4

The Design Process: Documenting and Installing Landscape Lighting

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Once the lighting designer and the client have met to discuss the project and a project agreement has been signed, work begins on the project. The process of turning initial design ideas into a completed, installed lighting system involves several steps. First, the owner needs to understand the design, which requires the designer to produce *presentation documentation* to convey the design intent, to express the quality/performance of the system, and to show an example(s) of the proposed lighting equipment. After receiving approval of the conceptual design from the owner, the designer then proceeds to produce working drawings, typically called *contract documents,* that provide the directions for the electrical contractor to install the lighting system.

After contract documents have been issued and bids have been reviewed, a contractor will be selected to carry out the installation. The designer and contractor will then walk the site, marking the locations of all equipment and accessories. Once the equipment has been installed, the designer will direct the aiming of the system to provide the desired lighting effects. During this phase of project work, the design team and the installing contractor need to note locations of all equipment, any changes in types or quantities of equipment, and any other information important for future project maintenance.

The last step in documentation includes providing the owner with as-built documentation, typically called *record documents.* This documentation includes drawings and specifications of all installed equipment, a description of all maintenance tasks that need to be done to keep the system functioning properly, and a schedule for ongoing design and maintenance.

The design and construction process for lighting projects varies with the size of the project, other construction (architectural or landscape) occurring simultaneously on the site, and the state of the site. On large projects that involve developing a new site, the lighting design will be just one part of the project, which may include architectural and landscape architectural design and construction. In this case, presentations to the owner are often integrated with other landscape design issues, and lighting drawings and specifications are integrated into a package of documentation for the entire project.

Alternatively, when lighting a relatively small and/or previously developed site, the documentation and process may be simplified. In some cases, it may make fiscal sense; in others, the owners may request that no drawings be produced, preferring that the entire design be developed through a combination of written requirements and on-site directions from the designer to the contractor. The major drawbacks to this approach include a greater risk of the contractor misunderstanding the design intent and the absence of any final documentation provided to the owner for ongoing system maintenance. In all cases, the designer should at least produce a sketch of the lighting layout on the site for the contractor and a sketch of the locations of fix-

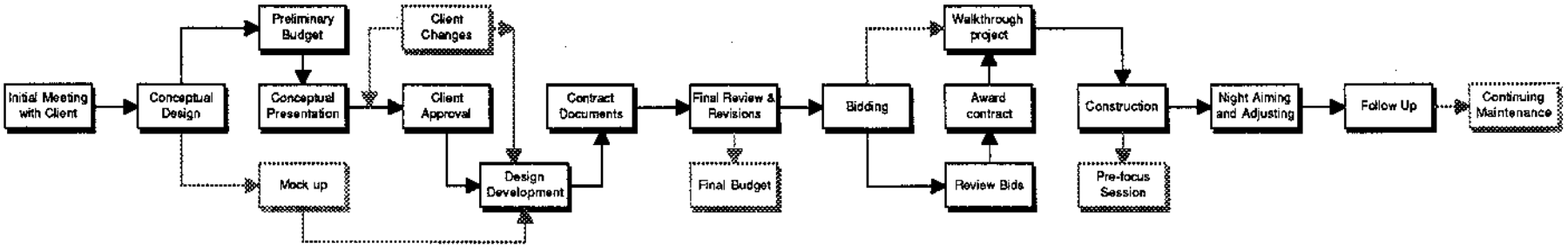

Figure 4.1. *Chart of typical project flow.*

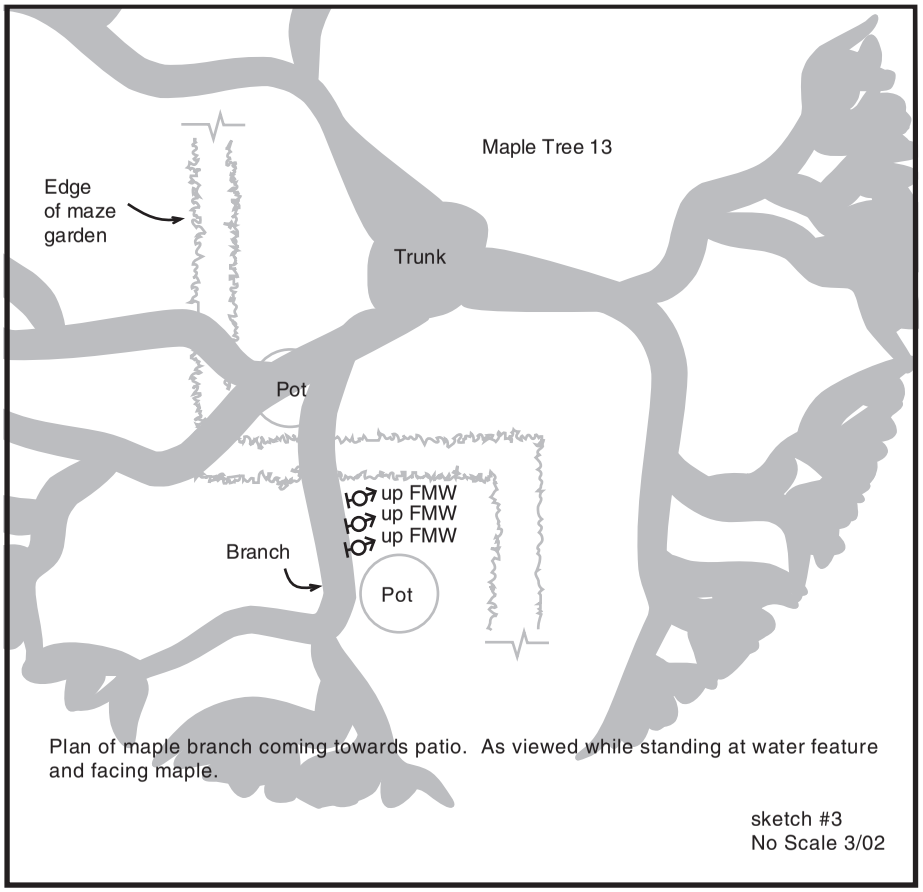

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Figure 4.2. *This sketch documents the location of fixtures in Maple Tree 13 so that the client can maintain the lighting. Drawing: Jim Gross & N. J. Smith.*

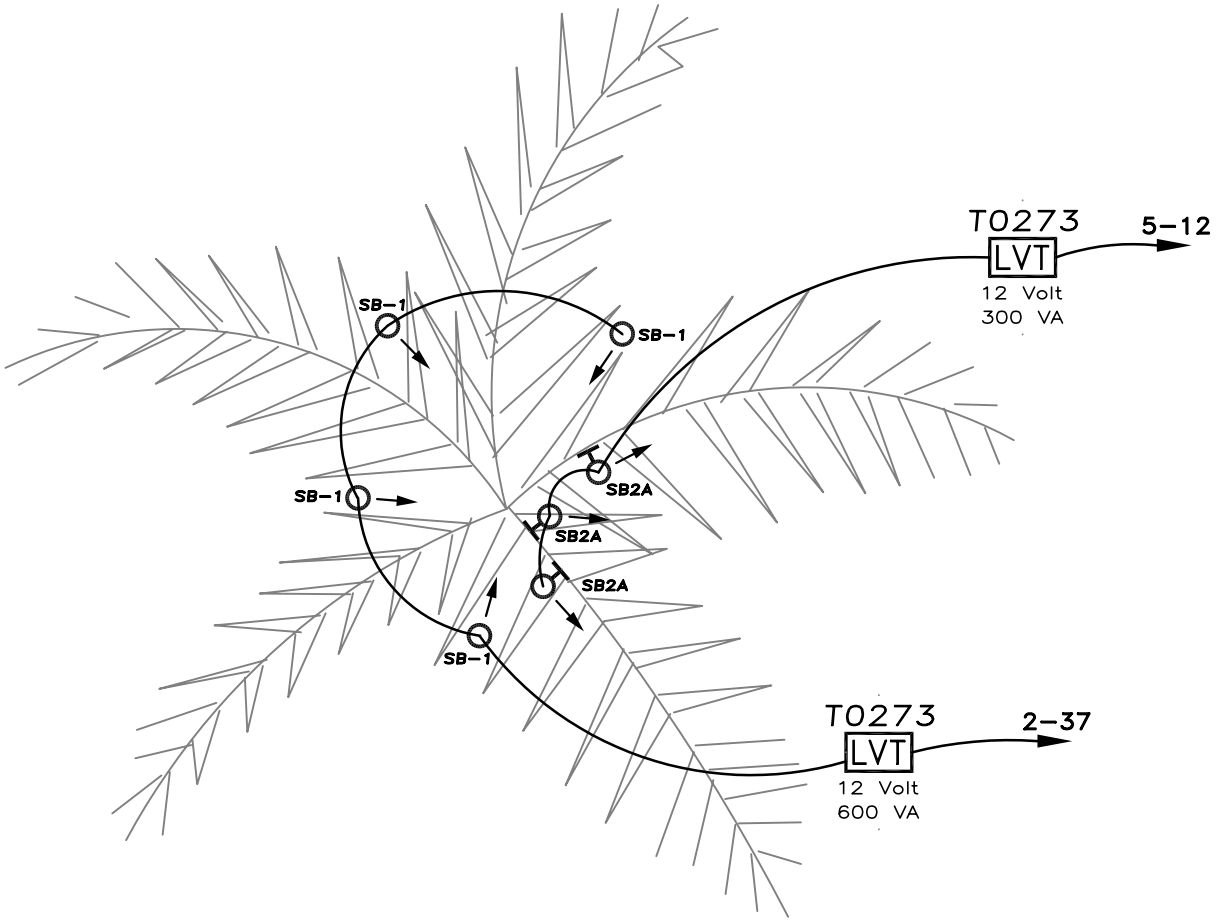


Figure 4.3. *Show all lighting information with dark, thick lines. All background information should show but be softened or lightened to allow the lighting to be easily identifiable. Having plant materials, hardscape, and structures on the plan provides a sense of context for future maintenance. Drawing: N. J. Smith.*

tures, lamps utilized, and aiming intent for the owner to use in maintaining the system (see Figures 4.2 & 4.4).

Regardless of the complexity or formality of the process and the type of documentation produced, the basic flow of steps to produce a finished lighting installation follows the same path (see Figure 4.1). This chapter discusses the work involved from conceptual design documentation through contract documents and construction. The next chapter will cover the process of converting contract documents into record documents and the maintenance documentation necessary to keep the lighting system functioning properly.

PROJECT COMMUNICATIONS

On any construction project, success requires clear communication between the team members—owner(s), designer(s), and installing contractor(s). Decisions made and directions taken at each stage must be clearly understood and supported by all people involved in the design and installation of the project work. Information can be disseminated verbally or visually, through photographic, written, or drawn documentation.

The results of successful communication, using any or all of these means of communication, will include:

- Execution of the design as conceived
- Maintenance of the design intent over the planned project life span
- Control of project costs
- Adherence to project schedules
- Owner satisfaction with the quality of the design and the construction process, the design concept, the project installation, and the performance of the design

At the time of the first edition of this book, most project drawings were done by hand. Today, computer technology allows the landscape designer to electroni-

Figure 4.4. *A marked-up photograph clearly documents information that the owner and/or installer needs to understand. This can accompany drawings or be used when no site drawings exist. Drawing: Jim Gross & N. J. Smith.*

cally transfer project information and drawings over the Internet, via a CD, or through a Web-based project management site. Having access to project information on a computer offers the lighting designer the ability to provide more information to the client than previously affordable, to easily show the client multiple options, to quickly change ideas/direction as the project progresses, and to keep lighting documents current as the project evolves (landscape design, civil engineering, architecture, etc.). Because of these benefits, hand drawings are no longer widely produced.

COMPUTER-AIDED DESIGN (CAD)

Lighting designers typically work from landscape drawings provided by the landscape designer. Using the landscape designer's AutoCAD (or other software program) project files as a base, lighting designers can create a wide range of drawing options from simple graphic representations of fixture quantity and location to elaborate renderings of proposed techniques.

As the project starts, the lighting designer needs to understand the documentation standards to be followed. The landscape team's CAD manager provides the lighting team with the document and CAD standards, including:

Document Standards
- Sheet size
- Drawings scales
- Title block layout
- Sheet name and numbering system
- Document issuing procedures: ID, name, and date

Figure 4.5A–C. *This series shows a daytime view of Evening Island at the Chicago Botanic Garden along with a rendering of the lighting concept and a photograph of the mockup. The complexity of plant material does not lend itself to realistic rendering. Lighting Design: Janet Lennox Moyer & Dan Dyer, MSH Visual Planners; Rendering: Dan Dyer; Photographs: Dan Dyer.*

CAD Standards

- Layer names
- Line weights
- Text and fonts
- Pen colors
- Pen widths
- Pen numbers
- XREF (external reference) files: overlay or attachment
- Adding new layers

Once the lighting designer has received a finished background plan from the landscape designer, the process of adding the layers with lighting information into the project drawing can begin. The lighting documentation should be produced on new lighting layers that no other team members modify in any way. This allows lighting updates to be done without affecting other work in other disciplines.

Often the computer files received by the lighting designer have more information than needed for understanding the lighting. Removing information unnecessary to the lighting by turning off layers simplifies the lighting background and allows the lighting information to show more easily and clearly. All landscape information should be softened to allow the lighting information to show most boldly (see Figure 4.3). Since the landscape background is likely to keep changing until well into or after construction completion, the lighting designer needs to stay in contact with the landscape designer to ensure that the background utilized for the lighting design documentation is current and accurate.

Often complete or accurate site drawings do not exist. The lighting designer may have to either produce the background or update the files provided with tree locations, new patios, pools, walkways, and so on. This coordination can take significant time and needs to be considered in the fee structure for the project.

The number of lighting layers and how the project is organized will depend on the scale and complexity of the project. Large-scale projects often require multiple sheets for the lighting layout. Trying to put the entire site onto one sheet would make the scale too small to read. Complicated projects might require a separate layer for fixture location, transformer, and/or controls information. Some projects require multiple sheets of schematic wiring and installation details.

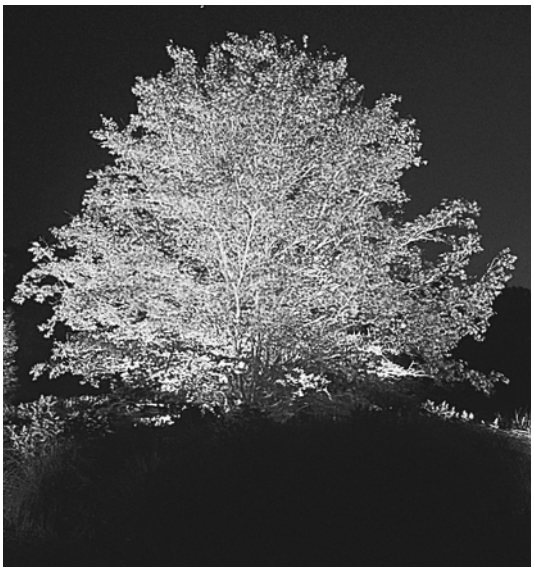


Figure 4.6A–C. *Looking at this individual tree in the Chicago Botanic Garden shows even more clearly how rendering on plant materials is not as effective at showing lighting as a mock-up. Lighting Design: Janet Lennox Moyer & Dan Dyer, MSH Visual Planners; Rendering: Dan Dyer; Photographs: Dan Dyer.*

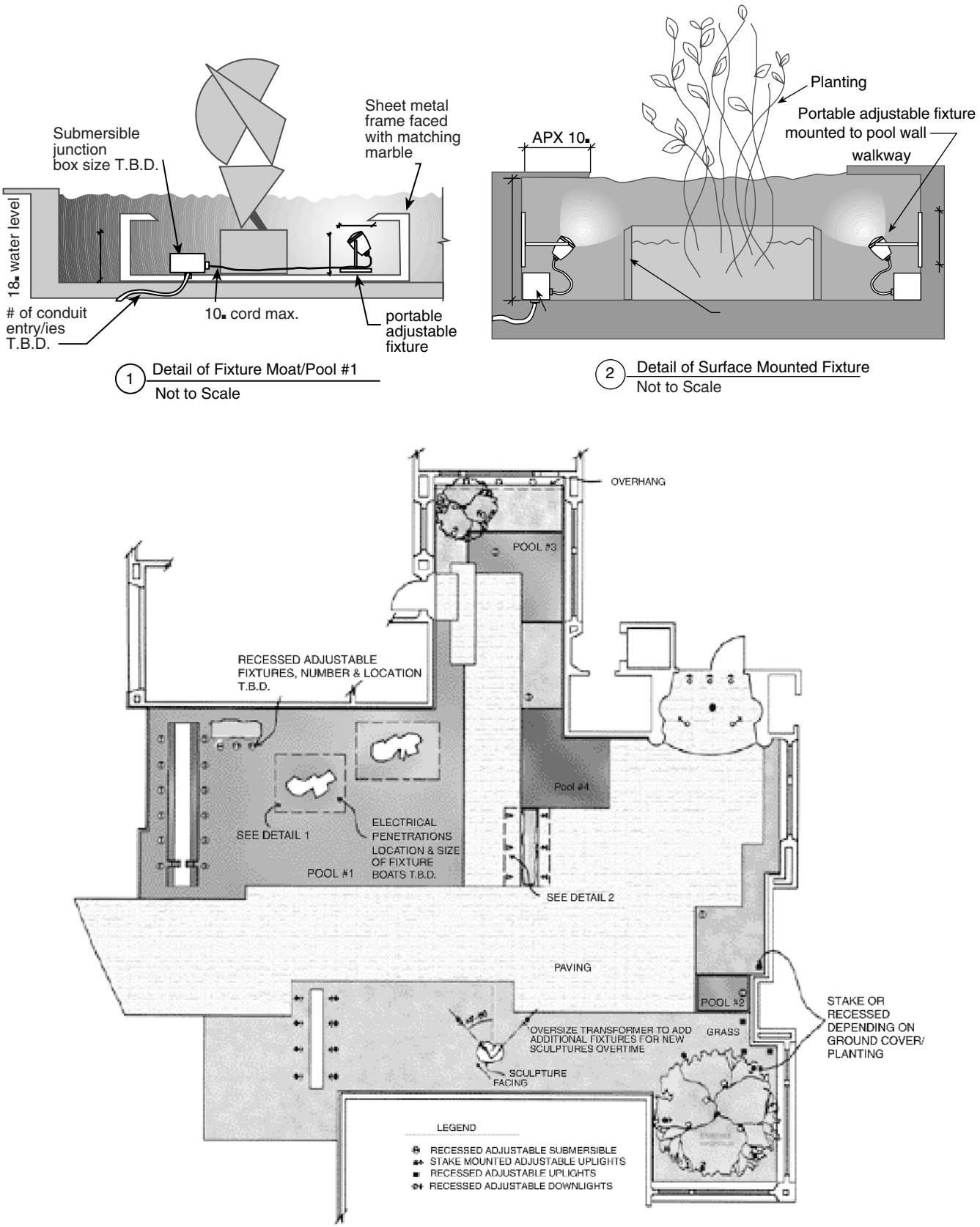
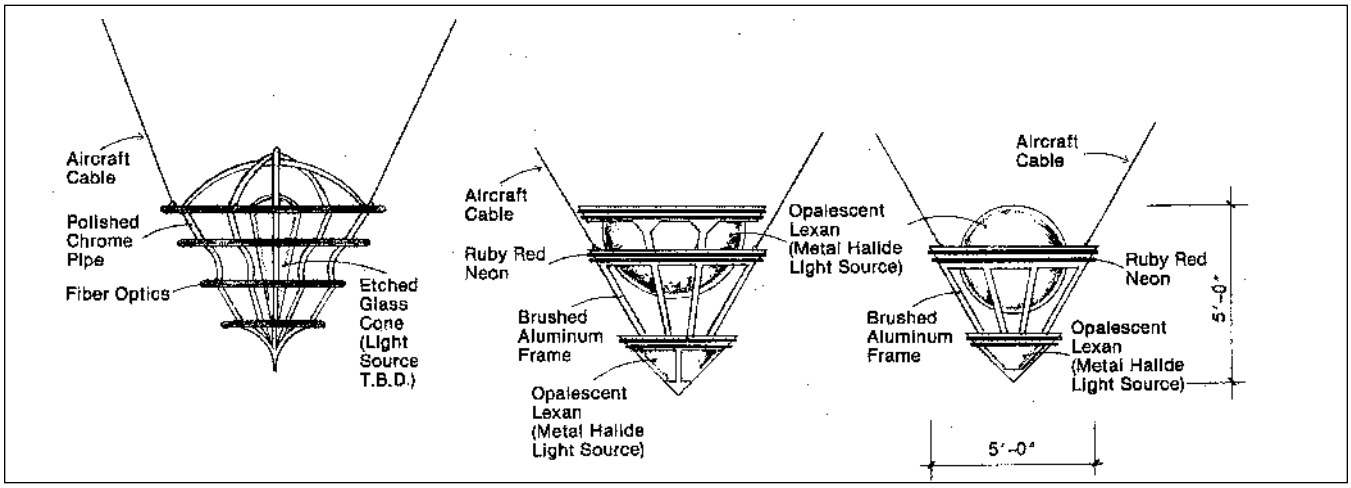
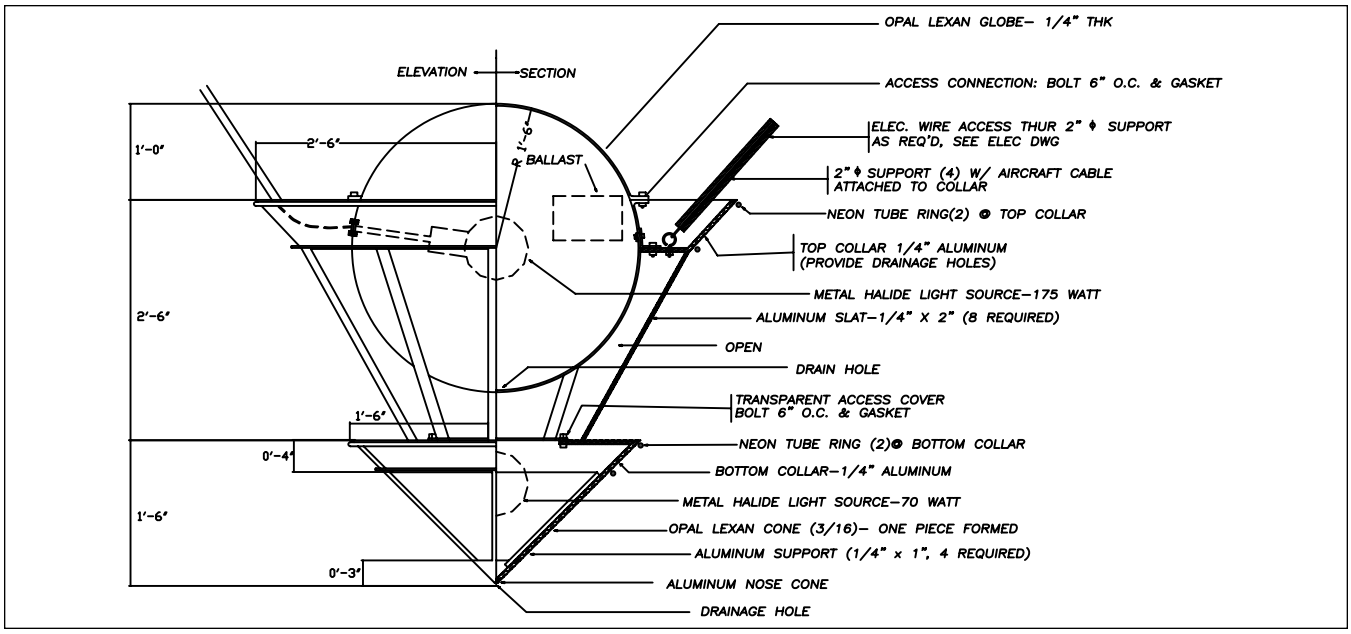


Figure 4.7A–C. *Preparing conceptual sketches using computer capabilities conveys ideas easily (color adds to the clarification—the water areas would be blue, for example). Drawings: Insiya Shakir, Jim Gross, & N. J. Smith.*



A.



B.

C.

Figure 4.8A–C. *Ten years ago, the right-hand fixture had just been selected from this trio of sketches for the Pierce Transit Commerce Street Improvements custom pendant. Winona Lighting then produced the construction submittal drawing (B). The transition from conceptual design to construction, while dramatic in the technical requirements and detailing, ends up producing a fixture exactly as the design team imagined it. Conceptual Fixture Design & Drawings: Lezlie Johannessen, Jan Moyer Design; Submittal Drawing: Winona Lighting; Photograph: Amphion Environmental.*

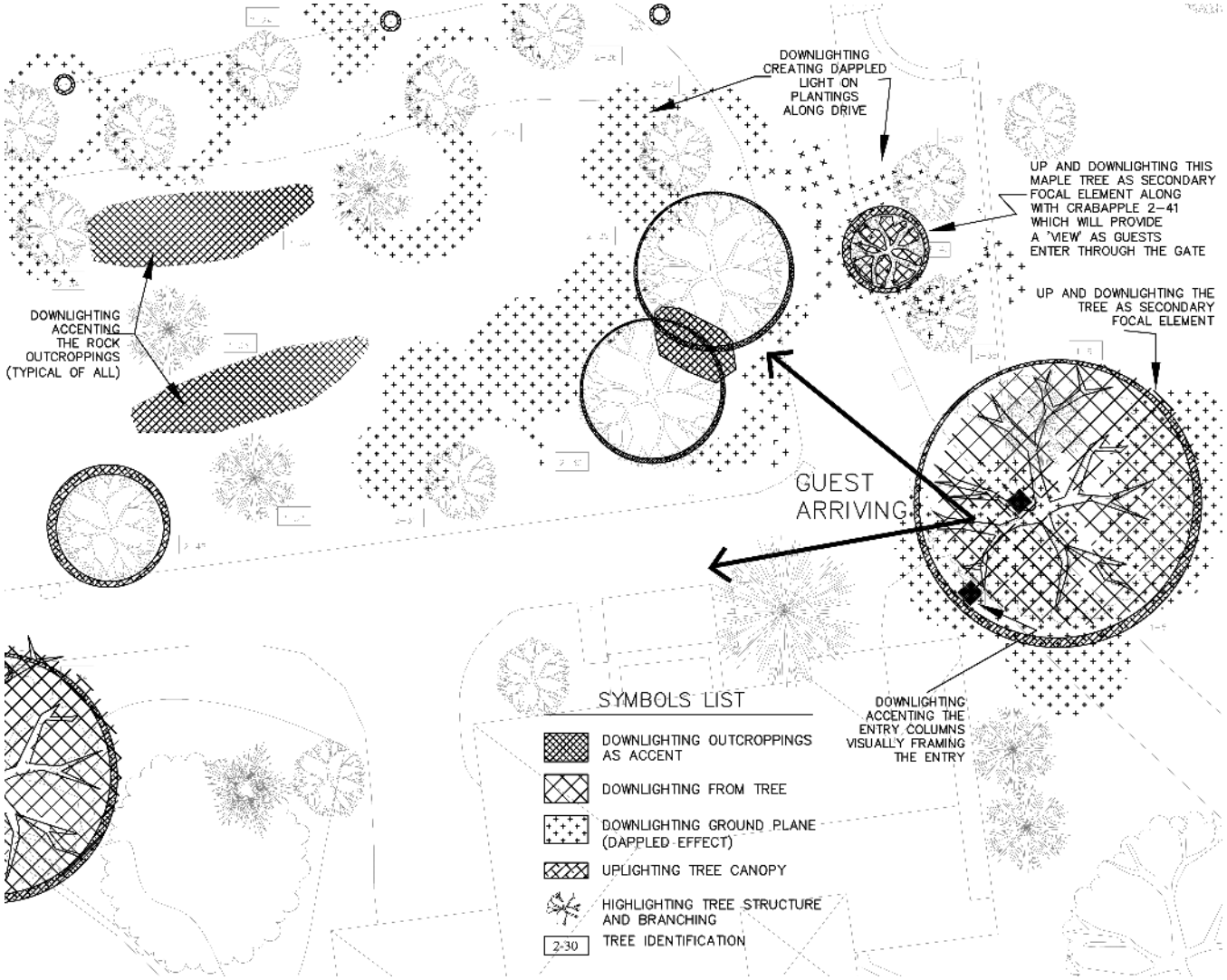


Figure 4.9. *An example of a shading technique master plan drawing (color adds clarity). Lighting Design: Janet Lennox Moyer, MSH Visual Planners; Drawing: Insiya Shakir.*

A variety of software exists for producing contract documents and for many other documentation purposes. All sorts of calculations can be done for parking lots and roadways, but, these programs have little use in landscape lighting. Calculating the way lighting will make a tree look isn't feasible. No graphics program can accurately illustrate the lighting effects intended for a tree (see Figures 4.5A–C & 4.6A–C).

CONCEPTUAL DESIGN PHASE DOCUMENTS

The conceptual design phase of a project begins with developing the lighting intent. It requires the designer(s) to evaluate all the client information gathered during interviews, including the intended uses of the space and the client's reactions to and preferences about light levels and lighting options as well as long-term development plans for the site. The designer must understand issues that pertain to the specific site identified during site visits, and must have discussed the landscape design with the landscape professional and studied the landscape design documents thoroughly enough to mentally visualize new gardens and the physical attributes of the site. The design team needs to have thoroughly synthesized this information collected from the client and the site in order to establish the lighting goals. This includes determining the owner's expected result(s) and identifying the lighting objectives—the specific visual elements that will result in the accomplishment of the project goals for the owner.

Figure 4.10. *This computer-generated rendering of the lighting concept for the front elevation of the University of Chicago Biomedical Building clearly showed the design team and the clients how the lighting would transform the building at night. Lighting Design: Michael Stewart Hooker; Drawing: John Court & Michael Stewart Hooker.*

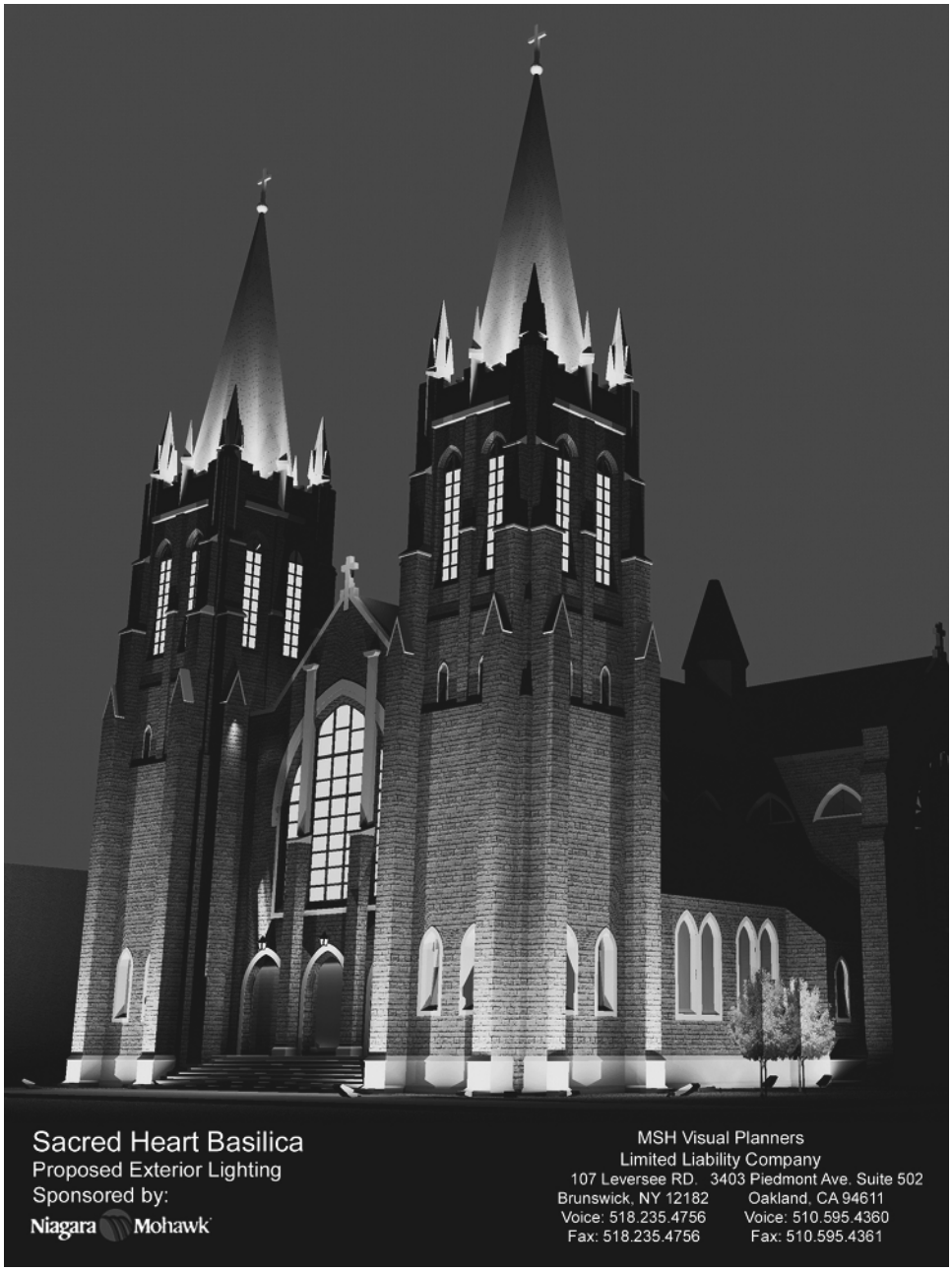


Figure 4.11. *A perspective rendering of the lighting concept for the Sacred Heart Basilica in Syracuse, New York, brings the building to life. The design team and clients can use this type of drawing to publicize the idea of building lighting. Lighting Design: Janet Lennox Moyer, Patricia Rizzo, Jean Paul Freyssinier Nova, & John Tokarczyk; Rendering: John Tokarczyk. Sacred Heart Basilica Proposed Exterior Lighting Sponsored by: Niagra Mohawk Power Corporation, a National Grid Company.*

TERMINOLOGY

PROJECT AGREEMENT	A document explaining the scope of the project, the tasks to be completed, and fees to be charged
AUTOCAD	A software program produced by AutoDesk. Other programs include MicroStation and PowerCAD for Macintosh users
CAD	Computer aided design—Software for the production of architectural plans
CIVIL TWILIGHT	The time each day that electric lighting becomes necessary in order to carry on outdoor activities
CUT SHEET	Manufacturers literature defining the parts, pieces, accessories, and finish for a lighting fixture
'FURNISH'	Deliver to the job site and to the Owner or Contractor
'INSTALL'	Install material furnished by the Owner or under other parts of the Contract (or by Unknown Others)
'PROVIDE'	Furnish, store, construct, install, test, clean, adjust, and place into operation

Figure 4.12

Lighting objectives include some combination of the following:

- *Visibility*—a composite of everything that assists in sight, understanding, and recognition
- *Composition*—the organization of brightness relationships between surfaces and/or objects in space
- *Image*—a visible representation of the desired style, character, and impression
- *Mood*—an emotional response to the environment
- *Comfort*—a subjective satisfaction or freedom from pain and anxiety (including physical, aesthetic, functional, and psychological support)
- *Orientation*—an awareness of location, time, enclosure, direction, destination, and/or presence

The designer makes initial decisions based on the way he/she envisions how the lighting will sculpt landscape or how it will reveal the selected landscape elements from the dark. These ideas then translate into the number and types of lamps required to produce the effects of this imagined night scene. With effects determined, generic fixtures that will hold the lamps can be identified. General fixture and transformer or ballast locations should be identified, and control strategies as well as provisions for future system expansion need to be considered.

Organize the conceptual ideas into a master plan by areas (See Documents Appendix Figures A6 & A7) and/or lighting effects. This provides the owner with a complete, cohesive design for the mature landscape. Lighting ideas and associated costs can then be reviewed by section of the garden or by layers of light. The first priority for most projects will be to implement the required power for the master plan throughout the site. Then, lighting for selected garden areas can be implemented over the course of years.

Presentation Drawings

Presentation drawings in the form of conceptual sketches, layouts, and/or renderings help the client understand the intent of the proposed lighting. At this juncture in the project, other issues are equally important to the visual impression. Initial and maintenance costs must be prepared and reviewed with the owner. This provides them with all the information required to evaluate aesthetic and financial ramifications before proceeding to the next phase of work. A designer needs to consider how to communicate the following issues

Figure 4.13. *Equipment has been laid out during the day to test more than one technique for lighting this tree. The fixtures have been lamped, connected to transformers and/or extension cords, and preaimed. Once darkness falls, the real work of testing the concept can begin. Photograph: Janet Lennox Moyer.*

when selecting how to present the design intent to the client:

- Aesthetic imagery
- Functional performance
- Performance requirements of equipment and materials
- Scale and cost of the work

To express these ideas to the owner and other design team members, one or more of the following types of design documents can be utilized:

- *Visual concept statements*—a project description including an explanation of how the lighting scheme will achieve the owner's goals and objectives, overall visual impressions and those from key vista points resulting from the conceived use of qualities of light, the functional characteristics of the system resulting from the conceived qualities of light, and technical qualitative and quantitative requirements
- *Visual concept renderings*—black and white or color, hand- or computer-generated images of one or more areas of a project
- *Performance concept sketches and/or layouts*—black and white or color, hand- or computer-generated plans showing equipment location and/or installation detail
- *Basic equipment layouts*—schematic location or quantitative allocation of fixtures for general or specific locations
- *Performance specifications and calculations*—one or more of the following as necessary:
  Perceptual brightness levels
  Luminance pattern, levels, and/or ratios
  Exitance levels and/or ratios
  Illuminance pattern, levels, and/or ratios
  Visibility levels
  Contrast ratios

Figure 4.14. *For either mock-up or actual aiming sessions, low-voltage stake-mounted fixtures should be laid down in the approximate location of the initial marker. Photograph: Janet Lennox Moyer.*

Discomfort glare levels
Disability glare levels
Color rendering levels
Correlated color temperatures, shifts, and/or contrast ratios

- *Lighting fixture information*—generic or specific fixture imagery, scale, lamping, mounting, finish, required or potential accessories
- *Budget and estimate information*—purchase and installation costs including typical industry markups and hourly costs (typically by area), thus allowing for potential phasing of installation

The format(s) of drawings will vary based on the client's ability to understand lighting and architectural drawings and the type of project (see "Types of Presentation Drawings," below). Using presentation documentation as a tool provides a client the opportunity to review the initial ideas and either request changes or additions or approve the concept as shown. Design documents should provide the following outcomes for a project:

- The owner's understanding, acceptance, and support of the design
- The owner's and designer's ability to manage project cost
- The contractor's and supplier's understanding, acceptance, and support of the design
- The contractor's and supplier's ability to execute the concepts as intended
- The project team's ability to integrate the design with other systems and project design elements

Most of the changes the owner will request happen at this stage of the project. It is crucial that the owner understands and approves the proposed design before working drawings are produced for construction. Most frequently this approval consists of the owner's signature on a blueprint or a letter authorizing the designer to proceed with the next phase of work. In some cases, when the designer and owner have worked together previously, know each other well, and have a strong trust between them, a verbal approval is enough to authorize proceeding to the next phase of work.

Types of Presentation Drawings

Presentation drawings vary widely in technique and formality. Each emphasizes different aspects of the lighting design. Sometimes, a suite of sketches with a preliminary fixture layout and details will graphically explain a concept (see Figure 4.7A–C). In some cases, the designer may present more than one concept. When alternative schemes are presented, it may be to provide the owners with aesthetic choices, or because different schemes offer varying benefits and drawbacks that need to be discussed and evaluated (see Figure 4.8A–C).

Other types of presentation drawings include more formal approaches that give the owners a visual picture of the intended design. An earlier edition of this book included several hand-drawn techniques. This edition will concentrate on computer-generated imagery.

Perhaps the simplest technique is to shade a plan with patterns and/or colors representing a specific lighting technique. Arrows delineate the important viewing locations and text explains the concept or technique (see Figure 4.9).

Shading a photograph of the site or an elevation/perspective drawing of an element (see Figure 4.6A–C) or a section of a garden (see Figure 4.5A–C) shows graphically how a familiar daytime setting will be transformed at night. Brightness variation provides some information about the hierarchical importance of elements. Using a graphics program such as Adobe Photoshop, a daytime view can be generally translated into a composite of nighttime brightness relationships. Several fixture manufacturers make available computer programs that allow a designer to create a general night scene of a garden (see the websites for Kichler and Vista in the Lighting Manufacturers Directory).

Using a combination of commercially available graphics programs, a more realistic lighting appear-

LANDSCAPE WIRE LIST

FRONT YARD:

WIRE #:	WIRE SIZE:	AREA:
1	#10	Mesquite tree
2	#10	Mesquite tree
6	#12	Street Octaillo
7	#12	Sonoran Palo Verde-by family room
8	#12	Sonoran Palo Verde-by family room
9	#12	Drive Saguaro
10	#12	**Future– drive Saguero**
11	#12	Yucca
12	#12	**Future– Yucca**
17	#12	Saguro by front door
18	#12	Saguro by front door
19	#12	Octaillo by front door

BACK YARD:

WIRE #:	WIRE SIZE:	AREA:
3	#10	Palo Verde Tree by sewing room
4	#10	Palo Verde Tree by sewing room
5	#10	**Future– Palo Verde tree by sewing room**
13	#12	Existing tree by house
14	#12	Octaillo by wash
15	#12	Existing tree
16	#12	Existing tree
20	#12	**Future– Palo Verde tree by sewing room**

Figure 4.15. *A chart showing the actual cables installed at a site facilitates future system expansion. Drawing: Janet Lennox Moyer & N. J. Smith.*

ance can be created on architectural elements (see Figures 4.10 & 4.11). The simplicity of the building materials, compared to the complex characteristics of leaf, canopy, and trunk structure of a tree (see Figure 4.6A–C and Chapter 14) allows for relatively reasonable computer calculation of the night appearance. Producing these images is time-consuming and requires an experienced hand; this person must be knowledgeable enough about lighting to know whether the imagery being generated by the computer can actually be produced using available lamps and associated lighting equipment.

Neither hand-drawn nor computer-generated drawings capture the actual experience of lighting (see Figure 4.5). This limitation of drawings needs to be understood by the designer, and expressed to the client. When the drawings are not enough to convey the ideas, the lighting designer needs to suggest a mock-up, take the client to see other projects, or show the client photographs of other installations utilizing similar ideas.

Mock-up Sessions

During the *conceptual design* stage, the designer may need to do a mock-up, either to illustrate to the owner the potential lighting effect(s) or to determine, for the design team, if a new idea will work. A mock-up consists of bringing lighting equipment to a site and setting it up to show or test lighting ideas at night.

As a marketing tool, setting up lighting in one or more areas of a client's garden can help convince a client to hire the designer or help the client understand the lighting effect(s). A mock-up, either on-site or in a darkened office space can determine appropriate lamp selection, fixture location, and/or best technique to use in a specific situation. Mock-up sessions visually explain what clients often have a hard time understanding from drawings and written descriptions.

Issues to plan for in determining a mock-up include:

- *Time of year.* The best time of year for a mock-up is late October through early April, when darkness

begins early in the day. The United States Naval Observatory, Astronomical Applications Department has a website, http://aa.usno.navy.mil, that tracks twilight (among other sun and moon phenomena) throughout the world over the course of the year. A daily or annual chart earth that lists the end of civil twilight (see "Terminology Chart," Figure 4.12) can be produced for any location on (see Documents Appendix Figures A.24 & A.25).

- *Time of day.* While the lighting setup has to wait until after dark, equipment can be packed and transported to the site during the day. Power can be extended from existing sources using extension cords, and fixtures can be prepared, including preliminary lamp selections. The actual work of a mock-up to create or test the ideas or equipment under consideration needs to be done after dark. The number of people needed and hours required to prepare, set up, test, show, and take down the mock-up needs to be planned.
- *Staffing.* The amount of equipment needed, the areas where equipment will be located, distances and complication of preparing/providing power, and the amount of work to be done after dark suggests how many people to bring. Include tasks such as retrieving items from toolboxes, cars, or even supply houses in this planning. During the course of the night setup, the number, type, and/or location of fixtures might require adjustment. Multiple fixtures might need to be set up to compare techniques or effects. The fixtures will need aiming, and this will involve moving fixtures, horizontal and vertical fixture rotation, changing lamps, adding accessories, and so on. A person needs to be assigned to take care of procuring snacks and/or meals; even in many warm climates, the temperature will cool off at night, and having a warm cup of coffee becomes an important consideration.
- *Equipment and power.* The lamps, fixtures, mounting assemblies, shielding accessories, tools, power cords, gloves, and sometimes even snowshoes need to be procured, organized, and brought to the mock-up site. Once at the site, power needs to be distributed from available sources.
- *Setup.* All the equipment that the designer(s) will need should be brought to each mock-up location and prepared for the night aiming. Fixtures should be assembled, including inserting the lamp and any shielding accessories, attaching the appropriate mount (spike, canopy, etc.), and placing the equipment how and where the designer designates (see Figures 4.13 & 4.14). Spare lamps and fixtures or alternative lamps and fixtures should be prepared so that the work effort can concentrate on creating and testing effects once it is dark.
- *Teardown.* The mock-up team and the owner need to determine how long the equipment will remain on site. All the equipment utilized in the mock-up should remain for the presentation and duration of the mock-up. Any additional equipment not utilized needs to be removed and returned.

Consider photographing the mock-up. Photography of lighting is an involved process and usually disruptive to the lighting setup. In planning, therefore, arrange to have the photographer arrive when the setup will be essentially complete. If the mock-up will remain in place for more than one night, the photography should be done on another evening. The benefits to photographing this session will be many—a reminder to both owner and designer as to what was done, an example for future reference, and a contribution to future documentation of the project.

There is one additional mock-up consideration. For all fixtures that are permanently mounted in a lighting system (for example, 120-volt ground-mounted adjustable accent fixtures, below-grade fixtures, tree-mounted fixtures, and building/structure-mounted fixtures), a locating mock-up should be done at night. This will be discussed in more detail later in this chapter.

Preliminary Budget

Clients typically don't understand the cost of lighting. Responding to this issue by offering inexpensive fixtures in an attempt to limit the project cost causes long-term discontent toward the lighting industry. Inexpensive fixtures are not manufactured to respond to environmental and site challenges. Fixtures need to withstand continual wetting and drying conditions, especially in tropical locations or in landscapes that have irrigation systems. Sockets fail, mounting arms break, and aluminum spikes completely disintegrate in the ground (often within less than one year). All too often, aiming angles are lost because fixture-locking mechanisms cannot withstand shovels or rakes. Worse, after aiming the fixtures at night, the locking mechanism can't tighten solidly enough to hold the desired angle. All these maintenance problems cause client dissatisfaction.

Instead of offering inexpensive fixtures, develop an overall master plan for the site. Organize the lighting into independent areas or phases that can be installed as the garden develops or as the client feels financially comfortable. This requires initially sizing the electrical infrastructure for the addition of future load(s) and distributing the appropriate conduit/power throughout the site (see Figure 4.15). Once a client experiences successful landscape lighting, he or she typically will be more understanding of the costs involved.

The preliminary budget includes an estimate of the purchase price of the equipment and the cost of installing the equipment. For some projects it might include the design fees. Equipment costs include fixtures and lamps, as well as accessories for the fixtures, such as louvers or shrouds, special color finishes, and mounting canopies or stakes/spikes. Each project and every fixture will have different accessory requirements. The equipment costs include wiring equipment, such as junction boxes, conduit, conduit connectors, wire, transformers, breakers/fuses, cable ties, screws, controls, and so on.

Installation costs include the contractor's labor to install all the equipment, dig ditches for conduits, and participate in the after-dark aiming session(s). Overall project costs vary greatly from one size project to another and from one site to another due to varying labor rates from one community or area of the country to another, site conditions, and the complexity of the design. There is no simple way to assign a square-foot cost based on the equipment and quality of the system, as designers often do for interior lighting systems. Cost estimating is one of the many situations where a computer aids the designer. A cost program can be set up that allows input of all the equipment and installation variables on a given project to produce a useful preliminary budget.

Some designers look at all the costs from previous similar jobs and determine a cost per fixture that includes all the costs of the project. This factor can then be multiplied by the anticipated number of fixtures to get a ballpark cost estimate. This fixture unit price helps in revising the project when the owner wants to add to or simplify the lighting at any stage of the project. This per-fixture method, while useful, can be dangerous if trying to apply it as an actual budget. Integrating the cost of transformers, complicated control systems, difficult site power distribution issues, and other wiring items into a per-fixture cost does not always translate directly to the actual project costs. It is often wise to list the control system, which is often a large-cost item, as a separate item in preliminary budgets.

The designer starts by requesting a price for all the fixtures from one or more manufacturers. This pricing comes from an independent company that acts as a manufacturer's representative. The designer must be cautious to request a specific price estimate. This will typically be one of three costs: either the price at which the representative will sell the equipment to an electrical distributor, an estimated cost that the electrical contractor will pay, or an estimated cost to the owner.

In the lighting industry, there are several intermediary layers of business entities that the equipment passes through before reaching the client. The typical path starts with the manufacturer selling to the manufacturer's representative, who sells to an electrical distributor, who sells to the electrical contractor, who sells to the owner. At each point along the way, a cost is added to the original selling price from the manufacturer. On large projects, the general contractor will add a percentage on top of everyone else! The typical markup percentage varies with the business entity and by geographical area. The designer must understand what cost type is being provided and add in all the appropriate markups when computing the estimated purchase price for each fixture.

Clients tend to remember the preliminary budget estimate number and expect that is what the project will cost. The designer needs to make clear to the owner that the budget is an estimate and that the actual cost will be determined by the electrical contractors bidding on the construction documents.

DESIGN DEVELOPMENT PHASE

The conceptual phase of work is followed by design development. The work in this phase refines the lighting ideas. Often, some research may be needed to determine how to produce an effect or how to build a custom fixture. The designer will meet with manufacturers or manufacturers' representatives to discuss how conceptual custom fixtures would be constructed. At this time, the designer should request current fixture costs to update the preliminary budget and advise the client as to any changes in project costs.

The designer reviews and determines the final type and quantity of fixtures. Associated equipment gets identified and located including remote transformers, ballasts, and/or intermediate junction boxes. Control strategies get defined and developed. The schedules required for all equipment get produced, always including provisions for future expansion of the system.

This phase of work culminates in translating the conceptual ideas into working drawings or contract documents that show the locations of fixtures and prescribe the equipment to be used for the project.

CONSTRUCTION OR CONTRACT DOCUMENTS

The purpose of this documentation is to provide the contractor with information about what material and equipment to purchase and where and how to install it. A designer should never assume that a contractor understands something or knows what the designer wants. Everything required for the project needs to be clearly indicated and explained on the drawings or in the specifications. The contract documents for lighting projects

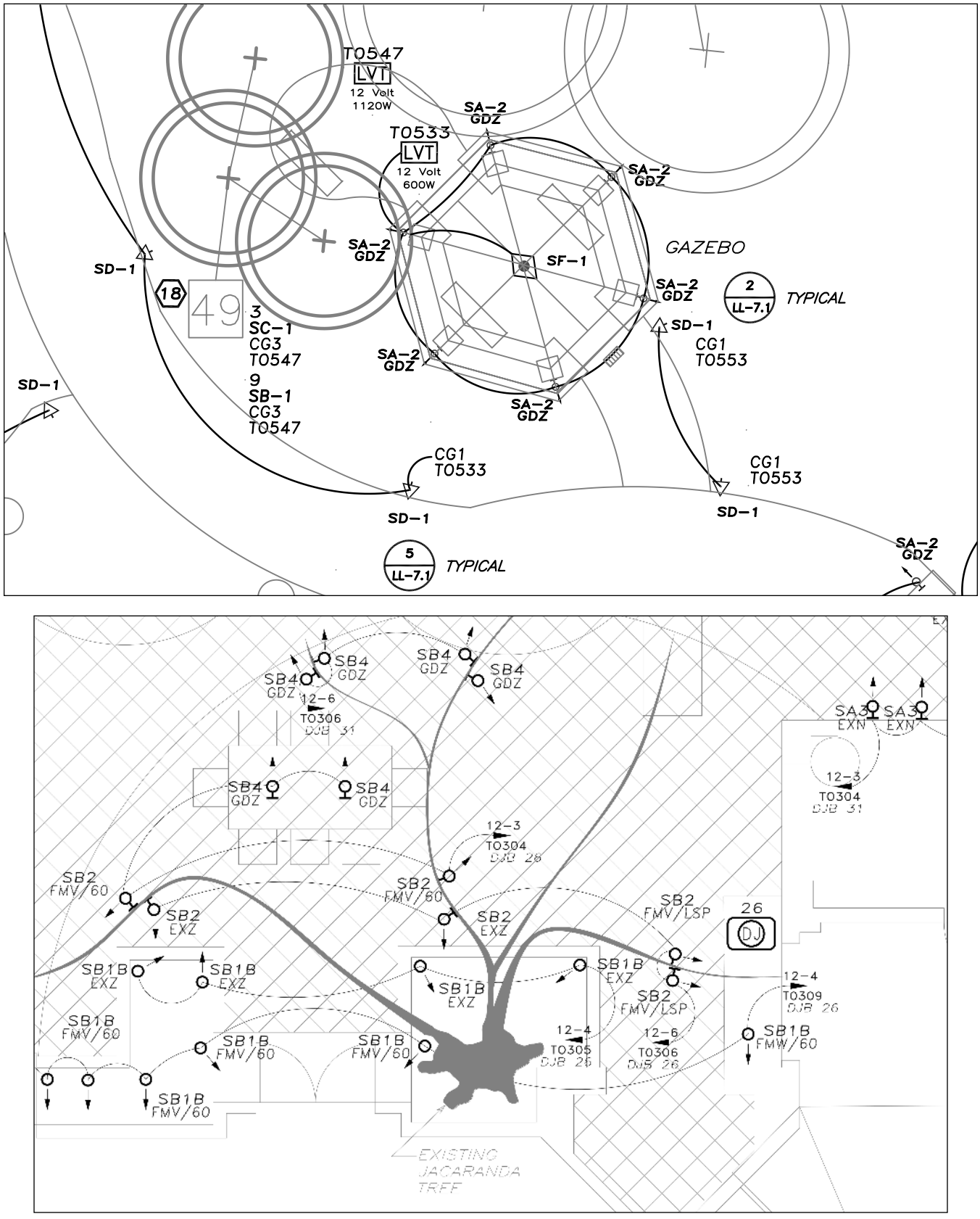


Figure 4.16A&B. *These two drawings show examples of alternate ways to provide lighting fixture, transformer, and controls information on contract document layout sheets. Lighting Design: Janet Lennox Moyer & Michael Stewart Hooker: Drawings: Elizabeth Krietemeyer & Andrew Johnson.*

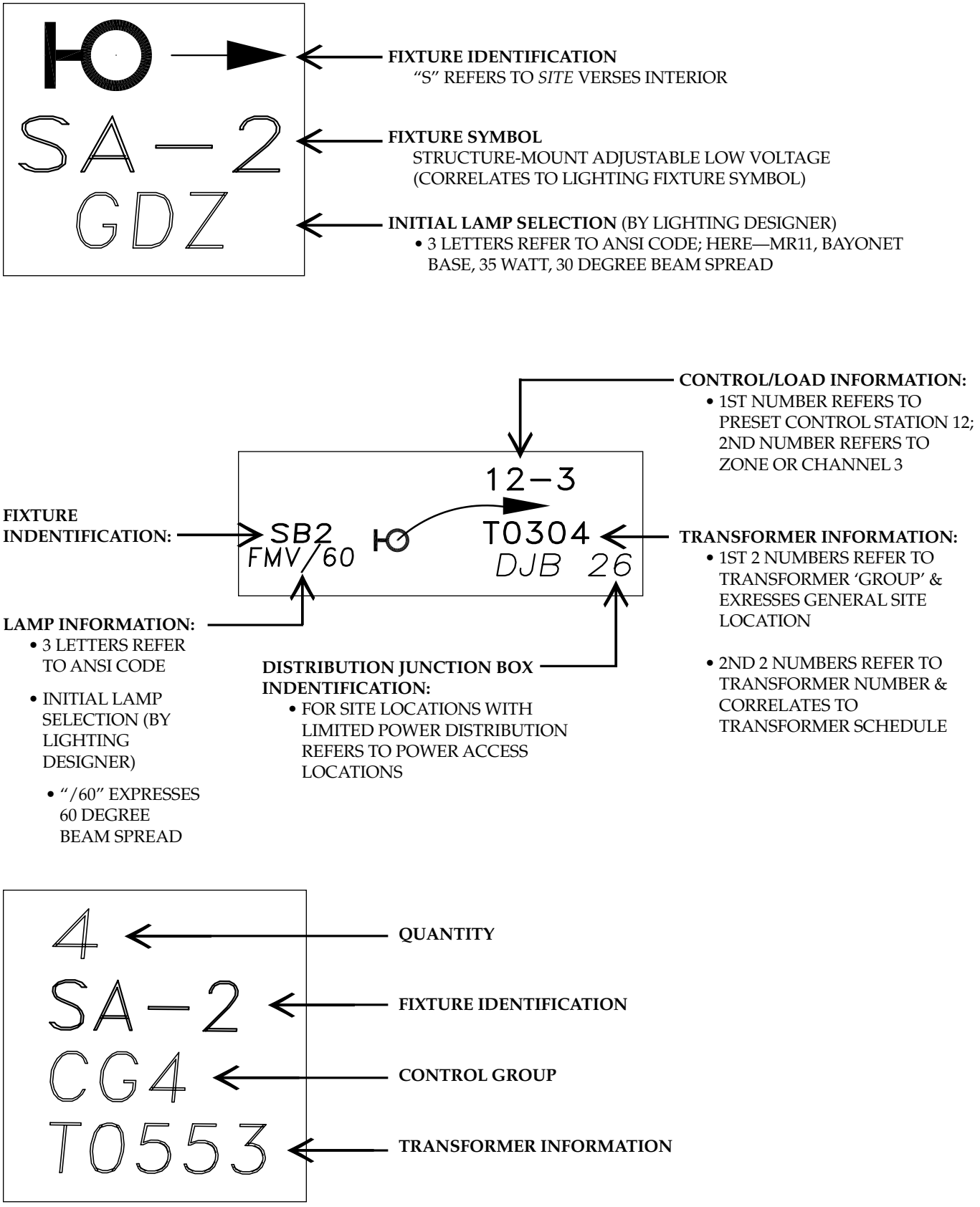


Figure 4.17. *Examples and explanation of varying symbology used in Figures 4.16A&B. Drawing: N. J. Smith.*

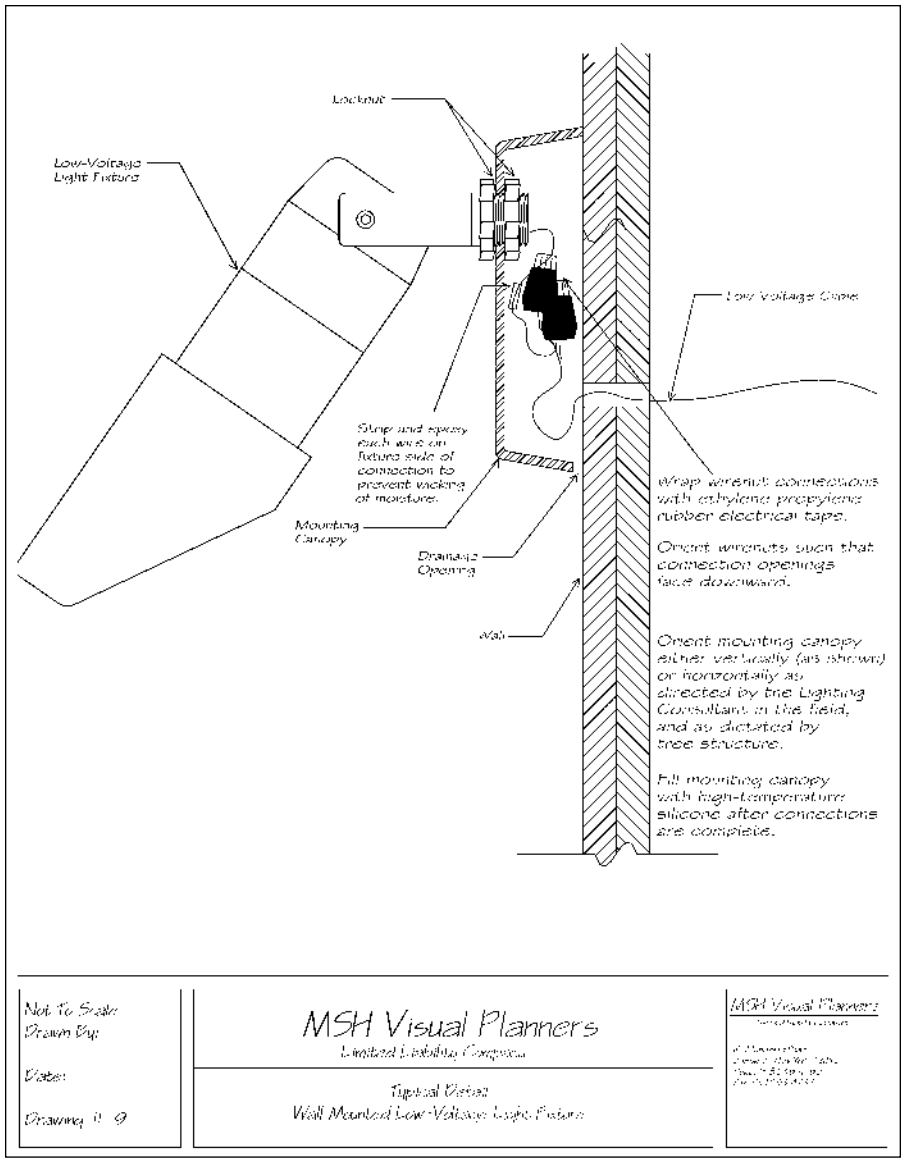


Figure 4.18. *Typical detail of a wall-mounted fixture showing aesthetic and installation requirements. Drawing: MSH Visual Planners.*

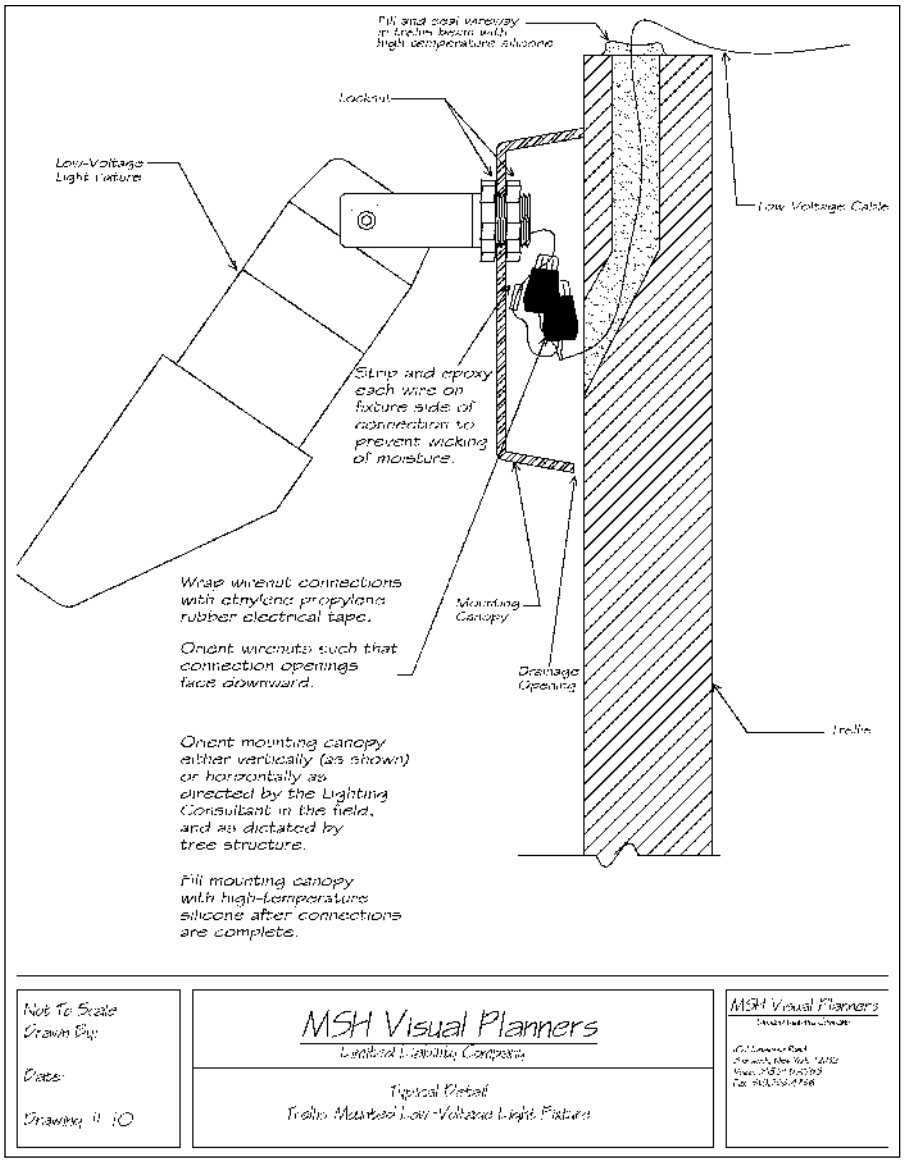


Figure 4.19. *Typical detail of a trellis-mounted fixture showing aesthetic and installation requirements. Drawing: MSH Visual Planners.*

***Figure 4.20**. Placing a photographic image of a fixture onto a photograph of the building can show exactly where and how a fixture should be located and installed. Drawing: Insiya Shakir.*

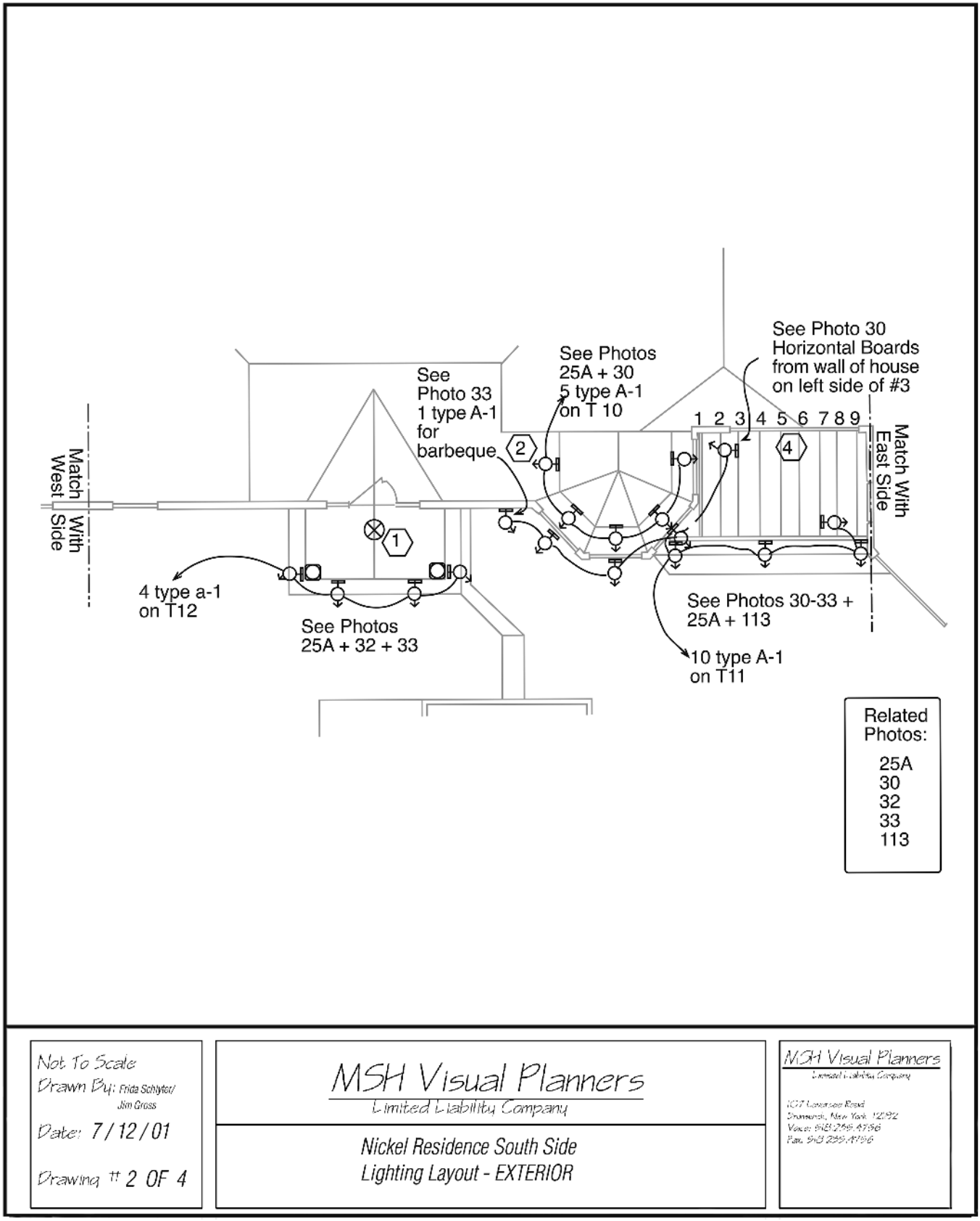


Figure 4.21. *A sketch showing locations of fixtures on a building keyed to related photographs that illustrate actual installation locations. Lighting Design: Janet Lennox Moyer & Frida Schlyter, MSH Visual Planners; Drawing: Frida Schlyter.*

Figure 4.22. *A photograph that accompanies the sketch illustrated in Figure 4.21. This format provides the owner and contractor with location and aiming information. Lighting Design: Janet Lennox Moyer & Frida Schlyter, MSH Visual Planners; Drawing: Frida Schlyter.*

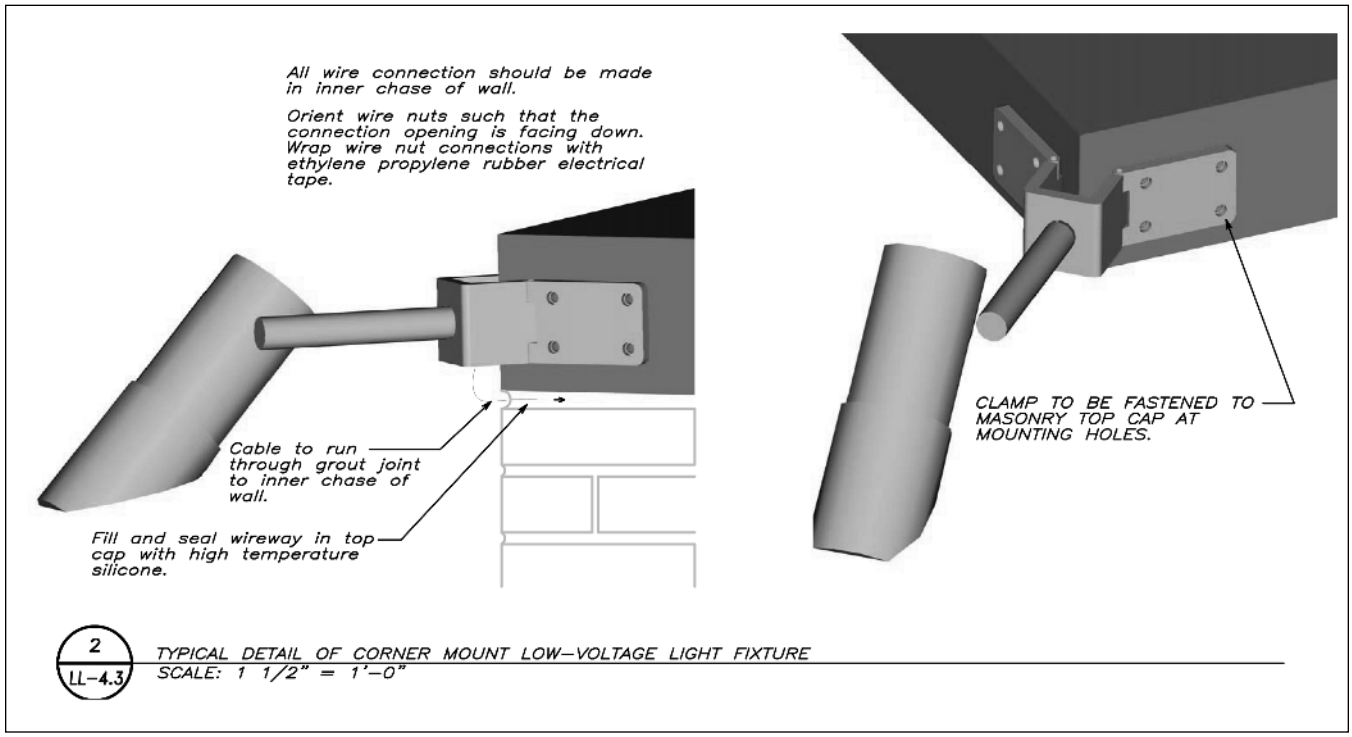


Figure 4.23. *Detail showing the concept of an adjustable corner mounting bracket. Lighting Design: Janet Lennox Moyer & Dan Dyer, MSH Visual Planners; Drawing: Dan Dyer.*

Figure 4.24. *The actual mount and MR8 fixture designed by Hiroshi Kira of H. Kira Design & Manufacturing. Photograph: Janet Lennox Moyer.*

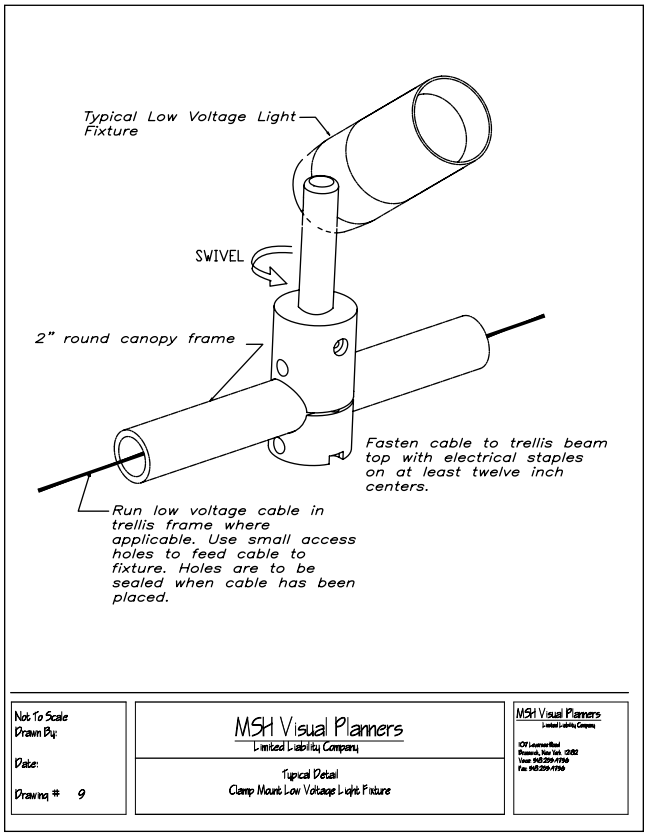


Figure 4.25. *A detail drawing showing the detail for an adjustable clamp-mounting bracket (available for both round and square canopy/frames). Drawing: Dan Dyer.*

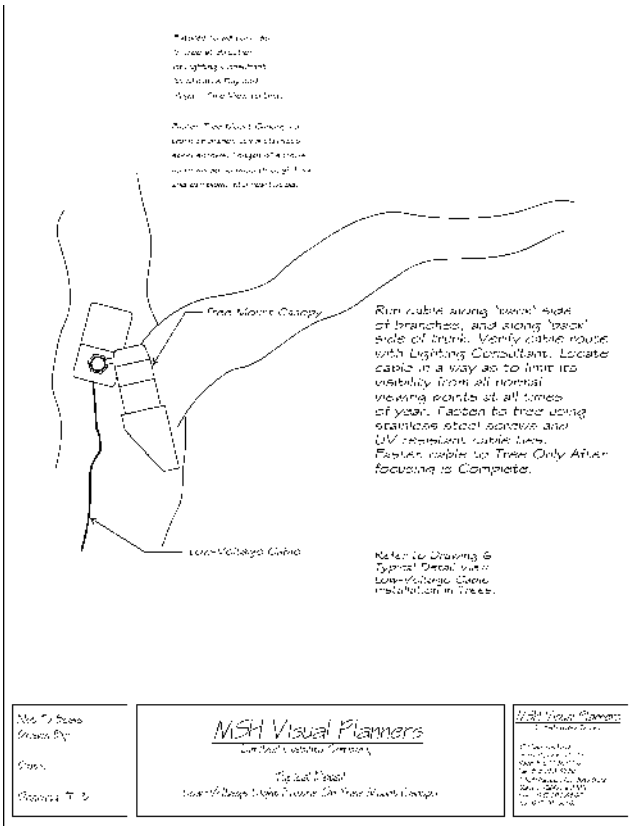


Figure 4.26. *A detail drawing showing a typical area on a tree for mounting a fixture. Using the trunk or branch as a shield both during the day and at night, the fixture becomes less obvious than the location illustrated in Figure 4.27. Drawing: Dan Dyer.*

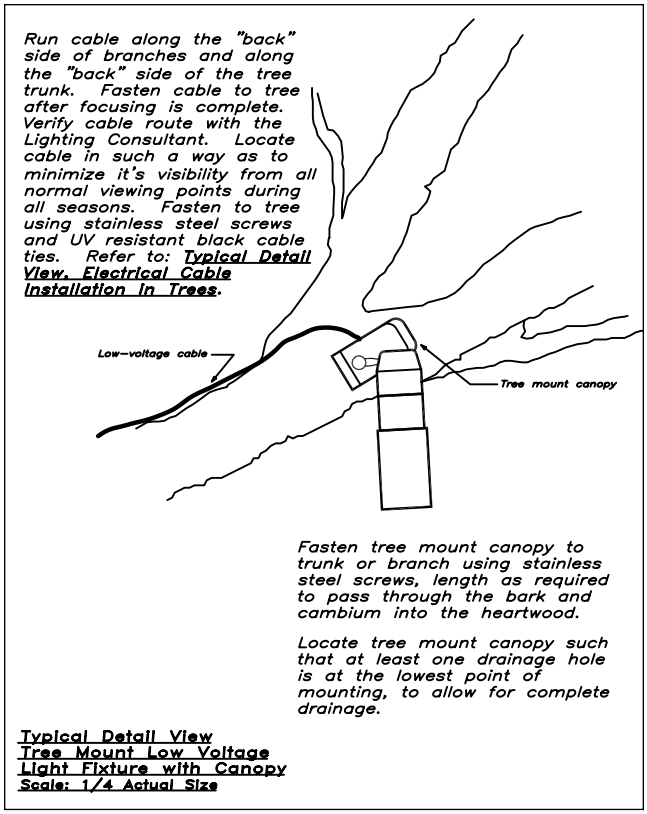


Figure 4.27. *A sketch showing a bad location for mounting a fixture in a tree. The fixture hanging down beyond the tree trunk or branch becomes much more obvious against the skylight during the day, and the back side has nothing to prevent viewing the brightness of the inside of the fixture at night. Drawing: Dan Dyer & N. J. Smith.*

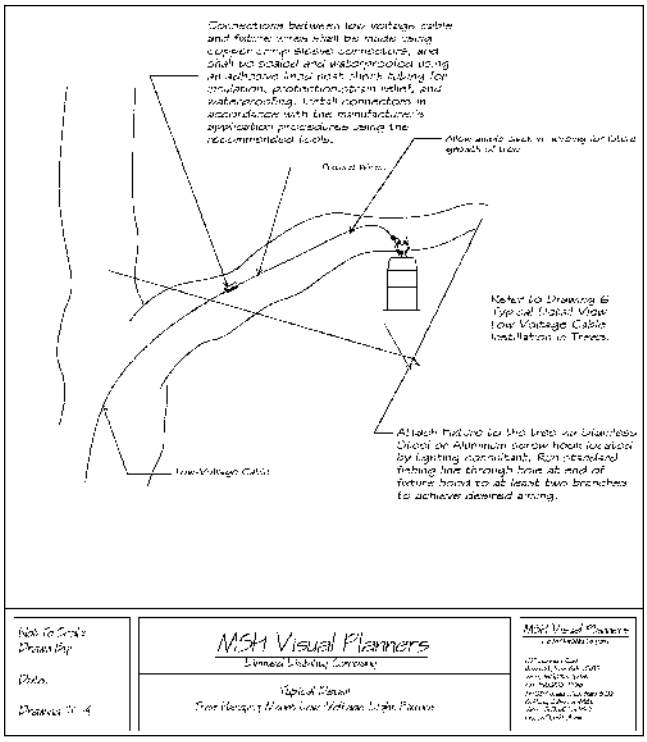


Figure 4.28. *A sketch showing the detail for installing a ring-mount low-voltage fixture. Drawing: Dan Dyer.*

Figure 4.29. *Close-up view of a ring-mounted fixture installed in a tree. Drawing: Dan Dyer.*

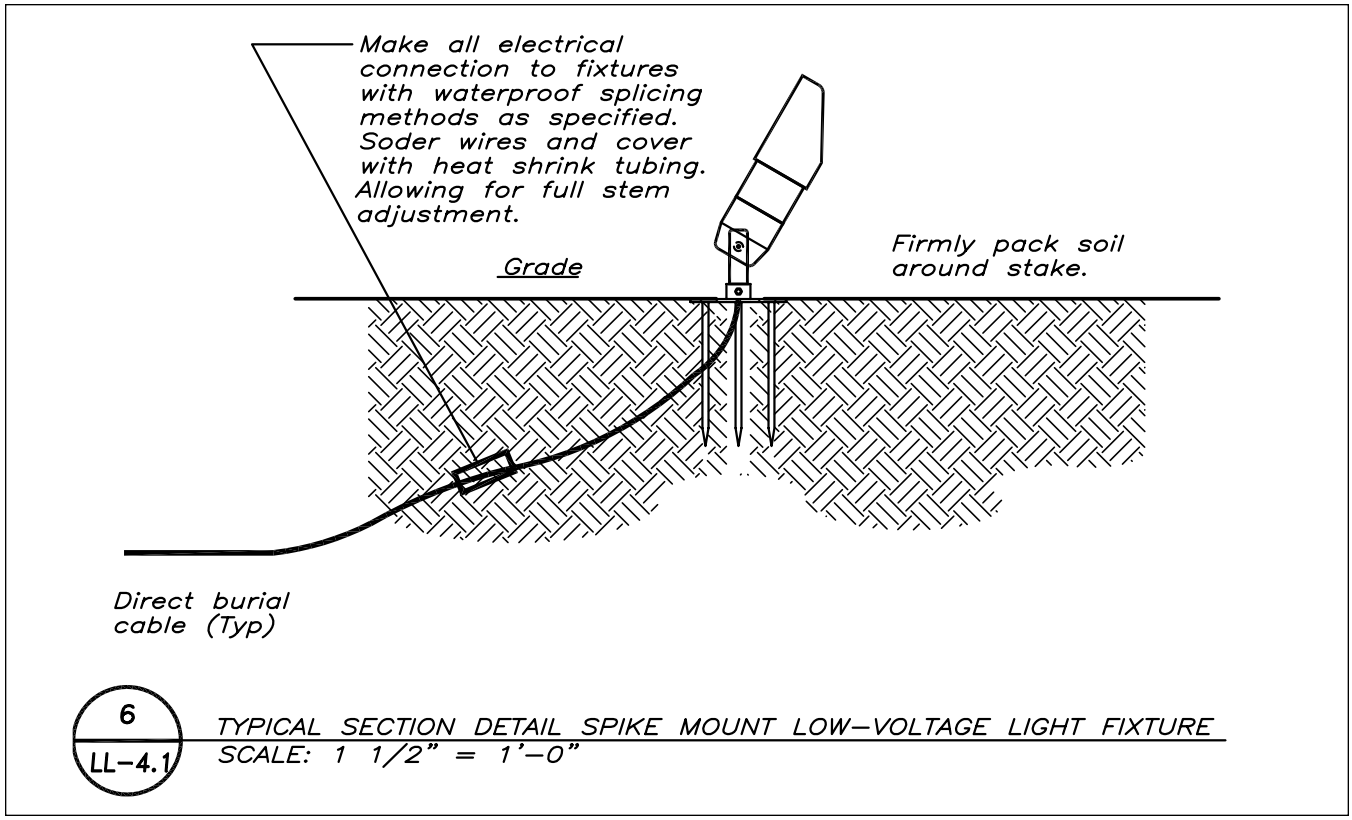


Figure 4.30. *A detail drawing showing the aesthetic and installation requirements for a standard three-prong spike-mounted low-voltage fixture. Drawing: Dan Dyer.*

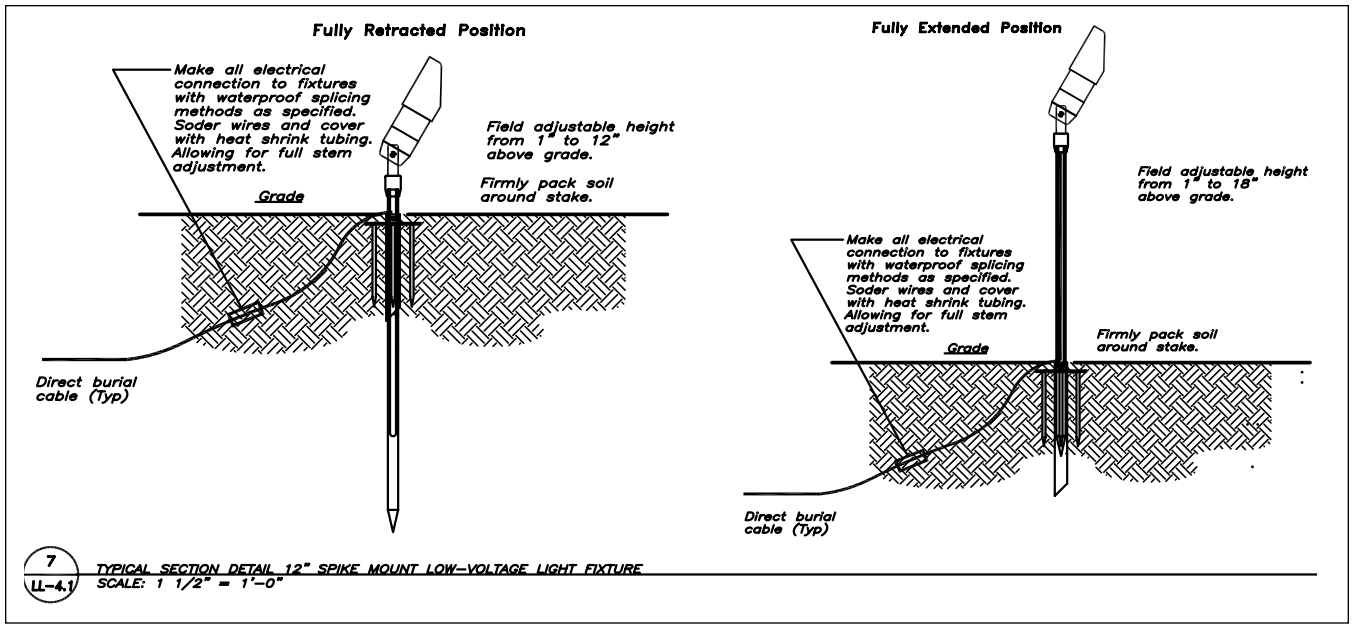


Figure 4.31. *A detail drawing showing the aesthetic and installation requirements for an adjustable three-prong spike-mounted low-voltage fixture. Drawing: Dan Dyer.*

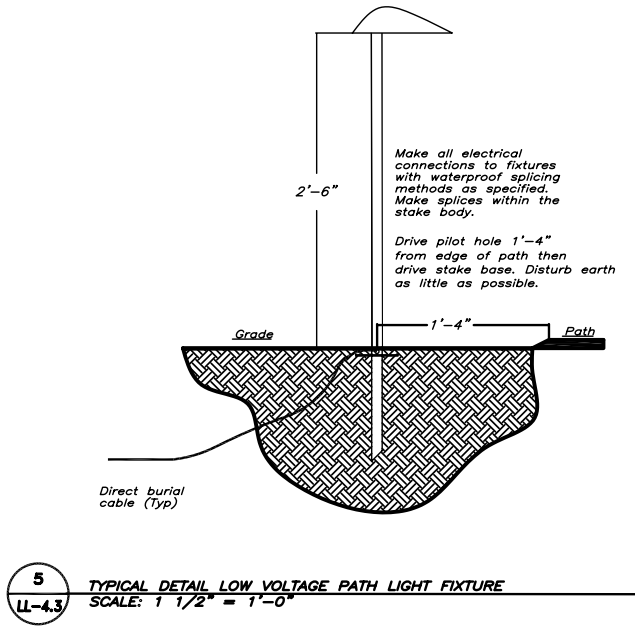


Figure 4.32. *A sketch showing the detail for a low-voltage spike-mounted path light fixture. Drawing: Dan Dyer.*

Figure 4.33. *Example of placing a marker for fixture locations on a site.*

normally include two basic elements: drawings and specifications. The goal in documentation is to efficiently produce clear, concise, precise, and definitive information about the project work. In accomplishing this goal, the designer can use written specifications and/or notes, plans, schedules, details, and photographs.

All the documents produced into a contract document set represent the legal basis of agreement between the Owner and the contractor of the work to be done and the terms and agreement, including the mutually accepted price for the work. Contract documents should include a description of all administrative requirements and all projected construction work, and show the location, sizes, and dimensions for construction. Plans and specifications should reflect only the elements you, the lighting designer, and the owner

Figure 4.34. *Photograph of a completely shielded, custom path light fixture. The splayed sides of the top and the overall shape of the top provide soft, wide light distribution. Courtesy of Escort Lighting.*

fully understand and choose to require. The requirements must be scientifically measurable. Subjective requirements such as "aesthetically pleasing" or "adequately proportioned" cannot be included in any drawing detail or written specifications.

Contract documents include three types of information:

- *General terms and conditions*
  a. General areas of concern that relate to the project and which define the general administrative and technical requirements
  b. A detailed definition that describes the acceptable equipment materials, fixtures, and fabrications to be incorporated into the project
  c. A detailed description of the expected execution of the work, including the manner and location in which the products are to be incorporated into the project
- *Plans*—drawn performance and technical requirements
- *Specifications*—written general, performance, and technical requirements

The format and content of contract documents will vary based on the project requirements. Determining what documents are needed and the format of these documents is one of the important decisions a lighting designer makes for each project.

Plans or Working Drawings

The drawings, out of necessity, will include other organization information such as:

- Index of drawings and standard details
- Symbols and standard abbreviation lists
- Notes, which could include general notes, numbered notes, and/or sheet notes

Index of Drawings
This is a schedule listing all the drawings in the set of documents with a drawing number and descriptive title. The schedule includes an issue date so that each team member knows which drawings they should have and the most recent version (see Documents Appendix Figure A.1A). This information helps to keep the project organized and allows team members to converse more easily over extended distances.

Project Layout Key
On large-scale projects, produce a schematic site diagram that identifies all the project areas. Show diagrammatically how the areas have been apportioned. This *key drawing* helps team members easily determine to what part of the site a specific drawing refers (see Documents Appendix Figure A.7).

Standard Symbols and Abbreviations
All sets of working drawings should include a symbols list that explains every notation on the drawing, including general drawing symbols such as detail designations, all abbreviations used, fixture symbols, controls symbols, etc. (see Documents Appendix Figures A.1A & B, A.2–A.5). Because an industry-wide standard list of symbols does not exist for landscape lighting, designers can use any symbols they want as long as they are indicated on the symbols list and are used consistently through all the drawings for the project. Typically, the symbols list appears only once on a set of drawings. In addition to defining each symbol used on the drawings, this list should also define every abbreviation used on the drawings (for example, "O.C.," which means "on center").

The accepted standard practice (in the United States) for identifying lighting equipment is to use symbols to identify mounting and voltage. For example, all 120-volt below-grade fixtures would have one symbol and 12-volt below-grade units would have a different symbol (see Documents Appendix Figure A.3). Then, each specific fixture will be assigned a fixture type, such as "SB1." In this case, the "S" refers to "site," the "B" is an alphabetical ordering, and the "1" refers to the first in a series of this type of fixture. Within a series the difference may be mounting type, lamping, finish color or type, accessories, and so on. The fixture type and transformer designation symbols include important information the contractor needs (see Figures 4.16 & 4.17).

Notes
Working drawings also can include a list of *general notes, numbered notes,* and/or *sheet notes.* General notes provide information about the overall project, while numbered notes provide information about a specific situation or location on the drawings. Sheet Notes refer to information specific to items on that sheet.

Important notes to include on all sets of landscape lighting drawings include but are not limited to:

- Fixture locations shown on the lighting plan are conceptual. It is not prudent to show the location of any ground- or tree-mounted accent light on a working drawing. Each tree varies in the way that it has grown, as well as the way it gets placed into its planting hole. There is no conceivable way to predetermine the location of fixtures for new trees. The complexity of tree branching structure does not lend itself to two-dimensional drawings. Showing fixtures in tree branches or on tree trunks is not practical.
- The contractor must refer to mounting details included in the set of drawings. Human nature is to not follow instructions. Details are made by the designer for a purpose, and finding that those instructions were not followed after the fact can cause significant cost or other problems for an installation.
- All actual fixture locations for ground- or tree-mount adjustable accent fixture types will be marked on the site at the direction of the designer in conjunction with the installing electrical contractor. A flag (or other marker) represents each initial fixture placement. The fixture type, transformer number, and/or initial lamp selection is identified on the flag. The designer needs to stress with the contractor that these are initial locations that serve as a starting point for the aiming session(s). Each fixture should be temporarily placed and no cables should be buried yet (see Figure 4.14).
- The cable location for tree mount fixtures must be determined at this time, before any fixtures are installed (see Figure 10.13).
- For path fixtures, bollards, post fixtures, sconces, and other permanently mounted fixtures that provide general lighting but do not light specific objects in the landscape, the designer may want to list dimensions for the approximate location. However, the general notes should require that even for these fixtures, the exact location should be marked by the designer with the electrical contractor at the site.

Lighting Layout, Schedule, and Detail Sheets
Plans or working drawings consist of all the drawings necessary for the installing contractor to construct the

Figure 4.35. *Photograph showing a tree climber getting into position for locating fixtures in a tree overhanging a cliff on the Monterey, California, coast. Photograph: Janet Lennox Moyer.*

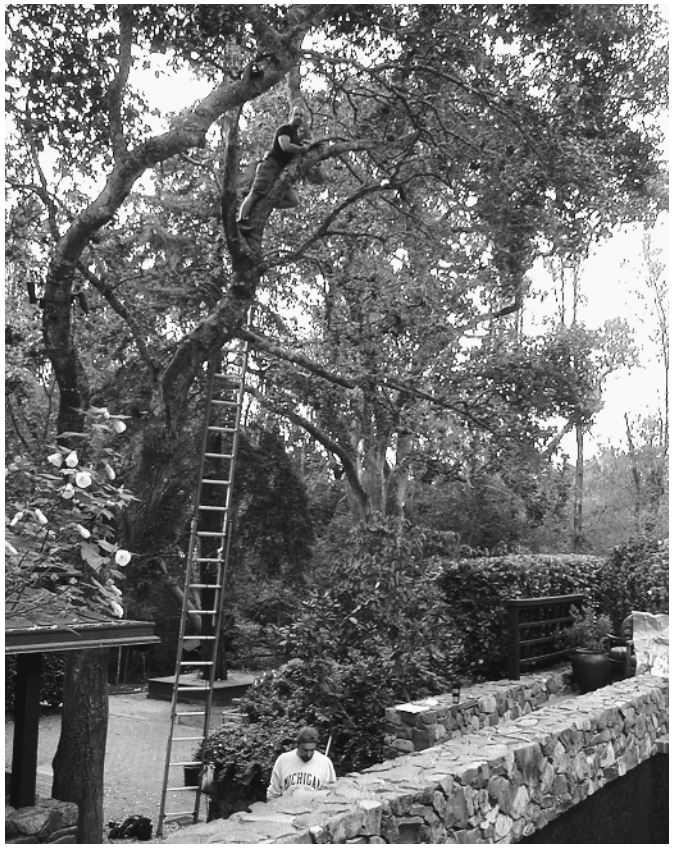
Figure 4.36. *Photograph showing a tree climber installing a fixture in a tree location. Photograph: Janet Lennox Moyer.*

design. The actual type and number of drawings will vary from project to project, but should include the following information:

- Fixture type and location, including any important location dimensions
- Remote transformer designations and schedules
- Control load designations and schedules
- Fixture control group designations and schedules
- Schematic wiring diagrams
- Custom or modified fixture details
- Special systems such as neon or fiber optics
- Installation details

On a project of any scale, having an area name designation allows the various parties involved in the project to communicate from a distance and provides the initial breakup of the site into separate drawings for the lighting plans, schedules, and details. Within the designated areas, all architectural spaces and all major trees should be identified for easy reference. Trees can be labeled either by a number that corresponds to a tree schedule or by Latin/common name (see Documents Appendix Figure A.9). All transformer, electrical load, and control groups need to be developed and shown in a consistent and logical manner that incorporates spare capacity for future plant growth and project development. The level of detail the lighting designer needs to include on the wiring for the system depends on other professionals included in the project. When electrical engineers are also working on the project, they will normally produce the wiring plans.

An important aspect of this documentation for all parties involved (designer, client, and installer) to understand is that landscape lighting fixture placement typically cannot be accurately shown on a lighting layout plan. One reason for this is that landscape elements, including pathways, stairs, plantings, and/or other elements, often change during construction. A designer needs to stay in close contact with the landscape designer and installing landscape contractor during construction to know what elements



4.37

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4.40

Figure 4.37. *Photograph showing an electrician using a ladder to get to a fixture location in a tree. Photograph: Janet Lennox Moyer.*

Figure 4.38. *Photograph showing an electrician mounting a fixture in a tree. Photograph: Janet Lennox Moyer.*

Figure 4.39. *Photograph showing an electrician using a ladder to get to a fixture location in a tree. Photograph: Janet Lennox Moyer.*

Figure 4.40. *Close-up showing an electrician mounting a fixture in a tree. Photograph: Janet Lennox Moyer.*

Figure 4.41. *A lift truck being delivered to a job site. Photograph: Janet Lennox Moyer.*

Figure 4.42. *Articulated lift trucks can maneuver easily into difficult positions, but they are often sensitive to a slight grade pitch. Photograph: Janet Lennox Moyer.*

Figure 4.43. *Articulated lift trucks often have incredible range, along with nearly unlimited maneuverability. Lift trucks can speed up installation of easily accessible trees with multiple fixtures located high up into tree canopies. Photograph: Janet Lennox Moyer.*

Figure 4.44. *The lighting designer can accompany the installer in the lift truck to show exactly how and where to mount the fixture(s)—as long as the designer isn't afraid of heights. . . . Photograph: Janet Lennox Moyer.*

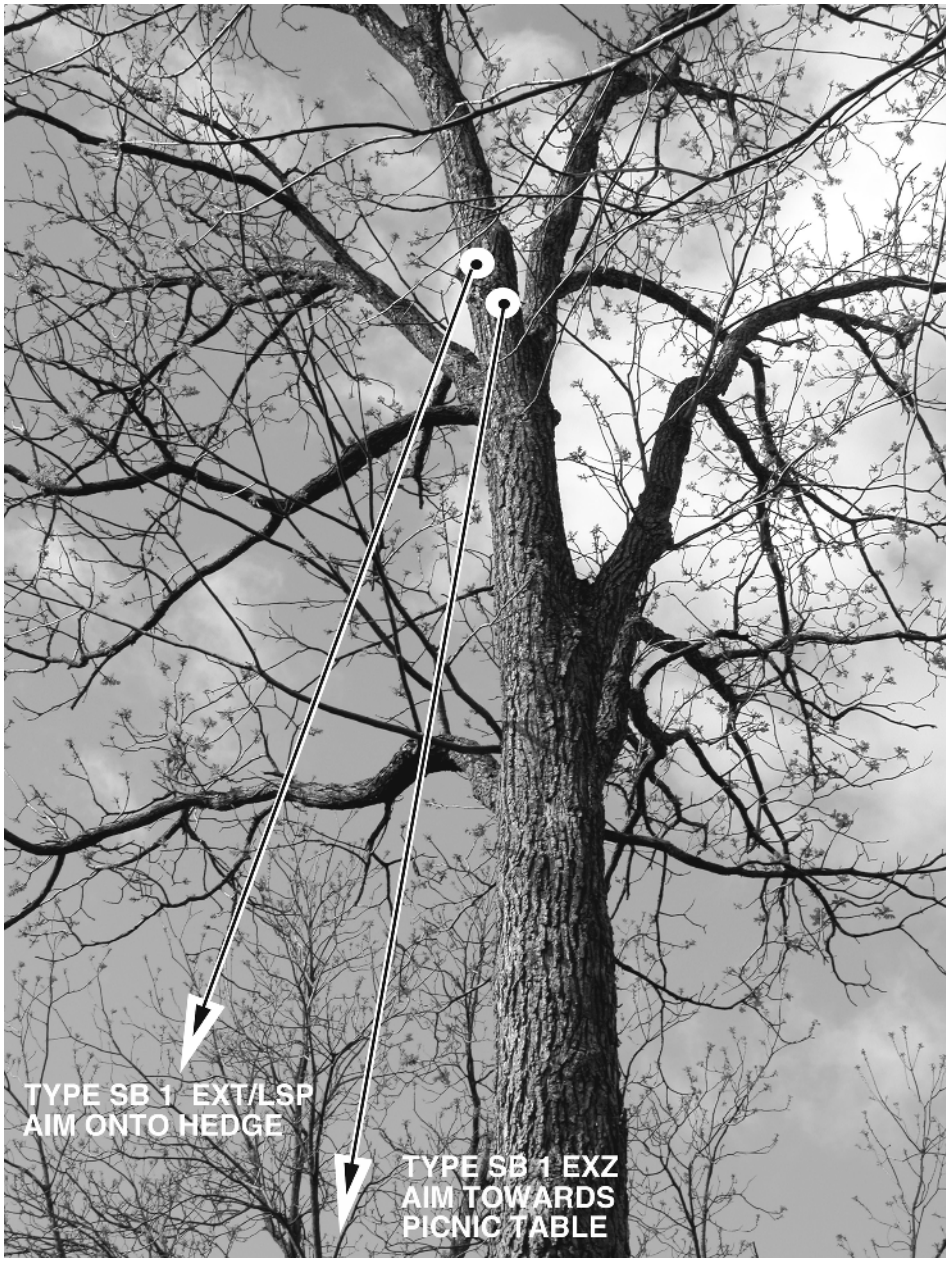

Figure 4.45. *This drawing showing fixture locations in a specific tree can serve as an alternative to the lighting designer working on site with the installer. Actual on-site location is always preferable. Drawing: N. J. Smith.*

change. Another difficulty in showing fixture location on a plan is the nature of individual trees, including size and physical characteristics (see Chapter 14, "Plant Materials").

On any plan some fixture information can be scaled and shown. When the designer chooses to show individual fixtures on the plan, the scale of the plan will need to be at least ⅛ inch equals 1 foot, but preferably ¼ inch equals 1 foot or larger. Most landscape drawings are shown at ⅛ inch equals 1 foot, 1:10 scale, or 1:50 metric scale. Using a scale smaller than these makes it difficult to show the fixture, its wiring, and its controls information clearly.

When the designer chooses not to show individual fixtures, a notation can be located by the element intended to be lit, such as a tree or sculpture. The notation includes the quantity and type of fixture, the transformer identification (for low-voltage fixtures), and the control load and/or zone identification. Another option is to use numbered notes that include the quantity and type of fixtures and any notes about installation or aiming that will be helpful to the installing contractor.

Pathway fixtures can be located on a large enough scale drawing (¼ inch minimum) with dimensions from paving edges and with typical paving pattern indi-

FOCUS CHECK LIST

Deadline:
Number of Sessions Anticipated?:
Scheduled Dates:
Meeting and Ending Times:
Crew
  Participants from design firm:
  Participants from electrical contractor:
  Tree Climber:
Is Client Participating?
All Fixtures Installed &Working?
All Accessories on site: Lamps, Louvers, Lenses, & Shrouds?
Are Fixtures fitted with lamps, louvers Lenses & Shrouds?
Has voltage drop been checked?
Is Control System Functioning?
Is wiring to fixture locations in trees ready?
Number and size of ladders:
Truck Lift
Tools:

☐ Leather Gloves	☐ Flashlights
☐ Spare Batteries	☐ Electrical Tape
☐ Screwdrivers	☐ Spare lamps, louvers, & Lenses
☐ Welders Glasses	☐ Spare Shrouds
☐ Wrenches	☐ Wire Nuts
☐ Wire Strippers	☐ Spare Wire
☐ Voltage Meter	☐ Welder
☐ Hammer	☐ Pruning Shears
☐ Paper Towels	☐ Saw
☐ Solvent	☐ Anti-Seize Compound
☐ Spare Gaskets	☐ Lubricating Compound
☐ Permanent Ink Pens	☐ Epoxy

Copies of Plans for Marking Lamping & Aiming Info.
Appropriate Clothing:
☐ Sweater or Jacket ☐ Hat ☐ Waterproof Shoes
Food
☐ Nearby Restaurant—Name & Phone Number:
☐ Thermoses With Coffee or Tea
Snacks:
Accommodations:
☐ Hotel: ☐ Phone Number:
☐ Reservation Confirmation:
☐ Location:

Figure 4.46

cated. Fixtures mounted on structures such as walls, eaves, and trellises can be dimensioned on the plan. However, each installation type requires at least one detail to express the actual location. For wall-mounted fixtures, an elevation is required to show the height to the center of the junction box and the coordinating horizontal distance from some architectural reference.

For tree-mounted fixtures, providing a note is all that can be done unless someone is willing to draw a plan and one or multiple sections showing the trunk and branching structure of the tree. The note should include the quantity and type of fixture, the transformer identification (for low-voltage fixtures), and the control load and/or zone identification.

Details Including Schedules

The type and quantity of details included in the working drawings vary from project to project. Details provide a closer look at a specific issue on the drawings (see Documents Appendix Figures A.12–A.15) or standard procedures required for the project (see Documents Appendix Figure A.10). Details include large-scale drawings of construction or connection techniques (see Figure 4.18), typical or specific mounting techniques (see Figures 4.18–4.32), and schematic one-line drawings that show basic wiring layouts (see Documents Appendix Figure A.11 and the one-line diagrams in Figure 10.2). Organize related details onto a detail sheet (see Documents Appendix Figure A.10).

Some detail information shows best in the form of a schedule. One or more of the following are typically required: Low-Voltage Transformers (see Documents Appendix Figures A.18 & A.19), Control Loads (see Documents Appendix Figure A.21), Control Schedules (see Documents Appendix Figures A.22 & A.23), and Approved Lamps (see Documents Appendix Figure A.20). Fiber optics, when used in landscape lighting, typically have an entirely separate specification section and require a number of schedules (see Documents Appendix Figures A.16 & A.17).

All these schedules need to account for anticipated system expansion over time. Some changes that affect general and/or specific systems sizing can be anticipated ahead of time, such as plant growth, while others may not be predictable, such as the owner's addition of a new path, sculpture, structure, site furniture, or garden area (see Chapter 15). The designer needs to discuss fixture issues and gauge expansion capacity required. This will affect individual fixture placement and load, which affects cable size and length, transformer size, control system loads, and so on.

Some projects can be handled with very little or no initial documents from the lighting designer. For a small site with no existing site or garden plan, the designer may walk the gardens with the owner, landscape designer, and installing contractor and make all the lighting decisions. A project description with sketches of layout and marked-up photographs to clarify mounting locations can then be provided to the

Figure 4.47. *Some of the tools used during aiming and adjusting phase of a project. Photograph: Janet Lennox Moyer.*

owner and contractor. These documents should show all the information that is necessary for contracting, purchasing, and installing the lighting system as determined in the walk-through meeting (see Figures 4.20–4.22).

Another option is for the contractor to take the responsibility to note the design as decisions are made throughout a site walk-through, to provide the correct number and type of fixture in the approximate location with the discussed controls, and to provide the record documents. With this approach, the owner and lighting designer must have extreme confidence in and experience with the contractor's understanding of landscape lighting, capability to install the project properly, and ability to provide documents after the installation that will serve as record plans.

Another issue to remember about documents is the physical size of the drawings. These plans spend an enormous amount of time outdoors at the site. It will nearly invariably be moist, which deteriorates the quality of the drawings. Typically, there is not a good work surface for laying out large drawings to reference on the site. So, consider preparing a set of drawings in 11″ by 17″ or 8½″ by 11″. This allows areas to be planned individually and handed out to a contractor assigned to that area. This size plan is easy to work with on site and can be easily laminated. Other sizes of plans can be laminated at printers or using clear contact paper but will still be awkward.

Specifications

In addition to the drawings, the contract documents will also include a set of specifications. In general, all dimensions, locations, and physical relationships should be shown on the drawings, and all materials, quality and installation standards, and methods should be listed in the specifications. To avoid contradictions between the drawings and the specifications, no information should appear in more than one place.

On projects where the lighting is only one portion of the construction work, the lighting specifications are included in Division 16 of the standard Construction Specifications Institute (CSI) specification format. This section of the specification document will have a general section that describes the responsibilities of the contractor, the work to be performed, and all processes to be followed. In this section, the designer puts all project-wide requirements for any and all equipment: products, fixtures, lamps, transformers, ballasts, lenses and louvers, mounting hardware, fiber optics, neon, light-emitting diodes, and/or electrical wire and cable (See Documents Appendix Figure A.28). The designer needs to determine which of these needs to be included and what information is pertinent for each type of equipment.

When the project consists of only lighting design, the specifications can either be a separate document in 8½″ by 11″ format or be included on the drawings. The

Figure 4.48. *Lighting Designers Michael Stewart Hooker and Janet Lennox Moyer getting equipment ready for a night focus session.*

information normally included in the general section may be integrated into the list of general notes.

General Section

The general section (or general notes) includes information such as acceptable fixture finishes; the processes required for those finishes; acceptable or required lamp, ballast, and transformer manufacturers; a time period in days for fixture orders to be placed and submittal drawings to be provided to the designers for approval by the contractor; and a description of the aiming and adjusting work to be done by the contractor, specifying that the work will be done after dark and listing the number of labor hours to include in the bid.

Lighting Fixture Section

Division 16 will also have a lighting fixture section that identifies and describes the equipment corresponding to the symbols and fixture identification tags on the drawings. Appendix Figure A.26 lists factors to consider in this specific description by equipment type. As with the general section, not all items on the list will be required for each piece of equipment listed on a specification. All standard features, required accessories, and modifications or custom features need to be identified in the fixture specification. The designer must determine which items are important for a specific project and include those in the specification.

This lighting fixture section may be shown on the drawing as a fixture legend rather than contained in the overall project specification for either large or small projects. There are at least three types of fixture specifications: one-name, multiple-name, and performance. Each has benefits and drawbacks, and only one type will be used for any given project.

Three Typical Fixture Specification Formats

A *one-name specification* lists only one manufacturer and fixture ordering number for each fixture. This provides the owner with the advantage of specifying the highest-quality product or the most appropriate product for the situation. It requires the specifier to be thorough in describing all important considerations that warrant the fixture being the only one under consideration. The disadvantage to the owner is that the cost may be higher than if several manufacturers were bidding against each other for the project. This method is used for private properties and is often not permitted for projects owned by public agencies.

A *multiple-name specification* lists at least two and typically three to four manufacturers for a given product. The benefit to the owner of a multiple-name specification is typically a lower cost per unit. The drawback is that the products being compared are often different in one or more features or characteristics, which can affect the quality of the installation. For example, one manufacturer's fixture might vertically adjust 360°, while another's may be limited to 110° due to the construction of the fixture. Another example might be an anodized finish versus a powder coat finish. A third

example might be the wattage capacity, with one fixture accepting up to 300 watts, while the other only accepts up to 150 watts based on its UL (Underwriters Laboratories; see Chapter 7) rating.

The last type, the *performance specification,* is the most rigorous. It consists of a construction description of each product and should include the light distribution or photometrics for each fixture, but lists no manufacturers or fixture numbers. This gives both the client and the designer a firm position for rejecting inferior products or good-quality products that do not have all the required capabilities or features. This type of specification is typically required on federal government projects and can be required for state and local government projects or on large commercial projects to provide equal opportunity to all contractors and manufacturers.

No matter which specification type is used, a pitfall to avoid is the use of the phrase "or equal." This essentially opens up the bidding to anyone. A safer phrase is "or approved by the lighting designer." This requires a bidder to request permission from the designer to substitute another manufacturer's fixture for the one listed. In the general section of the specification, require that substitutions be submitted to the lighting designer within a specific time frame prior to the bid submittal date. In discussing this requirement of prequalifying substitutions, consider what type and format of information should be required, including whether a sample needs to be provided for review.

Cut Sheets

Including copies of the manufacturer's catalog literature (called "cut sheets" in the trade) on each fixture, ballast, transformer, lamp, and control device aids the contractor in understanding the required equipment.

The accepted practice in the lighting industry is for the designer to make copies of the manufacturer's catalog sheets for all parts of the equipment and then to highlight all required features, such as finish color or accessories. This process of identifying all the specified characteristics and parts/accessories will further ensure that the contractor understands the complete requirements.

With the aid of computer technology, designers can produce a composite sheet for a specific product describing all the important characteristics, parts, and accessories with drawings and/or photographs of these important elements (see Documents Appendix Figure A.27).

BIDDING PROCESS PHASE

The specifications should be introduced by a document, called an *invitation to bid,* that outlines the general requirements of a contractor to provide a bid on the project. This document typically includes some or all of the following issues:

- A statement of the type of work to be done, such as "the final electrical engineering and installation of a lighting system to be done in [one, two, three] phases for . . ."
- The owner's right to select or reject any bid
- A due date and location for the bids to be submitted
- Whether the price is to be a *lump sum* or *time and materials*
- Whether a not-to-exceed provision shall be included
- How the price shall be submitted, including separating the fixture and installation costs or providing a unit cost per fixture, in case fixtures might be added or deleted at any time during the project
- When change orders will be accepted and how change orders will be handled
- A requirement for the bidders to inspect the site to ensure that they have an understanding of the scope of the project and to determine the method of proceeding with the work
- Whether substitutions will be allowed, when they will be accepted, and how they are to be presented
- Whom to contact for questions or clarifications
- How to obtain additional sets of drawings and the cost of these drawings
- A statement to the effect that the bidder fully understands the requirements of the project and that no additional charges will be accepted from the contractor unless either a condition could not be reasonably detected from the drawings and review of the site or changes are requested by the owner
- A requirement to post a performance bond and to have a certain type and amount of insurance, including liability, property damage, and personal injury or workers' compensation policies
- A requirement for a payment bond that protects the owner against liens on the property by subcontractors or suppliers that do not get paid by the general contractor (even though the owner paid the general contractor for its services or products)
- The time that the owner has to accept the bid and initiate work
- The time or date when the work is expected to begin and end, sometimes accompanied by a financial incentive or penalty clause
- A place for the bidder to sign and date the form

In order for contractors to reasonably bid a landscape lighting installation, they must become familiar with the

site and know how they will distribute power with minimal disruption to existing site conditions and plantings. For all low-voltage loads, they need to review specified transformer locations. The difference in location of 120-volt versus 12-volt power throughout a site can dramatically affect cost. They need to understand all the specified mounting details and be clear what kind of equipment (such as ladders or lift trucks) and additional help (such as tree climbers, landscape contractors, etc.) will be required (see Figures 4.35–4.44).

How the bidding is handled and who is invited to bid varies from project to project. On large projects, the general contractor may invite several electrical contractors to put together prices for the electrical portion of the project and then include those bids as a part of the total project bid. On small projects, the designer typically recommends that the owners solicit bids from several electrical contractors. If the owner does not know any qualified contractors, the designer will often provide a list of contractors. In some cases, the owner may already have a relationship with a contractor, whom the owner will use unless their bid is unreasonable.

On public projects, the designer is often not involved in the bidding process. However, on smaller projects, the bids are often presented to the designer. In this case, the designer reviews the bids and then presents them to the owner. The owner then selects the contractor but may ask the designer to provide an appraisal of the bids and even a recommendation as to which contractor should be selected.

CONSTRUCTION PHASE

In the construction phase, part of the control of the project passes from the designer to the contractor. The designer typically observes the construction, checking that everything is installed properly and in the correct location. However, the contractor is responsible for ensuring that everything is installed and functioning properly. It is imperative that the designer make it clear to the contractor the kind of communication and coordination expected. For example, the exact location of fixtures that will light plant materials cannot be determined until all the major plantings have been installed. The electrical contractor needs to coordinate with the landscape or planting contractor to determine when this will occur and to advise the designer. Then a meeting can be arranged to mark the location of the fixtures. The location of fixtures for lighting sculptures, stairs, structures, or any other kind of feature should also be coordinated in this manner.

Throughout the construction process, the decisions and procedures discussed in all meetings should be documented. Designers need to be as available as possible to avoid delaying the progress of construction. Job sites today have fax machines and/or computers with e-mail and often a Web-based project management site, so clarifications, revised drawings, or additional information the contractor or other team members need can be provided from the designer or other team members quickly and easily.

Submittal Drawings and Samples

Submittal drawings provide information on each fixture specified for a project. They are supplied by the manufacturer to the electrical contractor, who passes them on to the designer for final review and approval. These drawings are produced to ensure that the products being supplied to the job are correct. The specifications include the required procedure for submittal drawings to be supplied from the contractor to the designer. The designer reviews the submittal drawings and fills out a cover form approving the submittal, requesting more information, or rejecting it (see Documents Appendix Figure A.28). If a submittal is rejected, the designer lists each fixture that is not acceptable and notes the irregularities. At the designer's discretion, the contractor will resubmit to the designer either the entire package or just the revised sheets on the items that were rejected.

On projects requiring custom or modified fixtures, the specifications may also require samples for approval. When a large number of custom fixtures will be made for a project, the specifications often require that one prototype fixture be produced for review and approval. This prototype, if accepted, will count as one of the final fixtures for the project. This occurs primarily when a large number of the fixtures will be made. If a special finish is required on a fixture, the specification should require a finish sample for approval.

Construction

After the contract has been awarded, the designated construction foreman and the designer should walk through the site together to familiarize the foreman with the project. In this site visit, transformer or junction box locations can be set, fixture locations can be approximated, and any initial questions can be discussed. Throughout the construction, the designer should visit the site to check progress, answer questions, and ensure that proper power distribution, including future provisions, and installation techniques and details are being followed.

The actual construction process for installing lighting equipment includes several phases of work. In the case of a site being newly developed, control locations need to be determined in all areas of the buildings prior to

installing Sheetrock. Junction boxes and wiring to the boxes need to be installed. Conduit needs to be installed from the inside of the building to the outside wherever power will be required around the buildings, as well as under any permanent outdoor surfaces such as driveways and patios. These sleeves provide access for power to all areas of the site in the future.

Locating Fixtures on Site

Whether the job involves new construction or the renovation of a landscape, fixtures intended to light plant materials should be installed after planting has been substantially completed, but prior to the planting of ground covers (see Figures 4.33 & 4.45). Since each 120-volt above-grade fixture and each below-grade fixture is permanently mounted, the location of these fixtures should be marked after the plants that each will light have been installed. This location needs to be done at night with a working sample of the exact lamp/reflector assembly (if necessary) to allow visual determination of appropriate locations.

Low-voltage fixtures, which are somewhat portable, should be placed in an approximate location based on the plant they are intended to light. All these fixtures should be supplied with enough cord to provide movement within the predetermined area listed in the general notes (typically). These fixtures' spikes should not be firmly packed into the ground, nor should the wiring for these fixtures be buried (see Figure 4.14). The final installation needs to be done after the night aiming session, as fixtures might need to be moved slightly or substantially in order to create the desired effect on the plant material.

Locating Tree-Mounted Fixtures

Each tree-mounted fixture should be temporarily attached to the trunk or branch in a location identified by the designer at the site (see Figures 4.36 & 4.44). This location is the most critical of all fixtures. Depending on the size of the tree and the mounting height or extension out onto a branch, one of three methods for locating tree-mounted fixtures needs to be selected. For fixtures mounted less than 20 feet above grade and typically on a main trunk or easily accessible branch location, the installing contractor can locate the fixture using a ladder (see Figures 4.35, 4.36, & 4.41–4.44). For fixtures above 20 feet and located at an extreme branch location, either a tree climber or a lift truck needs to be employed (see Figures 4.35 & 4.36). Lift trucks can quickly move from one location to another but require essentially flat ground. Few work on even the slightest slope. Another issue to consider with lift trucks is the maneuverability. It is imperative that the bucket can extend to all required locations and maneuver through the branching structure. For locations where lift trucks cannot be utilized or to keep the noise down in quiet neighborhoods, tree climbers can install the fixtures (see Figures 4.35 & 4.36).

When the designer cannot be on site for the entire tree-mounted fixture installation, an option is to take photographs using a Polaroid or digital camera (if there is a printer on site). In this case, the designer needs to provide thorough details for each fixture location. Mark the exact place on the branch that the installer should place the mounting canopy; the preliminary lamping, aiming, and shielding information; and enough information as to where the photographer stood when shooting the image to allow someone to find the location again (see Figure 4.45).

In all cases, the fixtures need to be preassembled with the preliminary lamp selection, all distribution lenses and shielding devices such as louvers and hoods, the mounting canopy, and the appropriate length of wire to reach the desired location in the tree. As the fixtures are being installed, the designer needs to be cognizant of how well it is hidden in the tree from all viewing angles, and a preliminary aiming and glare-shield adjustment should be made.

This helps to limit the amount of night aiming required for tree-mounted fixtures. However, all tree-mounted fixtures need to be easy to move during the aiming and adjusting session, if necessary, in order to create the desired effects.

AIMING AND ADJUSTING THE LIGHTING SYSTEM

Near the end of construction, the electrical contractor notifies the designer of the anticipated completion date so that a mutual schedule (including all team members and the owner) can be determined for aiming and adjusting the fixtures. Before this session takes place, the contractor must confirm that all fixtures and the control system function properly. The aiming and adjusting session must be done after dark, as the effects cannot be seen during daylight.

Decisions made during the adjustment phase determine the success of the lighting. In order to streamline the process, all aspects of the session need to be planned by the designer. Perhaps the first decision is how many people are needed and with what skills. For example, when installing a large number of fixtures in trees, using professional tree pruners with tree-climbing equipment can make the process move more quickly. While one climber is attaching a fixture and then moving on to the next fixture location, the designer can be working with a second climber at another location.

A schedule listing the order of work and assigning a person to each task needs to be developed by the

designer and explained to each participant. On large projects, setting up more than one team to do the focusing can shorten the length of these sessions.

Aiming and adjusting sessions can often last for many hours. The number and length of sessions should be planned by the designer, keeping in mind that the participating members often have to be back at work the next morning. When all the participants work an 8-hour day before the focusing, restricting the length of the session to approximately 4 hours makes sense. When the site is out of town, the sessions can often be longer, as much as 8 hours or sometimes more (depending partially on the length of darkness), if the participants will not be returning to work the following day and can rest during much of the next day until the next evening session begins.

The designer must make sure that each person knows how to dress for these sessions. Some sites will get cold at night, and people need to have the appropriate clothing to avoid getting chilled. The designer needs to plan work breaks when sessions will be long, and provisions need to be made for snacks or food.

The designer must also make sure that all the equipment and supplies necessary to complete the work are brought to the site (see Figures 4.47 & 44.48). The required tools, ladders, fixture accessories, spare lamps, and other supplies will vary by project. A toolbox and maintenance kit stocked with everything that might be needed helps make sure that nothing gets left behind. Compiling a checklist of tools and supplies (such as those listed in Figure 4.46 and illustrated in Figures 4.47 & 4.48) helps ensure that the all the essential equipment necessary for a focusing session will get packed and brought to the site.

During the focusing session, the contractor adjusts each fixture to create the desired effect at the designer's direction. This adjustment can include placing low-voltage stake-mounted fixtures, then aiming them in the proper direction and at the proper angle, changing the lamp to create the desired effect, adding lenses to change the light distribution (such as spread lenses to widen and soften the effect or linear spread lenses to create a line of light rather than a circle of light), adding louvers or shrouds to shield people's eyes from the lamp brightness, and even changing the lamp (in incandescent fixtures) to properly balance brightness relationships from one area to another. For tree-mounted fixtures, the contractor moves the fixture until the correct placement is found and then completes the fixture aiming. At the conclusion of locating and aiming each fixture, the electrical contractor tightens the fixture's aiming mechanism to secure it. This session also includes setting the control system equipment, such as the operation times on time switches and presetting dimming levels on multiple-scene controllers.

As these adjustments are being made, the designer needs to check the brightness balance, overall composition, and potential glare from all viewpoints in the landscape, from all view locations inside buildings, and when necessary from the street as well as from neighboring properties. On large projects, using two-way radios can help the process move more quickly and save the participants' voices.

The last task to be completed during these sessions is to document the final settings on control devices, lamping selections for incandescent fixtures, and aiming directions (often including what the fixture is highlighting) for all adjustable fixtures. These data are transferred onto as-built plans that are supplied to the owner and maintenance staff, with a copy retained by the designer for future reference or maintenance.