



**PDHonline Course C322 (5 PDH)**

---

## **Basic Roadway Plan Preparation**

*Instructor: Jack Schmitt, PE, AVS*

**2020**

**PDH Online | PDH Center**

5272 Meadow Estates Drive  
Fairfax, VA 22030-6658  
Phone: 703-988-0088  
[www.PDHonline.com](http://www.PDHonline.com)

An Approved Continuing Education Provider

# Basic Roadway Plan Preparation

*Jack Schmitt, P.E., AVS*

## Course Content

### *Introduction*

This course provides instruction in the preparation of the general content and purpose of each sheet in a typical set of infrastructure plans that could represent a bike path, street, parking or utility improvement.

In this 5-hour on-line course, a generic format of each type of sheet explains the use of the sheet by various disciplines within the design teams, and suggests the expectations that a construction team might have for each sheet.

The goal of this course is to provide the student with an understanding of the usage and the reasoning that supports the variety of sheets in a typical set of contract plans. This understanding can provide the student with the basis for discussions with the client as well as with the other design team members on each assignment.

After completing this course, students will be familiar with:

- Setting up the Index Sheet in a manner that will avoid rework later in the project
- Typical information provided on the General Notes Sheet
- How to execute a project so the Summary of Quantities Sheet is done only once
- Structuring the Schedule of Quantities Sheet to minimize discrepancies with individual discipline sheets
  - Typical information shown on the Typical Section Sheet and how to avoid time-consuming rework
  - The steps associated with the development of Alignment and Ties Sheets, including field survey techniques employed and their design accuracies
  - Methods for establishing benchmarks
  - How Construction Traffic Control, Construction Sequencing, Detour Plan and Construction Access Sheets can minimize the impact of a project on local traffic and reduce potential project delays arising from construction-access issues
  - Typical information provided on the Profile, Drainage and Utility Relocation Sheets
  - How changes in elevation at the project boundaries illustrated on the Grading Sheet can be used to mitigate potential issues in the areas adjacent to the construction site
  - How sections are typically "cut" on the Cross Section Sheet and how the information normally depicted on this drawing has evolved over the years
  - Saving time and avoiding revisions when preparing a Construction Detail Sheet
  - How a construction project can cause sediment and erosion issues and how

sediment/erosion control is depicted in the project plans

- How seasonal landscaping restrictions can jeopardize a project completion schedule
- Regulatory requirements that impact the placement of pavement markings and signing at the conclusion of the project

This course is a "cookbook" for setting up the content and format of deliverables on the front end of a project. Any engineer involved in preparing infrastructure/roadway plans will benefit from the lessons learned by the course author, whose career has spanned three decades and included hundreds of sets of contract documents.

The intent is to reduce the expenditure of budget on false starts. The knowledge gained from the course can provide specific direction to the various disciplines involved. This knowledge can also help prepare questions for the client from a proactive position. The end result of this information is intended to be a savings in both time and labor spent on corrections or revisions, and can also reduce construction change orders.

This course provides valuable project execution tips that can save your project cost and schedule. Several low-cost activities on the front end of a project are covered that will prevent costly last minute changes.

### *The Cover or Title Sheet*

Most projects use a Title or Cover Sheet for identification purposes. For some jurisdictions or clients, a set of contract documents may be abbreviated to the degree that an official Title Sheet or Cover Sheet is not used. It is entirely possible for most of the information that might be contained on a formal Title or Cover Sheet will be included somewhere in the plans or contract documents. For the remainder of this text, the term "Title" will mean the Title and the Cover Sheet, as well as the "Lead" Sheet, "Sheet One" or any number of individualized terms in use by various agencies to identify the first or initial identification page of a set of construction plans.

The Title Sheet contains various labels, identifiers and information that will be useful to the agency funding the project, the contractor constructing the project and future designers looking for reference data that may help on other projects. The Title Sheet usually indicates a number of unique aspects of the project, including: the official name of the project; identification of the type of work to be performed and the funding program or source of money that is being drawn upon; a map or sketch showing the relationship of the project to the regional and local street network; an indication of the length of, or the area of the project; the name of the responsible agencies or design professionals involved in the preparation and administration of the project, and, in some instances, the Title Sheet may serve as a display area for such elements as the Index of Sheets or Plan Content, General Notes, public and private utility contacts, scales of the various drawings, and the delineation of labor union and permitting jurisdictions.

### **The Project Title**

The name of a project typically begins in the early planning stages, with the establishment of initial funding for studies or preliminary engineering. On rare occasions, as a project evolves, the nature of the final improvement may not exactly match the name of the project. For instance, a street-scape project may be determined to require pavement patching and then ultimately become a complete pavement reconstruction, but in order to monitor the status of the project by any of a number of

interested individuals within the funding agency, the original name of the project will remain constant. For another example, a project may begin as a roadway-resurfacing endeavor with an add-lane condition at an intersection. By the time that preliminary studies are complete, the project may have grown into one that includes a bridge replacement, a segment of complete pavement reconstruction and traffic signal modifications. It may not always serve the best interests of the funding entity to change the name of the project as additional work becomes necessary. The additional work could exceed the initial estimates for the project, which in turn could result in a formal name change as additional funding sources are applied. In some jurisdictions, the original project title or number or description remains from start to finish of the entire engineering process from preliminary or conceptual design, to final contract document preparation. Over time, based on funding constraints, the project might actually be divided into component parts. In such a case, each component would represent a particular specialty, such as roadway reconstruction, bridge replacement and traffic signal modifications. Each component could then become a separate set of plans, or the various components might become a sub-stage of the original resurfacing project, linked by completion dates to ensure a seamless progression of work.

Typically, a multi-disciplined project will involve various staff members representing individual specialties. The project could be re-named or categorized internally within the design firm, using a label understood by the firm's managing department. This process often results in the placement of a project name on an individual sheet within the plan set that is completely different from the project name that will appear on the Title Sheet. In many firms, it is common practice to label the product of a specific discipline, such as a drainage project, using a recognizable term. A client may have independent reasons for wanting to call the drawings by specific names. For instance, the engineers and technicians performing the design of the lighting segment may call it "electrical" work. The client may wish to refer to the sheets showing this work as "roadway electric plan" or "unit duct layout". If the internal staff applies their common term to the drawing rather than using the client's preferred term, the

client might have the impression that the work has passed out of the control of the project manager. This is evident when the client offers a review comment asking to use their terminology in the work produced.

The in-house process that may help avoid the expenditure of labor dollars to revise the project title that is used on the Title Sheet, as well as the project title that is used on any other sheet within the set of plans, can be quite simple. The project title might be within the Request for Proposals or in the Request for Qualifications. The project title could be in the Advertisement for Services or in an invitation to bid for Design-Build Services. However, the project title used in the initial pre-engineering period might not be the same as that used in the actual Agreement for Engineering Services. Therefore the Agreement for Engineering Services could define the engineering to be performed in general terms, but would most likely contain the official project title. Often, the representatives of the firm involved in signing the agreements are not the same as the individuals involved in the preparation of the pre-engineering submittals. Sometimes, when the firm is about to begin work, the representatives of the firm who attend the initial project kick-off meeting with the client may not be the same as the actual team members who will produce the work. In any case, the client can identify the official project title at any of the project initiation meetings. The firm then needs to advise all participants of the official name of the project and direct the staff to use the project name on all correspondence, all invoices and all sheets within the set of plans.

### **Jurisdiction and Funding Sources**

The Title Sheet will often indicate the hierarchy of authorities or jurisdictions having an interest in the project by virtue of their governmental capacity, ownership of the property upon which the project is constructed, or ultimate responsibility for the management and operation of the completed project. The project funding and approval may take place at a number of levels and be approved by various agencies or jurisdictions. It is common to display the names of these agencies at the top of the Title Sheet, in descending order or hierarchy or proportion of funding. This listing could

include the federal government, state, county, borough, parish, commonwealth, district, township, city, town, village, political precinct or management association. The listing may also acknowledge the priority for approval, or serve as a means to help identify the project as a local, regional or multi-state endeavor. It is possible for a project to commence with funding at the local level, and then to receive infusions of funding at various other levels of government or taxing jurisdictions, until the end product may consist of a Title Sheet that identifies a number of agencies whose funding has been utilized. "Ownership" or control of the project by the originating agency or client may remain unchanged.

The preferences of each client will differ regarding the ranking of the various governmental entities involved. The list might reflect the percentage of involvement, the relative liabilities incurred, or the political rankings in either ascending or descending order. An in-house process that may help to avoid exceeding the budget for the preparation of the Title Sheet would involve the preparation of a sample listing for discussion with, and concurrence from the client, thereby ensuring a minimum of revisions to the Title Sheet, since many clients allow only a few hours of effort for the preparation of this part of the work, but the end product may be revised several times as new information becomes available. A single confirmation meeting with the client would therefore save many hours of un-necessary revisions.

### **Project Identification Numbers**

Many agencies and clients utilize a numbering system as the means of identification for a project. Numbers become reference tags for the various agencies to track budgets, progress and status. This identification number may change during the various phases or stages of a project, so it is common for a project to have a unique number when it originates, a separate number when it reaches conceptual approval, another number at plan preparation and a new identification number for construction. Some agencies use the same number from beginning to end in order to ensure that a project can refocus in a different direction without losing its identity within an accounting system. For some

agency program staff, it is far easier and more cost-effective to re-define a project than to re-name or re-number it in a budget tracking system.

The numbering system may involve terms or labels such as job number, section number, project number, contract number, or other terms including fiscal year allocation, budget, line item, tracking system, appropriation, letting, or program. Each has a particular and unique origin, and each has a specific meaning to the agency. In most cases, the identification number is not interchangeable between terms and labels. The number may undergo subtle changes as the project advances from the preliminary to the final stage. A working knowledge of the derivation and meaning of the identification number is essential to ensure that it is in its proper place during design.

Given that the identification number is unique to the project, regardless of whether it refers to the project status, design job number, construction funding source or program year, the Title Sheet is the logical place for the display of all of the numbers, in the exact format that the agency prefers to see them listed, which have any bearing on the nature or development of the proposed improvement. This may include all manner of punctuation, hyphenation, brackets and spaces between letters and numbers. Often, the identification number appears in a specific manner or location on each of the drawings within the set of plans. The number may also be in bold font, italics or specific lettering size.

To avoid having to revise the project number on the Title Sheet as well as on the various other sheets or locations within the set of plans, the firm performing the work will need to understand the numbering system of the agency, the preferences of format for the number and the location for the number to be placed on a sheet. This also requires that the firm communicate the number to all disciplines involved in the project, as well as the firm's internal accounting and invoicing staffs. This will ensure that each transmittal to the client is identifiable for processing by the recipient departments. The need for this type of coordination becomes apparent on a multi-disciplined project, where each group of staff members involved in a unique specialty could generate drawings and reports using the identification number in a variety of forms and formats.



Structural teams will often use an initial project number for their preliminary submittal, and will retain the use of this number throughout the entire design process. This can result in last-minute revisions of each Sheet produced by a design discipline in order to comply with the client's system.

## **Project Maps**

The Title Sheet will typically contain a map to locate the project. The type and scale of the map will vary based on the client. In some cases, more than one map may help identify the project within various jurisdictions. A quick glance will show a state official, such as a member of the elected representative body, state maintenance or policing agency, or a labor-related official, where the project is located in order to determine whether action, reaction or acknowledgement is required. A prospective bidder on the project can use the mapping to identify the relative proximity to staging areas, supply sources, borrow pits or dump sites. The prospective bidder can also determine the surrounding access conditions. A project map can be used to provide an indication of the relative length of the proposed improvement.

## **State or County Map**

If a project is subject to federal or state funding, a statewide map will typically be included in order for the appropriate federal and state agency officials to quickly identify the work within their district or area of responsibility. Given the wide range of services provided at the state and federal levels, an agency may be involved or affected without having been in direct contact with the firm performing the design services or the client originating the assignment. This could include environmental agencies, interstate commerce commissions, regional planning coordinators and various bureaus whose databases will be affected or will require updating to reflect the project. There is inter-agency overview at various levels of government, but no singular entity can have all knowledge of all projects from the public and private sectors in any one region which might be taking place at any given time. It would be most undesirable to allow the

implementation of an improvement to have a negative impact on the regional transportation network. So, for that reason, a simple mark on a state-shaped map provides a macro-view that can suffice as a prompt to allow the exchange of critical information regarding projects which may overlap in a specific area.

### **Local Project Map**

The bidder or prospective contractor will focus on the micro-view of the project, typically presented as a location map or local sketch or roadway system map. This map identifies the project limits, the interaction with the local street network, the orientation of the project with regard to political boundaries such as city limits, county or township lines, and the survey terms such as USGS range and township so that other available mapping can be obtained in an efficient manner.

The interaction with the local street network would allow the potential contractor to see the access routes to the project, which might involve crossing railroad tracks, congested highways or bridges over waterways which may have seasonal delays. It would be beneficial for the location map to show all streets in the project area. However, each agency has its own requirements and it is common for a project location map that is used for a state or county project to have a different focus on the street network than the map used for a local municipality or township. All mapping would not be to the same degree of detail in every project, but it is typical to show all of the numbered routes, interchanges and intersecting streets as a minimum. The potential bidder will most likely visit the project site as a prelude to compiling an estimate of the costs involved in constructing each component part of the project. Access or delivery routes, areas for the field office, worker parking and material storage, overhead electric power and telephone lines, viaducts and heavy traffic generators would not necessarily be shown on the location map, but would be observed by the potential bidder during a visit to the project site. The contractor and suppliers may be approaching the project from all directions, at various times of the day, and will need to be able to prepare a bid based on the realities of dealing with all physical parameters associated with the project

site in order to be able to complete the project within the time-frame indicated in the proposed schedule.

The project might cross municipal, township or county lines, affecting labor rates, engaging various ordinances which might affect hours of operations, interrupt routine seasonal maintenance or impose noise restrictions. School District boundaries may also affect the hours of operations, since certain streets in the project area may contain bus-loading areas. Schools or Park Districts may have athletic fields within the immediate vicinity of a project, which would in turn affect the use of streets in the area. The location of a project will also necessitate an understanding of the jurisdictional boundaries for emergency services, public transit and school bus routes, in order to schedule the timely arrival of materials to the job-site, such as asphalt and concrete. Delays in arrival affect the placement of such time and temperature-sensitive materials. Forest Preserve District boundaries may also cross the project, initiating ordinances or regulations that could affect native flora and fauna.

A roadway-based map is not the only document that identifies the properties of a project area. By providing the township and range on the project location map, the prospective bidder can easily reference aerial-based photographic mapping, as well as soil conservation district documents to assist in locating borrow pits, areas under construction and drainage features. A project might require borrow or disposal of excess excavation, which will require an assessment of the logistical needs for access and return routing. A project that is affected by a nearby waterway might be augmented by a map that delineated the anticipated high-water elevation of record so that sufficient planning could take place to avoid flood damages. An overview or knowledge of the direction from which overland flow will arrive, and an identification of the downstream recipient of project runoff will assist in determining the frequency of maintenance and replacement of erosion control systems, avoiding seasonal events which could adversely impact operations. A map showing the soils of the area will inform the prospective bidder of the nature of the underground material which might be encountered. Many

categories of information and knowledge of the surrounding area are essential in the preparation of a competitive bid.

To be of sufficient practical use, at a minimum, the location mapping will need to identify the project limits against the background of the local street system. Regional roadway systems such as expressways and interchanges can assist in guiding the prospective bidder to the project site. The information conveyed by the location map or sketch will be enhanced with the inclusion of political or survey labels to help find other maps which might be of use to augment the preparation of a bid or to see the proximity of projects underway by other agencies. Providing the length of the improvement may help a potential bidder identify whether the project is of sufficient size to warrant the investment of resources to prepare a bid. Revisions to the map can be avoided through a discussion of the anticipated usage of the map with the client, by comparing the map to that shown on similar projects in the area, and by comparing the latest roadway mapping available with aerial photography and a field visit. Incorrect geographic placement of a project on a regional map can lead to revisions in construction staging, traffic detours and unintended labor hours in other parts of the plans. The project design team sometimes gets their job-site knowledge from a photo log, and sometimes the project budget only allows one field trip to the job-site. For projects of multiple-year duration, a person who made the visit or who took the photos could leave or be re-assigned. Job-site knowledge can be lost during a project.

### **Design Data**

The Title Sheet can convey basic design criteria for a roadway, which in turn serves as a guide or prompt for scheduling future maintenance operations. The criteria listed will not always reflect design criteria for internal elements such as drainage and landscaping. On the other hand, when the criteria identifies the intended design service life and the anticipated usage of the road, it can serve as a quick reference in the event that traffic were to be routed onto the project as part of a future detour that might be contemplated to allow expedient construction of another project. It is not infeasible for a

detour to adversely impact a roadway that had not been intended to handle a high volume of traffic. The design criteria for a water-main, sewer or culvert can also be useful as a quick reference for assessing the type of materials that may be required for construction.

## **Design Year**

Projects can be designed to serve the public for a specified number of years. A Drainage project involving a ditch may be expected to serve for a different length of time than a Drainage project involving a sewer pipe. A sanitary sewer project might be dependent on the anticipated daily loading that is to be temporarily conveyed during construction. A Bridge project may have components that are intended to endure for 50 years, while a mixed-use pedestrian / bike path could be expected to provide service for 25 years. The timeframes will depend on the local jurisdiction as well as industry guidelines.

Roadway projects are designed to serve traffic for a specific timeframe, known as the design life, which designates the intended service life of the pavement. This period of service, typically measured in units of axle loadings, but often stated in years, is based on the anticipated average annual traffic. In some jurisdictions, the design period serves to trigger implementation of routine inspection, pavement rating and programming of future budgets to ensure pavement maintenance. Even though a pavement may have a design life of 20, 30 or more years, the surface of the pavement may need routine maintenance in order to ensure that the intended friction factor is provided for the service life of the pavement. For an agency using a comprehensive pavement maintenance program, the Design Year data assists in the calculation of the estimated future costs of pavement rehabilitation.

Some pavements serve a limited number of heavy-axle and tandem-trailer vehicles over their service life. This number could be presented on the Title Sheet in one of several related terms, which could be the Average Daily Traffic ( ADT ), the Design Hourly Volume ( DHV ), the Traffic Factor ( TF ), Average Multiple Units ( MU )

anticipated in the design period or the Maximum Hourly Volume ( MHV ). There is a direct correlation between pavement design and the number of axle loadings anticipated to be received during the design life. In the event that the anticipated number of axle loadings occurs prior to the design life, the pavement will begin to fail, resulting in the need for attention by the maintaining agency prior to the date or time at which such work was anticipated or programmed. Premature pavement deterioration can also be the cause of vehicle incidents, which in turn can engage the designer in legal issues that were not anticipated.

The Design Year is a future date that is determined during the concept stage of a project. In some instances, based on policy modifications and the impacts of local development, the Design Year can change to a later future date during the plan preparation stage. Since the Design Year can affect the pavement typical section and in turn affect the content of various drawings within a set of plans, it is necessary for various design disciplines to routinely verify the Design Year in order to avoid spending labor budget to revise other drawings in the plans that depend on this information. This becomes more critical if a project involves a bridge, since the design loadings may vary depending on the projected traffic in the Design Year. The structural design staff could be faced with numerous revisions as well as re-application for approval of design criteria in the event that changes in the design parameters go un-noticed until the project is prepared for submittal.

### **Route Designation or Classification**

All roadways receive a designation or classification, based on their intended function, operation or use as well as by the geometry of the facility. The terminology can vary between states, jurisdictions and agencies. Both numbers and words are often used. The numbers can refer to a federal, state, county or township system. The wording may use terms such as urban, rural, collector, distributor, arterial, primary, secondary, major, minor, principal, freeway, highway and Interstate.

If a project is to cover several locations, it is common for the designation or classification to reflect the terminology relative to a region that uses terms that differ from those used by the client. Generally the Title Sheet is the first sheet that displays the roadway designation or classification. Future reference to the roadway designation or classification can provide the information necessary to verify the suitability of a pavement to serve as a detour route for heavy traffic or to track changes in the characteristics of regional travel.

### **Pavement Type**

While there are literally four million miles of roadways in the continental United States, only about half are paved. In various locales, a numbered route roadway could be a dirt, gravel, chip-sealed aggregate or full-depth aggregate road, but it would not necessarily be described as a paved road in the same fashion that the term would be applied to a concrete-surfaced or asphalt pavement.

Within the categories of concrete and asphalt pavements, there are a number of sub-categories for use on the Title Sheet to define a project in a word or two. An asphalt-surfaced pavement can be full depth or it can be a component of a compound pavement having a thin layer of asphalt placed over a variety of base courses. A concrete-surfaced pavement might consist of plain, jointed or reinforced concrete, all of which are different with regard to construction methods, service life and adaptability to various rehabilitation approaches.

The terms asphalt and concrete may engender differing images depending on the individual reading or hearing the term. Often, the subtleties of the pavement design will be of no interest to the driver or casual observer. The information displayed on the Title Sheet is of greater importance when referenced during a future contract, since the pavement type can immediately impact selection of construction type, pavement rehabilitation and the re-use of removed portions of the pavement for other purposes, such as recycled bituminous materials. It is necessary to use the correct terminology when labeling the pavement type in order to avoid mismatching the pavement with

another type. Plan revisions to implement jointing of two different types of pavement can be avoided if the identity of the adjoining pavement is known at the beginning of the project, and is conveyed to the design staff as personnel and management changes occur.

### **Design Speed and Posted Speed**

Some clients will require listing design speed or the posted speed for a roadway facility on the Title Sheet for quick comparison with criteria as well as for future reference during the life of the project. The design speed will govern the selection of horizontal and vertical geometry, lane width, sign information and sight distances. The posted speed limit is subject to legal implementation. The design speed applies to traffic analysis, detour selection and realignment studies.

The design speed is not necessarily interchangeable with the posted speed limit, and a clear understanding of this concept will avoid redesign of signing, traffic control, construction staging and roadside safety elements.

### **Responsible Parties**

Most projects begin with planning, meetings and decisions within an agency. A project may have an elected official as a designated funding sponsor. In most instances, that sponsor would not necessarily be listed as the authorizing party on the Title Sheet. The client from whom a firm receives the assignment to prepare a set of roadway plans might be the authorized agent of the actual funding or sponsoring source, but the client may not be the ultimate responsible party. The term "responsible" does not indicate maintenance jurisdiction, permit authorization or liability. It is intended to identify the main body through which action has been taken to process a need for an improvement from the concept stage, through various alternative studies and ultimately to the preparation of contract documents including the set of drawings containing the roadway plans.



In many cases, the Title Sheet will list a hierarchy of governmental agencies, in ascending or descending order, depending on the preference of the region, locale or the client. The state and local municipality will appear, while some of the other agencies listed might not have a funding or approval role in the project, but might be the origin of the controlling specifications for the work. In this manner, the State or Commonwealth, County, Borough or Parish, city, village or municipality, and perhaps additional entities such as a township or park district, could be involved with a project, depending on the nature of the work.

### **Agency Approval**

The Title Sheet will often provide an opportunity for a designated individual representing the authorizing agency to sign and date their approval of the set of contract plans and documents. This signature will often set in motion a sequence of events that will lead to the publication of intent to receive bids for the work. The name of the project manager or department head within the agency having jurisdiction over the preparation of the contract plans may appear, and in some instances, this person might sign the Title Sheet.

### **Funding Source Approval**

The entity providing the majority of the funds for the project is typically mentioned in the name of the proposed improvement, using terms such as “federal-aid”, “state-funded”, “tax increment financed” or “motor fuel tax”. In most instances, a representative of the funding agency will not sign the Title Sheet, but will have signed the appropriate forms at the conclusion of the preliminary engineering, during which the basic design parameters are established.

The authority to print and publish the plans to solicit bids appears as an expression such as “Printed by the Authority of the State”. The plans become the property of the constructing agency in most cases, and are not transferable to other agencies without proper legal documentation.

## **Licensed Professional Seal**

All work designed to serve the public good is prepared under the direct supervision of a licensed or registered professional engineer. In some cases, a project may be signed and sealed by an architect or by a Landscape Engineer. In addition, structural, electrical or architectural work will require the signature and seal of the appropriate individual who bears the liability for the safety of the public, required by law to be identified in most funding jurisdictions.

A sample set of plans can be the best guide for the layout or hierarchy of agency recognition on the Title Sheet. This will only be the case when the sample set represents similar work, similar funding conditions and a similar approval process, and is a recent product, prepared for the same client contact. Better still, it would be considered highly professional to simply ask the client if the sample set represents the latest in the client's expectations. The client would not appreciate having to remind the design firm of the project location, the source of funds or the name of the client agency that authorized the work. Often this information appears in correspondence, agreements and minutes of meetings. The unnecessary expenditure of labor dollars will be avoided by preparing a sample sheet for the client's review if the assigned staff is not able to access the necessary information that is to appear on the Title Sheet. Staff changes within the client organization are as frequent as those which occur in design firms. It is not unusual for a final draft of a Title Sheet to be returned for revisions due to staff reorganization in a client agency. This can be avoided by having the client contact perform a quick review of the names listed on the Title Sheet.

## **Miscellaneous Information**

For ease of filing, paperwork reduction, quick reference and standard practice, the Title Sheet may contain various bits of information that apply to the work or to the internal sheets themselves. In some agencies, redundancy is avoided, while in others, it is encouraged. These bits of information may need to be disseminated to the various

disciplines involved in plan preparation in order to avoid having to revise things such as drawing scale, utility contacts and sheet numbers.

A sewer project might include the names and contact information for emergency services as well as a listing of the current operational agency or owner, the regulatory board members, the types of effluent in the system, the pressures under which the system operates and the types of materials that compose the existing system.

## **Scales**

Plan drawings may be prepared in standard units of measure consisting of feet and inches, or in metric units consisting of meters and millimeters. The scale of a drawing will depend on the common practice of a discipline, and can range from a ratio of 1:5 to 1:500. Some agencies require that all scales be identified on the Title Sheet. Other agencies will require the identification of scale be displayed on each sheet.

The scales to be found on the drawings can be depicted in numerical terms or by using a bar scale. A bar scale will allow relative measurements to be scaled on a paper set of plan sheets that have undergone repeated printing and reproduction or fax transmission without introducing errors beyond an acceptable range of proximity. The bar scale can be accurate to the incremental division of units on the scale. Any further sub-division is subject to interpretation and a degree of inaccuracy.

The scales shown on the Title Sheet can be helpful if they represent the actual scales used on the drawings in the plan set. A set of infrastructure plans can include work by other disciplines such as Landscape Architects, Urban Planners, Structural and Electrical Engineers, who may by practice, utilize an expanded scale, a common scale such as 3/8:1, or who may use no scale at all. Coordination with the client is necessary to determine the preferred scale and the range of scales to be used on each project. In the event that the scales listed on the Title Sheet are not universally applicable to all drawings within a set of plans, a disclaimer may be needed. Many hours can be saved by familiarizing the design team with the content of the scale range shown on the Title Sheet.

## Utility Contacts

A project does not have to extend below the surface of a roadway in order to encounter utilities. Both public and privately-owned utilities can have facilities and appurtenances at grade (a manhole cover) as well as above grade (a fire hydrant or telephone pedestal) and overhead wires, (cables or conduit) which might be impacted by construction operations. Junction boxes on pedestals and low-hanging overhead wires, which can be inadvertently struck without intent to move or to adjust them, are common examples of ancillary utility involvement. Shallow buried conduits and vehicle detectors can also be impacted by unintentional operations such as advanced construction signing, vehicle parking or servicing. Utility companies are often acquired and third parties might manage their physical facilities. The coordination process that began during the concept stage may establish a primary contact for the exchange of information, locations and policies. It is not unusual for that contact to become invalidated by the time a set of roadway plans is in use for construction operations. For these and other reasons, the Title Sheet will typically provide the name or telephone number for a centralized contact that will attempt to ensure that all affected parties can be identified and have their facilities marked in the field. Often, a privately owned utility might choose not to participate in the collective identification process, in which case additional contact information may be required within the set of plans.

Striking an unidentified utility can be costly to the responsible parties and could be injurious to workers and the general public. The time invested in gathering the utility contact information may exceed the time that it takes to place the information on the Title Sheet or at another prominent location within the set of plans. Just as no single agency can be expected to know all of the potential projects which might be under development, it is also impossible for a single entity to know the status of every utility within a specific locale. A private utility can be sold, relocated, upgraded or removed during the time that a set of plans is being prepared. Repeated coordination with the utility company is the best method to obtain the latest information and confirmation of

the line-work shown on a set of plans. The client may invite all known utility owners to identify themselves when the project is advertised for bids. All of the identified utilities can have representatives attend the project pre-construction meeting. To safeguard the public good and to avoid overlooking a utility and incurring the resulting damages, it is in the best interests of the client and the designer to list the utility contacts, walk the jobsite and physically verify the utility information.

### **Finished Product File Location**

All agencies utilize a filing system of some sort from which to retrieve information from projects that will be useful in the future. Systems have evolved from hanging files, flat files, and cubby-holed rolls of prints, microfilmed, photographed and scanned sheets. The indication of the intended file location is shown on the Title Sheet for the client's use. The actual repository may change several times during the service life of the proposed improvement. The Title Sheet would be a logical point of origin for a future search of the files to obtain pertinent as-built information.

The client will indicate the current or intended filing location for the set of contract plans to be stored after the completion of design and construction. This information might be shown in a variety of ways, and no two agencies might use the same process or nomenclature.

A sample Title Sheet is shown in Figure 1. The sheet resembles the Title Sheet for a mid-sized roadway project. The Title Sheet can consist of something as minimal as a cover page containing the agency logo and a one-line description of the project. The Title Sheet can be a sheet that contains the project name and number.

The purpose for each sample contained in this text is to provide a foundation upon which to build selection criteria for information that could be presented on each of the various types of sheets. The samples are not intended to be used as a template for any sheets used by specific agencies. They are presented as a guide for the assembly of questions to ask internally or externally, to save time and labor dollars by avoiding unnecessary efforts, or to direct efforts in an organized manner.

As computer-aided drafting continues to dominate the preparation efforts, many agencies and clients have prepared cell libraries, base sheet templates and sample format sheets to assist in the plan sheet creation process. Some have gone to the extent of specifying font for lettering, line-weights to be used for centerlines, object lines, existing topography and actual sizes to be used for symbols to represent most topographic features that will be encountered, from guardrail to picket fencing, from inlets to junction chambers, from marsh grass to mature trees, and from traffic signals to runway edge lights. Familiarity with the client's library resources will save labor that might need to be spent re-drawing an object. Time can also be saved by ensuring that the correct symbols for common objects are being used, since all agencies do not use the same symbols or line weights for every case and contingency. The design team's creativity and individuality might be appreciated, but it can also be costly to revise if the client does not accept it.







### *The Index Sheet*

An Index Sheet may be as simple as a table of contents listing the names of the sheets contained in the set of plans. The Index Sheet can also be expansive and detailed, depending on the preference of the client or agency. The contents and arrangement of an Index Sheet varies from agency to agency and could simply mention the grouping of a variety of categories of sheets, such as paving and roadway plans, utility sheets, details and cross sections. An index of this type can often be small enough to fit on and be displayed on the Title Sheet. An expanded index often requires a sheet of its own to list the titles of all of the various sheets in the set of plans along with a listing of other stock agency standards and details that are referenced and may or may not be included within the plan set, depending on the client practice and reproduction cost restraints. The various other standards that are listed in the index but not included in the set of plans may need to be obtained by the contractor for use on the project. Incorrect reference may become an element of a change order, thereby requiring an assurance that the references are both accurate and up to date.

If the index requires its own Index Sheet, then it is typical to list each drawing contained or referenced in the set of plans by its full name. The order in which the sheets appear in the set of plans will vary by state, region, agency and funding source. Some clients prefer to present the sheets in logical order of operations, while others list the general informational sheets and all of the intended quantities before showing the actual work, followed by a presentation of the traffic control or above-ground work before showing the related drainage or underground work. Some agencies prefer to group the removal items together. Some clients address the erosion control or grading together with the typical sections. Some may present the removal items within the construction staging.

Given the variety of permutations and the preference for cross-referencing between sheets, it is incumbent upon the designer to have a clear understanding of the client preference in order to avoid having to re-number sheets, re-shuffle the order of presentation and revise the Index Sheet, all of which would represent additional labor

that could be avoided. The use of sub-sets or groupings of sheets in disciplines as well as the use of plan stationing rather than sheet numbers for cross-referencing can save labor prior to submittal. The content of the Index Sheet, as well as the content of any sheet in the set of plans, needs to match the information listed in the title block of the sheet.

Some agencies have begun using specific naming conventions as part of their filing system. This is particularly true for those agencies that have adopted a data base system that catalogues their drawings in one of the many available project management software programs. Learning the client's preferences and their naming conventions can save labor hours, and it can also serve as a basis for a sub-set numbering system for the various groups of sheets such as lighting or landscaping. Each agency or client may have their own preferences for dates to be placed on the sheets, identifiers such as "Preliminary", "Final", "Advertised" or "Amended".

A sample Index Sheet is shown in Figure 2.





### *The General Notes Sheet*

A full set of contract documents may include several other publications by reference. A set of infrastructure plans may require months of preparation, during which time the reference materials may be updated or superseded. The design of a project is guided or directed by specific criteria. The construction will also be controlled by Specifications, published manuals, agency guidelines, Special Provisions and regional best practices. Often, an agency's experience will dictate that it is beneficial to post specific directives or reminders in a prominent position for quick reference and to establish a hierarchy of precedence. In some cases, repetition of information found elsewhere might be discouraged. Instead, reference might be made to the preferred criteria, test methods, detour routes, work periods, utility contacts, borrow or disposal areas and unique details that might not be discovered by a cursory perusal of the infrastructure plans. Some information might be useful in obtaining bids. Additional information might alert the potential contractor to the need for special consideration of a local situation. For other agencies, redundancy is preferred in order to allow various sheets of the contract plans to be distributed to sub-contractors without printing or purchasing another set of plans.

The General Notes Sheet might serve in some jurisdictions as a location to "state the obvious". Often this procedure is used to reinforce the importance of a particular procedure that may have been the source of difficulty on a previous project. This condition makes it more important to read every General Note rather than copy a block of notes from one set of plans to the next, even if it appears to apply to similar work, since the condition that prompted the note could have been resolved long before the next set of plans is under preparation, thereby rendering the note unnecessary.

The presence of a General Note in a set of infrastructure plans prepared for an agency on one project does not automatically guarantee that the same General Note will be used on another project for the same agency. A General Note in one set of plans might have a title that resembles a topic that appears to apply to a similar case, but might only be applicable to certain communities. A thorough reading of each note will

determine whether each is applicable. As in all cases of providing services to a client, it is more cost-effective to prepare a draft for the client's review early in the project rather than to compile a set of General Notes that will be edited at the final stages when time is critical.

One of the most common situations that occur during the construction phase of a project is often the result of a line of text in a General Note, which introduces an approval process or transfers control of a segment of construction to another individual. This typically occurs when a General Note is inserted or copied from another set of plans without a thorough reading by the project staff.

A General Note can also be the basis for a construction claim if the text of the Note contradicts the content or text of a Special Provision. Most agencies will establish the hierarchy of control for the content of the contract documents. Complications can occur when external text, such as health and safety codes or regulations, is referenced and the content of the referenced document contradicts the content of a General Note. For instance, a General Note might indicate that a sewer is to be installed in accordance with Standard Specifications. The Standard Specifications might require the involvement of a public agency, and the General Notes might indicate that all work is to meet the approval of the Engineer.

A sample General Notes Sheet is shown in Figure 3.



FILE NO.	SECTION	COUNTY	TOTAL SHEETS
STA. TO STA.			8
TID. ROAD DIST. NO. 1			CONTRACT

### COMMITMENTS

- PRIOR TO CONSTRUCTION COMMENCING IN THE INTERCHANGE AREA, THE LOCATION OF THE IDENTIFIED AREAS WITHIN THE INTERCHANGE AREA TO BE IDENTIFIED AND FENCED OFF WITH RED FLAGGING. A MEETING WITH THE PRE-CONSTRUCTION MEETING TO ALERT CONSTRUCTION PERSONNEL OF THE SENSITIVITY OF THE PLANT SPECIES AND THE NEED TO AVOID ACCIDENTAL INTRUSIONS OR SPILLS IN THE AREA. THE TRADING AREAS THAT WILL NOT BE IMPACTED BY THIS PROJECT INCLUDES THE VOLBROCK WOODS AND SEEPAGE TAIL SITES, AND THE IDENTIFIED SAND FLATWOOD COMMUNITIES.
- BASED ON THE SENSITIVITY OF THE PLANT COMMUNITIES IN THE SOUTHWEST QUADRANT OF THE INTERCHANGE AREA, PRECAUTIONS WILL BE TAKEN TO MAINTAIN EXISTING GROUNDWATER LEVELS THAT ARE SUPPORTING THIS COMMUNITY. SUBBERT CREEK, A TRIBUTARY OF THE INTERCHANGE AREA, WILL BE PROTECTED BY ANTI-SEEP COLLARS PLACED ON STORM SEWERS IN THIS AREA.
- THE NEAR SURFACE GROUNDWATER UPON WHICH THE BIOLOGICALLY SENSITIVE AREAS DEPEND WILL BE PROTECTED FROM COMPACTATION DURING CONSTRUCTION AND DRAINAGE DURING ANY AND ALL EXCAVATIONS BELOW GROUNDWATER. IN ORDER TO MAINTAIN EXISTING SOIL PERMEABILITY IN THE INTERCHANGE AREA, THE CONTRACTOR SHALL TAKE CARE TO AVOID OVERLY COMPACTING VEHICLES OR MACHINERY ON THE WORK ZONE. THIS WILL INCLUDE THE USE OF LOW GROUND WEIGHT VEHICLES OR MACHINERY TO REDUCE RITTING. THE CONTRACTOR IS RESPONSIBLE FOR RESTORATION OF ALL RITTED OR COMPACTED AREAS TO THE SATISFACTION OF THE ENGINEER.
- THE CONSTRUCTION OF ROADSIDE DRAINAGE SHALES WILL NOT INTERRUPT GROUNDWATER LEVELS. ROADSIDE SHALES ARE CONSTRUCTED WITHIN THE INTERCHANGE AREAS TO ACCEPT ROADWAY DRAINAGE WATER. THE CONTRACTOR SHALL MAINTAIN THE EXISTING GROUNDWATER LEVELS WITHIN THE TEMPORARY WORK AREAS AFTER CONSTRUCTION IS COMPLETE. THE CONTRACTORS SHALL PROVIDE CHAIN LINK FENCING AROUND WETLANDS AND WATER BODIES TO PREVENT ACCIDENTAL INTRUSIONS OF THE CONSTRUCTION PERSONNEL AND EQUIPMENT. NON-INTRUSION ZONE SIGNING WILL ALSO BE INSTALLED WITH THE FENCING.
- UNLESS OTHERWISE SPECIFIED, WORK REQUIRED TO COMPLY WITH THE COMMITMENTS WILL NOT BE PAID FOR SEPARATELY, BUT WILL BE INCLUDED FOR PAYMENT WITH THE VARIOUS ITEMS INVOLVED

REVISIONS	DATE

GENERAL NOTES

# FIGURE 3

### GENERAL NOTES

- BEFORE STARTING EXCAVATION, THE CONTRACTOR SHALL CALL FOR FIELD LOCATIONS OF BURIED ELECTRIC, TELEPHONE, AND GAS FACILITIES. (48 HOURS NOTIFICATION IS REQUIRED)
- THE CONTRACTOR SHALL COORDINATE CONSTRUCTION ACTIVITIES WITH UTILITY COMPANIES, MUNICIPALITIES AND ADJACENT CONTRACTORS.
- THE CONTRACTOR WILL NOT BE ABLE TO SET UP A YARD OR FIELD OFFICE ON STATE PROPERTY WITHOUT WRITTEN PERMISSION FROM THE DEPARTMENT.
- THE REMOVAL OF QUARRIAL TERMINAL SECTIONS SHALL BE MEASURED AND PAID FOR AT UNIT PRICE PER METER FOR QUARRIAL REMOVAL.
- BARRICADES: THE CONTRACTOR SHALL PROVIDE AND INSTALL TWO (2) WEIGHTED SMOGBAGS ON EACH TYPE I OR TYPE II BARRICADE USED - ONE (1) WEIGHTED SMOGBAG ACROSS EACH BOTTOM RAIL.
- WHEN ARTIFICIAL LIGHTING IS UTILIZED IN NIGHT OPERATIONS, THE CONTRACTOR SHALL EXERCISE THE UTMOST PRECAUTIONS IN PREVENTING ADVERSE VISIBILITY TO THE MOTORING PUBLIC AND ADJACENT RESIDENTIAL AREAS.
- A NOMINAL QUANTITY OF "REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL" HAS BEEN INCLUDED. ALL POTENTIALLY UNSUITABLE SOILS SHOULD BE TESTED WITH A STATIC PENETROMETER AND TREATED IN ACCORDANCE WITH ARTICLE 301.03 OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION. UNSUITABLE MATERIAL IS MATERIAL THAT IS NOT SUITABLE FOR USE AS A SUBGRADE. UNSUITABLE MATERIAL IS NOT ENCOUNTERED, THEN THE QUANTITY SHALL BE DEDUCTED AND NO ADDITIONAL COMPENSATION WILL BE DUE TO THE CONTRACTOR.
- ANY REFERENCE TO "STANDARD" THROUGHOUT THE PLANS OR SPECIAL PROVISIONS SHALL BE CONSIDERED TO BE THE "STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION" ADOPTED JANUARY 1, 2003 BY REGIONAL SPECIFICATIONS DIVISION.
- WORK ON THIS CONTRACT MAY REQUIRE LABORERS TO CROSS EXISTING PARADELSES AND SHOULDER TO ACCESS WORK AREAS. THE CONTRACTOR SHALL PROVIDE AND MAINTAIN CHAIN LINK FENCING AND SIGNING TO PROTECT THE PARADELSES AND SHOULDER. NO COMPENSATION WILL BE MADE FOR THE REPAIR, REMOVAL AND/OR REPLACEMENT OF EXISTING PAVEMENT OR SHOULDER CAUSED BY THE CONTRACTOR'S OPERATIONS.
- POORUS GRANULAR ENHANCEMENT, SUBGRADE (PSES) HAS BEEN PROVIDED FOR USE AT THE LOCATIONS INDICATED ON THE PLANS. PSES SHALL BE INSTALLED AT THE TIME OF CONSTRUCTION BY THE CONTRACTOR IN ACCORDANCE WITH ARTICLE 301.03 AND THE DOT SUBGRADE STABILITY MANUAL. IF UNSUITABLE AND/OR UNSUITABLE MATERIAL IS NOT ENCOUNTERED, THEN THE QUANTITY SHALL BE DEDUCTED AND NO ADDITIONAL COMPENSATION WILL BE DUE TO THE CONTRACTOR.
- PRIOR TO THE INSTALLATION OF TOPSOIL, REGARDLESS OF SLOPE, THE SURGRADE SHALL BE RECONSTRUCTED BY A TRACKED VEHICLE NO MORE THAN 7 DAYS PRIOR TO PLACEMENT. THIS WORK SHALL BE INCLUDED IN THE COST OF "TOPSOIL FURNISH AND PLACE."
- THE PHASE III CONTRACTOR WILL BE RESPONSIBLE FOR THE RE-ESTABLISHMENT OF CONTROL AND THE POINTS AS SHOWN ON THE ALIGNMENT AND TIES SHEETS. THE CONSULTANT SHALL COORDINATE THE RE-ESTABLISHMENT OF EXISTING CONTROL AND TIES SHEETS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE RE-ESTABLISHMENT OF CONTROL AND TIES SHEETS AT A MORE FEASIBLE LOCATION, AS APPROVED BY THE RESIDENT ENGINEER. THE PHASE III CONSULTANT SHALL SUBMIT DOCUMENTATION OF ALL RE-ESTABLISHED CONTROL AND TIE POINTS TO THE DEPARTMENT NO LATER THAN ONE (1) MONTH AFTER COMPLETION OF THE CONTRACT.
- HORIZONTAL COORDINATES ARE BASED ON STATE PLANE COORDINATES EAST ZONE NAD 83 DATUM (1986 ADJUSTMENT) ELEVATIONS ARE BASED ON NAVD83 DATUM.
- THE ENGINEER SHALL BE THE SOLE JUDGE CONCERNING STABILITY TIME FOR THE VARIOUS RETURNING LIFTS.
- THE BITUMINOUS MATERIAL PRIME COAT QUANTITIES HAVE BEEN DETERMINED USING A RATE OF 2.0 L/m<sup>2</sup> (0.44 gal/yd<sup>2</sup>)

### *The Summary of Quantities Sheet*

Most agencies develop a general idea of the cost of a proposed improvement during the initial stages of project identification and planning. The estimated cost is often listed in the Request for Proposals or Request for Qualifications, and is used as a guide for determining the relative costs of preliminary engineering, based on the fees paid for services on similar projects. There may be a cost-sharing element contained within an inter-agency agreement that can affect the manner in which certain items of work are compensated. The initial estimated project cost may be based on recent work or it may be based on lane-miles of pavement or it may be based on an educated guess at the amount of work to be performed. The agency or client may ask for updates on the estimated cost of the project as the work progresses. These updated estimates would be provided by the design firm, and would be generalizations based on the knowledge available at that stage of work. An updated estimate of this type might be used in a design-build scenario, but would not be sufficient for the submittal of competitive bids for the work.

In a set of contract documents and plans for an infrastructure project, the items to be constructed will often have a specific, assigned nomenclature depending upon the funding agency and funding sources. A construction material used for pavement, such as bituminous concrete, might be known as surface, macadam or asphalt in various parts of the country. The material might be measured for payment based on the weight of its component parts or the areas covered by paving. This is dependent on the agency's Standard Specifications. Sewer might be constructed using clay, metal, concrete or plastic. Lighting luminaries might be mercury or sodium vapor. The client or funding agency may assign a unique numbering system or code as well as a preferred title for each item of work to be performed. Some agencies prefer to group work items together in the order of intended construction sequencing. Other agencies list the items in the same order as the agency's Standard Specifications. Still others will insist that the coded or number of the item be used as the guide for listing the items to be constructed. In any case, the Summary of Quantities is the complete listing of all work that is to be



constructed, and therefore represents all items for which a unit bid price is to be solicited. The Summary of Quantities provides a uniform definition of the work to be performed and will indicate the units of measure by which the work will be tallied.

Since the Summary of Quantities Sheet for an infrastructure project might have the pay items listed alphabetically or numerically, the Sheet can often be presented in tabular format. The Sheet could resemble a spreadsheet, it could be compiled from a database or it could be given as the actual bid sheets upon which the contractor submits a priced proposal. If the Summary of Quantities is in tabular format, it might include information such as the construction item's specific name and unique code number and the designation of a work group or construction code for tracking fund allocation. The work or pay items might have a Specialty Code to alert the bidder to a reference that is to be used, consulted or visited in order to understand a unique element of the item to be constructed. The items may be grouped by similarity, such as paving, drainage, signing, traffic control, environmental or electrical work. They may be grouped in construction stages, which can complicate the Summary and result in duplication of quantities.

As the design assignment progresses from preliminary to pre-final and on to final plan status, the client may request that the initial cost estimate be updated for funding and program planning purposes. This might require that each discipline take a close look at the plan sheets representing their work, compiling a list of general work items and applying a unit price to establish the estimated construction cost. A comparison between the initial project estimate and the interim estimate might reveal the need to use a contingency factor to account for elements of the design that are not completed. Various agencies and clients might prefer that the contingency factor be reduced as design continues, until each discipline has completed its work and a draft Summary of Quantities can be compiled.

Some clients or agencies will prefer that the quantities be considered as estimates, and will label them as such, providing a column for actual or constructed quantities.

Other agencies will prefer the listing to be the actual calculated quantity, but will also require a column to represent the “as-built” or constructed quantity.

Assignments such as those encountered in a design-build situation might require that a sheet be included with a listing of the anticipated items to be constructed, leaving a blank column to be filled in when the project is completed.

The tabular listing of the Summary of Quantities might be dictated by an agency’s practice of publishing bid tabulations as a record-keeping device or as a tracking mechanism for identifying potential sources of confusion on the part of the bidder if a line item’s bid price is seen to be outside an anticipated range. The impacts of energy and labor costs on various work items can also be obtained from the agency’s records.

The completion of the Summary of Quantities leads to the preparation of the cost estimate for a project. The cost estimate can be affected by the contents of the General Notes as well as the text of plan notes and Special Provisions. For instance, if the construction of a section of curb includes the repairs to landscaped parkways and the cleaning of tracked mud on adjacent streets, the price would be different from the price for the curb construction alone. An item referenced as “included” or “incidental” does not make that item appear on the project site without the utilization of labor and equipment.

The Summary of Quantities depends on the compilation of all of the work on all of the sheets of the set of plans. It may include work that is not shown on the plan sheets, but is required based on text in Special Provisions or Standard Specifications. For some projects, the Summary of Quantities Sheet could be compiled using the Schedules of Quantities. The content of the Summary of Quantities Sheet is dependent on a concentrated effort to read every note on every sheet in the set of plans, since some disciplines will treat certain work items as coincidental or included with another item of work. Most agencies will not include a contingency in a Summary of Quantities, while other agencies will include line items for mandatory penalties associated with “failure to perform” conditions. A precise organization of quantity calculations is often the key to avoiding any wasted effort in labor hours used in the preparation of a Summary of

Quantities, since it is essential that the calculations keep pace with the design in order to ensure that the summarization of items is done one time, without having to re-calculate each item for each submittal or milestone.

A General Note could have an impact on the Summary of Quantities if the General Note references an external document which requires additional work items in order to complete the work. Close coordination among all design team members will reduce the potential for a costly oversight, or a revision of a cost estimate, or an addendum to advise bidders of the additional work required.

A sample Summary of Quantities Sheet is shown in Figure 4.

CODE NO.	DESCRIPTION	UNIT	TOTAL QUANTITY	BRIDGE				ROADWAY				TOTAL QUANTITY	SIGNING	ELECTRICAL	
				ES	SP	OVER	AB	ES	SP	OVER	AB				
4200000	EARTH EXCAVATION	CU M	184,035					1000-2A							
4200000	CHANNEL EXCAVATION	CU M	172,850					X71-2A							
4200000	FURNISHED EXCAVATION	CU M	10,185												
4200000	PAROUS GRAPTS OR EQUIVALENT	CU M	8,377												
4200000	TRENCH BACKFILL	CU M													
4200000	GEOTECHNICAL FABRIC FOR GROUND STABILIZATION	HA													
4200000	SEEDING, CLASS 2A	HA													
4200000	SEEDING, CLASS 4	HA													
4200000	NITROGEN FERTILIZER NUTRIENT	KG													
4200000	PHOSPHORUS FERTILIZER NUTRIENT	KG													
4200000	POTASSIUM FERTILIZER NUTRIENT	KG													
4200000	MULCH, METHOD 2	HA													
4200000	EROSION CONTROL BLANKET	50 M													
4200000	SUPPLEMENTAL WATERING	UNIT													
4200000	EARTH EXCAVATION FOR EROSION CONTROL	CU M													
4200000	TEMPORARY EROSION CONTROL SEEDING	KG													
4200000	TEMPORARY DITCH CHECKS	EACH													
4200000	STONE RIPRAP, CLASS #4	50 M	625												
4200000	SUB-BASE GRANULAR MATERIAL, TYPE B 300MM	50 M	50,261												
4200000	STABILIZED SUB-BASE 100MM	50 M	7,972												
4200000	STABILIZED SUB-BASE 150MM	50 M	46,907												
4200000	PORTLAND CEMENT CONCRETE PAVEMENT 250MM UNFINISHED	50 M	7,288												
4200000	BRIDGE APPROACH PAVEMENT (SPECIAL)	50 M	252												
4200000	PROTECTIVE COAT	50 M	8,038												
4200000	CONTINUOUSLY REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT 300MM	50 M	35,056												
4200000	PAVEMENT REINFORCEMENT 300MM	50 M	36,056												
4200000	LUG SYSTEM COMPLETE 7.5 METER	EACH	1												
4200000	PROTECTIVE COAT	50 M	8,038												
4200000	PAVEMENT REMOVAL	50 M	25,147												
4200000	DUTTER REMOVAL	METER	70												

REVISOR'S NAME	DATE

SUMMARY OF QUANTITIES

# FIGURE 4

### *The Typical Sections Sheet*

The nature of a segment of an infrastructure project can be represented by a sketch known as a Typical Section. A roadway segment, for example, can be represented by both an existing and a proposed condition. A sewer or pipeline project might be represented by a common trench section. A grading project might be represented in “typical” fashion by a section that indicates the amount of topsoil to be removed.

Any infrastructure project involving a linear component can be represented by a typical section. This applies to sidewalks, ditches, runways, jogging paths, pipelines, utility trenches, levees, berms, canals, retaining walls, curbs, medians, rails and shipping channels. The section remains “typical” as long as it is representative of the infrastructure item at the location indicated. If one component or another of the construction materials are changed, or if the shape of a ditch, the width of a parkway or type of curb changes, a different “typical” section or a note advising the extent of the difference in construction would be needed.

Typical sections are usually shown from the viewer’s vantage point looking ahead, or up-station, or forward from the point of beginning. Often for ease of illustration, a typical section will be shown in “mirror-image” to reduce repetition or to reduce the number of sheets in a set of plans. A note would be provided to indicate this condition.

Some clients or agencies prefer to use directional information such as “viewed looking east” or “view is similar in both directions from mainline roadway”. The individual preference of the client will dictate the need to provide this information.

A segment of roadway may be slated for rehabilitation, widening, reconstruction or complete removal. In any situation, the nature of the construction of the existing roadway is useful information for the contractor in both the bidding and construction phases of a project. Knowing what has to be removed, widened, rehabilitated or used for construction staging is essential for the submittal of a responsive bid. During the preliminary design and planning phase, the nature and composition of the existing

roadway segment might be based on record or as-built plans, or it might be based on a visual inspection of the roadway. The true nature of the existing roadway can only be verified by the acquisition of pavement cores, which are samples of the pavement and can be taken from several locations to verify the findings. The composition and thickness of the existing pavement will be needed in order to determine how to join the proposed roadway at the termini of the project. The existing pavement may be different at each end of a project as well as at intersecting roadways. The existing pavement may have varying widths and turn lanes, medians and segments that cross bridges or culverts. More detailed information about the existing pavement will contribute to a more specific listing of pay items and work processes required to complete the project. Elements such as jointing and paving transitions are dependent on knowledge of the existing road. Actual presentation of the sections will be directed by the client or agency. Some will prefer that the existing typical section be placed on the sheets that show the portions of pavement to be removed. Others will require separate sheets.

The proposed typical section for a roadway project can be defined in the preliminary or planning stage as an anticipated facility, or it can be part of an agency's standard pavement inventory, or it may represent a desirable feature intended to serve for a predictable future period. The Design Year and projected traffic loadings will influence the selection of the proposed pavement. In some instances, a proposed typical section can change during the development of the project, or it can be affected by organizational or political decisions as well as by an influx of new information that is adopted by the client. The proposed typical section width can vary. It can have turn lanes, widened segments, bridge or culvert omissions as well as specialized construction elements at intersections. The sections are intended to be applicable from end to end of the project or improvement. A single section might be representative of a project intended to replace a segment of roadway that does not vary in width or have any lane transitions or intersections.

On a roadway project, the Typical Section Sheets will present both the existing and proposed pavements. The coverage will match the length of the project. Placement can



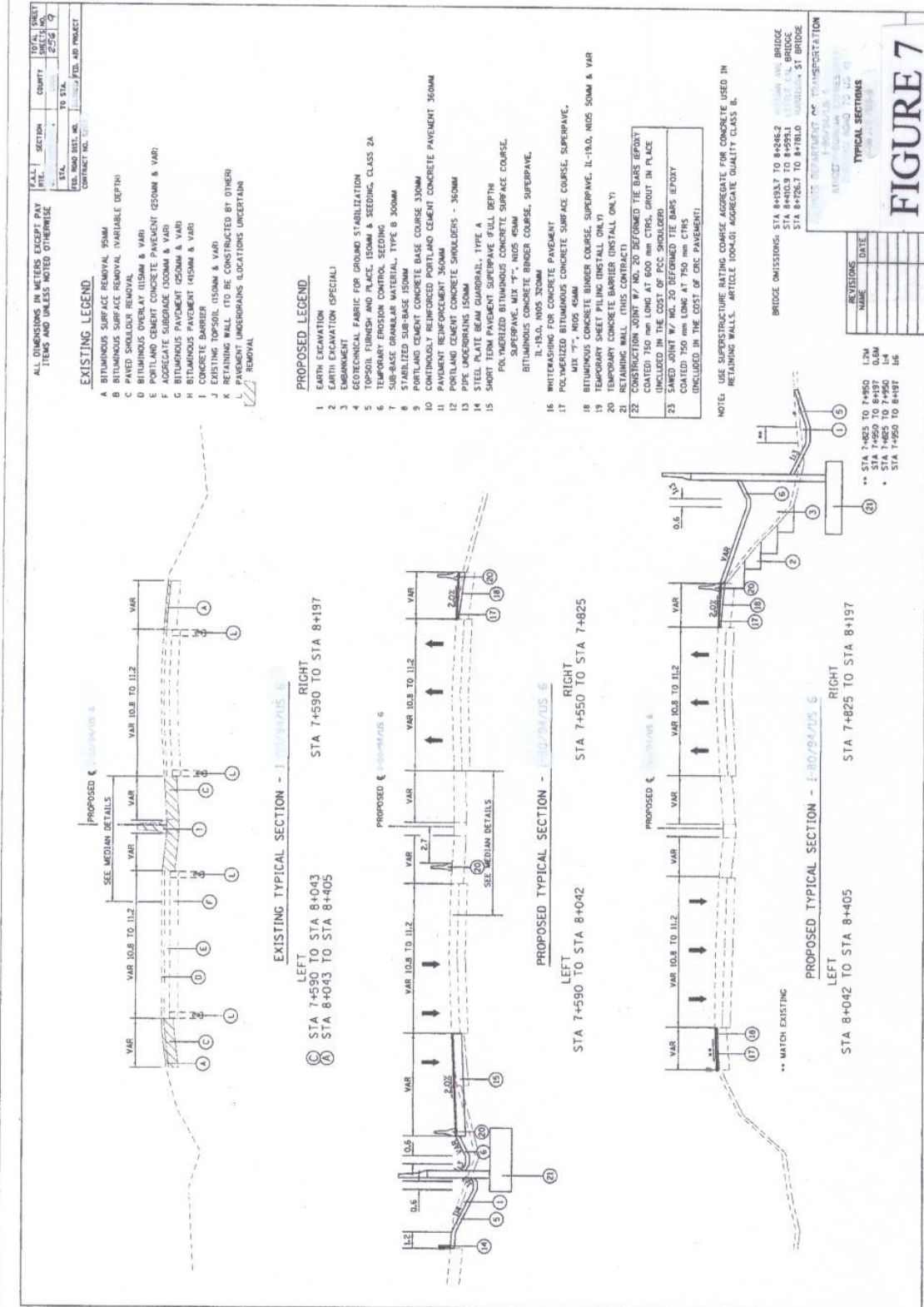
be top to bottom of the sheet, or bottom to top. Sections can be presented side by side, with the proposed adjacent to the existing. The Typical Sections will have each element of construction labeled, such as the pavement layers, curbing, shoulders, joints and location of profile grade line, centerline, survey or stationing control line, construction easements and right-of-way lines. The listing of construction elements might be shown on a separate sheet, or might be listed using coded pay item numbers or an alphanumeric code that is unique to a specific agency.

For a pipeline, force main or water-main project, the proposed typical section might be expressed verbally, indicating that a uniform amount of cover is to be placed on top of the installed pipe.

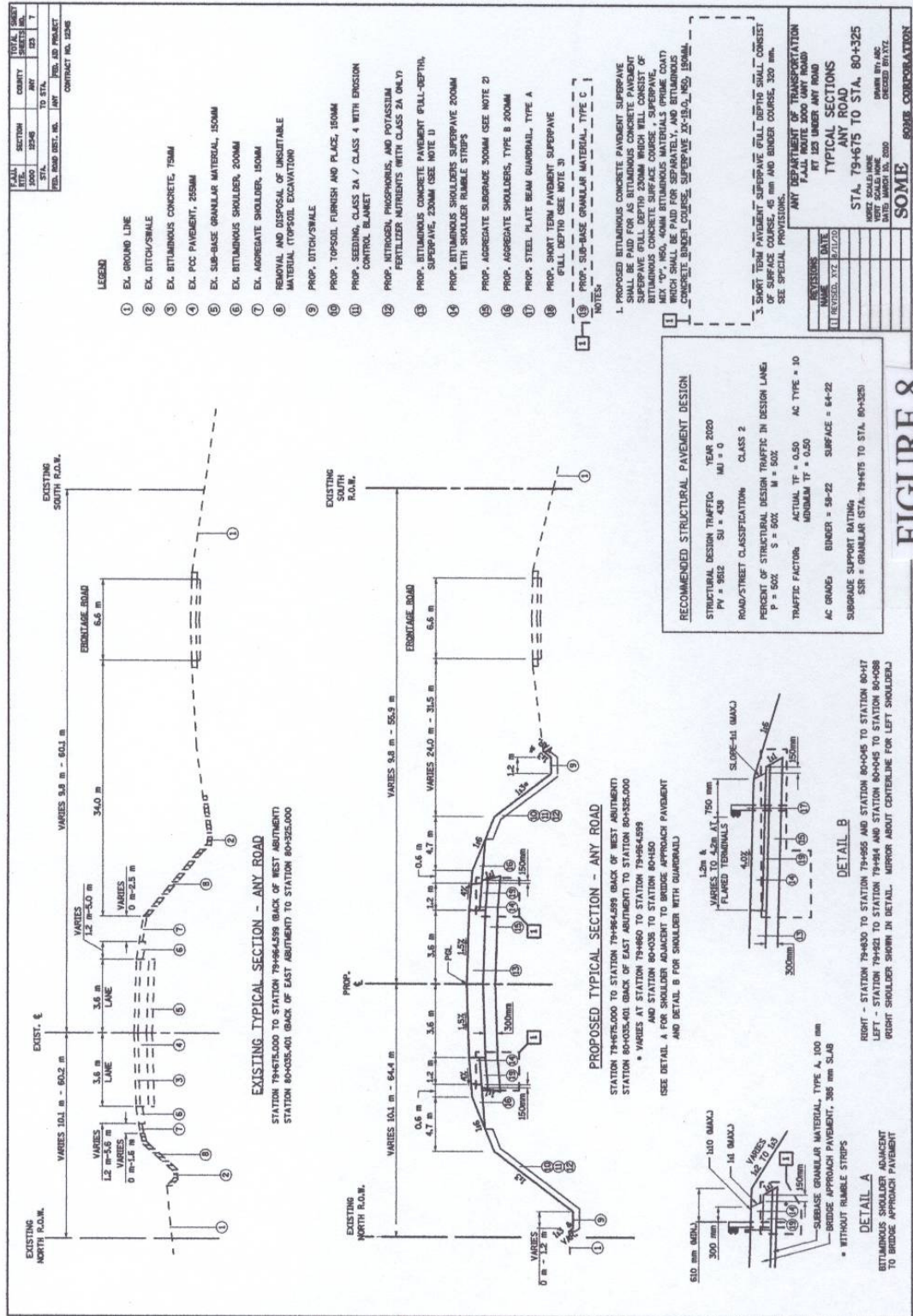
In any situation, the finished product could be uniform throughout the length of the improvement, or it could vary from segment to segment.

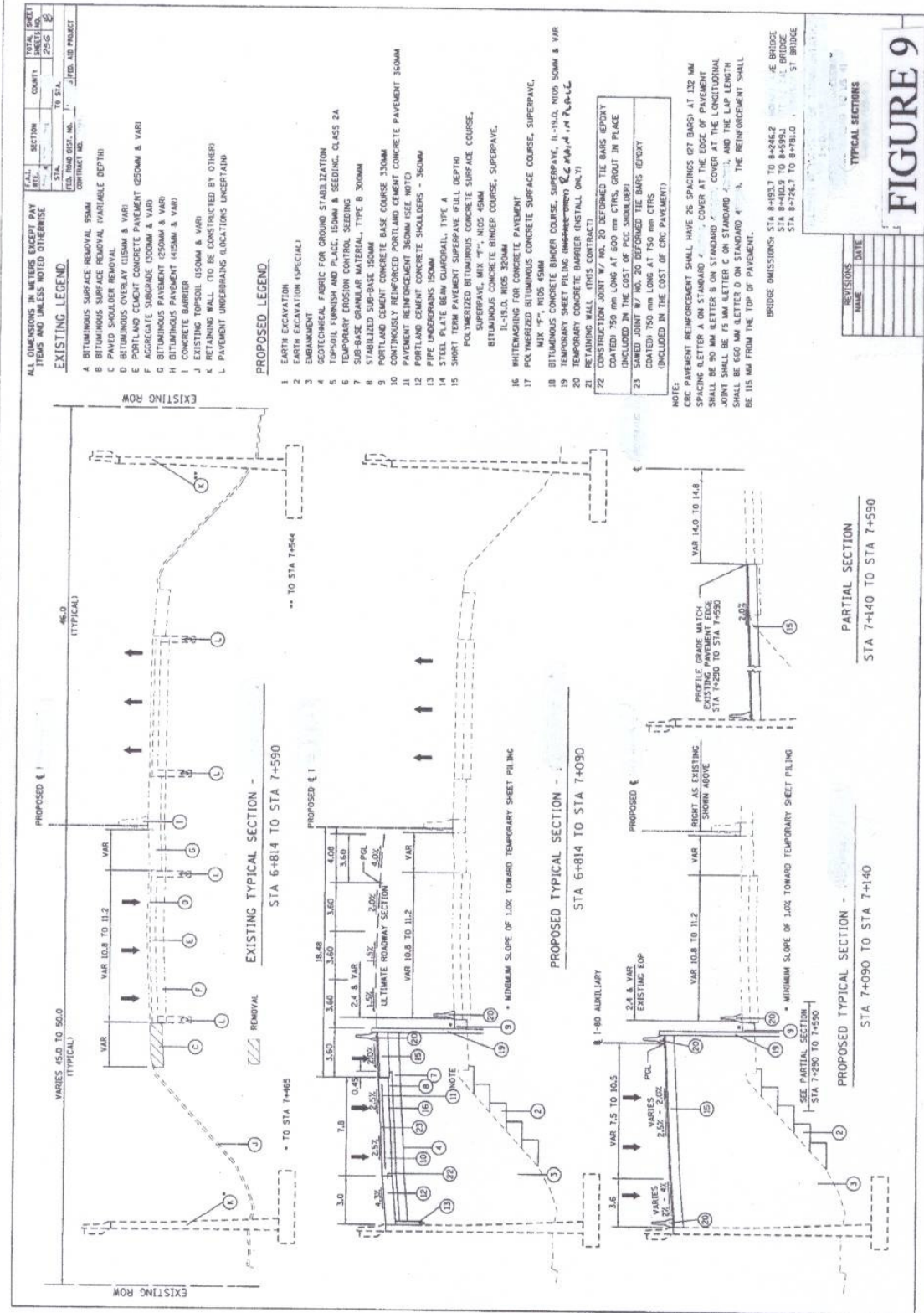
A Typical Section is a general guide that presents the intent of the project. Slight variations may occur within the segment covered by a Typical Section. Notes or references to the Cross-Sections or other sheets in the set of plans will assist in resolving any discrepancies.

The number of potential variations in the presentation of typical sections requires confirmation with the client in order to avoid re-drawing the sheets. It could take hours to compile sections, arrange them on a sheet, or re-arrange the sections to conform to the client's particular preference. Each agency or client has arrived at their preferred method of presenting information based on a history of plan development. A comparison of the plan view and cross sections is essential to ensure that the typical section represents the proposed improvement, and is not a copy of a section used on another slightly similar project. The nomenclature and labeling of each component of work that is shown in a Typical Section is intended to match the terminology used in the Summary of Quantities, the Schedules and the Plan views of the work. Sample Typical Section Sheets are shown in Figures 7, 8 and 9.









### *The Construction Layout Sheet*

No matter how precisely a proposed improvement is drawn on paper or designed by software in a computer, the intended construction must be staked or laid out on the ground to provide equipment operators, laborers and skilled technicians direction for orientation and placement of the elements of the project. Some computer-aided drafting programs can identify a point in a coordinate system to three or six decimal places. The accuracy might be a component of the software used. However, the layout performed in the field might be accomplished using a string and a can of spray paint. The layout could be performed using wooden hubs driven into the ground affixed with a nail driven into the top of the hub. The designer would benefit from a day spent in the field observing the skills utilized by the layout team. The skills displayed might cause a person to question the need for design accuracies to two decimal places, but measurements from the final product will confirm that the desired outcome has been achieved.

### **Alignment**

The concept that two points define a line has been acceptable from the earliest endeavors of construction. Defining a location along that line, as a distance from one end or the other is another concept that is taken for granted, but may differ widely in use or definition. The points may be miniscule or they may be as large as a fence post, tree, building corner or boulder. The line may have direction, relationship as in parallelism or skew from another line, or it may simply exist as the shortest distance between the two end points. The line may not in fact be tangible, since it may extend over water or through a site to be excavated. The line may originate in the field as established by topographic surveys, or it may be applied visually onto a photographic mosaic of the project site. Topography can be acquired using laser imaging performed by helicopter or satellite. A survey line might not be physically established while the topography is gathered, but it might be coordinated with the control points established for the laser operations. Stationing and geometric controls can be overlaid on the

acquired topography, and the physical location of the stations can be viewed using magnification of the visual data. In the event that the visual images are not obtained at a scale sufficient to see finer detail on the ground, a field check or walk along the line can determine whether the stationing can actually be set along the line. Physical objects such as buildings, utilities, bodies of water and rock piles can be situated on a location along a proposed survey control line, which could make it extremely difficult to establish the precise location of a station point in the field. A survey or control line could be superimposed onto a stand of trees, but placement of the line in the field would be difficult, and could be further complicated if tree removal was not an option.

Geometric alignment is often shown on a single sheet, often at a reduced scale to provide a more compact visual image. The alignment is shown together with the centerlines of intersecting streets, major utilities and stream crossings, but without any additional background information such as topography. If the alignment is established by field survey, the stations would have been physically located on the ground, or offset in the event that a point was inaccessible due to water or other topographic features. If the alignment is that of a proposed location of a project, the alignment can still be shown on a single sheet, and when it is transferred to a plan sheet containing the topography, it will then show the relationship between physical objects and location of stationing or intersecting lines.

## **Ties**

Finding the end points, or any other point in between, relies on the ability to physically locate the points with certainty in all weather or field conditions. A point is found through the use of identifiable features from which exact distances can be measured, resulting in the desired point location being established at the crossing or intersection of measured arcs from the Tie. A Tie is normally set by the survey crew. It is common practice to set more than one tie for each point to be used in establishing the alignment, since a singular tie can easily be eradicated. A Tie can be a paint mark, a chiseled mark on the lid of a drainage structure or on a curb. It can be a nail or grouping



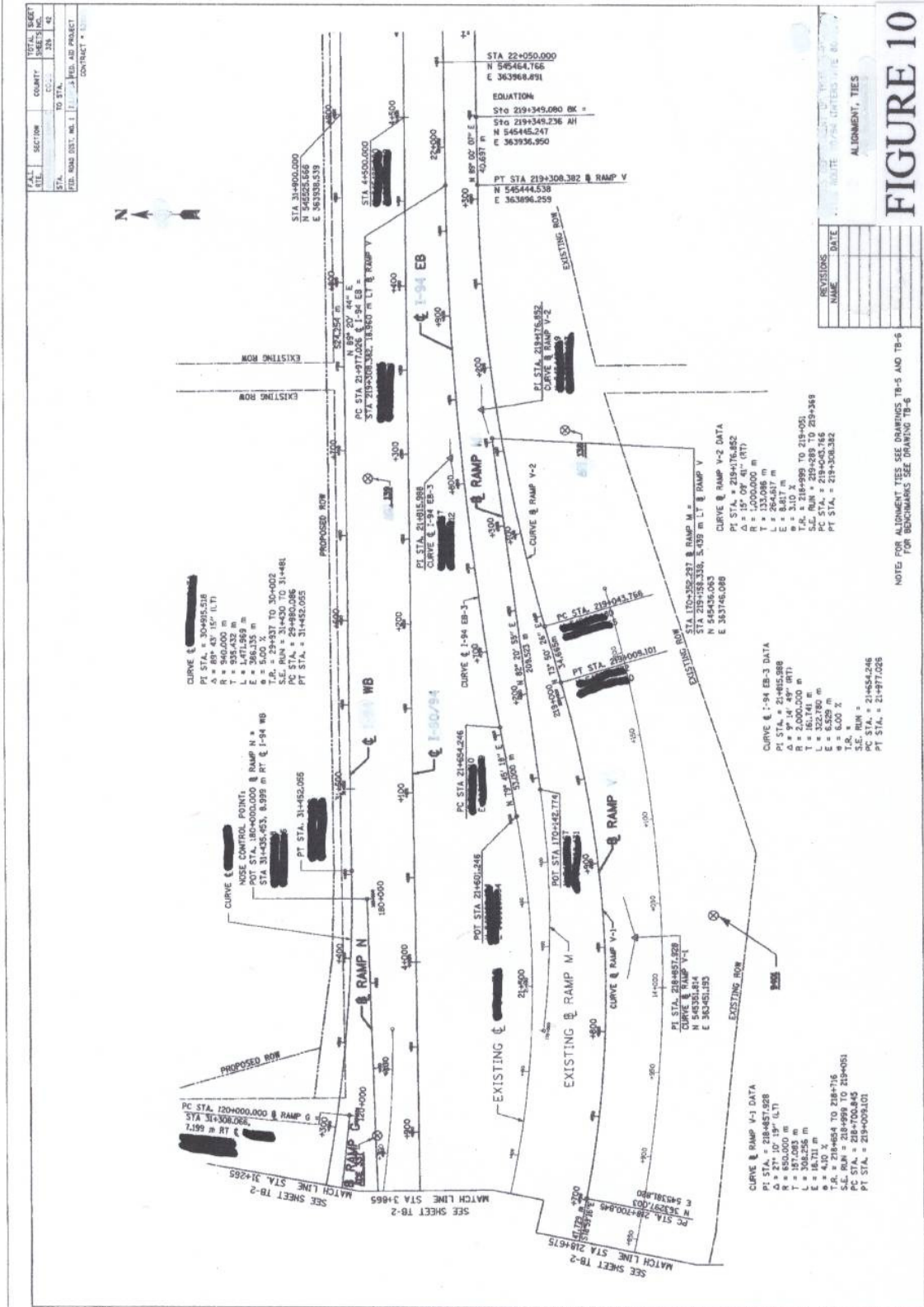
of nails in a pavement, in a utility pole or on a tree. It can be a fence post, a buried rod or a corner of a building. A Tie can serve two points, but the distinction between the two uses would be defined by the distances to the tied point. The depiction of a Tie can be photographic or drafted, depending on the survey methods used. Ground control for a project might be set years before a project is designed. It could be affected by utility work or ancillary improvements that are unforeseen by the agency requesting the proposed project. In the case of the use of objects such as trees or fences, it is not unusual for a Tie to be unrecoverable at the time that design surveys are done.

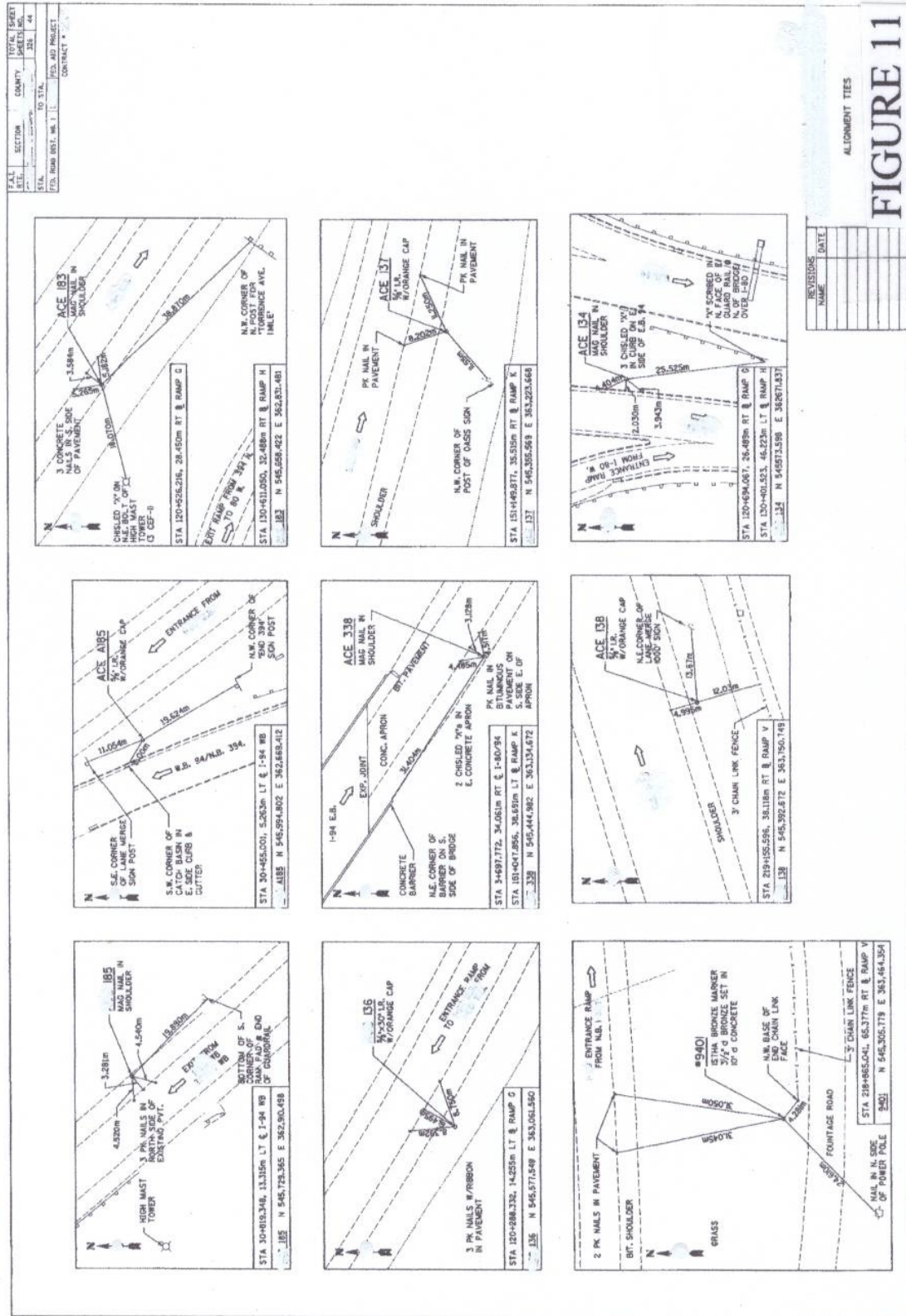
The description of a Tie often originates with the survey crew. Directions can easily be mis-interpreted, such as “the southernmost corner of the north landscape timber”. In the event that the directions were inadvertently reversed, a pictorial view of the Tie and the surrounding topography will clarify the intent.

Ties are shown on an Alignment and Ties sheet against the background of all relative topography, normally acquired by survey methods. The Tie could be provided with coordinates, lengthy descriptions as in the case of a foundation for a specific sign or a tree in a wooded area. The names of streets and the nature of the ground surface – gravel, shoulder, pavement or sidewalk - are required to orient the construction layout crew attempting to find the ties.

A tie can also be used to assist the layout of a proposed construction item. A tie may be given to a proposed back of curb, edge of pavement, center of construction or center of right of way. All references to a Tie are not interchangeable.

Sample Alignment and Ties Sheets are shown in Figures 10 and 11.





### ***The Traffic Control Sheet***

Construction of a project can take place by closing a road, shifting traffic to one side or another of an existing facility, using temporary pavement or a partial detour. Work can take place under traffic conditions, requiring the movement of construction vehicles within the existing traffic. While it is relatively simple to declare that the intent of the improvement is to maintain the existing traffic flow, it is inevitable that traffic might be delayed due to the construction operations, which in turn can delay the timely delivery of construction materials such as concrete and asphalt. For many clients and agencies, the traffic control and stages presented in the plans are offered as one logical sequence of operations. The successful bidder that is awarded the contract may be allowed to submit an alternate solution. Acceptance or rejection would be at the option of the awarding or funding agency. In some instances, the bidder is invited to submit their own approach to traffic control. This is at the option of local jurisdictions, and may have further legal implications regarding public safety, interpretation and intent.

Traffic control or maintenance of traffic is typically shown on sheets which display the existing project topography. The scale of the drawing is established by the client. Some prefer smaller scale drawings and symbols, while others prefer larger scales and exact detailing to avoid any misunderstanding that might need to be clarified through a legal process. The control of traffic through a construction zone requires a variety of traffic control devices, including signs and pavement markings, temporary guardrail, barrier wall, barricades and impact attenuators. The speed limit to be maintained during construction will affect the geometry and locations of the placement of traffic control devices.

### **Construction Sequencing or Staging**

The initial configuration of traffic in a project location is sometimes referred to as the “pre-stage” condition. Sheets which show this situation will allow the bidder to ascertain how the existing traffic is handled, where access to the construction site may



take place and what work is needed to prepare the site for the first stage of construction. This “pre-stage” work might include advance signing, construction of temporary pavement and modification of existing facilities such as signs, driveways, utilities and traffic signals. Presentation of the existing configuration can also aid in determining whether the work zone or project site can be accessed from within the existing traffic lanes or from an external location.

A project may have a number of stages required in order to complete all of the work required. The Construction Staging sheets typically show the configuration of the traffic lanes and the resulting work areas available in order for construction to take place. Each Construction Stage sheet would represent an end result condition rather than an interim condition. For instance, barricades and pavement markings that would need to be removed or relocated might be labeled with information describing lengths affected and dimensions required, and then these items would be shown in the desired position. The methods of achieving the relocation are left to the contractor, typically under the directive of a General Note assigning all safety provisions to the contractor. Local legal jurisdictions and maintenance operations such as accident response, roadway repairs and snow removal will prevail on each project.

Each Construction Stage normally carries the same number of lanes of traffic as the previous stage. A reduction in the number of lanes of traffic might make the construction operations easier, but the resulting negative impact on the traffic would also affect the arrival rate of construction materials to the job-site.

The affected limits of the project and any impacted areas beyond the work limits would be shown in the sheets for each construction stage. Some clients would prefer to show all of the project area irregardless of whether there is any work, since the sheets provided would allow the contractor or the client to use the sheets in the event that an alternate staging sequence is selected, or if there are unforeseen events such as weather or labor-related interruptions that could suspend work and require an interim routing of traffic through the project area.

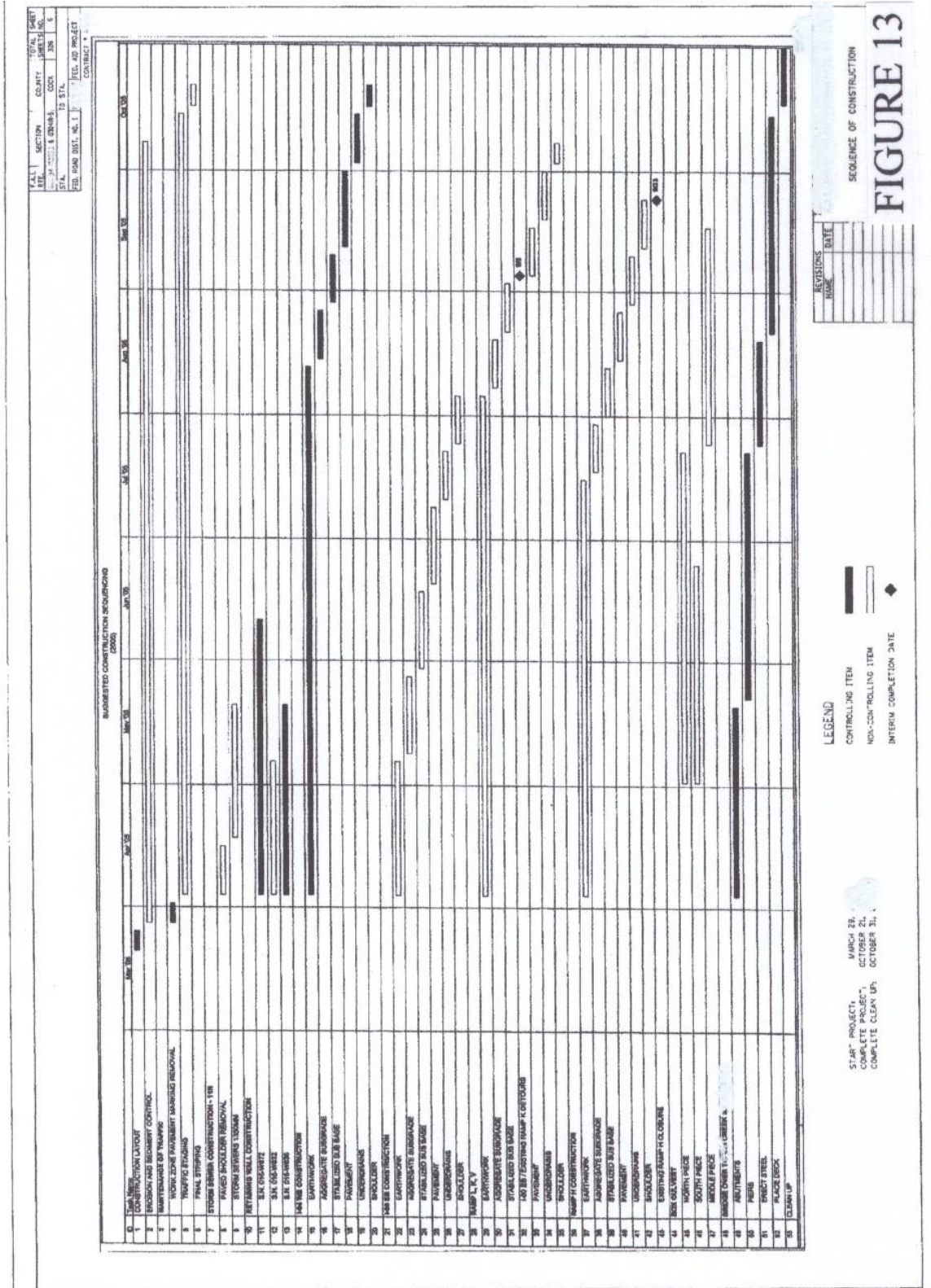
The depiction of the final configuration of the traffic lanes can be achieved using a construction stage or by reference to the proposed pavement marking sheet. The sheet showing the final Construction Stage would also be used to address any utility work, landscaping, signing, restoration of parking and driveways, or removal of temporary pavement prior to completion of the project and transfer of maintenance of the facility back to the client.

The final activities of the traffic control work will often include the repair and restoration of all shoulders used to stage traffic, the cleanout of all drainage appurtenances that would have received runoff from tracked mud, and the removal of all temporary areas such as construction staging and accident investigation sites. This additional work could be somewhat hidden from the calculation of a cost estimate, which emphasizes the need for close coordination between all members of the design team.

Each type of infrastructure project will have different impacts on the movement of goods and services through the area. An underground utility installation might be performed with minimal impacts to the adjacent roadway, but it might have a substantial impact on pedestrian traffic. A parking lot improvement might result in the displacement of vehicles that might be forced to find temporary parking within the surrounding neighborhood. A roadway project might include a detour that unintentionally affects business traffic in locations far removed from the work zone. For these reasons, the client might have input to the project that could add a stage of construction or revise the order in which work is performed. Close coordination and communication will help in these matters. An infrastructure improvement might be met with profound objection if the project results in the loss of local business, access, routine functions such as mail delivery and garbage collection, or emergency services.

A sample Construction Sequence Sheet is shown in Figure 13.

Sample Traffic Maintenance Sheets are shown in Figures 14 and 15.



FULL SHEET	SECTION		TOTAL SHEETS
DATE	DATE	TO STA.	NO.
REV. NO.	REV. NO.	FROM STA.	OF
DATE	DATE	TO STA.	NO.
REV. NO.	REV. NO.	FROM STA.	OF

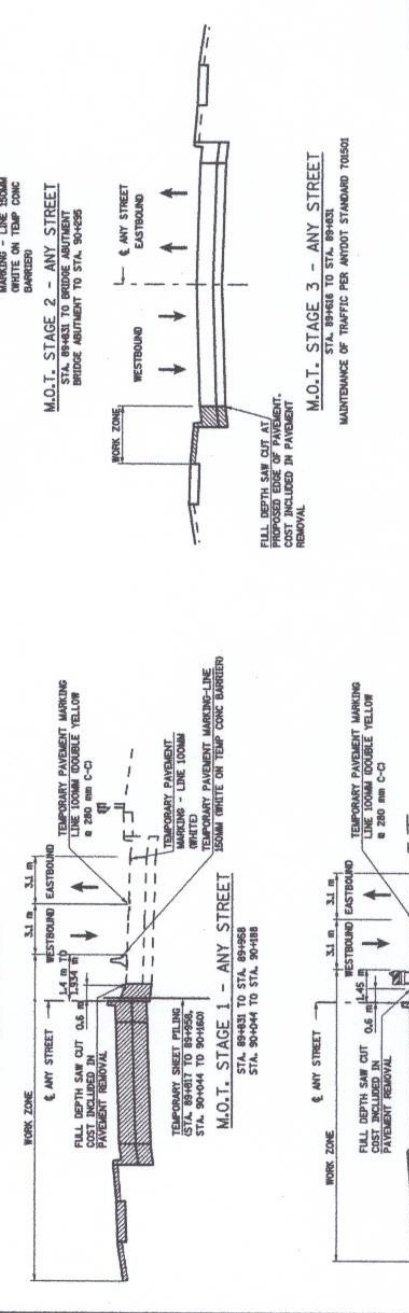
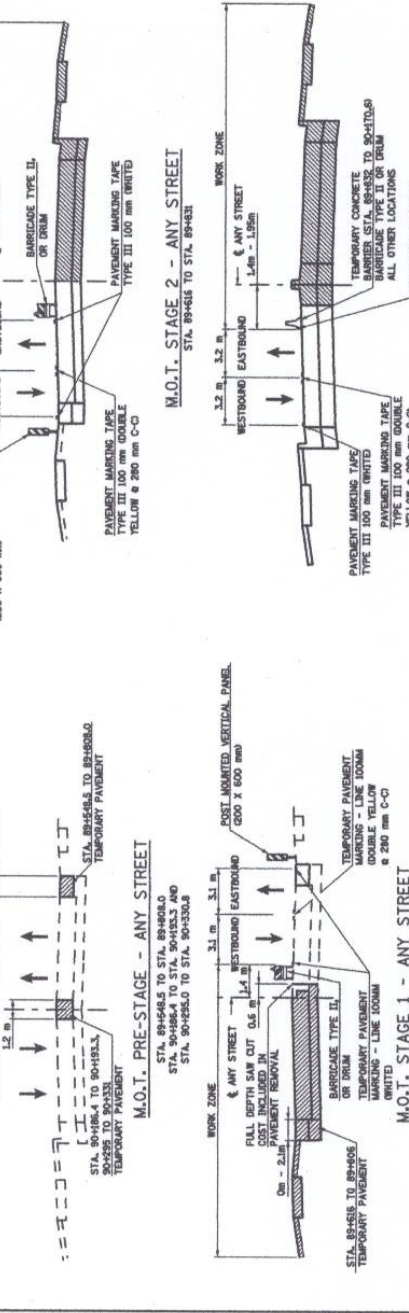
DATE	DATE
REV. NO.	REV. NO.
DATE	DATE
REV. NO.	REV. NO.

ANY DEPARTMENT OF TRANSPORTATION F.A.I. MAINT. 1000 ANY STREET 1-28/ARTISTS UNDER ANY STREET ANY ST.	DATE	DATE
ANY DEPARTMENT OF TRANSPORTATION F.A.I. MAINT. 1000 ANY STREET 1-28/ARTISTS UNDER ANY STREET ANY ST.	DATE	DATE
ANY DEPARTMENT OF TRANSPORTATION F.A.I. MAINT. 1000 ANY STREET 1-28/ARTISTS UNDER ANY STREET ANY ST.	DATE	DATE

ANY DEPARTMENT OF TRANSPORTATION  
F.A.I. MAINT. 1000 ANY STREET  
1-28/ARTISTS UNDER ANY STREET  
ANY ST.

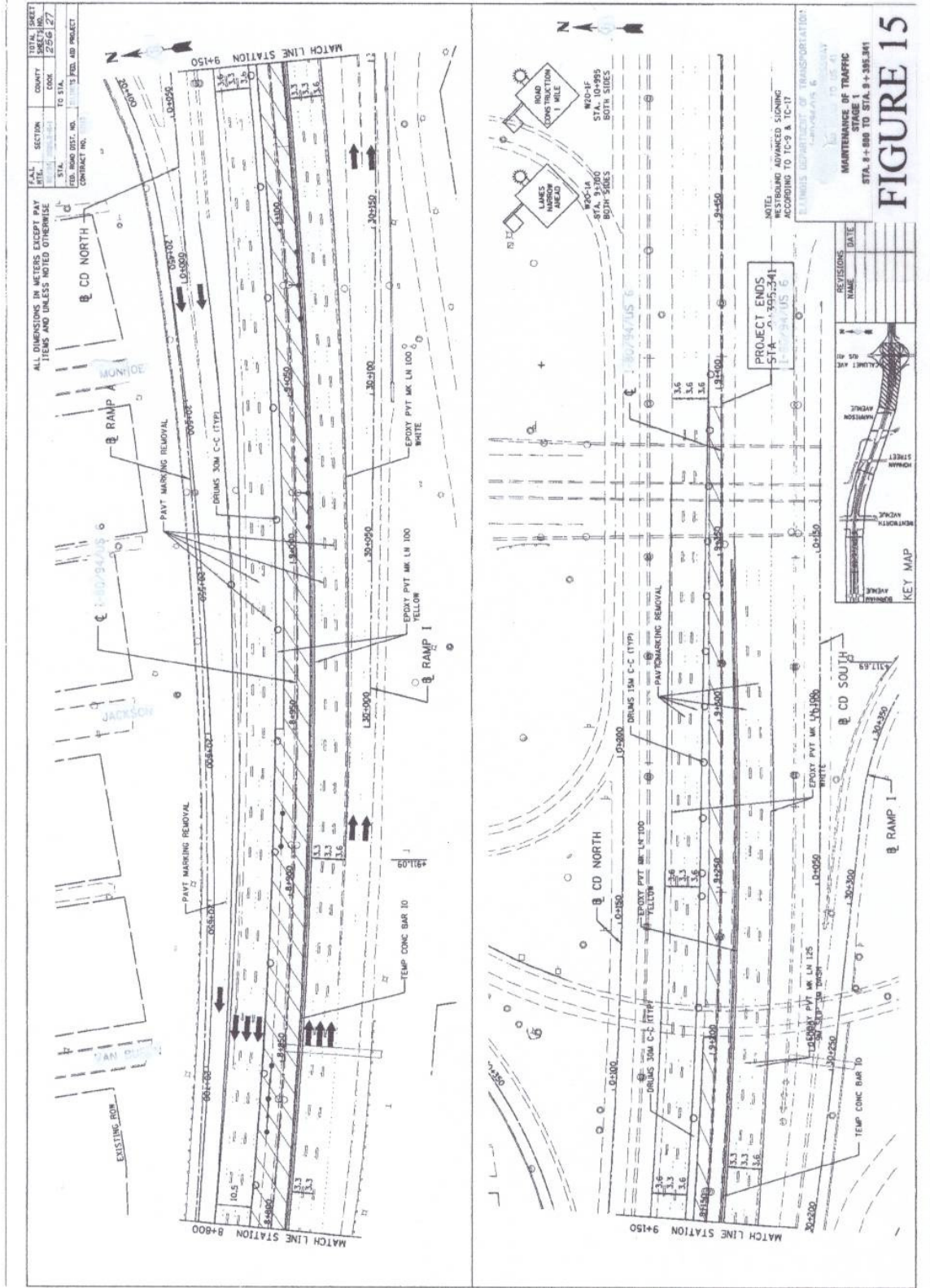
ANY DEPARTMENT OF TRANSPORTATION  
F.A.I. MAINT. 1000 ANY STREET  
1-28/ARTISTS UNDER ANY STREET  
ANY ST.

ANY DEPARTMENT OF TRANSPORTATION  
F.A.I. MAINT. 1000 ANY STREET  
1-28/ARTISTS UNDER ANY STREET  
ANY ST.



**FIGURE 14**







### *The Plan Sheet*

A plan view can be prepared for most types of infrastructure work.

A plan view of the geometrics, alignment, dimensions and components of the existing and proposed roadway is presented for a roadway project in the Roadway Plan Sheet. The preferences of the client might favor an attempt to show both the existing and proposed views on the same sheet for direct comparison between the two conditions. The scale of the drawings or the width of the right-of-way might prevent this type of presentation.

The Roadway Plan Sheet is intended to contain the majority of the information necessary to describe the intent of the proposed improvement. This would include location data such as: a centerline, survey line, construction limits, grading limits, removal limits, station and offsets or dimensions for all physical elements to be found within the project limits. Geometric information such as curb returns, centers of driveways, corners of sidewalks, edges of pavement and match lines for intersecting pavements will typically be shown. Each line represents some item to be found or constructed, from fences and driveways, intersecting streets and medians, to curbs and shoulders. Every tree, building, gate or garden, mailbox, sandbox and park bench to be moved, replaced or left untouched will be shown.

An infrastructure project such as a canal or a sewer line can be illustrated using a plan view, similar too a roadway project. All three types of projects involve the construction of various items of work beginning at the visible surface of the ground.

Pipeline projects that are constructed far underground without using open cut or trenching can also be displayed using a plan view, since it might be desirable to avoid crossing certain types of properties with the pipeline without having an agreement with the property owner. For instance, a pipeline might cross a water-bearing aquifer or intersect a well point without intending to do so. Having a plan view that displays all topographic features will assist in avoiding complications during construction.



The location of the proposed improvements can be referenced by coordinates, offsets to existing features, distances from an established monument or control point, or by the use of stationing from a centerline, survey line, construction or control line.

Limits of a project might be defined at the beginning of paving, the start of grading, the ends of pavement marking or the extent of erosion control. The limits can be labeled in a particular manner depending on the preference of the client.

The Plan Sheet serves as the origin of many of the items shown on the Schedule of Quantities, particularly the paved items of work. The existing plan view shows the nature of the project site anticipated to be found at the beginning of construction. The proposed plan view shows the ultimate condition anticipated to be completed through the use of the various stages of construction. Mailing addresses of buildings are often provided to assist in orientation for layout of the project. Client and agency preferences will determine whether items are measured, stationed, dimensioned, or related to the various types of survey or control lines. The number of significant decimal places provided for the location and offset of a point will be unique to the particular agency and the type of work. For projects involving rough grading and a gravel road, a measurement to the nearest half-foot might suffice. Other projects involving paved items might require that coordinates be measurable to six decimal places. In most cases, the plan view will show the information necessary to tabulate the work to be performed.

Plan notes may often be included on the Plan Sheet. A plan note might simply indicate that all work is to be performed to the satisfaction of the Engineer. In some jurisdictions, the Engineer does not have the contractual authority to approve work that is performed. In other situations, approval of work is the responsibility of the department or authority that will inherit the maintenance of the constructed facility.

A plan note might be inserted to allow the contractor to adjust the length of a constructed item to match the field conditions prevalent at the time of construction, indicating that some activity was underway at the time of survey or topographic acquisition that prevented an accurate measurement of the location or site at which a proposed item of work is to be performed. This is often the case when aerial

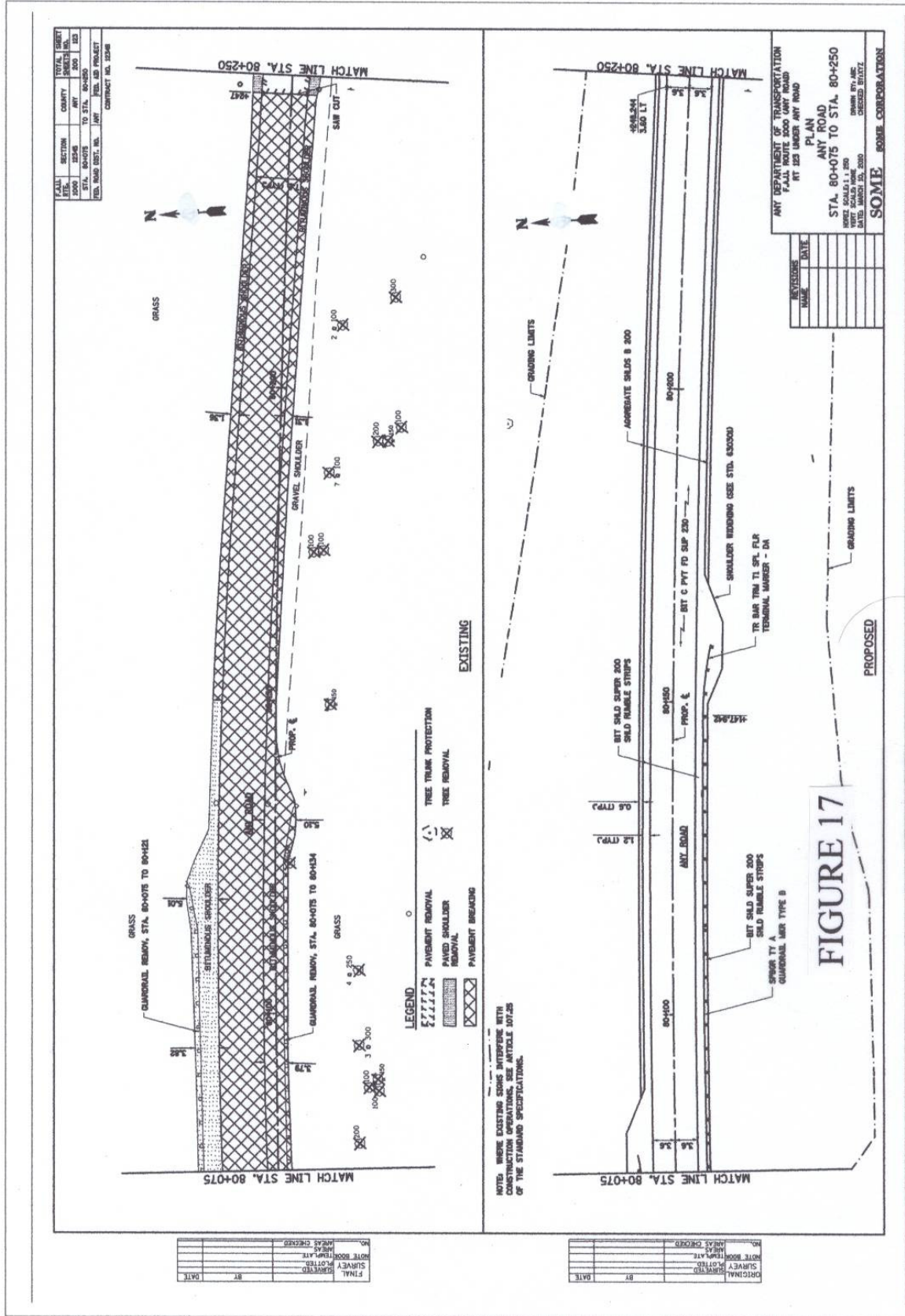
photography is used to acquire the topographic view for use as the plan sheet. In all cases, it is essential that the plan note not contradict the General Notes.

The project limits shown on the various plan sheets will need to match the limits shown on each type of work, as well as on the Title Sheet, the Cross Sections, Landscaping and the Erosion Control sheets.

A comparison of the topography used to show the Ties and the topography used to show the existing plan view will often appear to be mismatched. This could be a result of the source or methods of the topographic survey or data acquisition, and is a common source of discussion during plan reviews. The survey ties might be set prior to the acquisition of design topography, and certain elements such as trees and fences can be removed or be repainted to obscure a tie. The expenditure of last-minute labor to clarify or verify topography can be prevented by an early check of the topographic data. The inclusion of updated utility data can also affect the symbols used for items such as manholes, valve vaults and junction boxes, which are often used as ties, based on the anticipation that these items will not be moved and will represent recoverable objects that can be found during construction.

Work to be performed “By Others” will need to be clarified in order for the intended party or agency to be notified in a timely fashion, without incurring delays on the project.

A sample Roadway Plan Sheet is shown in Figure 17.



### *The Profile Sheet*

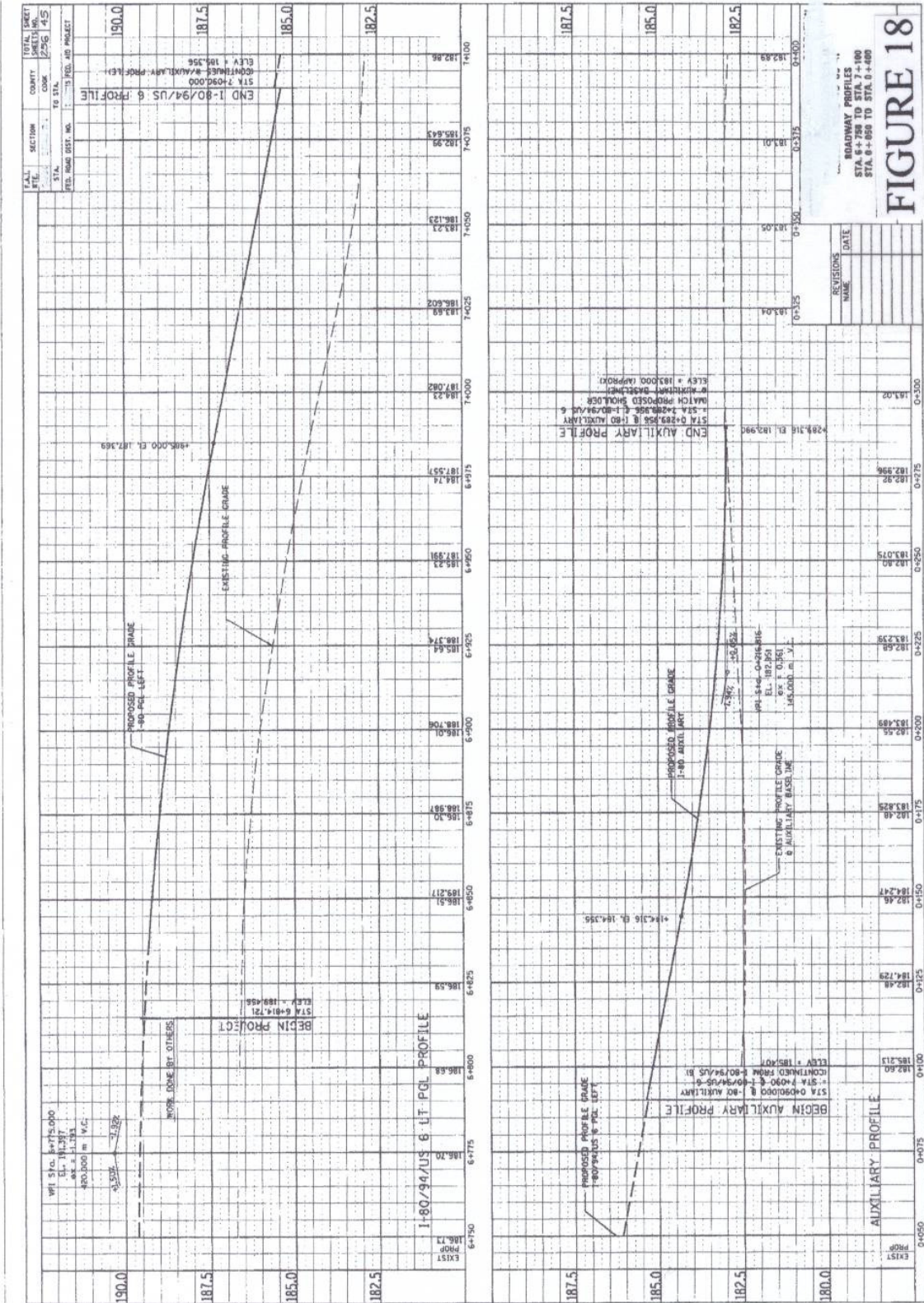
In addition to the horizontal geometry presented in the plan view, a roadway or paving project will be subject to vertical design criteria, which is expressed in terms of lengths of parabolic curve and super-elevation. These design elements are usually found together with the profile of the existing ground along the centerline of the improvement, on the Profile Sheet. Some agencies will request that this profile be presented on the same sheet as the Roadway Plan. Depending on the width of the project and the scale of the drawing, this request might not be possible to fulfill. Other agencies use the Profile Sheet to display a variety of information such as: the ground elevations along the right-of-way line, the profile grade line, location of unsuitable material, the location of driveways and the edge of pavement at intersections. The Profile Sheet can also be used to display ditch lines, gutter lines and sewer profiles. Bridge omissions are indicated where the profile is to be controlled by sheets contained within the grouping of structural plan sheets.

In order to ensure that the project presents a smooth transition between the existing top of pavement and the proposed paved surface, a length of existing profile is often provided beyond the project limits.

The profile of the existing ground can often cross open water, streams or channel lining such as rip-rap or broken concrete. Notation or symbols can be used to define the nature of the ground in order to ensure that a proposed item of construction matches the intended end point. A paving terminus that ends at a bridge or at an unpaved section of roadway would be constructed in a different manner than a terminus that ended at a similar paved segment of road. A ditch flow-line that ends at a rip-rap section of channel might need to be revised if it is shown connecting to the top of a pile of rip-rap. A situation such as this would result in the expenditure of additional labor and could require recalculation of ditch hydraulics, re-setting of structure inverts or revisions to cross sections, grading and earthwork.

A sample Profile Sheet is shown in Figure 18.





### *The Drainage Sheet*

The surface runoff is collected and conveyed to the sub-surface drainage system along a paved gutter, or along a ditch. Information necessary for the construction of drainage-related items is sometimes shown on the plan view sheet. However, the extent of notation required to convey all of the data required to ensure that the intent of the designer is communicated clearly to the layout crew, the contractor and the construction inspectors often necessitates the use of a separate sheet, most commonly labeled as the Drainage Sheet.

As in the case of the roadway view, the drainage view would involve both the existing and the proposed conditions. Coverage of topography beyond the anticipated ends of the roadway improvement would be essential. The existing view can show all sewers, culverts, collection structures, ditches, swales and bodies of water that are to be affected by the construction operations. It can show grading that conveys overland flow into or out of the project site, and can also show existing underground utilities that might be impacted or might need to be protected during the construction of drainage systems and appurtenances. The proposed view would show the drainage items that were constructed, the existing items that have been relocated, connections to existing drainage systems or outfalls and the final condition of any overland flow patterns. The sheets match each consecutive sheet using stationing or reference lines similar to other plan sheets. However, since drainage work might not follow the same centerline as the roadway improvements, the topography along the route of a proposed sewer or ditch might not be the same as that for the roadway. It is not unusual for the drainage portion of a project to require separate alignment and ties, benchmarks and stationing.

Drainage design might proceed based on the typical section, the profile and a rudimentary understanding of the regional storm water conveyance systems. The project limits for drainage work may extend beyond the limits of paving or other work, since an outlet for a sewer may be located a distance away from the paving activities. This may necessitate a return to the field for additional surveys beyond those needed for

the roadway improvements. The construction of the drainage work might entail the need for traffic control or staging that is different from that needed to pave.

Many clients and most design teams would prefer to have their project present an aesthetically pleasing view from the road. This would require that above-ground appurtenances such as fire hydrants, trees, signs and light poles are arranged in linear fashion along the roadside. Given the constricting nature of narrowed parkways in urban areas, often complicated by the inclusion of a sidewalk, the available horizontal area remaining for erection of appurtenances is limited. Contradicting or conflicting placement of work items, albeit unintentional, is almost inevitable if each team's input is isolated.

In order to avoid revisions to the plans during the final phase of the project, the various design teams will benefit from close coordination to ensure that a seamless presentation of the work is submitted to the client. The need for additional survey, structures, utility adjustments and construction staging might only become apparent when the design work from the various disciplines is compiled into one complete set of plans. The outlet system for the footing drains on a retaining wall or abutment might need to be addressed using a ditch or a drainage structure that would not necessarily be part of the roadway surface runoff collection system.

The intended relationship between the back of curb, the edge of pavement, the center of structure and the center of frame or lid will need to be clarified in order to avoid excessive adjustment during layout and construction.

The staging of construction of underground facilities such as drainage items, or any pipeline conveyance system, becomes critical when pavement removal or placement of embankment is involved. For instance, if a section of pavement is to be broken and seated, and if a section of sewer or pipeline is to be placed in the vicinity, or under the pavement that is to be broken, the operations will need to be coordinated. If an embankment is to be built and sewer or pipeline is to be constructed in the same location, coordination will be necessary. It is situations such as these which occur unintentionally, but lead to contradictions and delays during construction. Claims may

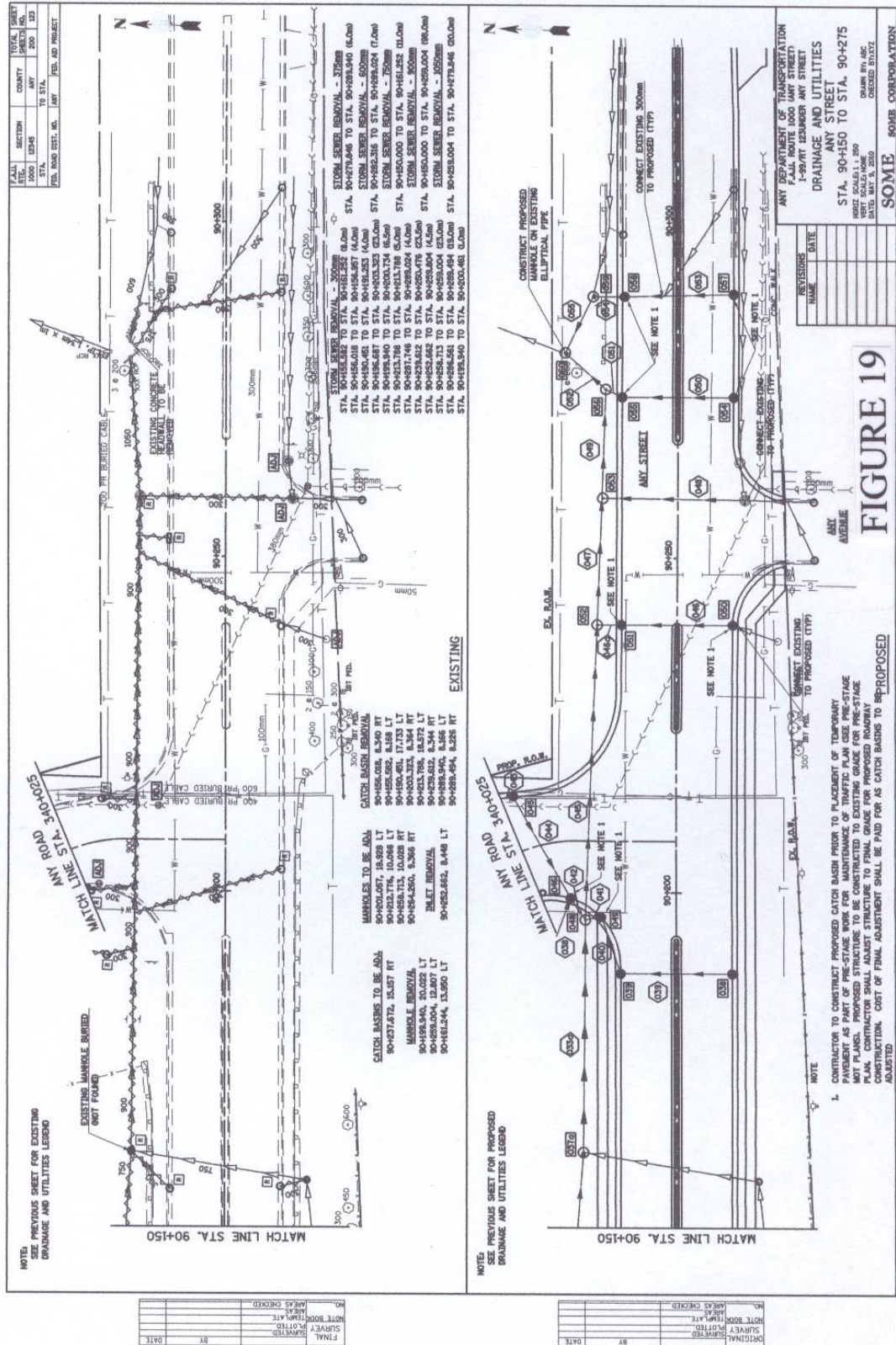


also occur if the exact sequencing shown in the plans leads to damage to the underground facility.

Activities such as pile driving, sheet wall or slurry wall construction, test strip paving and erosion control measures can also involve close coordination between several disciplines in order to avoid construction delays.

The presence of a manhole at the property line or at the limits of a proposed improvement can be an indication that excavation will encounter underground facilities that will be affected by the proposed improvement, even though such was not the intention of the project. A field visit together with a close review of the topography will avoid last-minute efforts to redesign or relocate a segment of sewer.

A sample Drainage Sheet is shown in Figure 19.





### *The Construction Detail Sheet*

Many agencies, municipalities and private clients have lists of standardized drawings that are to be used as a control for the construction of items such as pavement joints, roadside appurtenances and structural features. The list could include driveways, drainage structures, fence, ornamental lighting, and urban enhancement such as benches, planters and shelters. For some projects, the standardized drawing might not be applicable in all situations. This would require the preparation of a drawing that shows the particular elements of an item that differ from the standardized drawing. This could be different dimensions, different materials or a completely revised design that is preferable to the standard. For some situations, a detail might be based on literature or photos of a new product that is available and suitable for a project. Other situations require that the intent of the designer be presented in a sketch to serve as a guide for the construction of a special case that has not been encountered in previous projects.

Many agencies that have a library of standardized drawings would prefer that their designs be used on their projects, and not be considered to be interchangeable in all conditions. Labor and design time can be preserved based on a discussion with the client regarding the use of standards from other agencies.

For details prepared by a designer, the center point or a designated corner of an object would need to be identified in order to perform construction layout.

A sample Construction Detail Sheet is shown in Figure 22.



### *Miscellaneous Sheets*

Every project is unique. In addition to the basic plan, profile and typical section sheets, supported by standard drawings for frequently constructed items, the designer may need to provide additional instructions to the contractor. This is done through the use of specialized sheets such as Removal plans, traffic signal equipment and conduit layout, intersection details and pavement joint layout sheets. These sheets might require the design input of engineers who possess skills derived from formal training or years of focus in a particular area of expertise.

The miscellaneous sheets would be referenced from the plan view location where they are applicable. The scale of the sheets could be different, but the dimensions and location of existing and proposed items would be the same.

Some agencies rely on publications that represent acceptable methods or procedures to be followed for the construction of items that have a more direct affect on the public, such as water main and sanitary sewer systems. Labor by a specialized engineer can be costly, and best minimized or focused with certainty. Once the labor is expended, it cannot be recovered if it is found that the client had a particular design guideline in mind. The client's use of publications might not be part of the agreement for services or the scope of work. It might be assumed that the engineer is familiar with standard practices. This situation might not be discovered until a submittal is made, which could result in additional labor. A sample Miscellaneous Detail Sheet is shown in Figure 23.



