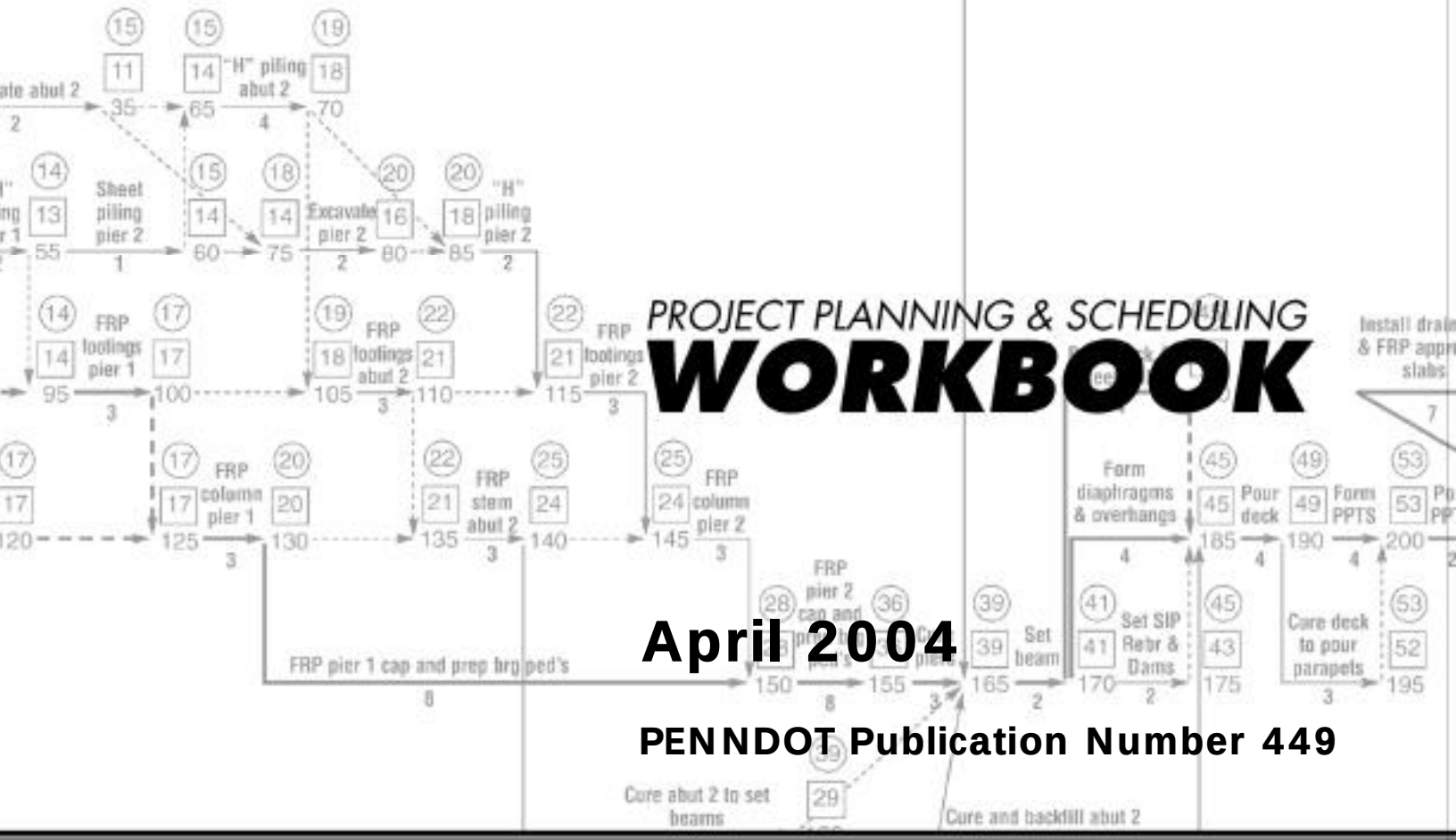


PROJECT PLANNING & SCHEDULING WORKBOOK

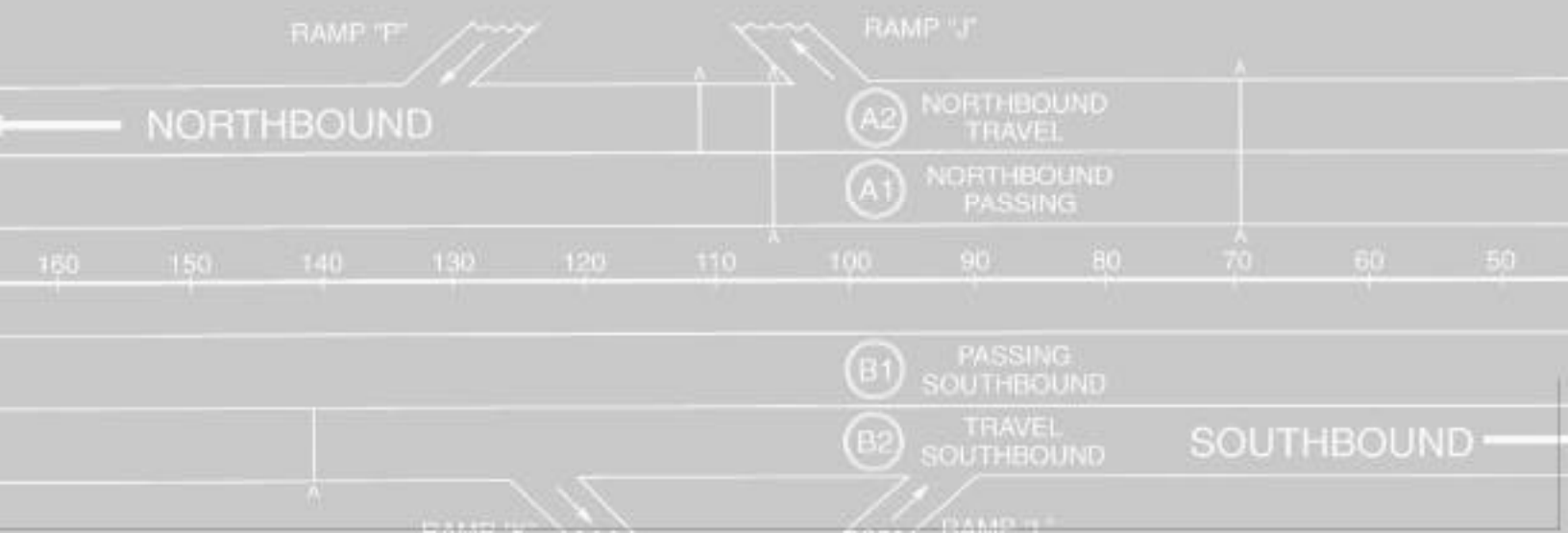
April 2004

PENNDOT Publication Number 449

For Training Workshop Information:

Bureau of Construction and Materials
Pennsylvania Department of Transportation

Commonwealth Keystone Building
400 North Street, 7th Floor
Harrisburg, PA 17120



3 activities/inch

CPM FORMULAS AND RULES

(Arrow) = Activity (task with duration listed below)

(I-J #'s) = ID numbers given at head/tail (node) of each activity

(Square) = Early Start or Finish

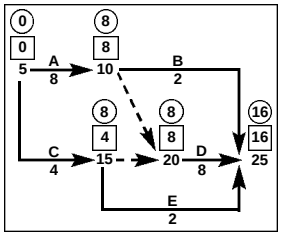
(Circle) = Late Start or Finish

ES = Number in square @ tail

LF = Number in circle @ head

EF = ES + Duration

LS = LF – Duration



Total Float (TF) = LS - ES or LF - EF or LF -ES - Duration

Free Float (FF) = Time available before effecting the Early Start of any Successor Activity

FF = ES of Successor Activity – (ES + Duration of that Activity)

Forward Pass Rule - highest number in the square

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Numbering Node Rule - Don't number head of arrow until all tails are numbered (increments greater than 1, recommend 5)

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Critical Path Rule - Number in square and circle at heads and tails are equal and the difference between them is the duration

8 STEPS to Construct a Network Diagram

(*Plan & Schedule*)

1. Determine workday calendar
2. List activities and durations (obtain work plan)
3. Draw arrow diagram asking:
   - What's first? (Predecessor)
   - What's next? (Successor)
   - What can be done at the same time? (Concurrent)
4. Create Dummies to rectify logic
5. Calculate Forward Pass to determine ES / EF (gives completion date)
6. Calculate Backward Pass to determine LS / LF
7. Number Nodes (I-J numbers) in increments greater than 1, recommend 5
8. Identify the Critical Path

5 STEPS to Complete an Activity Ranking Form

(for the Monitor/Daily Update Chart)

1. Enter I-J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF = LF – ES – Duration)
5. Determine the Ranking Number by the earliest Late Finish ascending to the latest Late Finish (In case of a tie: use ES first, Duration second, lowest I number next, and J number next.)

2 activities/inch

5 days/inch

CPM PROCESS
FORMULAS AND RULES

ECMS ENGINEERING & CONSTRUCTION MANAGEMENT SYSTEM
Pennsylvania Department of Transportation
Highway Administration
www.dot.state.pa.us

Recommended Notations for Use on the Daily Update Chart:

- x = activity worked
- ⊗ = activity finished
- ◯ = no work performed but they could have
- ● = no work, inclement weather

10 STEPS to Construct a Monitor/Daily Update Chart

(*Monitor Activities*)

1. Complete the Activity Ranking Form and the Workday Calendar.
2. Draw the grid: determine paper size (consider # of activities and # of calendar days)
   - **RULE:** Don't use more than 10 days/inch on the horizontal axis (recommend 5 days/inch on small projects)
   - **RULE:** Don't use more than 3 activities per inch on the vertical axis (recommend 2 activities/inch on small projects)

   This formula is the minimum. The steeper the line the better (preferable to make a steeper line so the activities are able to be separated for reading and monitoring)
3. Label lower horizontal axis with calendar days and the upper horizontal axis with project work days.
4. Draw vertical lines for non-work days between both horizontal axis.
5. Draw a diagonal line from the project start date at the zeropoint on the upper horizontal axis to the completion date onthe lower horizontal axis = Project Control Line (PCL).
6. For each critical path activity, locate the Late Finish (LF) on the PCL and draw a solid line to the left to the Early Start (ES). Label the I number at the start, J number at finish, the Duration below the solid line and the task above the line (if space is limited create a box in clear space beyond each activity line to describe the task and draw an arrow to the activity line).
7. Complete the Tally Sheet (plot the last LF activity first).
8. For non-critical activities, where space is available on the PCL,locate the Late Finish (LF) on the PCL, go horizontal to the left and draw a solid line from Early Start (ES) to Early Finish (EF) and then draw a dashed line to the PCL to indicate Float. Label the I number at ES, J number at EF, the Duration below the solid line and the task above the line (if space is limited create a box in clear space beyond each activity line to describe the task and draw an arrow to the activity line).
9. For an activity with the same Late Finish (LF) as another, drop down below the PCL into clear space to draw a secondary PCL segment parallel to the main PCL and extend left to show ES and EF. Use an arrow to indicate where the secondary PCL goes back up to the main PCL
10. Connect each activity to its predecessors with vertical dashed lines and list the dummies that connect non-identical J numbers to I numbers.

10 days/inch

10 days/inch

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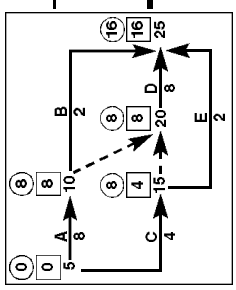

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3 activities/inch

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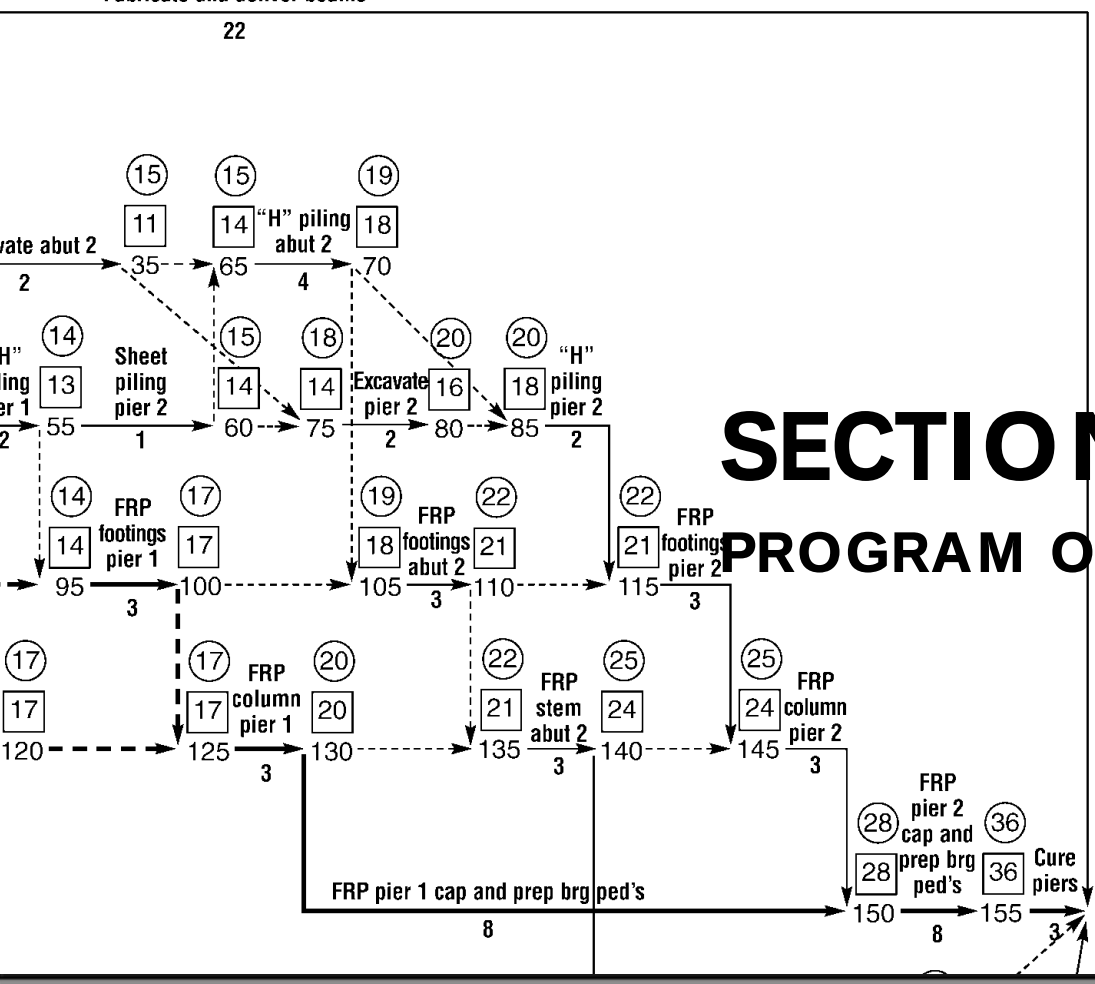
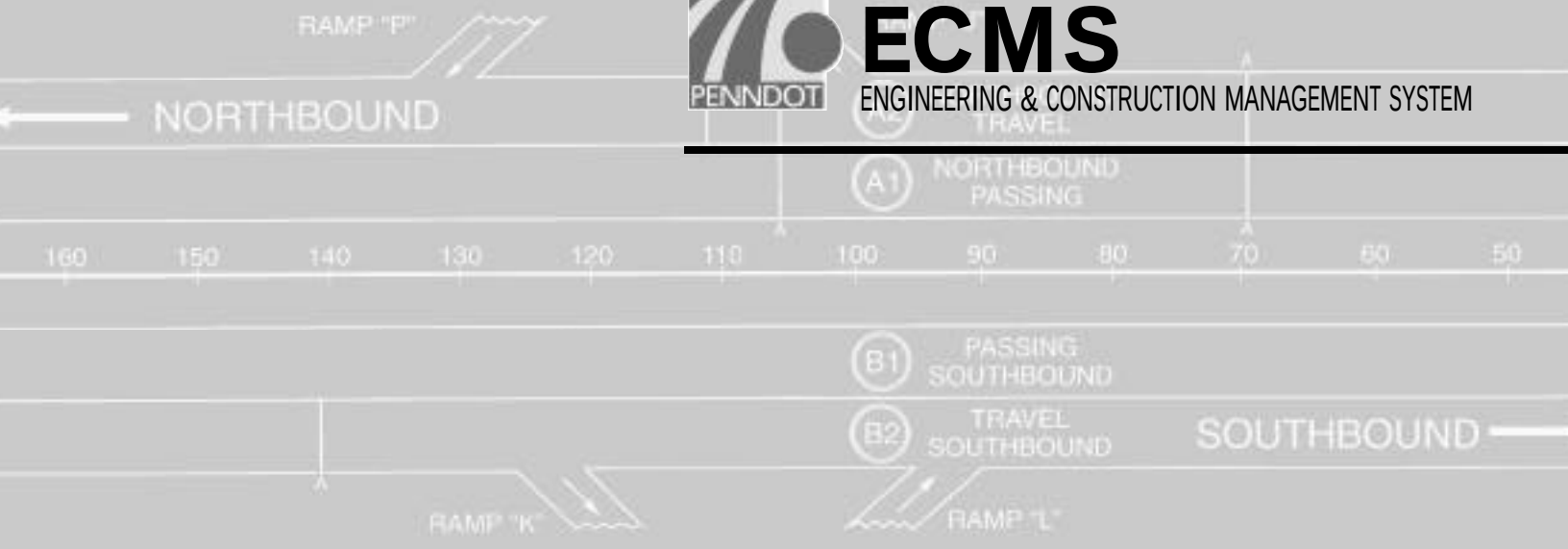


SECTION I

PROGRAM OVERVIEW



SECTION I – PROGRAM OVERVIEW

CHAPTER 1. INTRODUCTION TO PROJECT PLANNING AND SCHEDULING

At the direction of the Secretary of Transportation a Construction Claims Task Force was formed to study the escalating claims situation, develop recommendations and an action plan for their implementation. The Recommendations and Action Plan of the Task Force Group identified Critical Path Method (CPM) of scheduling as the top priority. The use of Critical Path Method (CPM) scheduling and a daily update chart provides factual information that can be used to defend construction delay claims. The implementation of critical path planning and scheduling has resulted in a drastic reduction of the number and dollar value of construction claims filed against the Department.

The proper preparation and use of construction schedules can reduce delays, cost overruns and disputes. Scheduling is the determination of the timing of activities. The use of CPM scheduling will help to define expectations and has proven to be effective in assessing actual vs. planned performance. CPM Scheduling and the use of a monitor / daily update chart will provide factual information to identify and deal with problems as they arise and will assist managers in making timely decisions about project completion. Understanding the CPM Schedule and using it as a tool to document and track performance will enable managers to analyze project delays, impacts of work order changes, and will help avoid delay claims.

A. Project Planning and Scheduling

Improvements to project planning and scheduling have been identified as one key area where managers can improve services, manage their operations more effectively through improved communications, and provide factual information to resolve disputes and avoid legal claims.

Project planning and scheduling involves all aspect of project development from final design up through the completion of construction. The process involves a coordinated effort between design and construction personnel to insure a timely completion of proposed improvement projects. The development of a pre-bid construction schedule is initiated in the final design process and is completed after the plans and specifications have been finalized. The development of a pre-bid schedule is a key element in the constructability review process and also is used to establish a realistic required completion date for the contract documents. A major benefit to the development of the pre-bid schedule is improved communications between design and construction personnel.

Implementation of these improved project management processes will result in more realistic construction completion dates through the development of a pre-bid construction schedule as part of a constructability review process. The improved project management process will also greatly improve claim avoidance during the course of construction through the effective monitoring of the contractor's schedule.

B. Project Management Defined

Any discussion of the critical path method must start with an understanding of project management. Project management is a process of achieving a project's objectives. Its purpose is to reach the project's goals and objectives within the allotted time frame, budget constraints, and quality standards. Project management is applicable to projects with a fixed end date, and specific goals and objectives, such as highway / bridge projects.

C. Project Management Functions

Planning

The project team plans the execution of the project by determining the activities to be accomplished, the responsibility for performing each activity, and how the project's objectives are to be met within given financial constraints. Planning strives to establish a predetermined course of action within given constraints.

Reasons to undertake project planning:

- Eliminating or reducing project risk,
- Obtaining a thorough understanding of the project's objectives,
- Formulating a strategy to attain those objectives, and
- Developing a monitoring framework to measure progress.

Scheduling
Scheduling means to determine when a specific activity or work must be started and completed. The tools used to accomplish this can be as simple as a bar chart or as complex as a CPM schedule.

Monitoring
Over the course of the project, it is crucial to ensure that the project's goals are being met according to the plan and schedule already defined. Monitoring means to track and document work activity, time, resources, and budget.

Controlling
Unanticipated problems can occur on any project. Having the tools to make informed adjustments for them is the key to controlling a project. A scheduling system will provide the project manager with adequate information to respond to problems in a timely manner. The CPM Process provides the manager factual information to respond in a timely manner to every impact to the schedule by using the network diagram and monitor / daily update chart to identify the impact and adjust accordingly.

D. Project Management Objectives

The primary objective of any formal project management process is to raise the level of efficiency of each of the following project disciplines.

Time Management
Project managers must properly manage time to avoid schedule slippage and cost overruns.

Resource Management
Proper planning and scheduling of labor, material, and equipment will ensure that needed resources are at the project site at the correct time. If resources arrive too soon they will become costly to store, and if they arrive too late, they will impact the schedule. Resource management can provide a structured framework to analyze and balance resources.

Quality Management
Quality levels for the completed project must meet all the requirements called for in the

project's contract documents, plans, and specifications. Proper project management will help ensure that there is enough time to perform the contracted work while meeting quality standards. It will provide sufficient time to procure materials and necessary equipment, and ensure that activities do not affect construction quality.

Risk Management

A well defined, planned, and executed project management process can reduce uncertainty by helping to identify risks. Organized and disciplined daily updating and monitoring of the project can also provide advanced warning of potential risks.

E. Planning and Scheduling Process

At the beginning of most projects, all that is known is the project objectives and goals, and desired end-dates. In general terms, meeting those goals within the time allotted means establishing an effective project management process by taking the following steps.

Identify Project Activities

This step requires the aid of someone with detailed knowledge of what is required to accomplish the desired project goals. That person must be able to review the project's plans and specifications, and be able to determine what must be done at each step in the project's process to meet the goals. The result will be a list that identifies each of the individual project activities (tasks).

Estimate Activity Durations

An estimated duration based on the anticipated labor, material, and equipment, as well as expected site conditions, is assigned to each of the activities. These durations are used for scheduling and controlling day-to-day work. Historical records of projects are reliable sources of information to obtain activity durations.

Develop the Project Plan

Before the project schedule can be displayed graphically, it is necessary to establish the order that activities must occur in relationship to other activities (interdependencies). In any project, there are some activities that must be completed before other activities can begin. That is, the scheduler has to begin by identifying, what activity must be done first, what must be done next, and what can be done at the same time. The identification of the order that activities are to occur determines if the project can be constructed as designed.

Schedule Project Activities

With a project start-date and activity durations assigned, it's possible to calculate and assign the required start and end date for each activity. Those dates, combined with each activity's expected duration, will provide the project manager with an idea of where and when resources must be used. It is this schedule that will be used as a basis for controlling work and the allocation of resources during construction. This schedule will also be used to identify realistic milestone dates and the project completion date.

Monitor the Schedule

This involves monitoring and documenting all work activities including the identification of days worked and days not worked. This effort documents production delays and gains and activity start delays and gains.

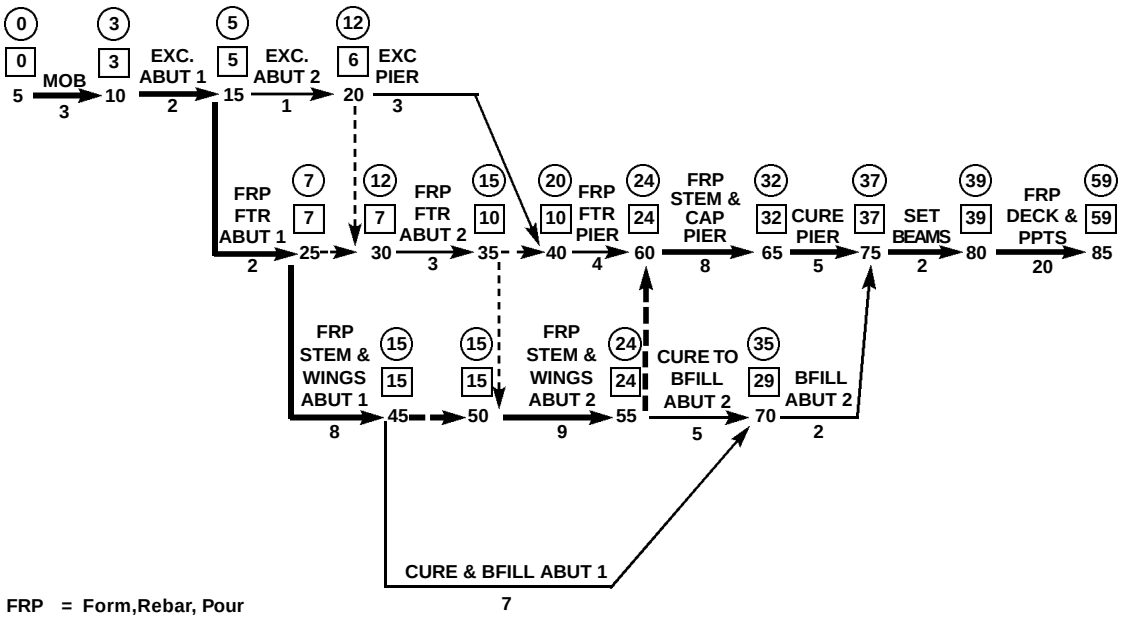
SECTION I

CHAPTER 2. CPM PROCESS OVERVIEW AND ITS ADVANTAGES

A project management process has been developed that involves the use of a Critical Path Method (CPM) technique to graphically plan, schedule, and monitor a project effectively. There are two key elements to this technique: the Network Diagram and a Monitor / Daily Update Chart.

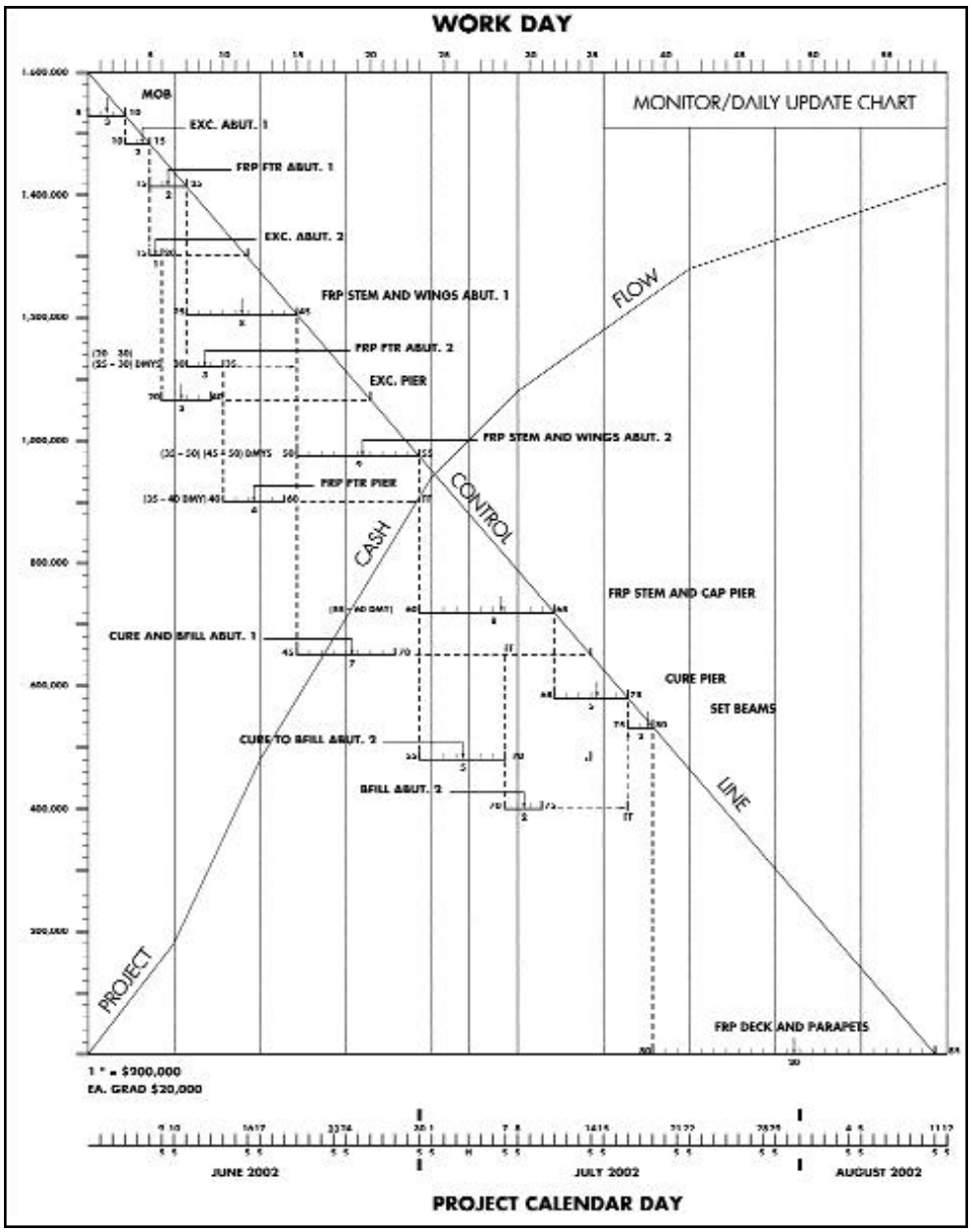
A Network Diagram graphically displays activities with their predessor and successor, using the CPM Activity-on-Arrow Technique. This diagram gives the project manager a detailed picture of what activities should be in process at any given time.

NETWORK DIAGRAM EXAMPLE



SECTION I

A Monitor / Daily Update Chart is used for daily monitoring of every project by using a bar chart format to display the progress of each activity. The first step in building the chart is ranking the activities. Once ranked, the activities are placed as horizontal bars on a graph that is plotted against a diagonal line (control line) from the first day (upper left corner) to the last day (lower right corner) in the project schedule. The project's calendar is plotted along the horizontal axis.



The actual day-to-day progress of every activity is then plotted on the monitor / daily update chart, with marks signifying each day when work is done, reasons for delays when work is not done, when the activity is actually completed, and any necessary adjustments for each succeeding activity.

Making use of the Monitor / Daily Update Chart as a tracking tool to monitor project status and document delays is a very effective tool for determining the causes and responsibilities for delays and cost overruns. If the chart is faithfully updated, project managers have factual information to resolve project disputes and contractor's legal claims and it becomes a basis to make payments when they are justified.

NOTE: Further applications for the CPM process can include resource allocation, cash flow management, and specific uses for maintenance operations and scheduling highway design activities.

Advantages:

- Improved organization and display for projects with large number of activities.
- Provides litigators with a graphical portrayal of the as planned comparison, to the as built project schedule, necessary for defense of claims.
- Provides a method for making time extension decisions, when the project is impacted by work orders or any unforeseen changes.
- Assist in the analysis of projects prior to letting to determine realistic milestone and project completion dates.
- Helps communicate the construction plan and lets everyone know when they are expected to start and finish their tasks.
- Establishes production goals and provides the framework for scheduling and planning the day-to-day work at the construction site.
- Monitors and measures progress and establishes the baseline against which the current status of the project can be compared to determine if it is ahead or behind schedule.
- CPM can be used to manage change by identifying the impact of an unexpected event or condition to allow the plan to be revised accordingly.

SECTION I

CHAPTER 3. CPM FORENSIC SCHEDULING OVERVIEW

The use of CPM scheduling and the monitor / daily update chart is an important tool that will enable managers to provide construction related support needed for defense preparation and presentation of legal claims. The monitor / daily updated chart provides a graphic schedule analysis that is very understandable to the layman and very effective in the defense of construction claims.

The forensic CPM analysis is an investigative tool that attempts to determine the who, what, when, where, and why facts concerning delays to the project completion. This information is presented in the graphic form of the monitor / daily update chart and enables the manager to prepare a factual description of the comparison between the as-planned and the as-built schedule. This information can be used to defend against claims and / or as a basis to justify or reject a time extension to the required completion date and / or milestone dates.

SECTION I

CHAPTER 4. PRE-BID CONSTRUCTION SCHEDULING OVERVIEW (CONSTRUCTABILITY REVIEW)

The purpose of a pre-bid construction schedule is to determine a contract completion date and to assist in the evaluation of the constructability of the project as designed. The development of a pre-bid schedule starts with Design Field View Approval (Step 9) and moves to the Project Manager (PM), who develops a tentative list of activities. At this point the PM creates the first, rough-cut version of a pre-bid schedule and if necessary coordinates the first review with Design, Traffic, Maintenance, Construction and Utilities personnel. Taken into consideration at those stages are type, size and location (TS&L) of any structures, letting date, initial quantity estimates, agreed upon method of construction, and any initial design changes. Periodic constructability reviews continue until plans and specifications are complete and the project designer creates a schedule. Next, a team from Design and Construction develops a pre-bid schedule.

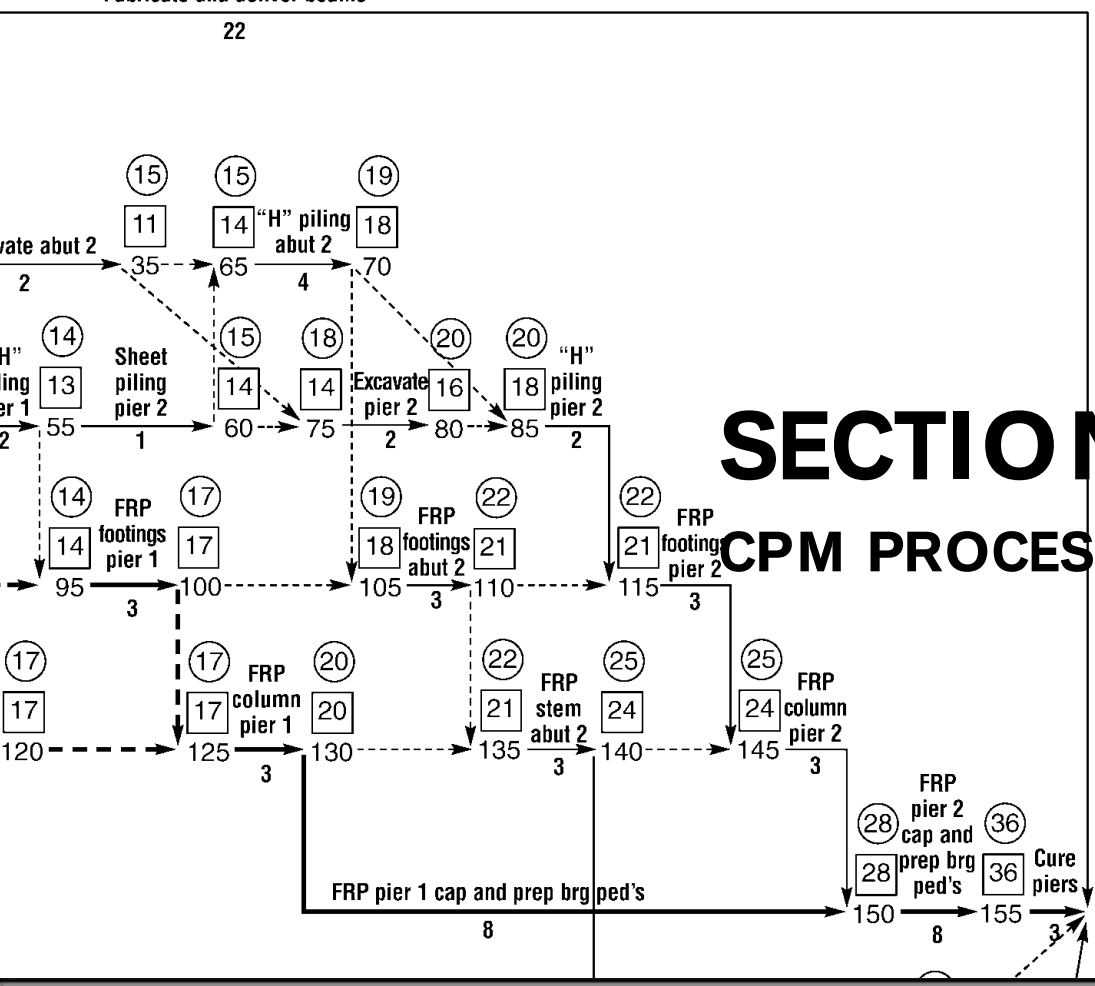
At this point District Contract Management incorporates milestones and a contract completion date into the bid package. A plans, specifications and estimates (PS&E) package is submitted to the Central Office for review and a decision is made based on the PS&E information as to whether the scheduled letting should be changed. If no change is recommended, the Department advertises for bids and requires contractors to submit their schedule if they are awarded the project. If the scheduled let date is changed; the PM is responsible for determining the impact to the pre-bid construction schedule and contract completion date. If the contract completion date is changed, the PM revises the pre-bid construction schedule and resubmits to Central Office Contract Management for review.

After a project is awarded the contractor has the opportunity to propose design changes. The PM and the constructability team are responsible for assessing any potential impacts of design changes on the schedule and contract completion date.

Implementing pre-bid construction scheduling statewide will have some impacts on the Department's traditional methods. Here are some of those impacts.

- All projects will be completion date contracts and the completion date will be determined by a pre-bid construction schedule.
- The Project Manager is responsible for the pre-bid construction schedule.
- The development of a pre-bid construction schedule is undertaken as part of the constructability review.

- The pre-bid construction schedule will provide the Department with a realistic completion date for each project.
- The development of a pre-bid construction schedule requires a joint effort by Design and Construction to complete.
- The development of pre-bid construction schedules require management support of the required staff effort and training.



SECTION II

CPM PROCESS

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CHAPTER 1. PROJECT MANAGEMENT

Project management is a process of achieving a project's objectives. Its purpose is to reach the project's goals and objectives within the allotted time frame, budget constraints, and quality standards. Project management is applicable to projects with a fixed end date, and specific goals and objectives, such as highway / bridge projects.

A. Project Management Functions

Project Management is made up of four key functions: plan, schedule, monitor and control. Planning must be separated from scheduling.

Planning

A knowledgeable project team plans the execution of the project. They determine what needs to be done, by whom and how project objectives are to be met. In short, they establish a predetermined course of action to take within the given constraints. An effective project manager will undertake formal project planning to eliminate or reduce project risk, obtain a thorough understanding of the project's objectives, formulate a strategy to attain those objectives, and develop a monitoring framework to measure progress. Planning is a process that establishes the interdependencies and interrelationships between each task within the project.

Scheduling

Simply put, project scheduling determines when specific work must be done. Scheduling tools can be as simple as a bar chart or as complex as a CPM network schedule or logic diagram.

Monitoring

Using the project schedule as the standard for tracking daily work ensures that the project's goals are being met. The monitoring process will document where delays take place, how long those delays may be, and what effect they may have on subsequent tasks. Monitoring tracks time as well as resources and budget.

Controlling

A well-planned and executed project schedule gives the project manager a useful tool for making adjustments if unanticipated problems occur. The most important thing a project

manager can do with any scheduling system is to use it to respond to adverse impacts. In addition, a detailed project schedule allows the project manager to anticipate and adjust for future impacts that may be caused by current project events. The Critical Path Method (CPM) allows the manager to respond to every disruption to the schedule using the Network Diagram and Monitor / Daily Update Chart to identify impacts and make adjustments.

B. Stakeholders

The Project Manager

The role of project manager can be very demanding—it's not difficult, but it requires constant attention to detail. The manager must be completely familiar with the project's contract document, plans, specifications, and standards. The manager must have knowledge of construction, work sequencing, resources, capabilities, durations, and monitoring.

The manager must establish and conduct project-scheduling meetings with the entire project team. The team will report on job progress to-date, review short-range and long-range scheduling goals, and review material delivery and approval requirements.

With the help of the project team, the manager should have the ability to recognize impacts to the schedule before hand, reschedule around anticipated impacts, minimize costs and / or delays to the project due to unavoidable impacts, and continue to monitor and maintain the work performance history.

The Inspector

The construction inspector is the owner's authorized representative assigned to make inspections of contract performance and of material furnished for the project. The construction inspector has the responsibility of monitoring progress, and approving or disapproving each major step of the project.

The Designer

The designer is responsible to furnish all plans, specifications & estimates (PS&E) for the proposed project. The designer is also responsible for providing the project team with the information necessary to prepare a pre-bid construction schedule to help evaluate the constructability of the project and to determine the required completion date of the project.

The Legal Department
The schedule monitoring system must provide the Legal Office with a clear documentation of any changes that have taken place and a clear audit trail of the agreed upon changes to help in the defense of construction claims.

The Contractor
The contractor is responsible for the construction of the proposed project. The contractor is also responsible for providing a realistic construction schedule that identifies the resources and work activity interdependencies necessary to complete the project by the required completion date.

The Utilities and Other Service Providers
The utility companies and service providers such as transit companies and school bus providers play an important part in the development of the pre-bid construction schedule. Proper and timely participation and coordination with the project manager and project team is necessary to successfully complete a realistic pre-bid construction schedule.

Consultants—Design, Management and Inspection
The Department uses consultant services for project design as well as construction management and construction inspection on many projects. Consultants are responsible for providing the same service and expertise that the Department employees provide for design, management and inspection on any specific project.

C. Relationships: Teamwork and Communication

The Owner and Builder Relationship (Teamwork)
The Department is in an Owner / Builder relationship with the construction contractor. As the project's owner, the Department's responsibility in the relationship is to produce all necessary plans, specifications and estimates (PS&E) for the project. This includes but is not limited to materials, site conditions, and completeness of plans.

The builder of the facility is determined by competitive bidding, usually the contractor with the lowest responsible bid. That contractor's responsibility in the relationship is to supply all necessary resources, maintain production rates and complete the work as specified by the required completion date. The builder also has a responsibility to notify the owner in a timely manner of any and all changes to the project that impact the builder's ability to complete the project as contracted.

SECTION II

The owner / builder relationship must be built on teamwork and two-way communication in order to bring about a successful completion of the project. Teamwork underscores the need for all workers to understand their role in the project, and a willingness to subordinate personal prominence to overall efficiency. Uninterrupted communication, both vertical as well as horizontal, is crucial to keeping any project on track. Skillful project management requires the ability to document day-to-day performance both verbally and in writing, and the willingness to respond to problems and seek remedies as soon as they arise.

Communication

Good Communications are critical to maintaining effective relationships.
Communication is a very important link to the successful completion of any project.
Communication is much more than the spoken word or the skill of listening.
Communication, especially in the owner / builder relationship, means writing letters, memos or notes to document approvals, acceptance, concerns, problems, information, work performance, changes, instruction, directions, orders, etc.

SECTION II

CHAPTER 2. CRITICAL PATH METHOD (CPM)

A. CPM – A Scheduling Tool

CPM is a complete planning and scheduling tool that uses a graphical display of the planned sequence of project activities to show their interrelationships and interdependencies.

It is a technique that requires a breakdown of the entire project into a series of individual tasks (activities) and an analysis of the time duration required to perform each task.

A project's critical path is the longest activity path through the project that establishes the overall project duration. It is composed of a continuous chain of activities with no float. All activities on the critical path must start and finish on their planned early start and finish times—delay of a critical activity will result in the overall project duration being extended. The critical path method of project management is generally diagrammed using one of two methods: the Activity-on-Arrow (AOA) network and the Activity-on-Node (AON) network.

B. CPM Techniques: Activity-on-Node, Activity-on-Arrow

Concept of Precedence

The concept of precedence assumes that any succeeding activity cannot start until the prerequisite or preceding activity is complete. For example, you can't pour the concrete for a wall until the footings are in place. Digging the footings is the precedent activity to pouring the concrete. Likewise, pouring the concrete is the successor to digging the footings. The combination of all the predecessor and successor relationships among the project activities forms the project network.

Concurrent

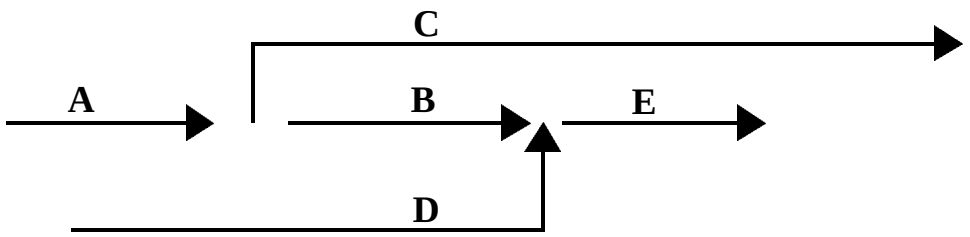
Unrelated activities can proceed concurrently and can run independent of each other.

Multiple Successors

An activity can have more than one successor.

Multiple Predecessors

An activity can have more than one predecessor.



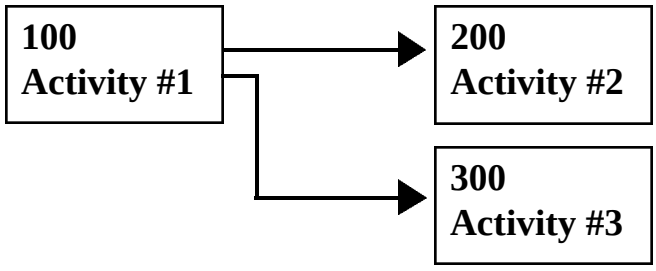
Activity-On-Node Technique

Activity-on-node (AON) is a project management technique that represents activities as boxes (or in some cases circles) and connecting arrows show the logical relationships between the activities. Each activity is pictured with a unique alphanumeric identifier, description, and estimated duration based on available resources, production rates and the site's physical conditions.

In an AON network, there must be physical, safety, resource and preferential relationships between the activities, and those relationships are restricted to being finish-to-start types (succeeding activities can't start until its predecessor finishes). Lag times must be incorporated as a separate activity. Unlike an AOA network, it requires a beginning and ending activity or milestone to tie the schedule together. Because of that aspect, an AON network usually starts with a "Notice to Proceed" milestone and ends with a "Project Complete" milestone.

Activity on Node Method (AON) is comprised of:

- A unique alphanumeric identifier for each activity, usually a number,
- A unique concise description for each activity,
- Estimated activity duration based on available resources, anticipated production rates, and physical conditions,
- Physical, safety, resource and preferential relationships between activities, and
- Restricted to relationships where a predessor must finish before a successor can begin.



SECTION II

Activity-On-Arrow Technique

In an Activity-on-Arrow (AOA) network each arrow begins and ends on a node. The arrows connecting the nodes represent the project activities, with a unique description printed above the arrow and that activity's duration below. The Activity on Arrow Method (AOA) assigns two (2) numbers to activities, the I and J numbers. The I number at the tail of the arrow and the J number at the head of the arrow.

Arrow Head: The arrow's head points to the node that indicates the end of the activity, identified by the activity's J number.

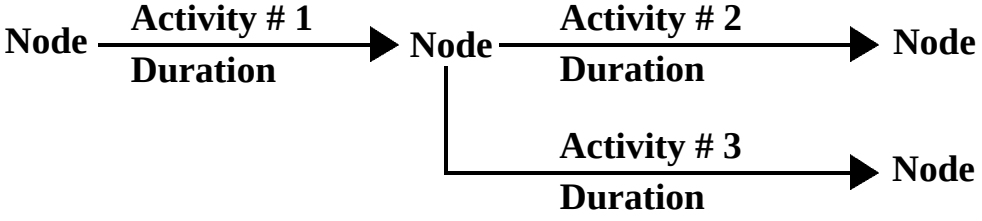
Arrow Tail: The arrow's tail starts from the node that indicates the beginning of the activity, identified by the activity's I number.

Nodes: A juncture point of the head of an arrow and the tail of an arrow that marks the end and the beginning of each activity. They will become a point in time in the schedule and act as logic transfer stations. The tail of the beginning activity and the head of the last activity are also nodes.

Every AOA network must contain a unique I - J number for each activity, a unique description for each activity, an estimated activity duration for each activity based on resources, production rates and conditions, and logical relationships between activities.

Activity on Arrow Method (AOA) is comprised of:

- Beginning and ending node for each activity,
- Unique I - J number for each activity,
- Unique concise description for each activity,
- Estimated activity duration based on available resources, anticipated production rates and physical conditions,
- Logical relationships between activities, with transfer points identified as nodes,
- Activities that are depicted by arrows, and
- Description placed above each arrow, and duration placed below.



SECTION II

For this Workbook, the primary focus is on the Activity-on-Arrow technique of CPM, which is used to display the interdependencies between activities and generate the Monitor/Daily Update Charts.

The Activity on Arrow Method is used because of the following benefits:

- The Activity on Arrow Method (AOA) assigns two (2) numbers to activities, the I and J numbers. The I number at the tail of the arrow and the J number at the head of the arrow.
- The J number becomes the I number of the successor activity.
- In all reports the logic can be determined by following the I - J numbers.
- In the Activity on Node Method the assigning of only one number to an activity prohibits determining the logic, without additional information.

C. CPM Process: The Network Diagram and Monitor/Daily Update Chart

Reasons for Implementing CPM

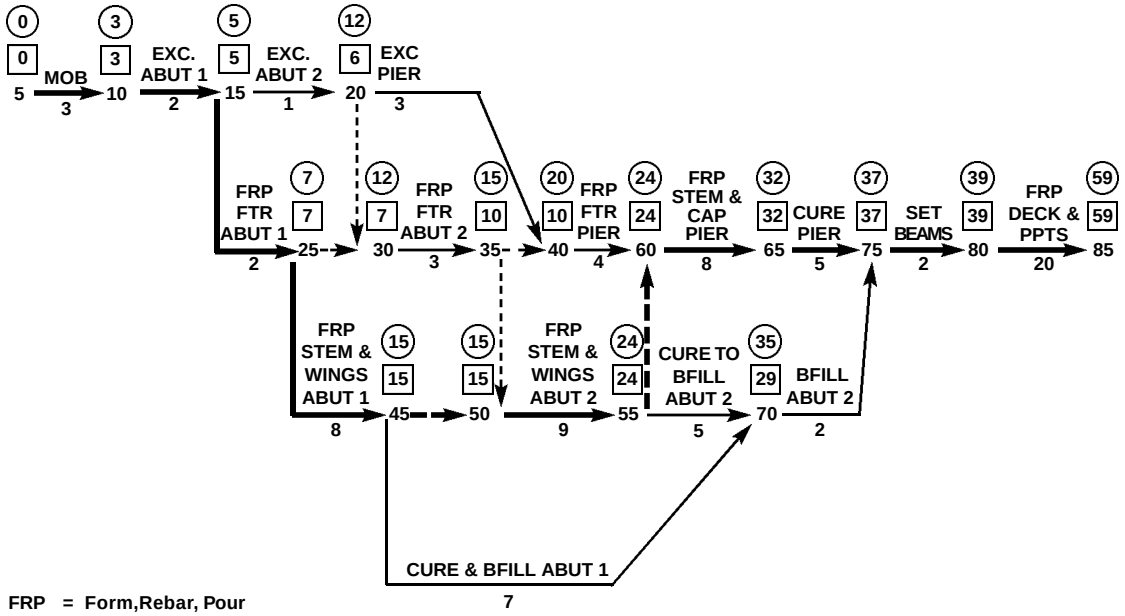
PENNDOT determined that it needed new tools to analyze its project schedules in response to a backlog of legal claims filed by contractors. A Construction Claims Task Force was formed to evaluate this escalating claims situation and identified the Critical Path Method (CPM) of scheduling as the top priority. This effort requires the contractor to make known how he plans to use his resources and what production rates he anticipates. Department staff is being trained to monitor the contractor's schedule. These efforts have substantially reduced both claims and ensuing litigation which is a drain on the resources of both the Department and the contractors.

SECTION II

Network Diagram

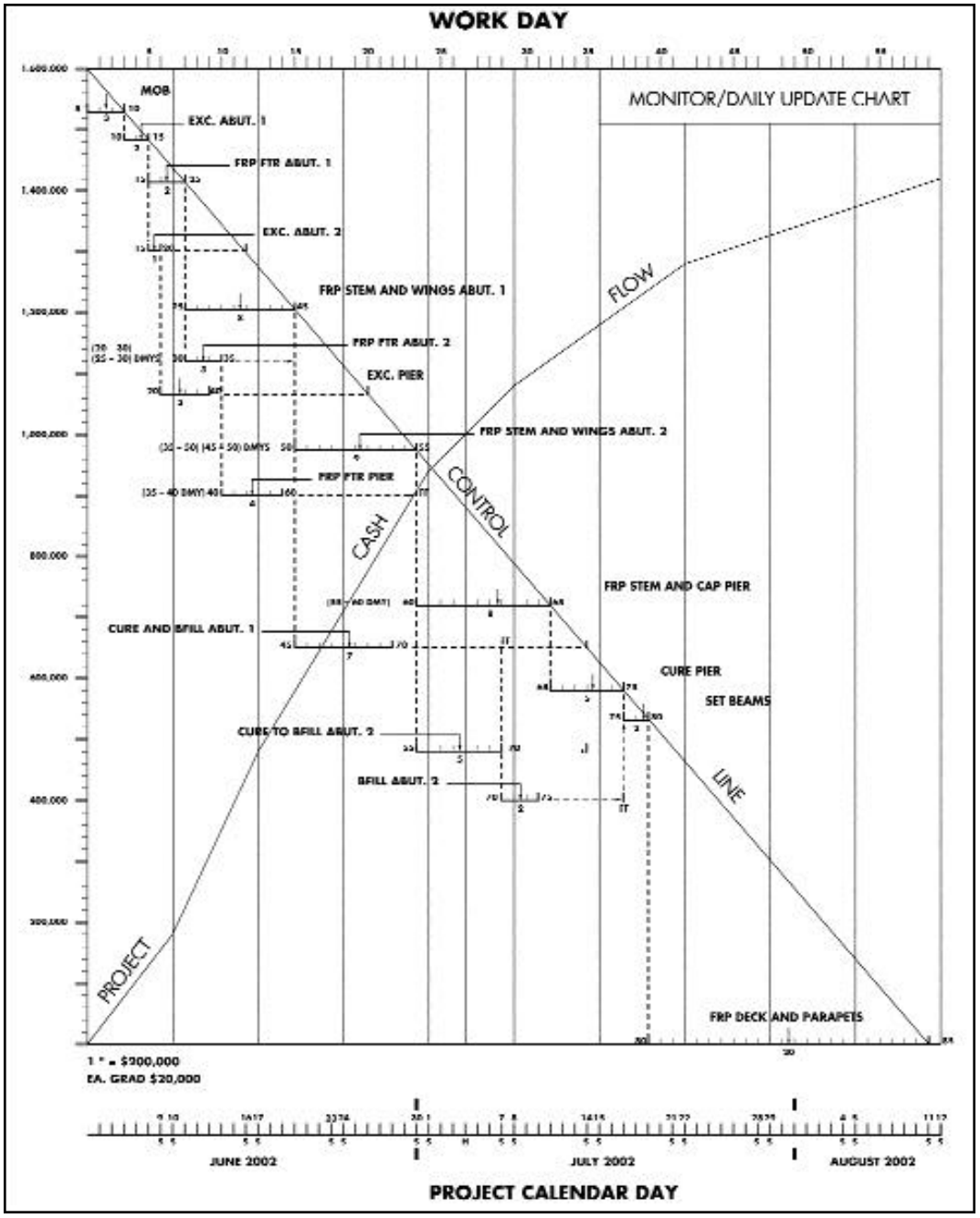
The network diagram displays the logical sequence of activities through the project. It relies on a list of project activities with descriptions and realistic time durations required to complete each activity. A network diagram is built using the Activity-on-Arrow technique. Once completed, the network diagram shows each activity and its relation to every other activity in the project, the project's critical path, and the expected end workday for the project.

NETWORK DIAGRAM EXAMPLE



Monitor / Daily Update Chart

Actual progress of a project can be monitored by means of a daily update chart, which is used as a tracking tool to verify the project status and minimize claims. It is generated from the information determined by the network diagram.



SECTION II

CHAPTER 3. THE NETWORK DIAGRAM – Project Planning and Scheduling

A. Project Planning and Scheduling

A network diagram uses a display known as the logic diagram. A logic diagram is a graphical view of all the project's activities presented in such a way as to show the logical and necessary sequence of activities from beginning to end. This will reflect the experience and judgment of those who are responsible for executing the work.

B. Eight Steps to Construct a Network Diagram

To construct a network diagram, which provides the plan, and identifies the project schedule, complete the following steps:

Step 1. Determine the workday calendar.

Once the starting date is known, identify all the workdays that fall within the project's time span. Start by marking the first day of the project with a one and increment by one for each subsequent workday until all the scheduled workdays over the time span of the project are marked with a number. Each scheduled non-workday is marked with an X.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
																X	1	2	3	4	5	6	X	7	8	9	10	11	12	X	JUNE
	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
	13	14	15	X	16	17	X	18	19	20	21	22	23	X	24	25	26	27	28	29	X	30	31	32	33	34	35	X	36	37	38	JULY
	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	

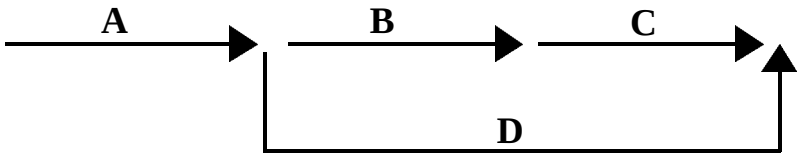
Step 2. Obtain the engineering work plans.

Develop a list of tasks and their durations. Gather this information by reviewing historical records from similar projects and interviewing knowledgeable personnel who can be relied on to give accurate and useful estimates of the work involved.

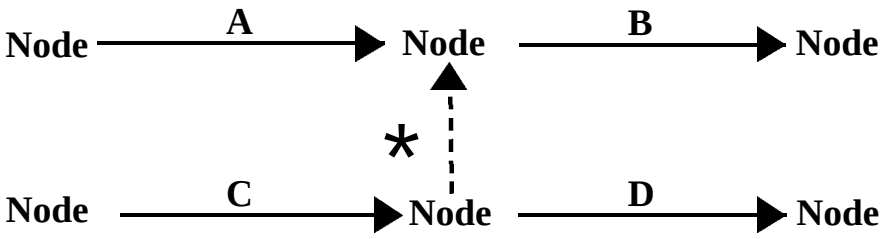
Step 3. Determine activity logic and Draw arrow diagram.

Determine what must be done first (predecessor), what must be done next (successor), and what can be done at the same time (concurrent). To begin the process of determining interdependencies between activities, define the logical flow of the activities. Determine

predecessor logic by asking what must be done before this activity can begin. Determine successor logic by asking what must be done after this activity finishes. Determine concurrence logic by asking if any other activities can occur at the same time. The duration of each activity should be shown under the arrow for each activity.



Step 4. Create dummies where necessary.
Dummies are activities with zero duration that serve to transfer logic from one node to another node (heads of arrows to tails of arrows). This makes it graphically apparent that the activity the logic comes from must be complete before the activity the logic goes to can start. Dummies are also used to eliminate the possibility of duplicate I - J number combinations and dummies are always shown as dashed lines.



*Dummy Activity

In this example, both activities A and C must be complete before activity B can begin, but activity D only relies on C as a predecessor. The same numbering rules apply for the dummy activity (*) as for the other activities with one exception: the time duration for a dummy activity is always 0.

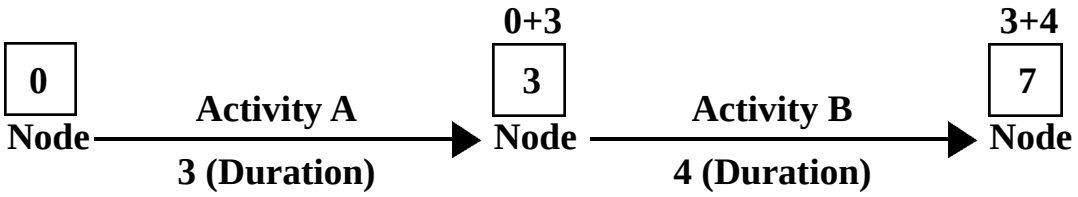
CPM hint: When in doubt, insert a dummy. Consider the use of the dummy as a tool to keep the logical relationship intact. The logical sequence of the network diagram always flows from tail to head, which applies to solid arrows as well as dashed arrows.

Step 5. Calculate the Forward Pass.

Determine the earliest time each activity can start (ES) and finish (EF). The Forward Pass locates each node relative to the beginning of a project. The starting point for the Forward Pass is the node at the tail of the first activities' arrow. Place a square above this node. Place a square above all remaining nodes in the arrow diagram. These squares will illustrate early start and early finishes. Place a zero in the early start square above the tail of the arrow for the first activity and add the duration of the activity. Place the result in the early start square above the head of the arrow for the activity. Add the duration of the successor activity to this number and place the result in the square above that node. Continue to do this calculation for each activity path throughout the network arrow diagram to determine the early start (ES) and early finish (EF) for each activity.

Early Start:
ES = Number in square @ tail

Early Finish:
EF = ES + Duration



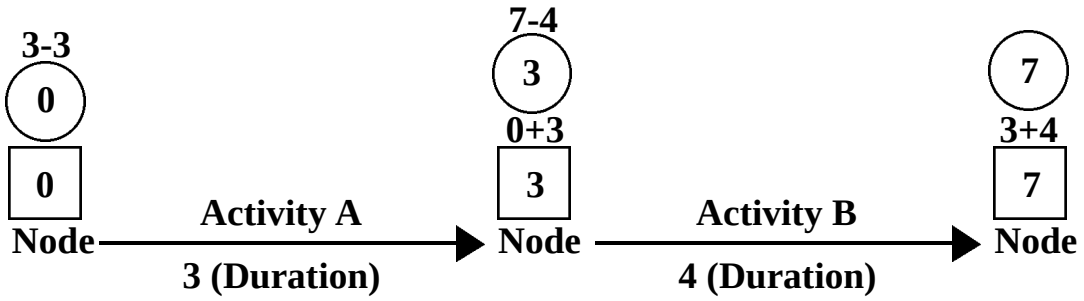
Forward Pass Rule: When multiple arrow heads enter a node, add the durations of each path of arrows and place the highest number in the square above the node.

Step 6. Calculate the Backward Pass.

Determine the latest time each activity can start (LS) and finish (LF). The Backward Pass locates each node relative to the end of the project. The starting point for the Backward Pass is the node at the head of the last activity's arrow. Place a circle above the square at this node. Place a circle above the squares of all remaining nodes in the arrow diagram. These circles will illustrate late start and late finish. Place the same number in the circle at the head of the last activity that is in the square at the head of this last activity and subtract the duration of this activity. Place the result in the late start circle above the tail for this activity. Subtract the duration of the predecessor activity from this number and place the result in the circle above that node. Continue to do this calculation for each activity path throughout the network arrow diagram to determine the late finish (LF) and late start (LS) for each activity.

Late Start:
LS = LF - Duration

Late Finish:
LF = Number in circle @ head



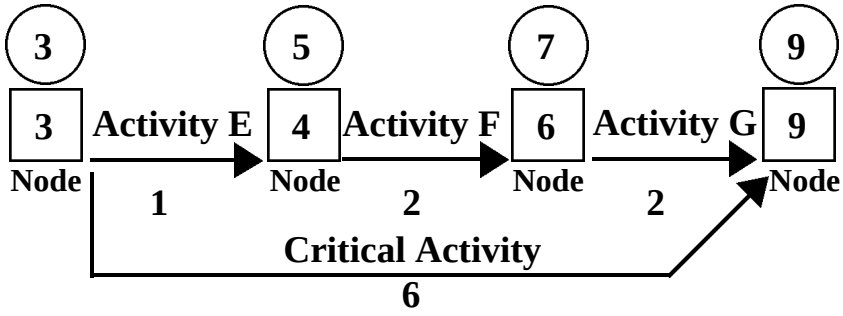
Backward Pass Rule: When multiple arrow tails enter a node, subtract the duration of each path of arrows and place the lowest number in the circle above the node.

Identify Float: After both the forward and backward passes have been completed, there is enough information on the logic diagram to identify the float in the project. Float is defined as the amount of time that a non-critical activity has before its completion affects the successor activity. The Forward and Backward Passes define total float and free float.

Total float exist for a non-critical network path and does not belong to any single activity along that path. Total float represents the amount of time along a non-critical network path that the starts and finishes of the activities on that path can be delayed without affecting the overall duration. Total float is then calculated for each activity.

Total Float (TF) = LS – ES or LF – EF or LF – ES – Duration

The total float is defined as; the number in the circle (LF) at the head of the arrow on the last activity in the string, minus the number in the square (ES) at the tail of the arrow of the first activity in the string, minus the cumulative total of the durations in the string of non critical activities.



Float Note: There is no float in any activities on the Critical Path.

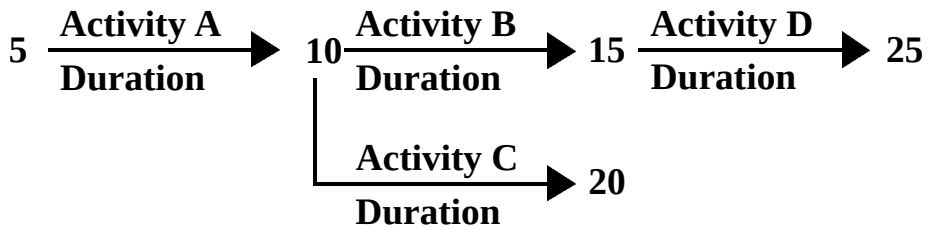
Free Float is expressed as the amount of time an activity's start can be delayed without affecting the early start date of its successor. It is also referred to as activity float, because it is a property of an activity.

Free Float (FF) = Time available before effecting the Early Start of any Successor Activity

Step 7. Number nodes (I – J numbers).

Each activity in the diagram will have it's own specific identifying number combination, called its I – J number. A recommended method of numbering nodes is to use sequential non-consecutive numbers in increments of five. That means that several consecutive numbers between the "I" and "J" numbers are omitted, which allows overlooked or unforeseen activities to be added to the network.

To number nodes, start with 5 as the I number at the tail of the arrow for the first activity and increment by five for the J number at the head of each arrow from that point on. The number in the J node must be greater than the number in the I node. I – J combinations must be unique, and the I must be numbered before the J.

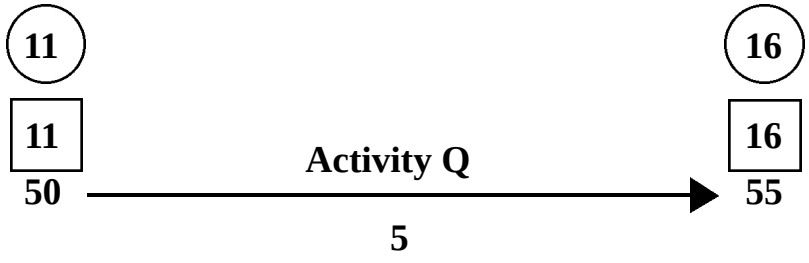


Numbering Node Rule: Don't number head of arrow until all tails are numbered (increments greater than 1, recommend 5)

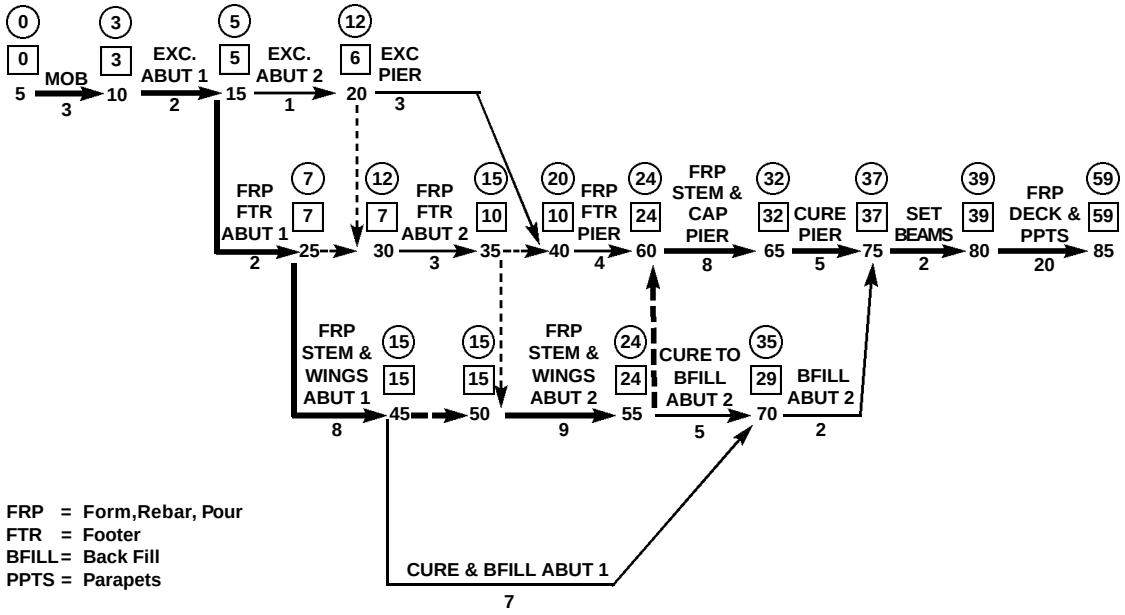
I – J Rule: J number= I number of successor and J number > I number

Step 8. Identify the Critical Path.

The critical path overlays or follows a chain of critical activities in the diagram. It is the longest string or route of interdependent or connected activities that establishes the overall project duration. It is only on the critical path that savings in project time units can be made. An activity is critical when the numbers in the square and circle at the I and J nodes are the same and the difference between them is equal to the duration.



NETWORK DIAGRAM EXAMPLE



C. Logic errors

The completed logic diagram is a construction manager's technique that reflects the experience and judgment of those who are responsible for executing the work. An illogical network will produce an illogical schedule. Even the best-laid plans can suffer if the scheduler has not taken into account the following potential pitfalls:

Incorrect logic

Activity logic must be correct to accurately reflect the construction process. Linking unrelated activities may extend the project duration and reduce the effectiveness of the network diagram as a planning and management tool.

Redundant logic

Make sure that all activity relationships are necessary to move the project toward completion. Redundancy unnecessarily complicates activity network.

SECTION II

CHAPTER 4. MONITOR/DAILY UPDATE CHART – Project Monitoring

With the schedule complete you can prepare a method to monitor and document the actual progress of the project as daily work is completed. While the logic diagram is a very useful tool for plotting the project and showing the activity flow from start to end, it does not make a very useful project-monitoring tool. The critical path may be followed without too much difficulty, but the interrelationships between non-critical activities can be hard to follow, and understanding the significance of early and late starts and finishes is also very difficult.

The Monitor / Daily Update Chart is a modified bar chart that displays the network logic. The interdependencies of the network diagram are displayed via the I - J numbers. The monitor / daily update chart is as easy to use as a bar chart while displaying all the logical information visible in the network diagram. The monitor / daily update chart is a tool for monitoring construction projects on a daily basis.

A. Resource Management Bar Charts

Efficient use of a resource such as manpower can be achieved by knowing where, when and how many crew members are needed for any given activity on any given day. Using a worksheet, the total number of crew members necessary for every activity for every day can be plotted and totaled. This can be converted to a bar chart for resource management.

Complete the Activity Ranking Form by listing the activities by I - J numbers, from lowest to highest. List the durations, early start and late finish for each activity. Calculate the early finish (ES + Duration), the late start (LF – Duration), and float (LF – ES – Duration). Activity ranking is done first by early start, then by float and duration in the case of ties. Find the activity with the earliest start and, if it is the only one with that early start, number it one. Then find all the activities with the next lowest early start. If there is more than one, the activity with the lowest float is next, and if the float is equal, the activity with the lowest duration is next. Continue in this manner, ranking each activity.

The manpower necessary to complete each activity can be plotted across a horizontal line with an entry for each day on the vertical line. For instance, assume the first activity starts on day one, is expected to last three days, has no float, and requires a crew of six for each day. Also assume that activity two can start on day three, has a duration of three days, requires four crew members on each day, and has three days float.

On the first horizontal line of the worksheet, in the box for day one enter a six, and moving across the line, enter a six in each of the next two boxes for days two and three. This will represent the use of six crew members for each of those three days. On the next horizontal line, plot the number of crew members needed for each day of activity two. Each activity can then be plotted on its own horizontal line by first finding its early start+one, then plotting the number of crew members needed for each day the activity lasts until it is completed. For activities with float, put a dot in each box after its early finish day through its late finish.

Once each activity is plotted on the worksheet, the total number of crew members needed for each day can be totaled across the bottom. The project manager can also determine where float can be found, and therefore, where manpower can be reallocated when needed.

Workdays	1	2	3	4	5	6	7	8
Activity # 1	6	6	6					
Activity # 2			4	4	4	•	•	•
Totals	6	6	10	4	4			

Note: Remember that an activity starts on the day after its early start designation. For instance, there is no day zero, so the first activity must start on day one even though its early start is zero.

B. Ten Steps to Construct a Monitor/Daily Update Chart

Drawing the Chart — Steps 1 Through 5

Step 1. Complete the Activity Ranking Form.

The Ranking Form completed for the Resource Management Chart was sorted by early start in order to eventually integrate the cash flow with the work. For the purposes of monitoring and updating progress we will rank the activities in order of their late finish. On the ranking form, list the activities by I – J numbers, from lowest to highest. List the durations, early start

and late finish for each activity in the appropriate boxes. Calculate the early finish (ES + Duration), the late start (LF – Duration), and float (LF – ES – Duration).

Activity ranking is done by the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

Step 2. Draw the grid: The workday calendar should have been completed earlier, when building the network diagram. Determine the dimensions of the chart (consider the number of activities and the number of calendar days).

Rule: Don't use more that 10 days / inch on the horizontal axis: five days / inch is recommended.

Rule: Don't use more than three activities / inch on the vertical axis: two activities / inch is recommended.

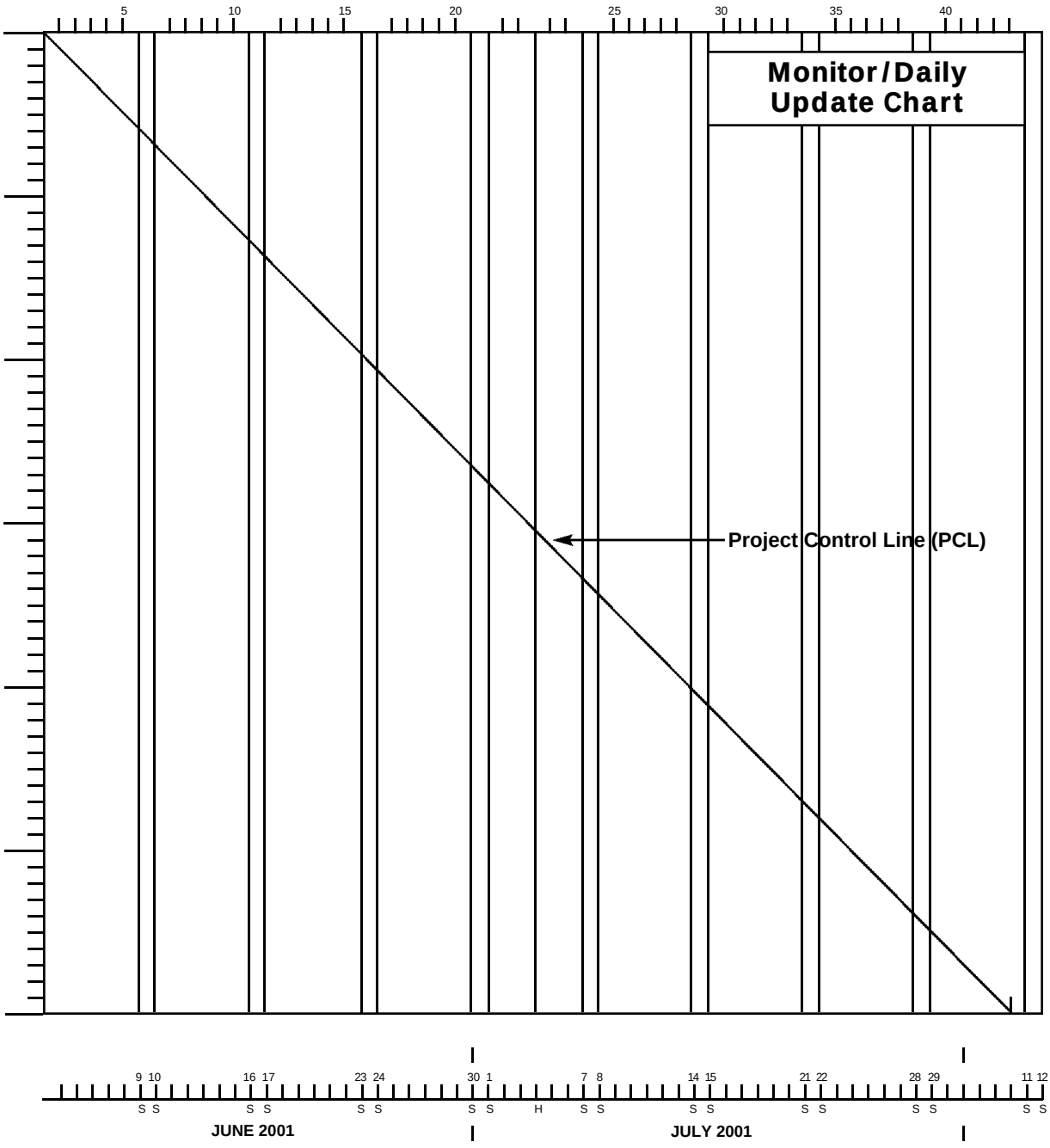
This formula should be considered the minimum. A steeper diagonal line allows the activities to be spread to allow for easier monitoring.

Step 3. Label the lower horizontal axis with the project's calendar days and the upper horizontal axis with the project's workdays from the workday calendar.

Step 4. Draw a vertical line for each non-work day between horizontal axes.

Step 5. Draw a diagonal line from the project start date on the upper horizontal axis to the project completion date on the lower horizontal axis. This is the project control line (PCL).

Before entering activities, the blank daily update chart should look like this. The left hand corner on the upper horizontal axis represents the start of the project and the completion date is represented on the lower horizontal axis close to the right hand corner.


5
10
15
20
25
30
35
40
Monitor/Daily Update Chart
Project Control Line (PCL)
9 10 16 17 23 24 30 1 7 8 14 15 21 22 28 29 11 12
S S S S S S S S H S S S S S S S S S
JUNE 2001
JULY 2001

Placing Activities — Steps 6 through 10

Step 6. For each critical path activity, locate the Late Finish (LF) on the PCL and draw a solid line to the left to the Early Start (ES). Label the I number at the start, J number at finish, the duration below the solid line and the task above the line (if space is limited create a box in clear space beyond each activity line to describe the task and draw an arrow to the activity line).

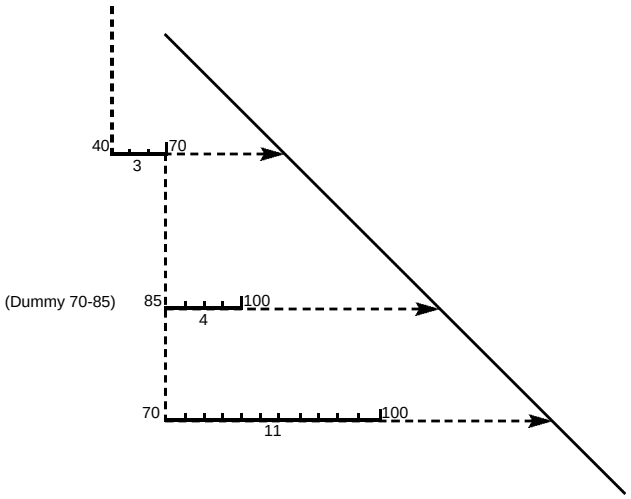
Step 7. Complete the Tally Sheet from the Activity Ranking Form.
Use the Tally Sheet to organize the location of non-critical activities on the Monitor / Daily Update Chart.

Step 8. For non-critical activities where space is available on the PCL, locate the Late Finish on the PCL, go horizontal to the left and draw a solid line from Early Start (ES) to Early Finish (EF) and then draw a dashed line to the PCL to indicate Float. Label the I number at ES, J number at EF, the duration below the solid line and the task above the line (if space is limited create a box in clear space beyond each activity line to describe the task and draw an arrow to the activity line).

Step 9. For an activity with the same Late Finish as another use the completed Tally Sheet to determine the vertical spacing of the remaining activities. Drop down below the PCL into clear space and draw the activity as in Step 8 indicating the Late Finish (LF) by an arrow head against a short vertical line.

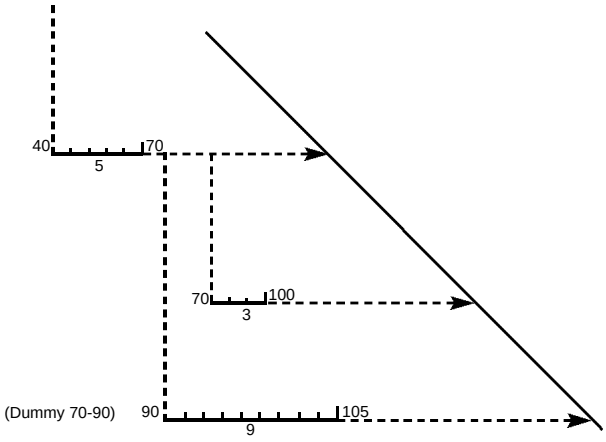
Step 10. Connect each activity to its predecessors. Connect common I - J numbers with a vertical dashed line. When determining if a vertical logic connector is needed, look not only at the successor's "I" number, but also at the "I" numbers of all dummies listed to the left of that activities "I" number. See examples on next page.

Connect common I - J numbers with a vertical dashed line. When determining if a vertical logic connector is needed, look not only at the successor's "I" number, but also at the "I" numbers of all dummies listed to the left of that activities "I" numbers. See examples below.



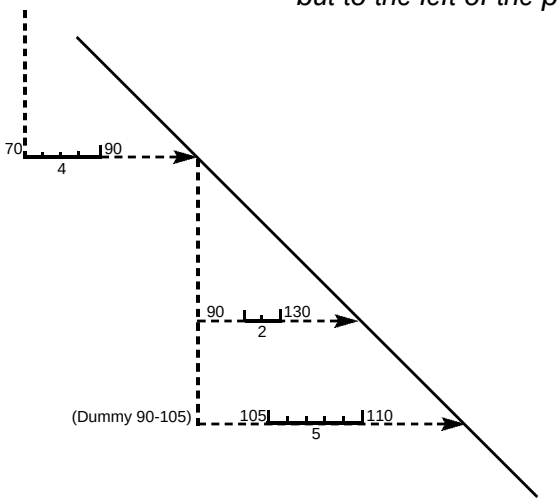
Example 1

The Successor's I - number is located directly below the predecessor's J - number.



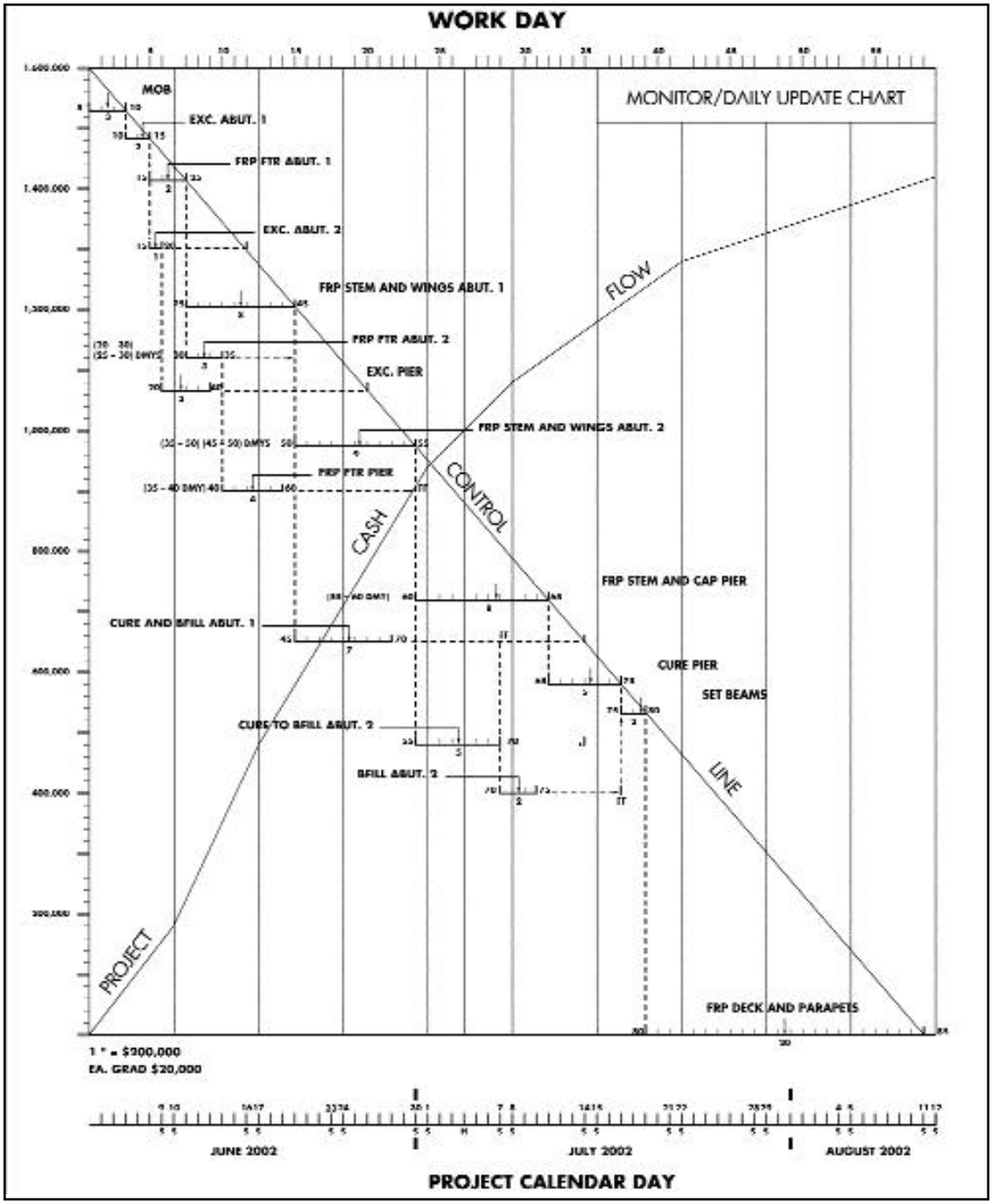
Example 2

The Successor's I - number is located to the right of the predecessor's J - number but to the left of the predecessor's LF.



Example 3

The Successor's I - number is located to the right of the predecessor's LF.



The total length of each horizontal line represents the duration from early start to early finish of the activity, plus any non-critical activity's float, shown as the dashed line.

C. Project Monitoring and Documenting using the Monitor / Daily Update Char t

With all the project's activities plotted on the monitor / daily update chart, it can be used to document periods of work and non-work.

Actual vs. Planned

The start of every activity should be marked on the day when it started, and for every subsequent day as that activity progresses. Likewise, if no work is performed during a day, that should also be indicated on the chart, but only if that activity has already started. Finally, a separate mark should be indicated on the time unit that the activity completes.

Most importantly, any project delay must also be documented, stating the reason for the delay. Having a simple graphical representation of project delay allows the project manager to more quickly respond to possible impacts on the schedule.

Impacts cause changes to the plan, altering the contractor's ability to follow the original schedule. Impacts may shorten or lengthen activity durations, and the lengthened durations may or may not change the critical path. Impacts may include delays to the Notice to Proceed, awards, submissions, approvals, rejections, and production. Delays could also be caused by incomplete plans and drawings, changed conditions, and additional or unforeseen work.

The monitor / daily update chart will document any production delays and gains throughout the project, as well as start delays and gains. A production delay occurs when an activity takes longer than scheduled, possibly pushing any successor activities past their scheduled starts. A start delay occurs when an activity can start on its scheduled start, but for some reason does not. This assumes that its predecessor activities have been completed. Gains occur when production takes less time than scheduled, or when an activity starts earlier than scheduled.

Note: A start delay can only occur when the delay is not attributed to the finish of its predecessor.

Documenting the who, what, when, where, why, and how the impact occurred on the monitor / daily update chart will bring attention to delays before they can be allowed to start a chain reaction. This will help determine what must be done to get the project back on schedule.

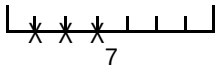
Recommended Notations for Use on the Monitor / Daily Update Chart:

X = activity worked

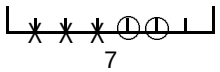
(X) = activity finished

○ = no work performed after it started, but they could have

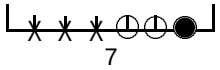
● = no work, inclement weather



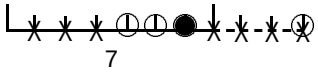
activity worked



no work performed but could have worked

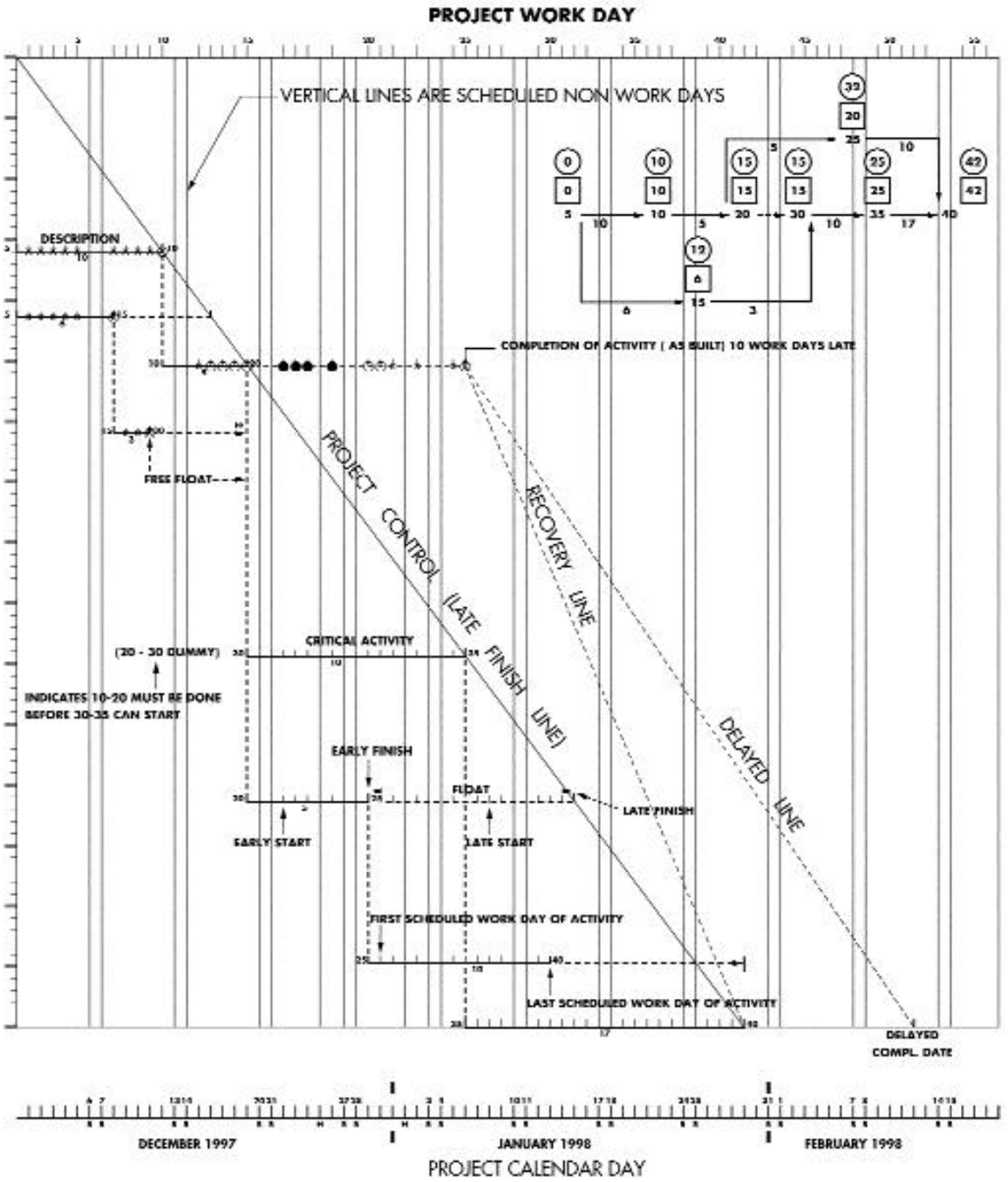


no work – inclement weather



activity complete

EXPLANATION OF MONITOR/DAILY UPDATE CHART



SECTION II

CHAPTER 5. CONVERTING CONTRACTOR SUBMISSIONS

A. Overview of Scheduling Software

You have learned how to plan and schedule a project from beginning to end. You will also be required to convert a contractor's submission into a usable CPM schedule, complete with network diagram and monitor / daily update chart.

Most contractors will submit their schedules using a commercial software package. These software products allow the contractor to create a schedule that establishes and maintains activities interdependencies.

B. Converting a Precedent Schedule to an I-J Schedule

A contractor's schedule submission will include the following information:

- Activity ID Number
- Activity description
- Assigned calendar
- Activity duration
- Early start
- Early finish
- Late start
- Late finish
- Activity float
- Workday calendar(s).

With this information you can build the Network Diagram, identify the critical path, and construct a Monitor / Daily Update Chart as illustrated in this Workbook.

C. Project Management Software – Open Plan

Open Plan is project management software system from Welcom, Inc. that is PENNDOT's standard and approved PM software. Open Plan is a Microsoft Windows-based integrated system that can be customized to fit PENNDOT's specific requirements. It comes in two editions—Open Plan Professional and Open Plan Desktop.

Open Plan allows the project administrator to enter activities, estimated durations, and predecessor and successor activities in a dialog box format that should be familiar to anyone who uses standard Microsoft Windows applications regularly. Forward pass and backward pass calculations are performed automatically and schedule changes are reflected immediately in a bar chart format. A number of preformatted reports are available that include critical path, resource use and project progress.

SECTION II

CHAPTER 6. CPM PROCESS – Other Uses

The CPM Process and its elements can be used in other aspects of project management such as cash flow management. (**see Exercise 3**)

A. Percent of Project Completed to Date

The project manager may want to know how much of any activity will be completed during a period (usually a week), how much money was spent for that activity in that period, how much of that activity is left to complete, and the running total spent for all activities thus far in the project. Each period generally ends on the Sunday of that week.

The Percent of Project Completed to Date form uses the cost entry from the project's Pay Item form, the Daily Update Chart and the workday calendar. If an activity starts on Thursday and is scheduled to take five days to complete, for that period ending Sunday, it would be two-fifths complete. Therefore, it would have accrued two-fifths of the total cost allocated for that activity in the Pay Item worksheet.

For example, assume that an activity identified as 5–10 started on a Tuesday with a duration of three days, and had a successor activity 10–15 with a duration of four days. Activity 5–10 finished on time on Thursday, and activity 10–15 started on Friday.

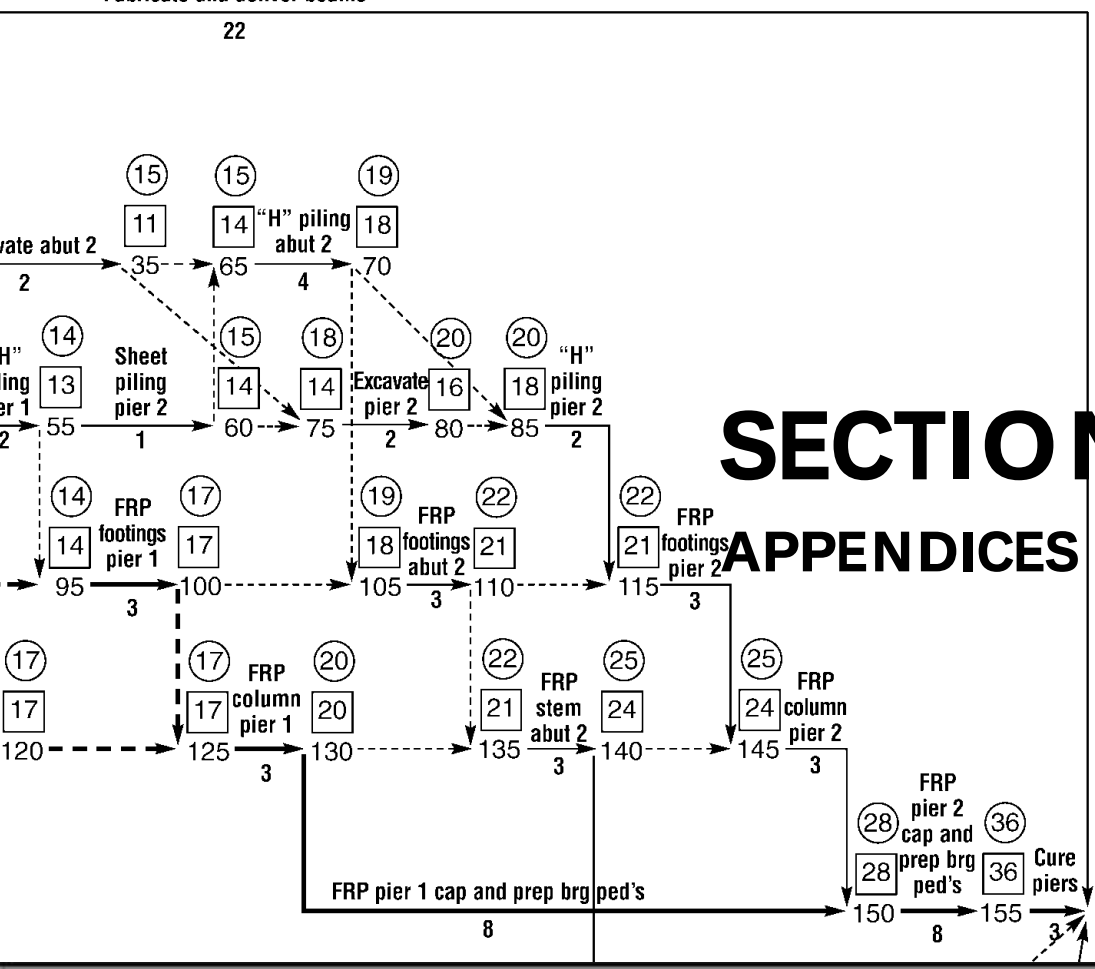
On the Percent Complete form [see Answer Sheet (Exercise 3) A 24], the entry for activity 5–10 would indicate "3 / 3" in the % column because all three days of scheduled work were completed in that period. Likewise, the entry for activity 10–15 would indicate "1 / 4" in its % entry because it couldn't start until 5–10 completed plus one day, meaning Friday, and only one of its scheduled four days have been completed.

If the total cost allocated for activity 5–10 was $1,324, according to the cost entry in the Pay Item worksheet, the cost accrued for that activity in that period was the entire $1,324. For activity 10–15, if the total cost allocated was $11,420.8, because one-fourth of its work was completed, the cost for that activity in that period was $2,855.20, or one-fourth of the total allotted.

B. Tracking Cash Flow

You can make use of the Monitor / Daily Update Chart to keep track of the project's cash flow by plotting the cumulative cost.

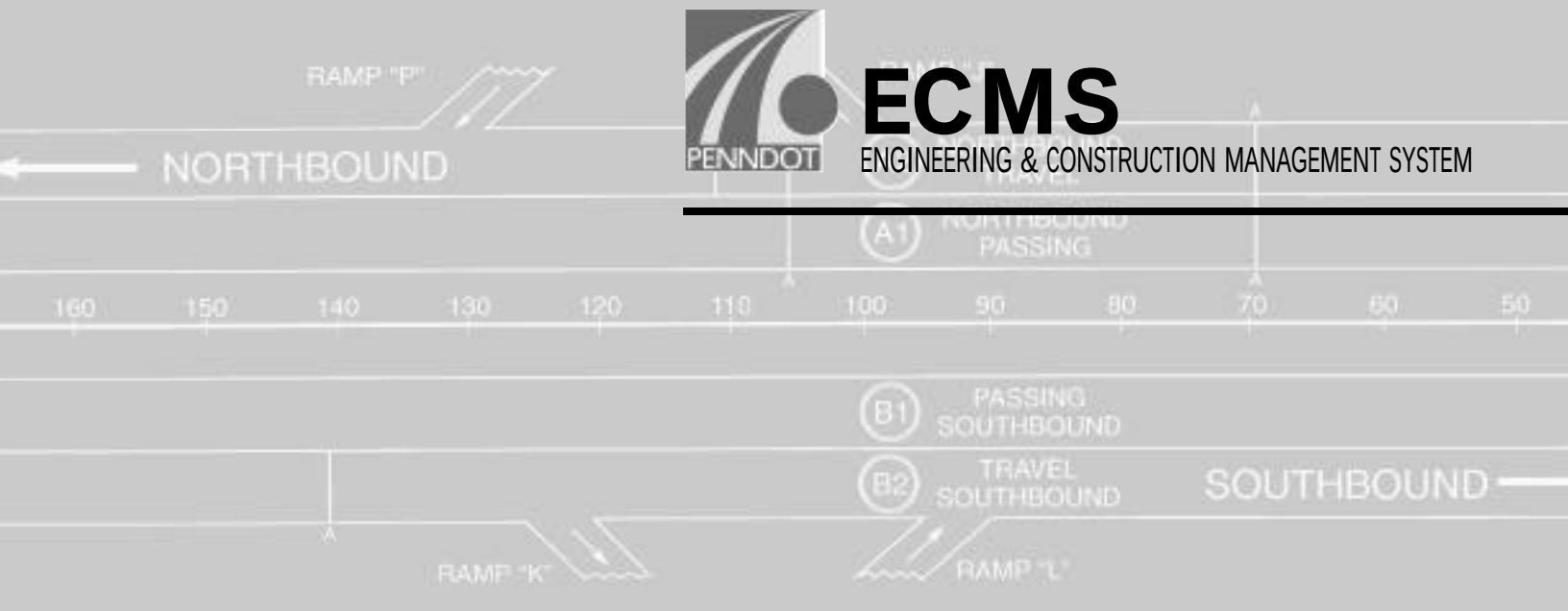
The left side Vertical axis of the monitor / daily update chart can be used to indicate dollar amounts. In the example above, the costs for the two activities plus two additional activities that were performed during the first period of the project totaled $ 13,204.49. On the monitor / daily update chart, find the point that indicates the intersection of the last day of that period on the lower horizontal axis and $ 13,204.49 on the vertical axis and plot a point. Repeat that process for each subsequent project period and connect the points with a line that starts on the first project calendar day in the lower left corner. That is the project's cumulative cost line.



SECTION III

APPENDICES

	281	204		281			519	506	810	4,464	16,814	(20) S. B. PASSING
	267	340		267			553	215	375	4,578		(19) S. B. TRAVEL
								26	14	658	1,421	(B) RAMP "L" (14' WIDE)
								29	36	614	1,973	(A) RAMP "J" (14' WIDE)
						20		33	96	702	1,454	(C) RAMP "K" (14' WIDE)
								29	87	733	1,425	(D) RAMP "F" (14' WIDE)
								70	275	720		AS DIRECTED
6	1,416	1,228	106	971	425	20	2,040	1,855	3,026	21,397	43,240	TOTAL

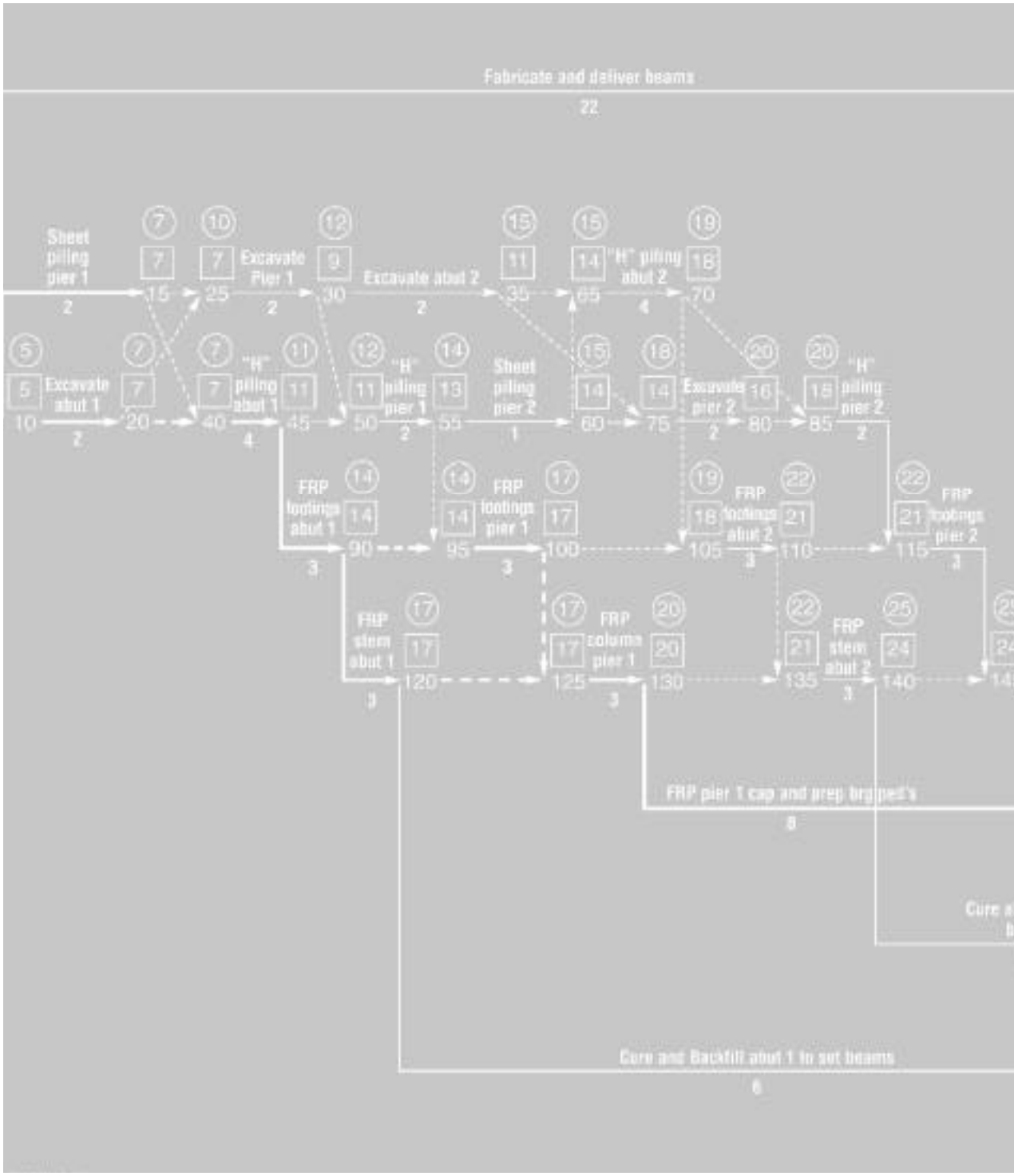


PENNDOT

ECMS

ENGINEERING & CONSTRUCTION MANAGEMENT SYSTEM

APPENDIX A – GLOSSARY OF TERMS



APPENDIX A

Activity – Any definable or time consuming operation, task, function, or time limited condition. Establishing a time frame or duration for each task turns each into an activity.

Activity on Arrow (AOA) – Activity network format where schedule activities are represented by arrows.

Activity on Node (AON) – Activity network format where schedule activities are normally represented by boxes and relationships are represented by arrows. AON networks include only finish-to-start relationships without lag.

Arrow – In an AOA network, a directed line between two nodes representing an activity (usually a solid line) or dummy (usually a dashed line). In an AON or PDM schedule, a directed line between two activities indicates a logical relationship.
NOTE: The length-direction and position of the arrow has no significance, only tails and heads of arrows

Arrow Head – The right side of the arrow. In an Activity-On-Arrow network the head indicates the finish of the activity

Arrow Tail – The left side of the arrow. In an Activity-On-Arrow network the tail indicates the start of the activity.

Backward Pass – Network schedule calculation that determines the latest each activity can start or finish and still maintain the minimum overall duration of the project as calculated by the forward pass. The backward pass derives its name from its procedure that works from the end of the network to the beginning in order to establish each activity's late start and finish dates.

Bar Chart – Graphic representation of a project that includes activities that make up the project, the estimated duration of each activity, and the planned sequence of the activity performance. Activities are represented by bars placed on the schedule with a time line along the horizontal axis and a list of activities along the vertical axis. Also know as the Gantt chart.

Controlling – Responses by the Project Manager to any adverse impacts on a project. The detailed project schedule allows the Project Manager to anticipate and adjust the schedule for future impacts caused by current project events.

APPENDIX A

Concurrent Activity – Used to describe activities that can occur during the same time period.

Critical Activity – Activity on the critical path. (activity with no float)

Critical Path – Longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.

Critical Path Method – CPM is a project management method that lists all activities with durations in a network schedule. The longest continuous chain of activities determines the minimum duration needed for the project to be completed.

Daily Update Chart – A chart used by PENNDOT to monitor progress of a specific project. The chart shows valuable information such as who, what, when, where, and why.

Dummy – In an AOA network, dummies are used to maintain activity logic. Dummies are activities with zero duration. A dummy in an AOA network is normally shown as a dotted line linking nodes. Also known as logic rectifiers. Dummies transfer the completion of an activity to the start of an activity.

Early Finish – The earliest an activity can finish given that activity's early start and duration. The early finish of each activity in the network is calculated during the forward pass.

Early Start – The earliest an activity can be started after all predecessors to the activity are completed. The early start of each activity in the network is calculated during the forward pass. This number is located in the box above the arrow head.

Forensic – A detailed investigation of the CPM schedule in the event of a claim or other questions about a project's delay. Tools needed to conduct a forensic investigation of a CPM schedule include the Daily Update Chart which indicates who, what, when, where, and other facts concerning project delays.

Forward Pass – Network schedule calculation that determines the earliest time each activity can start and finish as well as the minimum overall project duration. The forward pass derives its name from the procedure that works from the beginning of the network to the end in order to establish each activity's early start and finish dates.

APPENDIX A

Free Float – The amount of time that an activity's start can be delayed without affecting the start of the successor activities.

I Node – In an AOA schedule, the node at the beginning (tail) of the activity arrow.

J Node – In an AOA schedule, the node at the end (head) of the activity arrow.

Late Finish – The latest an activity can finish and still complete the project within the minimum overall duration determined by the forward pass.

Late Start – The latest that an activity can start and still complete the project within the minimum overall duration determined by the forward pass.

Logic Diagram – Graphic diagram of a network schedule showing the activities and activity relationships.

Logic Loop – An error in the network logic that results in other than unidirectional logic flow where a successor activity is logically related to a predecessor activity.

Milestone – Milestones are included in schedules to mark a particular point in time for references or measurement. Milestones do not consume any time or resources. An example of a milestone would be "building enclosed."

Network Scheduling – Method of planning and scheduling where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the project.

Notice to Proceed – This indicates the earliest date a project may begin.

Node – In an AOA schedule, the event marking the start (I node) or completion (J node) of an activity. Nodes eventually become a point in time.

Plan – A method of organizing tasks beforehand.

Pre-Bid Construction Schedule – A project specific schedule created by the Project Manager during the constructability review of a project to determine the project's constructability as designed. This schedule is usually put together as a CPM schedule and is used to determine the contract completion date of the project.

APPENDIX A

Precedence Diagram – Lists all project activities in the order of what must be completed prior to another project activity beginning.

Predecessor Activity – An activity that must be completed before a given activity can be started.

Project Management – The process of planning, scheduling, monitoring, and controlling a project.

Precedence Diagramming Method (PDM) – Activity network format similar to AON except that additional precedent relationships and lead and lag are allowed in the network development. In addition to the traditional finish-to-start relationship used in AON networks, PDM networks allow start-to-finish, finish-to-finish, and start-to-start relationships.

Quality Management – Ensuring that the project is completed with a degree of care necessary to meet quality levels.

Resource Management – Managing labor, material, and equipment to ensure the project stays on schedule.

Schedule – An organized method presenting information on when activities need to be started, how long activities are planned to take, and when activities are planned to be completed. A schedule may also convey the logical relationships between activities. A way to maximize efficiency of resources.

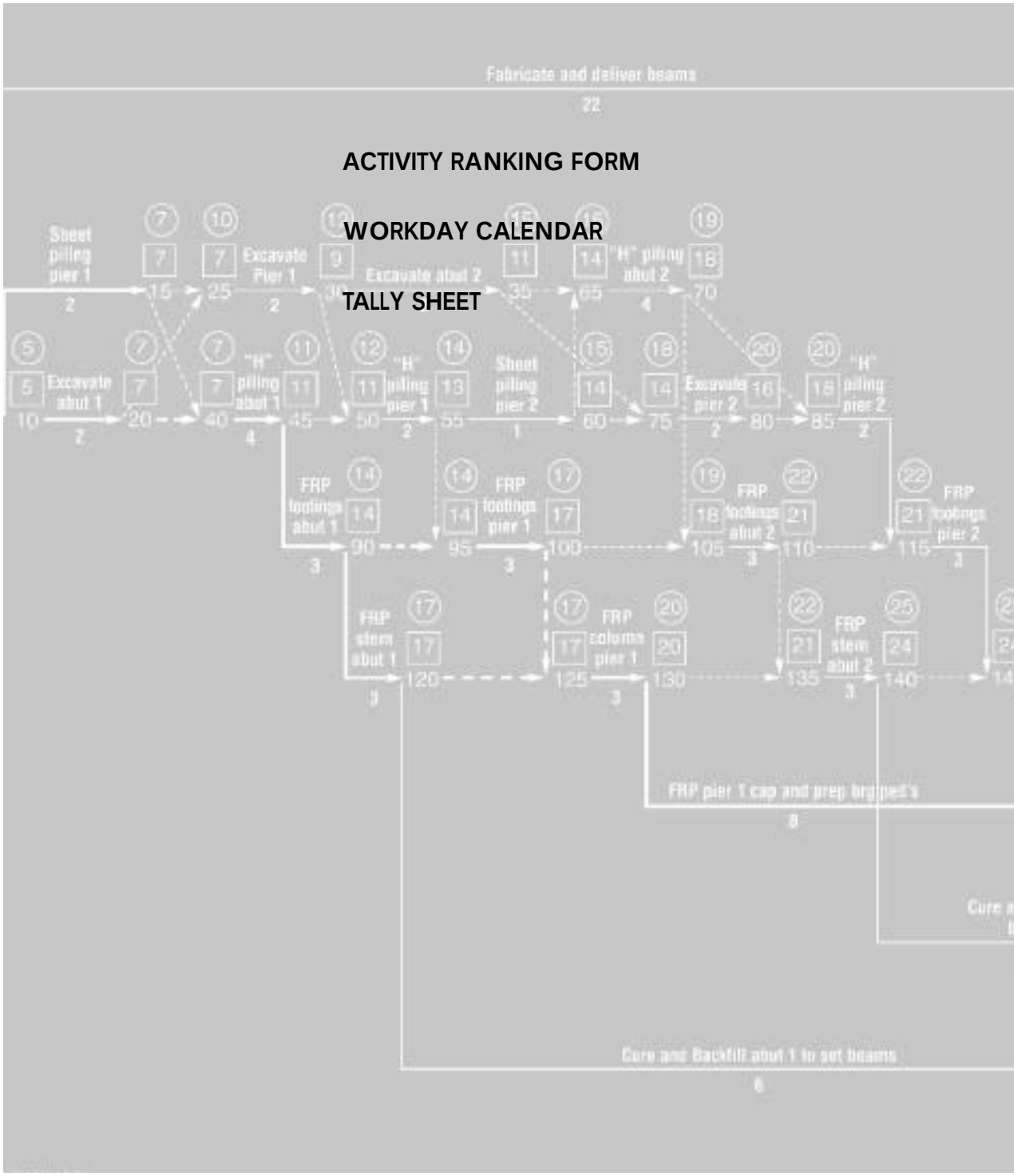
Successor Activity – An activity that cannot start until a given activity is completed.

Time Management – Process of properly managing time to avoid scheduling problems and cost overruns.

Total Float – Measure of the leeway in starting or completing a string of non-critical activities without affecting the planned project completion date.

Workday Calendar – With a known start date, the workday calendar consecutively numbers all days within a projects time span that work can be done.

APPENDIX B – PENNDOT CPM FORMS



ACTIVITY RANKING FORM
FOR MONITOR/DAILY UPDATE CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number: use the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	CREW SIZE	ACTIVITY DESCRIPTION

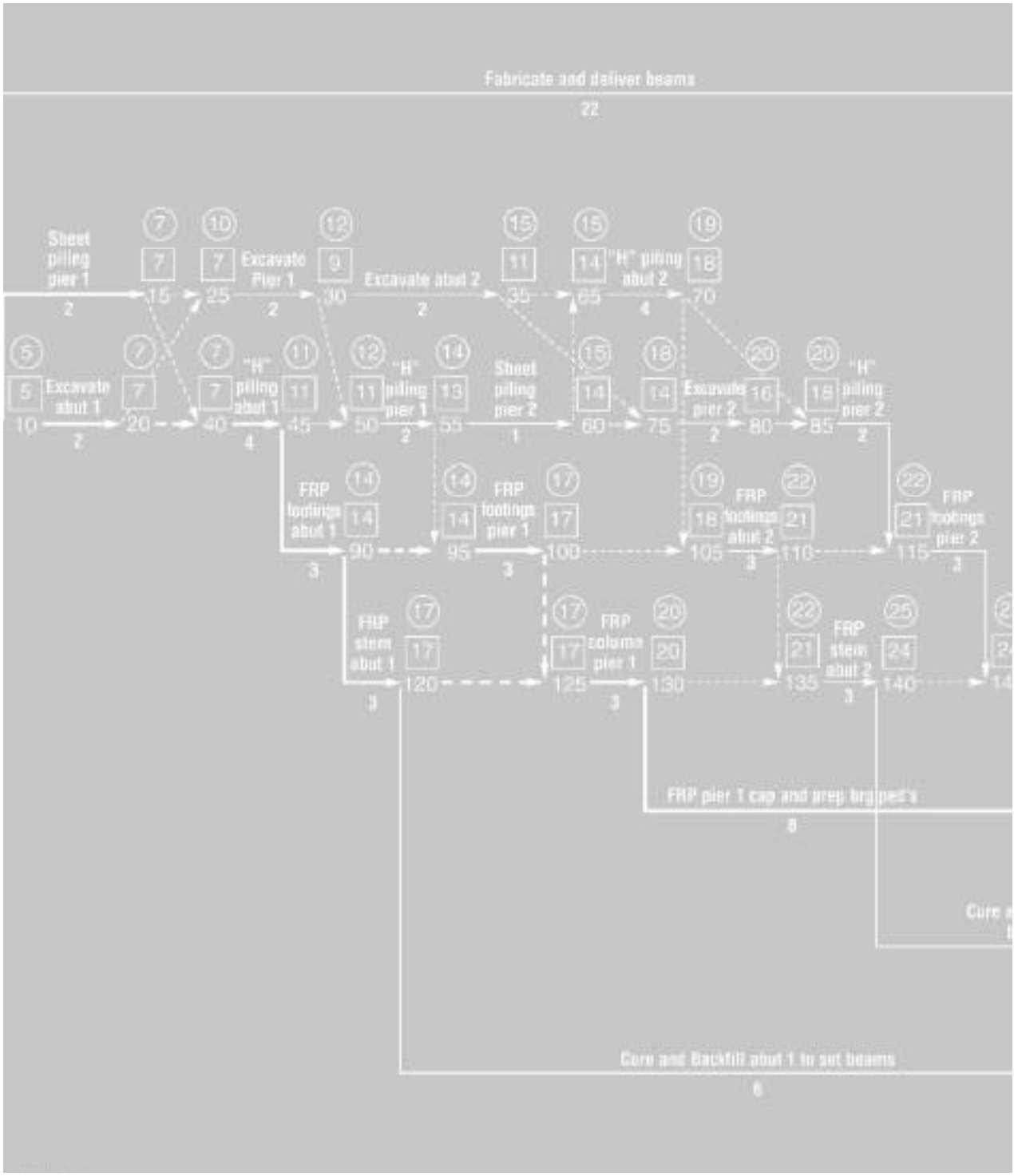
WORKDAY CALENDAR

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															JANUARY
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															FEBRUARY
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															MARCH
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															APRIL
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															MAY
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															JUNE
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															JULY
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															AUGUST
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															SEPTEMBER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															OCTOBER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															NOVEMBER
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
																															DECEMBER

MONITOR/DAILY UPDATE CHART TALLY SHEET

1. _____	51. _____	101. _____	151. _____	201. _____
2. _____	52. _____	102. _____	152. _____	202. _____
3. _____	53. _____	103. _____	153. _____	203. _____
4. _____	54. _____	104. _____	154. _____	204. _____
5. _____	55. _____	105. _____	155. _____	205. _____
6. _____	56. _____	106. _____	156. _____	206. _____
7. _____	57. _____	107. _____	157. _____	207. _____
8. _____	58. _____	108. _____	158. _____	208. _____
9. _____	59. _____	109. _____	159. _____	209. _____
10. _____	60. _____	110. _____	160. _____	210. _____
11. _____	61. _____	111. _____	161. _____	211. _____
12. _____	62. _____	112. _____	162. _____	212. _____
13. _____	63. _____	113. _____	163. _____	213. _____
14. _____	64. _____	114. _____	164. _____	214. _____
15. _____	65. _____	115. _____	165. _____	215. _____
16. _____	66. _____	116. _____	166. _____	216. _____
17. _____	67. _____	117. _____	167. _____	217. _____
18. _____	68. _____	118. _____	168. _____	218. _____
19. _____	69. _____	119. _____	169. _____	219. _____
20. _____	70. _____	120. _____	170. _____	220. _____
21. _____	71. _____	121. _____	171. _____	221. _____
22. _____	72. _____	122. _____	172. _____	222. _____
23. _____	73. _____	123. _____	173. _____	223. _____
24. _____	74. _____	124. _____	174. _____	224. _____
25. _____	75. _____	125. _____	175. _____	225. _____
26. _____	76. _____	126. _____	176. _____	226. _____
27. _____	77. _____	127. _____	177. _____	227. _____
28. _____	78. _____	128. _____	178. _____	228. _____
29. _____	79. _____	129. _____	179. _____	229. _____
30. _____	80. _____	130. _____	180. _____	230. _____
31. _____	81. _____	131. _____	181. _____	231. _____
32. _____	82. _____	132. _____	182. _____	232. _____
33. _____	83. _____	133. _____	183. _____	233. _____
34. _____	84. _____	134. _____	184. _____	234. _____
35. _____	85. _____	135. _____	185. _____	235. _____
36. _____	86. _____	136. _____	186. _____	236. _____
37. _____	87. _____	137. _____	187. _____	237. _____
38. _____	88. _____	138. _____	188. _____	238. _____
39. _____	89. _____	139. _____	189. _____	239. _____
40. _____	90. _____	140. _____	190. _____	240. _____
41. _____	91. _____	141. _____	191. _____	241. _____
42. _____	92. _____	142. _____	192. _____	242. _____
43. _____	93. _____	143. _____	193. _____	243. _____
44. _____	94. _____	144. _____	194. _____	244. _____
45. _____	95. _____	145. _____	195. _____	245. _____
46. _____	96. _____	146. _____	196. _____	246. _____
47. _____	97. _____	147. _____	197. _____	247. _____
48. _____	98. _____	148. _____	198. _____	248. _____
49. _____	99. _____	149. _____	199. _____	249. _____
50. _____	100. _____	150. _____	200. _____	250. _____

APPENDIX C – REFERENCE



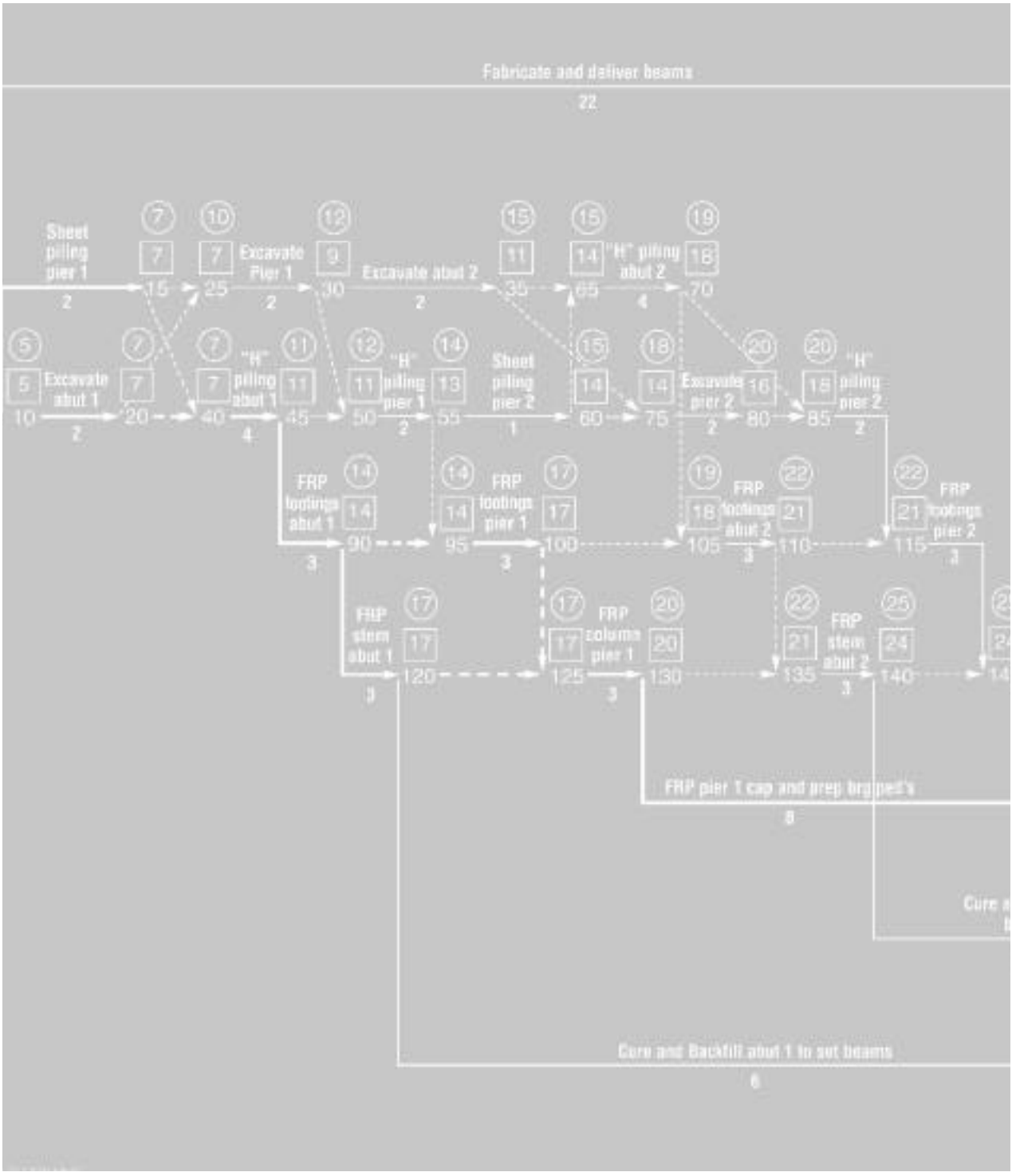
APPENDIX C

1. Associated General Contractors of America: The Use of CPM in Construction: A Manual for General Contractors and the Construction Industry, Washington, D.C.; AGC, 1976

2. Associated General Contractors of America: Construction Planning and Scheduling, Alexandria, VA; AGC, 1997

3. Michael T. Callahan, Daniel G. Quackenbush, James E. Rowings: Construction Project Scheduling, Boston, MA; McGraw-Hill; 1992

APPENDIX D – PRACTICE EXERCISES-WORKSHEETS



APPENDIX D

APPENDIX D – PRACTICE EXERCISES - WORKSHEET

APPENDIX D

APPENDIX D – PRACTICE EXERCISES - WORKSHEET

EXERCISE 1: **SPAGHETTI DINNER**

ACTIVITY LIST *(Work Plan)*

Project planning and scheduling using CPM may sound difficult but the technique can be applied to everything you do.

To demonstrate its effectiveness and to understand the process steps, we will plan and schedule a spaghetti dinner.

What tasks or work must be completed to have a successful dinner?

The first step is to prepare the work plan by identifying the tasks and times required to complete each task, called duration.

Task	**Duration**
Shop for groceries	3 hrs.
Mix meat balls	1 hr.
Brown meat balls	1 hr.
Prepare meat sauce	1 hr.
Cook sauce	2 hrs.
Cook sauce & meat balls	2 hrs.
Boil water & cook pasta	1 hr.
Set table	1 hr.
Chill wine	3 hrs.
Bake bread	3 hrs.
Bake pies	2 hrs.
Brew coffee	1 hr.
Prepare salad	1 hr.
Seat guests	1 hr.
Serve wine & salad	1 hr.
Serve bread, pasta & wine	2 hrs.
Serve coffee & dessert	1 hr.

EXERCISE 1: **SPAGHETTI DINNER**

NETWORK DIAGRAM

Instructions:

Draw Logic Diagram

a. Draw each activity as an arrow in a logical sequence of work asking: What's first, what's next, and what can be done at the same time?

b. Construct the Network Diagram by completing the rest of the eight step process. (See Reference Card)

WORK SHEET

EXERCISE 1: **SPAGHETTI DINNER**

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number to develop Bar Chart: use the earliest ES, assending to the latest ES. In case of tie, use lowest total float, lowest Duration, lowest I number, and lowest J number.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	ACTIVITY DESCRIPTION

EXERCISE 1: **SPAGHETTI DINNER**

RESOURCE MANAGEMENT BAR CHART

ACTIVITY RANKING					DURATION	RESOURCE	ACTIVITY DESCRIPTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NO	I	J	ES	TF																	

EXERCISE 1: **SPAGHETTI DINNER**

MONITOR/DAILY UPDATE CHART TALLY SHEET

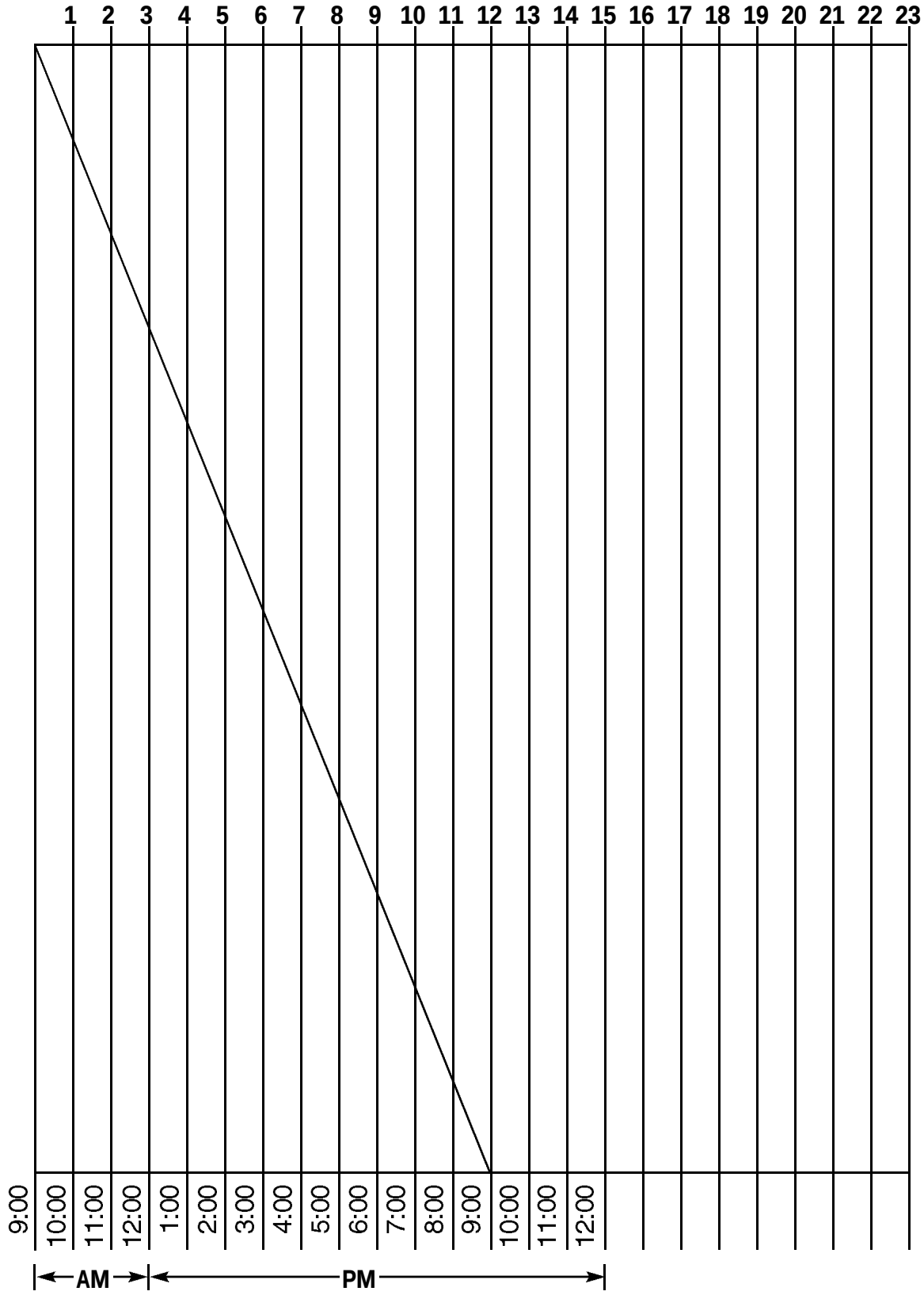
1. _____	51. _____	101. _____	151. _____	201. _____
2. _____	52. _____	102. _____	152. _____	202. _____
3. _____	53. _____	103. _____	153. _____	203. _____
4. _____	54. _____	104. _____	154. _____	204. _____
5. _____	55. _____	105. _____	155. _____	205. _____
6. _____	56. _____	106. _____	156. _____	206. _____
7. _____	57. _____	107. _____	157. _____	207. _____
8. _____	58. _____	108. _____	158. _____	208. _____
9. _____	59. _____	109. _____	159. _____	209. _____
10. _____	60. _____	110. _____	160. _____	210. _____
11. _____	61. _____	111. _____	161. _____	211. _____
12. _____	62. _____	112. _____	162. _____	212. _____
13. _____	63. _____	113. _____	163. _____	213. _____
14. _____	64. _____	114. _____	164. _____	214. _____
15. _____	65. _____	115. _____	165. _____	215. _____
16. _____	66. _____	116. _____	166. _____	216. _____
17. _____	67. _____	117. _____	167. _____	217. _____
18. _____	68. _____	118. _____	168. _____	218. _____
19. _____	69. _____	119. _____	169. _____	219. _____
20. _____	70. _____	120. _____	170. _____	220. _____
21. _____	71. _____	121. _____	171. _____	221. _____
22. _____	72. _____	122. _____	172. _____	222. _____
23. _____	73. _____	123. _____	173. _____	223. _____
24. _____	74. _____	124. _____	174. _____	224. _____
25. _____	75. _____	125. _____	175. _____	225. _____
26. _____	76. _____	126. _____	176. _____	226. _____
27. _____	77. _____	127. _____	177. _____	227. _____
28. _____	78. _____	128. _____	178. _____	228. _____
29. _____	79. _____	129. _____	179. _____	229. _____
30. _____	80. _____	130. _____	180. _____	230. _____
31. _____	81. _____	131. _____	181. _____	231. _____
32. _____	82. _____	132. _____	182. _____	232. _____
33. _____	83. _____	133. _____	183. _____	233. _____
34. _____	84. _____	134. _____	184. _____	234. _____
35. _____	85. _____	135. _____	185. _____	235. _____
36. _____	86. _____	136. _____	186. _____	236. _____
37. _____	87. _____	137. _____	187. _____	237. _____
38. _____	88. _____	138. _____	188. _____	238. _____
39. _____	89. _____	139. _____	189. _____	239. _____
40. _____	90. _____	140. _____	190. _____	240. _____
41. _____	91. _____	141. _____	191. _____	241. _____
42. _____	92. _____	142. _____	192. _____	242. _____
43. _____	93. _____	143. _____	193. _____	243. _____
44. _____	94. _____	144. _____	194. _____	244. _____
45. _____	95. _____	145. _____	195. _____	245. _____
46. _____	96. _____	146. _____	196. _____	246. _____
47. _____	97. _____	147. _____	197. _____	247. _____
48. _____	98. _____	148. _____	198. _____	248. _____
49. _____	99. _____	149. _____	199. _____	249. _____
50. _____	100. _____	150. _____	200. _____	250. _____

EXERCISE 1: **SPAGHETTI DINNER**

MONITOR/DAILY UPDATE CHART

Instructions:

Construct the Monitor/Daily Update Chart by completing the 10 Steps. (See CPM Formulas and Rules)



WORK PLAN

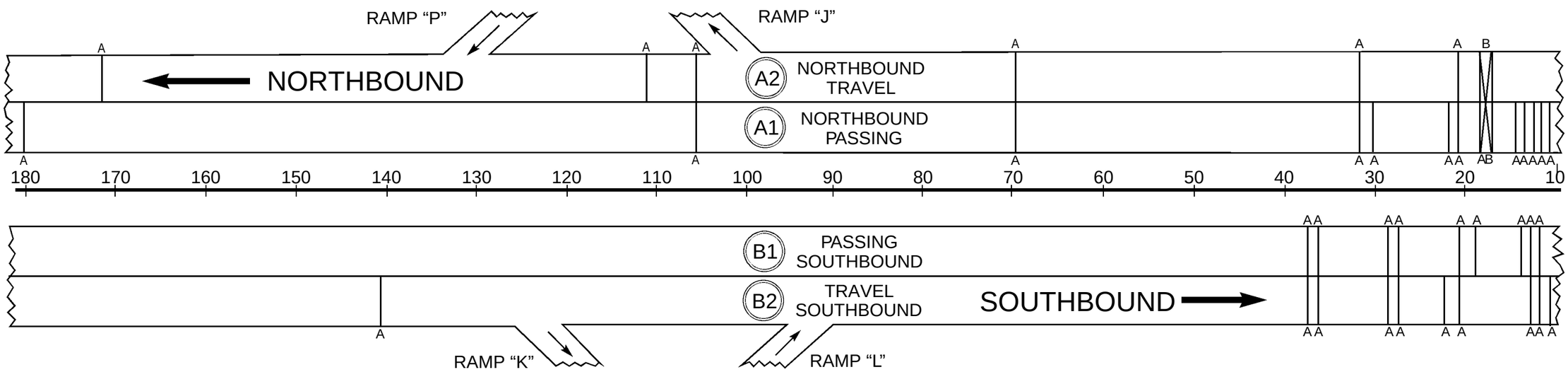
CLASS IA EXCAVATION 0203 0003 CY	SUBBASE MATERIAL 0350 0050 CY	PROTECTIVE COATING FOR CEMENT CONCRETE PAVEMENTS AND SHOULDERS 0503 0001 SY	PATCHING JOINT 0590 2007 LF	NEW PAVEMENT JOINT 0590 2008 LF	CONCRETE PAVEMENT PATCH TYPE "A" 0590 2009 SY	CONCRETE PAVEMENT PATCH TYPE "B" 0590 2010 SY	H.E.S. PAVEMENT PATCH TYPE "A" 0590 2011 SY	PAVEMENT BASE DRAIN 0610 7000 LF	CRACK CLEANING AND SEALING 2000 0001 LF	CONCRETE PAVEMENT SPALL REPAIR 2000 0002 SF	JOINT REHABILITATION TYPE 2 2590 0011 LF	LONGITUDINAL JOINT CLEAN AND SEAL 2590 0050 LF	ITEM NUMBER / UNIT	REMARKS
		350	240	60	127	223		147	214	1,188	4,524	18,153	(A2)	N. B. TRAVEL
50	50	498	384	48	296	202		821	733	145	4,404		(A1)	N. B. PASSING
50	50	281	264		281			519	506	810	4,464	18,814	(B1)	S. B. PASSING
		287	340		267			553	215	375	4,578		(B2)	S. B. TRAVEL
									26	14	658	1,421	(B2)	RAMP "L" (14'WIDE)
									29	36	614	1,973	(A2)	RAMP "J" (14'WIDE)
							20		33	96	702	1,454	(B2)	RAMP "K" (14'WIDE)
									29	87	733	1,425	(A2)	RAMP "P" (14'WIDE)
									70	275	720			AS DIRECTED
100	100	1,416	1,228	108	971	425	20	2,040	1,855	3,026	21,397	43,240		TOTAL

STRAIGHT LINE DIAGRAM FOR CONSTRUCTION OF PAVEMENT REHABILITATION

TYPE "A" PATCH — A

TYPE "B" PATCH — B

WORK SHEET



EXERCISE 2: **RT 60–PAVEMENT REHABILITATION PROJECT**

CONTRACTOR'S HISTORIC DATA

ITEM	CODE	PAY ITEM	DESCRIPTION	UNIT	QUANTITY	LABOR HOURS PER UNIT	LABOR COST PER UNIT	LABOR OVRHD. 41.2%	TOTAL LABOR PER UNIT	TOTAL LABOR	EQUIP. HOURS PER UNIT	EQUIP. COST PER UNIT	TOTAL EQUIP.	MATL. COST PER UNIT	TOTAL MATL.	UNIT COST	TOTAL COST	UNIT BID	TOTAL BID
1	1101	0203-0003	CLASS (1A) EXCAVATION	CY	100	.343			5.53			7.80				13.34	1334	18.70	1870
						(11.41)													
2	1600	0350-0050	SUBBASE MATERIAL	CY	100	.660			10.81			2.80		15.00		28.61	2861	40.00	4000
						(11.60)													
3	2106	0503-0001	PROT. COAT. FOR CONC. PVT. & SHLDRS.	SY	1416	.035			0.47			0.47		0.60		1.54	2181	2.15	3044.40
						(9.57)													
4		0590-2007	PATCHING JOINT	LF	1228	.198			2.68			1.38		3.70		7.76	9529	10.90	13385.20
	2108		SAW CUT	LF	1228	.111			1.50			1.07		1.00		3.57	4384	5.00	6140
	2107		DOWELS	LF	1228	.087			1.18			0.31		2.70		4.19	5145	5.90	7245.20
						(9.57)													
5	2109	0590-2008	NEW PAVT. JOINT	LF	108	.102			1.38			0.91		3.46		5.75	621	8.05	869.40
						(9.57)													
6		0590-2009	PATCHING TYPE "A"	SY	971	.867			12.44			6.75		22.07		41.26	40063	57.75	56075.25
		0590-2010	PATCHING TYPE "B"	SY	425	.867			12.44			6.75		22.07		41.26	17536	57.75	24543.75
		0590-2011	HES PATCHING TYPE "A"	SY	20	.867			12.44			6.75		28.77		47.96	959	70.00	1400.00
			BID SUMMARY ALL TYPES	SY	1416	.867			12.44			6.75		22.15		41.34	58537	57.89	81972.24
	2101		FULL DEPTH LONG. SAW CUT 890'	SY	1416	.030			0.43			0.29		1.00		1.72	2435	2.40	3398.40
	2102		INTERIOR SAW OR VERM. CUT 1406'	SY	1416	.107			1.54			0.88		2.50		4.92	6967	6.88	9472.08
	2100		DRILL VERT. LIFTING HOLES 624 EA	SY	1416	.029			0.43			0.31		0.10		0.84	1189	1.18	1670.88
	2103		REM. & DISPOSE OF SLABS 156 PCS	SY	1416	.210			3.02			3.66		——		6.68	9459	9.36	13253.76
	2104		PLACE MESH CHAIRS ETC. 725' CHRS	SY	1416	.035			0.47			0.10		2.23		2.80	3965	3.92	5550.72
	2105		FINE GO.-FM.-PLACE-FINISH-CLN UP	SY	1416	.456			6.55			1.51		16.32		24.38	34522	34.15	48356.40
						(10.16)													
7	7060	0608-0001	MOBILIZATION	LS	1	100.000			1452			2000				3452	3452	4800	4800
						(10.28)													
8	7070	0609-0004	INSP. FIELD OFFICE	LS	1	80.000			1081			550		1000		2631	2631	3600	3600
						(9.57)													
9	3004	0610-7000	PAVT. BASE DRAIN	LF	2040	.151			2.66			1.33		1.16		5.15	10506	7.20	14688
						(12.42)													
10		0901-0001	MAINT. PROT. TRAFFIC	LS	1	400.000			5405			550		10314		16269	16269	22700	22700
		0901-0201	ARROW BOARDS	EA	1	40.000			540			900				1440	1440	2000	2000
			BID SUMMARY	LS	1	440.000			5945			1450		10314		17709	17709	24700	24700
	6200		ALL COSTS BUT FLAGGING	LS	1	220.000			2972.50			1250		10314		14536.50	14536.50	20300	20300
	6201		COSTS OF FLAGGING TRAFFIC	LS	1	220.000			2972.50			200				3172.50	3172.50	4400	4400
						(9.57)													
11		2000-0001	CRACK CLEANING & SEALING	LF	1855	.022			0.30			0.27		0.32		0.89	1650	1.25	2318.75
	9412		SAW & CLEAN BY WATER BLASTING	LF	1855	.013			0.18			0.21		0.17		0.56	1039	0.78	1446.90
	9417		SEAL	LF	1855	.009			0.12			0.06		0.15		0.33	612	0.47	871.80
						(9.57)													
12		2000-0002	CONC. PAVT. SPALL REPAIR (LATEX)	SF	3026	.468			6.48			1.87		4.44		12.79	38703	18.00	54468
	9511		SAW	SF	3026	.035			0.48			0.31		0.64		1.43	4327	2.01	6082.26
	9512		REMOVE	SF	3026	.200			2.72			0.99		0.26		3.97	12013	5.58	16885.08
	9513		SAND BLAST	SF	3026	.035			0.47			0.26		0.48		1.21	3661	1.71	5174.40
	9515		PLACE	SF	3026	.198			2.81			0.31		3.06		6.18	18702	8.70	26326.20
						(9.80)													
13		2590-0011	JOINT REHAB. TYPE "2"	LF	21397	.134			1.31			1.07		0.36		2.74	58628	3.84	82164.48
	9621		SAW	LF	21397	.036			0.50			0.43		0.12		1.05	22467	1.47	31453.50
	9622		CLEAN OUT (ROUT)	LF	21397	.020			0.28			0.45		0.12		0.85	18187	1.19	25462.43
	9627		SEAL	LF	21397	.039			0.53			0.19		0.12		0.84	17973	1.18	25248.46
						(9.72)													
14		2590-0050	LONG. JOINT CLEAN & SEAL	LF	43240	.015			0.23			0.18		0.15		2.74	58628	3.84	82164.48
	9518		CLEAN OUT JOINT	LF	43240	.012			0.18			0.13		0.05		2.74	58628	3.84	82164.48
	9517		SEAL	LF	43240	.003			0.05			0.05		0.10		2.74	58628	3.84	82164.48
						(10.85)													
										95250.25									
15	7000		FUEL GREASE OIL ETC.	LS	1 (16.94)	60			1436			210		3200		4846	4846		
	7080		SUPERVISION	LS	1 (12.40)	600			10500			1050		1050		12600	12600		
	7099		BOND & LEGAL	LS	1									4000		4000	4000		
										107186.25									

WORK SHEET

BUDGET FOR THE CONSTRUCTION OF
PAVEMENT REHABILITATION FOR
RT 60 – ALLEGHENY CO.

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

2001 WORKDAY CALENDAR

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JANUARY	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
FEBRUARY	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MARCH	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
APRIL	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MAY	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THU

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
JUNE	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JULY	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
AUGUST	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
SEPTEMBER	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
OCTOBER	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED

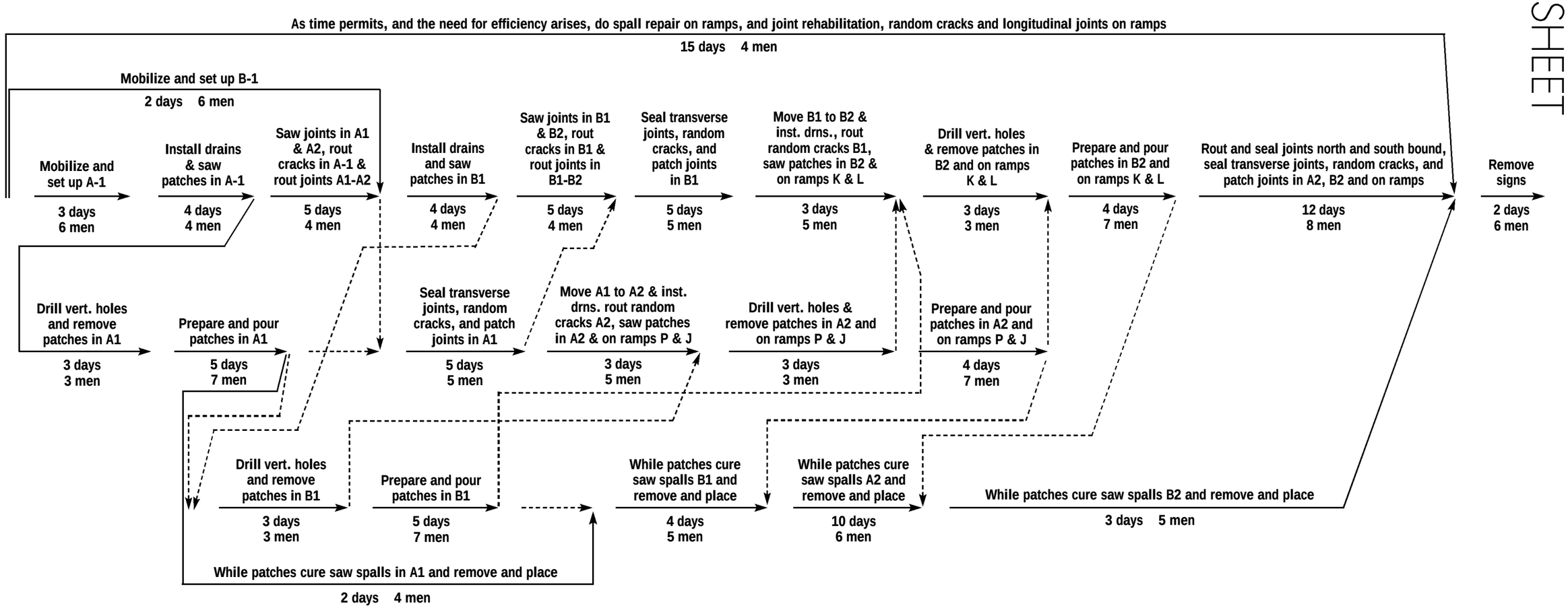
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
NOVEMBER	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
DECEMBER	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON

EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

NETWORK DIAGRAM

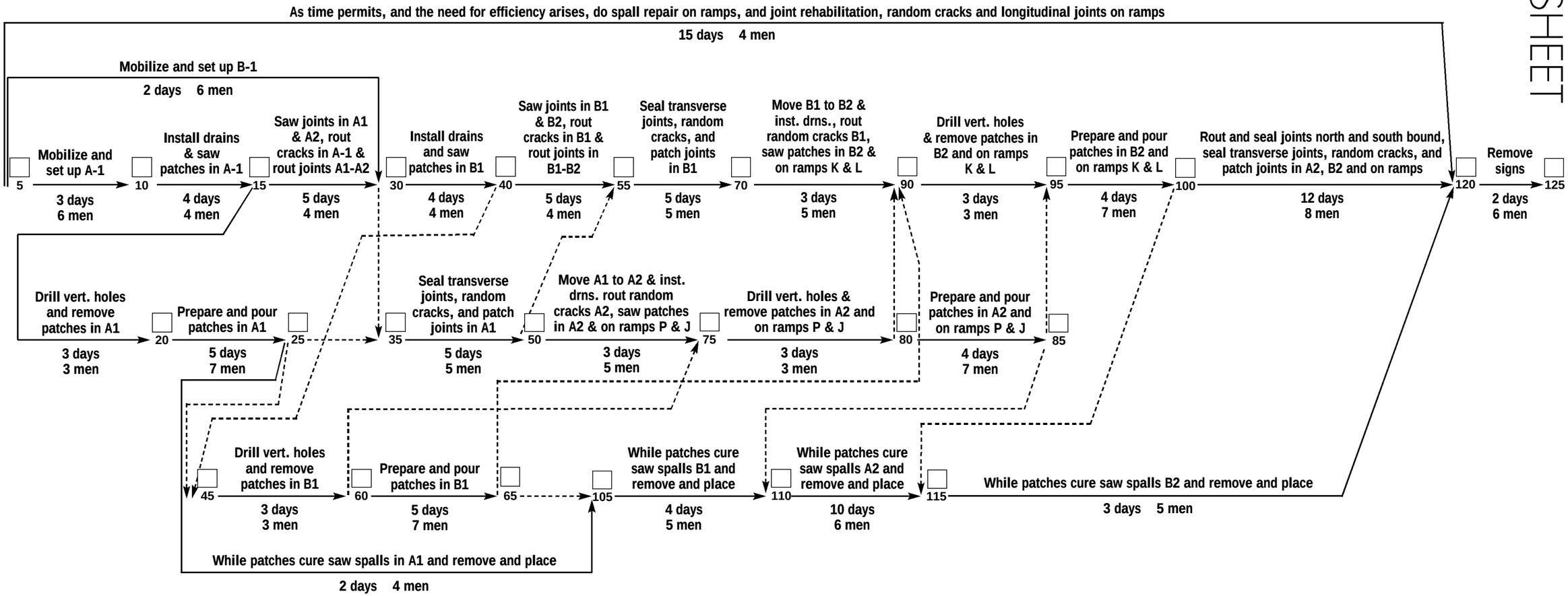
WORK SHEET



EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

NETWORK DIAGRAM

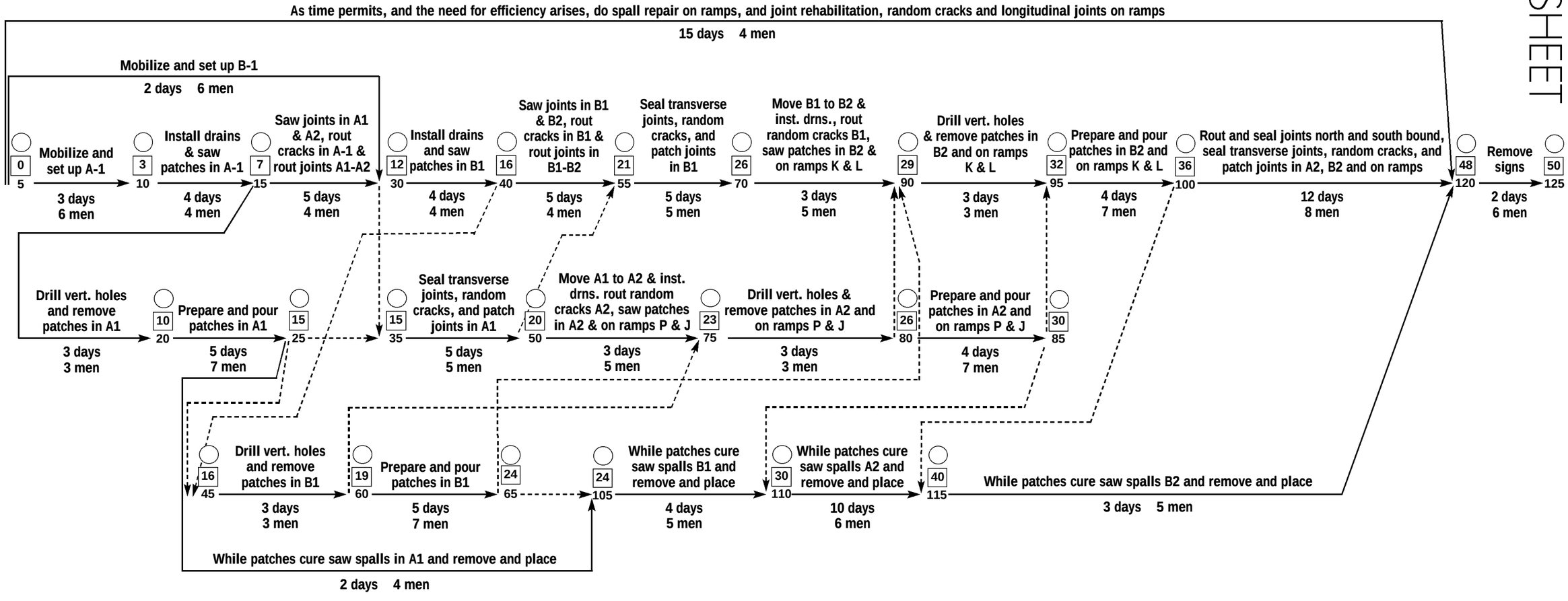
WORK SHEET



EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

NETWORK DIAGRAM

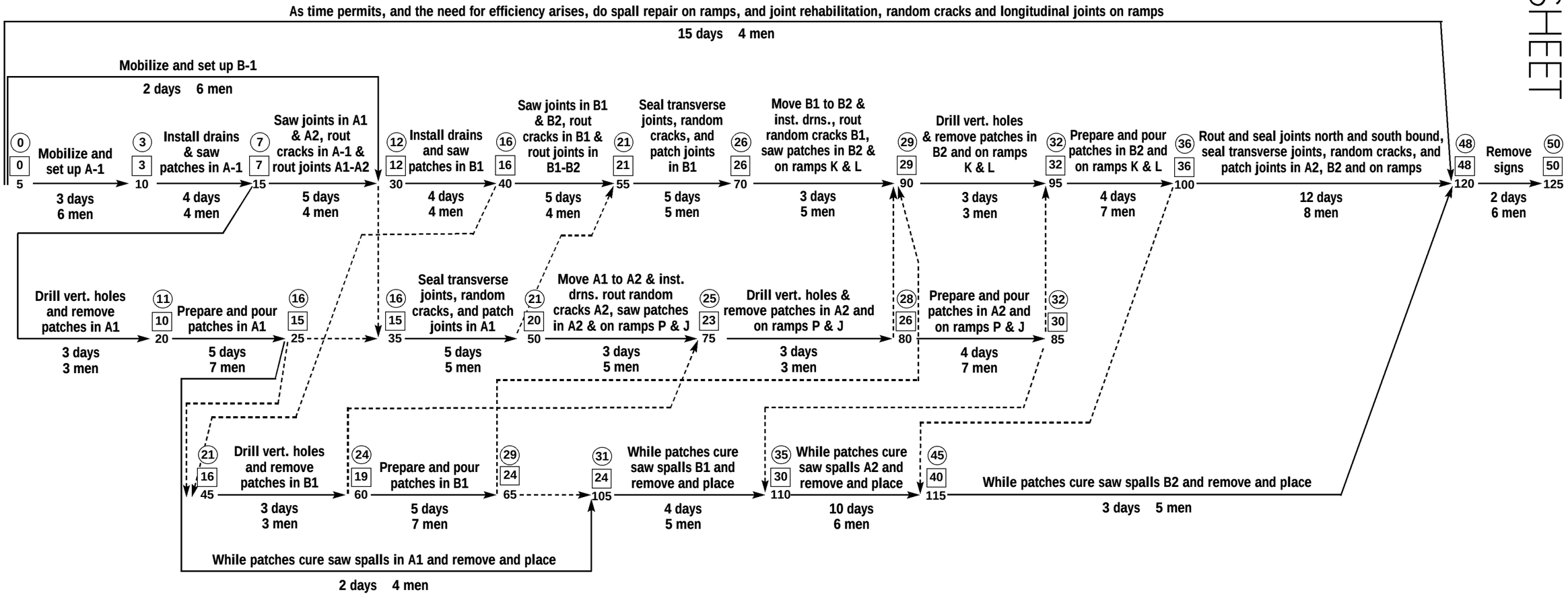
WORK SHEET



EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

NETWORK DIAGRAM

WORK SHEET



EXERCISE 2: RT 60–PAVEMENT REHABILITATION PROJECT

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number to develop Bar Chart: use the earliest ES, assending to the latest ES. In case of tie, use lowest total float, lowest Duration, lowest I number, and lowest J number.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	

EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

RESOURCE MANAGEMENT BAR CHART

RT. 60 PAVEMENT REHABILITATION PROJECT

DISTRIBUTION OF CONTRACT QUANTITIES AND JOB BUDGET BY ACTIVITY

NOTE:
In order to cover costs of fuel, supervision and bond the following % are added. 13% to labor, 2% to equip. and 10% to material.

ACTIVITY RANKING					DURATION	CREW SIZE
NO.	I	J	ES	TF		
1	5	10	0	0	3	6
2	5	30	0	10	2	6
3	5	120	0	33	15	4
4	10	15	3	0	4	4
5	15	30	7	0	5	4
6	15	20	7	1	3	3
7	20	25	10	1	5	7
8	30	40	12	0	4	4
9	30	35	12	4	0	0
10	25	35	15	1	0	0
11	35	50	15	1	5	5
12	25	45	15	6	0	0
13	25	105	15	14	2	4
14	40	55	16	0	5	4
15	40	45	16	5	0	0
16	45	60	16	5	3	3
17	60	65	19	5	5	7
18	60	75	19	6	0	0
19	50	55	20	1	0	0
20	50	75	20	2	3	5
21	55	70	21	0	5	5
22	75	80	23	2	3	3
23	65	90	24	5	0	0
24	65	105	24	7	0	0
25	105	110	24	7	4	5
26	70	90	26	0	3	5
27	80	85	26	2	4	7
28	80	90	26	3	0	0
29	90	95	29	0	3	3
30	85	95	30	2	0	0
31	85	110	30	5	0	0
32	110	115	30	5	10	6
33	95	100	32	0	4	7
34	100	120	36	0	12	8
35	100	115	36	9	0	0
36	115	120	40	5	3	5
37	120	125	48	0	2	6

WORK SHEET

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

MONITOR/DAILY UPDATE CHART TALLY SHEET

1._____	51._____	101._____	151._____	201._____	251._____
2._____	52._____	102._____	152._____	202._____	252._____
3._____	53._____	103._____	153._____	203._____	253._____
4._____	54._____	104._____	154._____	204._____	254._____
5._____	55._____	105._____	155._____	205._____	255._____
6._____	56._____	106._____	156._____	206._____	256._____
7._____	57._____	107._____	157._____	207._____	257._____
8._____	58._____	108._____	158._____	208._____	258._____
9._____	59._____	109._____	159._____	209._____	259._____
10._____	60._____	110._____	160._____	210._____	260._____
11._____	61._____	111._____	161._____	211._____	261._____
12._____	62._____	112._____	162._____	212._____	262._____
13._____	63._____	113._____	163._____	213._____	263._____
14._____	64._____	114._____	164._____	214._____	264._____
15._____	65._____	115._____	165._____	215._____	265._____
16._____	66._____	116._____	166._____	216._____	266._____
17._____	67._____	117._____	167._____	217._____	267._____
18._____	68._____	118._____	168._____	218._____	268._____
19._____	69._____	119._____	169._____	219._____	269._____
20._____	70._____	120._____	170._____	220._____	270._____
21._____	71._____	121._____	171._____	221._____	271._____
22._____	72._____	122._____	172._____	222._____	272._____
23._____	73._____	123._____	173._____	223._____	273._____
24._____	74._____	124._____	174._____	224._____	274._____
25._____	75._____	125._____	175._____	225._____	275._____
26._____	76._____	126._____	176._____	226._____	276._____
27._____	77._____	127._____	177._____	227._____	277._____
28._____	78._____	128._____	178._____	228._____	278._____
29._____	79._____	129._____	179._____	229._____	279._____
30._____	80._____	130._____	180._____	230._____	280._____
31._____	81._____	131._____	181._____	231._____	281._____
32._____	82._____	132._____	182._____	232._____	282._____
33._____	83._____	133._____	183._____	233._____	283._____
34._____	84._____	134._____	184._____	234._____	284._____
35._____	85._____	135._____	185._____	235._____	285._____
36._____	86._____	136._____	186._____	236._____	286._____
37._____	87._____	137._____	187._____	237._____	287._____
38._____	88._____	138._____	188._____	238._____	288._____
39._____	89._____	139._____	189._____	239._____	289._____
40._____	90._____	140._____	190._____	240._____	290._____
41._____	91._____	141._____	191._____	241._____	291._____
42._____	92._____	142._____	192._____	242._____	292._____
43._____	93._____	143._____	193._____	243._____	293._____
44._____	94._____	144._____	194._____	244._____	294._____
45._____	95._____	145._____	195._____	245._____	295._____
46._____	96._____	146._____	196._____	246._____	296._____
47._____	97._____	147._____	197._____	247._____	297._____
48._____	98._____	148._____	198._____	248._____	298._____
49._____	99._____	149._____	199._____	249._____	299._____
50._____	100._____	150._____	200. _____	250._____	300._____

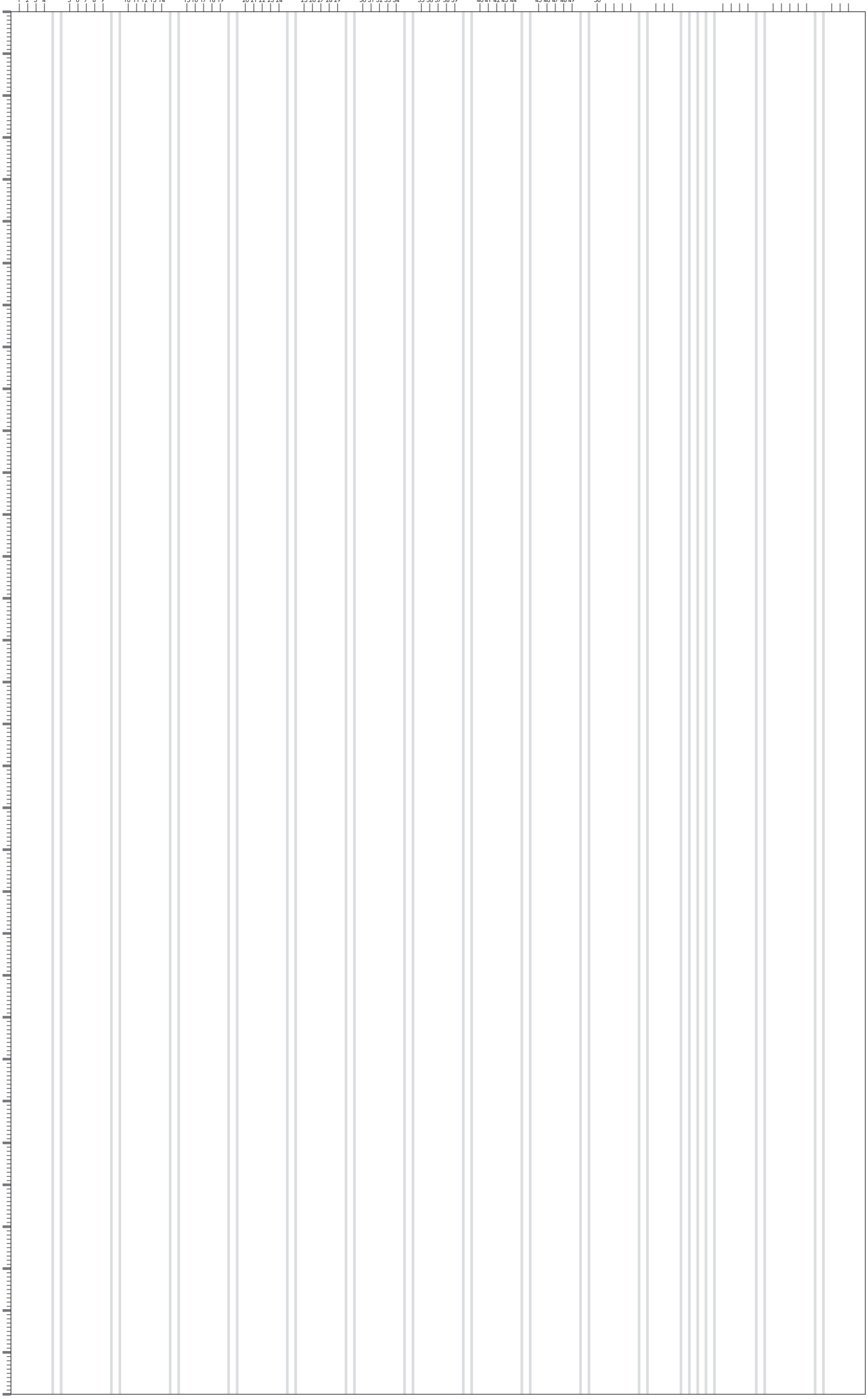
EXERCISE 2: **RT 60–PAVEMENT REHABILITATION PROJECT**

MONITOR/DAILY UPDATE CHART

NOTE: Number Designates Starting and Quitting Time That Day

PROJECT WORK DAY

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50



4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12

S S S S S S S S S S S S S S S S S S H H S S H S S S S

SEPTEMBER 2001 **OCTOBER 2001** **NOVEMBER 2001** **DECEMBER 2001**

PROJECT CALENDAR DAY

WORK SHEET

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

I – J NETWORK SCHEDULE REPORT

PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 16:04 RUN NO. 5 — START DATE 4SEP84 FIN DATE 12NOV84

Classic Schedule Report - Sort by ES, TF — DATA DATE 4SEP84 PAGE NO. 1

ACTIVITY ID		ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
05	10	3	3	1	0		Mobilize Set Up A1	4SEP84	6SEP84	4SEP84	6SEP84	0
05	30	2	2	1	0		Mobilize Set Up B1	4SEP84	5SEP84	18SEP84	19SEP84	10
05	120	15	15	1	0		Rehab work on ramps	4SEP84	24SEP84	19OCT84	8NOV84	33
10	15	4	4	1	0		Install drains & saw patches in A1	7SEP84	12SEP84	7SEP84	12SEP84	0
15	30	5	5	1	0		Saw and grout joints A1&A2, grout cracks A1	13SEP84	19SEP84	13SEP84	19SEP84	0
15	20	3	3	1	0		Drill vertical holes & remove patches in A1	13SEP84	17SEP84	14SEP84	18SEP84	1
20	25	5	5	1	0		Prepare & pour patches A1	18SEP84	24SEP84	19SEP84	25SEP84	1
30	40	4	4	1	0		Install drains & saw patches B1	20SEP84	25SEP84	20SEP84	25SEP84	0
30	35	0	0	1	0		dummy	20SEP84	19SEP84	26SEP84	25SEP84	4
25	35	0	0	1	0		dummy	25SEP84	24SEP84	26SEP84	25SEP84	1
35	50	5	5	1	0		Seal transv jnts, random cracks & patch jnts A1	25SEP84	1OCT84	26SEP84	2OCT84	1
25	45	0	0	1	0		dummy	25SEP84	24SEP84	3OCT84	2OCT84	6
25	105	2	2	1	0		Saw spalls A1 & remove & replace	25SEP84	26SEP84	15OCT84	16OCT84	14
40	55	5	5	1	0		Saw jnts B1 & B2, grt crcks B1 & grt jnys B1& B2	26SEP84	2OCT84	26SEP84	2OCT84	0
40	45	0	0	1	0		dummy	26SEP84	25SEP84	3OCT84	2OCT84	5
45	60	3	3	1	0		Drill vertical holes & remove patches B1	26SEP84	28SEP84	3OCT84	5OCT84	5
60	65	5	5	1	0		Prepare & pour patches B1	1OCT84	5OCT84	8OCT84	12OCT84	5
60	75	0	0	1	0		dummy	1OCT84	28SEP84	9OCT84	8OCT84	6
50	55	0	0	1	0		dummy	2OCT84	1OCT84	3OCT84	2OCT84	1
50	75	3	3	1	0		A1 to A2 instl drns, grt crks, saw patch A1,P&J	2OCT84	4OCT84	4OCT84	8OCT84	2
55	70	5	5	1	0		Seal transv jnts., cracks, & patch joints B1	3OCT84	9OCT84	3OCT84	9OCT84	0
75	80	3	3	1	0		Drill vertical holes & remove patches A2, P & J	5OCT84	9OCT84	9OCT84	11OCT84	2
65	90	0	0	1	0		dummy	8OCT84	5OCT84	15OCT84	12OCT84	5
65	105	0	0	1	0		dummy	8OCT84	5OCT84	17OCT84	16OCT84	7
105	110	4	4	1	0		Saw spalls B1 & remove & place	8OCT84	11OCT84	17OCT84	22OCT84	7
70	90	3	3	1	0		B1 to B2 drns, grout crks, saw ptch, B1, B2 K&L	10OCT84	12OCT84	10OCT84	12OCT84	0
80	85	4	4	1	0		Prep & pour ptchs A2 & ramps p&j	10OCT84	15OCT84	12OCT84	17OCT84	2
80	90	0	0	1	0		dummy	10OCT84	9OCT84	15OCT84	12OCT84	3
90	95	3	3	1	0		drill vert holes & remove ptchs B2 & ramps P & J	15OCT84	17OCT84	15OCT84	17OCT84	0
85	95	0	0	1	0		dummy	16OCT84	15OCT84	18OCT84	17OCT84	2
85	110	0	0	1	0		dummy	16OCT84	15OCT84	23OCT84	22OCT84	5
110	115	10	10	1	0		Saw spalls A2 & remove & place	16OCT84	29OCT84	23OCT84	5NOV84	5
95	100	4	4	1	0		Prep & pour ptchs B2 & Ramps K & L	18OCT84	23OCT84	18OCT84	23OCT84	0
100	120	12	12	1	0		C.L. Jnts NB&SB trans jts, cracks, ptch jts, A2,	24OCT84	8NOV84	24OCT84	8NOV84	0
100	115	0	0	1	0		dummy	24OCT84	23OCT84	6NOV84	5NOV84	9
115	120	3	3	1	0		Saw spalls B2 & remove & place	30OCT84	1NOV84	6NOV84	8NOV84	5
120	125	2	2	1	0		Remove signs	9NOV84	12NOV84	9NOV84	12NOV84	0

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PRECEDENT SCHEDULE REPORT

PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 14:08 RUN NO. 7 — START DATE 4SEP84 FIN DATE 12NOV84

Schedule Report - Sorted by Activity ID — DATA DATE 4SEP84 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
00	3	3	1	0		Mobilize Set Up A1	4SEP84	6SEP84	4SEP84	6SEP84	0
05	2	2	1	0		MobilizeSet Up B1	4SEP84	5SEP84	18SEP84	19SEP84	10
10	15	15	1	0		Miscellaneous work as time permits	4SEP84	24SEP84	19OCT84	8NOV84	33
15	4	4	1	0		Install drains & saw patches in A1	7SEP84	12SEP84	7SEP84	12SEP84	0
20	5	5	1	0		Saw and grout joints A1&A2, grout cracks A1	13SEP84	19SEP84	13SEP84	19SEP84	0
25	4	4	1	0		Install drains & saw patches B1	20SEP84	25SEP84	20SEP84	25SEP84	0
30	3	3	1	0		Drill vertical holes & remove patches in A1	13SEP84	17SEP84	14SEP84	18SEP84	1
35	5	5	1	0		Prepare & pour patches A1	18SEP84	24SEP84	19SEP84	25SEP84	1
50	2	2	1	0		While patches cure saw spalls A-1 & Rem. & Repl.	25SEP84	26SEP84	15OCT84	16OCT84	14
65	3	3	1	0		Drill vertical holes & rem. patches B-1	26SEP84	28SEP84	27SEP84	1OCT84	1
70	5	5	1	0		Prepare & pour patches B1	1OCT84	5OCT84	2OCT84	8OCT84	1
90	4	4	1	0		While patches cure saw spalls B1 & rem. & replac	8OCT84	11OCT84	17OCT84	22OCT84	7
95	5	5	1	0		Seal transv jnts, random cracks & patch jnts A1	25SEP84	1OCT84	26SEP84	2OCT84	1
100	5	5	1	0		Saw jnts B1 & B2, grt crcks B1 & grt jnts B1& B2	26SEP84	2OCT84	26SEP84	2OCT84	0
110	1	1	1	0		Move A1 & A2, grout cracks A2	2OCT84	2OCT84	8OCT84	8OCT84	4
115	5	5	1	0		Seal transv jnts., cracks, & patch joints B1	3OCT84	9OCT84	3OCT84	9OCT84	0
120	3	3	1	0		Drill vertical holes & remove patches A2, P & J	8OCT84	10OCT84	9OCT84	11OCT84	1
125	3	3	1	0		B1 to B2 drns, grout crks, saw ptch, B1, B2 K&L	10OCT84	12OCT84	10OCT84	12OCT84	0
135	4	4	1	0		Prep & pour ptchs A2 & Ramps P&J	11OCT84	16OCT84	12OCT84	17OCT84	1
140	3	3	1	0		drill vert holes & remove ptchs B2 & Ramps P & J	15OCT84	17OCT84	15OCT84	17OCT84	0
155	4	4	1	0		Prep & pour ptchs B2 & Ramps K & L	18OCT84	23OCT84	18OCT84	23OCT84	0
160	10	10	1	0		While patches cure saw spls A2 & rem & place	17OCT84	30OCT84	23OCT84	5NOV84	4
170	3	3	1	0		While patches cure saw spls B2 & rem & place	31OCT84	2NOV84	6NOV84	8NOV84	4
175	12	12	1	0		Rt. & seal cl jnts nb & sb seal trnsv jts crks	24OCT84	8NOV84	24OCT84	8NOV84	0
180	2	2	1	0		Remove signs	9NOV84	12NOV84	9NOV84	12NOV84	0
185	0	0	1	0		Project completion		12NOV84		12NOV84	0

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PRECEDENT SCHEDULE REPORT

PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 RUN NO. 6 — START DATE 4SEP84 FIN DATE 12NOV84
11:32
Schedule Report - Predecessors & Successors — DATA DATE 4SEP84 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
00	3	3	1	0		Mobilize Set Up A1	4SEP84	6SEP84	4SEP84	6SEP84	0
		S.L.D.F.,*		15.FS	0.	4. 0,					
05	2	2	1	0		MobilizeSet Up B1	4SEP84	5SEP84	18SEP84	19SEP84	10
		S.L.D.F.,		25.FS	0.	4. 0, 95.FS 0. 5. 1					
10	15	15	1	0		Miscellaneous work as time permits	4SEP84	24SEP84	19OCT84	8NOV84	33
		S.L.D.F.,		180.FS	0.	2. 0,					
		P.L.D.F.,*		00.FS	0.	3. 0,					
15	4	4	1	0		Install drains & saw patches in A1	7SEP84	12SEP84	7SEP84	12SEP84	0
		S.L.D.F.,*		20.FS	0.	5. 0,* 30.FS 0. 3. 1					
		P.L.D.F.,*		15.FS	0.	4. 0,					
20	5	5	1	0		Saw and grout joints A1&A2, grout cracks A1	13SEP84	19SEP84	13SEP84	19SEP84	0
		S.L.D.F.,*		25.FS	0.	4. 0, 95.FS 0. 5. 1					
		P.L.D.F.,*		15.FS	0.	4. 0,					
30	3	3	1	0		Drill vertical holes & remove patches in A1	13SEP84	17SEP84	14SEP84	18SEP84	1
		S.L.D.F.,*		35.FS	0.	5. 1,					
		P.L.D.F.,*		30.FS	0.	3. 1,					
35	5	5	1	0		Prepare & pour patches A1	18SEP84	24SEP84	19SEP84	25SEP84	1
		S.L.D.F.,*		50.FS	0.	2. 14, 65.FS 0. 3. 1					
		S.L.D.F.,*		95.FS	0.	5. 1,					

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PRECEDENT SCHEDULE REPORT

PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 RUN NO. 6 — START DATE 4SEP84 FIN DATE 12NOV84
11:32
Schedule Report - Predecessors & Successors — DATA DATE 4SEP84 PAGE NO. 2

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
					P.L.D.F., 05.FS 0. 2. 10,* 20.FS 0. 5. 0						
25	4	4	1	0		Install drains & saw patches B1	20SEP84	25SEP84	20SEP84	25SEP84	0
					S.L.D.F.,* 65.FS 0. 3. 1,* 100.FS 0. 5. 0						
					P.L.D.F., 05.FS 0. 2. 10, 20.FS 0. 5. 0 P.L.D.F.,* 35.FS 0. 5. 1,						
95	5	5	1	0		Seal transv jnts, random cracks & patch jnts A1	25SEP84	1OCT84	26SEP84	2OCT84	1
					S.L.D.F.,* 110.FS 0. 1. 4, 115.FS 0. 5. 0						
					P.L.D.F.,* 35.FS 0. 5. 1,						
50	2	2	1	0		While patches cure saw spalls A-1 & Rem. & Repl.	25SEP84	26SEP84	15OCT84	16OCT84	14
					S.L.D.F., 90.FS 0. 4. 7,						
					P.L.D.F.,* 25.FS 0. 4. 0,						
100	5	5	1	0		Saw jnts B1 & B2, grt crcks B1 & grt jnts B1& B2	26SEP84	2OCT84	26SEP84	2OCT84	0
					S.L.D.F.,* 115.FS 0. 5. 0,						
					P.L.D.F.,* 25.FS 0. 4. 0, 35.FS 0. 5. 1						
65	3	3	1	0		Drill vertical holes & rem. patches B-1	26SEP84	28SEP84	27SEP84	1OCT84	1
					S.L.D.F.,* 70.FS 0. 5. 1,						
					P.L.D.F.,* 65.FS 0. 3. 1,						
70	5	5	1	0		Prepare & pour patches B1	1OCT84	5OCT84	2OCT84	8OCT84	1
					S.L.D.F.,* 90.FS 0. 4. 7,* 120.FS 0. 3. 1 S.L.D.F., 140.FS 0. 3. 0,						
					P.L.D.F.,* 95.FS 0. 5. 1,						
110	1	1	1	0		Move A1 & A2, grout cracks A2	2OCT84	2OCT84	8OCT84	8OCT84	4

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PRECEDENT SCHEDULE REPORT

PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 11:32 RUN NO. 6 — START DATE 4SEP84 FIN DATE 12NOV84

Schedule Report - Predecessors & Successors — DATA DATE 4SEP84 PAGE NO. 3

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
					S.L.D.F., 120.FS 0. 3. 1,						
					P.L.D.F., 95.FS 0. 5. 1,* 100.FS 0. 5. 0						
115	5	5	1	0		Seal transv jnts., cracks, & patch joints B1	3OCT84	9OCT84	3OCT84	9OCT84	0
					S.L.D.F.,* 125.FS 0. 3. 0,						
					P.L.D.F.,* 70.FS 0. 5. 1, 110.FS 0. 1. 4						
120	3	3	1	0		Drill vertical holes & remove patches A2, P & J	8OCT84	10OCT84	9OCT84	11OCT84	1
					S.L.D.F.,* 135.FS 0. 4. 1, 140.FS 0. 3. 0						
					P.L.D.F., 50.FS 0. 2. 14,* 70.FS 0. 5. 1						
90	4	4	1	0		While patches cure saw spalls B1 & rem. & replac	8OCT84	11OCT84	17OCT84	22OCT84	7
					S.L.D.F., 160.FS 0. 10. 4,						
					P.L.D.F.,* 115.FS 0. 5. 0,						
125	3	3	1	0		B1 to B2 drns, grout crks, saw ptch, B1, B2 K&L	10OCT84	12OCT84	10OCT84	12OCT84	0
					S.L.D.F.,* 140.FS 0. 3. 0,						
					P.L.D.F.,* 120.FS 0. 3. 1,						
135	4	4	1	0		Prep & pour ptchs A2 & Ramps P&J	11OCT84	16OCT84	12OCT84	17OCT84	1
					S.L.D.F., 155.FS 0. 4. 0,* 160.FS 0. 10. 4						
					P.L.D.F., 70.FS 0. 5. 1, 120.FS 0. 3. 1 P.L.D.F.,* 125.FS 0. 3. 0,						
140	3	3	1	0		drill vert holes & remove ptchs B2 & Ramps P & J	15OCT84	17OCT84	15OCT84	17OCT84	0
					S.L.D.F.,* 155.FS 0. 4. 0,						
					P.L.D.F., 90.FS 0. 4. 7,* 135.FS 0. 4. 1						

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PRECEDENT SCHEDULE REPORT

PENNDOT — PRIMAVERA PROJECT PLANNER — RT. 60 - PAVEMENT REHABILITATION PRO

REPORT DATE 27FEB02 11:32 RUN NO. 6 — START DATE 4SEP84 FIN DATE 12NOV84

Schedule Report - Predecessors & Successors — DATA DATE 4SEP84 PAGE NO. 4

ACTIVITY ID	ORIG DUR	REM DUR	CAL	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
160	10	10	1	0		While patches cure saw spls A2 & rem & place	17OCT84	30OCT84	23OCT84	5NOV84	4
					S.L.D.F.,* 170.FS 0. 3. 4,						
					P.L.D.F., 135.FS 0. 4. 1,* 140.FS 0. 3. 0						
155	4	4	1	0		Prep & pour ptchs B2 & Ramps K & L	18OCT84	23OCT84	18OCT84	23OCT84	0
					S.L.D.F., 170.FS 0. 3. 4,* 175.FS 0. 12. 0						
					P.L.D.F.,* 155.FS 0. 4. 0,						
175	12	12	1	0		Rt. & seal cl jnts nb & sb seal trnsv jts crks	24OCT84	8NOV84	24OCT84	8NOV84	0
					S.L.D.F.,* 180.FS 0. 2. 0,						
					P.L.D.F., 155.FS 0. 4. 0,* 160.FS 0. 10. 4						
170	3	3	1	0		While patches cure saw spls B2 & rem & place	31OCT84	2NOV84	6NOV84	8NOV84	4
					S.L.D.F., 180.FS 0. 2. 0,						
					P.L.D.F., 10.FS 0. 15. 33, 170.FS 0. 3. 4 P.L.D.F.,* 175.FS 0. 12. 0,						
180	2	2	1	0		Remove signs	9NOV84	12NOV84	9NOV84	12NOV84	0
					S.L.D.F.,* 185.FS 0. 0. 0,						
					P.L.D.F.,* 180.FS 0. 2. 0,						
185	0	0	1	0		Project completion		12NOV84		12NOV84	0

EXERCISE 3: RT. 60–PAVEMENT REHABILITATION PROJECT

PROJECT CASH FLOW COMPUTATION

RT. 60 PAVEMENT REHABILITATION PROJECT

DISTRIBUTION OF CONTRACT QUANTITIES AND JOB BUDGET BY ACTIVITY

NOTE:

In order to cover costs of fuel, supervision and bond the following % are added. 13% to labor, 2% to equip. and 10% to material.

							Contract Price		18.70	40.00	2.15	10.90	8.05	57.75	57.75	70.00	7.20	1.25	18.00	3.84	0.80	4800	3600	22,700	2000		
							Contract Quantity		100	100	1416	1228	108	971	425	20	2040	1855	3026	21,397	43,240	1	1	1	1		
							PAY ITEM	Description	Class 1A Excavation	Subbase Material	Protective Coating for Cement Concrete Pavements and Shoulders	Patching Joint	New Pavement Joint	Concrete Pavement Patch Type "A"	Concrete Pavement Patch Type "B"	H. E. S. Pavement Patch Type "A"	Pavement Base Drain	Crack Cleaning and Sealing	Concrete Pavement Spall Repair	Joint Rehabilitation Type 2	Longitudinal Joint Clean and Seal	Mobilization	Insp. Fifld Office	Maint. Prot. of Traffic	Arrow Boards	COST	ACCUMULATIVE COST
								Item Number Unit	0203 0003 CY	0250 0050 CY	0503 0001 SY	0590 2007 LF	0590 2008 LF	0590 2009 SY	0590 2010 SY	0590 2011 SY	0610 7000 LF	2000 0001 LF	2000 0002 SF	0590 0011 LF	2590 0050 LF	0938 0001 LS	2590 0011 LS	0807 0001 LS	0901 0201 EA		
ACTIVITY RANKING					DURATION	CREW SIZE	ACTIVITY DESCRIPTION	Cost of Labor	6.24	12.21	.53	3.02	1.55	14.05	14.05	14.05	3.00	.33	7.32	1.48	.25	1640	1221	6107	610		
NO.	I	J	ES	TF				Cost of Equipment	7.95	2.85	.47	1.40	.92	6.88	6.88	6.88	1.34	.27	1.90	1.08	.18	2040	561	561	918		
								Cost of Material	—	16.50	.66	4.07	3.80	24.27	24.27	24.14	1.27	.35	4.88	.39	.16	—	1100	11345	—		
1	5	10	0	0	3	6	Mobilize and set up A1															4%	4%	4%	4%		
2	5	30	0	10	2	6	Mobilize and set up B1															4%	4%	4%	4%		
3	5	120	0	33	15	4	Spall repair on ramps and joint rehab., random cracks and long.jts. on ramps															4%	4%	4%	4%		
4	10	15	3	0	4	4	Install drains and saw patches in A1															4%	4%	4%	4%		
5	15	30	7	0	5	4	Saw jts. in A1 and A2 rout cracks in A1, and rout jts. in A1 and A2															4%	4%	4%	4%		
6	15	20	7	1	3	3	Drill vert.holes and remove patches in A1															4%	4%	4%	4%		
7	20	25	10	1	5	7	Prepare and pour patches in A1															4%	4%	4%	4%		
8	30	40	12	0	4	4	Install drains and saw patches in B1															4%	4%	4%	4%		
9	30	35	12	4	0	0	Dummy																				
10	25	35	15	1	0	0	Dummy																				
11	35	50	15	1	5	5	Seal transverse joints, random cracks and patch joints in A1															4%	4%	4%	4%		
12	25	45	15	6	0	0	Dummy																				
13	25	105	15	14	2	4	While patches cure, saw spalls in A1 and Remove and place															4%	4%	4%	4%		
14	40	55	16	0	5	4	Saw joints in B1 and B2, rout cracks in B1 and rout joints in B1 and B2															4%	4%	4%	4%		
15	40	45	16	5	0	0	Dummy																				
16	45	60	16	5	3	3	Drill vert.holes and remove patches in B1															4%	4%	4%	4%		
17	60	65	19	5	5	7	Prepare and pour patches in B1															4%	4%	4%	4%		
18	60	75	19	6	0	0	Dummy																				
19	50	55	20	1	0	0	Dummy																				
20	50	75	20	2	3	5	Move A1 to A2 install drains, rout random cracks in A2 and saw patches in A2 & ramps P& J															4%	4%	4%	4%		
21	55	70	21	0	5	5	Seal transverse joints, random cracks and patch joints in B1															4%	4%	4%	4%		
22	75	80	23	2	3	3	Drill vert.holes and remove patches in A2 & ramps P & J															4%	4%	4%	4%		
23	65	90	24	5	0	0	Dummy																				
24	65	105	24	7	0	0	Dummy																				
25	105	110	24	7	4	5	While patches cure saw spalls in B1 and remove and place															4%	4%	4%	4%		
26	70	90	26	0	3	5	Move B1 to B2, install drains rout random cracks in B1 and saw patches B2 & ramps K & L															4%	4%	4%	4%		
27	80	85	26	2	4	7	Prepare and pour patches in A2 and ramps P &J															4%	4%	4%	4%		
28	80	90	26	3	0	0	Dummy																				
29	90	95	29	0	3	3	Drill vert.holes and remove patches in B2 & ramps K & L															4%	4%	4%	4%		
30	85	95	30	2	0	0	Dummy																				
31	85	110	30	5	0	0	Dummy																				
32	110	115	30	5	10	6	While patches cure saw spalls in A1 and remove and place															4%	4%	4%	4%		
33	95	100	32	0	4	7	Prepare and pour patches in B2 and ramps K & L															4%	4%	4%	4%		
34	100	120	36	0	12	8	Rout and seal ℄ jts. NB., seal trans. jts. random cracks & patch jts. in A2 & B2 & all ramps															4%	4%	4%	4%		
35	100	115	36	9	0	0	Dummy																				
36	115	120	40	5	3	5	While patches cure saw spalls in B2 and remove and place															4%	4%	4%	4%		
37	120	125	48	0	2	6	Remove signs															4%	4%	4%	4%		
								TOTALS	100	100	1,416	1,228	108	971	425	20	2,040	1,855	3,026	21,397	43,240	100%	100%	100%	100%	326,519.23	

WORK SHEET

EXERCISE 3: RT. 60–PAVEMENT REHABILITATION PROJECT

DISTRIBUTION OF BUDGET ITEMS OVER THE JOB ACTIVITIES

WORK SHEET

EXERCISE 3: RT. 60 PAVEMENT REHABILITATION PROJECT
DISTRIBUTION OF BUDGET ITEMS OVER THE JOB ACTIVITIES

PRODUCTIVITY-COSTS BY CODE AND PAYMENT ITEM-INCOME AS RELATED TO JOB ACTIVITIES AND TIME

NOTE:
In order to cover costs of fuel, supervision and bond the following % are added. 13% to labor, 2% to equipment and 10% to material and is reflected in these costs.

These costs are distributed over all other costs.

NO	I	J	ES	TF	DURATION	CREW SIZE	ACTIVITY DESCRIPTION
1	5	10	0	0	3	6	Mobilize and set up A1
2	5	30	0	10	2	6	Mobilize and set up B1
3	5	120	0	33	15	4	Spall repair on ramps and joint rehab., random cracks and long. jts. on ramps
4	10	15	3	0	4	4	Install drains and saw patches in A1
5	15	30	7	0	5	4	Saw jts. in A1 and A2 rout cracks in A1, and rout jts. in A1 and A2
6	15	20	7	1	3	3	Drill vert. holes and remove patches in A1
7	20	25	10	1	5	7	Prepare and pour patches in A1
8	30	40	12	0	4	4	Install drains and saw patches in B1
9	30	35	12	4	0	0	Dummy
10	25	35	15	1	0	0	Dummy
11	35	50	15	1	5	5	Seal transverse joints, random cracks and patch joints in A1
12	25	45	15	7	0	0	Dummy
13	25	105	15	14	2	4	While patches cure, saw spalls in A1 and remove and place
14	40	55	16	0	5	4	Saw joints in B1 and B2, rout cracks in B1 and rout joints in B1 and B2
15	40	45	16	5	0	0	Dummy
16	45	60	16	5	3	3	Drill vert. holes and remove patches in B1
17	60	65	19	5	5	7	Prepare and pour patches in B1
18	60	75	19	6	0	0	Dummy
19	50	55	20	1	0	0	Dummy
20	50	75	20	2	3	5	Move A1 to A2 install drains, rout random cracks in A2 and saw patches in A2 & ramps P& J
21	55	70	21	0	5	5	Seal transverse joints, random cracks and patch joints in B1
22	75	80	23	2	3	3	Drill vert. holes and remove patches in A2 & ramps P & J
23	65	90	24	5	0	0	Dummy
24	65	105	24	7	0	0	Dummy
25	105	110	24	7	4	5	While patches cure saw spalls in B1 and remove and place
26	70	90	26	0	3	5	Move B1 to B2, install drains rout random cracks in B2 and saw patches B2 & ramps K & L
27	80	85	26	2	4	7	Prepare and pour patches in A2 and ramps P &J
28	80	90	26	3	0	0	Dummy
29	90	95	29	0	3	3	Drill vert. holes and remove patches in B2 & ramps K & L
30	85	95	30	2	0	0	Dummy
31	85	110	30	5	0	0	Dummy
32	110	115	30	5	10	6	While patches cure saw spalls in A1 and remove and place
33	95	100	32	0	4	7	Prepare and pour patches in B2 and ramps K & L
34	100	120	36	0	12	8	Rout and seal ℄ jts. NB. and SB., seal trans. jts. random cracks & patch jts. in A2 & B2 & all ramps
35	100	115	36	9	0	0	Dummy
36	115	120	40	5	3	5	While patches cure saw spalls in B2 and remove and place
37	120	125	48	0	2	6	Remove signs
							TOTALS

Description	Longitudinal Saw Cuts	Internal Saw or Vermeer Cuts	Drill Vert. holes to Lift	Lift out Patches	Place Mesh	Grade, Form, Place, Finish, Cure, Clean up	Set Baskets	Full Depth Transverse Saw Cut	Drill and install Dowels	Pavement Base Drain
Cost Code/Bid	2.40	6.88	1.18	9.36	3.92	34.15	8.05	5.00	5.90	7.20
Contract Units	1416	1416	1416	1416	1416	1416	108	1228	1228	2040
Pay Item	0590-2009 "A" 0590-2010 "B" 0590-2011 HES "A" Patching Work						0590-2007 0590-2008 New Pavement Joint Patching Joint			0610-7000
Cost Code	2101	2102	2100	2103	2104	2105	2109	2108	2107	3004
Cost of Labor	.49	1.74	.48	3.41	.53	7.40	1.55	1.69	1.33	3.00
Cost of Equipment	.29	.90	.32	3.73	.10	1.54	.92	1.09	.31	1.34
Cost of Material	1.10	2.75	.11	—	2.45	17.53	3.80	1.10	2.97	1.27
1										
2										
3										
4	498	498						384		821
5										
6			498	498						
7					498	498	48		384	
8	281	281						264		519
9										
10										
11										
12										
13										
14										
15										
16			281	281						
17					281	281			264	
18										
19										
20	350	350						240		147
21										
22			350	350						
23										
24										
25										
26	287	287						340		553
27					350	350	60		240	
28										
29			287	287						
30										
31										
32										
33					287	287			340	
34										
35										
36										
37										
TOTALS	1416	1416	1416	1416	1416	1416	108	1228	1228	2040

Description	Class "1A" Excavation Unsuitable	Subbase Material Replace Unsuitable	Saw Type "2" Joints	Clean-Rout Type "2" Joints	Seal Type "2" Joints	Saw, Clean, Rout, Random Cracks	Seal Random Cracks	Clean Longitudinal Joints	Seal Longitudinal Joints	Saw Type "1" Spalls	Remove Type "1" Spalls	Sandblast Type "1" Spalls	Place Type "1" Spalls
Cost Code/Bid	18.70	40.00	1.47	1.19	1.18	.78	.47	.51	.29	2.01	5.58	1.71	8.70
Contract Units	100	100	21,397	21,397	21,397	1855	1855	43,240	43,240	3026	3026	3026	3026
Pay Item	0203-0003	0350-0050	2590-0011 Joint Rehab Type 2			2000-0001 Crack, Clean and Seal		2590-0050 Long. Jt. Clean and Seal		2000-0002 Concrete Pavement Spall Repair "Latex"			
Cost Code	1101	1600	9621	9622	9627	9412	9417	9518	9517	9511	9512	9513	9515
Cost of Labor	6.24	12.21	.56	.32	.60	.20	.13	.20	.05	.54	3.07	.53	3.18
Cost of Equipment	7.95	2.85	.43	.46	.19	.21	.06	.13	.05	.31	1.01	.26	.32
Cost of Material	—	16.50	.13	.13	.13	.19	.16	.05	.11	.70	.28	.53	3.37
1													
2													
3			342	342	342	187	187	627	627	508	508	508	508
4			7	7	7			3	3				
5						733							
6	50	50	892	892									
7			8	8									
8													
9													
10													
11					440		733						
12					4								
13										145	145	145	145
14			904	904		506							
15			2	2									
16	50	50											
17													
18													
19													
20						214							
21					446		506						
22					4								
23													
24													
25										810	810	810	810
26						215							
27													
28													
29													
30													
31													
32										1188	1188	1188	1188
33													
34					9102		429	36967	36967				
35													
36										375	375	375	375
37													
TOTALS	100	100	21397	21397	21397	1855	1855	43240	43240	3026	3026	3026	3026

Description	Prot. Coat. Cem. Conc. "Linseed Oil"	Flag Traffic	All Maint. & Prot. Traffic "But Flag"	Inspectors Field Office	Mobilization	Fuel-Oil-Grease-Etc. "Distributed"	Supervision "Distributed"	Bond Legal "Distributed"
Cost Code/Bid	2.15	4400	20,300	3600	4800			
Contract Units	1416	1	1	1	1			
Pay Item	0503-0001	0901-0001 0901-0201 Arrow Boards		0609-0004	0608-0001	NA	NA	NA
Cost Code	2106	6201	6200	7070	7060	7000 DISTRIBUTED	7080	7099
Cost of Labor	.53	3359	3358	1221	1640	1436	10500	—
Cost of Equipment	.47	204	1275	561	2040	210	1050	—
Cost of Material	.66	—	11345	1100	—	3200	1050	4000
1		4%	4%	4%	4%			
2		4%	4%	4%	4%			
3		4%	4%	4%	4%			
4		4%	4%	4%	4%			
5		4%	4%	4%	4%			
6		4%	4%	4%	4%			
7	498	4%	4%	4%	4%			
8		4%	4%	4%	4%			
9								
10								
11		4%	4%	4%	4%			
12								
13		4%	4%	4%	4%			
14		4%	4%	4%	4%			
15								
16		4%	4%	4%	4%			
17	281	4%	4%	4%	4%			
18								
19								
20		4%	4%	4%	4%			
21		4%	4%	4%	4%			
22		4%	4%	4%	4%			
23								
24								
25		4%	4%	4%	4%			
26		4%	4%	4%	4%			
27	350	4%	4%	4%	4%			
28								
29		4%	4%	4%	4%			
30								
31								
32		4%	4%	4%	4%			
33	287	4%	4%	4%	4%			
34		4%	4%	4%	4%			
35								
36		4%	4%	4%	4%			
37		4%	4%	4%	4%			
TOTALS	1416	100%	100%	100%	100%			

COST AND INCOME BY ACTIVITY

NO	Labor	Cum. Labor	Equip.	Cum. Equip.	Matrl.	Accum. Matrl.	Income	Cum. Income
1	383		163		498		1324.00	
2	383		163		498		1324.00	
3	10803		6009		5383		28879.83	
4	4605		2274		3881		13776.64	
5	8386		8263		2959		25644.22	
6	3243		2720		1378		9507.92	
7	5181		1377		12102		24005.56	
8	3013		1481		2529		8988.48	
9								
10								
11	3121		1044		1188		6865.23	
12								
13	1444		438		1207		3934.00	
14	8441		8317		2945		25770.40	
15								
16	2399		1841		1354		7220.74	
17	3111		838		7083		14183.42	
18								
19								
20	2053		1083		2337		6997.32	
21	3127		1041		1159		6829.34	
22	1744		1580		536		5013.00	
23								
24								
25	6312		1702		4451		15904.00	
26	3299		1661		2720		9836.66	
27	3756		1031		8664		17300.00	
28								
29	1499		1325		530		4348.98	
30								
31								
32	9079		2420		6295		22708.00	
33	3263		874		7432		14873.14	
34	15142		8572		7665		41839.59	
35								
36	3128		876		2328		8074.00	
37	386		163		498		1370.76	
TOTALS	107301		57256		87620		326519.23	
	32.86% of Income		17.54% of Income		26.83% of Income		100% of Income	

ROUTE 60 PAVEMENT REHABILITATION PROJECT

WORK SHEET

Job Cost and Productivity by Activity (Using Cost Info.)

Week Ending	%	Activity	Labor	Equipment	Material	Income
09-09-01	3/3	5-10	383	163	498	1324
	1/4	10-15	1151	569	970	3444
	2/2	5-30	383	163	498	1324
	4/15	5-120	2881	1602	1435	7701
			4798	2497	3401	13793
09-16-01	3/4	10-15	3454	1705	2911	10333
	2/3	15-20	2162	1813	919	6339
	2/5	15-30	3354	3305	1184	10258
	5/15	5-120	3601	2003	1794	9627
			17369	11323	10209	50350
09-23-01	1/3	15-20	1081	907	459	3169
	3/5	15-30	5032	4958	1775	15386
	4/5	20-25	4145	1102	9682	19204
	2/4	30-40	1507	741	1265	4494
	5/15	5-120	3601	2003	1794	9627
			32735	21034	25184	102230
09-30-01	1/15	5-120	720	401	360	1925
	1/5	20-25	1036	275	2420	4802
	2/4	30-40	1506	740	1264	4494
	2/2	25-105	1444	438	1207	3934
	4/5	35-50	2497	835	950	5492
	3/5	40-55	5065	4990	1767	15462
	3/3	45-60	2399	1841	1354	7222
			47402	30554	34506	145560
10-07-01	1/5	35-50	624	209	238	1373
	2/5	40-55	3376	3327	1178	10308
	4/5	55-70	2502	833	927	5463
	3/3	50-75	2053	1083	2337	6997
	5/5	60-65	3111	838	7083	14183
	2/3	75-80	1163	1053	357	3342
			60231	37897	46626	187226
10-14-01	1/5	55-70	625	208	232	1366
	1/3	75-80	581	527	179	1671
	3/3	70-90	3299	1661	2720	9837
	3/4	80-85	2817	773	6498	12975
	4/4	105-110	6312	1702	4451	15904
			73865	42768	60706	228979
10-21-01	1/4	80-85	939	258	2166	4325
	3/3	90-95	1499	1325	530	4349
	3/4	95-100	2447	656	5574	11155
	4/10	110-115	3632	968	2518	9083
			82382	45975	71494	257891
10-28-01	1/4	95-100	816	218	1858	3718
	5/10	110-115	4540	1210	3148	11354
	3/12	100-120	3786	2143	1916	10460
			91524	49546	78416	283423
11-04-01	1/10	110-115	907	242	629	2271
	5/12	100-120	6309	3572	3194	17433
	3/3	115-120	3128	876	2328	8074
			101868	54236	84567	311201
11-12-01	4/12	100-120	5047	2857	2555	13947
	2/2	120-125	386	163	498	1324
			107301	57256	87620	326519

EXERCISE 3: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PERCENT OF PROJECT COMPLETED TO DATE

PERIOD	ACTIVITY	%	TOTAL THIS ACTIVITY	TOTAL THIS PERIOD	CUMULATIVE TOTAL	

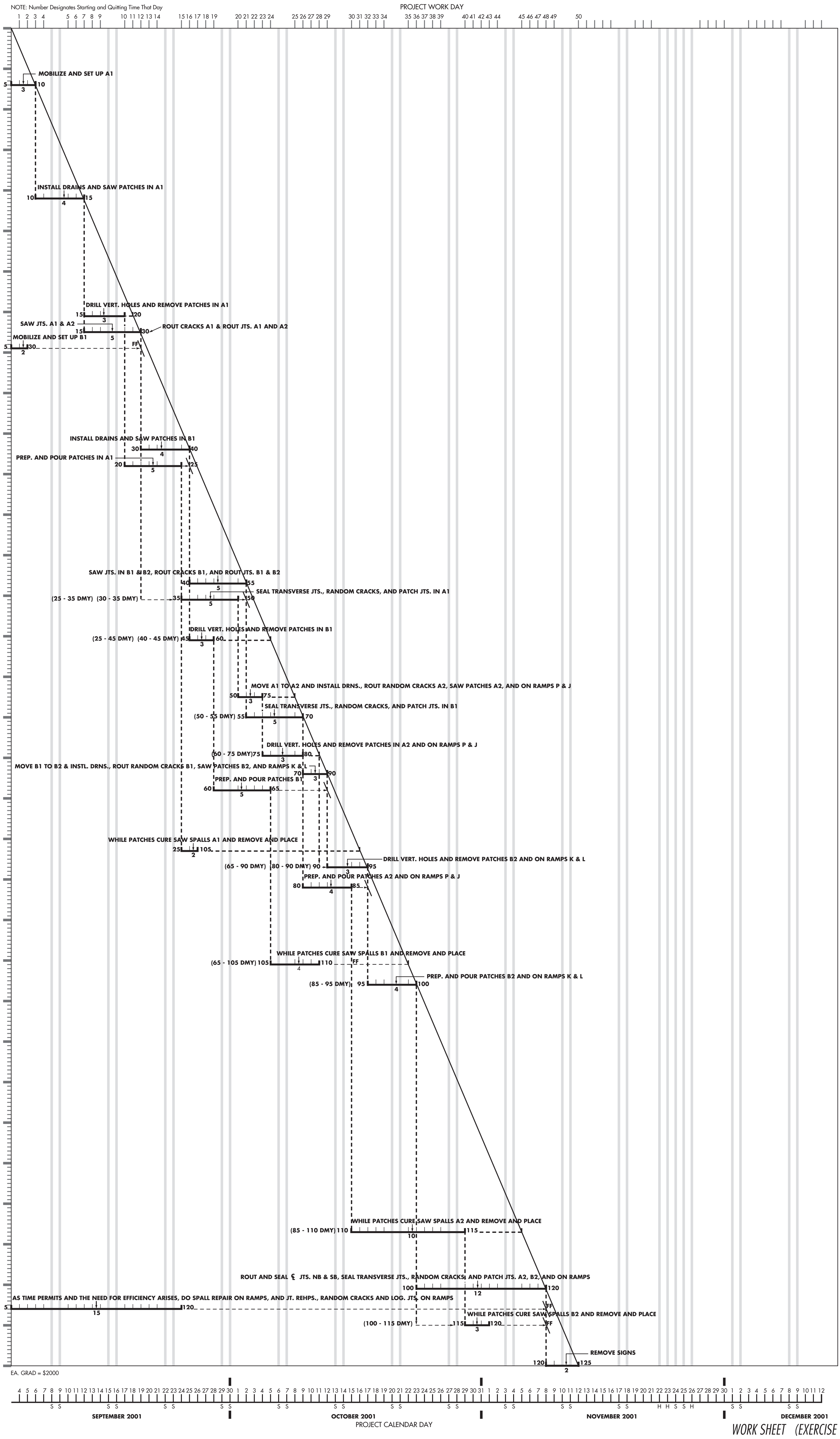
EXERCISE 3: **RT. 60-PAVEMENT REHABILITATION PROJECT**

PERCENT OF PROJECT COMPLETED TO DATE

PERIOD	ACTIVITY	%	TOTAL THIS ACTIVITY	TOTAL THIS PERIOD	CUMULATIVE TOTAL	

EXERCISE 3: **RT 60–PAVEMENT REHABILITATION PROJECT**

MONITOR/DAILY UPDATE CHART WITH CASH FLOW



WORK SHEET

PROJECT PLANNING & SCHEDULING **WORKBOOK**

EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

ACTIVITY LIST *(Work Plan)*

Project Description

The Route 17 project involves two contracts to construct two additional lanes to an existing two lane roadway. Contract No.1 for only Earthmoving was let in 1998 with a Notice to Proceed in January 1999. The contract completion date for Contract No. 1 was November 24, 1999.

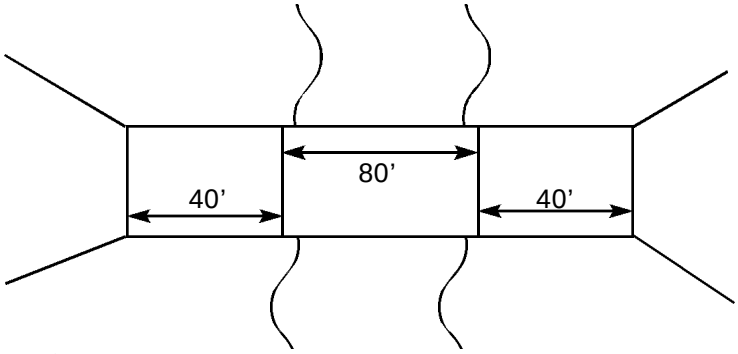
Contract No. 2, is for a bridge construction which is critical to completion of the Earthmoving contract. Contract No. 2 had not been let until April 1999 with a Notice to Proceed of June 14, 1999.

All of the earthmoving work in Contract No. 1 except 215,000 CuYd of Excavation for Embankment and Waste can be completed without having to cross the bridge to be constructed in Contract No. 2. Contractor No. 1 will need 48 workdays to haul the 215,000 CuYd to Embankment and Waste. It will start when Contract No. 2 has been completed.

Develop a Network Schedule for contract No. 2 with a completion date that will allow 48 workdays in contract No. 1 to haul the 215,000 CuYd of excavation for embankment and waste.

Contract No. 2 limitations to consider when creating the Network Schedule:

- You can only work 5 days per week because of restrictions placed on the contractor by residents.
- The following holidays are non-working days; July 5, 1999 and September 6, 1999
- You are not permitted in the stream, which runs between pier 1 and pier 2
- You have one excavator and one pile driver
- You can also set the pile driver between abutment 2 and pier 2 and reach both areas to place piling. The distances are as follows: 40 feet from abutment 1 to pier 1; 80 feet from pier 1 to pier 2; 40 feet from pier 2 to abutment 2.
- You have one excavator that can be placed and worked concurrently with the pile driver. The abutments get "H" piling. The piers must be excavated after sheet piling is installed, and they also get "H" piling.
- You have: a crew to FRP footings (Form, Rebar, Pour)
  a crew to FRP abutment stems and pier columns
  a crew to FRP pier caps
- You can set beams when piers are cured and 1 abutment is backfilled.
- You can move equipment from one side of the stream to the other via the existing parallel roadway. The new bridge will carry traffic over the stream when this existing 2-lane roadway becomes 4 lanes.



EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

ACTIVITY LIST *(Work Plan)*

Activity List

These are the activities and durations determined to be achievable by your estimations.

Task	Duration
Mobilize	5 days
Excavate abut 1	2 days
Excavate pier 1	2 days
Excavate abut 2	2 days
Excavate pier 2	2 days
Sheet piling pier 1	2 days
Sheet piling pier 2	1 day
"H" piling pier 1	2 days
"H" piling abut 1	4 days
"H" piling pier 2	2 days
"H" piling abut 2	4 days
FRP footings abut 1	3 days
FRP footings abut 2	3 days
FRP footings pier 1	3 days
FRP footings pier 2	3 days
FRP stem abut 1	3 days
FRP stem abut 2	3 days
FRP column pier 1	3 days
FRP column pier 2	3 days
FRP pier 1 cap and prep bearing pedistals	8 days
FRP pier 2 cap and prep bearing pedistals	8 days
Cure and backfill abut 1 to set beams	6 days
Cure abut 2 to set beams	5 days
Cure piers	3 days
Fabricate and deliver beams	22 days (start=June 14, 1999)
Cure and backfill abut 2	2 days
Set beams	2 days (only abut 1 to be backfilled)
Form diaphragms and overhangs	4 days
Set SIP (Stay in Place) forms and place rebar	2 days
Build back and cheekwalls	2 days
Pour deck	4 days
Form parapets	4 days
Cure deck to pour parapets	3 days
Pour parapets	2 days
Install drainage and FRP approach slabs	7 days
Cure parapets	3 days
Cure approach slabs	3 days

EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

1999 WORKDAY CALENDAR

WORK SHEET

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JANUARY	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN
FEBRUARY	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN			
MARCH	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED
APRIL	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	
MAY	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SSAT	SUN	MON
JUNE	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	
JULY	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT
AUGUST	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE
SEPTEMBER	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	
OCTOBER	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN
NOVEMBER	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	
DECEMBER	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

NETWORK DIAGRAM

WORK SHEET

Instructions:

Draw Logic Diagram

a. Draw each activity as an arrow in a logical sequence of work asking: What's first, what's next, and what can be done at the same time?

b. Construct the Network Diagram by completing the rest of the eight step process. (See Reference Card)

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR MONITOR/DAILY UPDATE CHART

WORK SHEET

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number: use the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

I	J	DUR.	ES	EF	LS	LF	TF	RANKING	ACTIVITY DESCRIPTION

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR MONITOR/DAILY UPDATE CHART

WORK SHEET

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I	J	DUR.	ES	EF	LS	LF	TF	RANKING	ACTIVITY DESCRIPTION

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR MONITOR/DAILY UPDATE CHART

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I	J	DUR.	ES	EF	LS	LF	TF	RANKING	ACTIVITY DESCRIPTION

EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

MONITOR/DAILY UPDATE CHART TALLY SHEET

1. _____	51. _____	101. _____	151. _____	201. _____
2. _____	52. _____	102. _____	152. _____	202. _____
3. _____	53. _____	103. _____	153. _____	203. _____
4. _____	54. _____	104. _____	154. _____	204. _____
5. _____	55. _____	105. _____	155. _____	205. _____
6. _____	56. _____	106. _____	156. _____	206. _____
7. _____	57. _____	107. _____	157. _____	207. _____
8. _____	58. _____	108. _____	158. _____	208. _____
9. _____	59. _____	109. _____	159. _____	209. _____
10. _____	60. _____	110. _____	160. _____	210. _____
11. _____	61. _____	111. _____	161. _____	211. _____
12. _____	62. _____	112. _____	162. _____	212. _____
13. _____	63. _____	113. _____	163. _____	213. _____
14. _____	64. _____	114. _____	164. _____	214. _____
15. _____	65. _____	115. _____	165. _____	215. _____
16. _____	66. _____	116. _____	166. _____	216. _____
17. _____	67. _____	117. _____	167. _____	217. _____
18. _____	68. _____	118. _____	168. _____	218. _____
19. _____	69. _____	119. _____	169. _____	219. _____
20. _____	70. _____	120. _____	170. _____	220. _____
21. _____	71. _____	121. _____	171. _____	221. _____
22. _____	72. _____	122. _____	172. _____	222. _____
23. _____	73. _____	123. _____	173. _____	223. _____
24. _____	74. _____	124. _____	174. _____	224. _____
25. _____	75. _____	125. _____	175. _____	225. _____
26. _____	76. _____	126. _____	176. _____	226. _____
27. _____	77. _____	127. _____	177. _____	227. _____
28. _____	78. _____	128. _____	178. _____	228. _____
29. _____	79. _____	129. _____	179. _____	229. _____
30. _____	80. _____	130. _____	180. _____	230. _____
31. _____	81. _____	131. _____	181. _____	231. _____
32. _____	82. _____	132. _____	182. _____	232. _____
33. _____	83. _____	133. _____	183. _____	233. _____
34. _____	84. _____	134. _____	184. _____	234. _____
35. _____	85. _____	135. _____	185. _____	235. _____
36. _____	86. _____	136. _____	186. _____	236. _____
37. _____	87. _____	137. _____	187. _____	237. _____
38. _____	88. _____	138. _____	188. _____	238. _____
39. _____	89. _____	139. _____	189. _____	239. _____
40. _____	90. _____	140. _____	190. _____	240. _____
41. _____	91. _____	141. _____	191. _____	241. _____
42. _____	92. _____	142. _____	192. _____	242. _____
43. _____	93. _____	143. _____	193. _____	243. _____
44. _____	94. _____	144. _____	194. _____	244. _____
45. _____	95. _____	145. _____	195. _____	245. _____
46. _____	96. _____	146. _____	196. _____	246. _____
47. _____	97. _____	147. _____	197. _____	247. _____
48. _____	98. _____	148. _____	198. _____	248. _____
49. _____	99. _____	149. _____	199. _____	249. _____
50. _____	100. _____	150. _____	200. _____	250. _____

EXERCISE 4: **RT 17 BRIDGE CONSTRUCTION PROJECT**

MONITOR/DAILY UPDATE CHART

NOTE: Number Designates Starting and Quitting Time That Day

PROJECT WORK DAY

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65

5

14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

S S S S S S H S S S S S S S S S S S S S S S S S S H S S S S

JUNE 1999 **JULY 1999** **AUGUST 1999** **SEPTEMBER 1999**

PROJECT CALENDAR DAY

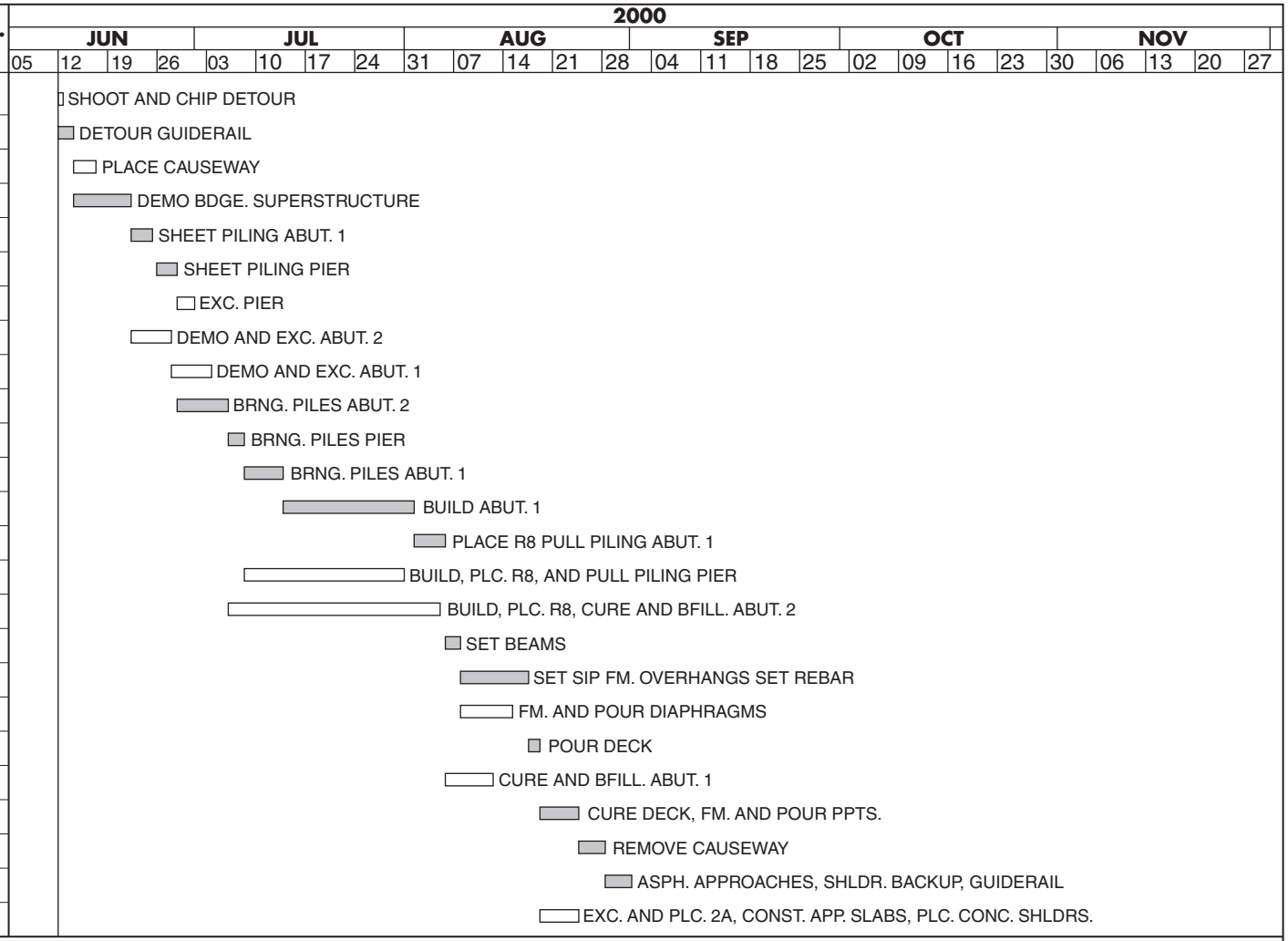
WORK SHEET

EXERCISE 5: **CONTRACTORS SUBMITTAL (BASELINE SCHEDULE)**

S.R. 0027 – B01

WORK SHEET

ACT ID	DESCRIPTION	ORIG. DUR.
1000	SHOOT AND CHIP DETOUR	1
1005	DETOUR GUIDERAIL	2
1010	PLACE CAUSEWAY	3
1015	DEMO BDGE. SUPERSTRUCTURE	7
1020	SHEET PILING ABUT. 1	3
1025	SHEET PILING PIER	3
1030	EXC. PIER	2
1035	DEMO AND EXC. ABUT. 2	5
1040	DEMO AND EXC. ABUT. 1	5
1045	BRNG. PILES ABUT. 2	5
1050	BRNG. PILES PIER	2
1055	BRNG. PILES ABUT. 1	5
1060	BUILD ABUT. 1	15
1065	PLACE R8 PULL PILING ABUT. 1	4
1070	BUILD, PLC. R8, AND PULL PILING PIER	19
1075	BUILD, PLC. R8, CURE AND BFILL. ABUT. 2	25
1080	SET BEAMS	2
1085	SET SIP FM. OVERHANGS SET REBAR	8
1090	FM. AND POUR DIAPHRAGMS	6
1095	POUR DECK	2
1100	CURE AND BFILL. ABUT. 1	6
1105	CURE DECK, FM. AND POUR PPTS.	5
1110	REMOVE CAUSEWAY	3
1115	ASPH. APPROACHES, SHLDR. BACKUP, GU	4
1120	EXC. AND	5



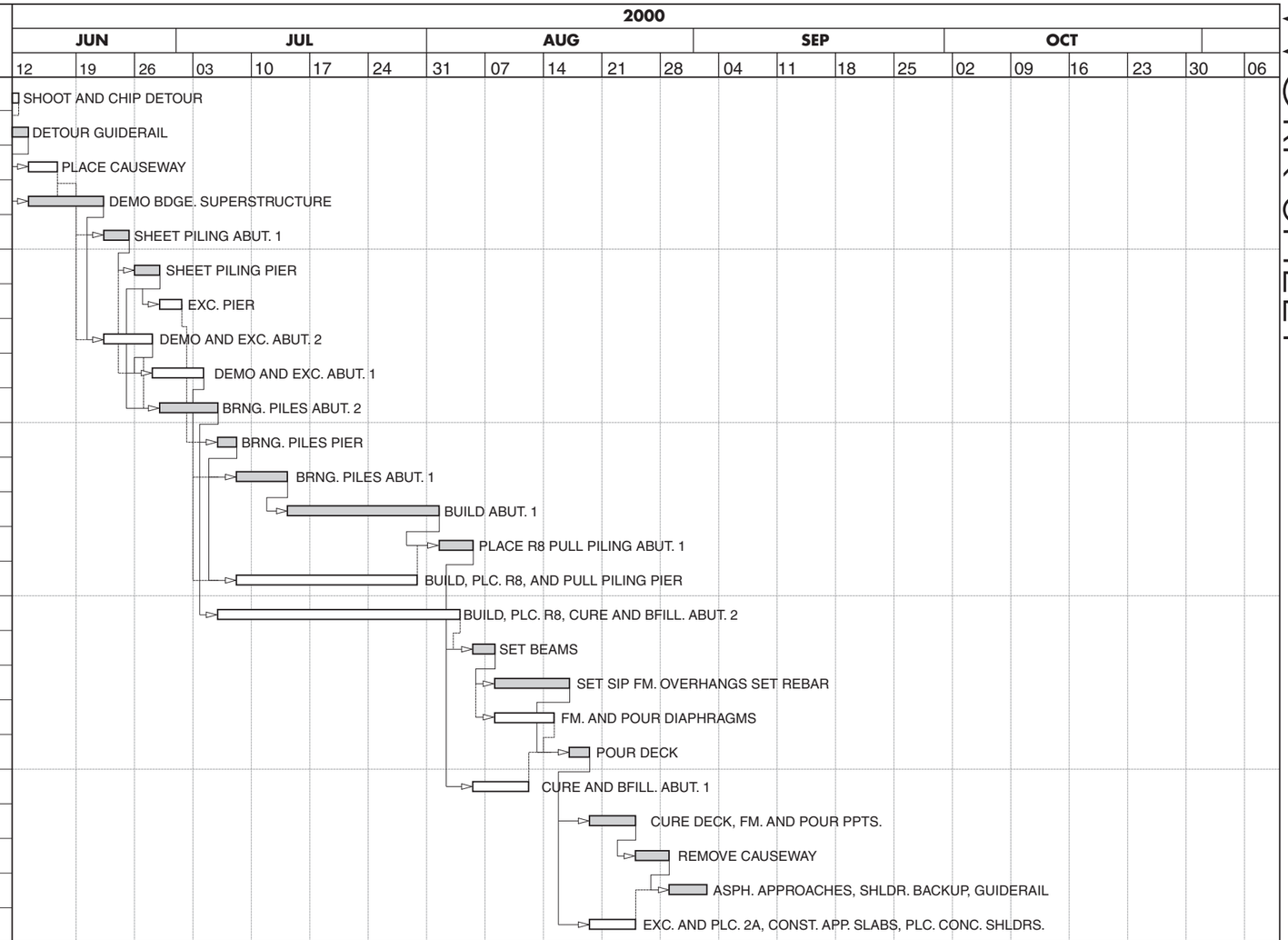
Start Date	12 JUN 00
Finish Date	01 SEP 00
Data Date	12 JUN 00
Run Date	31 JAN 03

Early Bar
Critical Bar

EXERCISE 5: **CONTRACTORS SUBMITTAL (BASELINE SCHEDULE) WITH RELATIONSHIPS**

S.R. 0027 - B01

ACT ID	DESCRIPTION	ORIG. DUR.	REM DUR.	EARLY START	EARLY FINISH	TOTAL FLOAT	%
1000	SHOOT AND CHIP DETOUR	1	1	12 JUN 00	12 JUN 00	1d	0
1005	DETOUR GUIDERAIL	2	2	12 JUN 00	13 JUN 00	0	0
1010	PLACE CAUSEWAY	3	3	14 JUN 00	16 JUN 00	4d	0
1015	DEMO BDGE. SUPERSTRUCTURE	7	7	14 JUN 00	21 JUN 00	0	0
1020	SHEET PILING ABUT. 1	3	3	22 JUN 00	24 JUN 00	0	0
1025	SHEET PILING PIER	3	3	26 JUN 00	28 JUN 00	0	0
1030	EXC. PIER	2	2	29 JUN 00	30 JUN 00	3d	0
1035	DEMO AND EXC. ABUT. 2	5	5	22 JUN 00	27 JUN 00	1d	0
1040	DEMO AND EXC. ABUT. 1	5	5	28 JUN 00	03 JUL 00	3d	0
1045	BRNG. PILES ABUT. 2	5	5	29 JUN 00	05 JUL 00	0	0
1050	BRNG. PILES PIER	2	2	06 JUL 00	07 JUL 00	0	0
1055	BRNG. PILES ABUT. 1	5	5	08 JUL 00	13 JUL 00	0	0
1060	BUILD ABUT. 1	15	15	14 JUL 00	31 JUL 00	0	0
1065	PLACE R8 PULL PILING ABUT. 1	4	4	01 AUG 00	04 AUG 00	0	0
1070	BUILD, PLC. R8, AND PULL PILING PIER	19	19	08 JUL 00	29 JUL 00	1d	0
1075	BUILD, PLC. R8, CURE AND BFILL. ABUT. 2	25	25	06 JUL 00	03 AUG 00	1d	0
1080	SET BEAMS	2	2	05 AUG 00	07 AUG 00	0	0
1085	SET SIP FM. OVERHANGS SET REBAR	8	8	08 AUG 00	16 AUG 00	0	0
1090	FM. AND POUR DIAPHRAGMS	6	6	08 AUG 00	14 AUG 00	2d	0
1095	POUR DECK	2	2	17 AUG 00	18 AUG 00	0	0
1100	CURE AND BFILL. ABUT. 1	6	6	05 AUG 00	11 AUG 00	4d	0
1105	CURE DECK, FM. AND POUR PPTS.	5	5	19 AUG 00	24 AUG 00	0	0
1110	REMOVE CAUSEWAY	3	3	25 AUG 00	28 AUG 00	0	0
1115	ASPH. APPROACHES, SHLDR. BACKUP, GU	4	4	29 AUG 00	01 SEP 00	0	0
1120	EXC. AND	5	5	19 AUG 00	24 AUG 00	3d	0



Start Date	12 JUN 00
Finish Date	01 SEP 00
Data Date	12 JUN 00
Run Date	31 JAN 03

Early Bar
Critical Bar

WORK SHEET

EXERCISE 5: **CONTRACTOR'S SUBMITTAL (BASELINE)**

S.R. 0027 B01

REPORT: ORG. BY PRED. **REPORT DATE: 04 FEB 03**
LAYOUT: ORGANIZED BY PREDECESSOR **PAGE 1A OF 2C**
FILTER: ALL ACTIVITIES

ACT ID	ACTIVITY DESCRIPTION	REM DUR.	%	EARLY START	EARLY FINISH	REL TYPE	REL LAG	FREE FLOAT	TOTAL FLOAT
SHOOT AND CHIP DETOUR									
1010	PLACE CAUSEWAY	3	0	14 JUN 00	16 JUN 00	FS –	0	4d	4d
1015	DEMO BDGE. SUPERSTRUCTURE	7	0	14 JUN 00	21 JUN 00	FS –	0	0	0
DETOUR GUIDERAIL									
1010	PLACE CAUSEWAY	3	0	14 JUN 00	16 JUN 00	FS –	0	4d	4d
1015	DEMO BDGE. SUPERSTRUCTURE	7	0	14 JUN 00	21 JUN 00	FS –	0	0	0
PLACE CAUSEWAY									
1020	SHEET PILING ABUT. 1	3	0	22 JUN 00	24 JUN 00	FS –	0	0	0
1035	DEMO AND EXC. ABUT. 2	5	0	22 JUN 00	27 JUN 00	FS –	0	0	1d
DEMO BDGE. SUPERSTRUCTURE									
1020	SHEET PILING ABUT. 1	3	0	22 JUN 00	24 JUN 00	FS –	0	0	0
1035	DEMO AND EXC. ABUT. 2	5	0	22 JUN 00	27 JUN 00	FS –	0	0	1d
SHEET PILING ABUT. 1									
1025	SHEET PILING PIER	3	0	26 JUN 00	28 JUN 00	FS –	0	0	0
1040	DEMO AND EXC. ABUT. 1	5	0	28 JUN 00	03 JUL 00	FS –	0	3d	3d
SHEET PILING PIER									
1030	EXC. PIER	2	0	29 JUN 00	30 JUN 00	FS –	0	3d	3d
1045	BRNG. PILES ABUT. 2	5	0	29 JUN 00	05 JUL 00	FS –	0	0	0
EXC. PIER									
1050	BRNG. PILES PIER	2	0	06 JUL 00	07 JUL 00	FS –	0	0	0
DEMO AND EXC. ABUT. 2									
1040	DEMO AND EXC. ABUT. 1	5	0	28 JUN 00	03 JUL 00	FS –	0	3d	3d
1045	BRNG. PILES ABUT. 2	5	0	29 JUN 00	05 JUL 00	FS –	0	0	0
DEMO AND EXC. ABUT. 1									
1055	BRNG. PILES ABUT. 1	5	0	08 JUL 00	13 JUL 00	FS –	0	0	0
1070	BUILD, PLC. R8, AND PULL PILING PIER	19	0	08 JUL 00	29 JUL 00	FS –	0	1d	1d
BRNG. PILES ABUT. 2									
1050	BRNG. PILES PIER	2	0	06 JUL 00	07 JUL 00	FS –	0	0	0
1075	BUILD, PLC. R8, CURE AND BFILL. ABUT. 2	25	0	06 JUL 00	03 AUG 00	FS –	0	1d	1d
BRNG. PILES PIER									
1055	BRNG. PILES ABUT. 1	5	0	08 JUL 00	13 JUL 00	FS –	0	0	0
1070	BUILD, PLC. R8, AND PULL PILING PIER	19	0	08 JUL 00	29 JUL 00	FS –	0	1d	1d
BRNG. PILES ABUT. 1									
1060	BUILD ABUT. 1	15	0	14 JUL 00	31 JUL 0	FS –	0	0	0
BUILD ABUT. 1									
1065	PLACE R8 PULL PILING ABUT. 1	4	0	01 AUG 00	04 AUG 00	FS –	0	0	0
PLACE R8 PULL PILING ABUT. 1									
1080	SET BEAMS	2	0	05 AUG 00	07 AUG 00	FS –	0	0	0
1100	CURE AND BFILL. ABUT. 1	6	0	05 AUG 00	11 AUG 00	FS –	0	4d	4d
BUILD, PLC. R8, AND PULL PILING PIER									
1065	PLACE R8 PULL PILING ABUT. 1	4	0	01 AUG 00	04 AUG 00	FS –	0	0	0
BUILD, PLC. R8, CURE AND BFILL. ABUT. 2									
1080	SET BEAMS	2	0	05 AUG 00	07 AUG 00	FS –	0	0	0
SET BEAMS									
1085	SET SIP FM. OVERHANGS SET REBAR	8	0	08 AUG 00	16 AUG 00	FS –	0	0	0
1090	FM. AND POUR DIAPHRAGMS	6	0	08 AUG 00	14 AUG 00	FS –	0	2d	2d
SET SIP FM. OVERHANGS SET REBAR									
1095	POUR DECK	2	0	17 AUG 00	18 AUG 00	FS –	0	0	0
FM. AND POUR DIAPHRAGMS									
1095	POUR DECK	2	0	17 AUG 00	18 AUG 00	FS –	0	0	0
POUR DECK									
1105	CURE DECK, FM. AND POUR PPTS.	5	0	19 AUG 00	24 AUG 00	FS –	0	0	0
1120	EXC. AND	5	0	19 AUG 00	24 AUG 00	FS –	0	3d	3d
CURE AND BFILL. ABUT. 1									
1095	POUR DECK	2	0	17 AUG 00	18 AUG 00	FS –	0	0	0
CURE DECK, FM. AND POUR PPTS.									
1110	REMOVE CAUSEWAY	3	0	25 AUG 00	28 AUG 00	FS –	0	0	0
REMOVE CAUSEWAY									
1115	ASPH. APPROACHES, SHLDR. BACKUP, GUIDERAIL	4	0	29 AUG 00	01 SEP 00	FS –	0	0	0
EXC. AND PLC. 2A, CONST. APP. SLABS, PLC. CONC. SHLDRS.									
1115	ASPH. APPROACHES, SHLDR. BACKUP, GUIDERAIL	4	0	29 AUG 00	01 SEP 00	FS –	0	0	0
1000	SHOOT AND CHIP DETOUR	1	0	12 JUN 00	12 JUN 00		0	1d	1d
1005	DETOUR GUIDERAIL	2	0	12 JUN 00	13 JUN 00		0	0	0
		70	0	12 JUN 00	01 SEP 00		0	0	0

DATA DATE	**12 JUN 00**
START DATE	**12 JUN 00**
FINISH DATE	**01 SEP 00**
MUST FINISH DATE	
TARGET FINISH DATE	

DATE	REVISION	CHECKED	APPROVED

EXERCISE 5: **CONTRACTOR'S SUBMITTAL (BASELINE)**

S.R. 0027 B01

REPORT: ORG. BY SUCC. **REPORT DATE: 04 FEB 03**
LAYOUT: ORGANIZED BY SUCCESSOR **PAGE 1A OF 2C**
FILTER: ALL ACTIVITIES

ACT ID	ACTIVITY DESCRIPTION	REM DUR.	%	EARLY START	EARLY FINISH	REL TYPE	REL LAG	FREE FLOAT	TOTAL FLOAT
PLACE CAUSEWAY									
1000	SHOOT AND CHIP DETOUR	1	0	12 JUN 00	12 JUN 00	FS –	0	1d	1d
1005	DETOUR GUIDERAIL	2	0	12 JUN 00	13 JUN 00	FS –	0	0	0
DEMO BDGE. SUPERSTRUCTURE									
1000	SHOOT AND CHIP DETOUR	1	0	12 JUN 00	12 JUN 00	FS –	0	1d	1d
1005	DETOUR GUIDERAIL	2	0	12 JUN 00	13 JUN 00	FS –	0	0	0
SHEET PILING ABUT. 1									
1010	PLACE CAUSEWAY	3	0	14 JUN 00	16 JUN 00	FS –	0	4d	4d
1015	DEMO BDGE. SUPERSTRUCTURE	7	0	14 JUN 00	21 JUN 00	FS –	0	0	0
SHEET PILING PIER									
1020	SHEET PILING ABUT. 1	3	0	22 JUN 00	24 JUN 00	FS –	0	0	0
EXC. PIER									
1025	SHEET PILING PIER	3	0	26 JUN 00	28 JUN 00	FS –	0	0	0
DEMO AND EXC. ABUT. 2									
1010	PLACE CAUSEWAY	3	0	14 JUN 00	16 JUN 00	FS –	0	4d	4d
1015	DEMO BDGE. SUPERSTRUCTURE	7	0	14 JUN 00	21 JUN 00	FS –	0	0	0
DEMO AND EXC. ABUT. 1									
1020	SHEET PILING ABUT. 1	3	0	22 JUN 00	24 JUN 00	FS –	0	0	0
1035	DEMO AND EXC. ABUT. 2	5	0	22 JUN 00	27 JUN 00	FS –	0	0	1d
BRNG. PILES ABUT. 2									
1035	DEMO AND EXC. ABUT. 2	5	0	22 JUN 00	27 JUN 00	FS –	0	0	1d
1025	SHEET PILING PIER	3	0	26 JUN 00	28 JUN 00	FS –	0	0	0
BRNG. PILES PIER									
1030	EXC. PIER	2	0	29 JUN 00	30 JUN 00	FS –	0	3d	3d
1045	BRNG. PILES ABUT. 2	5	0	29 JUN 00	05 JUL 00	FS –	0	0	0
BRNG. PILES ABUT. 1									
1040	DEMO AND EXC. ABUT. 1	5	0	28 JUN 00	03 JUL 00	FS –	0	3d	3d
1050	BRNG. PILES PIER	2	0	06 JUL 00	07 JUL 00	FS –	0	0	0
BUILD ABUT. 1									
1055	BRNG. PILES ABUT. 1	5	0	08 JUL 00	13 JUL 00	FS –	0	0	0
PLACE R8 PULL PILING ABUT. 1									
1070	BUILD, PLC. R8, AND PULL PILING PIER	19	0	08 JUL 00	29 JUL 00	FS –	0	1d	1d
1060	BUILD ABUT. 1	15	0	14 JUL 00	31 JUL 00	FS –	0	0	0
BUILD, PLC. R8, AND PULL PILING PIER									
1040	DEMO AND EXC. ABUT. 1	5	0	28 JUN 00	03 JUL 00	FS –	0	3d	3d
1050	BRNG. PILES PIER	2	0	06 JUL 00	07 JUL 00	FS –	0	0	0
BUILD, PLC. R8, CURE AND BFILL. ABUT. 2									
1045	BRNG. PILES ABUT. 2	5	0	29 JUN 00	05 JUL 00	FS –	0	0	0
SET BEAMS									
1075	BUILD, PLC. R8, CURE AND BFLL. ABUT. 2	25	0	06 JUL 00	03 AUG 00	FS –	0	1d	1d
1065	PLACE R8 PULL PILING ABUT. 1	4	0	01 AUG 00	04 AUG 00	FS –	0	0	0
SET SIP FM. OVERHANGS SET REBAR									
1080	SET BEAMS	2	0	05 AUG 00	07 AUG 00	FS –	0	0	0
FM. AND POUR DIAPHRAGMS									
1080	SET BEAMS	2	0	05 AUG 00	07 AUG 00	FS –	0	0	0
POUR DECK									
1100	CURE AND BFILL. ABUT. 1	6	0	05 AUG 00	11 AUG 00	FS –	0	4d	4d
1085	SET SIP FM. OVERHANGS SET REBAR	8	0	08 AUG 00	16 AUG 00	FS –	0	0	0
1090	FM. AND POUR DIAPHRAGMS	6	0	08 AUG 00	14 AUG 00	FS –	0	2d	2d
CURE AND BFILL. ABUT. 1									
1065	PLACE R8 PULL PILING ABUT. 1	4	0	01 AUG 00	04 AUG 00	FS –	0	0	0
CURE DECK, FM. AND POUR PPTS.									
1095	POUR DECK	2	0	17 AUG 00	18 AUG 00	FS –	0	0	0
REMOVE CAUSEWAY									
1105	CURE DECK, FM. AND POUR PPTS.	5	0	19 AUG 00	24 AUG 00	FS –	0	0	0
ASPH. APPROACHES, SHLDR. BACKUP, GUIDERAIL									
1120	EXC. AND	5	0	19 AUG 00	24 AUG 00	FS –	0	3d	3d
1110	REMOVE CAUSEWAY	3	0	25 AUG 00	28 AUG 00	FS –	0	0	0
EXC. AND PLC. 2A, CONST. APP. SLABS, PLC. CONC. SHLDRS.									
1095	POUR DECK	2	0	17 AUG 00	18 AUG 00	FS –	0	0	0
1115	ASPH. APPROACHES, SHLDR. BACKUP, GUIDERAIL	4	0	29 AUG 00	01 SEP 00		0	0	0
		70	0	12 JUN 00	01 SEP 00		0	0	0

DATA DATE	**12 JUN 00**
START DATE	**12 JUN 00**
FINISH DATE	**01 SEP 00**
MUST FINISH DATE	
TARGET FINISH DATE	

DATE	REVISION	CHECKED	APPROVED

EXERCISE 5: **CONTRACTORS SUBMITTAL (BASELINE SCHEDULE)**

S.R. 0027 – B01

Calendar: Normal Workweek
31 JAN 03
Hours/Day: Sun-0 Mon-8 Tue-8 Wed-8 Thu-8 Fri-8 Sat-8

WORK SHEET

JUNE 2000						
SUN	MON 8	TUE 8	WED 8	THU 8	FRI 8	SAT 8
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

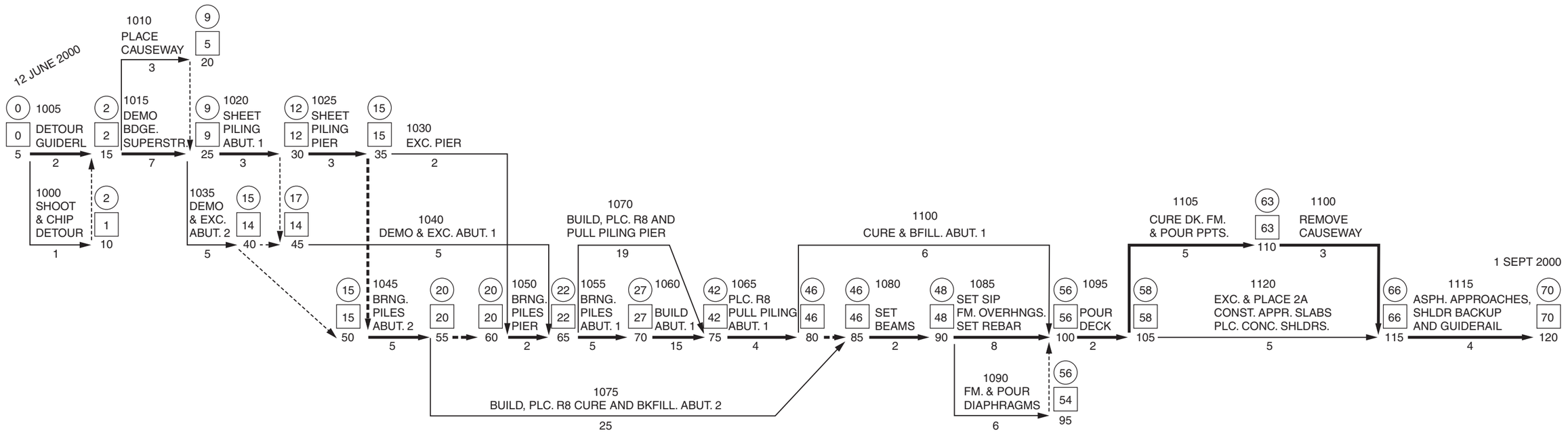
JULY 2000						
SUN	MON 8	TUE 8	WED 8	THU 8	FRI 8	SAT 8
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

AUGUST 2000						
SUN	MON 8	TUE 8	WED 8	THU 8	FRI 8	SAT 8
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEPTEMBER 2000						
SUN	MON 8	TUE 8	WED 8	THU 8	FRI 8	SAT 8
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

EXERCISE 5: **BASELINE SCHEDULE**

S.R. 0027 – B01



"2000" WORKDAY CALENDAR S.R. 0027 – B01

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	JUNE
										X	1	2	3	4	5	6	X	7	8	9	10	11	12	X	13	14	15	16	17	
THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	JULY
18	X	19	X	20	21	22	23	X	24	25	26	27	28	29	X	30	31	32	33	34	35	X	36	37	38	39	40	41	X	42	
SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	AUGUST
43	44	45	46	47	X	48	49	50	51	52	53	X	54	55	56	57	58	59	X	60	61	62	63	64	65	X	66	67	68	69	
TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	SEPTEMBER
70	71	X	X	72	73	74	75	76	X	77	78	79	80	81	82	X	83	84	85	86	87	88	X	89	90	91	92	93	94	
FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	

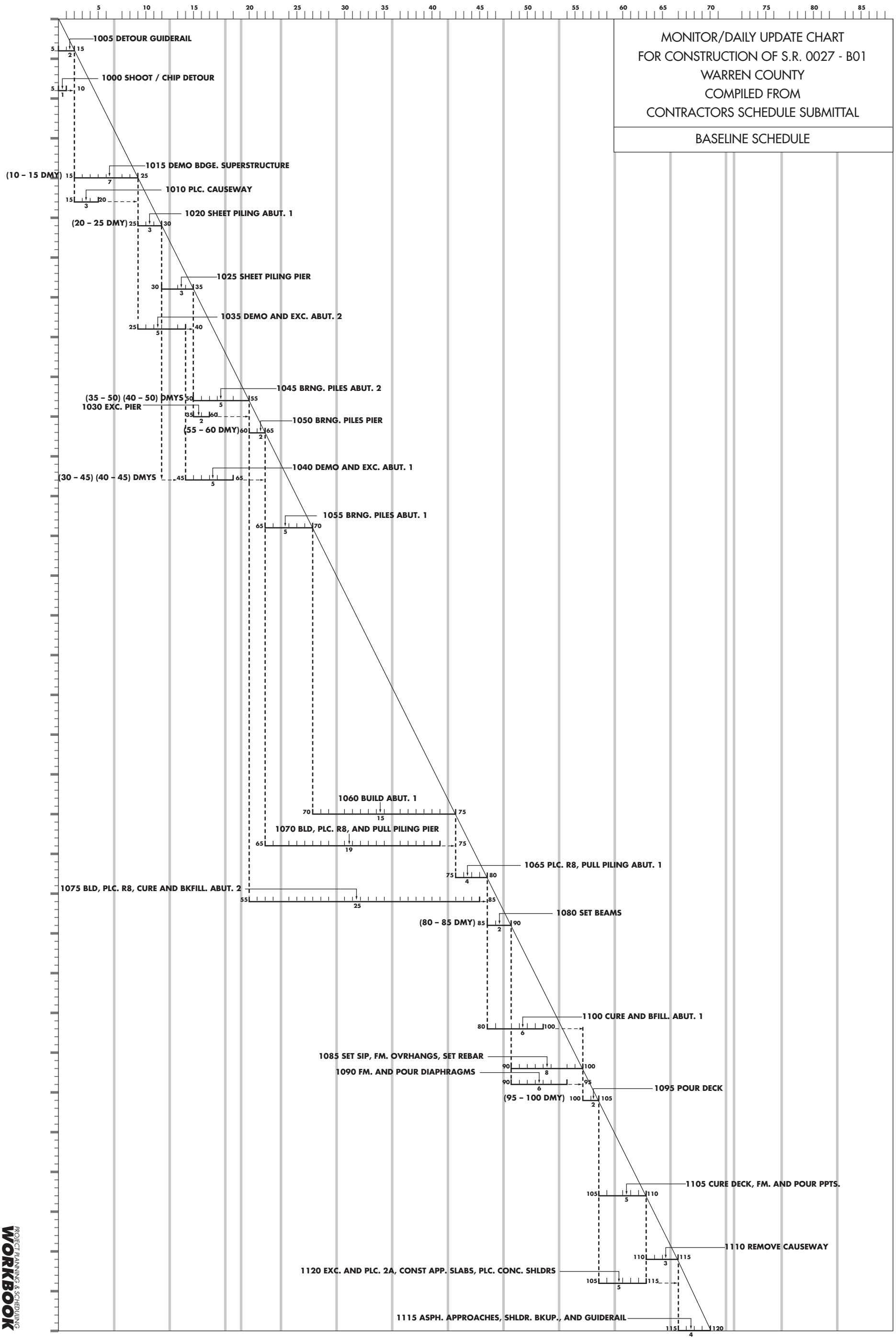
NETWORK DIAGRAM
ACTIVITY ON ARROW DIAGRAM
FOR CONSTRUCTION OF S.R. 0027 – B01
WARREN COUNTY
COMPILED FROM CONTRACTORS
SCHEDULE SUBMITTAL

BASELINE SCHEDULE

WORK SHEET

EXERCISE 5: **BASELINE SCHEDULE**

S.R. 0027 – B01



WORK SHEET

PROJECT PLANNING & SCHEDULING **WORKBOOK**

EXERCISE 5: **INFORMATION FROM INSPECTOR'S RECORDS: S.R. 0027 – B01**

Activity 1005 Install Detour Guiderail, started on 12 June and finished 13 June

Activity 1000 Shoot/Chip Detour, started and finished 12 June

Activity 1015 DEMO. Bridge Superstructure, started 14 June, finished 20 June (worked every day but Sunday)

Activity 1010 Place Causeway, started 14 June, worked on the 15th and finished 16 June

Activity 1020 Sheet Piling ABUT 1, started 21 June, worked 21-22 and on 23 June contractor was unable to finish the sheet piling at the wing because of Power Line interference. Contractor moved piling rig to pier

Activity 1025 Sheet Piling Pier, started Monday 26 June, worked 26-27-28-29-30, did not work 1 July, worked and finished Monday 3 July

Activity 1035 DEMO. and EXC. ABUT 2, started 23 June and worked 23-24-26-27 and on 28 June ABUT 2 demo was completed. EXC. started 29 June and worked 30 June, there was no work on this activity on Sat 1 July or Mon 3 July. Work resumed 5 July, and worked 6 and 7 July, while excavating on 7 July contractor hit a gas line. Gas Co. worked Sat the 8th and Sunday the 9th and relocated the gas line. Contractor did not work on this activity Sat. 8 July, and were rained out Mon 10 July. On 11 July completed EXC. Abut 2.

Activity 1030 EXC. Pier, started 7 July, worked Sat 8 July and EXC. was complete.

Activity 1050 BRNG. Piles Pier, started Mon. 10 July, worked 10-11-12 and finished 13 July

Activity 1040 DEMO. and EXC. ABUT 1, no exc. could take place due to Power Line interference with completing the sheet piling. However, demo of existing started 29 June, and worked 30 June. No work was performed on this activity Sat. the 1st or Mon. the 3rd. Work began again on 5 July and worked 6-7-8, there was no work on Sun. the 9th, and job was rained out on 10 July. Demo resumed 11 July, worked 12 and 13 and demo was complete.

EXERCISE 5: **INFORMATION FROM INSPECTOR'S RECORDS: S.R. 0027 – B01**

Activity 1045 BRNG. Piles Abut 2, after installing brng. piles at pier contractor moved to abut 2 and Sat. 15 July started brng. piles, worked 17-18-19-20-21-22 and finished 24 July.

Activity 1070 BLD-PLC. R8 and Pull Piling Pier, started 14 July, worked 15-17-18-19-20-21-22-24 and finished 25 July.

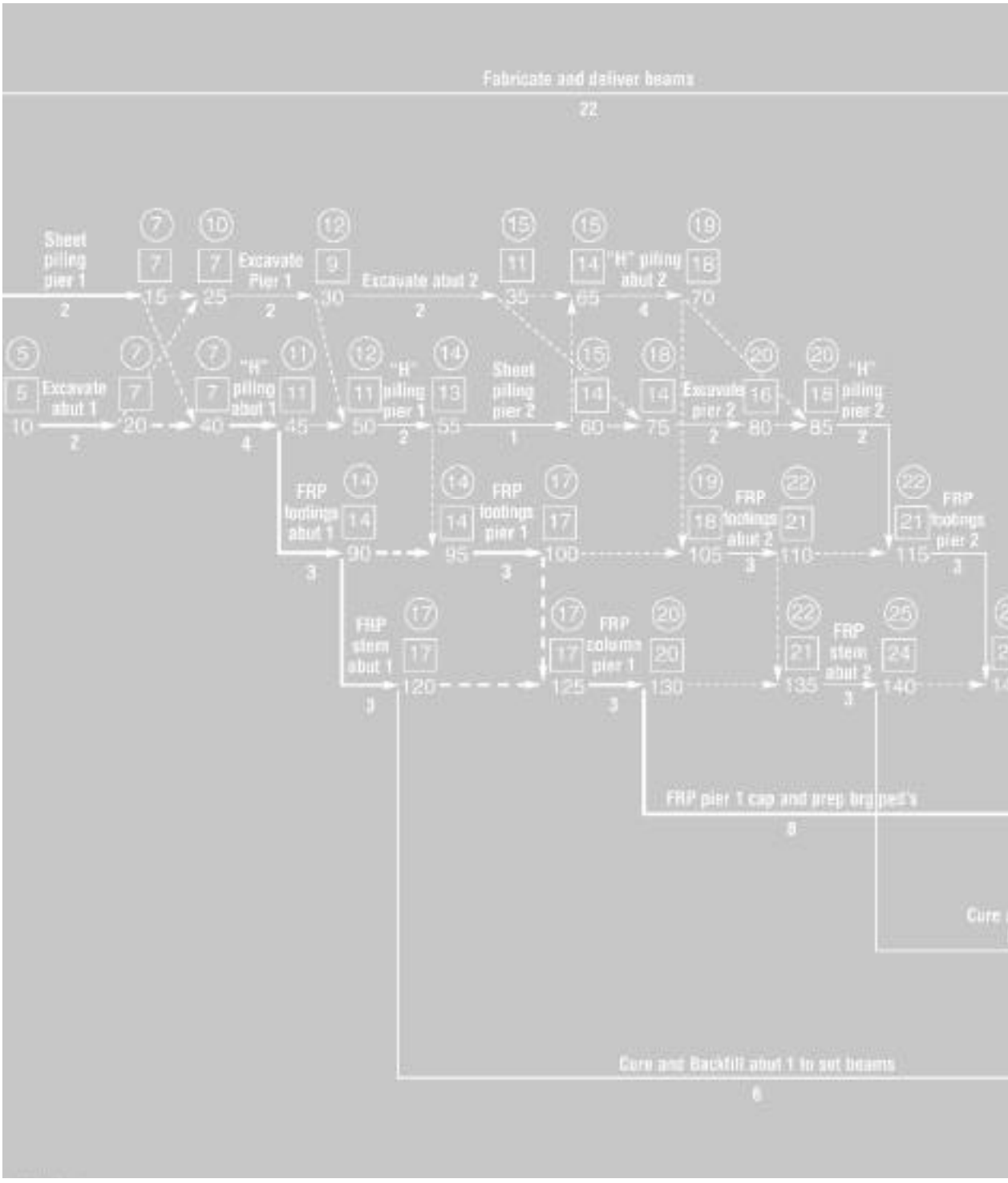
Activity 1075 BLD-PLC. R8 – Cure and BFILL Abut 2, although it couldn't be completed, work started 26 July and worked 27 and 28 July

Meanwhile the Dept. discovered the Power Line interfering with sheet piling ABUT 1, was relocated according to Dept. const. stakeout, which was in error. The Utility refused to relocate it again so the decision was made to redesign the wing. Redesign started 17 July, on 25 July the contractor was directed to lay back the slope at the wing, which was completed 26 July. On 27 and 28 July the contractor completed the sheet piling at ABUT 1. (34 Calendar days late) On 26 July the wing design was complete.

- Analyze the impact to the project due to these unforeseen delays.
- Assign responsibility for delays
- Determine a method of recovery, or if that isn't possible, determine the new completion date.

NOTE: *Work on this bridge started at completion of the school year, and school starts Sept. 5th. (the detour is 40 miles)*

APPENDIX E – PRACTICE EXERCISES-ANSWER SHEETS

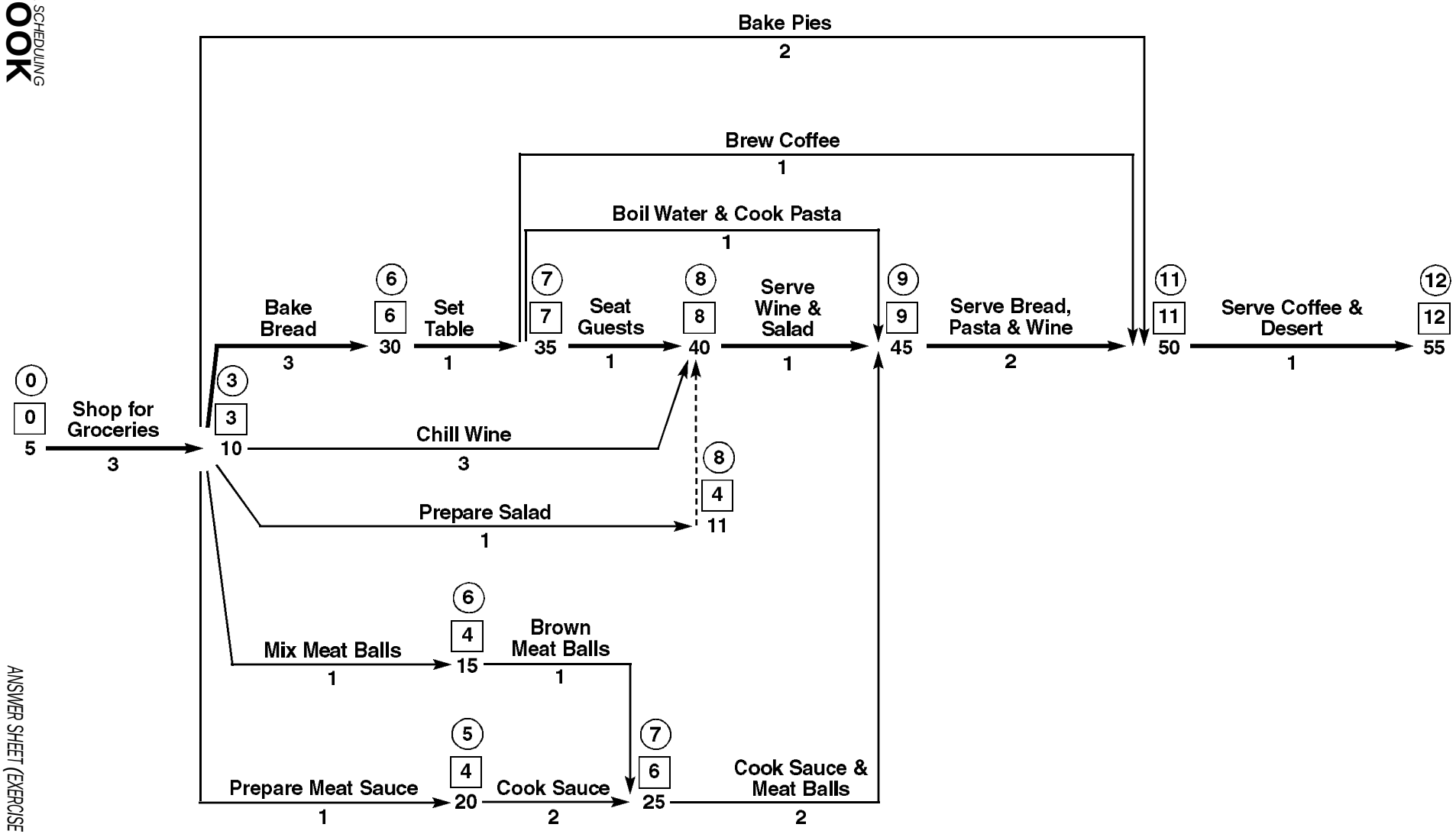


APPENDIX E

APPENDIX E – PRACTICE EXERCISES - ANSWER SHEETS

EXERCISE 1: SPAGHETTI DINNER

NETWORK DIAGRAM



EXERCISE 1: **SPAGHETTI DINNER**

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number to develop Bar Chart: use the earliest ES, assending to the latest ES. In case of tie, use lowest total float, lowest Duration, lowest I number, and lowest J number.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	ACTIVITY DESCRIPTION
5	10	3	0	3	0	3	0	1	Shop for Groceries
10	11	1	3	4	7	8	4	6	Prepare Salad
10	15	1	3	4	5	6	2	4	Mix Meat Balls
10	20	1	3	4	4	5	1	3	Prepare Meat Sauce
10	30	3	3	6	3	6	0	2	Bake Bread
10	40	3	3	6	5	8	2	5	Chill Wine
10	50	2	3	5	9	11	6	7	Bake Pies
11	40	0	4	4	8	8	4	10	Dummy
15	25	1	4	5	6	7	2	9	Brown Meat Balls
20	25	2	4	6	5	7	1	8	Cook Sauce
25	45	2	6	8	7	9	1	12	Cook Sauce & Meat Balls
30	35	1	6	7	6	7	0	11	Set Table
35	40	1	7	8	7	8	0	13	Seat Guests
35	45	1	7	8	8	9	1	14	Boil Water & Cook Pasta
35	50	1	7	8	10	11	3	15	Brew Coffee
40	45	1	8	9	8	9	0	16	Serve Wine & Salad
45	50	2	9	11	9	11	0	17	Serve Bread, Pasta & Wine
50	55	1	11	12	11	12	0	18	Serve Coffee & Dessert

EXERCISE 1: **SPAGHETTI DINNER**

RESOURCE MANAGEMENT BAR CHART

ACTIVITY RANKING					DURATION	RESOURCE		1	2	3	4	5	6	7	8	9	10	11	12
NO	I	J	ES	TF			ACTIVITY DESCRIPTION												
1	5	10	0	0	3		Shop for Groceries	/	/	/									
2	10	30	3	0	3		Bake Bread				/	/	/						
3	10	20	3	1	1		Prepare Meat Sauce				/	•							
4	10	15	3	2	1		Mix Meat Balls				/	•	•						
5	10	40	3	2	3		Chill Wine				/	/	/	•	•				
6	10	11	3	4	1		Prepare Salad				/	•	•	•	•				
7	10	50	3	6	2		Bake Pies				/	/	•	•	•	•	•	•	
8	20	25	4	1	2		Cook Sauce					/	/	•					
9	15	25	4	2	1		Brown Meat Balls					/	•	•					
10	11	40	4	4	0		Dummy					•	•	•	•				
11	30	35	6	0	1		Set Table							/					
12	25	45	6	1	2		Cook Sauce & Meatballs							/	/	•			
13	35	40	7	0	1		Seat Guests								/				
14	35	45	7	1	1		Boil Water & Cook Pasta								/	•			
15	35	50	7	3	1		Brew Coffee								/	•	•	•	
16	40	45	8	0	1		Serve Wine and Salad									/			
17	45	50	9	0	2		Serve Bread, Pasta & Wine										/	/	
18	50	55	11	0	1		Serve Coffee & Desert												/

NOTE: Dots (•) indicate float

EXERCISE 1: **SPAGHETTI DINNER**

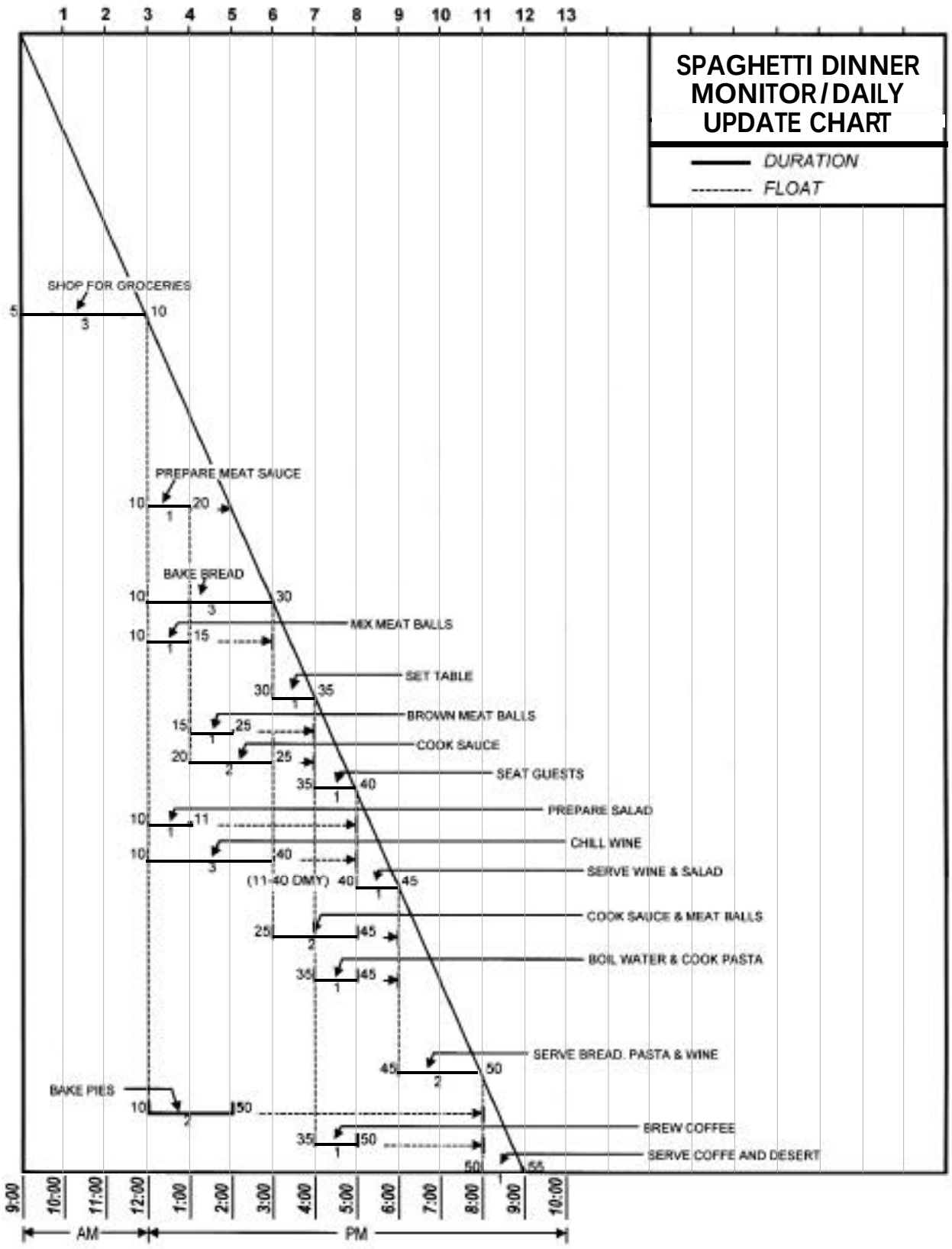
MONITOR/DAILY UPDATE CHART TALLY SHEET

1.	51.	101.	151.	201.
2.	52.	102.	152.	202.
3. ①	53.	103.	153.	203.
4.	54.	104.	154.	204.
5. |	55.	105.	155.	205.
6. | ①	56.	106.	156.	206.
7. || ①	57.	107.	157.	207.
8. ||| ①	58.	108.	158.	208.
9. || ①	59.	109.	159.	209.
10.	60.	110.	160.	210.
11. || ①	61.	111.	161.	211.
12. ①	62.	112.	162.	212.
13.	63.	113.	163.	213.
14.	64.	114.	164.	214.
15.	65.	115.	165.	215.
16.	66.	116.	166.	216.
17.	67.	117.	167.	217.
18.	68.	118.	168.	218.
19.	69.	119.	169.	219.
20.	70.	120.	170.	220.
21.	71.	121.	171.	221.
22.	72.	122.	172.	222.
23.	73.	123.	173.	223.
24.	74.	124.	174.	224.
25.	75.	125.	175.	225.
26.	76.	126.	176.	226.
27.	77.	127.	177.	227.
28.	78.	128.	178.	228.
29.	79.	129.	179.	229.
30.	80.	130.	180.	230.
31.	81.	131.	181.	231.
32.	82.	132.	182.	232.
33.	83.	133.	183.	233.
34.	84.	134.	184.	234.
35.	85.	135.	185.	235.
36.	86.	136.	186.	236.
37.	87.	137.	187.	237.
38.	88.	138.	188.	238.
39.	89.	139.	189.	239.
40.	90.	140.	190.	240.
41.	91.	141.	191.	241.
42.	92.	142.	192.	242.
43.	93.	143.	193.	243.
44.	94.	144.	194.	244.
45.	95.	145.	195.	245.
46.	96.	146.	196.	246.
47.	97.	147.	197.	247.
48.	98.	148.	198.	248.
49.	99.	149.	199.	249.
50.	100.	150.	200.	250.

NOTE: Circled tick marks indicate critical activity

EXERCISE 1: **SPAGHETTI DINNER**

MONITOR/DAILY UPDATE CHART



EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

2001 WORKDAY CALENDAR

ANSWER SHEET

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED

JANUARY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED			

FEBRUARY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT

MARCH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	

APRIL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THU

MAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	

JUNE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE

JULY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI

AUGUST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	

SEPTEMBER

20	21	22	23	24			25	26	27	28	29			30	31	32	33	34			35	36	37	38	39			40	41	42
MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED

OCTOBER

43	44			45	46	47	48	49			50	51	52	53	54			55	56	57						58	59	60	61	
THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	

NOVEMBER

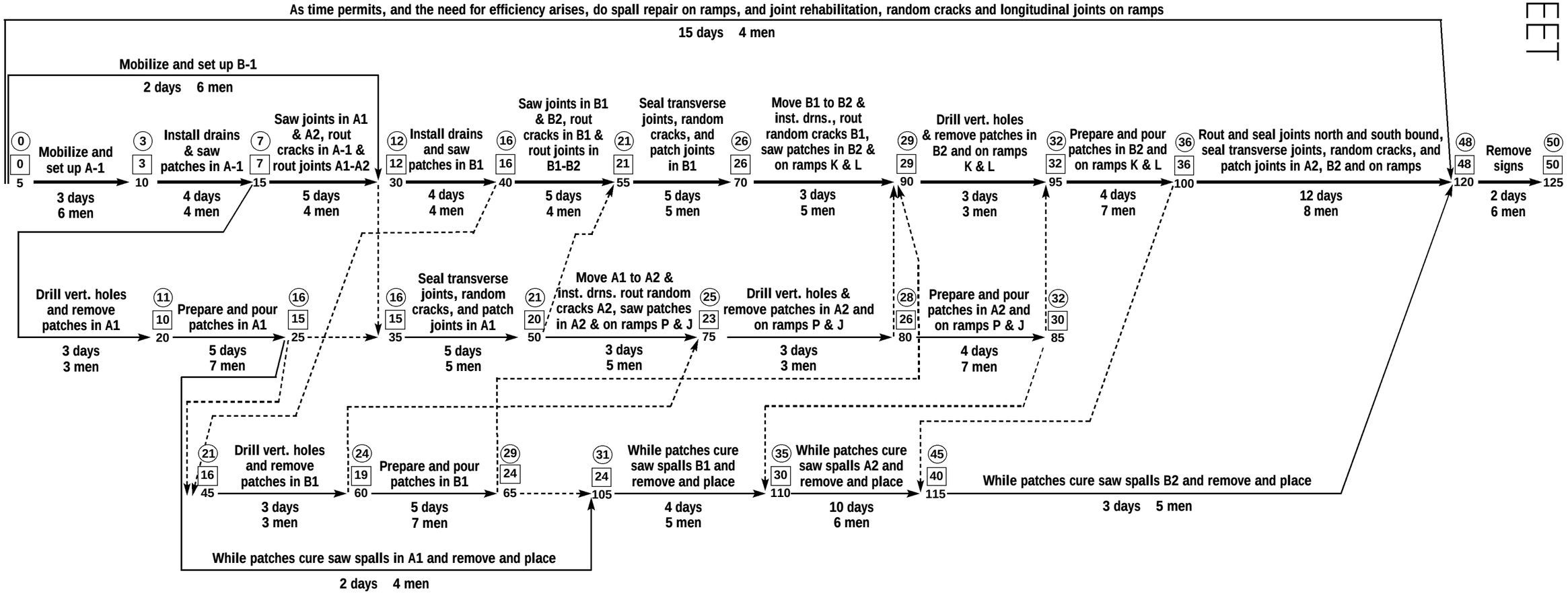
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON

DECEMBER

EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

NETWORK DIAGRAM

ANSWER SHEET



EXERCISE 2: RT 60–PAVEMENT REHABILITATION PROJECT

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number to develop Bar Chart: use the earliest ES, assending to the latest ES. In case of tie, use lowest total float, lowest Duration, lowest I number, and lowest J number.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	
5	10	3	0	3	0	3	0	1	
5	30	2	0	2	10	12	10	2	
5	120	15	0	15	33	48	33	3	
10	15	4	3	7	3	7	0	4	
15	20	3	7	10	8	11	1	6	
15	30	5	7	12	7	12	0	5	
20	25	5	10	15	11	16	1	7	
25	35	0	15	15	16	16	1	10	
25	45	0	15	15	21	21	6	12	
25	105	2	15	17	29	31	14	13	
30	35	0	12	12	16	16	4	9	
30	40	4	12	16	12	16	0	8	
35	50	5	15	20	16	21	1	11	
40	45	0	16	16	21	21	5	15	
40	55	5	16	21	16	21	0	14	
45	60	3	16	19	21	24	5	16	
50	55	0	20	20	21	21	1	19	
50	75	3	20	23	22	25	2	20	
55	70	5	21	26	21	26	0	21	
60	65	5	19	24	24	29	5	17	
60	75	0	19	19	25	25	6	18	
65	90	0	24	24	29	29	5	23	
65	105	0	24	24	31	31	7	24	
70	90	3	26	29	26	29	0	26	
75	80	3	23	26	25	28	2	22	
80	85	4	26	30	28	32	2	27	
80	90	0	26	26	29	29	3	28	
85	95	0	30	30	32	32	2	30	
85	110	0	30	30	35	35	5	31	
90	95	3	29	32	29	32	0	29	
95	100	4	32	36	32	36	0	33	
100	115	0	36	36	45	45	9	35	
100	120	12	36	48	36	48	0	34	
105	110	4	24	28	31	35	7	25	
110	115	10	30	40	35	45	5	32	
115	120	3	40	43	45	48	5	36	
120	125	2	48	50	48	50	0	37	

EXERCISE 2: RT. 60–PAVEMENT REHABILITATION PROJECT

RESOURCE MANAGEMENT BAR CHART

ANSWER SHEET

NO.	I	J	ES	TF	DUR.	CREW SIZE
1	5	10	0	0	3	6
2	5	30	0	10	2	6
3	5	120	0	33	15	4
4	10	15	3	0	4	4
5	15	30	7	0	5	4
6	15	20	7	1	3	3
7	20	25	10	1	5	7
8	30	40	12	0	4	4
9	30	35	12	4	0	0
10	25	35	15	1	0	0
11	35	50	15	1	5	5
12	25	45	15	6	0	0
13	25	105	15	14	2	4
14	40	55	16	0	5	4
15	40	45	16	5	0	0
16	45	60	16	5	3	3
17	60	65	19	5	5	7
18	60	75	19	6	0	0
19	50	55	20	1	0	0
20	50	75	20	2	3	5
21	55	70	21	0	5	5
22	75	80	23	2	3	3
23	65	90	24	5	0	0
24	65	105	24	7	0	0
25	105	110	24	7	4	5
26	70	90	26	0	3	5
27	80	85	26	2	4	7
28	80	90	26	3	0	0
29	90	95	29	0	3	3
30	85	95	30	2	0	0
31	85	110	30	5	0	0
32	110	115	30	5	10	6
33	95	100	32	0	4	7
34	100	120	36	0	12	8
35	100	115	36	9	0	0
36	115	120	40	5	3	5
37	120	125	48	0	2	6

WORKDAYS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
AVAILABLE RESOURCES	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
REMAINING RESOURCES	24	24	30	32	32	32	32	29	29	29	25	25	25	25	25	27	27	28	28	21	29	23	23	20	32	32	23	23	23	25	31	31	27	27	27	27	26	26	26	26	27	27	27	32	32	32	32	32	34	34
RESOURCE USED	16	16	10	8	8	8	8	11	11	11	15	15	15	15	15	13	13	12	12	19	11	17	17	20	8	8	17	17	17	15	9	9	13	13	13	13	14	14	14	14	13	13	13	8	8	8	8	8	6	6

EXERCISE 2: **RT. 60-PAVEMENT REHABILITATION PROJECT**

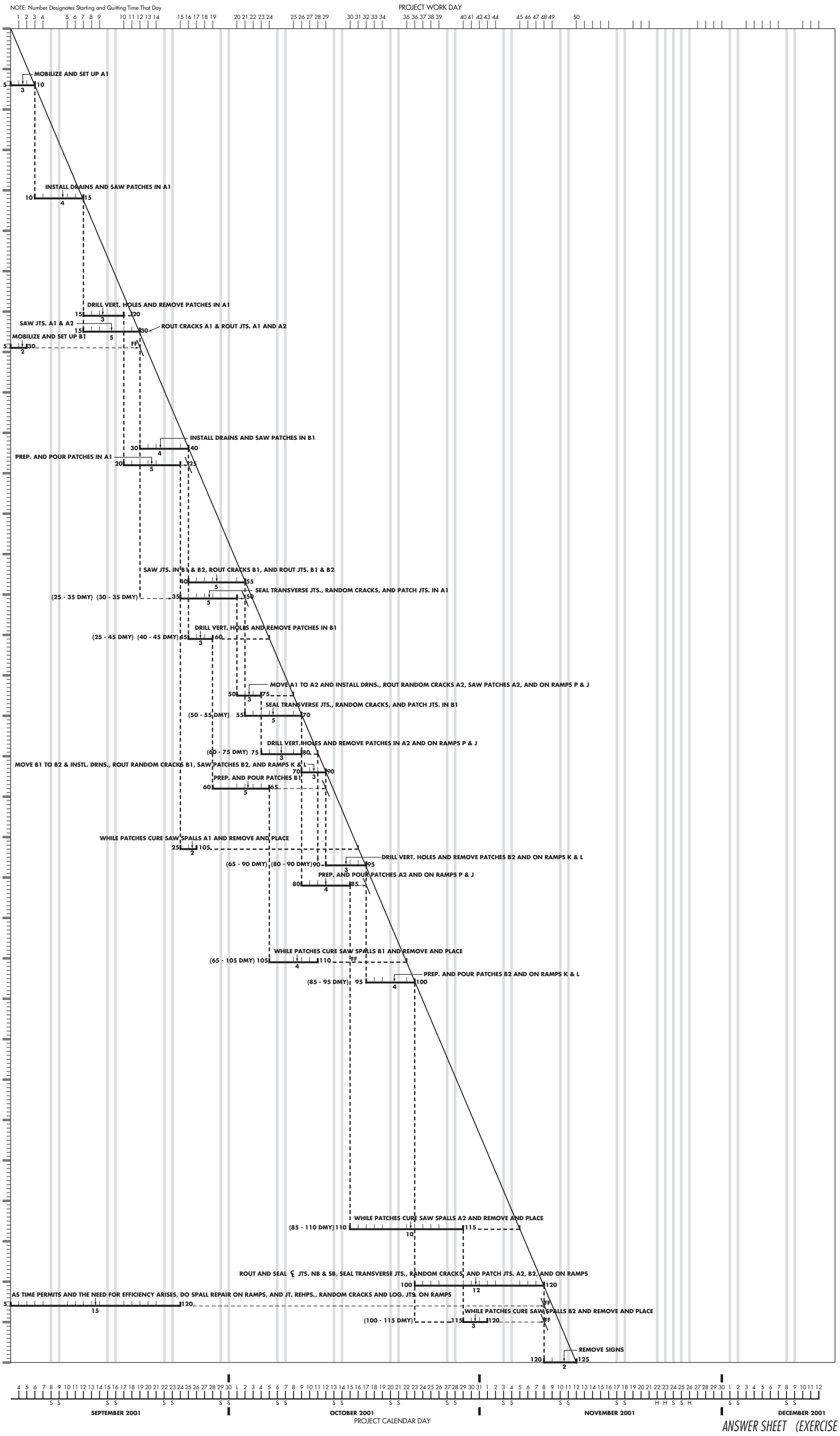
MONITOR/DAILY UPDATE CHART TALLY SHEET

1.	51.	101.	151.	201.
2.	52.	102.	152.	202.
3.	53.	103.	153.	203.
4.	54.	104.	154.	204.
5.	55.	105.	155.	205.
6.	56.	106.	156.	206.
7.	57.	107.	157.	207.
8.	58.	108.	158.	208.
9.	59.	109.	159.	209.
10.	60.	110.	160.	210.
11.	61.	111.	161.	211.
12.	62.	112.	162.	212.
13.	63.	113.	163.	213.
14.	64.	114.	164.	214.
15.	65.	115.	165.	215.
16.	66.	116.	166.	216.
17.	67.	117.	167.	217.
18.	68.	118.	168.	218.
19.	69.	119.	169.	219.
20.	70.	120.	170.	220.
21.	71.	121.	171.	221.
22.	72.	122.	172.	222.
23.	73.	123.	173.	223.
24.	74.	124.	174.	224.
25.	75.	125.	175.	225.
26.	76.	126.	176.	226.
27.	77.	127.	177.	227.
28.	78.	128.	178.	228.
29.	79.	129.	179.	229.
30.	80.	130.	180.	230.
31.	81.	131.	181.	231.
32.	82.	132.	182.	232.
33.	83.	133.	183.	233.
34.	84.	134.	184.	234.
35.	85.	135.	185.	235.
36.	86.	136.	186.	236.
37.	87.	137.	187.	237.
38.	88.	138.	188.	238.
39.	89.	139.	189.	239.
40.	90.	140.	190.	240.
41.	91.	141.	191.	241.
42.	92.	142.	192.	242.
43.	93.	143.	193.	243.
44.	94.	144.	194.	244.
45.	95.	145.	195.	245.
46.	96.	146.	196.	246.
47.	97.	147.	197.	247.
48.	98.	148.	198.	248.
49.	99.	149.	199.	249.
50.	100.	150.	200.	250.

Note: No dummies are identified on Tally Sheet.
Circled tick marks indicate critical activity

EXERCISE 2: **RT 60–PAVEMENT REHABILITATION PROJECT**

MONITOR/DAILY UPDATE CHART



ANSWER SHEET

EXERCISE 3: RT. 60–PAVEMENT REHABILITATION PROJECT

PROJECT CASH FLOW COMPUTATIONS

RT 60 PAVEMENT REHABILITATION

DISTRIBUTION OF CONTRACT QUANTITIES AND JOB BUDGET BY ACTIVITY

NOTE:

In order to cover costs of fuel, supervision and bond the following % are added. 13% to labor, 2% to equip. and 10% to matl.

							Contract Price	18.70	40.00	2.15	10.90	8.05	57.75	57.75	70.00	7.20	1.25	18.00	3.84	0.80	4800	3600	22,700	2000	
							Contract Quantity	100	100	1416	1228	108	971	425	20	2040	1855	3026	21,397	43,240	1	1	1	1	
							PAY ITEM Description	Class 1A Excavation	Subbase Material	Protective Coating for Cement Concrete Pavements and Shoulders	Patching Joint	New Pavement Joint	Concrete Pavement Patch Type "A"	Concrete Pavement Patch Type "B"	H. E. S. Pavement Patch TYPE "A"	Pavement Base Drain	Crack Cleaning and Sealing	Concrete Pavement Spall Repair	Joint Rehabilitation Type 2	Longitudinal Joint Clean and Seal	Mobilization	Insp. Fifld Office	Maint. Prot. of Traffic	Arrow Boards	COST
							Item Number Unit	0203 0003 CY	0350 0050 CY	0503 0001 SY	0530 2007 LF	0530 2008 LF	0530 2006 SY	0530 2010 SY	0530 2011 SY	0810 7000 LF	2000 0001 LF	2000 0002 SF	2500 0011 LF	2500 0050 LF	0608 0001 LS	2500 0011 LS	0607 0001 LS	0901 0201 EA.	
							Cost of Labor	6.24	12.21	.53	3.02	1.55	14.05	14.05	14.05	3.00	.33	7.32	1.48	.25	1640	1221	6107	610	
							Cost of Equipment	7.95	2.85	.47	1.40	.92	6.88	6.88	6.88	1.34	.27	1.90	1.08	.18	2040	561	561	918	
							Cost of Material	—	16.50	.66	4.07	3.80	24.27	24.27	26.14	1.27	.35	4.88	.39	.16	—	1100	11345	—	
ACTIVITY RANKING					DURATION	CREW SIZE	ACTIVITY DESCRIPTION																		
NO.	I	J	ES	TF																					
1	5	10	0	0	3	6	Mobilize and set up A1														4%	4%	4%	4%	1,324.00
2	5	30	0	10	2	6	Mobilize and set up B1														4%	4%	4%	4%	1,324.00
3	5	120	0	33	15	4	Spall repair on ramps and joint rehab., random cracks and long.jts. on ramps										187	508	3427	6273	4%	4%	4%	4%	28,879.83
4	10	15	3	0	4	4	Install drains and saw patches in A1				384					821					4%	4%	4%	4%	11,420.80
5	15	30	7	0	5	4	Saw jts. in A1 and A2 rout cracks in A1, and rout jts. in A1 and A2														4%	4%	4%	4%	1,324.00
6	15	20	7	1	3	3	Drill vert.holes and remove patches in A1	50	50												4%	4%	4%	4%	4,259.00
7	20	25	10	1	5	7	Prepare and pour patches in A1			498		48	296	202							4%	4%	4%	4%	31,540.60
8	30	40	12	0	4	4	Install drains and saw patches in B1				264					519					4%	4%	4%	4%	7,938.40
9	30	35	12	4	0	0	Dummy																		
10	25	35	15	1	0	0	Dummy																		
11	35	50	15	1	5	5	Seal transverse joints, random cracks and patch joints in A1										733		4404		4%	4%	4%	4%	19,151.61
12	25	45	15	6	0	0	Dummy																		
13	25	105	15	14	2	4	While patches cure, saw spalls in A1 and Remove and place											145			4%	4%	4%	4%	3,934.00
14	40	55	16	0	5	4	Saw joints in B1 and B2, rout cracks in B1 and rout joints in B1 and B2														4%	4%	4%	4%	1,324.00
15	40	45	16	5	0	0	Dummy																		
16	45	60	16	5	3	3	Drill vert.holes and remove patches in B1	50	50												4%	4%	4%	4%	4,259.00
17	60	65	19	5	5	7	Prepare and pour patches in B1			281			281								4%	4%	4%	4%	18,155.90
18	60	75	19	6	0	0	Dummy																		
19	50	55	20	1	0	0	Dummy																		
20	50	75	20	2	3	5	Move A1 to A2 install drains, rout random cracks in A2 and saw patches in A2 & ramps P& J				240					147					4%	4%	4%	4%	4,998.40
21	55	70	21	0	5	5	Seal transverse joints, random cracks and patch joints in B1										506		4464		4%	4%	4%	4%	19,098.26
22	75	80	23	2	3	3	Drill vert.holes and remove patches in A2 & ramps P & J														4%	4%	4%	4%	1,324.00
23	65	90	24	5	0	0	Dummy																		
24	65	105	24	7	0	0	Dummy																		
25	105	110	24	7	4	5	While patches cure saw spalls in B1 and remove and place											810			4%	4%	4%	4%	15,904.00
26	70	90	26	0	3	5	Move B1 to B2, install drains rout random cracks in B1 and saw patches B2 & ramps K & L				340					553					4%	4%	4%	4%	9,011.60
27	80	85	26	2	4	7	Prepare and pour patches in A2 and ramps P &J			350		60	127	223							4%	4%	4%	4%	22,772.00
28	80	90	26	3	0	0	Dummy																		
29	90	95	29	0	3	3	Drill vert.holes and remove patches in B2 & ramps K & L														4%	4%	4%	4%	1,324.00
30	85	95	30	2	0	0	Dummy																		
31	85	110	30	5	0	0	Dummy																		
32	110	115	30	5	10	6	While patches cure saw spalls in A1 and remove and place											1188			4%	4%	4%	4%	22,708.00
33	95	100	32	0	4	7	Prepare and pour patches in B2 and ramps K & L			287			267		20						4%	4%	4%	4%	18,760.30
34	100	120	36	0	12	8	Rout and seal ℄ jts. NB., seal trans. jts. random cracks & patch jts. in A2 & B2 & all ramps										429		9102	36967	4%	4%	4%	4%	66,385.53
35	100	115	36	9	0	0	Dummy																		
36	115	120	40	5	3	5	While patches cure saw spalls in B2 and remove and place											375			4%	4%	4%	4%	8,074.00
37	120	125	48	0	2	6	Remove signs														4%	4%	4%	4%	1,324.00
							TOTALS	100	100	1,416	1,228	108	971	425	20	2,040	1,855	3,026	21,397	43,240	100%	100%	100%	100%	326,519.23

ANSWER SHEET

EXERCISE 3: **RT 60–PAVEMENT REHABILITATION PROJECT**

PERCENT OF PROJECT COMPLETED TO DATE

WEEKLY BUDGETS FOR INCOME BASED ON ES AND EF AND PAY ITEMS

PERIOD	ACTIVITY	%	TOTAL THIS ACTIVITY	TOTAL THIS PERIOD	CUMULATIVE TOTAL	
SEPT. 4-9	5 - 10	3/3	1324	1324.00		
	10 - 15	1/4	11420.80	2855.20		
	5 - 30	2/2	1324	1324.00		
	5 - 120	4/15	28879.83	7701.29		
				13204.49	13204.49	
SEPT. 10-16	10 - 15	3/4	11420.80	8565.60		
	15 - 20	2/3	4259	2839.33		
	15 - 30	2/5	1324	529.60		
	5 - 120	5/15	28879.83	9626.61		
				21561.14	34765.63	
SEPT. 17-23	15 - 20	1/3	4259	1419.67		
	15 - 30	3/5	1324	794.40		
	30 - 40	2/4	7938.40	3969.20		
	20 - 25	4/5	31540.60	25232.48		
	5 - 120	5/15	28879.83	9626.61		
				41042.36	75807.99	
SEPT. 24-30	30 - 40	2/4	7938.40	3969.20		
	20 - 25	1/5	31540.60	6308.12		
	40 - 55	3/5	1324	794.40		
	35 - 50	4/5	19151.61	15321.29		
	45 - 60	3/3	4259	4259.00		
	25 - 105	2/2	3934	3934.00		
	5 - 120	1/15	28879.83	1925.32		
				36511.33	112319.32	
OCT. 1-7	40 - 55	2/5	1324	529.60		
	35 - 50	1/5	19151.61	3830.32		
	55 - 70	3/5	19098.26	11458.96		

EXERCISE 3: **RT 60–PAVEMENT REHABILITATION PROJECT**

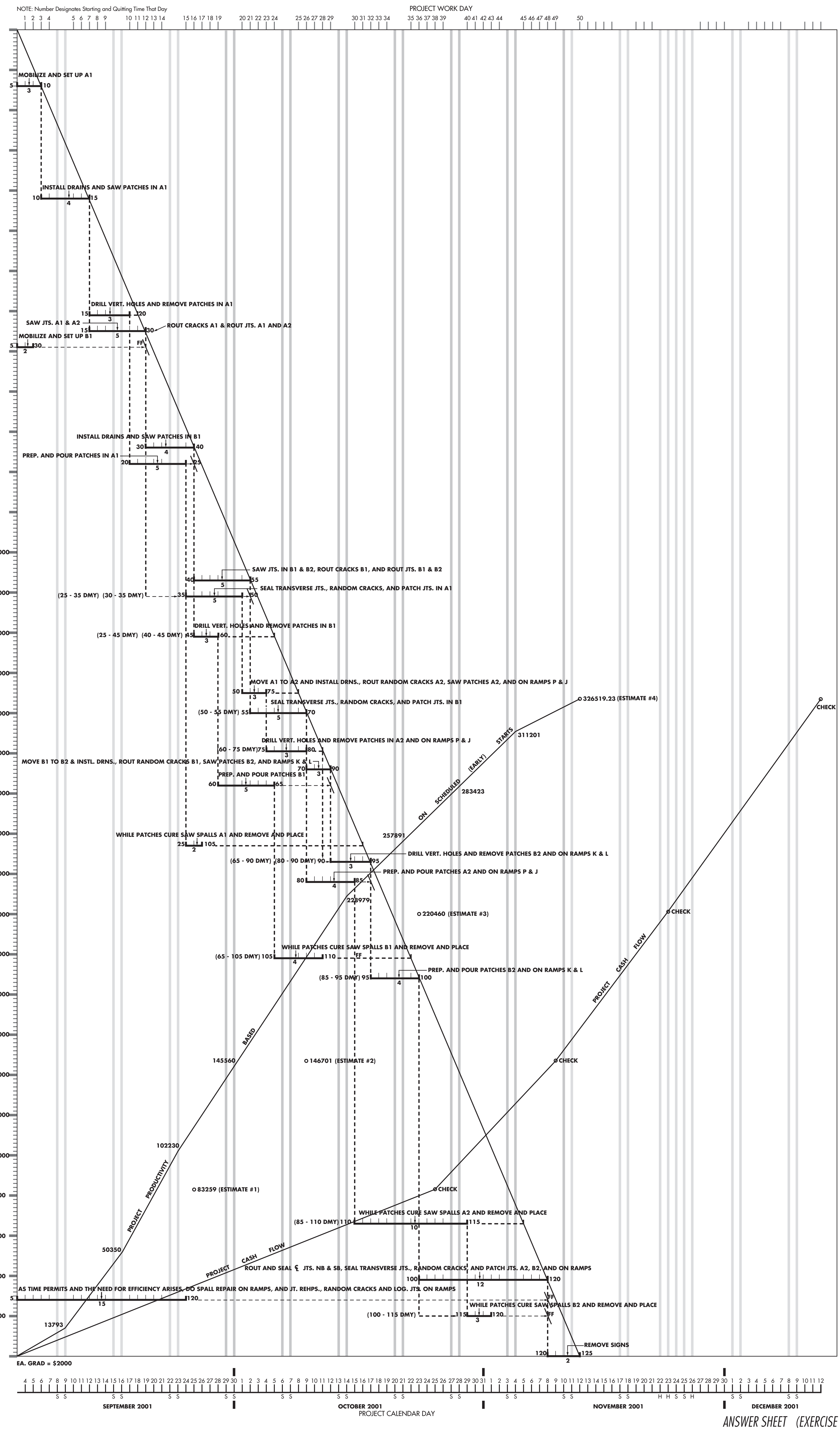
PERCENT OF PROJECT COMPLETED TO DATE

WEEKLY BUDGETS FOR INCOME BASED ON ES AND EF AND PAY ITEMS

PERIOD	ACTIVITY	%	TOTAL THIS ACTIVITY	TOTAL THIS PERIOD	CUMULATIVE TOTAL	
	50 - 75	3/3	4998.40	4998.40		
	75 - 80	1/3	1324	441.33		
	60 - 65	5/5	18155.90	18155.90		
				39414.51	151733.83	
OCT. 8-14	55 - 70	2/5	19098.26	7639.30		
	70 - 90	3/3	9011.60	9011.60		
	75 - 80	2/3	1324	382.67		
	80 - 85	3/4	22772	17079.00		
	105 - 110	4/4	15904	15904.00		
				50516.57	202250.40	
OCT. 15-21	90 - 95	3/3	1324	1324.00		
	80 - 85	1/4	22772	5693.00		
	95 - 100	2/4	18760.30	9380.15		
	110 - 115	4/10	22708	9083.20		
				25480.35	227730.75	
OCT. 22-28	95 - 100	2/4	18760.30	9380.15		
	110 - 115	5/10	22708	11354.40		
	100 - 120	3/12	66385.53	16596.38		
				37330.53	265061.28	
OCT. 29-NOV. 4	110 - 115	1/10	22708	2270.80		
	100 - 120	5/12	66385.53	27660.64		
	115 - 120	3/3	8074	8074.00		
				38005.44	303066.72	
NOV. 5-12	100 - 120	4/12	66385.53	22128.51		
	120 - 125	2/2	1324	1324.00		
				23452.51	326519.23	

EXERCISE 3: **RT 60–PAVEMENT REHABILITATION PROJECT**

MONITOR/DAILY UPDATE CHART WITH CASH FLOW



PROJECT PLANNING & SCHEDULING **WORKBOOK**

ANSWER SHEET

EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

1999 WORKDAY CALENDAR

ANSWER SHEET

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	JANUARY
FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28				FEBRUARY
MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MARCH
MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		APRIL
THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	MAY
SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		JUNE
											X	X	1	2	3	4	5	X	X	6	7	8	9	10	X	X	11	12	13		
TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	JULY
14	15	X	X	X	16	17	18	19	X	X	20	21	22	23	24	X	X	25	26	27	28	29	X	X	30	31	32	33	34	X	
THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	AUGUST
X	35	36	37	38	39	X	X	40	41	42	43	44	X	X	45	46	47	48	49	X	X	50	51	52	53	54	X	X	55	56	
SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		SEPTEMBER
57	58	59	X	X	X	60	61	62	63	X	X	64	65	66	67	68	X	X	69	70	71	72	73	X	X	74	75	76	77		
WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	OCTOBER
78	X	X	79	80	81	82	83	X	X	84	85	86	87	88	X	X	89	90	91	92	93	X	X	94	95	96	97	98	X	X	
FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	

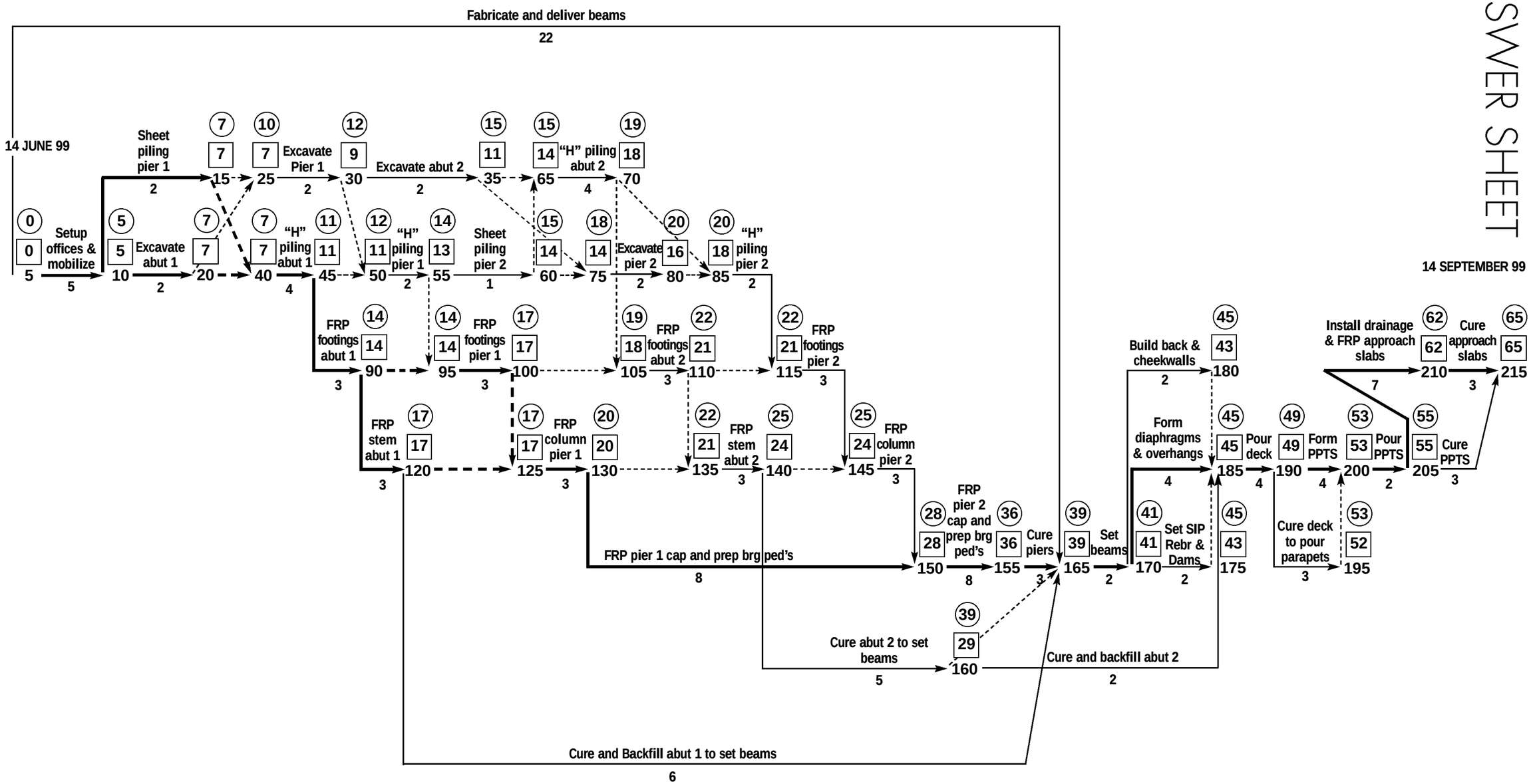
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		NOVEMBER
99	100	101	102	103	X	X	104	105	106	107	108	X	X	109	110	111	112	113	X	X	114	115	116	X		X	X				
MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	DECEMBER
WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	SAT	SUN	MON	TUE	WED	THUR	FRI	

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

NETWORK DIAGRAM

ANSWER SHEET



EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR MONITOR/DAILY UPDATE CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number: Use the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	ACTIVITY DESCRIPTION
5	10	5	0	5	0	5	0	1	
5	165	22	0	22	17	39	17	44	
10	15	2	5	7	5	7	0	2	
10	20	2	5	7	5	7	0	3	
15	25	0	7	7	10	10	3	6	
15	40	0	7	7	7	7	0	4	
20	25	0	7	7	10	10	3	7	
20	40	0	7	7	7	7	0	5	
25	30	2	7	9	10	12	3	9	
30	35	2	9	11	13	15	4	15	
30	50	0	9	9	12	12	3	10	
35	65	0	11	11	15	15	4	17	
35	75	0	11	11	18	18	7	24	
40	45	4	7	11	7	11	0	8	
45	50	0	11	11	12	12	1	11	
45	90	3	11	14	11	14	0	18	
50	55	2	11	13	12	14	1	12	
55	60	1	13	14	14	15	1	18	
55	95	0	13	13	14	14	1	14	
60	65	0	14	14	15	15	1	19	
60	75	0	14	14	18	18	4	25	
65	70	4	14	18	15	19	1	26	
70	85	0	18	18	20	20	2	32	
70	105	0	18	18	19	19	1	28	
75	80	2	14	16	18	20	4	29	

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number: Use the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	ACTIVITY DESCRIPTION
80	85	0	16	16	20	20	4	30	
85	115	2	18	20	20	22	2	33	
90	95	0	14	14	14	14	0	16	
90	120	3	14	17	14	17	0	20	
95	100	3	14	17	14	17	0	21	
100	105	0	17	17	19	19	2	27	
100	125	0	17	17	17	17	0	22	
105	110	3	18	21	19	22	1	34	
110	115	0	21	21	22	22	1	36	
110	135	0	21	21	22	22	1	37	
115	145	3	21	24	22	25	1	33	
120	125	0	17	17	17	17	0	23	
120	165	6	17	23	33	39	16	45	
125	130	3	17	20	17	20	0	31	
130	135	0	20	20	22	22	2	35	
130	150	8	20	28	20	28	0	41	
135	140	3	21	24	22	25	1	39	
140	145	0	24	24	25	25	1	40	
140	160	5	24	29	34	39	10	46	
145	150	3	24	27	25	28	1	42	
150	155	8	28	36	28	36	0	43	
155	165	3	36	39	36	39	0	48	
160	165	0	29	29	39	39	10	47	
160	185	2	29	31	43	45	14	50	
165	170	2	39	41	39	41	0	49	

EXERCISE 4: RT. 17 BRIDGE CONSTRUCTION PROJECT

ACTIVITY RANKING FORM FOR BAR CHART

5 STEPS to Rank Activities

1. Enter I – J numbers, Duration (DUR), ES and LF
2. Calculate EF = ES + DUR
3. Calculate LS = LF – DUR
4. Calculate the Total Float (TF=LS-ES = LF-EF)
5. Determine the Ranking Number: Use the earliest late finish ascending to the latest late finish. In the case of a tie, use early start first, duration second, lowest I number next and lowest J number next.

I	J	DUR.	ES	EF	LS	LF	TF	RANK	ACTIVITY DESCRIPTION
170	175	2	41	43	43	45	2	51	
170	180	2	41	43	43	45	2	52	
170	185	4	41	45	41	45	0	53	
175	185	0	43	43	45	45	2	54	
180	185	0	43	43	45	45	2	55	
185	190	4	45	49	45	49	0	56	
190	195	3	49	52	50	53	1	57	
190	200	4	49	53	49	53	0	58	
195	200	0	52	52	53	53	1	59	
200	205	2	53	55	53	55	0	60	
205	210	7	55	62	55	62	0	61	
205	215	3	55	58	62	65	7	62	
210	215	3	62	65	62	65	0	63	

EXERCISE 4: **RT. 17 BRIDGE CONSTRUCTION PROJECT**

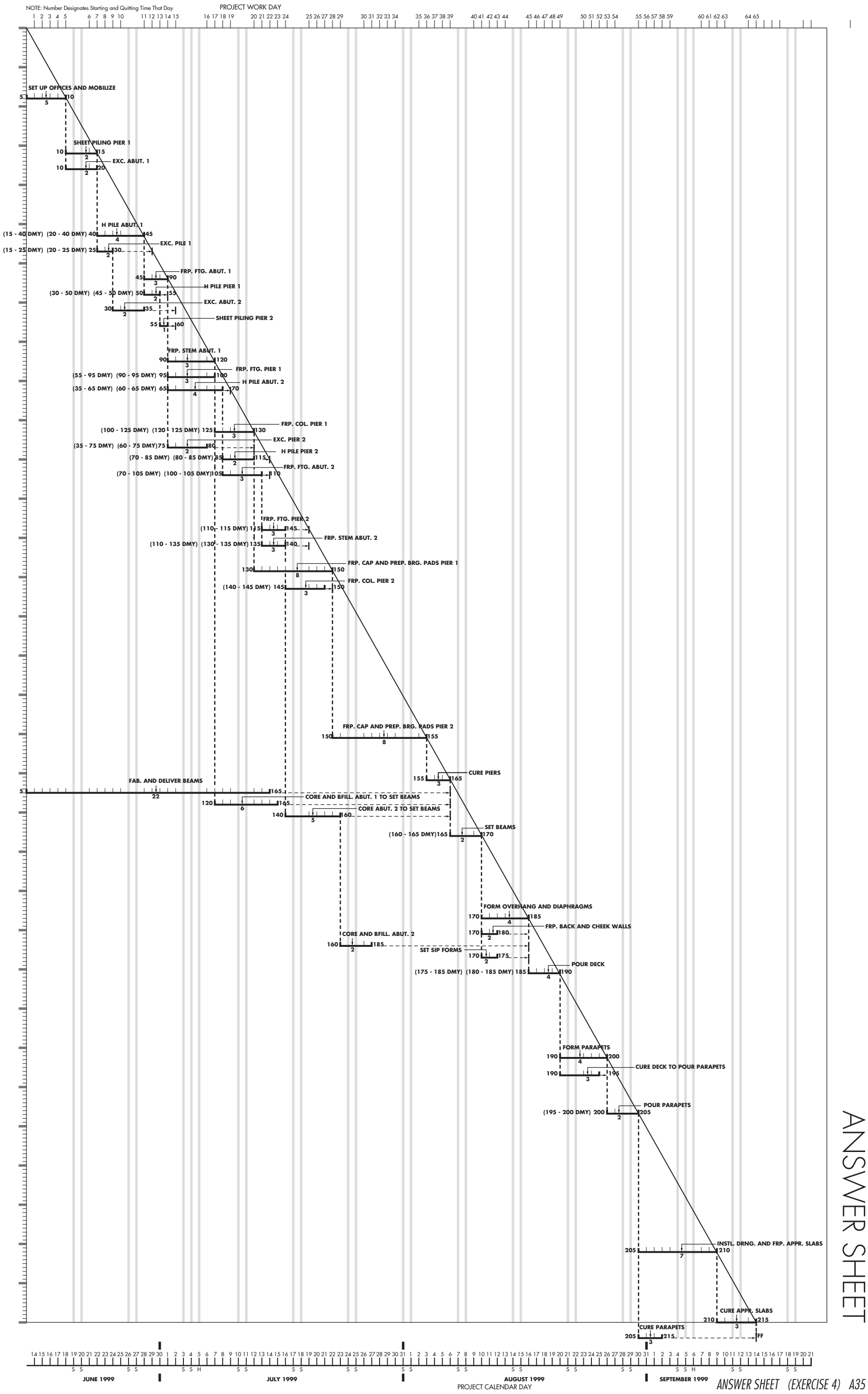
MONITOR/DAILY UPDATE CHART TALLY SHEET

1.	51.	101.	151.	201.
2.	52.	102.	152.	202.
3.	53.	103.	153.	203.
4.	54.	104.	154.	204.
5.	55.	105.	155.	205.
6.	56.	106.	156.	206.
7.	57.	107.	157.	207.
8.	58.	108.	158.	208.
9.	59.	109.	159.	209.
10.	60.	110.	160.	210.
11.	61.	111.	161.	211.
12.	62.	112.	162.	212.
13.	63.	113.	163.	213.
14.	64.	114.	164.	214.
15.	65.	115.	165.	215.
16.	66.	116.	166.	216.
17.	67.	117.	167.	217.
18.	68.	118.	168.	218.
19.	69.	119.	169.	219.
20.	70.	120.	170.	220.
21.	71.	121.	171.	221.
22.	72.	122.	172.	222.
23.	73.	123.	173.	223.
24.	74.	124.	174.	224.
25.	75.	125.	175.	225.
26.	76.	126.	176.	226.
27.	77.	127.	177.	227.
28.	78.	128.	178.	228.
29.	79.	129.	179.	229.
30.	80.	130.	180.	230.
31.	81.	131.	181.	231.
32.	82.	132.	182.	232.
33.	83.	133.	183.	233.
34.	84.	134.	184.	234.
35.	85.	135.	185.	235.
36.	86.	136.	186.	236.
37.	87.	137.	187.	237.
38.	88.	138.	188.	238.
39.	89.	139.	189.	239.
40.	90.	140.	190.	240.
41.	91.	141.	191.	241.
42.	92.	142.	192.	242.
43.	93.	143.	193.	243.
44.	94.	144.	194.	244.
45.	95.	145.	195.	245.
46.	96.	146.	196.	246.
47.	97.	147.	197.	247.
48.	98.	148.	198.	248.
49.	99.	149.	199.	249.
50.	100.	150.	200.	250.

Note: No dummies are identified on Tally Sheet.
Circled tick marks indicate critical activity

EXERCISE 4: **RT 17 BRIDGE CONSTRUCTION PROJECT**

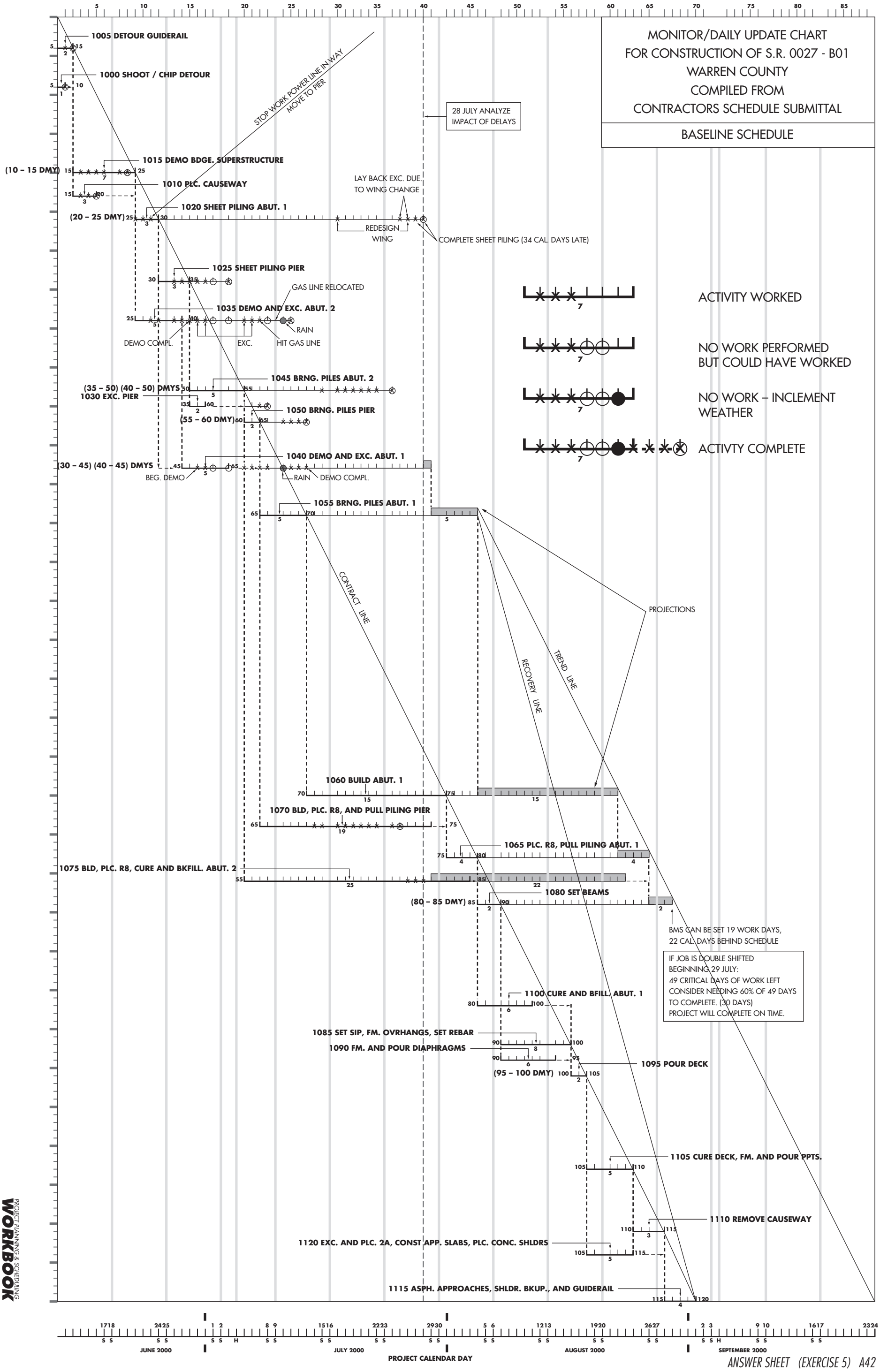
MONITOR/DAILY UPDATE CHART



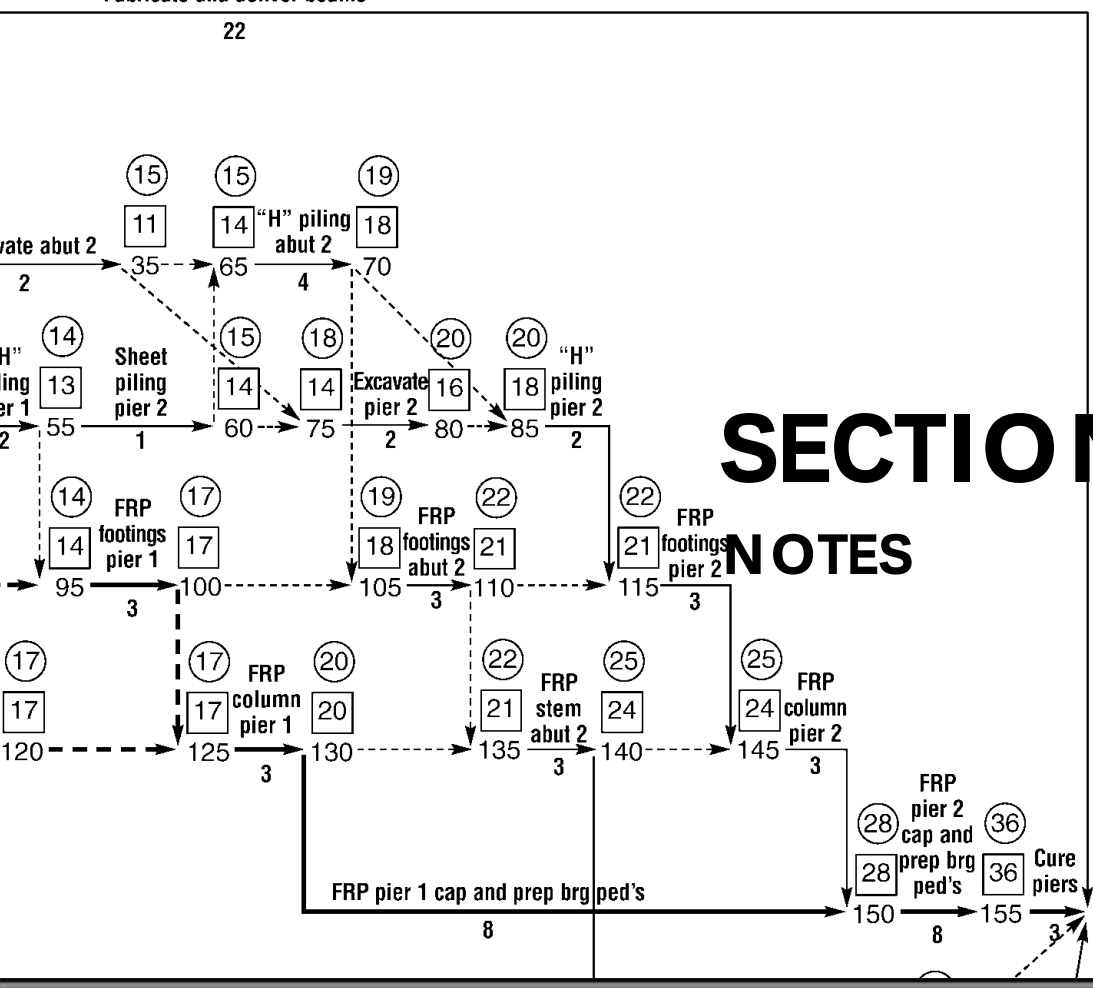
ANSWER SHEET

EXERCISE 5: **BASELINE SCHEDULE**

S.R. 0027 – B01



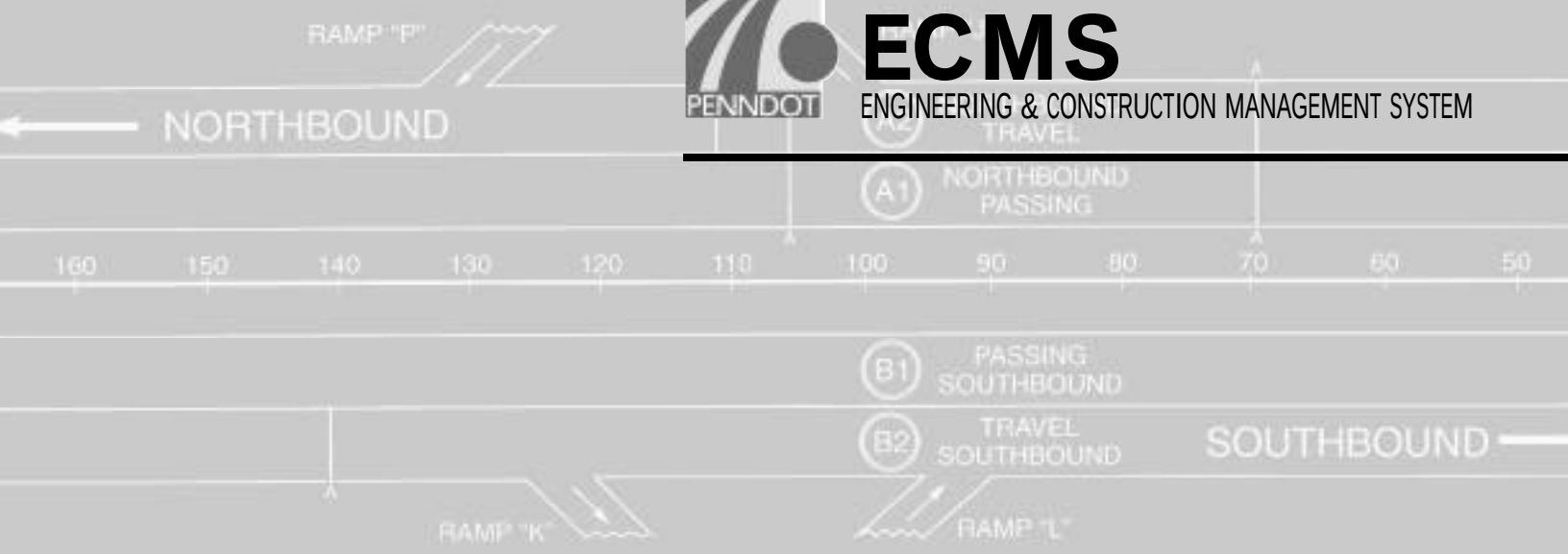
ANSWER SHEET



SECTION IV

NOTES

	281	264		281			519	506	810	4,464	16,814	(22) S. B. PASSING
	267	340		267			563	215	375	4,578		(45) S. B. TRAVEL
								26	14	658	1,421	(B) RAMP "L" (14' WIDE)
								29	36	614	1,973	(A) RAMP "J" (14' WIDE)
						20		33	96	702	1,454	(B) RAMP "K" (14' WIDE)
								29	87	733	1,425	(24) RAMP "F" (14' WIDE)
								70	275	720		AS DIRECTED
6	1,416	1,228	108	971	425	20	2,040	1,855	3,036	21,397	43,240	TOTAL



PENNDOT

ECMS

ENGINEERING & CONSTRUCTION MANAGEMENT SYSTEM