the contact for field surveys, sounding work, and other activities. The individual assigned this responsibility shall maintain a log of these contacts, which will be provided to the project manager. The log shall include dates and names of persons contacted and a synopsis of the discussion. The name, address, and telephone number should also be included. Consultants contracted by the department for engineering and related work must follow this same procedure.

When property owners refuse permission for entry upon their property, the District Preconstruction Engineer shall be responsible for initiating action. This action may include personal contact, contact with local officials for assistance, alternative methods of obtaining data, or other efforts as appropriate. Ultimately the use of KRS 416.560(4) may be necessary to ensure timely completion of planned activities. A certified letter providing 10 days' notice shall be given before entry upon property to initiate this process. The Preconstruction Branch Manager will be responsible for action. The date of entry should be included in the letter along with a commitment to exercise care while obtaining the necessary data.

DAMAGES: Compensation will be afforded for substantiated damages. Payment for these damages generally occurs after the actual damage and after a value has been assigned.

The Preconstruction Branch Manager shall initiate the process of compensation for damages. For amounts up to $1,000, the Preconstruction Branch Manager submits directly to the Division of Accounts appropriate documentation and a request for payment.

CONT.

DAMAGES (cont.): For amounts over $1,000, the Preconstruction Branch Manager requests a damage assessment from the District Right of Way Office. The District Right of Way Office shall determine the value of the damage. The damage value and supporting documentation shall be submitted to the director of the Division of Highway Design for approval and endorsement to the Division of Accounts for payment.

In such instances, the Branch Manager for Preconstruction shall submit to the director of the Division of Highway Design:

- A memorandum explaining the necessity for entering the property and a description of damage
- Documentation describing the property and location of the damage (include parcel number when applicable)
- Property owner's name, address, and social security number
- A copy of the release agreement

The district's right-of-way personnel will compute an assessment of losses and obtain necessary agreements and releases. The Location Engineer will be responsible for taking this request and preparing a letter of transmittal from the Director, Division of Highway Design, to the Director, Division of Accounts, requesting payment from Design funds. The social security number is needed to determine a vendor number for the property owner. The check should be directed to the Preconstruction Branch Manager, who will present the check to the designated payee upon obtaining the property owner's signature on the release agreement. This agreement, along with a copy of the check, is to be placed in the project file.

Consultants performing work for the department are encouraged to schedule and conduct their work to avoid damages to private property. Unjustified damages caused by consultant personnel shall remain the responsibility of the consultant. In the event that time constraints given to the consultant will not allow for normal scheduling of work, unavoidable damages are compensated through the Preconstruction Branch Manager in the manner described in the preceding material. The Preconstruction Branch Manager is to be contacted and his or her concurrence obtained prior to initiating actions that will cause damage. Such damage must be minimized to the extent practicable and should generally be outlined in direct communication with the property owner before the damage.

KYTC Highway Design	***Chapter*** SURVEYING
	Subject Right-of-Way Monumentation

RIGHT-OF-WAY LOCATION:

The right-of-way boundaries for newly acquired right of way shall be established and monumented for all projects. The existing right of way boundaries will not be permanently monumented. Monumentation shall be placed in accordance with the Standard Drawings and the Special Note for Right-of-Way Monuments. Monumentation includes right-of-way monuments, right-of-way witness monuments, and witness posts. The intent is to define the right-of-way boundaries on our plans and in the field.

Right-of-way monuments and witness monuments shall be flagged on the plans sheets with station and offset, and they will be documented on the coordinate control sheets with northing, easting, station, and offset. Coordinate control sheets shall be included in the right-of-way and construction plans.

All right-of-way monumentation shall be defined by the Kentucky State Plane Coordinate System, using project datum coordinates. This procedure will aid personnel in recovering the monument when necessary.

A project datum factor that relates the State Plane Coordinates and project datum coordinates for the right of way shall be published on the coordinate control sheets in the design plans.

All right-of-way monumentation shall be set under the direct supervision of a Kentucky Licensed Professional Land Surveyor.

CONT.

RIGHT-OF-WAY LOCATION (cont.): All right-of-way monuments shall be set on a project as determined by the project manager with guidance from the project development team (PDT). It is preferred that the monumentation be completed before construction. Where there is a high probability that a right-of-way monument will be disturbed by construction, the PDT may choose to permanently set monuments after the project's construction is complete. In this situation, the surveyor shall set a temporary 36-inch stake and a temporary ½-inch diameter (#4 or greater) steel rebar at the location until the monument can be placed in its final location. The stake and rebar are for temporary purposes only and will not under any circumstances be considered the final monumentation. The PDT will also make consideration of placing a witness monument outside the disturbed area if needed. In extreme cases, the omission of one right-of-way monument is permissible. In no case shall two consecutive monuments be omitted.

All right-of-way monumentation (including witness monuments) shall be established from the monumented control with an accuracy of 1:15,000 or greater. No right-of-way monuments shall be permanently set until the primary or supplemental control monuments are established and meet or exceed the accuracy required for survey control monumentation.

To aid others in the field location of the right-of-way or witness monuments, a six-foot orange witness post may be used. The land surveyor in charge of monumentation is encouraged to place a witness post for the right-of-way monuments where practical and feasible. If possible, a minimum of three witness posts per project should be placed. A witness post is to be set within one foot of the monument location and shall be set on the property of the Transportation Cabinet. A witness post shall have a label recognizing that the point is Kentucky Right of Way.

There are times when there may be several monuments in close proximity (e.g., when the right-of-way lines are making several short 90-degree turns) to one another, possibly in someone's "front yard" that becomes unsightly to property owners. In this situation, it is recommended setting only 36-inch wooden stakes within one foot of the monument. This gives the property owner notice of where the property line is.

The PDT is still encouraged to stake the right-of-way during the right-of-way process if deemed necessary to communicate with property owners. It may also be necessary to stake the right of way for construction.

EQUATIONS USED FOR PROCESS OF OBTAINING PROJECT DATUM FACTOR

THE RECOMMENDED METHOD OF DETERMINING POSITIONS ON THE PROJECT DATUM (FOR LOCALIZED AREAS WHERE AVERAGE ELEVATIONS AND AVERAGE SCALE FACTORS CAN BE USED WITHOUT A SIGNIFICANT LOSS OF ACCURACY IN MODELING THE ENTIRE PROJECT'S PLANE PROJECTION) IS AS FOLLOWS:

- DETERMINE THE TRUE KENTUCKY STATE PLANE POSITION OF EACH PROJECT CONTROL POINT.
- DETERMINE THE PROJECT SCALE FACTOR (SF) FROM THE MOST CENTRALIZED CONTROL POINT FOR THE PROJECT. THIS IS TO BE A PERMANENT CONTROL POINT (I.E. CONCRETE).
- DETERMINE THE PROJECT ELEVATION FACTOR (EF) FROM AN AVERAGE ELEVATION OF ALL CONTROL POINTS USED ON THE PROJECT.
- FROM THE SCALE FACTOR AND ELEVATION FACTOR, DETERMINE THE COMBINED FACTOR: **CF = (SF x EF).**
- CALCULATE THE PROJECT DATUM FACTOR AS THE RECIPROCAL OF THE COMBINED FACTOR: **PDF = (1 /CF)** -- THIS FACTOR WILL BE USED TO SCALE OR STRETCH THE MAPPING TO THE PROJECT DATUM.
- HOLDING 0.0,0.0 FIXED, MOVE OR SHIFT EACH CONTROL POSITION FROM STATE PLANE TO PROJECT DATUM.
- PROVIDE BOTH THE KENTUCKY STATE PLANE COORDINATE POSITION AND THE PROJECT DATUM POSITION FOR EACH POINT USED AS PROJECT CONTROL.

MATHEMATICALLY, THE SHIFT FOR EACH INDIVIDUAL POINT COULD BE REPRESENTED BY THE FOLLOWING EQUATIONS:

NPD = [NO + (NSP - NO)] * PDF
EPD = [EO + (ESP - EO)] * PDF

SINCE NO AND EO ARE 0.0, THE EQUATIONS SIMPLIFY TO:
NPD = NSP * PDF
EPD = ESP * PDF

WHERE:
NPD = NORTHING ON PROJECT DATUM
EPD = EASTING ON PROJECT DATUM
NSP = NORTHING ON A STATE PLANE PROJECTION
ESP = EASTING ON A STATE PLANE PROJECTION
NO = NORTHING ON HELD POINT
EO = EASTING ON HELD POINT
PDF = PROJECT DATUM FACTOR (THE RECIPROCAL OF THE COMBINED FACTOR)

SURVEY CLASS SPECIFICATIONS

ITEM	FIRST ORDER SURVEYS	SECOND ORDER SURVEYS		THIRD ORDER SURVEYS	
	PRIMARY HORIZONTAL CONTROLS		SUPPLEMENTAL AND OTHER SURVEYS		
RELATIVE ACCURACY BETWEEN DIRECTLY CONNECTED ADJACENT POINTS (AT LEAST)	1 PART IN 100,000	CLASS I 1 PART IN 50,000	CLASS II 1 PART IN 20,000	CLASS I 1 PART IN 10,000	CLASS II 1 PART IN 5,000
	PRIMARY VERTICAL CONTROL		SUPPLEMENTAL AND OTHER SURVEYS		
RELATIVE ACCUARACY BETWEEN DIRECTLY CONNECTED POINTS OR BENCHMARKS STANDARD ARROR (U.S. SURVEY FEET) (MI IS DISTANCE IN MILES)	CLASS I $.014\sqrt{MI}$ CLASS II $.018\sqrt{MI}$	CLASS I $.021\sqrt{MI}$	CLASS II $.028\sqrt{MI}$	$.042\sqrt{MI}$	
	TRAVERSE CONTROL				
		CLASS I	CLASS II	CLASS I	CLASS II
RECOMMENDED SPACING OF PRINCIPAL STATIONS	NETWORK STATIONS 6-9 MILES. OTHER SURVEYS SELDOM LESS THAN 2 MI.	2.5 MI	1.25 MI	.62 MI	.62 MI
SMALLEST READING OF HORIZONTAL CIRCLE ON INSTRUMENT	0.2 SECONDS	0.2 SECOND	0.2 SECOND	1.0 SECOND	1.0 SECOND
NUMBER OF HORIZONTAL OBSERVATIONS	16	8	6	4	2
REJECTION LIMIT FROM MEAN	4 SECONDS	4 SECONDS	4 SECONDS	5 SECONDS	5 SECONDS
NUMBER OF AND SPREAD BETWEEN VERTICAL ANGLE OBSERVATIONS	3 D/R 10 SECONDS	3 D/R 10 SECONDS	2 D/R 10 SECONDS	2 D/R 10 SECONDS	2 D/R 10 SECONDS
NUMBER OF ANGLE POINTS	5 OR 6	10 TO 12	15 TO 20	20 TO 25	30 TO 40
ANGULAR CLOSURE NOT TO EXCEED	2.0" PER MI STATION OR $2"\sqrt{N}$	3" PER MI STATION OR $3"\sqrt{N}$	4" PER MI STATION OR $6"\sqrt{N}$	5" PER MI STATION OR $10"\sqrt{N}$	6" PER MI STATION OR $30"\sqrt{N}$

NOTE: N = NUMBER OF ANGLE POINTS. "D" = DIRECT AND "R" = INVERTED

UNITED STATES NATIONAL MAP ACCURACY STANDARDS

1. **Horizontal accuracy.** For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scales; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings); etc. In general what is well defined will be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. In this class would come timber lines, soil boundaries, etc.

2. **Vertical accuracy**, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

3. **The accuracy of any map may be tested** by comparing the positions of points whose locations or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of the testing.

4. **Published maps meeting these accuracy requirements** shall note this fact on their legends, as follows: "This map complies with National Map accuracy Standards."

5. **Published maps whose errors exceed those aforestated** shall omit from their legends all mention of standard accuracy.

6. **When a published map is a considerable enlargement** of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20,000-scale map drawing," or "This map is an enlargement of a 1:24,000-scale published map."

7. **To facilitate ready interchange and use of basic information for map construction** among all Federal mapmaking agencies, manuscript maps and published maps, wherever economically feasible and consistent with the uses to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and longitude, or 7.5 minutes, or 3-3/4 minutes in size.

EXHIBIT 300-04

Control Monument Information Sheet

Kentucky Transportation Cabinet
Department of Highways
Division of Highway Design
Survey Coordination

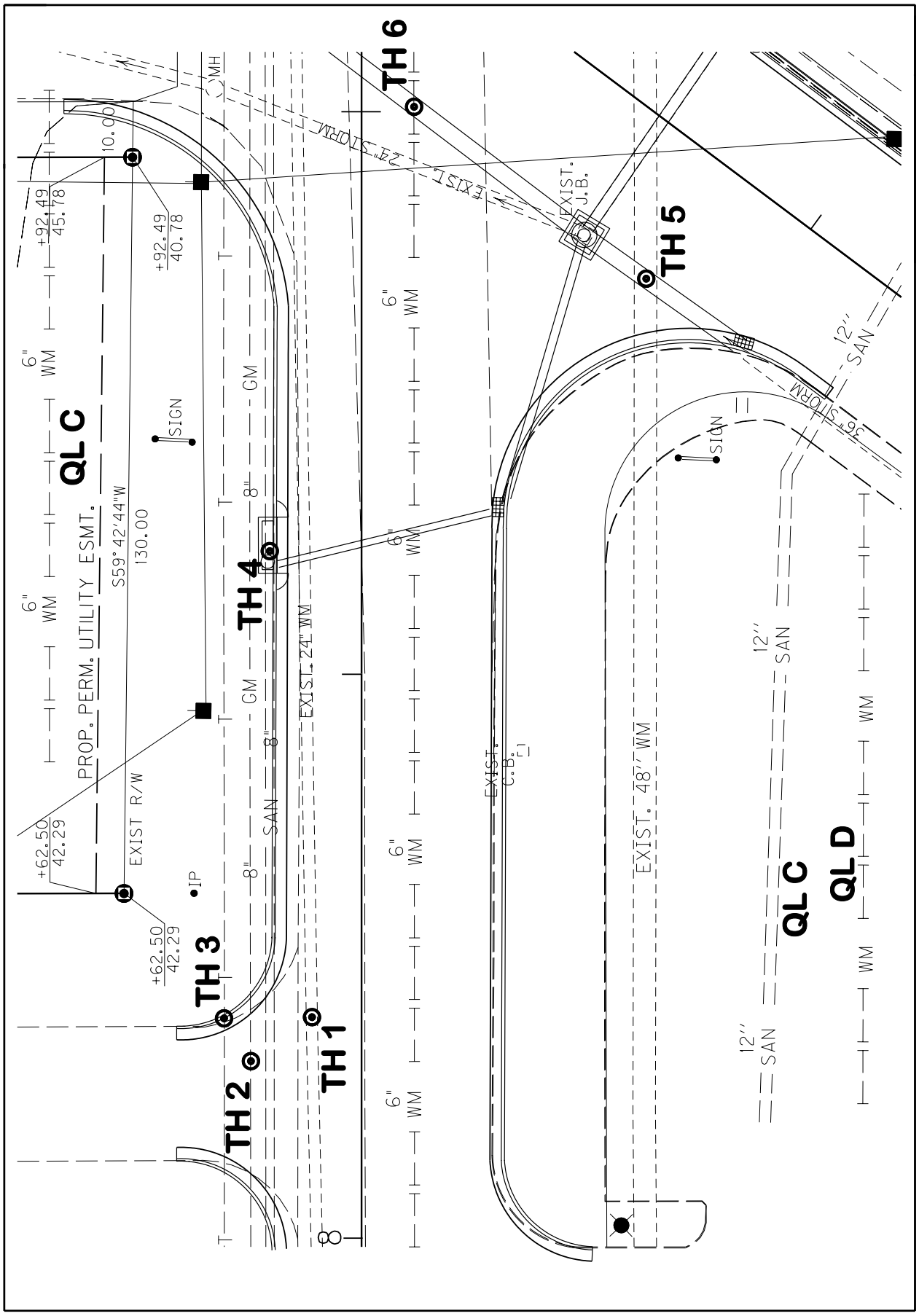
SITE/QUAD	STATION DESCRIPTION (COMPLETE DESCRIPTION REQUIRED) (TYPE, SIZE, DEPTH SET, etc.)			STATION DESIGNATION	
LOCALITY/COUNTY				STAMPING ON MARK	
DATE SET OR FOUND (DATE, with S or F)	LATITUDE	LONGITUDE	HORIZ. DATUM	ZONE	VERT. DATUM
	NORTHING (STATE PLANE) (US SURVEY FEET)	EASTING (STATE PLANE) (US SURVEY FEET)	ELEVATION	(UNDERLINE ONLY ONE) GPS DERIVED DIFF. LEVELS	ORDER ACCURACY
PERSON FILLING OUT FORM	NORTHING (PROJECT DATUM) (US SURVEY FEET)	EASTING (PROJECT DATUM) (US SURVEY FEET)	GEOID MODEL	ELLIPSOID HEIGHT	OTHER INFO.
ESTAB. BY AGENCY	PROJECT FACTOR	BACK STATION I.D.	GROUND AZIMUTH & DISTANCE TO BACK STATION		
SCALE FACTOR	ELEVATION FACTOR	AHEAD STATION I.D.	GROUND AZIMUTH & DISTANCE TO AHEAD STATION		

KENTUCKY REGISTERED LAND SURVEYOR IN CHARGE OF MONUMENTATION — KY. REGISTRATION NO.

GIVE A COMPLETE SKETCH AND LOCATION DESCRIPTION SO MONUMENT MAY BE RECOVERED BY OTHERS

EXAMPLE QUALITY LEVEL PLAN SHEET

EXHIBIT 300-05



TEXT REPRESENTING TEST HOLES AND QUALITY LEVELS ARE BOLDED FOR EXHIBIT PURPOSES.

DRAWING NOT TO SCALE

7-29-2004

EXAMPLE QL "A" DATA SUMMARY SHEET EXHIBIT 300-06

COUNTY OF	ITEM NO.	SHEET NO.
JEFFERSON	5-001.10	

QUALITY LEVEL "A" DATA SUMMARY

TEST HOLE#	UTILITY (SIZE & TYPE)	NORTHING (Y)	EASTING (X)	GROUND ELEVATION (FT)	TOP UTILITY ELEVATION (FT)	DEPTH (FT)	STATION	OFFSET (FT)	SURFACE TYPE	REMARKS
TH 1	24" CAST IRON WATER LINE	1601003.2612	276908.6201	547.06	544.27	2.79	8+36	8.28 LT.	ASPHALT	
TH 2	8" STEEL GAS LINE	1600930.3075	276914.9030	546.96	545.31	1.65	8+31	17.00 LT.	ASPHALT	
TH 3	TELEPHONE	1600933.2089	276923.4472	546.94	545.11	1.83	8+39	24.14 LT.	EARTH	12" W X 18" H CONCRETE DUCT
TH 4	12" PVC SANITARY SEWER	1601003.2612	276955.8379	547.89	542.52	5.37	9+14	16.87 LT.	EARTH	
TH 5	48" CAST IRON WATER LINE	1601085.7435	276927.1429	546.76	542.75	4.01	9+70	49.97 RT.	ASPHALT	
TH 6	6" PVC WATER LINE	1601091.4869	276977.9804	546.98	543.16	3.82	10+01	9.07 RT.	ASPHALT	
MH	24" CONCRETE STORM SEWER	1601075.0519	277010.1653	547.25	543.19	4.06	10+03	25.76 LT.	N/A	REMOVED LID TO EXPOSE UTILITY

UTILITY OWNERS:

BELLSOUTH TELECOMMUNICATIONS
3719 BARDSTOWN ROAD - 2ND FLOOR
LOUISVILLE, KY 40218
PHONE: (502) 454-9818 FAX: 545-2320

LOUISVILLE GAS AND ELECTRIC
ELECTRIC DEPARTMENT
820 WEST BROADWAY
LOUISVILLE, KY 40202
PHONE: (502) 627-3248 FAX: 627-4881

LOUISVILLE GAS AND ELECTRIC
GAS DEPARTMENT
820 WEST BROADWAY
LOUISVILLE, KY 40202
PHONE: (502) 627-3061 FAX: 627-4845

LOUISVILLE WATER COMPANY
435 SOUTH THIRD STREET
LOUISVILLE, KY 40202
PHONE: (502) 569-3600 FAX: 569-3691

ESPIRE COMMUNICATION
MEDINGER TOWER
462 S. 4TH STREET, SUITE 1770
LOUISVILLE, KY 40202
PHONE: (502) 583-6666 FAX: 583-9709

INTERMEDIA COMMUNICATIONS (C.A.T.V.)
11505 ELECTRON DRIVE
LOUISVILLE, KY 40299
PHONE: (502) 448-7336 FAX: 267-5852

METROPOLITAN SEWER DISTRICT
700 WEST LIBERTY STREET
LOUISVILLE, KY 40202
PHONE: (502) 540-6505 FAX: 540-6561

POWERTEL-SPECTRASITE
10172 LINN STATION ROAD
SUITE 400
LOUISVILLE, KY 40233
PHONE: (502) 412-7531 FAX: 412-7504

QUALITY LEVEL "A" DATA SUMMARY

EXHIBIT NOT TO SCALE 10-14-2004