Construction Industry Institute®

Project Definition Rating Index

Infrastructure Projects

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Implementation Resource 268-2
Version 4.0

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PDRI:
Project Definition Rating Index –
Infrastructure Projects

Project Definition Rating Index for Infrastructure Projects Research Team

Construction Industry Institute

Implementation Resource 268-2

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Version 4.0 (October 2013) – Fixed scoring and run-time errors in the software tool; coordinated version number to match other key front end planning products.

Foreword

Welcome to the fourth edition of the *PDRI: Project Definition Rating Index – Infrastructure Projects*, a document developed by the CII Research Team 268, PDRI for Infrastructure Projects. The significant software revisions of this edition were a part of a larger CII effort to revise and update all of the tools included in Implementation Resource 213-3, Version 4.0, *The CII Front End Planning Toolkit*.

Because it focuses on infrastructure projects, this PDRI tool filled a gap in CII's front end planning body of knowledge. With the original release of this publication, CII completed the "trilogy" of planning tools focused on major capital projects, the other two of which are Implementation Resource 113-2, *PDRI for Industrial Projects*, and Implementation Resource 155-2, *PDRI for Building Projects*. Each of these three resources complements the others and will be applicable to most capital projects being constructed today, both new construction and renovation projects. Indeed, infrastructure planners will undoubtedly use a combination of these three tools, depending on the horizontal/vertical construction mix of their particular programs.

In addition to this publication, an updated macro-enabled spreadsheet helps project teams assess their projects. This Excel® file can be downloaded from the CII online store, along with this publication, or found in the enclosed CD.

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What Is the PDRI?

The PDRI for Infrastructure projects is a simple and easy-to-use tool for measuring the degree of scope development.

The Project Definition Rating Index (PDRI) for Infrastructure Projects is a powerful and easy-to-use tool that offers a method to measure project scope definition for completeness. It identifies and precisely describes each critical element in a scope definition package. It also allows the project team to quickly identify project risk factors related to the desired outcomes for cost, schedule, and operating performance. Using the PDRI method, project teams can capture mitigation action items as well. It is designed to evaluate the completeness of scope definition at any point prior to detailed design and construction. (Note that there are two other versions of the PDRI: one for building projects, CII Implementation Resource 155-2, and one for industrial projects, Implementation Resource 113-2.) This implementation resource addresses the infrastructure version of the method.

An infrastructure project is defined as a capital project that provides transportation, transmission, distribution, collection, or other capabilities that support commerce or the interaction of goods, services, or people. Infrastructure projects generally cover a wide geographical area and affect multiple jurisdictions and stakeholder groups. They are characterized as projects with a primary purpose that is integral to the effective operation of a system. These collective capabilities provide a service and are made up of nodes and vectors that form a grid or system (e.g., pipelines are vectors that connect to nodes such as water treatment plants). Further examples of vectors fall under the following categories:

People and freight:

- highways
- railroads
- access ramps
- toll booths
- tunnels
- airport runways
- security fencing

Energy:

- electricity transmission/distribution
- fiber optic networks
- electrical substations/switch gears
- towers
- wide area networks

Fluids:

- pipelines
- aqueducts
- pumping and compressor stations
- locks, weirs
- reservoirs
- meters and regulator stations
- pig launchers and receivers
- canals
- water control structures
- levees

Nodes/centralized facilities:

- dams
- power generation facilities
- steam or chilled water production
- marine, rail or air terminals
- water/waste water/solid waste processing
- refineries.

In the context of built systems and according to this definition, an infrastructure project provides the needed services and connections (vectors) that enable industrial facilities and buildings to function effectively. If any of these vectors are disrupted and redundancy is not built into the system, the entire system will fail to function effectively. The diagram in Figure 1.1 illustrates such an integrated system, showing how infrastructure vectors such as pipelines, electrical distribution, canals, rail, and highways connection industrial facilities and buildings to a larger built system.

The PDRI is designed for use during front end planning (FEP), a project stage that encompasses the project activities shown in Figure 1.2. As shown, these FEP activities are performed up to Phase Gate 3 (the point at which the decision to fund design and construction is made) and include feasibility, concept and detailed scope definition. Front end planning has many other terms associated with it, including "front end loading," "pre-project planning," "programming," "schematic design," "design development," and "sanctioning," among others. Although the term "front

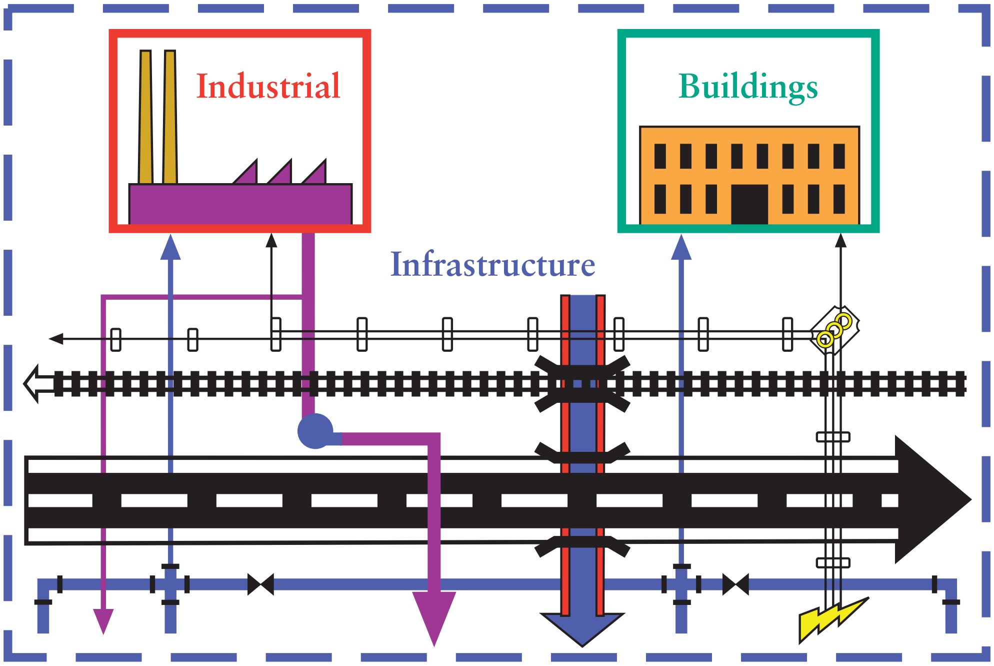

Figure 1.1. Infrastructure Interrelationship Diagram

end planning" is used in this document, it should be considered synonymous to the analogous term used in your business process. (More detailed information on timing and process is provided below.) The original PDRI was envisioned as a decision metric for funding detail design and project execution at Phase Gate 3, but experience has shown that, depending on project size and complexity, it should be used more than once prior to arriving at this gate.

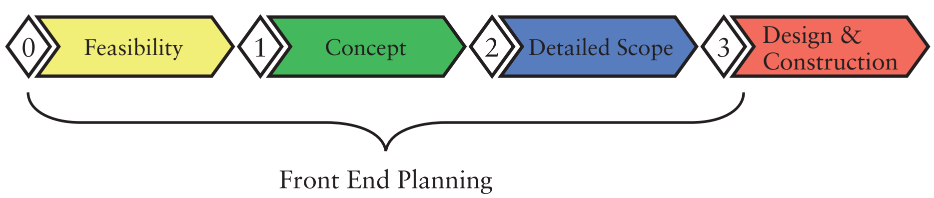

Figure 1.2. Project Life Cycle Diagram

The PDRI–Infrastructure offers a comprehensive checklist of 68 scope definition elements in an easy-to-use score sheet format. Each element is weighted based on its relative importance to the other elements. Since the PDRI score relates to risk, the areas that need further work can easily be isolated; once these problem areas are identified mitigation actions can be documented. (The weighting system is described in detail in Chapter 4.) As part of the development process for the PDRI–Infrastructure, input was gained from 64 industry professionals representing 37 organizations—15 owners and 21 contractors—with over 1400 years of individual experience in infrastructure projects.

The main characteristics of infrastructure, building, and industrial projects are summarized in the Table 1.1. The table can be used to select the most appropriate PDRI for any project under consideration.

Table 1.1. Project Sector Characteristics

PDRI Selection Matrix			
Characteristics	**Infrastructure**	**Building**	**Industrial**
Primary Designer	civil engineer	architect	chemical, mechanical, industrial
Project Orientation	horizontal	vertical	vertical
System	vector	node	node
Utilization	conveyance	functional use	transformation
Operational	flow dynamics, networked into a grid	nodal terminations	consumptions and production
Interface with Public	extensive	moderate	minimal
Environmental Impact	extensive	moderate	extensive
Primary Cost	earthwork, materials, associated structures	building, building system	piping, mechanical, equipment
Installed Equipment Cost	minimal	moderate	extensive
Land Cost	moderate to high	low to high	low to moderate
Jurisdiction Interface	extensive	moderate	moderate

The reader may also refer to the following facility examples for further clarification on PDRI selection. Applicable infrastructure-type projects may include the horizontal construction of the following types of projects:

People and freight:

- highways
- railroads
- access ramps
- tunnels
- airport runways
- security fencing

Energy:

- electricity transmission/distribution
- fiber optic networks
- electrical substations/switch gears
- towers
- wide area networks

Fluids:

- pipelines
- aqueducts
- pumping and compressor stations
- locks, weirs
- reservoirs
- meters and regulator stations

Nodes/centralized facilities:

- dams
- power generation facilities
- steam or chilled water production
- marine, rail or air terminals
- water/waste water/solid waste processing
- refineries.

The Building PDRI (CII IR 155-2) is typically applied to the following types of facilities:

- offices
- schools (classrooms)
- banks
- research and laboratory facilities
- medical facilities
- nursing homes
- institutional buildings
- stores and shopping centers
- dormitories
- apartments
- hotels and motels
- parking structures
- toll booths
- warehouses
- light assembly and manufacturing
- churches
- airport terminals
- recreational and athletic facilities
- public assembly and performance halls
- industrial control buildings
- government facilities.

The Industrial PDRI (CII IR 113-2) is typically applied to the following types of facilities:

- oil/gas production facilities
- textile mills
- chemical plants
- pharmaceutical plants
- paper mills
- steel/aluminum mills
- power plants
- steam heat/chilled water plants
- manufacturing facilities
- food processing plants
- refineries
- water/wastewater treatment
- plant upgrade/retrofit.

All versions of the PDRI consider specific risk factors relating to new construction ("greenfield") projects and renovation-and-revamp ("R&R") projects. An R&R project is defined as one that is focused on an existing facility but does not involve routine maintenance activities. It includes the act, process, or work of replacing, restoring, repairing, or improving the facility with capital funds or non-capital funds. It may include additional structures and systems to achieve a more functional, serviceable, or desirable condition. These modifications include improvements in profitability, reliability, efficiency, safety, security, environmental performance, or compliance with regulatory requirements. R&R projects may be known by numerous other names, such as repair, upgrade, modernization, restoration, among others. More details about how to adapt the PDRI to R&R projects will be given below. (For more information on how to manage front end planning of R&R projects, see Implementation Resource 242-2, *Front End Planning of Renovation and Revamp Projects*.)

PDRI

The PDRI consists of three main sections, each of which is broken down into a series of categories. The diagram of one part of the PDRI hierarchy in Figure 1.3 shows how these categories are divided into elements. Table 1.2 provides a complete list of the PDRI's three sections, 13 categories, and 68 elements.

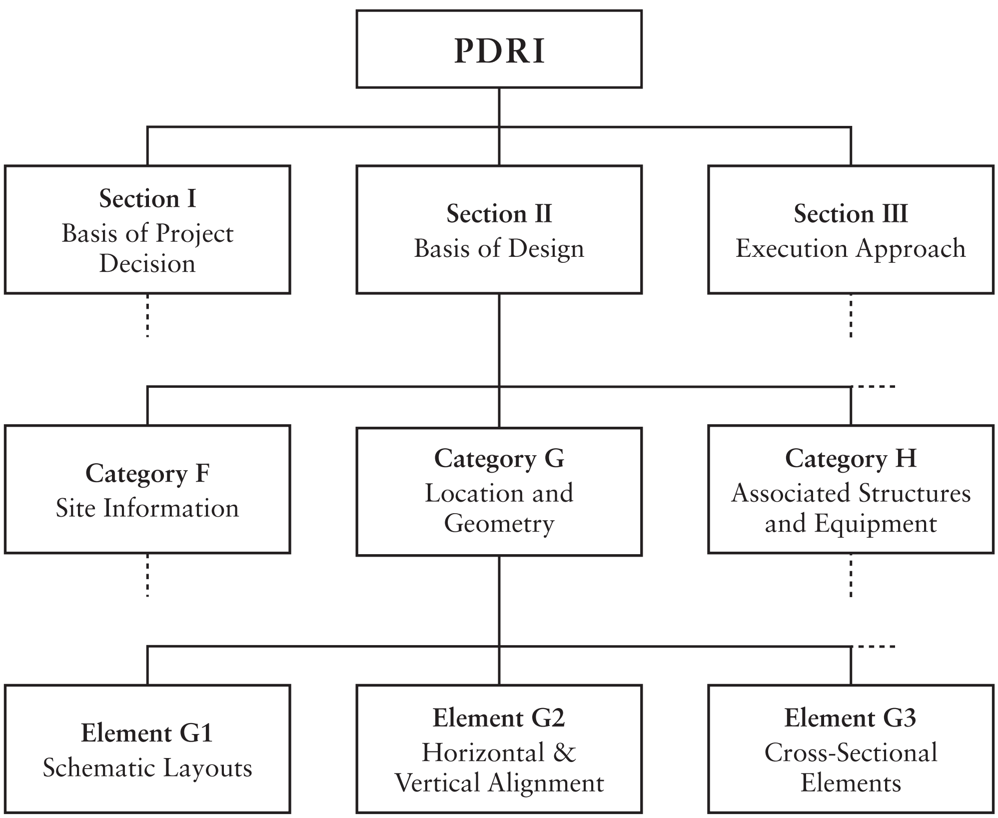

Figure 1.3. PDRI Partial Hierarchy

Table 1.1. PDRI Sections, Categories, and Elements

I. BASIS OF PROJECT DECISION

A. Project Strategy
- A1 Need & Purpose Documentation
- A2 Investment Studies & Alternatives Assessments
- A3 Key Team Member Coordination
- A4 Public Involvement

B. Owner/Operator Philosophies
- B1 Design Philosophy
- B2 Operating Philosophy
- B3 Maintenance Philosophy
- B4 Future Expansion & Alteration Considerations

C. Project Funding and Timing
- C1 Funding & Programming
- C2 Preliminary Project Schedule
- C3 Contingencies

D. Project Requirements
- D1 Project Objectives Statement
- D2 Functional Classification & Use
- D3 Evaluation of Compliance Requirements
- D4 Existing Environmental Conditions
- D5 Site Characteristics Available vs. Required
- D6 Dismantling & Demolition Requirements
- D7 Determination of Utility Impacts
- D8 Lead/Discipline Scope of Work

E. Value Analysis
- E1 Value Engineering Procedures
- E2 Design Simplification
- E3 Material Alternatives Considered
- E4 Constructability Procedures

II. BASIS OF DESIGN

F. Site Information
- F1 Geotechnical Characteristics
- F2 Hydrological Characteristics
- F3 Surveys & Mapping
- F4 Permitting Requirements
- F5 Environmental Documentation
- F6 Environmental Commitments & Mitigation
- F7 Property Descriptions
- F8 Right-of-Way Mapping & Site Issues

G. Location and Geometry
- G1 Schematic Layouts
- G2 Horizontal & Vertical Alignment
- G3 Cross-Sectional Elements
- G4 Control of Access

H. Associated Structures and Equipment
- H1 Support Structures
- H2 Hydraulic Structures
- H3 Miscellaneous Elements
- H4 Equipment List
- H5 Equipment Utility Requirements

I. Project Design Parameters
- I1 Capacity
- I2 Safety & Hazards
- I3 Civil/Structural
- I4 Mechanical/Equipment
- I5 Electrical/Controls
- I6 Operations/Maintenance

III. EXECUTION APPROACH

J. Land Acquisition Strategy
- J1 Local Public Agencies Contracts & Agreements
- J2 Long-Lead Parcel & Utility Adjustment Identification & Acquisition
- J3 Utility Agreement & Joint-Use Contracts
- J4 Land Appraisal Requirements
- J5 Advance Land Acquisition Requirements

K. Procurement Strategy
- K1 Project Delivery Method & Contracting Strategies
- K2 Long-Lead/Critical Equipment & Materials Identification
- K3 Procurement Procedures & Plans
- K4 Procurement Responsibility Matrix

L. Project Control
- L1 Right-of-Way & Utilities Cost Estimates
- L2 Design & Construction Cost Estimates
- L3 Project Cost Control
- L4 Project Schedule Control
- L5 Project Quality Assurance & Control

M. Project Execution Plan
- M1 Safety Procedures
- M2 Owner Approval Requirements
- M3 Documentation/Deliverables
- M4 Computing & CADD/Model Requirements
- M5 Design/Construction Plan & Approach
- M6 Intercompany & Interagency Coordination & agreements
- M7 Work Zone and Transportation Plan
- M8 Project Completion Requirements

The PDRI should be used in conjunction with Implementation Resource 113-3, *Alignment during Pre-Project Planning*, to ensure that critical risk issues are addressed and that stakeholder interests are represented effectively in the front end planning process.

Use the PDRI score sheet that is most closely related to your project's use or type.

In some cases, a project may include more than one type of facility. In such cases, project team members should use their discretion in selecting the most applicable PDRI (or combination of PDRIs), basing their decision on the relative size and importance of the facilities. In general, when a project involves a hybrid of infrastructure, industrial, and building types that have primarily been designed by civil engineers, the PDRI for Infrastructure Projects should be used. It should also be used if the project includes extensive horizontal construction and right-of-way acquisition. If the primary designers for the project are architects, then the PDRI for Buildings should be used. If the primary designers are process (chemical) engineers or industrial (mechanical) engineers, then the PDRI for Industrial Projects should be used. Alternatively, the team may look at the composition of the project in terms of work (design or construction expenditures) to make the decision. In some circumstances, the team may decide to use more than one PDRI for the same project.

Following are examples of hybrid cases and the PDRIs appropriate to them:

Example 1: Toll Road

The project is a medium-sized toll road in Florida consisting of roads, bridges, and toll stations. Toll roads and their associated structures (e.g., typical bridges and toll stations) are considered as an infrastructure projects. Therefore, the Infrastructure PDRI should be utilized in the definition rating of the whole project. However, the owner may elect to treat the bridges and toll stations as separate from the roads, due to their large construction costs or complexity. In such an instance, the project team would need to use more than one PDRI. The Infrastructure PDRI would be used for the toll road, the Building PDRI for the toll stations, and a combination of the two PDRIs would be used for the bridge.

Example 2: Hydroelectric Dam

The project is an integrated hydroelectric and irrigation project in Brazil that consists of a reservoir, a network of irrigation canals, a major dam, a hydroelectric plant, an electrical substation, and a long transmission line. Due to the high costs of the major project components, using multiple PDRIs should probably be considered at the project team's discretion. For example, the team could use an Infrastructure PDRI for the network of irrigational canals, a separate Infrastructure PDRI for the long transmission line, and the industrial PDRI for the dam, reservoir, hydroelectric plant and associated substation.

Many infrastructure projects (a pipeline, for example) require various types of buildings to support the operations and maintenance efforts they require. These facilities could consist of the following types of buildings:

- administration buildings
- toll booths
- warehouses
- control buildings
- maintenance facilities
- pumping stations
- security facilities.

In these cases, the Infrastructure PDRI should be used on the horizontal component of the project, while the PDRI–Buildings should be used on each building. If an entire assessment of each building is not possible, the PDRI–Buildings score sheet should at least be used as a check list.

In addition, the user should determine whether the project is a renovation or revamp project. Further, he or she should use the additional descriptions provided in the tool to address critical R&R issues during front end planning. Figure 1.4 provides a decision diagram to determine this further effort. (Note that, if the project includes a shutdown/turnaround/outage scenario, it is important that the project planning team also use the Shutdown Turnaround Alignment Readiness (STAR) front end planning tool provided in Implementation Resource 242-2, *Front End Planning of Renovation and Revamp Projects*, to help with the unique issues associated with these types of events.)

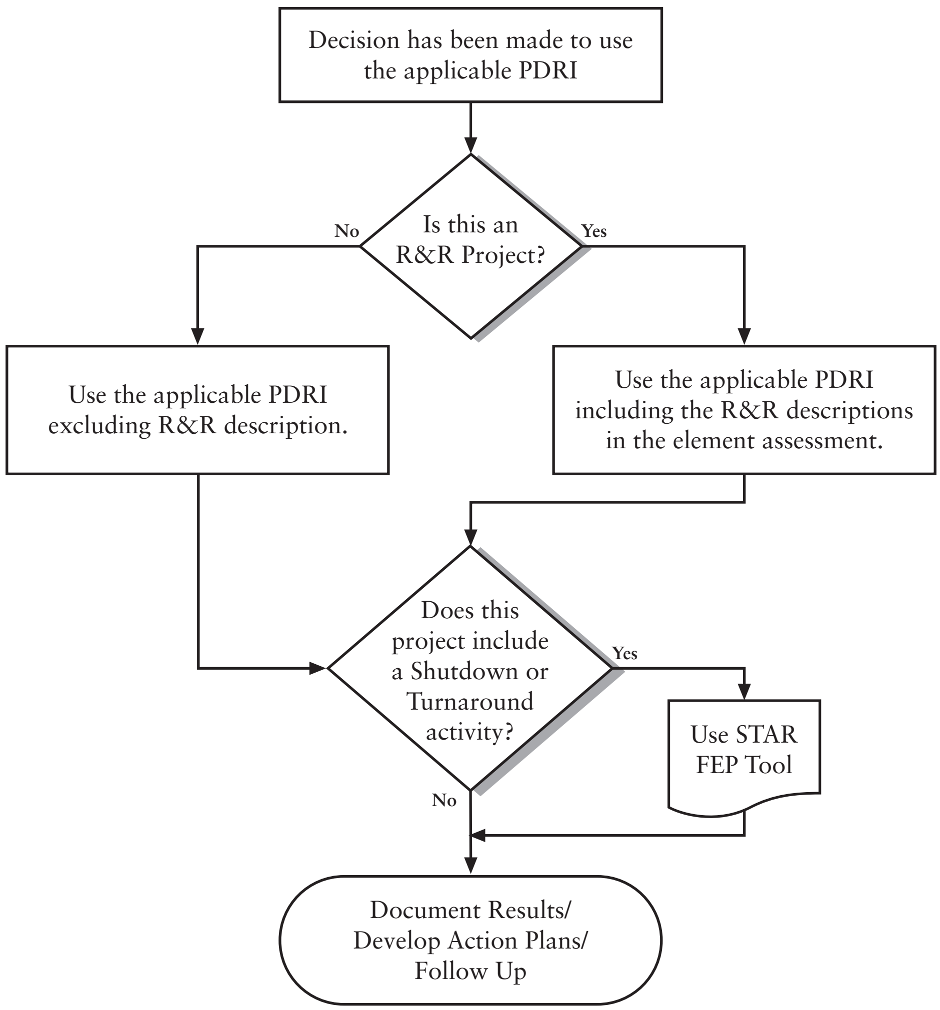

Figure 1.4. Use of Additional Tools to Supplement PDRI

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Benefits of the PDRI

Effective early project planning improves project performance, both in terms of cost and schedule as it reinforces the importance of early scope definition and in terms of its impact on project success. The PDRI allows a project planning team to quantify, rate, and assess the level of scope development on projects prior to detailed design and construction. Moreover, it is a means by which project enablers can be identified early and acted upon. The PDRI is a pro-active project management tool.

A significant feature of the PDRI is that it can be scaled or modified to fit the needs of almost any individual project, small or large. Elements that are not applicable to a specific project can be zeroed out, thus eliminating them from the final scoring calculation.

Following is a list of the ways the PDRI for Infrastructure functions can be used:

- as a **checklist** that a project team can use to determine the necessary steps for defining project scope, for both greenfield and R&R projects
- as a listing of **standardized scope definition terminology** for infrastructure projects
- as an industry standard for rating the completeness of the project scope definition package to facilitate **risk assessment** and prediction of escalation potential for disputes
- as a means to **monitor progress**—when used successively—at various stages of the front end planning effort
- as a tool that promotes **communication and alignment** between owners and design contractors by highlighting poorly defined areas in a scope definition package
- as a means for project team participants to **reconcile differences**, when used as a common basis for project evaluation
- as a means by which members of a project team can **identify enabling tasks and act upon them** before the project schedule becomes delayed
- as a **training tool** for organizations and individuals throughout the industry
- as a **benchmarking tool** for comparing completion of scope definition on current projects against performance on past projects, both within organizations and externally, in order to predict the probability of success on future projects.

Extent of Usage

A survey was conducted of the CII membership in 2004 to determine the extent of PDRI usage; seventy of 92 CII members responded (76 percent). (Note that the survey was conducted prior to development of the PDRI for Infrastructure.) Of the 70 respondents, 43 organizations were then in the process of using the PDRI on their capital projects, including 18 of 34 contractor and 25 of 36 owner respondents. The PDRI for industrial projects had been used for an average of 4.3 years, while the PDRI for building projects had been used for an average of 2.7 years. Of importance within the survey was a description of how the tool was used. (See Table 2.1.) These implementation uses are discussed in more detail below.

Table 2.1. Frequency of Use Among Organizations Using PDRI (N=43)

The PDRI is used:	**Frequency**
As a planning checklist in early project development	81%
As a “gate” check before moving to project execution	72%
In conjunction with other front end planning measurement methods (i.e., prepare for third party evaluations, internal measures)	72%
As a means of measuring or benchmarking front end planning process performance	70%
More than once on most projects	42%
As an audit tool	42%
In a modified form for small or unusual projects	33%
To help capture lessons learned	28%
With the help of an outside facilitator	29%

Who Should Use the PDRI?

Any organization wishing to improve the overall performance on its projects should use the PDRI.

The PDRI can benefit owners, designers, and constructors. Owners can use it as an assessment tool for establishing a comfort level that, when reached, prompts them to move forward with projects. Designers and constructors can use it as a method of identifying poorly-defined project scope elements. By functioning as an objective tool that provides a common basis for project scope evaluation, the PDRI provides a means for all project participants to communicate and reconcile any differences they have. Because the PDRI for Infrastructure can accommodate the jurisdictional intricacies, engineering complexities, and critical phasing issues that are inherent to most infrastructure projects, it is a tool that offers unique benefits to owners, users, and the public.

Owners should use the tool as a formal checklist of items that need to be clearly defined and communicated to ensure that the design team fully understands the project business objectives and drivers. Initially, owners should focus on the elements in Section I, the Basis of Business Decision. Accurate definition of these items will provide the strongest possible foundation on which the design team can make its decisions going forward. These items should be well defined at Phase Gate 2. As the project passes through the other phases, the owners should participate in the PDRI assessment sessions to ensure that the design team has correctly understood its requirements and is meeting the owner team expectations. Attendance at these sessions also provides an opportunity for the owner and the stakeholders—including operations and maintenance—to gain an understanding of the project and any issues pertaining to compliance with mandates. This sustained communication is essential to ensure that the design team is meeting the expectations and requirements of the owner stakeholders.

The PDRI is valuable for planning inter-jurisdictional infrastructure projects because, at an early stage, it prompts the owner and design team to validate their business and design assumptions against the will of the public and jurisdictional requirements. This assessment should be undertaken at Phase Gates 0 and 1, and then should be confirmed with the public and any stakeholder jurisdictions in hearings and meetings prior to proceeding with detailed scope development. Use of the PDRI–Infrastructure at this early stage will identify public issues prior to engagement, and the project team can have properly researched solutions and recommendations ready for public comment.

Contractors may become involved in projects at various points of the front end planning process and should use the PDRI to organize their work. Contractors should also use the PDRI as an alignment tool to understand and participate in the development of the owner's business objectives and drivers; using it in this way facilitates the design team's understanding of the elements defined in Section I, the Basis of Business Decision. The team should use this alignment check to make decisions concerning cost, quality, and schedule as the project progresses through the scope definition stage and into execution. As front end planning progresses, the

PDRI process helps the contractor clarify requirements outlined in Sections I and II of the PDRI. It also ensures the right input from key owner stakeholders, such as operations and maintenance, process engineering, research and development, manufacturing, and business, among others. The elements contained in Section III of the PDRI helps the contractor coordinate and execute planning in conjunction with the owner organization.

Contractors are often given a request for proposal (RFP) on projects for which the owner has defined all or a portion of the project scope, or for which the owner has hired a third party engineering firm to develop the scope definition package. In such instances, it is imperative that the contractor perform a PDRI assessment as a risk analysis to determine the degree of definition; this kind of risk analysis will help the contractor identify the potential weaknesses/areas of concern before responding to the RFP. The contractor should make every attempt to get as many of the project stakeholders as possible involved in this PDRI assessment session to assure that the team is making the correct evaluations and assumptions before proceeding to the next stage.

Contractors also may use the PDRI to determine if the work within their control is ready to move to the next step. Many contractors spend a portion of the project development effort performing design, procurement, and constructability reviews prior to the work starting in the field. For instance, the PDRI can be used to determine if, prior to the start of underground work or to the selection of a subcontractor to perform the work, sufficient definition has been developed to minimize schedule and/or cost impacts that may trigger mitigating strategies. This can also be done prior to staring other major activities at the construction site.

Many infrastructure projects are broken into separate segments or phases, and a PDRI–Infrastructure assessment should be conducted for each. In these situations, coordination should be performed to ensure that critical issues are addressed and that lessons are learned.

3

Instructions for Assessing a Project

Assessing a project is as easy as 1-2-3.

Individuals involved in front end planning should use the Project Score Sheet shown in Appendices A and B when assessing a project. Two score sheets are provided: the first is simply the unweighted checklist in Appendix A; the second contains the weighted values and allows a front end planning team to quantify the level of scope definition at any stage of the project on a 1000-point scale. The unweighted version should be used in the team scoring process to prevent bias in choosing the level of definition and in "targeting" a specific score. The team leader or facilitator can easily score the project as the weighting session is being held. If the project includes renovation work, the team should use the supplemental issues to consider that are provided in selected element descriptions.

When to Use PDRI

The PDRI is a powerful tool that should be used at points throughout front end planning to ensure continued alignment, process check-ups, and a continual focus on the key project priorities. Many companies now find value in utilizing this tool at various points in the early project planning process.

Project size, complexity, and duration will help determine the optimum times that the PDRI tool should be used. To aid in the expanded use of this tool, Figure 3.1 illustrates four potential application points at which the PDRI could be useful.

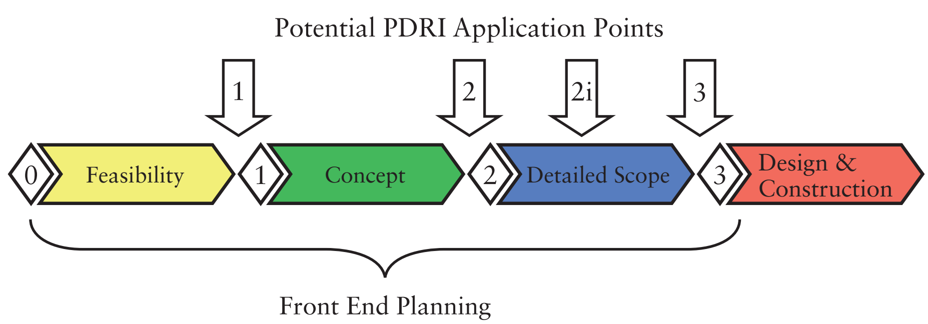


Figure 3.1. Employing the PDRI, Application Points

Regardless of the timing of the PDRI assessment, the same checklist/descriptions should be used. The evaluation should be conducted according to the guidelines outlined below. Objectives and overall scores of the PDRI assessments are given in the following discussions.

PDRI 1 Review – This is a high-level assessment of the project following Feasibility and prior to Phase Gate 1. It is part of the decision criteria for proceeding to the next phase. This assessment is typically held for projects at the initial project kick-off meeting, when an architect/engineering firm is brought on board. The PDRI 1 Review should focus on the following areas:

- aligning the team with project objectives
- ensuring good communication between business/sponsor to project/ contractor team
- highlighting stakeholder expectations to facilitate reasonable engineering estimates.

Typical PDRI scores at this assessment will be in the range of 550–800.

PDRI 2 Review – This is a high-level assessment of the project following the Concept Development phase of the project, or Phase Gate 2. It is part of the decision criteria for proceeding to the next phase. PDRI Section I, the Basis of Project Decision, should be well-defined (with a low relative PDRI score) at the end of this phase. For small or relatively simple projects, this assessment may not be necessary. In addition, the PDRI 2 Review should focus on the following areas:

- aligning project objectives and stakeholders needs
- identifying high priority project deliverables that need to be completed
- helping to eliminate late project surprises
- facilitating communication across the project team and stakeholders.

Typical PDRI scores at this phase of the project may be in the range of 450–600. The assessment will highlight the areas on which resources need to be focused during the succeeding phase of front end planning.

PDRI 2i Review – This is an intermediate (i) assessment of the project during the Detailed Scope phase of a project. It typically should be held midway through this phase. Section II, the Basis of Design, and Section III, the Execution Approach, should be well-defined during this phase of the project. The PDRI 2i Review should focus on the following areas:

- assuring alignment of project objectives and stakeholders needs
- confirming that resources are properly deployed to get the largest value for the time and effort being applied
- verifying scope in relation to the original project goals
- identifying and planning remaining activities to achieve the level of detail necessary to complete front end planning in preparation for Phase Gate 3.

Typical PDRI scores at this phase of the project may be in the range of 300–450.

PDRI 3 Review – This is typically the final assessment of the project at the end of front end project planning, prior to Phase Gate 3. The PDRI 3 assessment should be conducted for all projects. At this stage, risk issues have been identified and mitigation plans are in place or are being developed. Typical scores for this review are 150 to 250, with a target of typically 200 or below.

In addition to the four PDRI reviews outlined above, the tool can be used at other points. For instance, it can be used early in Feasibility as a checklist to help organize work effort, or during the design phase (after Phase Gate 3) to verify the design before moving on to construction. It has been used effectively as an alignment tool during the kick-off of design/build projects.

Figure 3.2 shows approximate ranges of overall project scores based on the timing of the assessment during front end planning. As planning progresses, the level of definition improves and the overall score is reduced.

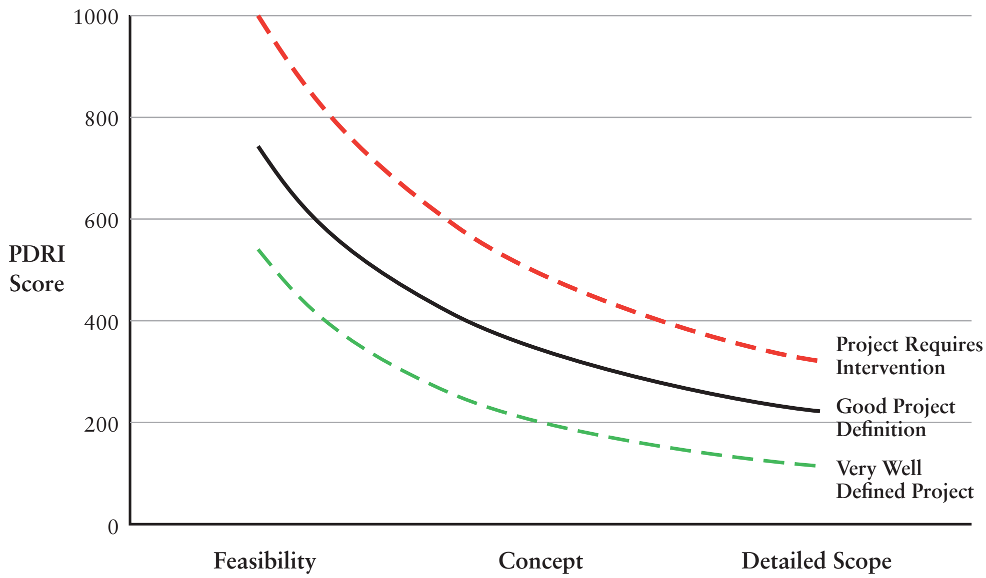


Figure 3.2. Score Ranges versus Planning Phase

As noted above, the PDRI consists of three main sections that are broken down into 13 categories. The categories are further divided into 68 elements. The elements are individually described in Appendix C, Element Descriptions. Elements should be rated numerically from 0 to 5. The scores range from 0 – not applicable, 1 – complete definition to 5 – incomplete or poor definition, as indicated in the legend at the bottom of the score sheet. The elements that are as well-defined as possible should receive a perfect definition level of "one." Elements that are not completely defined should receive a "two," "three," "four," or "five," depending on their levels of definition as determined by the team. A score of 2 indicates minor deficiencies, a score of 3 indicates some deficiencies, and a score of 4 indicates major deficiencies. Those elements deemed not applicable to the project under consideration should receive a "zero," and thus will not affect the final score.

It should be noted that establishing the basis for determining the level of definition depends on developing the overall project scope of work such that the project has a higher probability of achieving a cost or schedule estimate at the ±10 percent level at Phase Gate 3. This level of definition roughly relates to approximately 25–30 percent of design completion for the entire project.

Figure 3.3 outlines a method of assessing the level of definition of an element at a given point in time. For those elements that are completely defined, no further work is needed during front end planning. For those elements with minor deficiencies, no further work is needed during the front end planning phase, and the issue will not affect cost and schedule performance; however, the minor issues identified will need to be tracked and addressed as the project proceeds into the design phase. Elements that are assessed as having some deficiencies, as having major deficiencies, or as incomplete should be addressed during front end planning so that the project can move through Phase Gate 3.

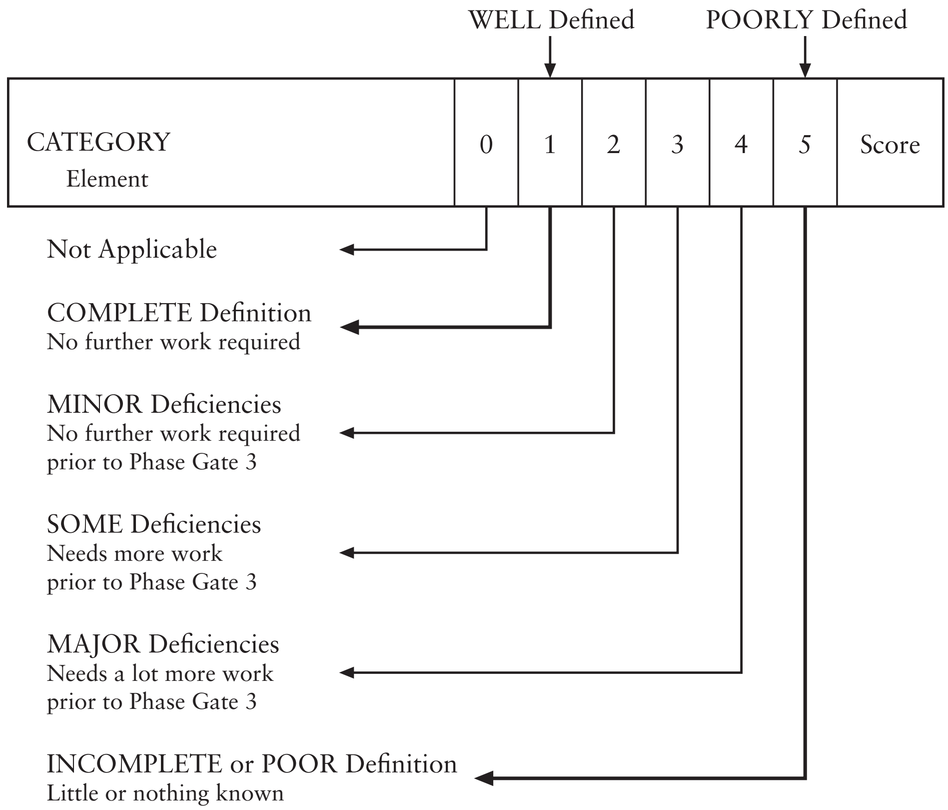


Figure 3.3. PDRI Definition Levels versus Further Work Required During Front End Planning

The relative level of definition of a PDRI element is also tied to its importance to the project at hand. The PDRI's flexibility allows the project team some leeway in assessing individual element definitions. For instance, if the issues missing from the scope documentation of a particular PDRI element are integral to project success (and to reduction of risk), the team can perhaps rate the issue at definition level "three," "four," or even "five". On a different project, the absence of definition of these same issues within a PDRI element may not be of concern, and the team might decide to rate the element at definition level "two." As the old saying goes, "do not turn off your brain" when you are using this tool.

Assessing a PDRI Element

To assess an element, first refer to the Project Assessment Sheet in Appendix A or B. Next, read its corresponding description in Appendix C. Some elements contain a list of items that should be considered when their levels of definition are evaluated. These lists may be used as checklists. Additional issues may be applicable for renovation projects. All elements have five pre-assigned scores, one for each of the five possible levels of definition.

Choose only one definition level (0, 1, 2, 3, 4, or 5) for each element based on the perception of how well it has been addressed. The suggested method for making this determination is open discussion among the project team members. When considering the completeness of the PDRI elements, the front end planning team needs to take into account the project's desired operating performance alongside the desired cost and schedule outcomes. It is important that all participants understand the issues surrounding each of the elements and that the project leaders promote a common understanding of the work required to achieve complete definition. It is important to defer to the team members who are most knowledgeable about any given issues (for example, storm water issues are deferred to the civil and environmental discipline leads), while respecting the concerns of any of the other team members. As the discussion unfolds, capture action items or "gaps." An example action item (gap) list is given in Appendix G.

Once you have chosen the appropriate definition level for the element, write the value of the score that corresponds to the level of definition chosen in the "Score" column. Do this for each of the 68 elements on the Project Score Sheet. Be sure to assess each element.

The scores for all of the elements within a category should be added to produce a total score for that category. The scores for all of the categories within a section should then be added to arrive at a section score. Finally, the three section scores should be added to achieve a total PDRI score.

Assessment Example

Consider that you are a member of a front end planning team responsible for developing the scope definition package for a roadway project that will provide vehicular access to a new midfield terminal project that is currently under construction at a major international airport. Throughout front end planning, your team has identified major milestones at which you plan to use the PDRI to evaluate the current level of "completeness" of the scope definition package. Assume that at the time of this particular evaluation the scope development effort is underway, but it is not yet complete.

Your responsibility is to evaluate how well the project control requirements have been identified and defined to date. This information is covered in PDRI Category L, Project Control. As shown below, this category consists of five elements: L1 Right-of-Way & Utilities Cost Estimates; L2, Design & Construction Cost Estimates; L3, Project Cost Control; L4, Project Schedule Control; and L5, Project Quality Assurance & Control. The unweighted assessment sheet is recommended when projects are evaluated in a team setting.

CATEGORY Element	**Definition Level**						**Score**
	0	1	2	3	4	5	
L. PROJECT CONTROL							
L1. Right-of-Way & Utilities Cost Estimates							
L2. Design and Construction Cost Estimates							
L3. Project Cost Control							
L4. Project Schedule Control							
L5. Project Quality Assurance & Control							

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

To fill out Category L, Project Control, follow the steps below:

Step 1: **Read the description for each element in Appendix C.** Some elements contain a list of items that should be considered when their levels of definition are evaluated. These lists may be used as checklists.

Step 2: **Collect all data that you may need** to properly evaluate and select the definition level for each element in this category. This may require input from other individuals involved in the scope development effort.

Step 3: **Select the definition level for each element** as described and show below.

Element L1: Requirements for right-of-way and utility cost estimates have been well defined. The project is being constructed on existing airport property, therefore there are no property acquisition costs. However, utilities must still be brought to the site, and existing utilities will require modification. The cost estimates for the third party utility work to bring power to the site are not entirely complete. You feel that this element has *some deficiencies* that should be addressed prior to authorization of the project. **Definition Level = 3.**

Element L2: Your team has prepared a thorough design and construction cost estimate based upon the project's current design status. Reasonable contingencies as well as labor/material escalation values have been established. Your team recognizes that there are unique insurance requirements that are necessary on jobsites located around an operational airfield; however, these have not yet been fully identified nor have their costs been determined. You feel that this element has some *minor deficiencies* that should be addressed prior to authorization of the project. **Definition Level = 2.**

Element L3: Although your team plans to specify methods for cost control and financial reporting, it has not yet done this work. Prior to starting work on this element, your team had been focusing its efforts on completing the costs elements as defined in element L2. The team is particularly concerned about cash flow projections and the costs of each of the project's multiple phases. It is *incomplete.* **Definition Level = 5.**

Element L4: Requirements for the project's schedule are well defined:

- the baseline schedule for both design and construction has been established
- project phases have been identified
- long lead items have been researched and considered

- municipality and airport review requirements have been reviewed and their timing requirements have been incorporated
- procurement methods and timing have been established.

The project requires significant coordination and phasing with numerous user groups and multiple construction contracts. While the milestones for each of these phases have been defined, not all of the current completion dates for each of these phases have been verified and updated. You feel that this element has some *minor deficiencies* that should be addressed prior to the authorization of the project. **Definition Level = 2.**

Element L5: Your team has outlined the basic framework for the project's quality assurance and control. However, these requirements only exist in outline format. Decisions regarding responsibility of QA/QC during the construction phase have not been finalized. The type and requirements for the QA/QC system have been started, but are also only in outline format. This element has *major deficiencies*. **Definition Level = 4.**

CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
L. PROJECT CONTROL							
L1. Right-of-Way & Utilities Cost Estimates				X			
L2. Design and Construction Cost Estimates			X				
L3. Project Cost Control						X	
L4. Project Schedule Control			X				
L5. Project Quality Assurance & Control					X		

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

As the discussion progresses, be sure to capture action items and comments for use during the final step of the PDRI process. This accrued set of items and comments is referred to as a "gap" list because it isolates the issues that need to be addressed to move the project forward and identifies any gaps in the planning activities.

Step 4: For each element, **write the score that corresponds to its level of definition** in the "Score" column. If the team feels that any or all of the elements in a category are **not applicable for a project, they should be given a definition level of "0" and zeroed out**. The weighted score sheet is given below with the elements circled for the chosen definition levels in this example.

Step 5: **Add the element scores to obtain a category score.** Repeat this process for each element in the PDRI. In this example, the category has a total score of 45. Add category scores to obtain section scores.

CATEGORY Element	**Definition Level**						**Score**
	0	**1**	**2**	**3**	**4**	**5**	
L. PROJECT CONTROL (Maximum Score = 80)							
L1. Right-of-Way & Utilities Cost Estimates	0	1	3	5	7	10	7
L2. Design and Construction Cost Estimates	0	2	8	14	20	25	8
L3. Project Cost Control	0	1	5	9	13	15	15
L4. Project Schedule Control	0	1	5	9	13	17	5
L5. Project Quality Assurance & Control	0	1	4	7	10	13	10
CATEGORY L TOTAL							**45**

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

Add section scores to obtain a total PDRI score. Completed PDRI score sheets for fluid, people and freight, and energy projects are included in Appendix D for reference.

Step 6: **Take Action.** In this example, Category L has a total score of 45 (out of 80 total points). The element scores indicate that the project needs more work for elements L2, L3 and L5. Use the gap list to identify issues that need additional attention.

Philosophy of Use

Ideally, the project team conducts a PDRI evaluation at various points in the project. Experience has shown that the scoring process works best in a team environment, with a neutral facilitator who understands the process. The facilitator provides objective feedback to the team and controls the pace of team meetings. (See Appendix F for details on facilitation.) If this team-facilitator arrangement is not possible, an alternative approach is to have key individuals evaluate the project separately, then evaluate it together and ultimately agree on a final evaluation. Even using the PDRI from an individual standpoint provides a method for project evaluation. For example, the right-of-way (ROW) discipline lead may utilize applicable portions of the PDRI to isolate land acquisition and jurisdictional issues in order to stimulate discussion on areas of interest and/or to evaluate potential risk areas. Such targeted assessments may help the project team determine long lead or extended timeframe areas.

Experience has shown that the PDRI is best used as a tool to help project managers (i.e., project coordinators and project planners) organize and monitor the progress of the front end planning effort. In many cases, a planner may use the PDRI prior to the formation of a team in order to understand major risk areas. Using the PDRI early in the project life cycle will usually lead to high PDRI scores. This initial result is normal, and the completed score sheet will give a road map of areas that are weak in terms of definition.

The PDRI provides an excellent tool to use in early project team meetings insofar as it provides a means for team members to align themselves on the project and organize their work. Experienced PDRI users feel that the final PDRI score is less important than the process used to arrive at that score. The PDRI can also provide an effective means of handing the project off to other entities or of maintaining continuity as new project participants are added to the project.

If the organization has front end planning procedures, execution standards, and deliverables in place, many PDRI elements may be partially defined when the project begins its front end planning. An organization may want to standardize many of the PDRI elements to improve cycle time of planning activities.

PDRI scores may change on a day-to-day or week-to-week basis as team members realize that some elements are not as well defined as they initially assumed. It is important to assess the elements honestly. The planning process is inherently iterative in nature, and any changes that occur in assumptions or planning parameters need to be resolved with planning decisions as quickly as possible. The target score may not be as important as the team's ability over time to resolve issues that harbor risk in a timely manner.

The PDRI was developed as a "point-in-time" tool with elements that are as discrete as possible. Most of these elements constitute deliverables to the planning process. However, a close review of the elements shows an embedded logic. Certain ones must first be defined well before others can be defined. This sequential logic works within project phases and from one phase to the next. Thus, the PDRI was designed for iterative use during front end planning and is often used during each project phase to evaluate progress prior to the next approval level.

In some instances, infrastructure projects can last many years or even decades, with associated delays—especially in the public sector. In other cases, these projects can be delayed for shorter periods as project personnel await administrative decisions. For instance, delays can be caused by changes in political will, reallocation of funding, or new regulations. It is important in these situations that the PDRI assessments and planning documents be kept in order so that momentum can be regained quickly in case of a re-start of the project.

Figure 3.4 outlines the logic at a section level. In general, Section I elements must be well defined before the elements in Section II and III can be defined. This process does not follow a typical construction project management (CPM) approach, wherein certain elements must reach a minimum point of completion before the elements downstream can start. With the PDRI, elements can often be pursued concurrently; as information is gained downstream, elements already defined can be revisited and redefined.

Figure 3.5 outlines the general logic flow of the PDRI categories. Again, the flow does not follow a traditional CPM model. Moreover, the diagram is given only as a guideline; with the PDRI, there are many other ways to organize the work. For instance, if information gained in Category F, Site Information diverges from what is expected or assumed, then the planner should assess the impact of that difference on Categories A, B, C, D and E.

If an organization wants to standardize its front end planning process, the logic presented in these diagrams could provide the basis for that development. Full-sized color versions of Figures 3.4 and 3.5 are provided in Appendix E.

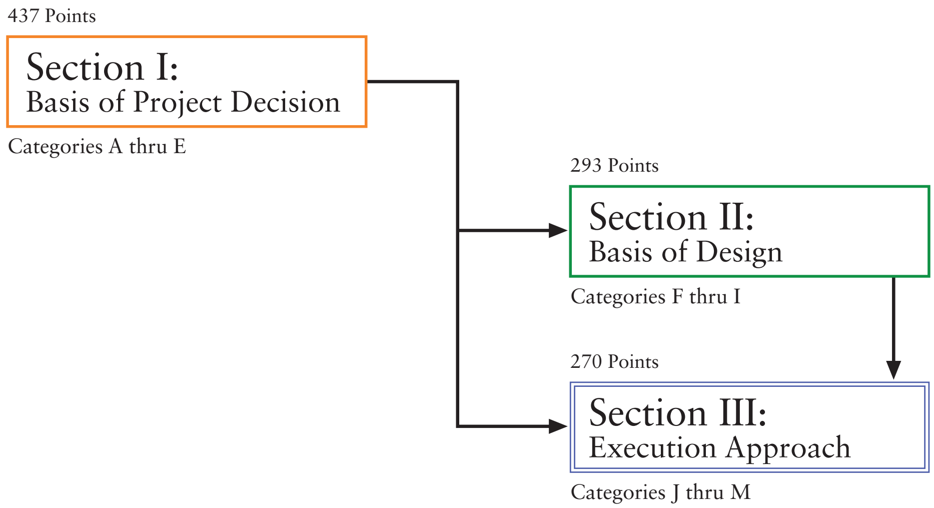


Figure 3.4. Infrastructure PDRI Section Logic Flow Diagram

Use of PDRI on Small or Renovation Projects

The PDRI can be customized to meet any organization's needs.

Small or renovation/upgrade projects can also benefit from the PDRI process, even if they are small, short in duration, and frequently performed. Many large organizations have a number of these types of projects at any one time. Such projects may be driven by environmental regulations, safety requirements, or by the need to keep a facility in repair or in operation. They may also be focused on restoring an historically significant building or on relocating a business function or production line.

On small projects or renovations, the scope may not encompass many of the elements contained in the entire PDRI. In particular, some of the Basis of Project Decision elements found in Section I of the PDRI may not be clearly defined on these kinds of projects. Although business planning is generally performed on an owner's overall program of small projects, it may be difficult to determine whether specific business decisions directly apply to one individual project. Long term use has shown that customizing the PDRI to reflect each individual project is highly beneficial.

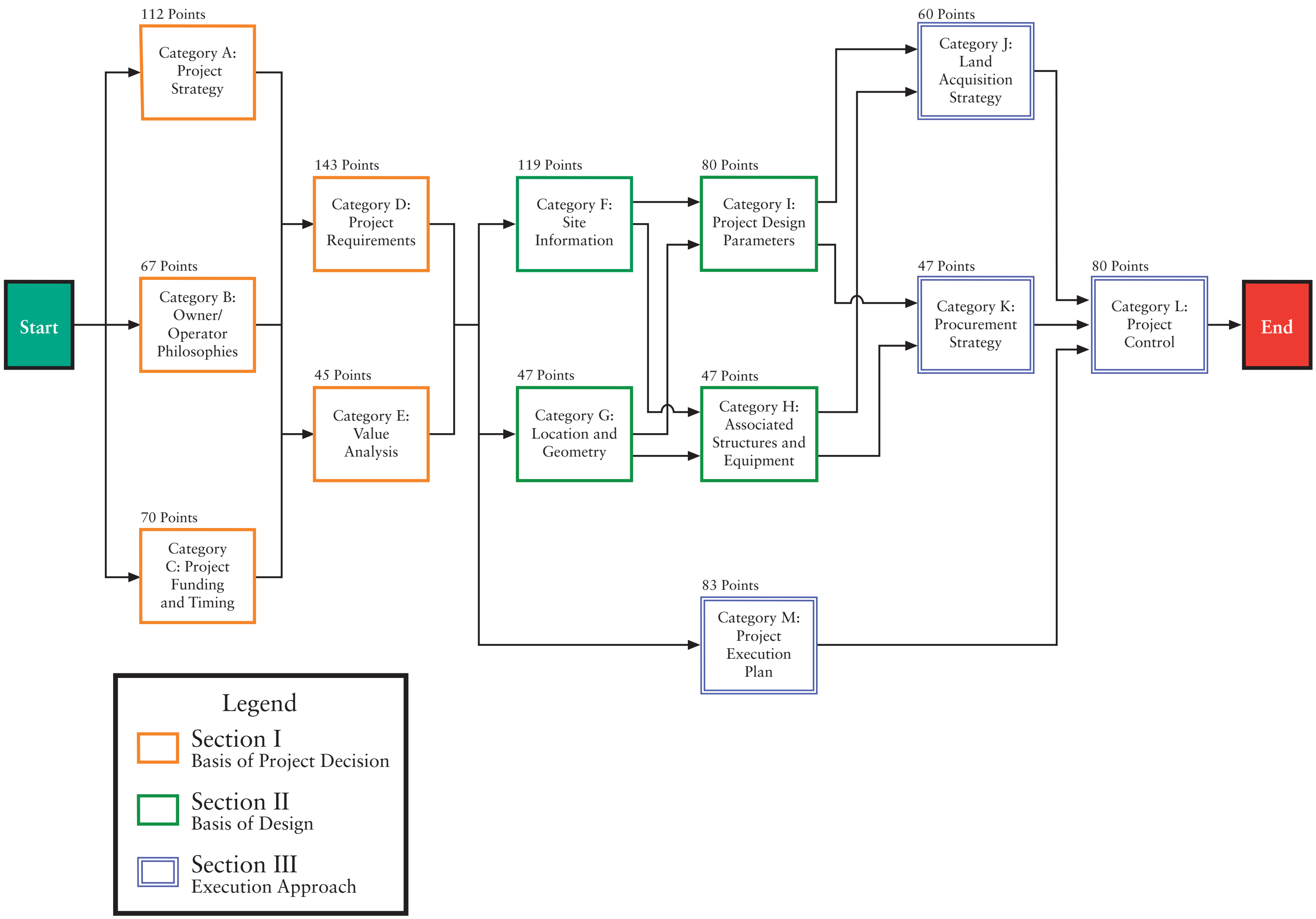


Figure 3.5. Infrastructure PDRI Category Logic Flow Diagram

After the release of the initial PDRIs in 1996, many companies attempted to customize the elements to fit the needs of smaller projects. The description list of PDRI includes language that should make it adaptable to smaller projects or renovations. Experience has proven that gathering the project team around a well understood and customized PDRI can save time, money, and frustration.

Smaller projects may range in size from $50,000 to $5,000,000 in total project costs. Some may consist of one or two of the following design disciplines:

- environmental project to improve drainage and capture storm runoff
- airport runway or road pavement repairs or upgrades
- pipeline compressor or pump station upgrades
- repair or replacement of pipelines and manholes
- new electrical transmission feed
- instrument upgrade project.

In any of the above projects, the PDRI can be a very helpful tool in highlighting gaps in thinking and execution. The following are some guidelines for using the PDRI on small or "single-discipline" projects:

1. "Cross out" all elements that clearly do not apply.

   Example: A storm water or drainage improvement project may not have any instrumentation or equipment requirements. In such cases, cross out (mark as NA) the Equipment List (Element H4), Electrical/Controls (Element I5), and other elements as necessary prior to the assessment session. Note: if there is any doubt regarding an element, then leave it in until the team has had time to discuss it.

2. Convene the project team and assess the project using only the PDRI elements that remain to be assessed; be sure to include those elements specifically designated for renovation projects, if applicable. At the conclusion of the PDRI assessment session, have representatives of each discipline sign off to signify their agreement with the definition of the project.

3. Revert to the normalized score (percentage) as a basis for determining how well the project is defined.

4. Since some of the most heavily weighted items of Section I could receive a "zero," the facilitator should make the team aware of the elements that have the most impact on the final score. Other elements may become more important to predicting project success.

5. Alternatively, the tool can be used strictly as a checklist to identify issues that need to be addressed to develop a good scope. Use of the PDRI as an early checklist can have a great positive effect on the project and help focus the project team toward a common goal. If the project is a renovation, pay particular attention to the issues that have been identified for these types of projects.

Normalizing the Score

If an organization decides to create a scaled-down version of the PDRI, it must be aware of the fact that this procedure will alter the maximum possible score from 1000 points to some lower number. Each time an element is deleted from the score sheet, the maximum score for the project is reduced by that element's total weight. Further, not only will the maximum score be reduced, but the lowest possible score that can be achieved with complete definition will also drop from 70 points to some lower number.

Rework example: For example, on infrastructure revamp projects, the PDRI can be used effectively with some modification. Some elements may be "zeroed" as not applicable, e.g., Public Involvement (A4) and Surveys and Mapping (F3). A "not applicable" element essentially provides no risk (no potential negative impact) to the project. Other elements may become more critical, e.g., Permitting Requirements (F4) and Site Characteristics Available vs. Required (D5). After the assessment, if the organization's scaled-down version has a maximum possible score of 752 (after certain elements are rated "not applicable" in the score sheet), it may determine that a score of 120 (16 percent of the total applicable points) must be reached before authorizing its small projects for design.

Teams on small-projects must also determine new PDRI target scores, which, when reached, will trigger the project's authorization for detailed design and construction. Each organization should develop an appropriate threshold range of scores for each phase of front end planning. These thresholds are dependent upon the size, type, and complexity of each project.

Caution: Using the PDRI for this purpose should be done carefully, or else elements that are more important for small projects may be given less emphasis than needed. The imperative for using the PDRI in these situations is "use common sense." An experienced facilitator can help in this regard.

Implementation across an Organization

The first requirement for implementation of the PDRI across any owner or contractor organization—i.e., using it on all projects—is the unwavering support of upper management. Upper management must create a procedure that requires the utilization of the PDRI before a project is authorized to proceed into the execution phase. Many successful organizations require a PDRI report as a part of their project approval process at Phase Gate 3. Some organizations require a specific score of 200 or less before a project can be approved for the next phase.

There is some danger in too much focus on scoring, however. Some smaller maintenance projects may be fully acceptable at a much higher PDRI score, as long as the project risks have been defined and a mitigation plan is in place to control the project. As stated above, common sense should prevail when PDRI results from a project are being reviewed. Requiring teams to reach a specific score could result in a team artificially adjusting the score so that its project can be executed (to the detriment of the organization, the project, and the team participants). In most cases, it is more beneficial for the sponsor to have a PDRI assessment with a score above 200—along with identified risk issues (gap list) and corresponding mitigation steps—than to have a PDRI assessment with a lower score and no commentary. Sponsors should focus on the gap list generated in the assessment session, not only on the PDRI score. Placing too much emphasis on the score can lead to the use of the tool as merely an administrative exercise.

The second requirement for implementation across an organization is a local champion. This person is an enthusiastic supporter and advocate of the application of this tool. He or she gains knowledge about the tool and fosters its widespread application by staying in contact with other organizations that use the PDRI.

The third requirement for implementation is training. Several facilitators should be trained, with the number will varying by organization and according to the number of projects that require approval. The objective is to ensure that every project has access to a trained facilitator in a timely manner. The facilitator should NOT be a member of that project team. In many organizations, project managers are trained as facilitators for their peers' projects.

In addition to developing a cadre of facilitators, every organization should ensure that all of its key members should understand the PDRI. In most cases, this is accomplished with just-in-time training. At the outset of each session, the facilitator will brief the participants on the purpose of the PDRI process and explain their respective roles in making the session a success. The facilitator should further take the opportunity to comment on specific behaviors as the team progresses through the assessment session. Soon, key members will be well trained and know what to expect during future PDRI assessment sessions.

If the PDRI is implemented across an organization, its use should be monitored. Many organizations have modified PDRI element descriptions to address proprietary concerns and lessons learned, or to include specific terminology based on its business environment.

4

What Does A PDRI Score Mean?

A low PDRI score represents a project definition package that is well-defined and, in general, corresponds to an increased probability for project success. Higher scores signify that certain elements within the project definition package lack adequate definition.

The PDRI, in its various forms, has been used on hundreds of projects worth billions of dollars in investment. As part of the tool-testing process during its development, the PDRI for Infrastructure was used to assess the efficacy of the front end planning efforts on four projects representing over $2 billion in investment; planning was also assessed on an additional 21 completed projects representing almost $6 billion in capital investment. These projects covered a wide range of infrastructure projects and included tunnels, security perimeters, pipelines, wharfs, electrical distribution, airport runways and taxiways, and roadways.

Table 4.1 compares project performance for the sample of 21 infrastructure projects, using a 200-point PDRI score cutoff. Each project was assessed by a key project participant and a PDRI score was determined after the fact, at a point just prior to detailed design; actual performance results were captured rather than estimated at that point. The 200-point cut-off has been used in previous PRDI tools and represents a good break point in the validation data. Additionally an analysis at the 150-point level is shown for comparison in Table 4.2.

The data show the mean performance for the projects as against the execution estimate for design and construction. These data also show the absolute value of changes as a percentage of total project cost. Projects with a PDRI score under 200 (a lower score is better) outperformed projects with a PDRI score above 200 in terms of cost, schedule, and change orders. The same can be said of projects with a PDRI score below 150 and those scoring above 150. For this relatively small sample, the differences in performance parameters are all statistically significant. (For more information on this data analysis, see Reference 9.)

Table 4.1. Comparison of Projects with PDRI–**Infrastructure** Projects Scores Above and Below 200

Performance	PDRI Score	
	< 200	> 200
Cost	5% below budget	25% above budget
Schedule	13% behind schedule	30% behind schedule
Change Orders	3% of budget	10% of budget
	(N=12)	(N=9)

Table 4.2. Comparison of Projects with PDRI–**Infrastructure** Projects Scores Above and Below 150

Performance	PDRI Score	
	< 150	> 150
Cost	6% below budget	24% over budget
Schedule	7% behind schedule	28% behind schedule
Change Orders	2% of budget	8% of budget
	(N=7)	(N=14)

The projects used in these samples were submitted from industry professionals from 15 different organizations, with project sizes ranging from approximately $400,000 to over $2 billion and with an average cost of approximately $282 million. The evaluations provided here are valid for the samples as given. These samples may or may not be indicative of projects in your organization and the samples may be biased because of the size and types of projects making up the sample. However, the results are convincing in terms of performance predictability.

The analysis revealed a significant difference in performance between the projects scoring above 200 and the projects scoring below 200 prior to detailed design and construction, for the PDRI–Infrastructure. An even larger difference was seen for those projects scoring below 150 and projects above 150.

Other PDRI Assessment Data

A large number of building and industrial projects were evaluated with the appropriate PDRIs in a prior CII investigation. For each of these projects, PDRI scores and project success criteria were computed. (Note: these projects were also scored after the fact.) An analysis of these data yielded a strong correlation between low (good) PDRI scores and high project success. For more information on the validation sample and methodology, see Reference 6. These results are consistent with those obtained from the PDRI–Infrastructure.

Table 4.3 compares project performance for a sample of 108 building projects worth $2.3 billion, using a 200-point PDRI score cut-off. These data show the mean performance for the projects as against the execution estimate for design and construction. The data also show the absolute value of changes as a percentage of total project cost. Projects with a PDRI score under 200 (a lower score is better) statistically outperformed projects with a PDRI score above 200 in terms of cost, schedule, and change orders. The PDRI score was determined just prior to the beginning of detailed design, and the differences in performance parameters are statistically significant.

Table 4.3. Comparison of Projects with PDRI–Building Projects Scores Above and Below 200

Performance	PDRI Score	
	< 200	> 200
Cost	3% above budget	9% above budget
Schedule	5% behind schedule	21% behind schedule
Change Orders	8% of budget (N=25)	11% of budget (N=83)

A similar evaluation was performed on a sample of 129 industrial projects representing approximately $6.7 billion. Table 4.4 summarizes the project performance and PDRI score using the same 200-point PDRI score cut-off. Again, projects with better scope definition (lower PDRI score) outperformed projects with poorly defined scope in terms of cost performance at the 95 percent confidence level.

Table 4.4. Comparison of Projects with PDRI–Industrial Projects Scores Above and Below 200

Performance	PDRI Score	
	< 200	> 200
Cost	4% below budget	4% over budget
Schedule	4% behind schedule	10% behind schedule
Change Orders	7% of budget (N=75)	8% of budget (N=54)

The projects used in these samples were voluntarily submitted. The Building PDRI sample included data from 24 organizations, including office, control building, recreation, institutional, and research facilities. Project sizes ranged from approximately $630,000 to $251 million, with an average cost of approximately $22 million. The Industrial PDRI sample included data from 53 organizations and represented heavy and light industrial projects, including chemical, pharmaceutical, power, pulp and paper, refining, and metals facilities. Project size ranged from $120,000 to $635 million, with an average size of approximately $53 million.

5

Concluding Remarks

The PDRI can benefit owners, developers, designers, and contractors. Facility owners, developers, and lending institutions can use it as an assessment tool for establishing a comfort level at which they are willing to move forward on projects. Designers and constructors can use it as a means of negotiating with owners when identifying poorly defined project scope definition elements. The PDRI provides a forum for all project participants to communicate and reconcile differences; because it is an objective tool, it provides a common basis for project scope evaluation. It also provides excellent input into the detailed design process and a solid baseline for design management.

The PDRI for Infrastructure can benefit the public as well. Since infrastructure typically spans the public domain, the transparent communication of project objectives and expectations to the public can enhance and facilitate planning. Moreover, the PDRI can help the project team anticipate the public's main concerns and begin to address them pro-actively. Soliciting and acting upon public input is an essential element of the PDRI for Infrastructure.

Anyone who wishes to improve the overall performance of their infrastructure projects should use the PDRI.

How to Improve Performance on Future Projects

The following suggestions are offered to individuals or organizations who adopt the PDRI with the desire to improve performance on their infrastructure projects:

- **Commit to early project planning.** Effective planning in the early stages of infrastructure projects can greatly enhance cost, schedule, and operational performance while minimizing the possibility of financial failures and disasters.
- **Gain and maintain project team alignment** by using the PDRI throughout front end planning. Discussions around the scope definition checklists are particularly effective in helping with team alignment.

- **Use the CII Front End Planning Toolkit.** This interactive Toolkit has been developed to guide the project team through the front end planning process, including where and how to employ the PDRI. Encourage its use across the organization.
- **Be especially cognizant of specific scope elements on renovation and revamp projects.** Use the specific R&R issues identified in the element descriptions. Also, use CII Implementation Resource 242-2, *Front End Planning of Renovation and Revamp Projects*, if your project is an R&R project. This resource is especially helpful if the project includes a shutdown/turnaround/outage scenario.
- **Adjust the PDRI as necessary to meet the specific needs of your project.** The PDRI was designed so that certain elements considered inapplicable to a particular project can be "zeroed out," thus eliminating them from the final scoring calculation.
- **Use the PDRI to improve project performance.** Build your own internal database of PDRI–scored projects. Compute PDRI scores at various times during scope development and correlate them to project success. Based upon the relationship between the PDRI scores and project success, establish your own basis for the level of scope definition that you feel is acceptable for moving from phase to phase.
- **Use caution when beginning detailed design of projects with PDRI scores greater than 200.** CII data have shown that a direct correlation exists between high PDRI scores and poor project performance.
- **PDRI scores are only a portion of the output.** While PDRI scores, in aggregate, demonstrate the level of project planning development, the more valuable output from the process is the insight that can be gleaned from the remarks, lessons learned, and coordinating tasks identified during the assessment session. Executive leadership can better assess where and how to commit limited planning resources to enhance project execution.

CII research has shown that the PDRI can effectively be used to improve the predictability of project performance. However, the PDRI alone will not ensure successful projects. When combined with sound business planning, alignment, and good project execution, it can greatly improve the probability of meeting or exceeding project objectives.

Appendix A:
Unweighted Project Score Sheet

An Excel™ version of this matrix is on the compact disc that accompanies this book.

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. PROJECT STRATEGY							
A1. Need & Purpose Documentation							
A2. Investment Studies & Alternatives Assessments							
A3. Key Team Member Coordination							
A4. Public Involvement							
CATEGORY A TOTAL							
B. OWNER/OPERATOR PHILOSOPHIES							
B1. Design Philosophy							
B2. Operating Philosophy							
B3. Maintenance Philosophy							
B4. Future Expansion & Alteration Considerations							
CATEGORY B TOTAL							
C. PROJECT FUNDING AND TIMING							
C1. Funding & Programming							
C2. Preliminary Project Schedule							
C3. Contingencies							
CATEGORY C TOTAL							
D. PROJECT REQUIREMENTS							
D1. Project Objectives Statement							
D2. Functional Classification & Use							
D3. Evaluation of Compliance Requirements							
D4. Existing Environmental Conditions							
D5. Site Characteristics Available vs. Required							
D6. Dismantling & Demolition Requirements							
D7. Determination of Utility Impacts							
D8. Lead/Discipline Scope of Work							
CATEGORY D TOTAL							
E. VALUE ANALYSIS							
E1. Value Engineering Procedures							
E2. Design Simplification							
E3. Material Alternatives Considered							
E4. Constructability Procedures							
CATEGORY E TOTAL							

Definition Levels

0 = Not Applicable   **2 = Minor Deficiencies**   **4 = Major Deficiencies**

1 = Complete Definition   **3 = Some Deficiencies**   **5 = Incomplete or Poor Definition**

SECTION II – BASIS OF DESIGN							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
F. SITE INFORMATION							
F1. Geotechnical Characteristics							
F2. Hydrological Characteristics							
F3. Surveys & Mapping							
F4. Permitting Requirements							
F5. Environmental Documentation							
F6. Environmental Commitments & Mitigation							
F7. Property Descriptions							
F8. Right-of-Way Mapping & Site Issues							
CATEGORY F TOTAL							
G. LOCATION and GEOMETRY							
G1. Schematic Layouts							
G2. Horizontal & Vertical Alignment							
G3. Cross-Sectional Elements							
G4. Control of Access							
CATEGORY G TOTAL							
H. ASSOCIATED STRUCTURES and EQUIPMENT							
H1. Support Structures							
H2. Hydraulic Structures							
H3. Miscellaneous Elements							
H4. Equipment List							
H5. Equipment Utility Requirements							
CATEGORY H TOTAL							
I. PROJECT DESIGN PARAMETERS							
I1. Capacity							
I2. Safety & Hazards							
I3. Civil/Structural							
I4. Mechanical/Equipment							
I5. Electrical/Controls							
I6. Operations/Maintenance							
CATEGORY I TOTAL							

Definition Levels
0 = Not Applicable
1 = Complete Definition
2 = Minor Deficiencies
3 = Some Deficiencies
4 = Major Deficiencies
5 = Incomplete or Poor Definition

SECTION III – EXECUTION APPROACH							
CATEGORY Element	**Definition Level**						**Score**
	0	**1**	**2**	**3**	**4**	**5**	
J. LAND ACQUISITION STRATEGY							
J1. Local Public Agencies Contr. & Agreements							
J2. Long-Lead Parcel & Utility Adjustment Identification & Acquisition							
J3. Utility Agreement & Joint-Use Contracts							
J4. Land Appraisal Requirements							
J5. Advance Land Acquisition Requirements							
CATEGORY J TOTAL							
K. PROCUREMENT STRATEGY							
K1. Project Delivery Method & Contr. Strategies							
K2. Long-Lead/Critical Equip. & Mat'ls Identif.							
K3. Procurement Procedures & Plans							
K4. Procurement Responsibility Matrix							
CATEGORY K TOTAL							
L. PROJECT CONTROL							
L1. Right-of-Way & Utilities Cost Estimates							
L2. Design & Construction Cost Estimates							
L3. Project Cost Control							
L4. Project Schedule Control							
L5. Project Quality Assurance & Control							
CATEGORY L TOTAL							
M. PROJECT EXECUTION PLAN							
M1. Safety Procedures							
M2. Owner Approval Requirements							
M3. Documentation/Deliverables							
M4. Computing & CADD/Model Requirements							
M5. Design/Construction Plan & Approach							
M6. Intercompany and Interagency Coordination & Agreements							
M7. Work Zone and Transportation Plan							
M8. Project Completion Requirements							
CATEGORY M TOTAL							

Definition Levels

0 = Not Applicable   **2 = Minor Deficiencies**   **4 = Major Deficiencies**
1 = Complete Definition   **3 = Some Deficiencies**   **5 = Incomplete or Poor Definition**

Appendix B:
Weighted Project Score Sheet

An Excel™ version of this matrix is on the compact disc that accompanies this book.

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY	**Definition Level**						
Element	**0**	**1**	**2**	**3**	**4**	**5**	**Score**
A. PROJECT STRATEGY (Maximum Score = 112)							
A1. Need & Purpose Documentation	0	2	13	24	35	44	
A2. Investment Studies & Alternatives Assessments	0	1	8	15	22	28	
A3. Key Team Member Coordination	0	1	6	11	16	19	
A4. Public Involvement	0	1	6	11	16	21	
CATEGORY A TOTAL							
B. OWNER/OPERATOR PHILOSOPHIES (Maximum Score = 67)							
B1. Design Philosophy	0	2	7	12	17	22	
B2. Operating Philosophy	0	1	5	9	13	16	
B3. Maintenance Philosophy	0	1	4	7	10	12	
B4. Future Expansion & Alteration Considerations	0	1	9	9	13	17	
CATEGORY B TOTAL							
C. PROJECT FUNDING AND TIMING (Maximum Score = 70)							
C1. Funding & Programming	0	1	6	11	16	21	
C2. Preliminary Project Schedule	0	2	7	12	17	22	
C3. Contingencies	0	2	8	14	20	27	
CATEGORY C TOTAL							
D. PROJECT REQUIREMENTS (Maximum Score = 143)							
D1. Project Objectives Statement	0	1	6	11	16	19	
D2. Functional Classification & Use	0	1	6	11	16	19	
D3. Evaluation of Compliance Requirements	0	1	6	11	16	22	
D4. Existing Environmental Conditions	0	1	6	11	16	22	
D5. Site Characteristics Available vs. Required	0	1	5	9	13	18	
D6. Dismantling & Demolition Requirements	0	1	4	7	10	11	
D7. Determination of Utility Impacts	0	1	6	11	16	19	
D8. Lead/Discipline Scope of Work	0	1	4	7	10	13	
CATEGORY D TOTAL							
E. VALUE ANALYSIS (Maximum Score = 45)							
E1. Value Engineering Procedures	0	1	3	5	7	10	
E2. Design Simplification	0	0	3	6	9	11	
E3. Material Alternatives Considered	0	1	3	5	7	9	
E4. Constructability Procedures	0	1	5	9	13	15	
CATEGORY E TOTAL							
Section I Maximum Score = 437 — SECTION I TOTAL							

Definition Levels

0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

SECTION II – BASIS OF DESIGN							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
F. SITE INFORMATION (Maximum Score = 119)							
F1. Geotechnical Characteristics	0	2	7	12	17	21	
F2. Hydrological Characteristics	0	1	4	7	10	13	
F3. Surveys & Mapping	0	1	4	7	10	14	
F4. Permitting Requirements	0	1	5	9	13	15	
F5. Environmental Documentation	0	1	5	9	13	18	
F6. Environmental Commitments & Mitigation	0	1	4	7	10	14	
F7. Property Descriptions	0	1	3	5	7	10	
F8. Right-of-Way Mapping & Site Issues	0	1	4	7	10	14	
CATEGORY F TOTAL							
G. LOCATION and GEOMETRY (Maximum Score = 47)							
G1. Schematic Layouts	0	1	4	7	10	13	
G2. Horizontal & Vertical Alignment	0	1	4	7	10	13	
G3. Cross-Sectional Elements	0	1	4	7	10	11	
G4. Control of Access	0	1	3	5	7	10	
CATEGORY G TOTAL							
H. ASSOCIATED STRUCTURES and EQUIPMENT (Maximum Score = 47)							
H1. Support Structures	0	1	4	7	10	11	
H2. Hydraulic Structures	0	1	3	5	7	9	
H3. Miscellaneous Elements	0	1	3	5	7	7	
H4. Equipment List	0	1	4	7	10	11	
H5. Equipment Utility Requirements	0	1	3	5	7	9	
CATEGORY H TOTAL							
I. PROJECT DESIGN PARAMETERS (Maximum Score = 80)							
I1. Capacity	0	1	6	11	16	22	
I2. Safety & Hazards	0	1	4	7	10	12	
I3. Civil/Structural	0	1	5	9	13	15	
I4. Mechanical/Equipment	0	1	3	5	7	10	
I5. Electrical/Controls	0	1	3	5	7	10	
I6. Operations/Maintenance	0	1	4	7	10	11	
CATEGORY I TOTAL							
Section II Maximum Score = 293 SECTION II TOTAL							

Definition Levels

0 = Not Applicable	**2 = Minor Deficiencies**	**4 = Major Deficiencies**
1 = Complete Definition	**3 = Some Deficiencies**	**5 = Incomplete or Poor Definition**

SECTION III – EXECUTION APPROACH							
CATEGORY	**Definition Level**						
Element	**0**	**1**	**2**	**3**	**4**	**5**	**Score**
J. LAND ACQUISITION STRATEGY (Maximum Score = 60)							
J1. Local Public Agencies Contr. & Agreements	0	1	4	7	10	14	
J2. Long-Lead Parcel & Utility Adjustment Identification & Acquisition	0	1	5	9	13	15	
J3. Utility Agreement & Joint-Use Contracts	0	1	4	7	10	12	
J4. Land Appraisal Requirements	0	1	3	5	7	10	
J5. Advance Land Acquisition Requirements	0	1	3	5	7	9	
CATEGORY J TOTAL							
K. PROCUREMENT STRATEGY (Maximum Score = 47)							
K1. Project Delivery Method & Contr. Strategies	0	1	5	9	13	15	
K2. Long-Lead/Critical Equip. & Mat'ls Identif.	0	1	4	7	10	13	
K3. Procurement Procedures & Plans	0	1	4	7	10	11	
K4. Procurement Responsibility Matrix	0	0	2	4	6	8	
CATEGORY K TOTAL							
L. PROJECT CONTROL (Maximum Score = 80)							
L1. Right-of-Way & Utilities Cost Estimates	0	1	3	5	7	10	
L2. Design & Construction Cost Estimates	0	2	8	14	20	25	
L3. Project Cost Control	0	1	5	9	13	15	
L4. Project Schedule Control	0	1	5	9	13	17	
L5. Project Quality Assurance & Control	0	1	4	7	10	13	
CATEGORY L TOTAL							
M. PROJECT EXECUTION PLAN (Maximum Score = 83)							
M1. Safety Procedures	0	1	4	7	10	12	
M2. Owner Approval Requirements	0	1	3	5	7	10	
M3. Documentation/Deliverables	0	1	3	5	7	9	
M4. Computing & CADD/Model Requirements	0	1	3	5	7	7	
M5. Design/Construction Plan & Approach	0	1	4	7	10	14	
M6. Intercompany and Interagency Coordination & Agreements	0	1	4	7	10	13	
M7. Work Zone and Transportation Plan	0	1	3	5	7	9	
M8. Project Completion Requirements	0	1	3	5	7	9	
CATEGORY M TOTAL							
Section III Maximum Score = 270 SECTION III TOTAL							

PDRI TOTAL SCORE

Maximum Score = 1000

Definition Levels

0 = Not Applicable
1 = Complete Definition
2 = Minor Deficiencies
3 = Some Deficiencies
4 = Major Deficiencies
5 = Incomplete or Poor Definition

Appendix C:
Element Descriptions

The following descriptions have been developed to help generate a clear understanding of the terms used in the Unweighted Project Score Sheet. Some descriptions include checklists of sub-elements. These sub-elements clarify concepts and facilitate ideas to make the assessment of each element easier. These checklists are not all-inclusive and the user may supplement these lists when necessary.

The descriptions follow the order in which they are presented in the Unweighted or Weighted Project Score Sheet; they are organized in a hierarchy by section, category, and element. The score sheet consists of three main sections, each of which is a series of categories broken down into elements. Some of the elements have issues listed that are specific to projects that are renovations and revamps. These issues are identified as "Additional items to consider for Renovation & Revamp projects." Use these issues for discussion if applicable. Scoring is performed by the evaluation of each element's definition level.

It should be noted that this tool and these descriptions have been developed to address a variety of types of infrastructure projects that are "horizontal" in nature and connect nodes in different types of infrastructure systems. Three basic varieties of projects are addressed in this tool: 1) projects that convey people and freight, such as highways and railroads; 2) projects that convey fluids, such as pipelines and open channels; and 3) projects that convey energy, such as transmission lines or microwave corridors. For example, a pipeline project may connect a tank farm to a port facility, or transmission lines may connect a power plant to a substation and then to a home or business. Throughout the descriptions, the user will see sub-elements that relate to the variety of projects the tool is meant to encompass. These sub-elements are provided in the order in which they are discussed above. If the sub-element is not applicable to the project that the user is assessing, then it should be ignored. (Note: the PDRI–Building Projects and the PDRI–Industrial Projects should be used singly or combined for the vertical (node) aspects of the infrastructure project, as deemed appropriate.) Detailed user information is provided in Chapter 1 of this document. Particular focus should be maintained to ensure that no gaps develop at the interfaces of the vertical and horizontal elements during the project management team's FEP process. The sections, categories, and elements are organized as discussed below.

SECTION I: BASIS OF PROJECT DECISION

This section consists of information necessary for understanding the project objectives. The completeness of this section determines the degree to which the project team will be able to achieve alignment in meeting the project's business objectives.

Categories:

A – Project Strategy
B – Owner/Operator Philosophies
C – Project Funding and Timing
D – Project Requirements
E – Value Analysis

SECTION II: BASIS OF DESIGN

This section consists of geotechnical, hydrological, environmental, structural, and other technical design elements that should be evaluated for full understanding of their impacts on the project and its risk.

Categories:

F – Site Information
G – Location and Geometry
H – Associated Structures and Equipment
I – Project Design Parameters

SECTION III: EXECUTION APPROACH

This section consists of elements that should be evaluated for fully understanding the requirements of the owner's execution strategy and approaches to detailed design, right-of-way acquisition, utility adjustments, and construction.

Categories:

J – Land Acquisition Strategy
K – Procurement Strategy
L – Project Control
M – Project Execution Plan

The following pages contain detailed descriptions for all of the elements in the PDRI.

SECTION I: BASIS OF PROJECT DECISION

A. PROJECT STRATEGY

A1. Need & Purpose Documentation

The need for a project may be identified in many ways, including through eliciting suggestions from operations and maintenance personnel, engineers, planners, local elected officials, developers, and the public. The importance of projects may also be determined by current market needs or future growth. This process typically includes site visits and input from individuals and/or agencies with relevant knowledge. Documentation should assess the need and purpose of a potential project and should be based on factual evidence of current and future conditions, including why the project is being pursued. It will eventually serve as the basis for identifying, comparing, and selecting alternatives. These considerations may include the following:

- ❑ High-level project scope and definition
- ❑ Capacity improvement needs:
  - ❑ Existing levels of service
  - ❑ Modeling of future demands
  - ❑ Trend analysis and forecasted growth
- ❑ Profitability or benefit analysis
- ❑ Facility multi-modal or other multi-use capabilities, including interface options
- ❑ Current and future economic development needs
- ❑ Community concerns and critical issues, such as impact on cultural resources, adjacent facilities, land use, traffic, visual and so on
- ❑ Environmental and/or sustainability drivers
- ❑ Mitigation and remediation issues
- ❑ Constraints such as geographic, institutional, political, or technical
- ❑ Conformance with current geometric, general owner, or other jurisdictional standards
- ❑ Existing infrastructure conditions
- ❑ Safety improvements needs and expectations (including event frequency, severity, and hazards mitigation, as well as compliance requirements)
- ❑ Vulnerability assessment
- ❑ Input into any required planning documents such as a “Need & Purpose Statement” or other
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Renovation & revamp project’s compatibility with existing facilities

A2. Investment Studies & Alternatives Assessments

Various studies address possible alternatives when the solution is unknown. In some cases, these studies may show that the project is not economically justifiable, or that it has so many environmental or social impacts that it is not viable. Early determination of these findings will prevent unnecessary expenditures on preliminary engineering and related costs and will also confirm the viability of proceeding with the selected option. These studies may take the form of feasibility/route studies or major investment studies. This economic model, sometimes known as the regulatory regime, sets the economic rules guiding decision making on the project. Issues to consider include the following:

- ❑ Profitability or value/benefit
- ❑ Identification of "show stoppers"
- ❑ Alternatives requirement determinations such as routes, acquisition strategy or technology
- ❑ Stakeholder identification and management
- ❑ Consultant reviews and selection
- ❑ Corridor selection and major alternatives
- ❑ Location of nodes such as interchanges, stations, control points and depots
  - ❑ Preliminary surveys:
  - ❑ Population densities
  - ❑ Trends in land use and development
  - ❑ Existing infrastructure
  - ❑ Environmental conditions
  - ❑ Existing demand
  - ❑ Directional distribution and volumes
  - ❑ Economic, safety, security and social conditions
  - ❑ Use of geographic information systems (GIS), satellite imaging, and light detection and ranging (LIDAR) technologies
- ❑ Existing data at governmental levels (e.g., local, regional, national)
- ❑ Alternative profile layouts and preliminary mapping
- ❑ Project corridor preservation
- ❑ Investment and financing requirements, including public or private funds and tax implications
- ❑ Availability of insurance/bonding
- ❑ Cost estimate of sufficient quality to support the selected option
- ❑ Preliminary project schedule of sufficient depth for alternative duration comparison
- ❑ Coordination with other relevant planning efforts, short, medium, and long term
- ❑ Other user defined

A.3 Key Team Member Coordination

Establishing a positive alliance among all key project team members facilitates the potential for an efficient, successful outcome—particularly if this alliance is achieved early during the planning process. The project manager is typically a central figure in this coordination. Definition of the roles and responsibilities of each key team member should be documented. Infrastructure projects typically involve many different stakeholders, in both the public and private sectors. All key team members must be competent in their roles in the project at hand, informed of project decisions, and given the opportunity to attend project planning meetings. Establishing such a strong team will minimize negative impacts on subsequent activities. Key team members may include the following experts:

- ❑ Planners and programmers
- ❑ Project managers
- ❑ Design engineers
- ❑ Project controls personnel
- ❑ Right-of-way planners
- ❑ Environmental planners
- ❑ Construction engineers
- ❑ Operations and maintenance personnel
- ❑ Procurement personnel
- ❑ Marketing/business personnel
- ❑ Public relations personnel
- ❑ Consultants
- ❑ Local, regional, and national governmental authorities, agencies, and officials
- ❑ Budgeting officers
- ❑ Safety personnel
- ❑ Other user defined

Specialized input into any expected meetings—such as a "Feasibility Scoping Meeting," "Project Concept Conference," "Utility Coordination Meetings," or other meetings—should be considered when key team members are chosen.

A.4 Public Involvement

Public involvement is an integral part of project development and should be planned and managed. Most infrastructure projects have to afford some level of public involvement to inform the public of project scope issues and to measure public attitudes regarding the development process. The level of public involvement and transparency of operations is dependent upon a number of social, economic, and environmental factors, along with the type and complexity of the project. In general, public involvement, input, and interaction are important components of successful infrastructure planning. Community involvement efforts may include meetings with key stakeholders, including contact with affected governmental and non-governmental organizations (NGOs), first nation members or native inhabitants, property owners, business interests, and citizens at public meeting and public hearings. Issues to consider include the following:

- ❑ Policy determinations regarding public involvement
- ❑ Notification procedures and responsibilities
- ❑ Identification of key stakeholders
- ❑ Identification of utility providers
- ❑ Types of public involvement:
  - ❑ Press releases and notices
  - ❑ Public meetings/hearings
  - ❑ Individual or group meetings with affected property owners
- ❑ Local support and/or opposition
- ❑ Public involvement strategies after project approval
- ❑ Available website content
- ❑ Input of public involvement information into any typical deliverables such as “Environmental Impact Statements,” “Public Hearing Notices,” or other forms of public documentation or communication
- ❑ Other user defined

B. OWNER/OPERATOR PHILOSOPHIES

B1. Design Philosophy

A list of general design principles should be developed to achieve a successful project that fulfills the functional requirements and assimilates into the existing infrastructure system. Issues to consider include the following:

- ❑ Design life
- ❑ Configuration strategy
- ❑ Reliability
- ❑ Failure modes
- ❑ Design risk analysis
- ❑ Life cycle cost studies
- ❑ Safety improvement requirements, (safety, health, and environmental (SH&E), including event frequency, severity, and hazards mitigation, as well as compliance with applicable jurisdictional requirements)
- ❑ Security/anti-terrorism enhancements based on project vulnerabilities
- ❑ Sustainability guidelines
- ❑ Use of existing or new technology
- ❑ Automation philosophy
- ❑ Compatibility with other uses or adjacent projects and facilities
- ❑ Aesthetics or image requirements
- ❑ Compatibility with long-range goals and other infrastructure improvement programs
- ❑ Environmental sustainability
- ❑ Access management
- ❑ Geometric/alignment
- ❑ System validation
- ❑ Commissioning
- ❑ Decommissioning strategies
- ❑ Other user defined

B2. Operating Philosophy

A list of general design principles should be developed to preserve the level of service desired at a sufficient capacity over an extended period of time. This list focuses particularly on developing strategic operations plans to prevent problems related to sub-optimal capacity. Issues to consider include the following:

- ❑ Daily level of service requirements
- ❑ Capacity change requirements
- ❑ Operating schedules or timetables
- ❑ Technological needs assessment
- ❑ Future improvement schedule
- ❑ Flexibility to change layout
- ❑ Owner/operator of the facility through its life
- ❑ Third party operations personnel
- ❑ Safety strategy for hazards mitigation
- ❑ Training requirements
- ❑ Control requirements
- ❑ Personnel and equipment requirements
- ❑ Alternative operating procedures, (i.e., consideration of manual versus automated modes)
- ❑ Utilities location in relation to facility
- ❑ Operational security
- ❑ Other user defined

B3. Maintenance Philosophy

A list of general design principles should be developed to lay out guidelines to maintain adequate and safe operations over an extended period of time. Furthermore, a specific operations control and maintenance plan should be in place, including interface and maintenance procedures. Issues to consider include the following:

- ❑ Monitoring requirements
- ❑ Equipment access needs and provisions
- ❑ Government regulated maintenance
- ❑ Safety strategy
- ❑ Documentation and training requirements
- ❑ Personnel and equipment requirements
- ❑ Third-party maintenance personnel
- ❑ Environmental conservation programs
- ❑ Selection of materials for design and construction to minimize maintenance activities
- ❑ Warrantees
- ❑ Output quality or serviceability level
- ❑ Maintenance and repair cycles, both preventative and planned
- ❑ Reliability:
  - ❑ Spare equipment
  - ❑ Commonality of parts
  - ❑ System redundancy
  - ❑ Intermediate storage to permit independent shutdown
  - ❑ Mechanical/structural integrity
  - ❑ Scheduled shut-down frequencies and durations
  - ❑ Response for unplanned shutdowns and outages
- ❑ Efficiency of process
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Potential impacts to existing operations
- ❑ Maintenance impact of renovation projects
- ❑ Common/spare parts (i.e., consideration of repair versus replacement of existing components)
- ❑ Interruptions to existing and adjacent facilities during R&R work
- ❑ Compatibility of maintenance philosophy for new systems and equipment with existing use and maintenance philosophy
- ❑ Coordination of the project with any maintenance projects

B4. Future Expansion & Alteration Considerations

The possibility of expansion and/or alteration of this infrastructure facility and site should be evaluated. These considerations consist of a list of items that will facilitate the potential expansion or evolution of facility use. Issues to consider may include the following:

- ❑ Regional/local infrastructure/capacity plans
- ❑ Interface with other future infrastructure projects
- ❑ Expected population densities along corridor and/or capacity needs
- ❑ Future changes in demand
- ❑ Availability for added capacity and/or widening
  - ❑ Vertical added capacity
  - ❑ Horizontal added capacity
- ❑ Availability for project enhancement and/or expansion (e.g., interchanges, pumping stations, turbines, clarifiers, access ramps, frontages, pumping stations, taxi-ways, rail sidings, switchgear, transformers, additional land, etc.)
- ❑ Pending and future facility and product quality constraints and regulations
- ❑ Corridor preservation (i.e., sloped to grade, with potential for retaining walls in the future)
- ❑ Other user defined

C. PROJECT FUNDING AND TIMING

C1. Funding & Programming

Authorization of projects within national, regional, and local regulatory agencies is a typical requirement prior to executing funding agreements. As part of the authorization process, initial cost estimates must be prepared. These estimates must assess funding provided for planning, design, construction, right-of-way acquisition, utility adjustment, maintenance, and other project expenses. Funding can be provided by the project owner or from a third party. For public projects, this is normally the government but can include elements of private financing. Third parties for private projects can be financial institutions or other private investors. As such, strategic measures must be in place for determining the sources, levels, and forms of funding available to the project as it competes against others for limited funds, whether public or private. Issues to consider include the following:

- ❑ Sources and forms of funding
  - ❑ Internal funding, equity, or debt
  - ❑ Public private partnerships (PPP)
  - ❑ Private entities
  - ❑ Local government entities
  - ❑ Federal and regional agencies
  - ❑ Donations
  - ❑ Funding for economically disadvantaged communities
  - ❑ Congruity with local infrastructure projects and programs
  - ❑ Other funding sources
- ❑ Comparison of funding options
- ❑ The impact of available project funds on project phasing and sequencing, as well as risk profile of project participants
- ❑ Cash flow spend plan for project
- ❑ Congruity with local infrastructure programs
- ❑ Breakdown of funding participation
- ❑ Franchise or operating periods before transfer
- ❑ Tax credits or liability of funding options
- ❑ Cost drivers, such as environmental/mitigation costs, major work elements, limiting work conditions, or major equipment procurement
- ❑ Estimates
  - ❑ Initial construction cost estimates
  - ❑ Initial right-of-way cost estimates
  - ❑ Initial operating and maintenance cost estimates
- ❑ Input into any required planning documents such as a “Programming Assessment Study,” “Advance Funding Agreement,” or other early project documentation
- ❑ Other user defined

C2. Preliminary Project Schedule

A preliminary project schedule should be developed, analyzed, and agreed upon by the major project participants factoring in major risk components. The following major risk components should be included in this preliminary schedule:

- milestones
- unusual schedule considerations
- appropriate master schedule contingency time (float)
- the procurement plan (long-lead or critical pacing of equipment/material and contracting)
- required submissions and approvals.

The project schedule is created to determine a timetable for the program and to assess its constructability. It should be maintained and updated throughout the course of front end planning with additional detail added as knowledge is gained, including work breakdown structure (WBS). It should be periodically updated and modified to show progress and ensure that tasks are completed on time. Third-party activities that are required to carry out the project need to be included in the project schedule, and the appropriate relationships should be considered in order to determine the critical path. The project schedule becomes the basis for detailed scheduling of design and construction activities. (Note that project schedule control is addressed in Element L4.) This schedule should involve obtaining early input from and assigning responsibility to the following project personnel:

- ❑ Owner/Operations
- ❑ Program/Project Management
- ❑ Design/Engineering
- ❑ Construction
- ❑ Procurement
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ The schedule should contain input from traffic or flow control management personnel to coordinate disruptions

R&R projects require a high level of planning to minimize risk because they interface with existing operations and are many times performed in conjunction with other on-going projects. Shutdowns/turnarounds/outages are special cases in that they are particularly constrained in terms of time and space, requiring very detailed plans and schedules.

C3. Contingencies

Project risks must be identified and understood so that proper contingencies can be allocated and maintained in order to mitigate unforeseen issues. The contingency management process should effectively communicate the contingency magnitude and confidence level to all appropriate stakeholders. Estimates are used to plan and budget the project from the earliest stages of planning and are essential in managing project contingency. It is important to have estimates of the proper accuracy, consistency, and clarity at the right phase of the planning process. Contingencies are forecasted and adjusted throughout the planning process, based on level of confidence in the current estimate accuracy. It is also important to assign ownership of the different contingency allocations (such as management reserve, project contingency, and contractor contingency) for the project, as well as authority to release these funds. (Note that final cost estimates for the planning phase are covered in Elements L1 and L2. Project cost control is addressed in Element L3.) Issues to consider include the following:

Estimates evolve in terms of accuracy and may be based on

- ❑ Order-of-magnitude cost model
- ❑ Benchmarks
- ❑ Parametric cost estimates (e.g., $/unit)
- ❑ Unit Price estimate
- ❑ Detailed element cost estimate

Contingency set aside may include funds and/or schedule for uncertainty in

- ❑ Weather
- ❑ Scope changes
- ❑ Unforeseen site conditions
- ❑ Extended overhead for potential project delays
- ❑ Critical path impact
- ❑ Market conditions

- ❑ Commodity pricing
- ❑ Currency exchange rates
- ❑ Escalation pricing
- ❑ Contracting strategy
- ❑ Labor availability
- ❑ Labor competency
- ❑ Project location
- ❑ Political stability
- ❑ Definition of project
- ❑ Other user defined

D. PROJECT REQUIREMENTS

D1. Project Objectives Statement

This statement defines the project objectives and priorities for meeting the business strategy, including project need and purpose. It should be clear, concise, measurable, and specific to the project. It is desirable to obtain consensus from the entire project team regarding these objectives and priorities to ensure alignment. Specifically, the priorities among cost, schedule, and value-added quality features should be clear. To ensure the project is aligned to the applicable objectives, the following should be considered:

- ❑ Stakeholder's understanding of objectives, including questions or concerns
- ❑ Constraints or limitations placed on the project
- ❑ Typical objectives with associated performance metrics:
  - ❑ Safety
  - ❑ Quality
  - ❑ Cost
  - ❑ Schedule including milestones
  - ❑ Technology usage
  - ❑ Capacity or size
  - ❑ Start-up or commissioning
  - ❑ Communication
  - ❑ Operational performance
  - ❑ Maintainability
  - ❑ Security
  - ❑ Sustainability, including possible certification (for example, by the U.S. Green Building Council)
  - ❑ Other user defined

D2. Functional Classification & Use

An essential step in the design process is the determination of the functions that the project is to serve, including how the product or service will be conveyed throughout the infrastructure system. Important in this classification is whether the project is for private or public use. Examples of functional types include the following:

- ❑ Capacities or volumes
- ❑ Intrastate or interstate
- ❑ Domestic or international
- ❑ Urban/suburban/rural
- ❑ Underground or above ground
- ❑ On-shore or off-shore
- ❑ Modes of conveyance:
  - ❑ Automobiles and trucks
  - ❑ Aircraft
  - ❑ Trains
  - ❑ Barges
  - ❑ Ships
  - ❑ Conveyors (e.g., gravity, power, and belt)
  - ❑ Pressure or gravity
  - ❑ Conduction
  - ❑ Electromagnetic
- ❑ Types of product(s) to be conveyed
  - ❑ Freight
  - ❑ Pedestrians
  - ❑ Fluids
  - ❑ Gases
  - ❑ Solids
  - ❑ Power
  - ❑ Information or data
- ❑ Types of conveyance
  - ❑ Rail
  - ❑ Road
  - ❑ Runway
  - ❑ Conveyer belts
  - ❑ Pedestrian movers (e.g., escalators and moving walkways)
  - ❑ Pipe, gravity or pressure
  - ❑ Open channel
  - ❑ Harbor or reservoir
  - ❑ Lines or cable
  - ❑ Energy (e.g., microwave, infrared, and sound)
- ❑ Other user defined

D3. Evaluation of Compliance Requirements

A fundamental part of decision making is the understanding of adherence requirements to various local, regional, and national plans. As a basic part of project development, project planners must determine, document, and understand the applicable requirements. (Note that compliance requirements for permitting and environmental issues are addressed in more detail in Category F.) Issues to consider for compliance include the following:

- ❑ Compliance with existing plans, codes, and standards, including
  - ❑ Coastal zone management
  - ❑ Security and anti-terrorism
  - ❑ Wetlands encroachment
  - ❑ Intracoastal waterways
  - ❑ Metropolitan planning
  - ❑ Regional transportation plans
  - ❑ Statewide transportation improvement program (STIP)
  - ❑ Federal directives
- ❑ National, regional, or local requirements defined and understood, including input from
  - ❑ Regional highway departments
  - ❑ Municipal departments
  - ❑ Public utilities commission
  - ❑ Public housing authorities
  - ❑ Railroad companies
  - ❑ Ports and harbors
  - ❑ Transit authorities
  - ❑ Governmental councils or regulatory commissions (e.g., the U.S. Federal Energy Regulatory Commission (FERC))
  - ❑ General counsel
- ❑ Utilization of Design Standards
  - ❑ Owner's
  - ❑ Contractor's
  - ❑ Mixed

- ❑ Construction and operations residuals management (e.g., handling of excess excavated soils and sludge handling)

Additional items to consider for Renovation & Revamp projects

- ❑ Clear definition of controlling specifications, especially where new codes and regulations will override older requirements
- ❑ Assurance that specifications support replacement of any obsolete systems or equipment
- ❑ Other user defined

D4. Existing Environmental Conditions

Decision making requires an understanding of existing environmental conditions, which must be ascertained from a variety of sources, including previous surveys, geographic information systems, and resource agency databases. Identifying problematic issues at an early stage in the project development process enables better decision making and gives project personnel adequate time to address and mitigate these concerns. (Note that many of these issues are addressed in more detail in Category F.) Issues to consider include the following:

- ❑ Natural resource surveys
  - ❑ Endangered species
  - ❑ Wetland status
  - ❑ Bodies of water
  - ❑ Existing and potential park system land
  - ❑ Permit requirements
- ❑ Cultural resource surveys
  - ❑ Historical preservation
  - ❑ Existence of cemeteries
  - ❑ Archaeological sites
  - ❑ Local customs
- ❑ Air quality surveys
  - ❑ Mobile source pollutants
  - ❑ Air quality analysis
  - ❑ Congestion mitigation-air quality
- ❑ Noise surveys including evaluation of need for abatement

- ❑ Hazardous materials
  - ❑ Existing land use (e.g., the existence of an underground storage tank)
  - ❑ Superfund and regulatory agency database review
- ❑ Contaminated material not classified as hazardous
- ❑ Climatic data
- ❑ Site visits
- ❑ Local inhabitant interviews
- ❑ Socioeconomic impacts
- ❑ Other user defined

D5. Site Characteristics Available versus Required

An assessment of the discrepancy between the available site characteristics and the required site characteristics is needed. The intent is to ensure that the project team has taken into consideration the need to improve or upgrade existing site utilities and support characteristics. Issues to consider should include the following:

- ❑ Capacity
  - ❑ Utilities
  - ❑ Fire water
  - ❑ Cooling water
  - ❑ Power
- ❑ Waste treatment/disposal
- ❑ Storm water containment and/or transport system
- ❑ Type of buildings/structures
- ❑ Land area
- ❑ Amenities
  - ❑ Food service
  - ❑ Change rooms
  - ❑ Medical facilities
  - ❑ Recreation facilities
  - ❑ Ambulatory access
- ❑ Product shipping facilities
- ❑ Material receiving facilities
- ❑ Material or product storage facilities

- ❑ Security
  - ❑ Setbacks
  - ❑ Sight lines
  - ❑ Clear zones
  - ❑ Access and egress
  - ❑ Fencing, gates, and barriers
  - ❑ Security lighting
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Complete condition assessment of existing facilities and infrastructure
- ❑ As-built accuracy and availability (i.e., update/verify as-built documentation prior to project initiation)
- ❑ Worksite availability and access for R&R activities
- ❑ Existing space available to occupants during renovation work
- ❑ Uncertainty of “as-found” conditions, especially related to
  - ❑ Structural integrity; steel or concrete loading
  - ❑ Sub-base conditions
  - ❑ Piping capacity/integrity/routing
  - ❑ Location, condition, and capacity of electrical systems components
  - ❑ Installed equipment
  - ❑ Condition of required isolation points
- ❑ Investigation tools to assist in the documentation of existing conditions:
  - ❑ Photographs/video
  - ❑ Remote inspection
  - ❑ Laser scanning
  - ❑ Infrared scanning
  - ❑ Ground penetrating radar
  - ❑ Ultrasonic testing
  - ❑ Hydro-excavation
  - ❑ Other user defined

D6. Dismantling & Demolition Requirements

A scope of work has been defined and documented for the decommissioning and dismantling of existing equipment/piping/structures/pavements that may be necessary for completing new construction. This scope of work should support an estimate for cost and schedule. Evaluation criteria should include the following

- ❑ Timing/sequencing
- ❑ Permits
- ❑ Approval
- ❑ Safety and security requirements
- ❑ Hazardous operations and/or materials
- ❑ Plant/operations requirements
- ❑ Storage or disposal of dismantled equipment/ materials
- ❑ Narrative (scope of work) for each system
- ❑ Environmental assessment
- ❑ Are the systems or items that will be decommissioned/dismantled:
  - ❑ Named and marked on process flow diagrams piping and instrumentation diagrams (P&IDs), or flow schematics
  - ❑ Denoted on line lists and equipment lists
  - ❑ Denoted on piping plans or photo drawings
  - ❑ Delineated by zone or boundary
- ❑ Sustainability issues, including reuse of materials
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Use of photographs, video records, and other media in scope documents to ensure that existing conditions are clearly defined
- ❑ Physical identification of extent of demolition to clearly define limits
- ❑ Segregation of demolition activities from new construction, and operations (e.g., physical disconnect or "air gap")
- ❑ Establish decontamination and purge requirements to support dismantling.

D7. Determination of Utility Impacts

Infrastructure projects often necessitate the adjustment of utilities to accommodate the design and construction of the proposed project. Failure to mitigate utility conflicts in the design process or to relocate facilities in a timely manner can result in unwarranted delays and increased project costs. Issues to consider include the following:

- ❑ Field verification of existing utilities facilities and capacity
- ❑ Field verification with proposed alignment or project footprint
- ❑ Necessary utility facility repair and modernization or expansion
- ❑ Physical constraints to utility placement
- ❑ Schedule/cost impacts of utility relocations and adjustments
- ❑ Determination of utility location in existing right-of-way or boundaries
- ❑ Local ordinances or industry standards
- ❑ Safety clearance or physical separation requirements
- ❑ Availability of alternative right-of-ways
- ❑ Action plans for utility adjustments
- ❑ Regional or local regulations related to utility adjustment
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Determination of utility locations or relocations in relation to renovation work
- ❑ Accessibility of utilities for relocation work

D8. Lead/Discipline Scope of Work

The project manager's complete narrative description of the project should be developed and oriented towards the architect/engineer/contracting agent; this narrative should be generally discipline oriented and should lay out the major components of work to be accomplished. It should also be tied to a high-level work breakdown structure (WBS) for the project. Items to consider would include the following:

- ❑ Background information
- ❑ Project summary
- ❑ High-level WBS
- ❑ Level of requirement development by each discipline
- ❑ Sequencing of work

- ❑ Interface issues for various contractors, contracts, or work packages
- ❑ Exclusions and limitations to the scope of work
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Identification of specific interface or coordination efforts with operations and owner's staff

E. VALUE ANALYSIS

E1. Value Engineering Procedures

Procedures for conducting Value Engineering (VE) during front end planning—and later in the project during design and construction—need to be in place. VE methodology should be used to assess a project's overall effectiveness or how well the project meets identified needs. VE is designed to consolidate the expertise and experience of individuals to produce the most effective solution to the conveyance need. For instance, study findings may show that redesign of an alternative is needed; in such cases, concepts or schematics may require revisions. Issues to consider include the following:

- ❑ Policy requirements and procedures
- ❑ Team member and team leader identification
- ❑ Session attendance requirements
- ❑ Frequency of assessments
- ❑ Documentation requirements
- ❑ Strategic resource collection and studies
  - ❑ Lessons learned review
  - ❑ Redundancy factors
  - ❑ Over-capacity factors
  - ❑ Life-cycle and replacement costs
  - ❑ Environmental impact resolution
- ❑ Report preparation and recommendations
- ❑ Approved response submittals
- ❑ Planning document revisions
- ❑ Other user defined

E2. Design Simplification

Procedures for conducting design simplification during front end planning and later in the project need to be in place. In this step, the project team identifies and documents activities or strategies—through studies or reviews—for reducing the number of process steps, the number of interchanges, the number of bridges, the length of route, the extent of right-of-way, or the amount of equipment needed in the design. This streamlining of the project helps optimize performance without compromising safety, function, reliability, or security. Items to evaluate for simplification include the following:

- ❑ Redundancies
- ❑ Overcapacity
- ❑ Horizontal or vertical alignment
- ❑ Above or below ground or water
- ❑ Retaining walls versus embankments
- ❑ Commonality
- ❑ Flexibility
- ❑ Discretionary scope issues
- ❑ Discretionary spares
- ❑ Controls simplification
- ❑ Other user defined

E3. Material Alternatives Considered

A structured approach should be in place to consider and select among material alternatives; this approach should include sustainability considerations that begin during front end planning and continue as the project progresses. Rejected material alternatives should be documented. Material evaluation should include the following:

- ❑ Cost effective materials of construction
- ❑ Life-cycle analysis, including operations and maintenance considerations
- ❑ Modularized or pre-fabricated components
- ❑ Ease or cost effectiveness during construction
- ❑ Sustainability considerations (e.g., use of local materials, pollution abating concrete, recycled materials, and LED lighting)
- ❑ Environment in which materials are to be installed or operated (e.g., hot, humid, corrosive, etc.)
- ❑ Other user defined

E4. Constructability Procedures

A structured process and procedures should be in place for constructability analysis during front end planning and as the project proceeds into design and construction. CII defines constructability as

> the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Maximum benefits occur when people with construction knowledge and experience become involved at the very beginning of a project.

Provisions have been made to provide this on an ongoing basis. This process includes examining design options that minimize construction costs while maintaining standards of safety, security, quality, and schedule. This process should be initiated in the front end planning process during concept or detailed scope definition. Elements of constructability during front end planning include the following:

- ❑ Constructability program already established
- ❑ Construction knowledge/ experience used in project planning
- ❑ Early construction involvement in contracting strategy development
- ❑ Developing a construction-sensitive project schedule, with operations input and operational needs considered
- ❑ Consideration of major construction methods in basic design approaches
- ❑ Development of site layouts for efficient construction
- ❑ Early identification of project team participants for constructability analysis
- ❑ Use of advanced information technologies
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Installability (e.g., smaller components/modules/pre-assembly to facilitate installation in congested areas)
- ❑ Opportunities to perform as much work as possible outside of shutdowns or outages
- ❑ Development of an operations-sensitive project schedule (e.g., minimization of shutdown/turnaround work and hot work in operating areas, and reduction of traffic disruption at high volume times)

SECTION II: BASIS OF DESIGN

F. SITE INFORMATION

F1. Geotechnical Characteristics

Geotechnical and soil test evaluations of the project footprint should be developed. Ways in which the project will be affected by geotechnical characteristics should be considered. Items to evaluate and consider include the following:

- ❑ General site descriptions (e.g., terrain, spoil removals, and areas of hazardous waste)
- ❑ Collection of all previous geotechnical investigation data
- ❑ Soil composition and strata structure
- ❑ Potential soil expansion considerations
- ❑ Soil densities and compaction requirements
- ❑ Seismic requirements, including liquefaction potential
- ❑ Foundation requirements
  - ❑ Allowable bearing capacities
  - ❑ Pier/pile capacities
- ❑ Water table
- ❑ Groundwater flow rates and directions
- ❑ Soil percolation rate and conductivity
- ❑ Karst formations, caves, or mines
- ❑ Man-made/abandoned facilities
- ❑ Existing foundations or subsurface structures
- ❑ Existing or abandoned landfills
- ❑ Existing or abandoned cemeteries
- ❑ Site characterization to identify areas of hazardous or toxic soils
- ❑ Soil treatment and remediation needs
- ❑ Soil boring tests and test pits
- ❑ Horizontal directional drilling versus open cut
- ❑ Geological baseline reports (GBR)
- ❑ Other user defined

F2. Hydrological Characteristics

Hydraulic information should be reviewed and analyzed at a high level prior to selection of alternatives and detailed design. This information is necessary for determining hydraulic structural requirements and detention facilities, as well as preliminary right-of-way requirements. Issues to consider include the following:

- ❑ Drainage basin characteristics
  - ❑ Size, shape, and orientation
  - ❑ Slope of terrain
  - ❑ Groundwater
  - ❑ Watershed development potential
  - ❑ Geology
  - ❑ Surface infiltration
  - ❑ Antecedent moisture condition
  - ❑ Storage potential (e.g., overbank, wetlands, ponds, reservoirs, and channels)
- ❑ Flood plain characteristics
- ❑ Waves, tides, and currents
- ❑ Soil types and characteristics
- ❑ Cathodic protection requirements
- ❑ Ground cover and erosion concerns, including scour susceptibility
- ❑ Meteorological characteristics
  - ❑ Precipitation types and amounts
  - ❑ Peak flow rates
  - ❑ Hydrographs
  - ❑ Special precipitation concerns
  - ❑ Storm water runoff control
- ❑ Potential impacts of future development
- ❑ Affected communities or agencies such as watershed districts/regulations
- ❑ Other user defined

F3. Surveys & Mapping

Once it has been determined that a corridor or site needs to be studied, a reconnaissance of the corridor/site should be conducted. This includes a study of the entire area. The study facilitates the development of one or more routes or corridors or location options. It provides sufficient detail to enable appropriate officials to recommend the optimal location. Issues to consider include the following:

- ❑ Existing geographic/mapping information from general sources or previous study, including geographical information system data
- ❑ Right-of-entry requirements
- ❑ Surveying consultant requirements
- ❑ Aerial photography from general sources or previous studies and surveys
- ❑ Regional demographic maps, identifying areas of special impact
- ❑ Existing right-of-way maps/inventory, including easements
- ❑ Preliminary survey, including recovery of existing monuments
- ❑ Topography (contours)
- ❑ Existing structure locations
- ❑ Grid ticks and centerlines
- ❑ Geotechnical summaries
- ❑ Utility information
- ❑ Satellite/light detection and ranging (LIDAR) surveys
- ❑ Affected area maps
- ❑ Special property owner concerns
- ❑ Use of subsurface utility engineers (SUE)
- ❑ Other user defined

F4. Permitting Requirements

Permitting usually begins concurrently with surveys and continues throughout project construction. Personnel responsibilities should be clearly delineated and specific to each permit, including a listing of all organizations that may require permitting. In many cases, permits must be obtained before further approval of project development activities and site access; in some cases permits may have schedule constraints. Issues to consider include the following:

- ❑ Noise
- ❑ Traffic
- ❑ Building
- ❑ Navigation
- ❑ Land use or zoning
- ❑ Operating
- ❑ Approved points of discharge permits
- ❑ Grading and erosion permits
- ❑ Local, regional, or national jurisdictional permits
- ❑ Construction
- ❑ Utility
- ❑ Crossing
- ❑ Waterway permits (e.g., the U.S. Rivers and Harbors Act Section 10 requirements)
- ❑ Wetland permits (e.g., the U.S. Clean Water Act Section 404 requirements)
- ❑ Flora and fauna permits (e.g., those required by the U.S. Endangered Species Act)
- ❑ Resource agency permits (e.g., those administered by the U.S. Federal Energy Regulatory Commission (FERC))
- ❑ Historic and cultural association permits
- ❑ Pollutant and emissions permits
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Original intent of codes and regulations and any "grandfathered" requirements

F5. Environmental Documentation

Funding sources and the project's environmental classification drive the type of environmental documentation that is required. Environmental documentation should provide a brief summary of the results of analysis and coordination, as well as information about the social, economic, and environmental impacts of a project. This summary should include a determination of what decision should be made on a project's construction, location, and design. In addition, the document should describe early interagency coordination and preliminary public involvement, including estimates of time required for milestones. While some jurisdictions may have policies that differ from those of federal agencies, most follow U.S. classifications. Typical types of environmental documentation include the following:

- ❑ Environmental Assessments (EA)
- ❑ Environmental Impact statements (EIS)
- ❑ Environmental Impact Report (EIR)
- ❑ Categorical Exclusions (CE)
- ❑ Potential Outcomes
  - ❑ Findings of No Significant Impact (FONSI)
  - ❑ Notice of Intent (NOI)
  - ❑ Record of Decision (ROD)
  - ❑ Categorical Exclusion (CE)
- ❑ Section 4F documentation (e.g., parks and recreation areas, refuges, cultural resources, and other sites)
- ❑ Environmental monitoring
- ❑ Environmental constraints should be incorporated into preliminary right-of-way maps and schematics (as described in Element F7).
- ❑ Other user defined

(Note: All jurisdictions have specific environmental policies and requirements that need to be understood by planners. For example, the U.S. National Environmental Policy Act (NEPA) requires three levels of environmental analysis. At the first level, an undertaking may be categorically excluded (CE) from a detailed environmental analysis if it meets certain previously determined federal criteria for having no significant environmental impact. At the second level of analysis, a federal agency prepares a written Environmental Assessment (EA) to determine whether or not a federal undertaking would significantly affect the environment. If this is not the case, the agency issues a Finding of No Significant Impact (FONSI). An Environmental Impact Statement (EIS) is a more detailed evaluation of the proposed action and alternatives. A Notice of Intent (NOI) announces an agency's decision to prepare an EIS for a particular action and must be published in the Federal Register. The public, other federal agencies, and outside parties may provide input into the preparation of an EIS and then comment on the draft EIS when it is completed. Following the final EIS, the agency will prepare a Record of Decision (ROD).)

F6. Environmental Commitments & Mitigation

Environmental commitments determine what a project's involved parties can and cannot do to protect the environment. Environmental commitments begin at the earliest phase of project development, although completion of commitments may not occur until the operation and maintenance phase of a project. Because there is a substantial time gap between the beginning and end of a commitment, it is imperative that commitments are communicated from environmental clearance through detailed design, pre-bid conference, project letting, maintenance, and operation. Issues to consider include the following:

- ❑ Avoidance commitments
- ❑ Compensation commitments
- ❑ Enhancements commitments
- ❑ Minimization commitments
- ❑ Habitat mitigation
- ❑ Water quality facilities management
- ❑ Wetland mitigation
- ❑ Storm water management plans
- ❑ Cultural resources mitigation
- ❑ Noise abatement remediation
- ❑ Hazardous materials abatement locations
- ❑ Environmental remediation plans
- ❑ Other user defined

F7. Property Descriptions

Property descriptions are prepared as exhibits for the conveyance of property interests that will be affected by a project. The property descriptions reflect a boundary survey showing ownership and including legal descriptions, as well as parcel plat determinations. Property descriptions should be summarized from survey information into a form of documentation that can be logged into project information systems. The level of confidence and validation of the documentation—such as field verified versus scaled from existing maps—should be noted. Information needed includes the following:

- ❑ Type of property or businesses affected
- ❑ Historical data used in preparing the survey
- ❑ Parcel plats
- ❑ Parcel size and area
- ❑ Control reference point data
- ❑ Easements
- ❑ Centerline station ties
- ❑ Control of access lines
- ❑ Gates, fences, and barriers
- ❑ County, city, federal, or other jurisdictional boundary lines
- ❑ Review of existing right-of-way maps from previous projects
- ❑ On-site canvas of the proposed affected properties
- ❑ Appraisal maps and records
- ❑ Abstractor's indices
- ❑ Real property records
- ❑ Mineral and water rights
- ❑ Other user defined

F8. Right-of-Way Mapping & Site Issues

A right-of-way map is a compilation of internal data, property descriptions with field notes and parcel plats, appraisal information, and improvements related to the project. Right-of-way maps are typically internal planning and management documents, with significant impact on the project development process. Preparation of these maps normally begins after obtaining schematic design approval. Parcels that may cause difficulties in acquisition should be identified, including indications of specific site conditions or characteristics that may cause delays or problems. Issues to consider include the following:

- ❑ Parcel numbers and priority
- ❑ Existing site information
  - ❑ Improvements within right-of-way
  - ❑ Previous uses of land
  - ❑ Zoning
  - ❑ Utility locations
  - ❑ Record ownership data of adjacent properties
  - ❑ Existing boundaries and limits
  - ❑ Existing drainage channels and easements
- ❑ Design information
  - ❑ Access control lines
  - ❑ Configuration of infrastructure project
  - ❑ Hydraulics
  - ❑ Maintenance access or connecting ramps
  - ❑ Limit of flood pool
- ❑ Parcel information
  - ❑ Property owner name
  - ❑ Parcel title requirements
  - ❑ Parcel number
  - ❑ Parent tract
  - ❑ Type of conveyance, if known (e.g., donation, negotiation, and condemnation)
  - ❑ Station to station limits and offset
  - ❑ Area in acres and/or square feet
  - ❑ Area of uneconomic remainders

- ❑ Property lines
- ❑ Bearing and distance to control points
- ❑ Property descriptions

❑ Inherent parcel issues that may cause difficulties in right-of-way acquisition

- ❑ Landfill and superfund records
- ❑ Hazardous material exposure (e.g., poly-chlorinated biphenyls (PCB) transformers or underground storage tank locations)
- ❑ Wetlands identification
- ❑ Floodway identification
- ❑ Endangered species locations
- ❑ Stockpiles and production sites
- ❑ Outfall locations
- ❑ Oil and gas well piping
- ❑ Railroad and/or roadway interests
- ❑ Special use properties (e.g., government use, alcohol sales, and cemeteries)
- ❑ Beautification and signage
- ❑ Land use impacts
- ❑ Socioeconomic impacts
- ❑ Economic development/speculation
- ❑ Legal (lawyer) activity in area
- ❑ Title curative issues
- ❑ National, regional, or locally owned properties
- ❑ Number of partial takings
- ❑ Splitting of parcels
- ❑ Landlocked parcels
- ❑ Existing easements
- ❑ Cultural issues
- ❑ Public park space
- ❑ Cultural resources
- ❑ Historical landmarks
- ❑ Archeologically sensitive sites

❑ Other user defined

G. LOCATION and GEOMETRY

G1. Schematic Layouts

The submission of schematic layouts should include basic information necessary for the proper review and evaluation of the proposed improvement. The schematic is essential for use in public meetings and coordinating design features. Format and delivery should be tailored to the audience. Issues to consider include the following:

- ❑ General project information (e.g., boundary limits, speed or volume, and classification)
- ❑ Location of structures (e.g., interchanges, main lanes, frontages, ramps, levees, channels, ditches, dam structures, towers, utilities, and drainage structures)
- ❑ Signage schematics
- ❑ Profiles and alignments
- ❑ Overhead and underground right-of-way
- ❑ Added or future capacity analyses
- ❑ Tentative right-of-way limits
- ❑ Geometrics
- ❑ Location of retaining and noise abatement walls
- ❑ Projected capacities
- ❑ Control of access during and after construction
- ❑ Existing structures and removal of improvements
- ❑ Master plan zoning map
- ❑ Soils maps
- ❑ Cut and fill balance
- ❑ Jurisdictional map
- ❑ Watershed/water basin delineation
- ❑ Other user defined

Location/arrangement drawings identify the location of each major project item, including equipment, support structure, or miscellaneous elements. These drawings should include the following:

- ❑ Location, including coordinates
- ❑ Coordination of location among all items
- ❑ Setbacks
- ❑ Interface
- ❑ Elevation views
- ❑ Visibility or line of sight
- ❑ Access
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Renovation work in relation to existing structures and demolition
- ❑ Detours or bypasses
- ❑ Temporary conveyance facilities
- ❑ Clear identification of existing systems and equipment to be removed, rearranged, or to remain in place

G2. Horizontal & Vertical Alignment

Due to the near permanent nature of the right-of-way alignment once the infrastructure project is constructed, it is important that the proper alignment be selected according to the system's design speed, pressure pipe hydraulics, open channel hydraulic parameters, existing and future roadside or adjacent development, subsurface conditions, topography, among other parameters. Issues to consider include the following:

- ❑ Horizontal geometry
- ❑ Vertical geometry
- ❑ Design exceptions or waivers identified and validated
- ❑ Pipeline or power line corridors and easements
- ❑ Sight distances
- ❑ Geometry referenced to a surveying control system
- ❑ Crossover grades and profiles
- ❑ Vertical lift
- ❑ Vertex data
- ❑ Access to target users or market
- ❑ Proximity to raw materials
- ❑ Natural corridors
- ❑ Upstream and downstream control structures/parameters
- ❑ Social/political constraints
- ❑ Constrained right-of-way zones areas (i.e., choke points)
- ❑ River, lake, or ocean crossings, including landfall or transitions
- ❑ Existing above-ground and underground utilities, especially in dense urban areas
- ❑ Horizontal directional drilling (HDD)/tunneling feasibility
- ❑ Other user defined

G3. Cross-Sectional Elements

Cross-sections are an important design element related to the cost and schedule of the proposed project. The width of the right-of-way will be controlled by the proposed design. Examination of the typical cross-section will indicate those elements of design affecting the width of the proposed right-of-way and utility adjustments, among other factors. Issues to consider include the following:

- ❑ Maintenance access
- ❑ Cut or fill slopes
- ❑ Easements
- ❑ Horizontal clearances to obstructions
- ❑ Pavement cross slopes
- ❑ Frontage roads and ramp radii
- ❑ Sidewalks and pedestrian elements
- ❑ Noise abatement (e.g., walls, structures, or operating limitations)
- ❑ Number and width of road lanes
- ❑ Width of median
- ❑ Width of shoulder
- ❑ Pipeline support berm width
- ❑ Extent of berm areas
- ❑ Channel levee widths
- ❑ Cross drainage structures
- ❑ Extent of side slopes and ditches, including levees and dams
- ❑ Linear profile for hydraulic/hydrostatic testing
- ❑ Channel routing models
- ❑ Other user defined

G4. Control of Access

It is important during front end planning to maintain access to specific portions of the infrastructure project for both construction and permanent access. Planners need to address the concerns of controlled access limits to and from adjacent property or facilities. Access control should be coordinated with right-of-way acquisition, including access deeds and restrictions. Issues to consider include the following:

- ❑ Entrance/exit locations and length
- ❑ Growth capacity
- ❑ Access deed restrictions
- ❑ Safety and security of access
- ❑ Trunk tie-ins
- ❑ Special required access lanes
  - ❑ Bike and pedestrian lanes
  - ❑ High Occupancy Vehicle (HOV)/High Occupancy Toll (HOT) lanes
  - ❑ Truck-only lanes
  - ❑ Crossover lanes or access
  - ❑ Turnarounds
- ❑ Frontage road requirements
- ❑ Controlled access systems, including life safety requirements
- ❑ Split-parcel access requirements
- ❑ Driveway access requirements
- ❑ Waiting lanes or rails
- ❑ Bypasses
- ❑ Access to runways
- ❑ Intermodal interface
- ❑ Pumping or support stations
- ❑ Valve tie-ins
- ❑ Pig access
- ❑ Cleanouts
- ❑ Pretreatment, including bar screens, grit removal, grinders, and compactors
- ❑ Desalting and settling tanks
- ❑ Manholes
- ❑ Transformer location
- ❑ Switching stations
- ❑ Data security
- ❑ Integration and compatibility
- ❑ Other user defined

H. ASSOCIATED STRUCTURES and EQUIPMENT

H1. Support Structures

Infrastructure projects often require support structures for conveyance requirements along the extent of right-of-way, e.g., bridges for freight, people, or pipelines. As a result, right-of-way requirements must take into account the impacts of structure design on the affected corridor. For example, pipelines may need to span a gap while maintaining a specified grade, and transportation and distribution facilities must span long gaps while maintaining a specified clearance above a transportation corridor. Planners should address the following structural considerations:

- ❑ Structure locations
- ❑ Materials of construction
- ❑ Foundation requirements
- ❑ Seismic requirements
- ❑ Right-of-way impacts
- ❑ Towers
- ❑ Stringing requirements
- ❑ Toll plazas
- ❑ Safety tolerances
  - ❑ Maximum height
  - ❑ Minimum clearances
  - ❑ Maximum loads and capacities
  - ❑ Clear roadway width
- ❑ Utilities attached to bridge structures
- ❑ Turnarounds
- ❑ Access requirements
- ❑ Maintenance of right-of-way
- ❑ Retaining walls and abutments
- ❑ Vertical and horizontal alignment
- ❑ Fencing
- ❑ Lightning protection
- ❑ Safety lighting
- ❑ Maintenance accessibility
- ❑ Pipe racks
- ❑ Cable trays
- ❑ Span gap
- ❑ Special load requirements (e.g., ice, wind, and heavy load)
- ❑ Thrust blocks
- ❑ Valve and pumping stations/enclosures
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Current condition and life expectancy
- ❑ Temporary signage
- ❑ Maximum construction bridge loading
- ❑ Bypasses or temporary conveyance
- ❑ Detour bridge requirements or lane rerouting

H2. Hydraulic Structures

In the analysis or design of drainage facilities, the relative importance of facility will determine the appropriate investment of time, expense, concentration, and completeness. Some of the basic components inherent in the design or analysis of any pipeline, channel, or highway drainage facility include the following types of data:

- surveys of existing characteristics
- estimates of future characteristics
- engineering design criteria
- discharge estimates
- structure requirements and constraints
- receiving facilities.

Issues to consider include the following:

- ❑ Open channels, tunnels, and outfall structures
  - ❑ Right-of-way impact
  - ❑ Environmental impact
- ❑ Storm drain systems
- ❑ Emergency spillways
- ❑ Collection basins
- ❑ Culverts
- ❑ Fluid energy abatement
- ❑ Inlets/outlets
- ❑ Irrigation controls
- ❑ Street cleaning requirements
- ❑ Special required easements
- ❑ Hydraulic routing
- ❑ Hydraulic channel controls
- ❑ Wildlife crossing structures
- ❑ Life-cycle maintenance considerations and costs
- ❑ Multipurpose requirements (e.g., flood control plus power generation)
- ❑ Erosion control
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Current condition and life expectancy
- ❑ Bypasses or temporary conveyance

H3. Miscellaneous Elements

In addition to typical pipeline, water channel, energy, and/or roadway design elements, the following features may require consideration and planning. In some cases, acquisition of additional right-of-way may be required. These items should be identified and listed, and may include the following:

- ❑ Longitudinal barriers
- ❑ Rip-rap/gabions/soil retaining structures
- ❑ Fencing
- ❑ Emergency management issues
- ❑ Noise abatement walls
- ❑ Visual architectural blending structures
- ❑ Maintenance and storage yards
- ❑ Tollway structures
- ❑ Border and immigration structures
- ❑ Parking
- ❑ Rest areas and stops
- ❑ Blast deflection devices
- ❑ Signage, delineation, roadway markings, and historical markers
- ❑ Extended shoulders for service
- ❑ Truck weigh stations
- ❑ Pedestrian separations and ramps
- ❑ Emergency median openings and widths
- ❑ Runaway vehicle lanes
- ❑ Hazardous material traps
- ❑ Storm septors and other storm water control devices
- ❑ Emergency spillway area
- ❑ Berms or containment structures
- ❑ Other user defined

H4. Equipment List

Project-specific installed equipment should be defined and listed. In some cases, equipment may have to be manufactured and purchased specifically for construction of the facility. In situations in which owners are furnishing equipment, the equipment should be properly defined and purchased. Items may include the following:

- ❑ Traffic control devices
  - ❑ Low-volume roads
  - ❑ School zones
  - ❑ Highway-rail or light-rail transit grade crossings
  - ❑ Bicycles
  - ❑ Temporary
- ❑ Intelligent transportation systems devices
  - ❑ Cameras
  - ❑ Loop detectors
  - ❑ Sensors
  - ❑ Monitors
- ❑ Specialized equipment (e.g., tunnel boring machines (TBM), dredges, and cranes)
- ❑ Electronic signage
- ❑ Highway traffic signals
- ❑ Toll equipment
- ❑ Rest area requirements
- ❑ Turbines
- ❑ Compressors
- ❑ Pumps
- ❑ Conveyor systems
- ❑ Grinders
- ❑ Clarifiers
- ❑ Tanks or basins
- ❑ Filtering
- ❑ Transformers
- ❑ Electrical substations (breakers, disconnect switches, and protection and control equipment)
- ❑ Spares and commonality requirements
- ❑ Other user defined

Training requirements for equipment operation have been defined, with responsibilities established in some of the following areas:

- ❑ Control systems
- ❑ Information systems and technology
- ❑ Equipment operation
- ❑ Maintenance of systems
- ❑ Training materials and equipment (e.g., manuals and simulations)
- ❑ Safety
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Identification of systems and equipment as new, existing or relocate, existing or in place, remove, etc.
- ❑ Clear definition of any modifications to existing systems and equipment

H5. Equipment Utility Requirements

A tabulated list of utility requirements for all major installed equipment items should be developed for an understanding of overall utility load and distribution for the facility. As part of this determination of requirements, it may be appropriate to perform a utility optimization study. Items to consider include the following:

- ❑ Power
  - ❑ Hard line
  - ❑ Solar
  - ❑ Auxiliary or backup
- ❑ Water
- ❑ Air and specialty gasses
- ❑ Steam
- ❑ Sewage
- ❑ Communications, including cables or fiber-optics
- ❑ Fuel
- ❑ Other user defined

I. PROJECT DESIGN PARAMETERS

I1. Capacity

In general, a capacity study is required for scope definition of many infrastructure projects. These studies provide a description of the related process flows and interactions, allowing the planning team to ensure adequate facility capacity while guarding against over- or under-design. The capacity study should fit within the need and purpose of the project as defined in Element A1. Capacity studies generally include flow diagrams, which construction organizations refer to variously by the following acronyms:

- ❑ EFDs Engineering Flow Diagrams
- ❑ MFDs Mechanical Flow Diagrams
- ❑ PMCDs Process & Mechanical Control Diagrams
- ❑ P&IDs Process and Instrumentation Diagrams
- ❑ CCS Corridor Capacity Study
- ❑ SLD Single Line Diagrams

Capacity studies should address the following areas:

- ❑ Flow of resources and outputs
- ❑ Contractual requirements
- ❑ Primary control loops for the major equipment items
- ❑ Capacity constraints and growth considerations
- ❑ Major equipment items
- ❑ Utilities
- ❑ Instrumentation
- ❑ Safety/security systems
- ❑ Sustainability concerns
- ❑ Special notations
- ❑ Level of service
- ❑ Level of flow
- ❑ Standard component size
- ❑ Service/industry standards
- ❑ Other user defined

Following are typical items to consider for people and freight-type projects:

- ❑ Traffic capacity studies
- ❑ Passenger or freight handling
- ❑ Interchanges
- ❑ Signage
- ❑ Security check points
- ❑ Tolling
- ❑ Vehicle parking
- ❑ Rail switch location
- ❑ Siding rails and spurs
- ❑ Corridor capacity
- ❑ Taxiways and parking aprons
- ❑ Instrumentation and lighting
- ❑ Runway orientation
- ❑ Controlled air space
- ❑ Airport/port layout plan
- ❑ Lock capacity

Following are typical items to consider for fluid-type projects:

- ❑ Piping
- ❑ Hydraulic profile
- ❑ Flow rate
- ❑ Containment and storage
- ❑ Open channel
- ❑ Dewatering systems
- ❑ Leakage
- ❑ Friction and head loss
- ❑ Valves
- ❑ Equipment
- ❑ Control
- ❑ Piping specialty items

Following are typical items to consider for energy-type projects:

- ❑ Grid integration
- ❑ Transmission line capacity
- ❑ Resistance and impedance
- ❑ Generation
- ❑ Bandwidth capacity
- ❑ Tie-ins or interchanges
- ❑ Transformers and switching gear
- ❑ Telecommunication media (e.g., fiber-optic, power line carrier (PLC), or microwave)

Additional items to consider for Renovation & Revamp projects

- ❑ Definition of owner's requirements for updating existing flow diagrams
- ❑ Tie-in points
- ❑ Accuracy of existing capacity studies and flow diagrams (i.e., field verify)
- ❑ Scope of work on existing flow diagrams (i.e., clouding or shading to indicate new, refurbished, modified, and/or relocated equipment, piping, instruments, and controls).

Since incomplete information in capacity studies can cause project escalation, it is important to understand a project's level of completeness. These studies generally evolve as the project scope definition is developed. However, the study documents must be complete enough to support the required accuracy of estimate.

I2. Safety and Hazards

This element refers to a formal process for identifying and mitigating safety and environmental hazards. This process is used to identify potential risk of injury to the environment or populace for certain types of infrastructure projects. Many jurisdictions—or organizations—will have their own specific compliance requirements; for example, in the United States, OSHA Regulation 1910.119 compliance is required for oil and gas conveyance. The important issue is whether the owner has clearly communicated the requirements, methodology, and responsibility for the various activities to the project team. If the analysis has not been conducted, the team should consider the potential of risks that could affect the schedule and cost of the project. Issues to consider include the following:

- ❑ Handling of nuclear materials
- ❑ Cleanup requirements in case of spills
- ❑ Containment requirements
- ❑ Confined space
- ❑ Air monitoring
- ❑ Hazardous Operations (HAZOP) requirements
- ❑ Other user defined

I3.Civil/Structural

A clear statement of civil/structural requirements should first be identified or developed and then documented as a basis of design. This documentation should include some of the following issues:

- ❑ Client specifications (e.g., basis for design loads, capacity, and vulnerability and risk assessments)
- ❑ Future expansion considerations
- ❑ Physical requirements
- ❑ Seismic requirements
- ❑ Safety considerations
- ❑ Construction materials (e.g., concrete, steel, and client standards)
- ❑ Sustainability considerations, including certification
- ❑ Standard or customized design
- ❑ Definition of nomenclature and documentation requirements for civil drawings
    - ❑ Overall project site plan
    - ❑ Project phasing requirements
    - ❑ Interim traffic or by-pass control plans
    - ❑ Structures
    - ❑ Location of equipment and facilities
    - ❑ Utilities
    - ❑ Roads and paving
    - ❑ Grading/drainage/erosion control/landscaping
    - ❑ Corrosion control/protective coatings
    - ❑ Minimum clearances
    - ❑ Architectural theme
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Existing structural conditions (e.g., foundations, building framing, and harmonics/vibrations)
- ❑ Potential effect of noise, vibration, and restricted headroom in installation of piling and on existing operations
- ❑ Underground interference that necessitates shallow-depth designs

I4. Mechanical/Equipment

A clear statement of mechanical and equipment design requirements should first be identified or developed, and then documented as a basis of design. This documentation should include some of the following issues:

- ❑ Life cycle costing basis
- ❑ Energy conservation
- ❑ Sustainability considerations, including certification
- ❑ Equipment/space special requirements with respect to environmental conditions (e.g., air quality and special temperatures)
- ❑ System redundancy requirements
- ❑ Special ventilation or exhaust requirements
- ❑ Acoustical requirements
- ❑ Water treatment
- ❑ Auxiliary/emergency power requirements
- ❑ System zones and control strategy
- ❑ Air circulation requirements
- ❑ Outdoor design conditions (e.g., minimum and maximum yearly temperatures)
- ❑ Indoor design conditions (e.g., temperature, humidity, pressure, and air quality)
- ❑ Emissions control
- ❑ Utility support requirements
- ❑ Plumbing requirements
- ❑ Special piping requirements
- ❑ Seismic requirements
- ❑ Fire protection systems requirements
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Renovation projects' alteration of existing mechanical design assumptions
- ❑ Potential reuse of existing equipment and systems for renovation project
- ❑ New bypasses and tie-in requirements

I5. Electrical/Controls

A clear statement of electrical design requirements should be identified or developed, and then documented as a basis of design. This documentation should include some of the following issues:

- ❑ Life cycle costing basis
- ❑ Electrical classification based on environment
- ❑ Programmable logic controllers (PLC) versus Distributed Control System (DCS)
- ❑ Local versus remote control
- ❑ Automated versus manual control
- ❑ Energy consumption/ conservation
- ❑ Sustainability, including certification
- ❑ Power sources with available voltage/amperage
- ❑ Electrical substations, transformers, switching gear
- ❑ Uninterruptable power source (UPS) and/ or emergency power requirements
- ❑ Lightning/grounding requirements
- ❑ Code and safety requirements
- ❑ Alternate energy systems (e.g., solar and wind)
- ❑ Flow measuring and monitoring
- ❑ Special lighting considerations (e.g., security, lighting levels, exterior/security, use of day lighting, color rendition, signage or traffic lights)
- ❑ Voice, data, and video communications requirements
- ❑ Telecommunication and data systems
- ❑ Instrumentation
- ❑ Advanced audio/visual (A/V) connections
- ❑ Personnel sensing
- ❑ Security/access control systems
- ❑ Other user defined

Additional items to consider for Renovation & Revamp projects

- ❑ Integration of new technology with existing systems, including interface issues
- ❑ Safety systems potentially compromised by any new technology
- ❑ Renovation projects' alteration of existing electrical design assumptions
- ❑ Potential reuse of existing equipment and systems for renovation project

I6. Operations/Maintenance

A clear statement of operations/maintenance design requirements should first be identified or developed, and then documented as part of the basis of design. Operations and maintenance activities are related to the performance of routine, preventive, predictive, scheduled, and unscheduled actions aimed at preventing equipment failure or decline. These activities maintain the correct level of efficiency, reliability, and safety. Operational efficiency represents the life-cycle cost-effective mix of preventive, predictive, and reliability-centered maintenance technologies, coupled with equipment calibration, tracking, and computerized maintenance management capabilities. This mix of technologies and capabilities ensures reliability, safety, occupant comfort, and system efficiency. Sustainability concerns should be addressed as appropriate. Design parameters for operations/maintenance should be considered for infrastructure components such as levees, utilities, roadway structures, drainage structures, traffic control devices, vegetation, and other items related to infrastructure projects. To the extent practical, the use of desirable design criteria regarding maximum side-slope ratios and ditch profile grades will reduce maintenance and make required maintenance operation easier to accomplish. Items to consider include the following:

- ❑ Accessibility:
  - ❑ Access roads, gates, and ramps
  - ❑ Seasonal access requirements
  - ❑ Restricted access
  - ❑ Surveillance and intrusion detection systems
  - ❑ Elevated and subsurface access
  - ❑ Valve and pumping station
  - ❑ Barriers/obstructions/berms/fences
- ❑ Egress and access structures
  - ❑ Manholes
  - ❑ Platforms
  - ❑ Vaults
  - ❑ Underground pedestrian tunnels
  - ❑ Steam stations

- ❑ Safety
  - ❑ Confined space permitting
  - ❑ Fall protection
  - ❑ Overhead power lines
  - ❑ Underground utilities
  - ❑ Emergency response evacuation and communications system
- ❑ Detour or bypass options
- ❑ Temporary structures for maintenance
- ❑ Repair parts storage and fabrication facilities
- ❑ Surface finishes (e.g., paint and hot-dip galvanized)
- ❑ Right-of-way vegetative clearing and maintenance
  - ❑ Types of vegetation
  - ❑ Overhead interferences
- ❑ Remote monitoring capabilities
- ❑ Other user defined

SECTION III: EXECUTION APPROACH

J. LAND ACQUISITION STRATEGY

J1. Local Public Agencies Contracts & Agreements

Contractual agreements with local public agency (LPA) participants may be required. The execution of contractual agreements establishes responsibilities for the acquisition of right of way, adjustment of utilities and cost sharing between the LPA(s) and the project owner. The type of contract to be used is determined by whether the LPA chooses to administer right-of-way activities and payments or defers those responsibilities to the owner. In some cases an agreement must be entered into before a project is released for right-of-way acquisition. Issues to consider include the following:

- ❑ Master agreement governing local agency project advance funding
- ❑ Cost participation and work responsibilities between the owner and LPAs or others
- ❑ Reimbursement to the Local Public Agencies (LPA) or others for purchased parcels
- ❑ Lender requirements or stipulations
- ❑ Prerequisites to secure right-of-way project release on non-federal-aid projects
- ❑ Request for determination of eligibility
- ❑ Compatibility with local regulations and procedures
- ❑ Long-term operation and maintenance responsibility
- ❑ Other user defined

J2. Long-lead Parcel & Utility Adjustment Identification and Acquisition

Right-of-way acquisition and utility adjustment are almost always on the critical path of an infrastructure project. It is important to identify and focus on all parcels within the right-of-way (ROW), but those that might cause delay—such as those that may require eminent domain acquisition or have other inherent problems (as identified in Element F7)—require special attention. Utilities with a history of slow response in making adjustments should be aggressively managed. It should be noted that ROW and utility adjustment issues may be of concern even in cases in which the parcel or utility is owned by a separate public entity. A strategy must be developed to address these problematic parcels and/or utility adjustments. Issues to consider include the following:

- ❑ Identification and prioritization of long-lead parcels and utilities
- ❑ Defining responsible party for parcel acquisition and utility adjustment
- ❑ Appraisal responsibility and performance
- ❑ Acquisition of parcels
- ❑ Relocation of displaced land owners
- ❑ Abatement and removal of existing improvements
- ❑ Other user defined

J3. Utility Agreement & Joint-Use Contracts

Prioritizing utility agreements may be essential to ensure that the concurrent review and approval processes are coordinated and efficient. The utility agreements and joint-use contracts effectively enable the utility to share space on public or private right-of-way and to complete utility adjustments. (Note that single utilities are sometimes owned and controlled by separate public entities and must be coordinated.) Issues to consider include the following:

- ❑ Utility agreements, plans, and estimates
- ❑ Public or private utilities
- ❑ Crossing permits for transportation vectors (e.g., highways, railroads, and canals)
- ❑ Supporting documentation
- ❑ Transmittal memo from district to division
- ❑ Crossing and parallel encroachment permits
- ❑ Compatibility with jurisdictional regulatory and approval processes
- ❑ Other user defined

J4. Land Appraisal Requirements

Acquisition should not begin until a formal right-of-way release or organizational go-ahead is obtained. An early step in acquisition is to determine the value of parcels for reimbursement. Ensuring that appraisal occurs in a timely manner is essential. Appraisal requirements include the following:

- ❑ Pre-appraisal contacts
- ❑ Determination of number of appraisers required
- ❑ Determination of appraisal assignments
- ❑ Use of in-house or contract appraisers
- ❑ Prioritization of parcel appraisals, if required
- ❑ Other user defined

J5. Advance Land Acquisition Requirements

Because advance acquisition involves the acquisition of right-of-way before normal release for right-of-way acquisition is given for the project, advance acquisition requirements need to be identified and addressed as soon as possible in the project. Although this process bypasses detailed environmental scoping, consideration for environmental effects should be made when parcels are slated for advance acquisition. (Note: this is not the acquisition of long-lead parcels that occurs through the normal release process.) Examples of advance acquisition include the following:

- ❑ Protective buying to prevent imminent parcel development that would materially increase right-of-way costs
- ❑ Hardship acquisition of a parcel at the property owner's request
- ❑ Donation of land for right-of-way purposes for no consideration
- ❑ Acquisition of parcels with multiple, sometimes undivided, owners or unknown owners
- ❑ Other user defined

K. PROCUREMENT STRATEGY

K1. Project Delivery Method & Contracting Strategies

The methods of project design and construction delivery, including fee structure and risk allocation for the project should be identified. Types of project delivery methods and contract strategies to consider include the following:

- ❑ Owner self-performed
- ❑ Selected methods (e.g., design/build, construction management (CM) at risk, competitive sealed proposal, bridging, design-bid-build, multi-prime, and sole source negotiated)
- ❑ Requirements under franchises, concessions, or other agreements
- ❑ Designer and constructor qualification selection process
- ❑ Compensation arrangement (e.g., lump sum, cost-plus, and negotiated)
- ❑ Design/build scope package considerations
- ❑ Solicitation package is competitive in the market place (i.e., biddability)
- ❑ Craft labor studies
- ❑ Small business and disadvantaged business contract requirements
- ❑ Local content requirements
- ❑ Other user defined

K2. Long-Lead/Critical Equipment & Materials Identification

Installed equipment and material items with long lead times may affect the design and construction schedule. These items should be identified and tracked. A strategy should be developed to expedite these items if possible. Examples may include some of the following items:

- ❑ Engineered components
- ❑ Toll equipment
- ❑ Electronic information boards
- ❑ Bridge or tower structural components
- ❑ Pre-cast elements
- ❑ Directional lighting systems
- ❑ Computer and/or software systems
- ❑ Pumps, piping, and valves
- ❑ Transformers and switchgear
- ❑ Cable
- ❑ Structural steel
- ❑ Other user defined

K3. Procurement Procedures & Plans

Procurement procedures and plans include specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project. Issues to consider include the following:

- ❑ Responsibility for performing procurement
- ❑ Listing of approved vendors, if applicable
- ❑ Client or contractor purchase orders
- ❑ Reimbursement terms and conditions
- ❑ Equipment/material specifications
- ❑ Guidelines for supplier alliances, single source, or competitive bids
- ❑ Guidelines for engineering/ construction contracts and approval
- ❑ Responsibility for owner-purchased items
  - ❑ Financial
  - ❑ Shop inspection documentation (e.g., factory acceptance tests)
  - ❑ Expediting and tracking
- ❑ Tax strategy
  - ❑ Depreciation capture
  - ❑ Local sales and use tax treatment
  - ❑ Investment tax credits
  - ❑ Local regulations (e.g., tax restrictions and tax advantages)
- ❑ Definition of source inspection requirements and responsibilities
- ❑ Definition of traffic/ insurance responsibilities
- ❑ Definition of procurement status reporting requirements
- ❑ Additional/special owner accounting requirements
- ❑ Definition of spare parts requirements
- ❑ Incentive/penalty strategy for contracts
- ❑ Delivery requirements
- ❑ Receiving, staging, and storage
- ❑ Warranty
- ❑ Operating manual requirements and training
- ❑ Restricted distribution of construction documents for security and anti-terrorism considerations
- ❑ Other user defined

K4. Procurement Responsibility Matrix

A procurement responsibility matrix should be developed showing authority and responsibility for procurement. This matrix should outline responsibilities for the following:

- ❑ Engineering, design and professional services
- ❑ Engineered equipment
- ❑ Construction
- ❑ Bulk materials
- ❑ Fabrication/modularization
- ❑ Consulting services
- ❑ Commissioning and start-up materials
- ❑ Source inspection
- ❑ Other

Additional items to consider for Renovation & Revamp projects

- ❑ Utilization of reused and existing equipment, materials, lines, and electrical and instrumentation.
- ❑ Availability of procurement support during time-constrained R&R work, especially when expedited material services are required.

L. PROJECT CONTROL

L1. Right-of-Way & Utilities Cost Estimates

Right-of-way costs are defined as those instances in which there is an interest in land acquired; these costs include all costs necessary to acquire the property. In some cases, land and interests in land must be acquired outside of existing right-of-way for or by the utility. The cost estimates in some cases are prepared by the utility and submitted in support of the utility agreement and the plans required for the proposed work. These estimates should cover only the work for clearing infrastructure project construction. Issues to consider include the following:

- ❑ Cost of right-of-way
- ❑ Amounts paid to fee appraisers for appraisal of the right-of-way
- ❑ Costs normally paid that are incidental to land acquisition
- ❑ Payment of property damages and losses to improvements
- ❑ Recording costs
- ❑ Deed fees
- ❑ Salaries and expenses of employees engaged in the valuation and negotiation
- ❑ Right-of-way costs incurred by a utility
- ❑ Cost of utility adjustment and bringing necessary utilities to site
- ❑ Other user defined

L2. Design & Construction Cost Estimates

The project cost estimates should address all costs necessary for completion of the project —excluding the right-of-way acquisition and utility adjustment costs that are addressed in Element L1. These cost estimates may include the following:

- ❑ Design costs
- ❑ Construction contract estimate
- ❑ Professional fees
- ❑ Construction management fees
- ❑ General conditions costs
- ❑ Trades resource plan
- ❑ Administrative costs
- ❑ Inspection costs
- ❑ Environmental monitoring
- ❑ Public relations
- ❑ Contingencies
- ❑ Cost escalation for labor and materials
- ❑ Cost escalation for elements beyond the project cost estimates
- ❑ Start-up and commissioning costs
- ❑ Capitalized overhead
- ❑ Safety, health, and environmental items
- ❑ Site-specific insurance requirements
- ❑ Incentives
- ❑ Miscellaneous expenses
  - ❑ Specialty consultants
  - ❑ Inspection and testing services
  - ❑ Bidding costs
  - ❑ Site clearance
  - ❑ Environmental impact mitigation measures
  - ❑ Jurisdictional permit fees
  - ❑ Sureties
  - ❑ Other expenses
- ❑ Taxes
  - ❑ Depreciation schedule
  - ❑ Capitalized/expensed
  - ❑ Tax incentives
  - ❑ Contractors' sales tax
- ❑ Utility costs during construction—a cost to the project, whether paid by owner or contractor
- ❑ Interest on borrowed funds (i.e., the cost of money)
- ❑ Site surveys and soils tests
- ❑ Availability of construction lay-down and storage at site, or in remote or rented facilities
- ❑ Licensing
- ❑ Other user defined

L3. Project Cost Control

Procedures for controlling project cost need to be outlined and responsibility should be assigned. These procedures may include some of the following cost control requirements:

- ❑ Financial (client/regulatory)
- ❑ Phasing or area sub-accounting
- ❑ Capital versus non-capital expenditures
- ❑ Report requirements
- ❑ Payment schedules and procedures
- ❑ Cash flow projections/draw down analysis
- ❑ Cost code scheme/strategy
- ❑ Costs for each project phase
- ❑ Periodic control check estimates
- ❑ Change order management procedure, including scope control and interface with information systems
- ❑ Costs pertaining to right-of-way acquisition and utility adjustment during project execution
- ❑ Project and financial control software
- ❑ Other user defined

L4. Project Schedule Control

The project schedule is created to show progress and to ensure that the project is completed on time. The schedule is necessary for design and construction of the facility. A schedule format and control procedures should be developed during front end planning, and should include assignment of responsibilities. Typical items to consider include the following:

- ❑ Milestones
- ❑ Required submissions and/or approvals
- ❑ Resource loading requirements
- ❑ Required documentation/responsible party
- ❑ Baseline schedule versus progress-to-date schedule
- ❑ Critical path activities, including field surveys
- ❑ Contingency or "float time"
- ❑ Force majeure
- ❑ Permitting or regulatory approvals
- ❑ Activation and commissioning
- ❑ Liquidated damages/incentives
- ❑ Unusual schedule considerations
- ❑ Unscheduled delays due to adverse weather
- ❑ Owner determination of how special project issues will be scheduled
  - ❑ Selection, procurement, and installation of equipment
  - ❑ Stages of the project that must be handled differently than other project stages
  - ❑ Tie-ins, service interruptions, and road closures
  - ❑ Other special project issues
- ❑ Other user defined

L5. Project Quality Assurance & Control

Quality assurance and quality control procedures for the project need to be established, and should include assignment of responsibilities for approvals. These procedures may include the following:

- ❑ Administration of contracted professional services
- ❑ Responsibility during design and construction
- ❑ Testing of materials and workmanship
- ❑ Quality management system requirements, including audits (e.g., ISO 9000)
- ❑ Environmental quality control
- ❑ Submittals
- ❑ Inspection reporting requirements, including "hold or witness" points
- ❑ Progress photos
- ❑ Reviewing changes and modifications
- ❑ Communication documents (e.g., Requests for Information and Requests for Qualifications)
- ❑ Lessons-learned feedback
- ❑ Correction of impaired materials, equipment, and construction
- ❑ Jurisdictional quality control requirements such as those outlined in U.S. National Environmental Policy Act (NEPA)
- ❑ Other user defined

M. PROJECT EXECUTION PLAN

M1. Safety Procedures

Safety procedures and responsibilities must be identified for design consideration and construction. Safety issues to be addressed may include the following:

- ❑ Staging area for material handling
- ❑ Transportation of personnel and material to/from off-site storage
- ❑ Environmental safety procedures, including hazardous material handling
- ❑ Right-of-way needs for safe construction
- ❑ Safety in utility adjustment
- ❑ Interaction with the public/securing site
- ❑ Working at elevations/fall hazards
- ❑ Excavation
- ❑ Evacuation plans and procedures
- ❑ Drug testing
- ❑ First aid stations
- ❑ Location and/or availability of medical facilities
- ❑ Accident reporting and investigation, including incident management
- ❑ Pre-task planning
- ❑ Safety for motorists and workers, including work zone safety
- ❑ Requirements for safety personnel (e.g., designated/dedicated and third party)
- ❑ Safety orientation and planning
- ❑ Safety communication
- ❑ Safety incentives
- ❑ Owner Controlled Insurance Program (OCIP)
- ❑ Development of site-specific safety plan
- ❑ Crane action plans
- ❑ Contractor requirements
- ❑ Sub-contractor requirements
- ❑ Other special or unusual safety issues

M2. Owner Approval Requirements

All documents that require owner approval should be clearly defined. These documents may be developed in planning or during design or construction. These may include the following:

- ❑ Project objectives statement
- ❑ High-level scope and project definition
- ❑ Design philosophy
- ❑ Operating philosophy
- ❑ Maintenance philosophy
- ❑ Project milestone or resource-loaded schedule
- ❑ Corridor selection
- ❑ Permit responsibility matrix
- ❑ Schematic design approval
- ❑ Project design parameters
- ❑ Land acquisition strategy, including acquisition release
- ❑ Milestones for drawing approval
    - ❑ Comment
    - ❑ Approval
    - ❑ Bid issued
    - ❑ Construction
- ❑ Electronic model reviews
- ❑ Durations of approval cycle compatible with schedule
- ❑ Individual(s) responsible for reconciling comments before return
- ❑ Types of drawings that require formal approval
- ❑ Purchase documents
    - ❑ Data sheets
    - ❑ Inquiries
    - ❑ Bid tabs
    - ❑ Purchase orders
- ❑ Change management approval authority
- ❑ Quality assurance/quality control plan
- ❑ Vendor information
- ❑ Other

M3. Documentation/Deliverables

Deliverables during design, construction, and commissioning of the facility should be identified. The following items should be included in a list of deliverables:

- ❑ Field surveying books
- ❑ Estimates
- ❑ Required submissions and/or approvals
- ❑ Drawings
- ❑ Project correspondence
- ❑ Permits
- ❑ Project data books (e.g., quantity, format, contents, and completion date)
- ❑ Equipment folders (e.g., quantity, format, contents, and completion date)
- ❑ Design calculations (e.g., quantity, format, contents, and completion date)
- ❑ Procuring documents
- ❑ As-built documents
- ❑ Quality assurance documents
- ❑ Updated information systems and databases
- ❑ Operations and maintenance manuals
- ❑ Plans, specifications, and estimates (PS&E) checklist and data sheet
- ❑ Other user defined

M4. Computing & CADD/Model Requirements

Computing hardware, software, and Computer Aided Drafting and Design (CADD) requirements to support planning, design, and construction should be defined. These requirements should include any hard or soft model needs and computing guidelines. Evaluation criteria should include the following:

- ❑ Handling of life cycle facility data including asset information, models, and electronic documents
- ❑ Civil Information System (CIS) requirements
- ❑ Geographical Information System (GIS) requirements
- ❑ Building Information Modeling (BIM) requirements
- ❑ Owner/contractor standard symbols, file formats and details
- ❑ Information technology infrastructure to support electronic modeling systems, including uninterruptible power systems (UPS) and disaster recovery
- ❑ Application software preference—e.g., 2D and 3D CADD or application service provider (ASP)—including licensing requirements
- ❑ Configuration and administration of servers and systems documentation defined
- ❑ Compatibility requirements of information systems (e.g., design information system or construction information system)
- ❑ Security and auditing requirements defined
- ❑ Physical model requirements
- ❑ Other user defined

M5. Design/Construction Plan & Approach

A documented plan should be developed identifying specific approaches to be used in designing and constructing the project. This plan may include the following items:

- ❑ Organizational structure
- ❑ Work Breakdown Structure (WBS)
- ❑ Interface with other projects or facilities, including coordination
- ❑ Responsibility matrix
- ❑ Subcontracting strategy
- ❑ Project labor agreements
- ❑ Work week plan/schedule, including weekend and night work
- ❑ Permitting requirements and action plan
- ❑ Design and approval of sequencing with parcel acquisition
- ❑ Construction sequencing of events
- ❑ Site logistics plan
- ❑ Integration of safety requirements/program with plan
- ❑ Identification of critical activities that have potential impact on facilities (i.e., existing facilities, traffic flows, and utility shut downs and tie-ins)
- ❑ Quality assurance/quality control (QA/QC) plan
- ❑ Environmental monitoring plan
- ❑ Design and approvals sequencing of events
- ❑ Integration of permitting, design, right-of-way acquisition, utility adjustment, and construction
- ❑ Materials management, including field equipment and materials transportation, receiving, warehousing, staging, maintenance, and control
- ❑ Contractor meeting/reporting schedule
- ❑ Partnering or strategic alliances
- ❑ Alternative dispute resolution
- ❑ Responsibility for furnishings, equipment, and built-ins
- ❑ Public relations and community communications
- ❑ Other user defined

M6. Intercompany and Interagency Coordination & Agreements

Coordination with appropriate private owners, contractors, resource agencies, local governmental entities, and the public plays a vital role in project execution planning of proposed infrastructure projects. Both public and private entities may be responsible for coordination during project execution, and agreements should be in place to ensure efficient project delivery. Coordination is initiated at the appropriate levels. Coordination entities to consider may include the following:

- ❑ Owner/funding sources
- ❑ Key contractors and suppliers
- ❑ State historic preservation offices
- ❑ Natural resource conservation services
- ❑ Environmental protection agencies (e.g., the U.S. Environmental Protection Agency (EPA))
- ❑ Air quality boards
- ❑ Fish and wildlife services
- ❑ International boundary and water commissions
- ❑ Federal emergency management organizations (e.g., the U.S. Federal Emergency Management Agency (FEMA))
- ❑ Offices of habitat conservation
- ❑ Law enforcement agencies
- ❑ Immigration agencies
- ❑ Parks and wildlife agencies
- ❑ Federal, state, and municipal building departments
- ❑ Railroad agencies
- ❑ Federal agencies (e.g., the U.S. Army Corps of Engineers (USACE))
- ❑ Flood control district
- ❑ Departments of transportation
- ❑ Utility companies
- ❑ Special districts (e.g., municipal utility districts (MUDs) and roadway utility districts (RUDs))
- ❑ Other user defined

M7. Work Zone and Transportation Plan

A preliminary work zone and transportation plan should be developed to establish a full understanding of project logistics and safety. The plan should clearly show provisions for safe and efficient operation of all modes of transportation that are adjacent to or concurrent with the project during construction; this plan should include considerations for the safety of construction workers and inspection personnel. The plan should address the use of heavy equipment and the delivery and storage of equipment and materials during construction. The plan should be compliant with national, regional, and local jurisdictional requirements. Issues to consider include the following:

- ❑ Compliance with requirements (e.g., a transportation department's Manual of Uniform Traffic Control Devices (MUTCD) or other compliance publications)
- ❑ Control plan, including provisions to minimize disruption of services or functionality (e.g., lane rental requirements for a road construction project or liquidated damages for service down-time)
- ❑ Detours or bypass plans
- ❑ Appropriate signs, markings, and barricades per the traffic control plan
- ❑ Safety equipment
  - ❑ Barrels
  - ❑ Signage
  - ❑ Flagmen
  - ❑ Positive barriers
  - ❑ Vertical panels
  - ❑ Other safety equipment
- ❑ Clear zone protection devices
  - ❑ Concrete traffic barriers
  - ❑ Metal beam guard fencing
  - ❑ Appropriate end treatments
- ❑ Other clear zone protection devices ❑ Other appropriate warning devices
- ❑ Special permitting (e.g., for moving equipment or materials across a levee or a beach)
- ❑ Hazardous material movement
- ❑ Pedestrian safety
- ❑ Oversized loads
- ❑ Heavy hauls and lifts
- ❑ Transportation, including barges, sea-lifts, rail, trailers, and other equipment
- ❑ Remote location access
- ❑ Other user defined

M8. Project Completion Requirements

Issues related to project completion should be addressed to make sure that the project has a smooth transition to operations. The owner's required sequence for turnover of the project for pre-commissioning, testing, and start-up activation should be developed. It may include the following items:

- ❑ Sequence of turnover, including system identification and priority
- ❑ Contractor's and owner's required level of involvement
  - ❑ In pre-commissioning
  - ❑ In training
  - ❑ In testing
- ❑ Clear definition of mechanical/electrical acceptance/ approval requirements

Start-up requirements should be defined and responsibility should be established. A process should be in place to ensure that start-up planning will be performed. Issues include the following:

- ❑ Start-up goals
- ❑ Leadership responsibility
- ❑ Sequencing of start-up
- ❑ Technology start-up support on-site, including information technology
- ❑ Feedstock/raw materials
- ❑ Off-grade waste disposal
- ❑ Quality assurance/quality control
- ❑ Work force requirements

Substantial Completion (SC) is the point in time when the facilities are ready to be used for their intended purposes. Preliminary requirements for substantial completion need to be determined to assist the planning and design efforts. The following requirements may need to be addressed:

- ❑ Specific requirements for SC responsibilities developed and documented
- ❑ Warranty, permitting, insurance, and tax implication considerations
- ❑ Technology start-up support on-site, including information technology and systems
- ❑ Equipment/systems start-up and performance testing
- ❑ Occupancy phasing
- ❑ Final code inspection
- ❑ Calibration
- ❑ Verification
- ❑ Documentation
- ❑ Training requirements for all systems
- ❑ Community acceptance
- ❑ Landscape requirements
- ❑ Punch list completion plan and schedule
- ❑ Substantial completion certificate
- ❑ Other user defined

Appendix D:
Examples of Completed PDRIs

Example Project 1: Fluids

Project Type:	Fluids
Project:	Pipeline
Scope:	Approximately 70 km pipeline; shared route corridor; developing countries.
Budget:	Final cost approximately $130 million
Scheduled Completion:	June 2007
Date Scored:	February 16, 2010
Objective of the Meeting:	Use the PDRI for Infrastructure on a completed project as a tool to validate research hypothesis about front end planning.
Methodology:	Project team retroactively evaluated each element and collectively scored the project according to its scope definition within each element.
Project Status:	100 percent complete with construction and start-up
Performance Data:	$30 million over budget. Two months behind schedule. Change orders representing two percent of total costs.
Success rating:	Four out of five.
Major Findings/Areas for Further Study:	Overrun in execution duration due to change orders, government regulation changes, and late mobilization of workers. Land acquisition also contributed to delay and cost increases. Overall business performance was better than expected.

Project Definition Rating Index for Infrastructure
Project Score Sheet: Example Project 1: Fluids

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. PROJECT STRATEGY (Maximum Score = 112)							
A1. Need & Purpose Documentation	0	(2)	13	24	35	44	2
A2. Investment Studies & Alternatives Assessments	0	(1)	8	15	22	28	1
A3. Key Team Member Coordination	0	1	(6)	11	16	19	6
A4. Public Involvement	0	(1)	6	11	16	21	1
CATEGORY A TOTAL							**10**
B. OWNER/OPERATOR PHILOSOPHIES (Maximum Score = 67)							
B1. Design Philosophy	0	2	(7)	12	17	22	7
B2. Operating Philosophy	0	1	(5)	9	13	16	5
B3. Maintenance Philosophy	0	1	(4)	7	10	12	4
B4. Future Expansion & Alteration Considerations	(0)	1	9	9	13	17	0
CATEGORY B TOTAL							**16**
C. PROJECT FUNDING AND TIMING (Maximum Score = 70)							
C1. Funding & Programming	0	1	(6)	11	16	21	6
C2. Preliminary Project Schedule	0	2	(7)	12	17	22	7
C3. Contingencies	0	2	(8)	14	20	27	8
CATEGORY C TOTAL							**21**
D. PROJECT REQUIREMENTS (Maximum Score = 143)							
D1. Project Objectives Statement	0	(1)	6	11	16	19	1
D2. Functional Classification & Use	0	(1)	6	11	16	19	1
D3. Evaluation of Compliance Requirements	0	1	(6)	11	16	22	6
D4. Existing Environmental Conditions	0	(1)	6	11	16	22	1
D5. Site Characteristics Available vs. Required	0	1	(5)	9	13	18	5
D6. Dismantling & Demolition Requirements	(0)	1	4	7	10	11	0
D7. Determination of Utility Impacts	0	1	(6)	11	16	19	6
D8. Lead/Discipline Scope of Work	0	(1)	4	7	10	13	1
CATEGORY D TOTAL							**21**
E. VALUE ANALYSIS (Maximum Score = 45)							
E1. Value Engineering Procedures	0	(1)	3	5	7	10	1
E2. Design Simplification	0	0	(3)	6	9	11	3
E3. Material Alternatives Considered	0	(1)	3	5	7	9	1
E4. Constructability Procedures	0	1	5	(9)	13	15	9
CATEGORY E TOTAL							**14**
Section I Maximum Score = 437	SECTION I TOTAL						**82**

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

SECTION II – BASIS OF DESIGN							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
F. SITE INFORMATION (Maximum Score = 119)							
F1. Geotechnical Characteristics	0	2	7	12	17	21	12
F2. Hydrological Characteristics	0	1	4	7	10	13	7
F3. Surveys & Mapping	0	1	4	7	10	14	1
F4. Permitting Requirements	0	1	5	9	13	15	5
F5. Environmental Documentation	0	1	5	9	13	18	1
F6. Environmental Commitments & Mitigation	0	1	4	7	10	14	1
F7. Property Descriptions	0	1	3	5	7	10	1
F8. Right-of-Way Mapping & Site Issues	0	1	4	7	10	14	4
CATEGORY F TOTAL							**32**
G. LOCATION and GEOMETRY (Maximum Score = 47)							
G1. Schematic Layouts	0	1	4	7	10	13	4
G2. Horizontal & Vertical Alignment	0	1	4	7	10	13	1
G3. Cross-Sectional Elements	0	1	4	7	10	11	1
G4. Control of Access	0	1	3	5	7	10	3
CATEGORY G TOTAL							**9**
H. ASSOCIATED STRUCTURES and EQUIPMENT (Maximum Score = 47)							
H1. Support Structures	0	1	4	7	10	11	1
H2. Hydraulic Structures	0	1	3	5	7	9	1
H3. Miscellaneous Elements	0	1	3	5	7	7	1
H4. Equipment List	0	1	4	7	10	11	1
H5. Equipment Utility Requirements	0	1	3	5	7	9	1
CATEGORY H TOTAL							**5**
I. PROJECT DESIGN PARAMETERS (Maximum Score = 80)							
I1. Capacity	0	1	6	11	16	22	1
I2. Safety & Hazards	0	1	4	7	10	12	1
I3. Civil/Structural	0	1	5	9	13	15	5
I4. Mechanical/Equipment	0	1	3	5	7	10	1
I5. Electrical/Controls	0	1	3	5	7	10	3
I6. Operations/Maintenance	0	1	4	7	10	11	1
CATEGORY I TOTAL							**12**
Section II Maximum Score = 293	SECTION II TOTAL						58

Definition Levels

0 = Not Applicable | **2 = Minor Deficiencies** | **4 = Major Deficiencies**

1 = Complete Definition | **3 = Some Deficiencies** | **5 = Incomplete or Poor Definition**

SECTION III – EXECUTION APPROACH							
CATEGORY	Definition Level						
Element	0	1	2	3	4	5	Score
J. LAND ACQUISITION STRATEGY (Maximum Score = 60)							
J1. Local Public Agencies Contr. & Agreements	0	1	4	7	10	14	7
J2. Long-Lead Parcel & Utility Adjustment Identification & Acquisition	0	1	5	9	13	15	5
J3. Utility Agreement & Joint-Use Contracts	0	1	4	7	10	12	4
J4. Land Appraisal Requirements	0	1	3	5	7	10	3
J5. Advance Land Acquisition Requirements	0	1	3	5	7	9	3
CATEGORY J TOTAL							**22**
K. PROCUREMENT STRATEGY (Maximum Score = 47)							
K1. Project Delivery Method & Contr. Strategies	0	1	5	9	13	15	13
K2. Long-Lead/Critical Equip. & Mat'ls Identif.	0	1	4	7	10	13	1
K3. Procurement Procedures & Plans	0	1	4	7	10	11	1
K4. Procurement Responsibility Matrix	0	0	2	4	6	8	0
CATEGORY K TOTAL							**15**
L. PROJECT CONTROL (Maximum Score = 80)							
L1. Right-of-Way & Utilities Cost Estimates	0	1	3	5	7	10	1
L2. Design & Construction Cost Estimates	0	2	8	14	20	25	14
L3. Project Cost Control	0	1	5	9	13	15	1
L4. Project Schedule Control	0	1	5	9	13	17	9
L5. Project Quality Assurance & Control	0	1	4	7	10	13	10
CATEGORY L TOTAL							**35**
M. PROJECT EXECUTION PLAN (Maximum Score = 83)							
M1. Safety Procedures	0	1	4	7	10	12	1
M2. Owner Approval Requirements	0	1	3	5	7	10	1
M3. Documentation/Deliverables	0	1	3	5	7	9	3
M4. Computing & CADD/Model Requirements	0	1	3	5	7	7	1
M5. Design/Construction Plan & Approach	0	1	4	7	10	14	1
M6. Intercompany and Interagency Coordination & Agreements	0	1	4	7	10	13	1
M7. Work Zone and Transportation Plan	0	1	3	5	7	9	1
M8. Project Completion Requirements	0	1	3	5	7	9	5
CATEGORY M TOTAL							**14**
Section III Maximum Score = 270 — SECTION III TOTAL							**86**

PDRI TOTAL SCORE **226**

Maximum Score = 1000

Definition Levels

0 = Not Applicable	**2 = Minor Deficiencies**	**4 = Major Deficiencies**
1 = Complete Definition	**3 = Some Deficiencies**	**5 = Incomplete or Poor Definition**

Example Project 2: People and Freight

Project Type:	People and Freight
Project:	Highway
Scope:	Approximately nine kilometer highway corridor expressway extension, tolled; reduced to seven kilometer after scope changes; tropical location in environmentally sensitive area.
Budget:	Final cost approximately $200 million
Scheduled Completion:	December 2011
Date Scored:	February 18, 2010
Objective of the Meeting:	Use the PDRI for Infrastructure on a completed project as a tool to validate research hypothesis about front end planning.
Methodology:	Project Manager evaluated each element and scored the project according to its scope definition within each element.
Project Status:	100 percent complete with feasibility, concept, and detailed scope; before design and construction
Performance Data:	Within budget due to scope reduction. Over 40 months over schedule. Change orders representing three percent of total costs.
Success rating:	Three out of five.
Major Findings/Areas for Further Study:	Many delays caused by significant changes in scope. Access to properties had significant impact on surveying and geotechnical studies. Changes in funding changed scope of work.

Project Definition Rating Index for Infrastructure
Project Score Sheet: Example Project 2: People and Freight

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
A. PROJECT STRATEGY (Maximum Score = 112)							
A1. Need & Purpose Documentation	0	(2)	13	24	35	44	2
A2. Investment Studies & Alternatives Assessments	0	1	8	(15)	22	28	15
A3. Key Team Member Coordination	0	(1)	6	11	16	19	1
A4. Public Involvement	0	(1)	6	11	16	21	1
CATEGORY A TOTAL							**19**
B. OWNER/OPERATOR PHILOSOPHIES (Maximum Score = 67)							
B1. Design Philosophy	0	2	(7)	12	17	22	7
B2. Operating Philosophy	0	1	(5)	9	13	16	5
B3. Maintenance Philosophy	0	1	4	7	(10)	12	10
B4. Future Expansion & Alteration Considerations	0	(1)	9	9	13	17	1
CATEGORY B TOTAL							**23**
C. PROJECT FUNDING AND TIMING (Maximum Score = 70)							
C1. Funding & Programming	0	1	6	(11)	16	21	11
C2. Preliminary Project Schedule	0	(2)	7	12	17	22	2
C3. Contingencies	0	2	8	14	20	(27)	27
CATEGORY C TOTAL							**40**
D. PROJECT REQUIREMENTS (Maximum Score = 143)							
D1. Project Objectives Statement	0	1	(6)	11	16	19	6
D2. Functional Classification & Use	0	(1)	6	11	16	19	1
D3. Evaluation of Compliance Requirements	0	(1)	6	11	16	22	1
D4. Existing Environmental Conditions	0	(1)	6	11	16	22	1
D5. Site Characteristics Available vs. Required	0	(1)	5	9	13	18	1
D6. Dismantling & Demolition Requirements	0	(1)	4	7	10	11	1
D7. Determination of Utility Impacts	0	(1)	6	11	16	19	1
D8. Lead/Discipline Scope of Work	0	1	4	(7)	10	13	7
CATEGORY D TOTAL							**19**
E. VALUE ANALYSIS (Maximum Score = 45)							
E1. Value Engineering Procedures	0	1	3	(5)	7	10	5
E2. Design Simplification	0	0	3	(6)	9	11	6
E3. Material Alternatives Considered	0	(1)	3	5	7	9	1
E4. Constructability Procedures	0	1	(5)	9	13	15	5
CATEGORY E TOTAL							**17**
Section I Maximum Score = 437 SECTION I TOTAL							**118**

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

SECTION II – BASIS OF DESIGN							
CATEGORY Element	Definition Level						Score
	0	1	2	3	4	5	
F. SITE INFORMATION (Maximum Score = 119)							
F1. Geotechnical Characteristics	0	2	7	12	17	21	2
F2. Hydrological Characteristics	0	1	4	7	10	13	1
F3. Surveys & Mapping	0	1	4	7	10	14	1
F4. Permitting Requirements	0	1	5	9	13	15	1
F5. Environmental Documentation	0	1	5	9	13	18	1
F6. Environmental Commitments & Mitigation	0	1	4	7	10	14	7
F7. Property Descriptions	0	1	3	5	7	10	1
F8. Right-of-Way Mapping & Site Issues	0	1	4	7	10	14	1
CATEGORY F TOTAL							**15**
G. LOCATION and GEOMETRY (Maximum Score = 47)							
G1. Schematic Layouts	0	1	4	7	10	13	1
G2. Horizontal & Vertical Alignment	0	1	4	7	10	13	1
G3. Cross-Sectional Elements	0	1	4	7	10	11	1
G4. Control of Access	0	1	3	5	7	10	1
CATEGORY G TOTAL							**4**
H. ASSOCIATED STRUCTURES and EQUIPMENT (Maximum Score = 47)							
H1. Support Structures	0	1	4	7	10	11	4
H2. Hydraulic Structures	0	1	3	5	7	9	3
H3. Miscellaneous Elements	0	1	3	5	7	7	1
H4. Equipment List	0	1	4	7	10	11	1
H5. Equipment Utility Requirements	0	1	3	5	7	9	1
CATEGORY H TOTAL							**10**
I. PROJECT DESIGN PARAMETERS (Maximum Score = 80)							
I1. Capacity	0	1	6	11	16	22	11
I2. Safety & Hazards	0	1	4	7	10	12	1
I3. Civil/Structural	0	1	5	9	13	15	1
I4. Mechanical/Equipment	0	1	3	5	7	10	3
I5. Electrical/Controls	0	1	3	5	7	10	7
I6. Operations/Maintenance	0	1	4	7	10	11	10
CATEGORY I TOTAL							**33**
Section II Maximum Score = 293	SECTION II TOTAL						**62**

Definition Levels
0 = Not Applicable | **2 = Minor Deficiencies** | **4 = Major Deficiencies**
1 = Complete Definition | **3 = Some Deficiencies** | **5 = Incomplete or Poor Definition**

SECTION III – EXECUTION APPROACH							
CATEGORY Element	**Definition Level**						**Score**
	0	**1**	**2**	**3**	**4**	**5**	
J. LAND ACQUISITION STRATEGY (Maximum Score = 60)							
J1. Local Public Agencies Contr. & Agreements	0	1	4	7	10	14	10
J2. Long-Lead Parcel & Utility Adjustment Identification & Acquisition	0	1	5	9	13	15	5
J3. Utility Agreement & Joint-Use Contracts	0	1	4	7	10	12	4
J4. Land Appraisal Requirements	0	1	3	5	7	10	1
J5. Advance Land Acquisition Requirements	0	1	3	5	7	9	1
CATEGORY J TOTAL							**29**
K. PROCUREMENT STRATEGY (Maximum Score = 47)							
K1. Project Delivery Method & Contr. Strategies	0	1	5	9	13	15	1
K2. Long-Lead/Critical Equip. & Mat'ls Identif.	0	1	4	7	10	13	1
K3. Procurement Procedures & Plans	0	1	4	7	10	11	1
K4. Procurement Responsibility Matrix	0	0	2	4	6	8	6
CATEGORY K TOTAL							**9**
L. PROJECT CONTROL (Maximum Score = 80)							
L1. Right-of-Way & Utilities Cost Estimates	0	1	3	5	7	10	5
L2. Design & Construction Cost Estimates	0	2	8	14	20	25	8
L3. Project Cost Control	0	1	5	9	13	15	13
L4. Project Schedule Control	0	1	5	9	13	17	9
L5. Project Quality Assurance & Control	0	1	4	7	10	13	10
CATEGORY L TOTAL							**42**
M. PROJECT EXECUTION PLAN (Maximum Score = 83)							
M1. Safety Procedures	0	1	4	7	10	12	7
M2. Owner Approval Requirements	0	1	3	5	7	10	1
M3. Documentation/Deliverables	0	1	3	5	7	9	1
M4. Computing & CADD/Model Requirements	0	1	3	5	7	7	3
M5. Design/Construction Plan & Approach	0	1	4	7	10	14	10
M6. Intercompany and Interagency Coordination & Agreements	0	1	4	7	10	13	7
M7. Work Zone and Transportation Plan	0	1	3	5	7	9	3
M8. Project Completion Requirements	0	1	3	5	7	9	3
CATEGORY M TOTAL							**35**
Section III Maximum Score = 270 — SECTION III TOTAL							**115**

PDRI TOTAL SCORE **295**

Maximum Score = 1000

Definition Levels

0 = Not Applicable	**2 = Minor Deficiencies**	**4 = Major Deficiencies**
1 = Complete Definition	**3 = Some Deficiencies**	**5 = Incomplete or Poor Definition**

Example Project 3: Energy

Project Type:	Energy
Project:	Highway
Scope:	Replacement of an existing electrical substation that was unable to keep up with voltage demands in a densely populated area.
Budget:	Final cost approximately $32 million
Scheduled Completion:	May 2008
Date Scored:	March 12, 2010
Objective of the Meeting:	Use the PDRI for Infrastructure on a completed project as a tool to validate research hypothesis about front end planning.
Methodology:	Benchmarking advisor provided project information collected from the project's management team and historical data.
Project Status:	100 percent complete with front end planning, design, and construction
Performance Data:	$700,000 under budget. Five months behind schedule. Change orders representing one percent of total costs.
Success rating:	Four out of five.
Major Findings/Areas for Further Study:	A change in priorities during execution gave an opportunity to reduce cost and led to an increase in project duration.

Project Definition Rating Index for Infrastructure
Project Score Sheet: Example Project 3: Energy

SECTION I – BASIS OF PROJECT DECISION							
CATEGORY	Definition Level						
Element	0	1	2	3	4	5	Score
A. PROJECT STRATEGY (Maximum Score = 112)							
A1. Need & Purpose Documentation	0	**(2)**	13	24	35	44	2
A2. Investment Studies & Alternatives Assessments	0	**(1)**	8	15	22	28	1
A3. Key Team Member Coordination	0	1	**(6)**	11	16	19	6
A4. Public Involvement	0	**(1)**	6	11	16	21	1
						CATEGORY A TOTAL	**10**
B. OWNER/OPERATOR PHILOSOPHIES (Maximum Score = 67)							
B1. Design Philosophy	0	**(2)**	7	12	17	22	2
B2. Operating Philosophy	0	**(1)**	5	9	13	16	1
B3. Maintenance Philosophy	0	**(1)**	4	7	10	12	1
B4. Future Expansion & Alteration Considerations	0	**(1)**	9	9	13	17	1
						CATEGORY B TOTAL	**5**
C. PROJECT FUNDING AND TIMING (Maximum Score = 70)							
C1. Funding & Programming	0	**(1)**	6	11	16	21	1
C2. Preliminary Project Schedule	0	2	**(7)**	12	17	22	7
C3. Contingencies	0	**(2)**	8	14	20	27	2
						CATEGORY C TOTAL	**10**
D. PROJECT REQUIREMENTS (Maximum Score = 143)							
D1. Project Objectives Statement	0	**(1)**	6	11	16	19	1
D2. Functional Classification & Use	0	**(1)**	6	11	16	19	1
D3. Evaluation of Compliance Requirements	0	**(1)**	6	11	16	22	1
D4. Existing Environmental Conditions	0	**(1)**	6	11	16	22	1
D5. Site Characteristics Available vs. Required	0	**(1)**	5	9	13	18	1
D6. Dismantling & Demolition Requirements	0	**(1)**	4	7	10	11	1
D7. Determination of Utility Impacts	0	**(1)**	6	11	16	19	1
D8. Lead/Discipline Scope of Work	0	**(1)**	4	7	10	13	1
						CATEGORY D TOTAL	**8**
E. VALUE ANALYSIS (Maximum Score = 45)							
E1. Value Engineering Procedures	0	**(1)**	3	5	7	10	1
E2. Design Simplification	**(0)**	0	3	6	9	11	0
E3. Material Alternatives Considered	0	**(1)**	3	5	7	9	1
E4. Constructability Procedures	0	**(1)**	5	9	13	15	1
						CATEGORY E TOTAL	**3**
Section I Maximum Score = 437						SECTION I TOTAL	**36**

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

SECTION II – BASIS OF DESIGN							
CATEGORY Element	**Definition Level**						**Score**
	0	**1**	**2**	**3**	**4**	**5**	
F. SITE INFORMATION (Maximum Score = 119)							
F1. Geotechnical Characteristics	0	2	7	12	17	21	2
F2. Hydrological Characteristics	0	1	4	7	10	13	1
F3. Surveys & Mapping	0	1	4	7	10	14	0
F4. Permitting Requirements	0	1	5	9	13	15	1
F5. Environmental Documentation	0	1	5	9	13	18	1
F6. Environmental Commitments & Mitigation	0	1	4	7	10	14	1
F7. Property Descriptions	0	1	3	5	7	10	1
F8. Right-of-Way Mapping & Site Issues	0	1	4	7	10	14	0
CATEGORY F TOTAL							**7**
G. LOCATION and GEOMETRY (Maximum Score = 47)							
G1. Schematic Layouts	0	1	4	7	10	13	1
G2. Horizontal & Vertical Alignment	0	1	4	7	10	13	1
G3. Cross-Sectional Elements	0	1	4	7	10	11	1
G4. Control of Access	0	1	3	5	7	10	1
CATEGORY G TOTAL							**4**
H. ASSOCIATED STRUCTURES and EQUIPMENT (Maximum Score = 47)							
H1. Support Structures	0	1	4	7	10	11	1
H2. Hydraulic Structures	0	1	3	5	7	9	0
H3. Miscellaneous Elements	0	1	3	5	7	7	1
H4. Equipment List	0	1	4	7	10	11	1
H5. Equipment Utility Requirements	0	1	3	5	7	9	1
CATEGORY H TOTAL							**4**
I. PROJECT DESIGN PARAMETERS (Maximum Score = 80)							
I1. Capacity	0	1	6	11	16	22	1
I2. Safety & Hazards	0	1	4	7	10	12	1
I3. Civil/Structural	0	1	5	9	13	15	1
I4. Mechanical/Equipment	0	1	3	5	7	10	1
I5. Electrical/Controls	0	1	3	5	7	10	1
I6. Operations/Maintenance	0	1	4	7	10	11	4
CATEGORY I TOTAL							**9**
Section II Maximum Score = 293 — SECTION II TOTAL							**24**

Definition Levels
0 = Not Applicable **2 = Minor Deficiencies** **4 = Major Deficiencies**
1 = Complete Definition **3 = Some Deficiencies** **5 = Incomplete or Poor Definition**

SECTION III – EXECUTION APPROACH							
CATEGORY Element	**Definition Level**						**Score**
	0	**1**	**2**	**3**	**4**	**5**	
J. LAND ACQUISITION STRATEGY (Maximum Score = 60)							
J1. Local Public Agencies Contr. & Agreements	(0)	1	4	7	10	14	0
J2. Long-Lead Parcel & Utility Adjustment Identification & Acquisition	(0)	1	5	9	13	15	0
J3. Utility Agreement & Joint-Use Contracts	(0)	1	4	7	10	12	0
J4. Land Appraisal Requirements	(0)	1	3	5	7	10	0
J5. Advance Land Acquisition Requirements	(0)	1	3	5	7	9	0
CATEGORY J TOTAL							**0**
K. PROCUREMENT STRATEGY (Maximum Score = 47)							
K1. Project Delivery Method & Contr. Strategies	0	(1)	5	9	13	15	1
K2. Long-Lead/Critical Equip. & Mat'ls Identif.	0	(1)	4	7	10	13	1
K3. Procurement Procedures & Plans	0	1	(4)	7	10	11	4
K4. Procurement Responsibility Matrix	0	0	(2)	4	6	8	2
CATEGORY K TOTAL							**8**
L. PROJECT CONTROL (Maximum Score = 80)							
L1. Right-of-Way & Utilities Cost Estimates	(0)	1	3	5	7	10	0
L2. Design & Construction Cost Estimates	0	(2)	8	14	20	25	2
L3. Project Cost Control	0	(1)	5	9	13	15	1
L4. Project Schedule Control	0	1	(5)	9	13	17	5
L5. Project Quality Assurance & Control	0	(1)	4	7	10	13	1
CATEGORY L TOTAL							**9**
M. PROJECT EXECUTION PLAN (Maximum Score = 83)							
M1. Safety Procedures	0	(1)	4	7	10	12	1
M2. Owner Approval Requirements	0	(1)	3	5	7	10	1
M3. Documentation/Deliverables	0	(1)	3	5	7	9	1
M4. Computing & CADD/Model Requirements	0	(1)	3	5	7	7	1
M5. Design/Construction Plan & Approach	0	(1)	4	7	10	14	1
M6. Intercompany and Interagency Coordination & Agreements	0	1	(4)	7	10	13	4
M7. Work Zone and Transportation Plan	0	(1)	3	5	7	9	1
M8. Project Completion Requirements	0	(1)	3	5	7	9	1
CATEGORY M TOTAL							**11**
Section III Maximum Score = 270 — SECTION III TOTAL							**28**

PDRI TOTAL SCORE **88**

Maximum Score = 1000

Definition Levels

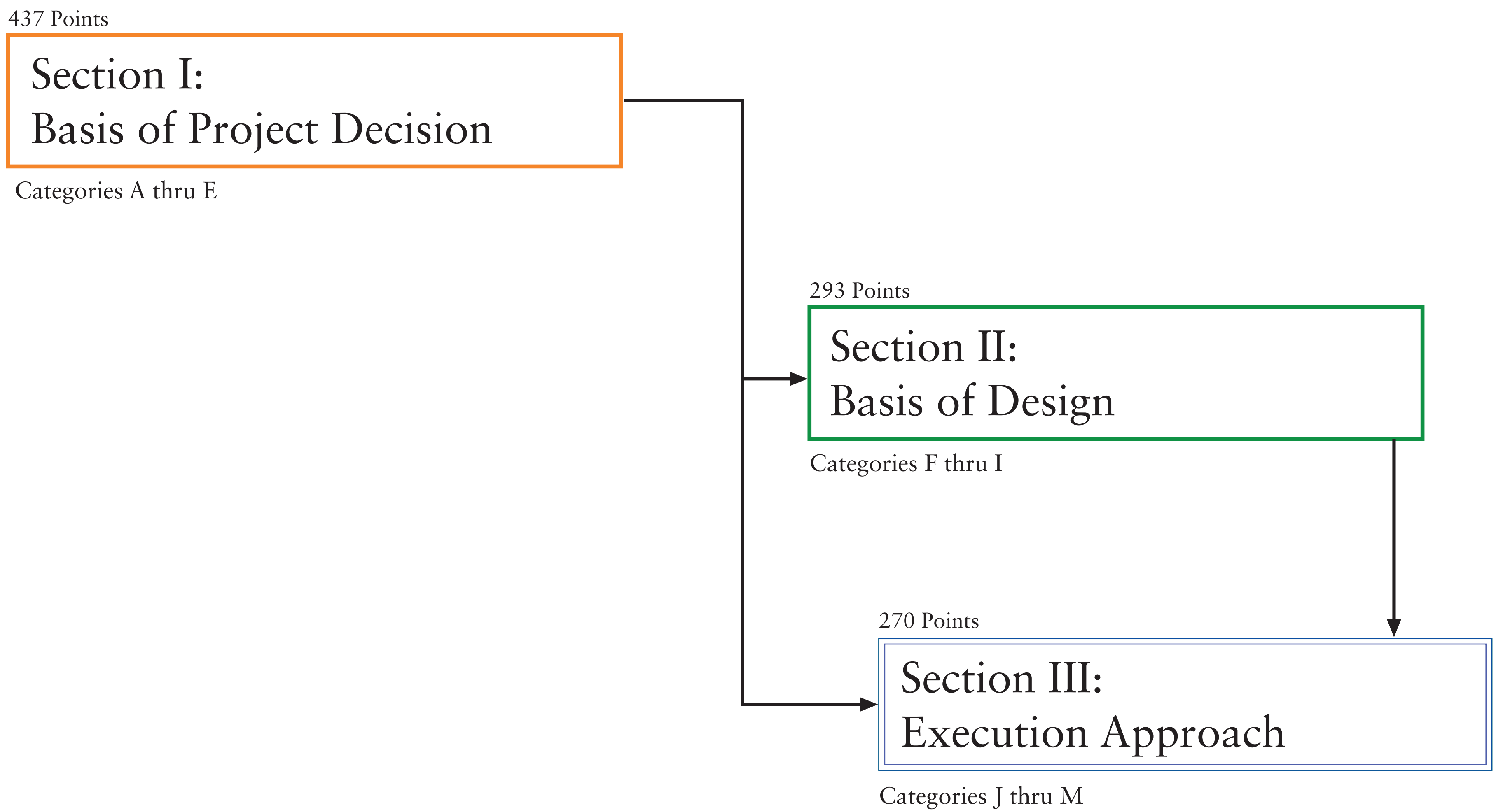
0 = Not Applicable | **2 = Minor Deficiencies** | **4 = Major Deficiencies**

1 = Complete Definition | **3 = Some Deficiencies** | **5 = Incomplete or Poor Definition**

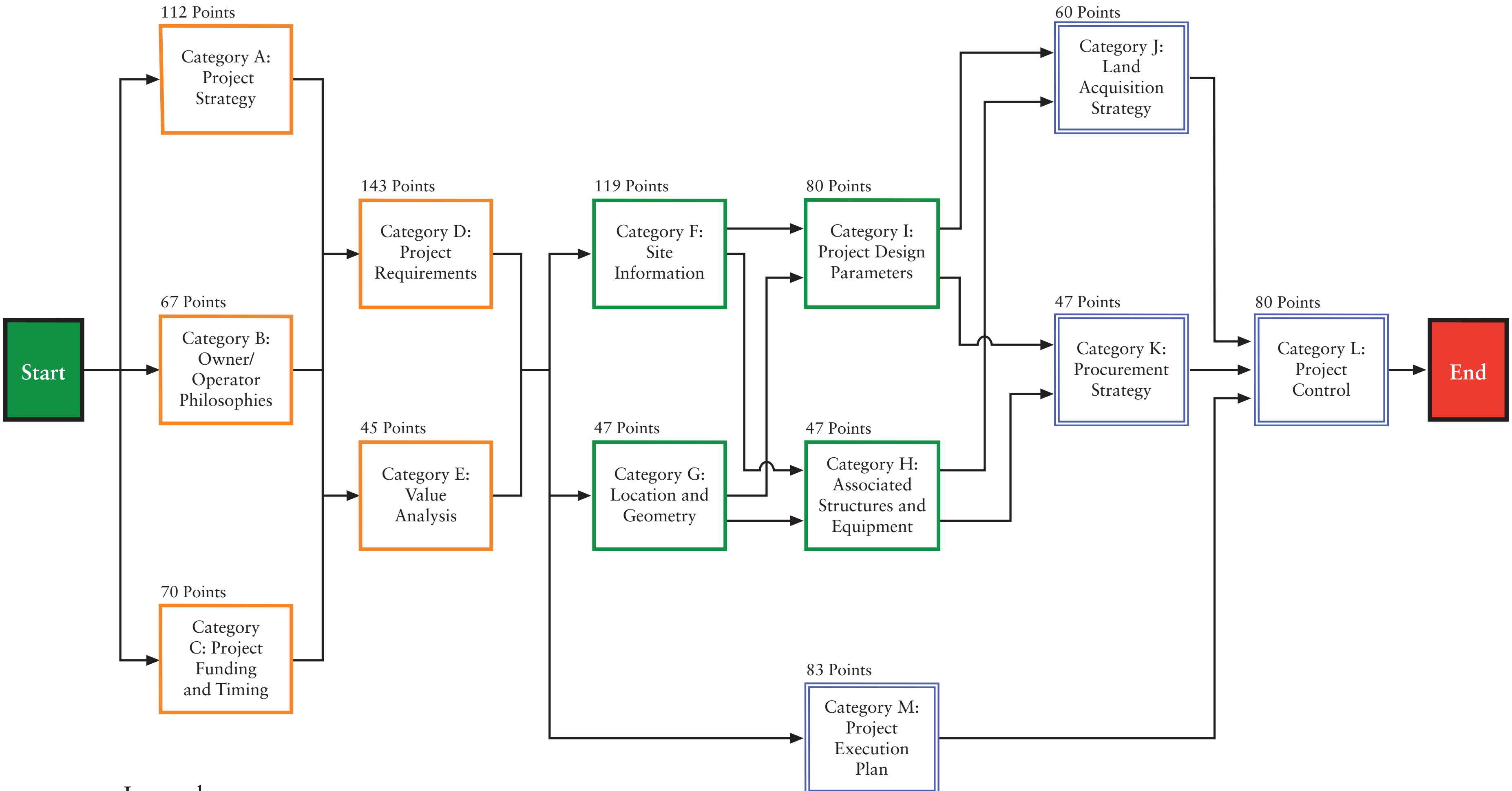
Appendix E:

Logic Flow Diagrams

Section Diagram



Category Diagram



Legend

Section I
Basis of Project Decision

Section II
Basis of Design

Section III
Execution Approach

Logic Flow Diagrams Project Definition Rating Index (PDRI) for Infrastructure Projects	
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Appendix F:

Facilitation Instructions

After many years of observing the PDRI process, the research team has determined that an external facilitator—a person who is not directly involved with the project—is essential to ensuring that the PDRI assessment session is effective. Whether the facilitator is a person internal to the organization or an outside consultant, he or she should be experienced in front end planning, should be familiar with the PDRI tool and terminology, and should have excellent facilitation skills. The following issues should be addressed by the facilitator to prepare for and conduct the PDRI assessment.

Pre-meeting Activities

The facilitator should establish a meeting with the project manager/engineer to receive a briefing on the nature and purpose of the project to be evaluated. The facilitator's objective should be to learn enough about the project from the project manager/engineer to be able to ask intelligent/probing questions of the project team members during the session. Many times in PDRI assessment sessions, the open-ended discussions concerning key elements provide the most value. Therefore, it is the responsibility of the facilitator to ask the types of questions that will generate an open discussion. Gaining some insight into the nature and circumstances of the project prior to the assessment helps in the formulation of such questions.

This meeting also serves as a good opportunity to preview the PDRI elements to see if any of them do not apply to the project at hand. This is especially true for small projects or renovations. In some cases, it is obvious that some of the elements do not apply, and these can be removed in advance to save the team time in the assessment.

The facilitator should inform the project manager that this is her/his opportunity to listen to the team members to see how well they understand the scope of work. The project manager should work with the facilitator to probe the design team and the owner to ensure clear two-way understanding of scope requirements and expectations. If the project manager dominates the discussion and the subsequent scoring, the rest of the design team will quickly "clam up" and fall in line. This will result in a PDRI assessment that reflects the understanding of the project manager, not the team members.

The facilitator should remind the project manager that the PDRI assessment session is an opportunity for team building and alignment of the team members on the project's critical requirements. Experience has shown that serving food—perhaps lunch or breakfast—can help to increase participation as well as interaction between team members.

The facilitator and project manager should discuss who, among the key stakeholders, should attend the session. Ensure that all key stakeholders are in attendance. Reducing the number of attendees will make the session go more efficiently, but this may compromise the true value of the PDRI assessment. Work with the project manager to send out meeting notices in time for the major stakeholders to be able to attend.

Logistics

The facilitator should ensure that the facilities are large enough to comfortably accommodate the key project stakeholders. One method of assessment is to utilize a computer projector to keep score as the assessment progresses. Therefore, a room with a screen, a computer, and a projector is a plus. The PDRI scores can also be tabulated manually. When tabulated manually, separate score sheets and element definitions should be given to each participant so the entire team can follow along.

The assessment session takes approximately two to four hours per project. It could take the full four hours for an inexperienced team or for a more experienced team faced with a very complex project. As teams within an organization get accustomed to the PDRI sessions, the time will drop to around two hours. However, it is the discussion occurring during the assessment session that is perhaps its most important benefit. Do not allow an artificial time limit to restrain open communications between team members. Some organizations conduct the sessions over an extended lunch period. In these situations, it is best to start with a short lunch period as an ice breaker and then to conduct the session.

The facilitator should use the following checklist to ensure that the room is set up in advance:

- ❑ Make sure the computer, projector, and programs are functioning.
- ❑ Make sure a flip chart is available.

- ❑ Set up the notes and action items pages.
- ❑ Make sure all participants have the proper handouts.
- ❑ When using the automated PDRI Scoring Programs, make sure the operator is skilled. Lack of computer skills and preparation can lead to ineffectiveness.
- ❑ Ensure that the programs are loaded and working prior to the session.
- ❑ Designate a scribe to capture actions on a flip chart as the session progresses.

Participants

Suggested attendees of the assessment session may include the following:

- ❑ Engineering Team Discipline Leads and Support Services, as required
- ❑ Project Manager/Project Engineer(s)
- ❑ Owner Engineering Project Representatives
- ❑ Owner Business Sponsor
- ❑ Owner Operations – Key Personnel
- ❑ Owner Support Services – Maintenance, Construction, Safety, Environmental, Logistics, QA/QC, Procurement, among others required
- ❑ Contractors if possible.

It is important that all assessment session participants come prepared to actively engage in the assessment. Typically this involvement can be facilitated by sending the PDRI assessment sheets and element descriptions out ahead of time as a pre-reading assignment. Expectations of participants include the following:

- ❑ All participants should be prepared to discuss their understanding of the elements that apply to them and to voice any concerns they have about them.
- ❑ Design/engineering should be prepared to explain what they are doing with regard to each PDRI element.
- ❑ Owner representatives should voice their expectations and question the planning team to ensure their full understanding.

Roles and responsibilities during the assessment session should include the following:

- ❑ The project manager should assist the facilitator to probe the team members for answers and insight.
- ❑ The facilitator will ensure that all participants have an opportunity to voice their opinions and concerns.

Conducting the session

The facilitator should use the following checklist to ensure that the session is meaningful and useful to the team:

- ❑ The facilitator or project manager should define the purpose and desired outcomes of the assessment session.
- ❑ The facilitator should provide the team members with a short overview of the PDRI.
- ❑ The project manager should give a quick update of the project and its status, including progress supporting the estimate and plan.
- ❑ The facilitator should explain the scoring mechanism (Definition Levels 0, 1, 2, 3, 4, and 5) and explain that the evaluation is a consensus activity.
- ❑ The facilitator should explain that certain elements may apply more to certain team members or stakeholders. The facilitator should make sure that these key stakeholders have the greatest say in deciding the level of definition.
- ❑ The facilitator should keep the session moving and not allowing the participants to "bog down." Participants often want to "solve the problem" during the assessment session. The facilitator should not allow this to happen. It is important to remember that the session is to perform a detailed assessment only and that actions can be performed later.
- ❑ The facilitator should always challenge assumptions and continue to ask the question, "Is the material in writing?"
- ❑ The following assessment session objectives should be noted at the start of the meeting:
  1. Capture the degree of definition for each element.
  2. Capture significant comments from open discussions.
  3. Capture action items, assign responsibility and due dates—either at the end of the session, or shortly thereafter.

4. Ensure that the team understands the notes captured and agrees with the path forward.
5. Create alignment among the session attendees.

Roles and responsibilities/expectations

- ❑ Post session activities: The facilitator should ensure that the PDRI notes, action items, and score card are all published within 48 hours of the sessions. The ideal target is 24 hours.
- ❑ If possible, the facilitator should stay engaged with the team to ensure that all action items are completed as required to support the scope definition process.
- ❑ The project manager should ensure that the actions are addressed.

Small Project Considerations

- ❑ Small retrofit projects or single discipline projects may have several elements that do not apply.
- ❑ As previously mentioned, the facilitator and project manager can meet ahead of time to identify some of these inapplicable elements.
- ❑ Assigning a zero to a significant number of PDRI elements can greatly affect the score. It is best to use the normalized score in these cases, because less significant elements can have a more significant impact on the overall score. Be careful in interpretation of this score.

The PDRI was originally designed to evaluate the definition of an entire unit, building, facility, or item of infrastructure. On smaller retro-fit projects, the facilitator may have to make the leap from an entire infrastructure project to a small component of existing infrastructure. For example, a project to install a new substation may not have a product, a technology, or require any process simplification. It does, however, have a design capacity that it is expected by the owner/operators.

Experience has shown that the smaller retro-fit projects do not get the same level of attention from owner operations that a larger project might receive. In many cases, the PDRI assessment session may be the very first opportunity the planning design team has to meet with the owner operations personnel to discuss the expectations of the project. The facilitator must be fully aware that such situations are possible before conducting the session. In such cases, the facilitator should make a special effort to ensure that 1) the owner's operation personnel attend the session and 2) open discussions take place to establish mutual understanding.

Alliance-Planned Projects

Many smaller projects are conducted by an alliance design firm. These firms act as the design/engineering capability for the facility owner and may execute numerous small projects per year. Many of the PDRI elements refer to location, standards, stress requirements, hazard analysis, deliverables, accounting, and other repetitive requirements. For these types of projects, the facilitator will merely have to ask the question, "Is there anything different or unusual about this project for this element?" It is also a good time to ask whether there is any opportunity for improvement in any of these areas that would improve the project and other projects to follow.

Appendix G:
Example Action List

Project title/date:

(Sorted in order of PDRI element)

Item #	PDRI Element(s)	Level of Definition	PDRI Element Score	Item Description	Date Completed	Responsible

Example Pipeline Project

Project title/date: Project Assessment Session Action Items for Big Oil Pipeline, June 22, 20xx

(Sorted in order of PDRI element)

Item #	PDRI Element(s)	Level of Definition	PDRI Element Score	Item Description	Date Completed	Responsible
1	A1	3	24	Finalize need and purpose documentation and get management buy-off.	July 1, 20xx	John Ramos
2	A4	5	21	Develop a public involvement plan for the project.	July 1, 20xx	Jake Blinn
3	C3	3	14	Develop a contingency plan for the project.	July 1, 20xx	Sue Howard
4	D1	5	19	Develop a project objective statement and get buy-off from key stakeholders.	July 15, 20xx	Jose Garcia
5	I1	4	16	Finalize pipeline capacity study: • tie back to business plan • look at venture partner obligations • flow rates • friction and head loss • and so on	July 31, 20xx	Jake Blinn
6	L1	4	7	Begin working on preliminary (Class 1) right-of-way and utilities cost estimates.	July 31, 20xx	Tina Towne
				And so on.....		

References

1. *Project Definition Rating Index (PDRI) for Industrial Projects*. Research Report 113-11. Construction Industry Institute, Austin, Texas, 1995.

2. *Development of the Project Definition Rating Index (PDRI) for Building Projects*. Research Report 155-11. Construction Industry Institute, Austin, Texas, 1999.

3. *Pre-Project Planning Tools: PDRI and Alignment*, Research Summary 113-1, Construction Industry Institute, Austin, Texas, 1997.

4. *Alignment during Pre-Project Planning*, Implementation Resource 113-3, Version 4.0, Construction Industry Institute, Austin, Texas, 2013.

5. *PDRI: Project Definition Rating Index – Building Projects*, Implementation Resource 155-2, Version 4.0, Construction Industry Institute, Austin, Texas, 2013.

6. *Data Analysis to Support Front End Planning Implementation*. Research Report 213-11. Construction Industry Institute, Austin, Texas, 2005.

7. *Front End Planning: Break the Rules, Pay the Price*, Research Summary 213-1, Construction Industry Institute, Austin, Texas, 2006.

8. *PDRI: Project Definition Rating Index – Industrial Projects*, Implementation Resource 113-2, Version 4.0, Construction Industry Institute, Austin, Texas, 2013.

9. *Front End Planning for Renovation and Revamp Projects: An Overview*, Research Summary 242-1, Construction Industry Institute, Austin, Texas, 2008.

10. *Front End Planning for Renovation and Revamp*, Implementation Resource 242-2, Version 4.0, Construction Industry Institute, Austin, Texas, 2013.

11. *Development of the Project Definition Rating Index for Infrastructure Projects*. Research Report 268-11, Construction Industry Institute, Austin, Texas, 2010.

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