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PROCESS MAPPING OF RESIDENTIAL FOUNDATION SLAB CONSTRUCTION PROCESSES

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ABSTRACT

With the purpose of mapping residential foundation slab construction processes, the authors collected the necessary process mapping information. After the completion of the process mapping for several common residential foundation slab construction processes, the team then used the process maps to identify potential process improvements and documented these in new, revised process maps. The residential foundation slab construction process mapping effort coupled with process simulation demonstrated the existence of opportunities for residential foundation slab construction process improvements. This has motivated the homebuilder partners to further pursue the issue by developing a residential foundation slab construction process to a stage where several prototype foundation slabs can be built. This report provides information on all steps accomplished and all issues involving the process mapping effort.

1 INTRODUCTION

By virtue of its preponderant importance in satisfying the basic human need for shelter, the U.S. homebuilding industry has developed into a significant contributor to the U.S. economy. Today, homebuilding employs more than 3.5 million workers and produces approximately 1.5 million new homes (NAHB 2001), worth about $225 billion, every year. Indeed, housing investment and consumption contribute one-fifth of the US gross domestic product (Joint Center for Housing Studies, 1997) and the US housing stock has developed into the nation's largest single assets with a total value that exceeds that of the US equity markets. However, despite its importance and significance, the U.S. homebuilding industry is confronted with a multitude of persistent problems ranging from little innovation and production management difficulties, due to a fragmented nature of the industry, to regulatory hurdles and constant sales fluctuations.

The 1990's have produced a large consolidation process in the residential construction industry and resulted in a significant growth in the size of production homebuilders. These large production homebuilders have been attempting to find solutions to production management problems. For instance ways to create assembly line processes at the construction sites have been studied with the intent of implementing processes that capitalize on efficiencies inherent in such processes. Motivated by these developments and interaction with several production homebuilders, the authors of this paper decided to use process mapping aimed at obtaining a thorough understanding of the residential foundation slab construction processes being used by homebuilders in the Phoenix, AZ metro area. The process mapping study described in this paper is in fact part of a bigger effort that has been undertaken at Arizona State University. With the help of a number of supporting entities a partnership titled "Arizona Partnership for Advancing Technology in Housing (AzPath)" has been started. One of the initiatives undertaken by AzPath relates to cycle time reduction and the activity described in this paper is part of this initiative.

2 PROBLEM STATEMNENT

The residential construction process in general and the construction of residential foundation slabs in particular is characterized by significant complexity due to a large number of interrelated tasks that have to be performed by several different entities. Any research geared toward improving the current processes or toward finding alternatives must start from a position of thorough understanding of the common practice or state of the art. Thus, the first step in preparing for research geared toward improving the residential foundation slab construction process is to create process maps that depict the current practice.

3 GOAL AND OBJECTIVES

The goal of the present project was to achieve a thorough understanding of the current residential foundation slab construction process and to identify opportunities for process improvement through the creation of process maps for residential foundation slab construction processes and subsequent analysis of this data. Several objectives were determined in pursuit of this overall goal:

(1) Collect the information needed to create the process maps
(2) Identify and agree on a consistent nomenclature and symbology to be used in the process maps
(3) Create process map drafts of the processes, then submit the drafts for review by stakeholders such as homebuilders and trade contractors
(4) Finalize process maps
(5) Identify opportunities for process improvements
(6) Create process maps depicting the improved processes

4 METHODOLOGY

4.1 Information Collection

The information needed for the creation of process maps can be collected from literature sources and one or a combination of three basic methods (Damelio, 1996): (1) self-generation by the individual creating the process map; (2) one-on-one interviews with stakeholders such as suppliers, customers, etc.; and (3) group interviews with the same stakeholders. Although some information for the residential foundation slab construction process mapping effort was obtained from literature or through self-generation, one-on-one and group interviews were the major sources used to collect the information needed for the planned process maps. The AzPath research team conducted one-on-one interviews with trade contractors at their offices or at the side of AzPath meetings. Group interviews were conducted during two of AzPath's monthly meetings with its homebuilder partners.

4.2 Nomenclature and Symbology

Process maps are graphical depictions of the steps that make up a process. However, the nature of the steps composing the process can be variable. Thus, in useful process maps that help recognize process inefficiencies, representative symbols that visually designate activities, buffers, transportation, communication, decisions, and other operations are used. Descriptions added to these symbols can provide further information on the type of activity, inspection, etc. being performed. In the process map, arrows connect each symbol in sequence.

For the residential foundation slab construction process mapping effort, it was decided to utilize symbology provided in the MS® Visio® TQM template. The most important symbols used in the residential foundation slab construction process maps are reproduced in Figure 1 below.

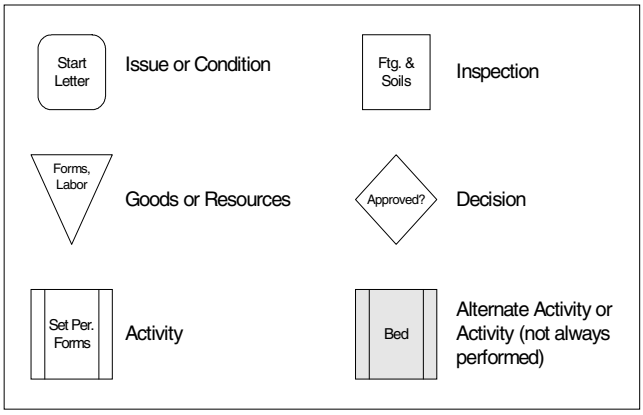

Figure 1: Process Mapping Symbology

Two of the more common symbols, for instance, are the rounded square (denoting an issue, a condition, or communication) and the square with two lines close to the vertical edges (denoting an activity). Symbols with a gray background denote alternatives or operations that are not always performed in the process, but that still need to be mapped.

4.3 Cross-Functional Process Map

The type of process map used in the residential foundation slab construction process mapping effort is the Cross-Functional Process Map. Cross-Functional Process Maps depict how an organization's work processes cut across several functions or entities (Damelio, 1996). This type of process map shows the sequence of steps of the process, as well as the functions or entities that are responsible for these steps. It should be noted that the functions or entities can be from within one company–such as different departments of the same company–or, as in the case of processes in the homebuilding industry, from several companies–such as the homebuilder, trade contractors, and the city inspectors, etc. This type of identification of responsible parties in the case of homebuilding processes is in fact a very useful mechanism that helps identify complexities involved in the construction process.

In Cross-Functional Process Maps, one row, or swimlane as it is sometimes referred to, is designated for each function or entity. Everything this function or entity is responsible for will be depicted in this row of the process map. Figure 2 depicts a sample cross-functional process map for illustration purposes. The rows or swim lanes pro-

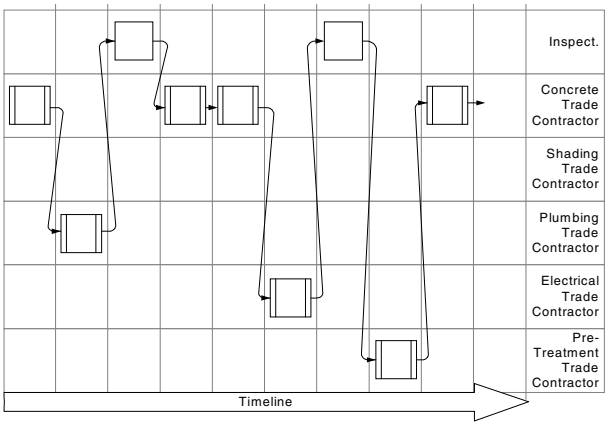

Figure 2: Example of a Cross-Functional Process Map

vided in the figure list the functions or entities involved in the process under consideration. The process map is drawn using a left-to-right sequence with the timeline displayed along the horizontal axis.

5 PROCESS MAPS

5.1 Current Practice Maps

Three different types of residential foundation slab construction processes were found to be commonly used by homebuilders in the Phoenix metro area. The process map for the first, referred to as the "Traditional Stem and Slab" is depicted in Figure 3 below. The second process, the so-called "Semi-Monolithic Slab" construction process, is mapped in Figure 4, while the third, the "Post-Tensioned Slab" is mapped in Figure 5.

5.2 Process Maps with Suggested Changes

After the completion of the process maps depicting the current practice of residential foundation slab construction processes used by the homebuilders in the Phoenix metro area, the process maps were analyzed to identify potential sources of improvement to the processes. It was found that the current residential foundation slab construction processes contained a large number of hand-offs between functions or entities, which are often the source of delays and other inefficiencies. Many of those were related to hand-offs before and after inspections.

Although it was contemplated to produce process maps for the residential foundation slab construction processes using outsourced inspections as one potential improvement, it was decided to focus on improvements in activities and hand-offs performed by the trade contractors because these could more realistically be implemented. The processes with the largest potential for improvement were found to be the traditional stem-and-slab and the semi-monolithic slab construction processes. Process maps depicting these two processes with the suggested changes were produced by the AzPath research

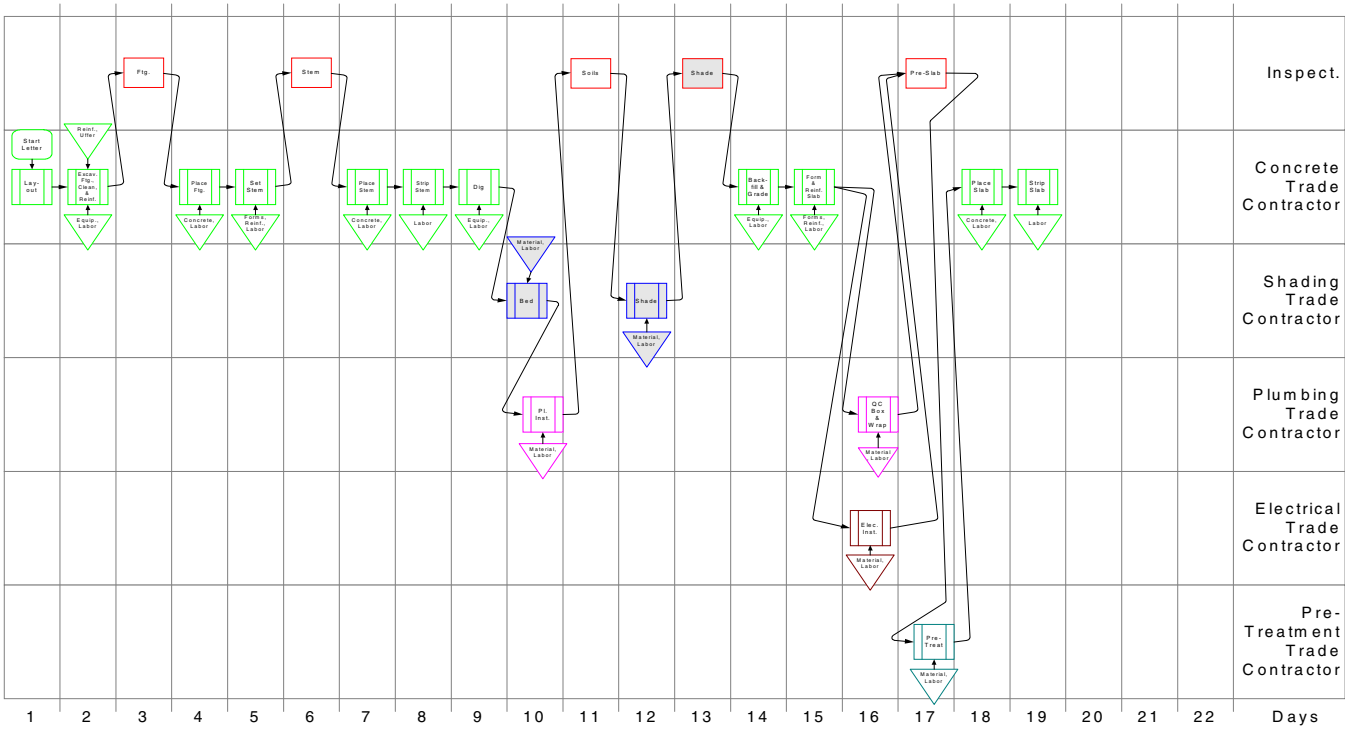

Figure 3: Process Map of the "Typical Stem and Slab" Foundation Construction Process

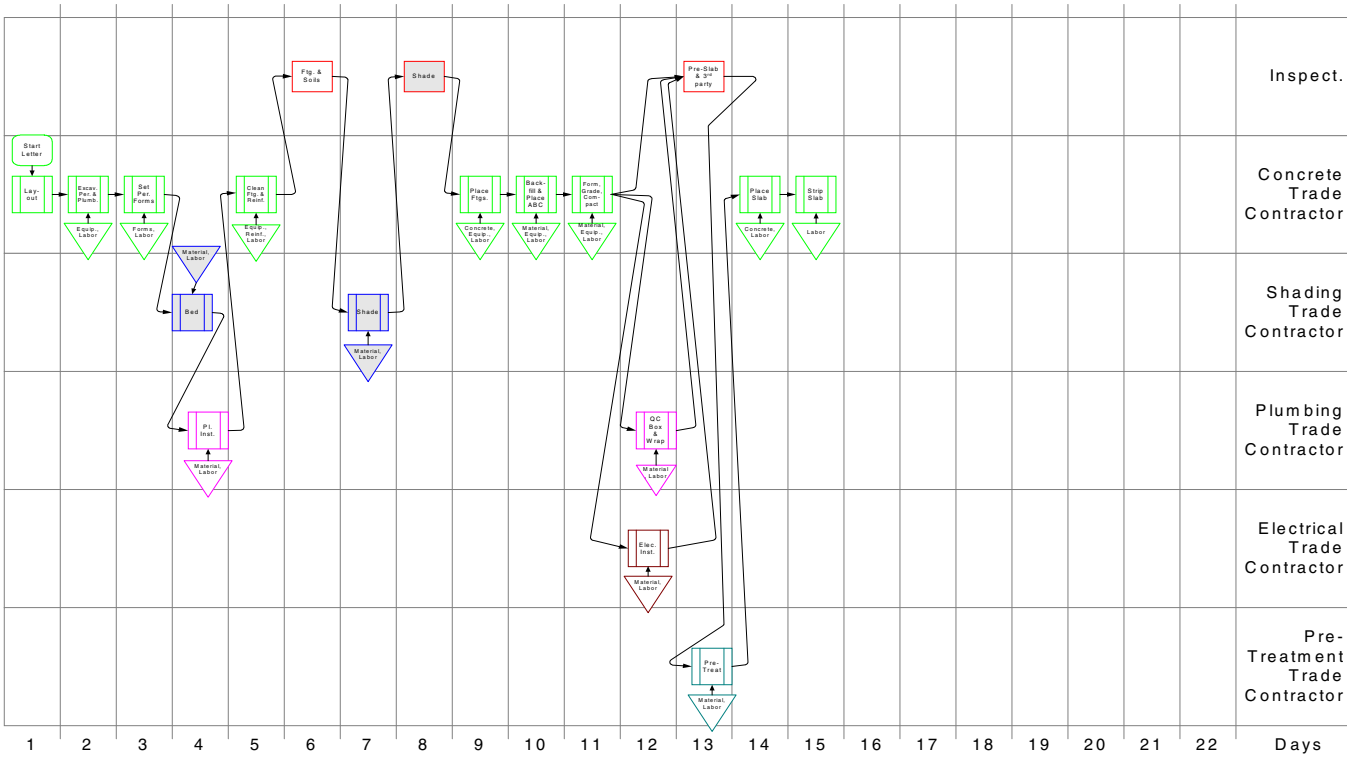

Figure 4: Process Map of the "Semi-Monolithic Slab" Foundation Construction Process

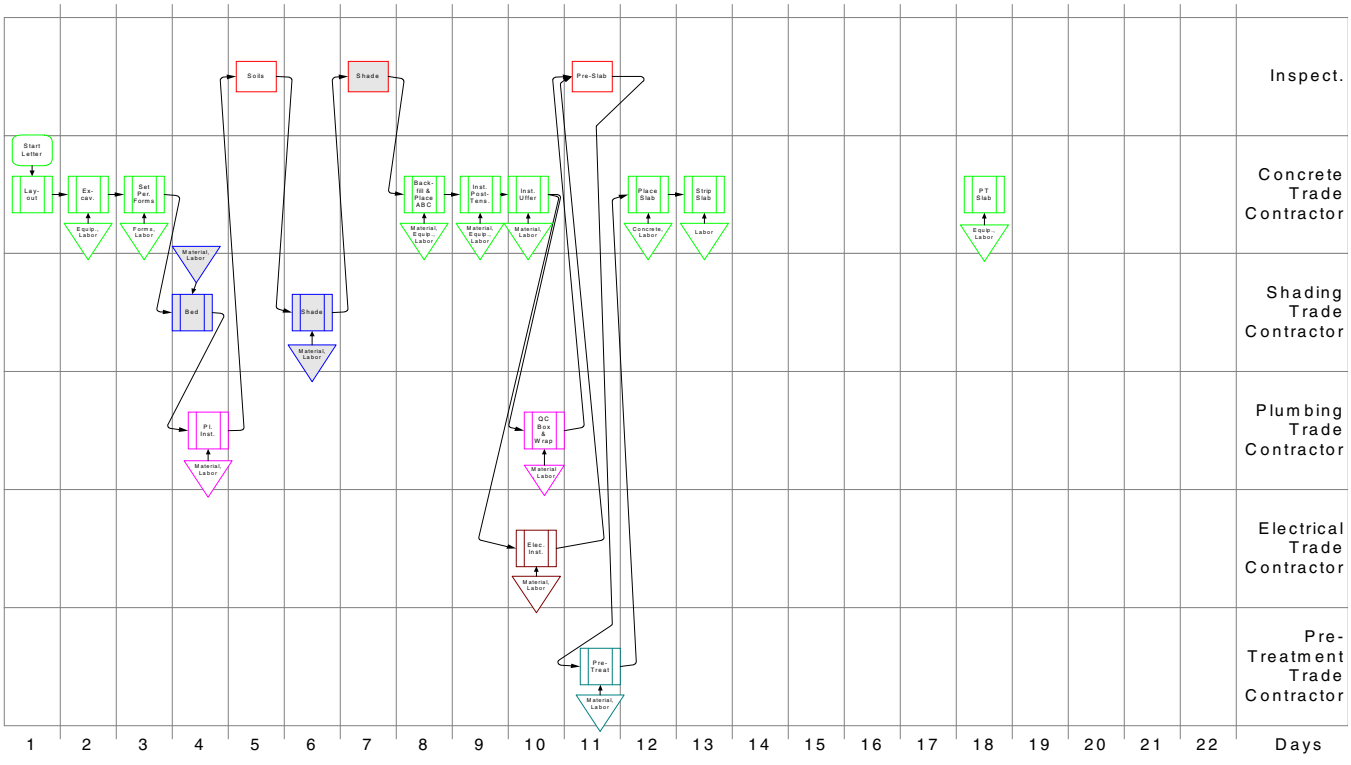

Figure 5: Process Map of the "Post-Tensioned Slab" Foundation Construction Process

team and presented to the homebuilders at one of AzPath's monthly meetings. These two process maps are depicted in Figure 6 and Figure 7 respectively.

5.3 Discussion

The process maps developed for the current residential foundation slab construction processes clearly demonstrated the large number of hand-offs (between functions or entities), which are a potential source of delays or other inefficiencies. Also, inspections were found to consume significant time because the uncertainty of the time of day when inspections are performed requires homebuilders to schedule an entire day for each inspection although inspections take only a short time (in the order of minutes) to do. The AzPath research team extensively discussed means of improving the situation caused by the current inspection system but, for the purpose of improvement suggestions to the residential foundation slab construction processes, had to discard the inspection related improvements because they involved entities outside of the AzPath partnership. Improvements thus focused on reducing the number of hand-offs by combining activities and, where possible, changing activity sequences. This resulted in reduced construction schedules for the new residential foundation slab construction processes. For instance, for a stem and slab foundation, the schedule was reduced by six (6) workdays from nineteen (19) to thirteen (13) workdays. For the semi-monolithic slab foundation, the schedule was reduced from fifteen (15) to eleven (11) workdays, a reduction of almost one (1) week.

The residential foundation slab construction process mapping effort conducted by AzPath demonstrated the existence of opportunities for residential foundation slab construction process improvements. This has motivated the AzPath homebuilder partners to further pursue the issue by developing a residential foundation slab construction process to a stage where several prototype foundation slabs can be built. A separate report will be produced to document these follow-up activities and the experiences gained from the prototyping effort.

6 CONCLUSION

The present project contributed to a thorough understanding of the current residential foundation slab construction processes through the development of process maps. The process mapping effort also demonstrated the existence of opportunities for residential foundation slab construction process improvements. Yogi Bera once said that you could observe a lot just by watching. In this spirit, detailed process maps can create opportunities to improve a lot just by looking. New process maps depicting suggested alternative

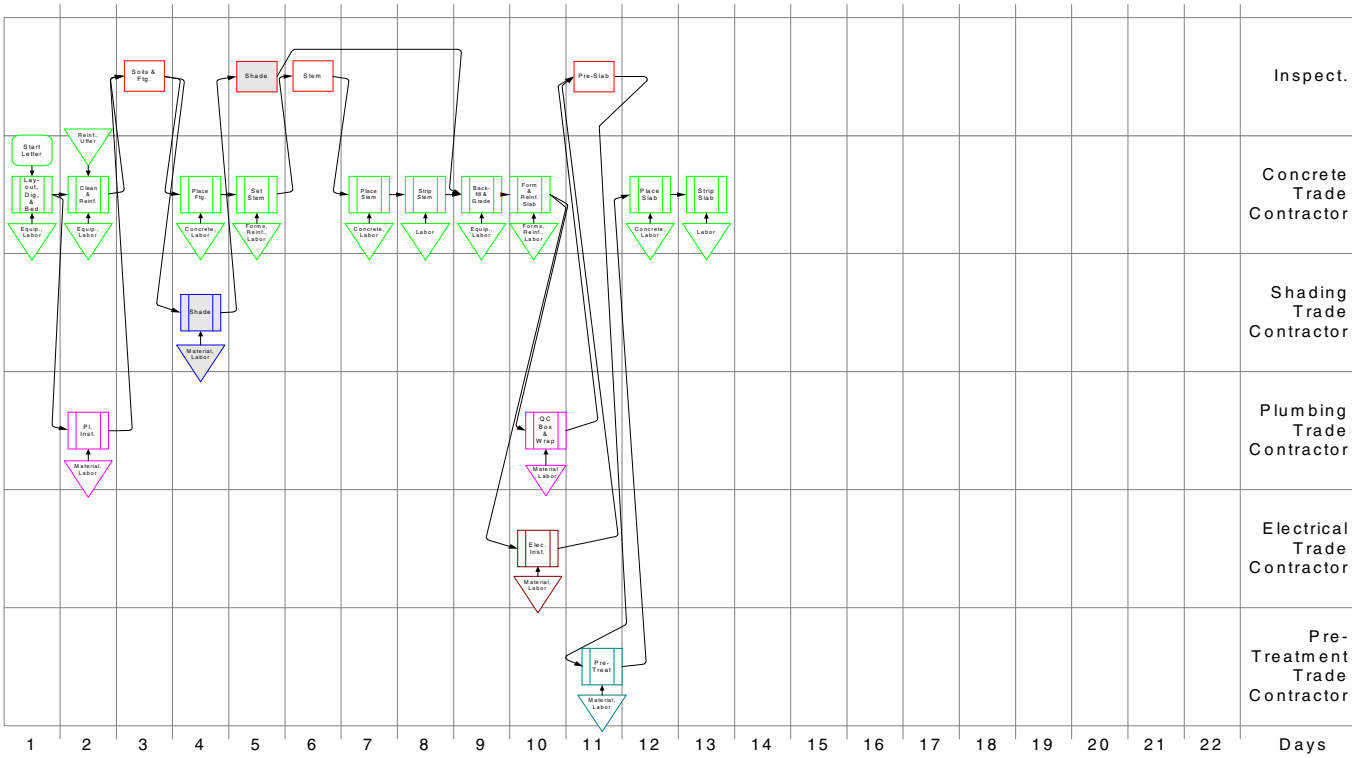

Figure 6: Process Map of the Suggested "Stem and Slab" Foundation Construction Process

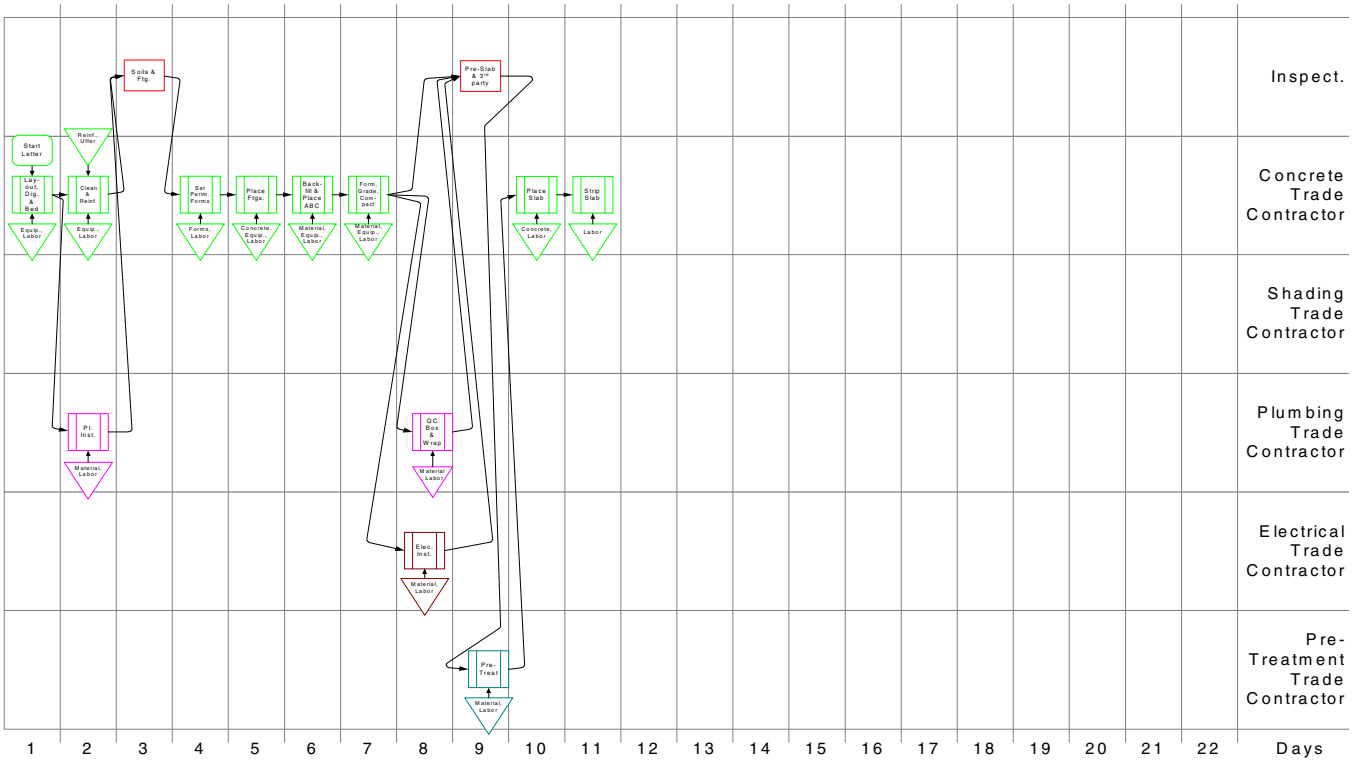

Figure 7: Process Map of the Suggested "Semi-Monolithic Slab" Foundation Construction Process

or new residential foundation slab construction processes documented these potential improvements. The objectives of the process mapping effort, which included the collection of information needed for the process maps, the identification of a consistent symbology to be used in the process maps, the development of residential foundation slab construction process maps, the identification of potential sources of improvement to the processes mapped, and the development of process maps depicting improved residential foundation slab construction processes, were accomplished.

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