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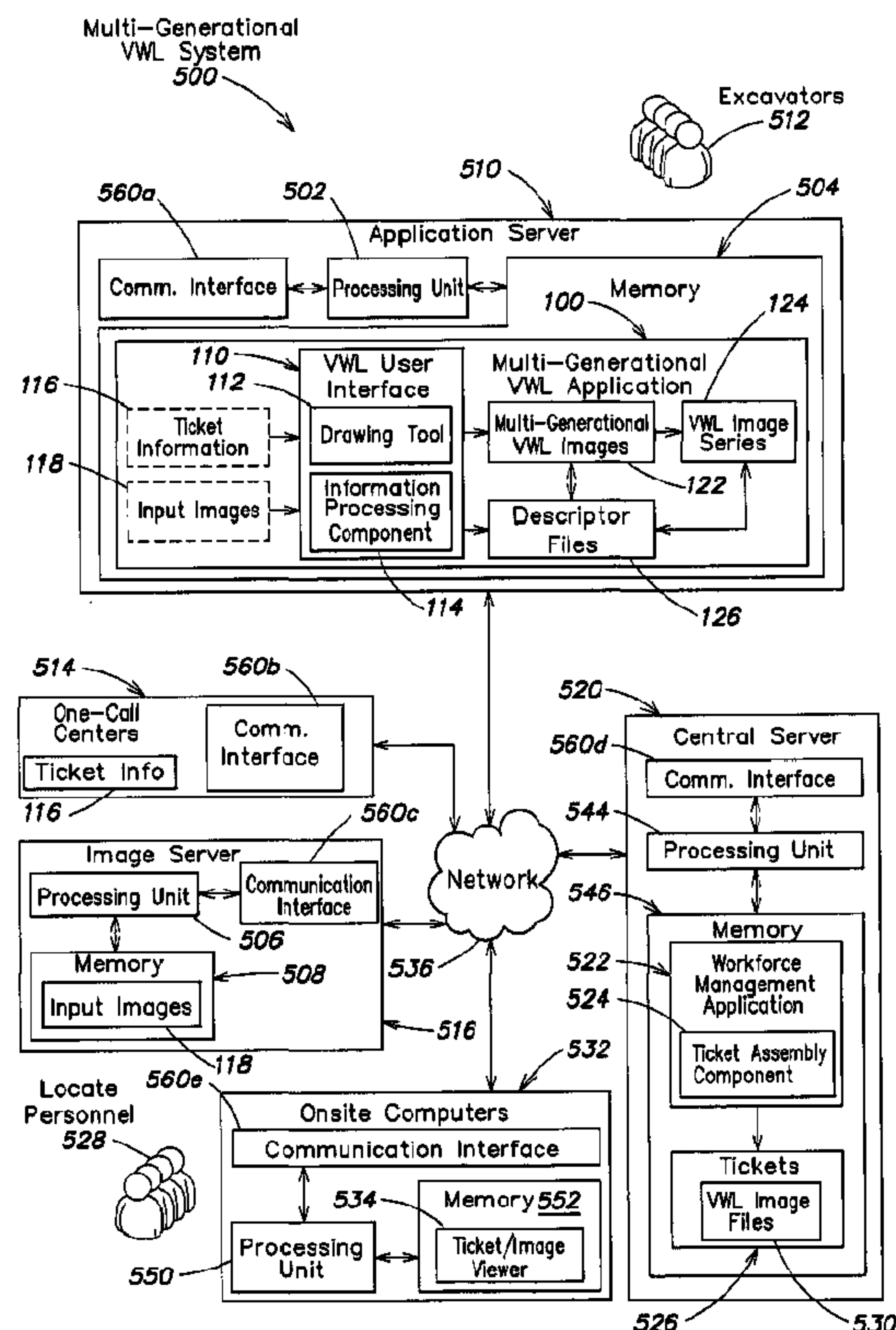
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(54) Titre : SYSTEMES, PROCEDES ET APPAREIL CONCERNANT LA GENERATION, LA TRANSMISSION, L'ACCES ET LE STOCKAGE D'IMAGES ET DE DONNEES DE LIGNE BLANCHE VIRTUELLE (VWL) POUR DES PROJETS DE FOUILLES

(54) Title: SYSTEMS, METHODS AND APPARATUS RELATING TO GENERATION, TRANSMISSION, ACCESS AND STORAGE OF VIRTUAL WHITE LINE (VWL) IMAGES AND DATA FOR EXCAVATION PROJECTS



(57) Abrégé/Abstract:

Systems, methods and apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area. Source data representing one or more input images of a geographic area including the dig area is electronically received



(57) **Abrégé(suite)/Abstract(continued):**

at a first user location, which may be remote from the dig area. The source data is processed so as to display at least a portion of the input image(s) on a display device. One or more indicators are added to the displayed input image(s), via a user input device associated with the display device, to provide at least one indication of the dig area and thereby generate a marked-up digital image. In one example of a staged excavation project, the input image, or a plurality of associated images, may be marked-up to include multiple dig area indicators corresponding to multiple stages of the staged excavation project.

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(54) Title: SYSTEMS, METHODS AND APPARATUS RELATING TO GENERATION, TRANSMISSION, ACCESS AND STORAGE OF VIRTUAL WHITE LINE (VWL) IMAGES AND DATA FOR EXCAVATION PROJECTS

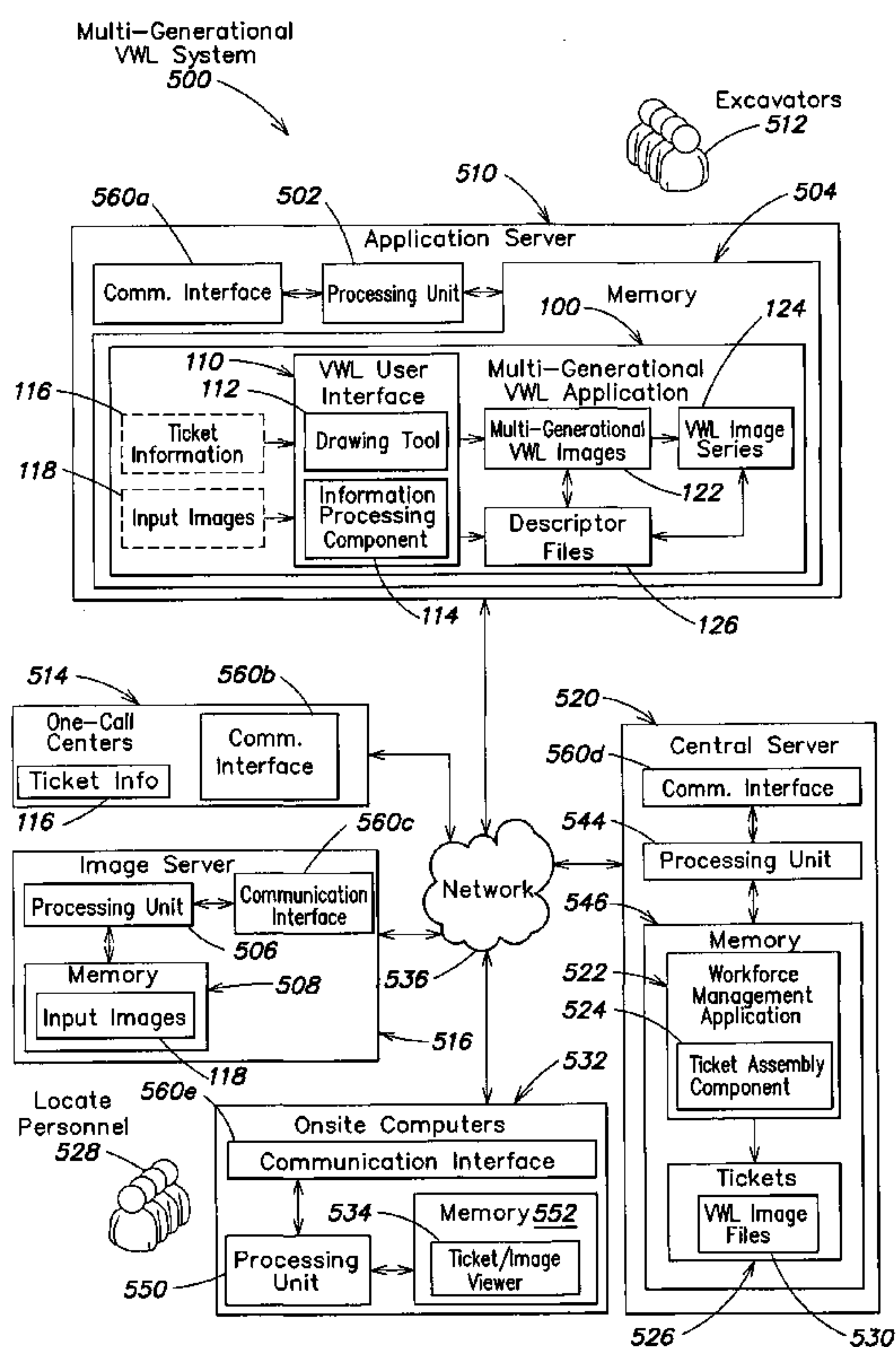


FIG. 5

(57) Abstract: Systems, methods and apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area. Source data representing one or more input images of a geographic area including the dig area is electronically received at a first user location, which may be remote from the dig area. The source data is processed so as to display at least a portion of the input image(s) on a display device. One or more indicators are added to the displayed input image(s), via a user input device associated with the display device, to provide at least one indication of the dig area and thereby generate a marked-up digital image. In one example of a staged excavation project, the input image, or a plurality of associated images, may be marked-up to include multiple dig area indicators corresponding to multiple stages of the staged excavation project.

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**SYSTEMS, METHODS AND APPARATUS RELATING TO GENERATION,
TRANSMISSION, ACCESS AND STORAGE OF VIRTUAL WHITE LINE (VWL)
IMAGES AND DATA FOR EXCAVATION PROJECTS**

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Background

[0001] Excavators are required to notify underground facility owners in advance of their excavation activities and to describe and communicate the geographic area of those activities to the underground facility owners. As a result, excavators may submit a work order (i.e., locate request or ticket) to, for example, a one-call center, which serves as
10 notification to underground facility owners. A locate request (or ticket) may be any communication or instruction to perform a locate operation at a certain dig area, which is any specified geographic area within which excavation may occur. One call centers may receive locate requests from excavators via electronic delivery or verbally through a telephone conversation between the excavator and a human call center operator. Whether
15 communicated electronically or verbally, excavators must describe the planned geographic locations of dig areas. This description may be ultimately reduced to text, which, along with other data about a locate request, is communicated to the appropriate locate service provider.

[0002] Textual descriptions of dig areas can be very imprecise as to exact physical
20 locations. In addition, addresses which are provided may be unclear, indicating only cross streets and vague descriptions of the extent of the dig area. Therefore, when a locate request is submitted by an excavator, it may be beneficial for the excavator to supplement the locate request with a visit to the site of the dig area for the purpose of delimiting and/or otherwise indicating the particular geographic location of the proposed excavation. For
25 example, marks may be used to physically delimit a dig area. These marks may consist of chalk or paint that is applied to the surface of the ground, and are generally known as “white lines.” The delimited dig area indicates to a locate technician the extent of the boundaries where a locate operation is to be performed according to the locate request that was submitted by the excavator.

30 [0003] However, the use of these physical white lines to physically delimit the dig area may be limited. For example, these physical white lines provide only a temporary

indication of the dig area, as the physical white lines may deteriorate or be eliminated over time by such events as precipitation, excessive pedestrian or vehicle traffic, erosion, the excavation process, or numerous other events. Therefore, a need exists for improved ways of delimiting and/or otherwise indicating the proposed excavation site in a more permanent and/or reproducible manner.

[0004] Further, certain excavation projects may be suitably large to require that locate operations be performed in multiple stages and/or phases over a period of time. In one example, an excavation project along several miles of a highway may be performed over several days, weeks, and/or months. In another example, an excavation project of a large residential or commercial subdivision again may be performed over several days, weeks, and/or months. The request for locate operations with respect to a multiple-stage excavation project that spans a period of time may be submitted via multiple individual tickets. Alternatively, this request for may be submitted under a single ticket, which is hereafter referred to as a "project ticket." The locate operations with respect to multiple-stage excavation projects must be coordinated between excavators and locate personnel, such as locate technicians. For example, throughout the multiple stages of the excavation project, there may be communication between excavators and locate technicians about the location of the respective subsections of the overall dig area to be located and about the timing of the respective locate operations. Further, at each stage of the project, excavators may delimit and/or otherwise indicate the respective subsections of the overall dig area to be located using physical white lines.

[0005] Currently, with respect to multiple-stage excavation projects, the communication process between excavators and locate technicians may be poorly coordinated due to poor infrastructure and, therefore, the day-to-day activities of excavators and locate personnel may be poorly synchronized. As a result, there is a risk of locate operations occurring at the wrong subsections of the project dig area and/or at the wrong times. This leads to poor operating efficiencies and, perhaps, lost profit with respect to both excavation companies and locate companies. Furthermore, excavators may perform the planned excavation with a certain amount of uncertainty as to whether a certain locate operation of the project ticket is complete and with limited confidence that the certain locate operation of the project ticket has been performed satisfactorily. As a result, there is a certain amount of risk of damage to underground facilities.

[0006] Consequently, a need exists for improved synchronization between excavators and locate personnel with respect to multiple-stage excavation projects in order to better coordinate the day-to-day activities, thereby improving operating efficiency. Further, a need exists for improved communication mechanisms between excavators and locate personnel with respect to project tickets in order to improve efficiency; reduce uncertainty and, thereby, reduce the risk of damage to underground facilities; and improve information exchange for making better and more timely decisions with respect to allocating resources.

Summary

[0007] Various embodiments of the inventive subject matter disclosed herein relate to systems, methods and apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area. More specifically, various embodiments are directed to creating an electronic record relating to a geographic area including one or more dig areas to be excavated or otherwise disturbed. As part of the electronic record, the dig area(s) is/are somehow identified with respect to its/their immediate surroundings in the geographic area.

[0008] For example, to create such an electronic record, one or more input images relating to the geographic area including the dig areas may be utilized. In particular, in some exemplary embodiments, source data representing one or more input images of a geographic area including the dig area is electronically received at a first user location, which may be remote from the dig area. The source data is processed so as to display at least a portion of the input image(s) on a display device. One or more indicators are added to the displayed input image(s), via a user input device associated with the display device, to provide at least one indication of the dig area (“a dig area indicator”) and thereby generate one or more marked-up digital images constituting at least a portion of the electronic record.

[0009] In some implementations of the inventive concepts disclosed herein, the electronic record may include a variety of non-image information, such as to facilitate identification of one or more dig areas and/or provide information concerning a multi-stage excavation process. Such non-image information may include, for example, a text description of the dig area(s), an address or lot number of a property within which the dig area(s) is located, geo-encoded information such as geographic coordinates relating to the

dig area(s) and/or various aspects of the geographic area surrounding the dig area(s), one or more ticket numbers, etc. The marked-up image(s) and the non-image information may be formatted in a variety of manners in the electronic record; for example, in one implementation the non-image information may be included as metadata associated with the marked-up image(s), while in other implementations the marked-up image(s) and the non-image information may be formatted as separate data sets. These separate data sets may be transmitted and/or stored separately, but may nonetheless be linked together in some manner as relating to a common electronic record.

[0010] In some exemplary embodiments relating to a staged excavation project, an input image, or a plurality of associated images, may be marked-up to include multiple dig area indicators, in some cases corresponding to multiple stages of the staged excavation project. In other exemplary implementations, one or more marked-up digital images may be electronically bundled with information from a corresponding locate request ticket. A descriptor file may be used to identify one or more marked-up images corresponding to such a ticket. In yet other exemplary implementations, a limited access file comprising information relating to one or more marked-up images may be transmitted (e.g., as part of a ticket bundle) to at least one party associated with the at least one underground facility. In one aspect of this example, the limited access file may be configured so as to facilitate viewing of the digital marked-up image(s) only via a corresponding image file viewer which, for example, may prevent write access, save access, and/or copy access to the limited access file.

[0011] In sum, one embodiment described herein is directed to a method for facilitating detection of a presence or an absence of at least one underground facility within a plurality of dig areas comprising a first dig area and at least one additional dig area, wherein at least a portion of the plurality of dig areas may be excavated or disturbed during excavation activities. The method comprises: A) electronically receiving source data representing at least one input image of a geographic area including the first dig area and the at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project; B) processing the source data so as to display at least a portion of the at least one input image on a display device; C) adding, via at least one user input device associated with the display device, at least one first indicator

to the displayed at least one input image to provide at least one indication of the first dig area and thereby generate a first generation marked-up digital image; D) adding, via the at least one user input device, at least one additional indicator to the first generation marked-up digital image to provide at least one indication of the at least one additional dig area and thereby generate a multi-generational marked-up digital image; and E) electronically transmitting and/or electronically storing information relating to the multi-generational marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the plurality of dig areas.

[0012] Another embodiment is directed to at least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The method comprises: A) electronically receiving source data representing at least one input image of a geographic area including the first dig area and the at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project; B) processing the source data so as to display at least a portion of the at least one input image on a display device; C) receiving at least one first user input via at least one user input device associated with the display device; D) adding, based on the at least one first user input, at least one first indicator to the displayed at least one input image to provide at least one indication of the first dig area and thereby generate a first generation marked-up digital image; E) receiving at least one second user input via the at least one user input device; F) adding, based on the at least one second user input, at least one additional indicator to the first generation marked-up digital image to provide at least one indication of the at least one additional dig area and thereby generate a multi-generational marked-up digital image; and G) electronically transmitting and/or electronically storing information relating to the multi-generational marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the plurality of dig areas.

[0013] Another embodiment is directed to an apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at

least a portion of the dig area may be excavated or disturbed during excavation activities. The apparatus comprises: a communication interface; a display device; at least one user input device; a memory to store processor-executable instructions; and a processing unit coupled to the communication interface, the display device, the at least one user input device, and the memory, wherein upon execution of the processor-executable instructions by the processing unit. The processing unit: controls the communication interface to electronically receive source data representing at least one input image of a geographic area including the first dig area and the at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project; controls the display device to display at least a portion of the at least one input image; acquires at least one first user input from the at least one user input device; generates a first generation marked-up digital image including at least one first indicator overlaid on the at least one input image to provide at least one indication of the first dig area; acquires at least one second user input from the at least one user input device; generates a multi-generational marked-up digital image including at least one additional indicator overlaid on the first generation marked-up digital image to provide at least one indication of the at least one additional dig area; and further controls the communication interface and/or the memory to electronically transmit and/or electronically store information relating to the multi-generational marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the plurality of dig areas.

[0014] Another embodiment is directed to a method for facilitating detection of a presence or an absence of at least one underground facility within a plurality of dig areas comprising a first dig area and a second dig area, wherein at least a portion of the first and second dig areas may be excavated or disturbed during excavation activities. The method comprises: A) electronically receiving first source data representing a first input image of a geographic area including a first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project; B) processing the first source data so as to display at least a portion of the first input image on the display device; C) adding, via at least one user input device associated with the display device, at least one first indicator to the displayed first input image to provide at least one indication of the first dig area and

thereby generate a first marked-up digital image; D) electronically receiving second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project; E) processing the second source data so as to display at least a portion of the second input image on the display device; F) adding, via the at least one user input device, at least one second indicator to the displayed second input image to provide at least one indication of the second dig area and thereby generate a second marked-up digital image; and G) electronically transmitting and/or electronically storing first information relating to the first marked-up digital image together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

[0015] A further embodiment is directed to at least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The method comprises: A) electronically receiving first source data representing a first input image of a geographic area including a first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project; B) processing the first source data so as to display at least a portion of the first input image on the display device; C) receiving at least one first user input via at least one user input device associated with the display device; D) adding, based on the at least one first user input, at least one first indicator to the displayed first input image to provide at least one indication of the first dig area and thereby generate a first marked-up digital image; E) electronically receiving second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project; F) processing the second source data so as to display at least a portion of the second input image on the display device; G) receiving at least one second user input via the at least one user input device; H) adding, based on the at least one second user input, at least one second indicator to the displayed second input image to provide at least one indication of the second dig area and thereby generate a second marked-up digital image; and I) electronically transmitting and/or electronically storing first information relating to the first marked-up digital image

together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

[0016] Another embodiment is directed to an apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The apparatus comprises: a communication interface; a display device; at least one user input device; a memory to store processor-executable instructions; and a processing unit coupled to the communication interface, the display device, the at least one user input device, and the memory, wherein upon execution of the processor-executable instructions by the processing unit. The processing unit: controls the communication interface to electronically receive first source data representing a first input image of a geographic area including a first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project; controls the display device to display at least a portion of the first input image on the display device; acquires at least one first user input from the at least one user input device; generates a first marked-up digital image including at least one first indicator overlaid on the first input image to provide at least one indication of the first dig area; controls the communication interface to electronically receive second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project; controls the display device to display at least a portion of the second input image on the display device; acquires at least one second user input from the at least one user input device; generates a second marked-up digital image including at least one second indicator overlaid on the second input image to provide at least one indication of the second dig area; and further controls the communication interface and/or the memory to electronically transmit and/or electronically store first information relating to the first marked-up digital image together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

[0017] Another embodiment is directed to an apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities.

The apparatus comprises a communication interface; a memory to store processor-executable instructions; and a processing unit coupled to the communication interface and the memory. Upon execution of the processor-executable instructions by the processing unit, the processing unit digitally searches the memory to identify a descriptor file
 5 corresponding to a ticket; based on identifying information in the descriptor file, identifies at least one image corresponding to the ticket, the at least one image comprising at least one indication of at least one dig area; electronically bundles the at least one image with ticket information from the ticket to generate the ticket bundle; and provides the ticket bundle to at least one party associated with the at least one underground facility.

10 **[0018]** Another embodiment is directed to at least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The method comprises A) digitally searching a
 15 memory to identify a descriptor file corresponding to a ticket; B) based on identifying information in the descriptor file, digitally searching for at least one image corresponding to the ticket, the at least one image comprising at least one indication of at least one dig area; C) electronically bundling the at least one image with ticket information from the ticket to generate a ticket bundle; and D) providing the ticket bundle to at least one party
 20 associated with the at least one underground facility.

[0019] A further embodiment is directed to a method for facilitating detection of a presence or an absence of at least one underground facility within at least one dig area, wherein at least a portion of the at least one dig areas may be excavated or disturbed during excavation activities. The method comprises A) digitally searching a memory to
 25 identify a descriptor file corresponding to a ticket; B) based on identifying information in the descriptor file, digitally searching for at least one image corresponding to the ticket, the at least one image comprising at least one indication of at least one dig area; C) electronically bundling the at least one image with ticket information from the ticket to generate a ticket bundle; and D) providing the ticket bundle to at least one party associated
 30 with the at least one underground facility.

[0020] Another embodiment is directed to an apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at

least a portion of the dig area may be excavated or disturbed during excavation activities. The apparatus comprises a communication interface; a memory to store processor-executable instructions; and a processing unit coupled to the communication interface and the memory. Upon execution of the processor-executable instructions by the processing unit, the processing unit: electronically receives, via the communication interface, at least one image corresponding to at least one ticket or at least one link to the at least one image, the at least one image comprising at least one indication of at least one dig area, and data relating to the at least one image; based on the data relating to the at least one image, identifies ticket information in the memory corresponding to the at least one ticket; electronically bundles the at least one image or the at least one link with the ticket information to generate a ticket bundle; and provides the ticket bundle, via the communication interface, to at least one party associated with the at least one underground facility.

[0021] A further embodiment is directed to at least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The method comprises A) electronically receiving at least one image corresponding to at least one ticket or at least one link to the at least one image, the at least one image comprising at least one indication of at least one dig area, and data relating to the at least one image; B) based on the data relating to the at least one image, identifying ticket information corresponding to the at least one ticket; C) electronically bundling the at least one image or the at least one link with the ticket information to generate a ticket bundle; and D) providing the ticket bundle to at least one party associated with the at least one underground facility.

[0022] Another embodiment is directed to a method for facilitating detection of a presence or an absence of at least one underground facility within at least one dig area, wherein at least a portion of the at least one dig areas may be excavated or disturbed during excavation activities. The method comprises A) receiving at least one image corresponding to at least one ticket or at least one link to the at least one image, the at least one image comprising at least one indication of at least one dig area, and data relating to the at least one image; B) based on the data relating to the at least one image, identifying

ticket information corresponding to the at least one ticket; C) electronically bundling the at least one image or the at least one link with the ticket information to generate a ticket bundle; and D) providing the ticket bundle to at least one party associated with the at least one underground facility.

5 **[0023]** A further embodiment is directed to an apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The apparatus comprises a communication interface; a memory to store processor-executable instructions; and a processing unit coupled to the communication interface and
10 the memory. Upon execution of the processor-executable instructions by the processing unit, the processing unit: electronically receives, via the communication interface, at least one user input relating to the dig area; based on the at least one user input, renders a digital virtual white line image including at least one indicator to provide at least one indication of the dig area with respect to a geographic area; and transmits a limited access file
15 comprising information relating to the digital virtual white line image, via the communication interface, to at least one party associated with the at least one underground facility so as to facilitate the detection of the presence or the absence of the at least one underground facility within the dig area.

[0024] Another embodiment is directed to a method for facilitating detection of a
20 presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities. The method comprises A) electronically receiving at least one user input relating to the dig area; B) based on the at least one user input, rendering a digital virtual white line image including at least one indicator to provide at least one indication of the dig area with
25 respect to a geographic area; and C) electronically transmitting a limited access file comprising information relating to the digital virtual white line image to at least one party associated with the at least one underground facility so as to facilitate the detection of the presence or the absence of the at least one underground facility within the dig area.

[0025] A further embodiment is directed to at least one computer-readable medium
30 encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or

disturbed during excavation activities. The method comprises A) electronically receiving at least one user input relating to the dig area; B) based on the at least one user input, rendering a digital virtual white line image including at least one indicator to provide at least one indication of the dig area with respect to a geographic area; and C) electronically transmitting a limited access file comprising information relating to the digital virtual white line image to at least one party associated with the at least one underground facility so as to facilitate the detection of the presence or the absence of the at least one underground facility within the dig area.

[0026] The following U.S. patent and published patent application are referenced: U.S. Patent No. 7,640,105, issued December 29, 2009, and entitled "Marking System and Method With Location and/or Time Tracking;" and U.S. Patent Publication No. 2008-0245299-A1, published October 9, 2008, filed April 4, 2007, and entitled "Marking System and Method." Further, this application references the following co-pending U.S. patent application: U.S. Patent Publication No. 2010-0201690, entitled "VIRTUAL WHITE LINES (VWL) APPLICATION FOR INDICATING A PLANNED EXCAVATION OR LOCATE PATH," published on August 12, 2010.

[0027] It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail below (provided such concepts are not mutually inconsistent) are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein. It should also be appreciated that terminology explicitly employed herein should be accorded a meaning most consistent with the particular concepts disclosed herein.

Brief Description of the Drawings

[0028] The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention.

[0029] The objects and features of the present disclosure, which are believed to be novel, are set forth with particularity in the appended claims. The present disclosure, both as to its organization and manner of operation, together with further objectives and

advantages, may be best understood by reference to the following description, taken in connection with the accompanying drawings as set forth below:

[0030] Figure 1 illustrates a functional block diagram of a multi-generational virtual white lines application for delimiting planned excavation sites of staged excavation projects, according to the present disclosure;

[0031] Figure 2 illustrates a view of a multi-generational virtual white lines image, which shows the one image-to-multiple virtual white lines scenario of the multi-generational virtual white lines application, according to the present disclosure;

[0032] Figures 3 and 4 illustrate views of a virtual white lines image series, which shows the multiple image-to-multiple virtual white lines scenario of the multi-generational virtual white lines application, according to the present disclosure;

[0033] Figure 5 illustrates a functional block diagram of a multi-generational virtual white lines system that includes the multi-generational virtual white lines application, according to the present disclosure;

[0034] Figures 6A and 6B illustrate a flow diagram of an example of a method of operation and/or of using the multi-generational virtual white lines system, according to the present disclosure;

[0035] Figure 7 shows a sketch 700, representing an exemplary input image;

[0036] Figure 8 shows a map 800, representing an exemplary input image;

[0037] Figure 9 shows a facility map 900, representing an exemplary input image;

[0038] Figure 10 shows a construction/engineering drawing 1000, representing an exemplary input image;

[0039] Figure 11 shows a land survey map 1100, representing an exemplary input image;

[0040] Figure 12 shows a grid 1200, overlaid on the land survey map 1100 of Figure 11, representing an exemplary input image; and

[0041] Figure 13 shows a street level image 1300, representing an exemplary input image.

Detailed Description

[0042] Following below are more detailed descriptions of various concepts related to, and embodiments of, inventive methods and apparatus according to the present disclosure for associating one or more virtual white line images with corresponding ticket information for a given excavation project. It should be appreciated that various concepts introduced above and discussed in greater detail below may be implemented in any of numerous ways, as the disclosed concepts are not limited to any particular manner of implementation. Examples of specific implementations and applications are provided primarily for illustrative purposes.

[0043] Various embodiments described herein are directed to methods, apparatus and systems for creating an electronic record relating to a geographic area including a dig area to be excavated or otherwise disturbed. The electronic record may comprise one or more virtual white line (VWL) images for delimiting one or more planned excavation sites. In some examples, the excavation projects are staged excavation projects, and the term “multi-generational” refers to the excavation stages of multiple related tickets and/or a project ticket. One or more VWL images may be created using a VWL application that allows a user to generate (e.g., draw) one or more virtual white lines for electronically delimiting one or more dig areas. The virtual white line(s) may be overlaid on an input image depicting a geographic area including one or more dig areas, for example. In a multistage excavation project, each of the multiple virtual white lines may be manually and/or automatically ordered and dated with respect to a timetable of the multiple-stage excavation project. In embodiments described herein relating to multi-generational staged excavation projects, as well as in other embodiments relating to more limited excavation projects in connection with a given dig area (e.g., as described in some embodiments of methods and apparatus disclosed in U.S. Patent No. 7,640,105 and U.S. Patent Publication No. 2008-0245299-A1), methods and apparatus according to the present disclosure allow the image(s) and other information associated with one or more virtual white lines to be electronically bundled with the ticket information and dispatched to the locate personnel for viewing when performing the locate operation(s).

[0044] The multi-generational VWL application, system and/or method described herein may provide tools for clearly conveying information about planned excavation, such as a multiple-stage excavation project. The information may comprise, for example,

the limits of one or more dig areas. The information about the planned excavation may be provided in a substantially permanent and/or reproducible manner so that the information may be referenced throughout the duration of the planned excavation. Plans for staged excavation may be documented with respect to, for example, multiple related tickets
5 and/or project tickets.

[0045] Further, the multi-generational VWL application, system and/or method described herein may provide improved communication mechanisms between excavators and locate personnel for synchronizing staged excavation activities and locate operations. As a result, improved operating efficiency may be achieved for both excavation companies
10 and locate service providers. Improved information exchange allows excavation companies and locate service providers to make better and more timely decisions with respect to allocating resources.

[0046] The improved tools and communication mechanisms between excavators and locate personnel may reduce or eliminate the uncertainty for excavators about the status
15 and/or quality of locate operations, and thereby reduce or eliminate the risk of damage to underground facilities.

[0047] Figure 1 illustrates a functional block diagram of an exemplary multi-generational VWL application 100 for delimiting planned excavation sites of staged excavation projects. Multi-generational VWL application 100 may be, for example, a
20 web-based application that is accessible via the Internet. In another embodiment, multi-generational VWL application 100 may be a desktop application that is running on the user's local computing device.

[0048] Multi-generational VWL application 100 may include, but is not limited to, a VWL user interface 110 that may further include a drawing tool 112 and an information
25 processing component 114. Certain inputs to the VWL application may include, but are not limited to, one-call center information 116, input images 118, and user inputs received via one or more user input devices 134. Certain outputs of multi-generational VWL application 100 may include, but are not limited to, one or more multi-generational VWL images 122 and/or a collection of multi-generational VWL images 122 that are arranged in
30 a series, such as VWL image series 124, along with a corresponding set of descriptor files 126.

[0049] VWL user interface 110 may be a web-based graphical user interface (GUI) that is accessible via the Internet. VWL user interface 110 may provide a secure login function, which allows users, such as excavators and/or system administrators, to access the functions of multi-generational VWL application 100. In one example, excavators
5 may login to multi-generational VWL application 100 via VWL user interface 110 and enter user-specific information which may be saved in, for example, a user profile. The user-specific information may include, for example, the excavators name, user-ID, and excavation company name.

[0050] Drawing tool 112 may be a drawing application, which, in excavation
10 applications, may be used by excavators as a dig area marking tool. More specifically, drawing tool 112 may be used by the excavator to add markings to any digital image that corresponds to the geographic location of the dig area, which may be read into multi-generational VWL application 100 from input images 118.

[0051] It should be appreciated that the multi-generational virtual white lines
15 application described in connection with Figure 1 is merely exemplary and that many implementations of such an application are possible. For example, the drawing application or dig area marking tool application described in each of U.S. Patent Application No. 8,280,117 entitled "VIRTUAL WHITE LINES FOR INDICATING
20 PLANNED EXCAVATION SITES ON ELECTRONIC IMAGES" issued on October 2, 2012, and U.S. Patent No. 8,249,306 entitled "VIRTUAL WHITE LINES FOR DELIMITING PLANNED EXCAVATION SITES" issued August 21, 2012 may be configured to create single or multi-generational virtual white line images. In addition, the user device described in each of U.S. Patent Nos. 8,280,117 and 8,249,306 may be used as a hardware interface to create the multi-generational VWL images described herein.

[0052] For purposes of the present disclosure, an input image 118 is any image
25 represented by source data that is electronically processed (e.g., the source data is in a computer-readable format) to display the image on a display device. An input image 118 may include any of a variety of paper/tangible image sources that are scanned (e.g., via an electronic scanner) or otherwise converted so as to create source data (e.g., in various
30 formats such as XML, PDF, JPG, BMP, etc.) that can be processed to display the input image 118. An input image 118 also may include an image that originates as source data or an electronic file without necessarily having a corresponding paper/tangible copy of the

image (e.g., an image of a “real-world” scene acquired by a digital still frame or video camera or other image acquisition device, in which the source data, at least in part, represents pixel information from the image acquisition device).

[0053] In some exemplary implementations, input images 118 described herein may be created, provided, and/or processed by a geographic information system (GIS) that captures, stores, analyzes, manages and presents data referring to (or linked to) location, such that the source data representing the input image 118 includes pixel information from an image acquisition device (corresponding to an acquired “real world” scene or representation thereof), and/or spatial/geographic information (“geo-encoded information”). In this manner, a GIS provides a framework for data manipulation and display of images that may facilitate one or more of (a) location verification, (b) location correlation, (c) locational relationships, (d) district coding, (e) route analysis, (f) area analysis and (g) mapping/display creation, for example.

[0054] In view of the foregoing, various examples of input images and source data representing input images 118 described herein, to which the inventive concepts disclosed herein may be applied, include but are not limited to:

- Manual “free-hand” paper sketches of the geographic area (which may include one or more buildings, natural or man-made landmarks, property boundaries, streets/intersections, public works or facilities such as street lighting, signage, fire hydrants, mail boxes, parking meters, etc.). Figure 7 shows an exemplary sketch 700;
- Various maps indicating surface features and/or extents of geographical areas, such as street/road maps (e.g., map 800 of Figure 8), topographical maps, military maps, parcel maps, tax maps, town and county planning maps, call-center and/or facility polygon maps, virtual maps, etc. (such maps may or may not include geo-encoded information);
- Facility maps illustrating installed underground facilities, such as gas, power, telephone, cable, fiber optics, water, sewer, drainage, etc. Facility maps may also indicate street-level features (streets, buildings, public facilities, etc.) in relation to the depicted underground facilities. Examples of facility maps include CAD drawings that may be created and viewed with a GIS to include geo-encoded

information (e.g., metadata) that provides location information (e.g., infrastructure vectors) for represented items on the facility map. An exemplary facility map 900 is shown in Figure 9;

- Architectural, construction and/or engineering drawings and virtual renditions of a space/geographic area (including “as built” or post-construction drawings). An exemplary construction/engineering drawing 1000 is shown in Figure 10;
- Land surveys, i.e., plots produced at ground level using references to known points such as the center line of a street to plot the metes and bounds and related location data regarding a building, parcel, utility, roadway, or other object or installation.

Figure 11 shows an exemplary land survey map 1100;

- A grid (a pattern of horizontal and vertical lines used as a reference) to provide representational geographic information (which may be used “as is” for an input image 118 or as an overlay for an acquired “real world” scene, drawing, map, etc.). An exemplary grid 1200, overlaid on construction/engineering drawing 1000, is shown in Figure 12. It should be appreciated that the grid 1200 may itself serve as the input image (i.e., a “bare” grid), or be used together with another underlying input image;

- “Bare” data representing geo-encoded information (geographical data points) and not necessarily derived from an acquired/captured real-world scene (e.g., not pixel information from a digital camera or other digital image acquisition device). Such “bare” data may be nonetheless used to construct a displayed input image 118, and may be in any of a variety of computer-readable formats, including XML); and

- Photographic renderings/images, including street level (see e.g., street level image 1300 of Figure 13), topographical, satellite, and aerial photographic renderings/images, any of which may be updated periodically to capture changes in a given geographic area over time (e.g., seasonal changes such as foliage density, which may variably impact the ability to see some aspects of the image).

[0055] It should also be appreciated that source data representing an input image 118 may be compiled from multiple data/information sources; for example, any two or more of the examples provided above for input images and source data representing input images 118, or any two or more other data sources, can provide information that can be combined

or integrated to form source data that is electronically processed to display an image on a display device.

[0056] Once read into multi-generational VWL application 100 from input images 118, a digital image may be rendered in the viewing window of drawing tool 112. In one example, Figure 1 shows a rendered image 130 that is displayed in the viewing window of drawing tool 112. The markings that the excavator adds to rendered image 130 are used to graphically delimit and/or otherwise indicate the dig area. For example and referring to Figure 1, drawing tool 112 may be used to superimpose over or otherwise display one or more “virtual white lines” (VWL) 132 for delimiting and/or otherwise indicating the planned excavation upon rendered image 130.

[0057] Creating a “single-generational” VWL image is described in U.S. patent application serial nos. 12/366,853 and 12/050,055 and may involve the steps of sending an image to a user via a network; receiving a marked-up version of the image from the user via the network that includes one or more virtual white lines added to the image that indicate a dig area in which excavation is planned; and providing the marked-up version of the image, via one of an electronic or tangible delivery system, to another entity. The virtual white lines may include two-dimensional (2D) drawing shapes, shades, points, lines, symbols, coordinates, data sets, or other indicators to indicate on a digital image the dig area in which excavation is to occur. A drawing tool may be provided that allows the user to provide one or more dig area indicators to indicate the dig area (e.g., delimit or mark lines that indicate a line or path of planned excavation) and to enter textual information on the image. The marked-up image may be saved as a VWL image, associated with a certain locate request (or ticket), transmitted to locate personnel, and used by locate personnel during locate operations with respect to the line or path of planned excavation.

[0058] In addition to creating “single-generational” VWL images, the multi-generational VWL application 100 described herein provides the capability to create multi-generational virtual white lines for delimiting and/or otherwise indicating planned excavation with respect to multiple-stage excavation projects. For example, the virtual white lines may indicate a line or path of planned excavation with respect to multiple-stage excavation projects.

[0059] As used herein, “virtual white lines” (VWLs) may include lines, such as single-segment lines, multiple-segment lines, substantially straight lines, curved lines, and the like; 2D drawing shapes; shades; points; symbols; coordinates; data sets; or other indicators to delimit and/or otherwise indicate on an image one or more dig areas in which excavation is to occur. With respect to multiple-stage excavation projects, examples of multi-generational virtual white lines that may be created using drawing tool 112 are shown with reference to Figures 2, 3, and 4.

[0060] Information processing component 114 may be a software component of multi-generational VWL application 100 (e.g., a processing unit executing processor-executable instructions stored in memory) for entering and/or associating other information with the multi-generational virtual white lines that are created using drawing tool 112. This information may include excavator-specific, one-call center-specific, and/or other ticket information.

[0061] Ticket information 116 provides a source of information that may be processed using VWL user interface 110 of multi-generational VWL application 100. For example, ticket information 116 may include the geographic location(s) of one or more dig areas designated for excavation, for which a locate operation is being requested. Ticket information 116 generally is provided by a one-call center and may include one or more addresses of dig areas, or other location information (e.g., GPS latitude and longitude coordinates). Also, the ticket information 116 may specify a project or multi-stage excavation. Based on address and/or other information, the ticket information 116 may be filtered when presented to the user of multi-generational VWL application 100.

[0062] When an excavator completes the sketch of the virtual white lines of the proposed dig area, e.g., VWL 132 on rendered image 130, the marked-up image may be saved as one or more multi-generational VWL images 122. One or more multi-generational VWL images 122 may be associated with multiple related tickets and/or a project ticket, as discussed in greater detail below. In particular, multiple multi-generational VWL images 122 that are associated with staged excavation may be aggregated and saved as a VWL image series 124.

[0063] In one exemplary implementation, each multi-generational VWL image 122 and/or each multi-generational VWL image 122 of a VWL image series 124 may have one

or more corresponding descriptor files 126. When each VWL image series 124 is saved, the corresponding descriptor files 126 include(s) information about the multi-generational VWL images 122 of the VWL image series 124. For example and with respect to multiple-stage excavation projects, each descriptor file 126 may include, for example, the ticket numbers, the names of multi-generational VWL images 122 of the VWL image series 124, the stage number and stage date with respect to the ticket, and the like. Other information that may be included in one or more descriptor files 126 includes, but is not limited to date and time information indicating when the VWL image was created, an identifier for the creator of the VWL image (e.g., the excavator), location information (geo-coordinates) for the VWL indicating the dig area (dig area indicators), provider information relating to a service (e.g., the image server 516) for the underlying image on which a VWL is created, latitude/longitude and/or altitude information relating to the underlying image, and the like. Descriptor files 126 provide a mechanism by which the multi-generational VWL application 100 may be queried by another application, such as a ticket management application, for processing multi-generational VWL images 122 of the VWL image series 124. In one example, descriptor file(s) 126 may be extensible markup language (XML) files that are created during a save process for the multi-generational VWL images 122. More details of a system and method of using multi-generational VWL application 100 are described with reference to Figures 5, 6A, and 6B.

[0064] In a “one image-to-multiple VWL” scenario, when the geographic area of the ticket is suitably small to be shown fully on a single image, only one image need be read from input images 118 into multi-generational VWL application 100 and then multiple virtual white lines are created thereon in order to delimit the multiple dig areas, respectively, of staged excavation of multiple related tickets and/or project ticket. An example of this scenario is described with reference to Figure 2.

[0065] In a “multiple image-to-multiple VWL” scenario, when the geographic area of the multiple related tickets and/or project ticket is suitably large that it cannot be shown fully with a sufficient level of detail on a single image, multiple images may be read from input images 118 into multi-generational VWL application 100 and then at least one virtual white line (at least one dig area indicator) is created on each image in succession. An example of this scenario is described with reference to Figures 3 and 4.

[0066] Referring to Figure 2, a view of a multi-generational VWL image 200, which shows the “one image-to-multiple VWL” scenario of multi-generational VWL application 100, is presented. More specifically, Figure 2 shows an example in which the geographic area of a certain ticket is suitably small to be shown fully on a single image, such as multi-generational VWL image 200. Multi-generational VWL image 200 further shows multiple virtual white lines that delimit multiple planned excavations that are staged to occur over time with respect to the multiple related tickets and/or project ticket. For example, multi-generational VWL image 200 shows a VWL 201, which may be the VWL for the first stage of excavation; a VWL 202, which may be the VWL for the second stage of excavation; a VWL 203, which may be the VWL for the third stage of excavation; and so on through a VWL 211, which may be the VWL for the eleventh stage of excavation. VWL 201 through VWL 211 correspond to contiguous stages of the multiple-stage project. VWL 201 through VWL 211 are created by use of VWL user interface 110 of multi-generational VWL application 100.

[0067] Further, each VWL may be automatically labeled and dated according to the planned excavation order and dates of the multiple related tickets and/or project ticket. For example, VWL 201 may be labeled “Stage 1” and dated 05JAN09; VWL 202 may be labeled “Stage 2” and dated 12JAN09; VWL 203 may be labeled “Stage 3” and dated 19JAN09; and so on through VWL 211, which may be labeled “Stage 11” and dated 16MAR09.

[0068] Referring again to Figure 2, when made available to locate personnel, a multi-generational VWL image, such as multi-generational VWL image 200, and the information associated therewith provides precise clarity as to the order and timing of locate operations that are associated with the multiple related tickets and/or project ticket. As a result, the multi-generational VWL image of this scenario, which is created using the multi-generational VWL application 100 described herein, provides a mechanism by which excavators can clearly communicate to locate personnel information about the staged excavation, which is useful for optimally synchronizing the day-to-day activities of excavators and locate personnel.

[0069] Referring to Figures 3 and 4, views of a VWL image series 300, which shows the “multiple image-to-multiple VWL” scenario of multi-generational VWL application 100 are presented. More specifically, Figure 3 shows an example in which the geographic

area of a certain ticket is suitably large to require it to be shown across a series of images, such as VWL image series 300. Further, each image of VWL image series 300 shows at least one set of virtual white lines. Collectively, the virtual white lines included in VWL image series 300 delimit multiple planned excavations that are staged to occur over time.

5 For example, VWL image series 300 may include a multi-generational VWL image 301, a multi-generational VWL image 302, a multi-generational VWL image 303, and a multi-generational VWL image 304.

[0070] Additionally, multi-generational VWL image 301 shows a VWL 311, which may be the VWL for the first stage of excavation. Multi-generational VWL image 302
10 shows a VWL 312, which may be the VWL for the second stage of excavation. Multi-generational VWL image 303 shows a VWL 313, which may be the VWL for the third stage of excavation. Multi-generational VWL image 304 shows a VWL 314, which may be the VWL for the fourth stage of excavation. VWL 311 through VWL 314 correspond to contiguous stages of the multiple-stage project. VWL 311 through VWL 314 are
15 created by use of VWL user interface 110 of multi-generational VWL application 100.

[0071] Further, each multi-generational VWL image and each VWL of VWL image series 300 may be automatically labeled and dated by the multigenerational VWL application 100 according to the planned excavation order and dates of the multiple related tickets and/or project ticket. For example, multi-generational VWL image 301 may be
20 labeled "IMAGE01 OF 04" and VWL 311 may be labeled "Stage 1" and dated 02FEB09; multi-generational VWL image 302 may be labeled "IMAGE02 OF 04" and VWL 312 may be labeled "Stage 2" and dated 09FEB09; multi-generational VWL image 303 may be labeled "IMAGE03 OF 04" and VWL 313 may be labeled "Stage 3" and dated 16FEB09; and multi-generational VWL image 304 may be labeled "IMAGE04 OF 04" and VWL
25 314 may be labeled "Stage 4" and dated 23FEB09.

[0072] While Figure 3 shows details of each multi-generational VWL image of VWL image series 300 separately, Figure 4 shows multi-generational VWL images 301, 302, 303, and 304 overlaid in a fashion that shows the full scope of the staged excavations of the multiple related tickets and/or project ticket.

30 [0073] Referring again to Figures 3 and 4, when made available to locate personnel, a VWL image series, such as VWL image series 300, and the information associated

therewith provides precise clarity as to the order and timing of locate operations that are associated with the multiple related tickets and/or project ticket. As a result, the VWL image series of this scenario, which is created using the multi-generational VWL application 100 described herein, provides a mechanism by which excavators can clearly communicate to locate personnel information about the staged excavation, which is useful for optimally synchronizing the day-to-day activities of excavators and locate personnel.

[0074] Referring to Figures 1 through 4, during the save operation of multi-generational VWL application 100, any multi-generational VWL images created therein may be converted to any standard digital image file format, such as JPG file format, and saved to an associated file system (not shown).

[0075] Referring to Figure 5, a functional block diagram of a multi-generational VWL system 500 that includes multi-generational VWL application 100 is presented. The multi-generational VWL system 500 described herein may include an application server 510, which includes processing unit 502 and memory 504 (memory 504 may include one or more storage media components). In one exemplary implementation, multi-generational VWL application 100, which is described with reference to Figures 1 through 4, is stored in memory 504 (e.g., as processor-executable instructions and data associated with execution of these instructions) and executed by processing unit 502. Application server 510 may be any application server, such as a web application server and/or web portal, by which one or more excavators 512 may access multi-generational VWL application 100 with respect to generating multi-generational virtual white lines. Application server 510 may be accessed by excavators 512 via any networked computing device (not shown). Excavators 512 may be any personnel associated with excavation companies (not shown), such as, but not limited to, individuals who are requesting and/or performing excavation activities.

[0076] Multi-generational VWL system 500 may further include one or more one-call centers 514. One-call centers 514 may be any organizations, entities, and/or systems that receive, process, and/or transmit locate requests. The locate request (or ticket) may be any communication or instruction to perform a locate operation compiled as ticket information 116. One-call centers are generally owned, controlled, or funded by underground facility owners, such as telephone companies, cable television multiple system operators, electric utilities, gas utilities, or others. One-call center operations may be managed by a non-

profit entity or outsourced to a for-profit firm. Excavators, such as excavators 512, are required to notify one-call centers in advance of their excavation activities and identify through the locate request the dig area where individual excavating activities will be performed. Locate requests include information supplied by the excavator to the one-call center regarding the specific geographic location of the dig area, date, time, purpose of excavation, and so on. The locate request, in turn, requires activity from an underground facility owner (or a locate contractor) to perform a locate operation in the specified dig area pursuant to the ticket information 116.

[0077] With respect to multi-generational VWL system 500, one type of locate request that may be processed by one-call centers 514 is a project ticket that may warrant a multi-generational VWL image and/or a VWL image series associated therewith.

[0078] Multi-generational VWL system 500 may further include an image server 516. Image server 516, which includes processing unit 506 and memory 508, stores and provides input images 118. For example, image server 516 may be associated with a party that provides aerial images of geographic locations for a fee. Image server 516 is one example of an entity supplying input images 118 to multi-generational VWL application 100 residing on application server 510.

[0079] Multi-generational VWL system 500 may further include a central server 520 of, for example, a locate service provider. The central server includes processing unit 544 and memory 546, which may include one or more storage media components. A workforce management application 522 is stored on memory 546 (e.g., as processor-executable instructions) and executed by processor 544. In one exemplary implementation, the workforce management application 522 may include a ticket assembly component 524 which processes the output of the multi-generational VWL application 100 and dispatches tickets 526 to locate personnel 528. Locate personnel 528 may be, for example, locate technicians and/or quality control technicians that, for example, perform locate operations.

[0080] More specifically, workforce management application 522 of central server 520 may be used to process the locate requests, such as multiple related tickets and/or project tickets that are received from one-call centers 514, and dispatch tickets 526 to locate personnel 528 that are in the field. In particular, ticket assembly component 524

associates one or more descriptor files 126 with active tickets provided by one-call centers 514, identifies and/or assembles the multi-generational VWL image(s) 122 (in the form of image files 530) that are specified in descriptor file(s) 126 along with its corresponding ticket information, and bundles all image files and information (e.g., in some cases the descriptor file(s) themselves) in order to create tickets 526, stored in memory 546. In particular, one or more machine-readable VWL image files 530 (and optionally their associated descriptor file(s)) may be bundled with the ticket information provided by the one-call center to generate tickets 526 via ticket assembly component 524.

[0081] Tickets 526 that are dispatched from central server 520 may be received by locate personnel 528 via one or more onsite computers 532. Each onsite computer 532 may be a computer including processing unit 532 and memory 552, such as, but not limited to, a computer that is present in the vehicle that is being used by locate personnel 528. Each onsite computer 532 may be, for example, any computing device, such as portable computer, a personal computer, a tablet device, a PDA, a cellular radiotelephone, a mobile computing device, a touch-screen device, a touchpad device, or generally any device including, or connected to, a processor and a user interface. Preferably, onsite computer 532 is a portable computing device, such as laptop computer or tablet device. Residing in memory 552 of onsite computer 532, may be certain tools, such as a viewer 534, which may be executed by processing unit 550. Viewer 534 may be any viewer application that is capable of reading and displaying ticket information and/or digital images, such as VWL image files 530. In one exemplary implementation, one or more VWL image files 530 bundled in a ticket 526 may be “limited access files,” e.g., encoded, encrypted, formatted, compiled and/or named in some particular fashion (e.g., having a proprietary filename extension), and the viewer 534 may be particularly designed (i.e., a “custom or proprietary” viewer) such that access to the VWL image files is limited in some manner (e.g., the image files may only be opened/viewed by the customized/proprietary viewer that recognizes the proprietary filename extension). Additional details of a method of operation and/or using multi-generational VWL system 500 are described with reference to Figures 6A and 6B.

[0082] A network 536 provides the communication link between any and/or all entities of multi-generational VWL system 500. For example, network 536 provides the communication network by which information may be exchanged between application

server 510, one-call centers 514, image server 516, central server 520 and onsite computers 532. Network 536 may be, for example, any local area network (LAN) and/or wide area network (WAN) for connecting to the Internet.

[0083] In order to connect to network 536, each entity of multi-generational VWL system 500 includes a communication interface. For example, the respective communication interfaces 560a-e of application server 510, one-call centers 514, image server 516, central server 520 and onsite computers 532 may be any wired and/or wireless communication interface by which information may be exchanged between any entities of multi-generational VWL system 500. Examples of wired communication interfaces may include, but are not limited to, USB ports, RS232 connectors, RJ45 connectors, Ethernet, and any combinations thereof. Examples of wireless communication interfaces may include, but are not limited to, an Intranet connection, Internet, Bluetooth® technology, Wi-Fi, Wi-Max, IEEE 802.11 technology, radio frequency (RF), Infrared Data Association (IrDA) compatible protocols, Local Area Networks (LAN), Wide Area Networks (WAN), Shared Wireless Access Protocol (SWAP), any combinations thereof, and other types of wireless networking protocols.

[0084] Multi-generational VWL system 500 is not limited to the types and numbers of entities that are shown in Figure 5. Any types and numbers of entities that may be useful in underground facilities locate applications may be included in multi-generational VWL system 500. Further, the distribution of storage and processing of data shown in Figure 5 is merely exemplary, as described below.

[0085] For example, in another alternative implementation, rather than employing central server 520 in the VWL system 500, a one-call center 514 may include and maintain the ticket assembly component 524 (shown in Figure 5 as part of the workforce management application 522), and may receive from the multi-generational VWL application 100 one or more of multi-generational VWL images 122, VWL image series 124 (e.g., in the form of image files 530) and/or descriptor file(s) 126 to be associated with ticket information 116.

[0086] In this example, excavators may initiate locate requests with the one-call center 514 and provide ticket information 116. The one-call center 514 may in turn pass the ticket information 116 to the VWL application 100, and re-direct the excavator to the

VWL application 100 for creation of one or more VWL images 122 and/or image series 124. Upon completion of the VWL images, the VWL application 100 transmits back to the ticket assembly component 524 resident at the one-call center 514 one or more image files 530 and descriptor file(s) 126, which the ticket assembly component 524 then
 5 bundles with the ticket information 116 prior to dispatching tickets 526 to locate personnel 528.

[0087] It should be appreciated that the methods described above in connection with ticket assembly (i.e., bundling of ticket information, one or more VWL images, and optionally one or more descriptor files) and dispatch of assembled tickets may be
 10 employed for excavation projects involving a single dig area as well as multi-generational staged excavation projects. For single-stage projects in which only one VWL image is created to identify a single dig area, a VWL application (e.g., as described in U.S. patent application serial nos. 12/366,853 and 12/050,055) may provide to the ticket assembly component (wherever resident) a VWL image file and in some cases a descriptor file (e.g.,
 15 an XML file), and/or metadata forming part of the VWL image file, including information associated with the VWL image. Examples of information that may be included as metadata in the VWL image file or included in the descriptor file may include, but is not limited to, date and time information indicating when the VWL image was created, an identifier for the creator of the VWL image (e.g., the excavator), location information
 20 (geo-coordinates) for the VWL indicating the dig area (dig area indicators), provider information relating to a service (e.g., the image server 516) for the underlying image on which a VWL is created, latitude/longitude and/or altitude information relating to the underlying image, and the like. As in the multi-generational VWL implementation described above, ticket assembly component bundles the VWL image and optionally the
 25 metadata and/or descriptor file with the ticket information so as to compile a ticket for dispatching to locate personnel.

[0088] In some instances, for either single-stage or multi-generational staged excavation projects, it may be desirable for a single entity or a limited number of entities to retain control over the VWL image file(s) 530 and any associated metadata and/or
 30 descriptor file(s). For example, it may be desirable for the entity that provides access to a VWL creation application (e.g., the multi-generational VWL application 100) and has initial control of one or more created VWL images (e.g., application server 510) to retain

control of such VWL images. One potential benefit of retaining control of the VWL image(s) once created is avoiding unauthorized edits to or unauthorized use of the image(s).

5 [0089] According to one example, a “controlling” entity that provides access to a VWL creation application (e.g., the multi-generational VWL application 100) retains control of one or more created images, but allows other entities to access the images in some instances in a limited manner. For example, the controlling entity may provide a link (e.g., a hyperlink) to one or more VWL images (e.g., via an e-mail) or otherwise provide an interface allowing the VWL image(s) to be accessed (e.g., via a customized or
10 proprietary image viewing application). To maintain the integrity of the VWL image(s), the application providing access to the VWL image(s) may prohibit copying of, saving of, or writing to the images. For example, the VWL image may be viewable only using a corresponding image file viewer that allows limited access to the VWL image. In particular, copy, save and/or write access to the VWL image may be prohibited. In these
15 and other respects discussed below, one or more VWL image files may be stored and/or transmitted as “limited access files.”

[0090] The VWL image may, for example, be transmitted to a party associated with the at least one underground facility with the corresponding image file viewer so that the party may view the VWL image. For example, an executable file comprising the VWL image
20 and image file viewer may be transmitted (e.g., a customized image viewer 534 may be transmitted to one or more onsite computers 532). Alternatively, the image file viewer may be downloaded/installed separately, e.g., from a website of the controlling entity, or the VWL image may be viewed using an image file viewer stored and executed on a server of the controlling entity.

25 [0091] In one implementation, the controlling entity may allow access to the VWL image(s) only when a certain condition or conditions are met. For example, the controlling entity may require a password protected log-in procedure for access to the VWL image(s). In particular, the image file viewer may require a password to permit access to the VWL image. As another example, the controlling entity may require
30 acceptance of certain terms and/or conditions to permit access to the VWL image. According to one implementation, the image file viewer may be programmed to require an indication of acceptance of terms and/or conditions prior to permitting access to the VWL

image. According to yet another example, the controlling entity may charge a fee for permitting a third party to access one or more VWL images, such as a per-transaction fee or a subscription fee.

[0092] To prevent access to the VWL image unless or until a condition or conditions are met, the VWL image may be encrypted and require decryption to be readable. A corresponding image file viewer may be required to decrypt the VWL image. The VWL image and/or the corresponding image file viewer may also or alternatively be proprietary, and may have a format specific to the controlling entity. The image file viewer may optionally be programmed to determine whether an updated version of the image file viewer is available. For example, the image file viewer may interrogate information associated with the VWL image to determine a corresponding version of the image file viewer. If an updated version is found, the viewer may prompt the user to upgrade the application or otherwise facilitate an update.

[0093] The VWL image may be transmitted in a variety of different formats. For example, the VWL image may be transmitted as an image including virtual white lines thereon. Alternatively, the VWL image may be transmitted as a base image with associated metadata and/or a separate file (e.g., an XML file) including information that allows virtual white lines to be rendered on or in connection with the base image. Such information may comprise geographic coordinates specifying the virtual white lines to be displayed on the base image. The information included in the metadata and/or separate file may also specify access permissions for the virtual white lines. For example, in the case where the information that allows virtual white lines to be rendered relates to a plurality of dig sites, virtual white line information for one or more dig sites may have restricted access such that the corresponding virtual white lines are not rendered unless certain access conditions are met.

[0094] Since the workforce management application 522 may require access to one or more VWL image file(s) 530 to assemble, attach or otherwise integrate the image file(s) with ticket information, it may be desirable in some implementations to store and execute the workforce management application 522 on the application server 510, which facilitates creation of one or more VWL images. Alternatively, the workforce management application 522 may be stored and executed on the central server 520 or at one-call centers 514, but the VWL image(s) may be stored remotely. In this case, the bundling performed

by the ticket assembly component (wherever resident) may involve, e.g., bundling the information of tickets 526 with a link to one or more VWL images or other information specifying or permitting access to the VWL image(s). According to another arrangement, the central server 520 or the one-call centers 514 may control one or more VWL images
 5 by storing the VWL image(s) and also storing and executing the workforce management application 522.

[0095] Referring to Figures 6A and 6B, a flow diagram of an example of a method 600 of operation and/or of using multi-generational VWL system 500 is presented. Method 600 may include, but is not limited to, the following steps, which are not limited to any
 10 order.

[0096] At step 612, a certain excavator 512 requests a ticket number from any controlling entity. For example, the excavator 512 calls and/or accesses a web portal of the one-call center 514 and requests, for example, a project ticket number because the planned excavation is related to a project wherein excavation is to be performed in
 15 multiple stages over time (e.g., over several days, weeks, and/or months).

[0097] At step 614, the certain excavator 512 logs into multi-generational VWL application 100 and enters certain information. For example, using the Internet browser of any networked computer, the excavator 512 logs into multi-generational VWL application 100 at application server 510 in order to access VWL user interface 110 and certain
 20 information, such as, but not limited to, the excavator's name, excavation company name, excavation company location, ticket number, and the dig area address and/or other location information. Alternatively, the excavator may enter this information via the one-call center web portal, and the one-call center may redirect the excavator to the multi-generational VWL application and pass on to the application some or all of the
 25 information provided by the excavator (e.g., as an XML file). Information processing component 114 temporarily caches this information in order to later associate this information as may be necessary or desirable with multi-generational VWL images 122 and/or VWL image series 124 that are created by multi-generational VWL application 100.

[0098] At decision step 616, based on the address and/or other location information of the proposed dig area, it may be determined whether a single input image 118 from image

server 516 is needed or multiple input images 118 are needed in order to render the full scope of the multiple related tickets and/or project ticket. If a single input image 118 only is needed to fully render the project (i.e., the “one image-to-multiple VWL” scenario), method 600 proceeds to step 618. However, if multiple input images 118 are needed to
 5 fully render the project (i.e., the “multiple image-to-multiple VWL” scenario), method 600 proceeds to step 626.

[0099] At step 618, multi-generational VWL application 100 acquires and renders an input image 118, which may be an aerial image, of the excavation site location. In one example, using VWL user interface 110, the excavator 512 may enter the address and/or
 10 other location information (e.g., latitude/longitude coordinates) of the proposed dig area and multi-generational VWL application 100 automatically queries image server 516 for the corresponding input image 118 which is read into the application and rendered in drawing tool 112. In another example, multi-generational VWL application 100 provides a mechanism by which the excavator 512 may view and pan over an aerial map of a region
 15 and then manually identify the location of the proposed dig area. Once manually identified, the corresponding input image 118 is read into the application and rendered in drawing tool 112. By way of example and referring again to Figure 2, an input image 118, such as multi-generational VWL image 200, is read into the application and rendered in drawing tool 112.

[00100] At step 620, the excavator 512 creates the first virtual white line that delimits the dig area of the first stage of the project. By way of example and referring again to Figure 2, the excavator 512 creates VWL 201 on multi-generational VWL image 200 using drawing tool 112, which delimits the dig area of the first stage of the project. Additionally, the excavator 512 is prompted for or otherwise enters information that is
 25 automatically associated with VWL 201. For example, the excavator 512 enters the stage number (e.g., stage 1) and the stage date (e.g., 05JAN09), which may be superimposed on multi-generational VWL image 200 at VWL 201.

[00101] At decision step 622, the excavator 512 is prompted or otherwise indicates whether another virtual white line is to be created. If yes, method 600 proceeds to step
 30 624. If no, method 600 proceeds to step 636.

[00102] At step 624, the excavator 512 creates the next virtual white line that delimits the dig area of the next stage of the project. By way of example and referring again to Figure 2, the excavator 512 creates the next virtual white line, such as VWL 202 (then VWL 203, then VWL 204, and so on) on multi-generational VWL image 200 using drawing tool 112, which delimits the dig area of the next stage of the project.

Additionally, the excavator 512 is prompted for or otherwise enters information that is automatically associated with the next virtual white line, such as VWL 202. For example, for VWL 202, the excavator 512 enters the stage number (e.g., stage 2) and the stage date (e.g., 12JAN09), which may be superimposed on multi-generational VWL image 200 at VWL 202. Method 600 returns to step 622.

[00103] At step 626, multi-generational VWL application 100 acquires and renders the first input image 118, which may be an aerial image, of the excavation site location. In one example, using VWL user interface 110, the excavator 512 may enter the address and/or other location information (e.g., latitude/longitude coordinates) of the first proposed dig area and multi-generational VWL application 100 automatically queries image server 516 for the corresponding input image 118 which is read into the application and rendered in drawing tool 112. In another example, multi-generational VWL application 100 provides a mechanism by which the excavator 512 may view and pan over an aerial map of a region and then manually identify the location of the proposed dig area. Once manually identified, the corresponding input image 118 is read into the application and rendered in drawing tool 112. By way of example and referring again to Figures 3 and 4, an input image 118, such as multi-generational VWL image 301, is read into the application and rendered in drawing tool 112.

[00104] At step 628, the excavator 512 creates the first virtual white line that delimits the dig area of the first stage of the project on the first input image 118. By way of example and referring again to Figures 3 and 4, the excavator 512 creates VWL 311 on multi-generational VWL image 301 using drawing tool 112, which delimits the dig area of the first stage of the project. Additionally, the excavator 512 is prompted for or otherwise enters information that is automatically associated with VWL 311. For example, the excavator 512 enters the stage number (e.g., stage 1) and the stage date (e.g., 02FEB09), which may be superimposed on multi-generational VWL image 301 at VWL 311.

[00105] At decision step 630, the excavator 512 is prompted or otherwise indicates whether another virtual white line is to be created. If yes, method 600 proceeds to step 632. If no, the VWL image series is complete and method 600 proceeds to step 636.

[00106] At step 632, multi-generational VWL application 100 acquires and renders the
 5 next input image 118, which may be an aerial image, of the excavation site location. In one example, using VWL user interface 110, the excavator 512 may enter the address and/or other location information (e.g., latitude/longitude coordinates) of the next proposed dig area and multi-generational VWL application 100 automatically queries image server 516 for the corresponding input image 118 which is read into the application
 10 and rendered in drawing tool 112. In another example, multi-generational VWL application 100 provides a mechanism by which the excavator 512 may view and pan over an aerial map of a region and then manually identify the location of the next proposed dig area. Once manually identified, the corresponding input image 118 is read into the application and rendered in drawing tool 112. By way of example and referring again to
 15 Figures 3 and 4, an input image 118, such as multi-generational VWL image 302 (then multi-generational VWL image 303, then multi-generational VWL image 304), is read into the application and rendered in drawing tool 112.

[00107] At step 634, the excavator 512 creates the next virtual white line that delimits the dig area of the next stage of the project on the next input image 118. By way of
 20 example and referring again to Figures 3 and 4, the excavator 512 creates the next virtual white line, such as VWL 312 (then VWL 313, then VWL 314) on multi-generational VWL image 302 (then multi-generational VWL image 303, then multi-generational VWL image 304) using drawing tool 112, which delimits the dig area of the next stage of the project. Additionally, the excavator 512 is prompted for or otherwise enters information
 25 that is automatically associated with the next virtual white line, such as VWL 312. For example, for VWL 312, the excavator 512 enters the stage number (e.g., stage 2) and the stage date (e.g., 09FEB09), which may be superimposed on multi-generational VWL image 302 at VWL 312. The transition from one multi-generational VWL image to the next may be assisted via geo-coding or other geographical identification metadata therein
 30 for “stitching” the images together in a contiguous fashion. Method 600 returns to step 630.

[00108] At step 636 shown in Figure 6B, a save operation of multi-generational VWL application 100 is performed. In particular, one or more virtual white lines, one or more multi-generational VWL images, one or more VWL image series, and/or other information is saved in multi-generational VWL application 100. For example, the excavator 512 may initiate a save operation by selecting a SAVE button of VWL user interface 110 in order to save the contents of the session at application server 510 and/or central server 520. In particular, all of the multi-generational VWL images showing the multi-generational virtual white lines that delimit or otherwise indicate the respective stages of the multiple related tickets and/or project ticket are saved as standard machine-readable image files, such as JPG files, which are hereafter referred to as VWL image files. During the save operation, the excavator 512 may be prompted to enter certain information. For example, the excavator 512 may be prompted to enter the ticket number that was provided by the one-call center 514 at step 612. Additionally, in order to log the one-call center 514 for this ticket, the excavator 512 may be prompted to select the originating one-call center 514.

[00109] At step 638, multi-generational VWL application 100 creates one or more descriptor files 126 for all information associated with the multi-generational VWL images and/or VWL image series of the session. For example, when each multi-generational VWL image and/or VWL image series is saved, a corresponding descriptor file 126 (e.g., corresponding XML file) is created that includes information about the multi-generational VWL images and/or VWL image series, such as multi-generational VWL image 200 of Figure 2 and/or VWL image series 300 of Figure 3 and 4. For example and with respect to multiple-stage excavation projects, each descriptor file 126 may include the ticket number, the name of multi-generational VWL image, the name of the VWL image series, the stage number and stage date with respect to each virtual white line of the multiple related tickets and/or project ticket, and other information as discussed above.

[00110] At step 640, ticket assembly component 524 queries the file directory of application server 510 in order to identify descriptor files 126 that correspond to active tickets of one-call centers 514. This may be accomplished by matching the ticket number information of descriptor files 126 to active tickets of one-call centers 514.

[00111] At step 642, once a descriptor file 126 that corresponds to an active ticket is identified, ticket assembly component 524 reads the identified descriptor file 126 and searches for the VWL image files 530 of the multi-generational VWL images that are specified therein for the ticket of interest. In one example and referring to Figure 2, multi-generational VWL image 200 may be specified in the identified descriptor file 126. In another example and referring to Figures 3 and 4, multi-generational VWL images 301, 302, 303, and 304 of VWL image series 300 may be specified in the identified descriptor file 126.

[00112] At step 644, ticket assembly component 524 bundles the multi-generational VWL images (in the form of VWL image files 530) that are specified in the identified descriptor file 126 along with its corresponding ticket information in order to create a certain ticket 526. In one example and referring to Figure 2, a VWL image file 530 of multi-generational VWL image 200 may be bundled along with its corresponding ticket information in order to create a certain ticket 526. In another example and referring to Figures 3 and 4, VWL image files 530 of multi-generational VWL images 301, 302, 303, and 304 of VWL image series 300 may be bundled in the correct order along with the corresponding ticket information in order to create a certain ticket 526.

[00113] According to one example, the ticket assembly component 524 forms a ticket bundle by assembling a file including the at least one image and the ticket information. Alternatively, the ticket assembly component 524 may form the ticket bundle by associating a file including the at least one image and a file including the ticket information. The ticket bundle need not include the actual at least one image. Instead, the ticket bundle may comprise information specifying or permitting access to the at least one image (e.g., a link to the at least one image). Thus, the ticket bundle may comprise a file including the ticket information and a link (e.g., a hyperlink) to the at least one image. In some implementations, the ticket bundle may include one or more descriptor files themselves.

[00114] At step 646, one or more tickets 526 are dispatched and locate personnel 528 retrieve the one or more tickets 526 (e.g., from central server 520) via their respective onsite computers 532. For example, the tickets 526 may be electronically transmitted to the locate personnel 528 from the central server 520. Alternatively, the tickets 526 may be made accessible to the locate personnel 528 on the central server 520. In one example and

referring to Figure 2, a certain locate personnel 528 retrieves a ticket 526 that includes the VWL image file 530 of multi-generational VWL image 200 along with its corresponding ticket information. In another example and referring to Figures 3 and 4, a certain locate personnel 528 retrieves a ticket 526 that includes the VWL image files 530 of multi-generational VWL images 301, 302, 303, and 304 of VWL image series 300 along with the corresponding ticket information. According to yet another example, the ticket may include a link to the one or more VWL images or other information specifying or permitting access to the one or more VWL images, rather than including the image or images themselves. As noted above, custom viewers also may be employed by ticket recipients to provide limited access to VWL images.

[00115] At step 648, locate personnel 528 views the ticket information and the multi-generational VWLs in order to perform a locate operation. In one example and referring to Figure 2, a certain locate personnel 528 uses viewer 534 to view information of ticket 526 and to view VWL 201 through 211 of multi-generational VWL image 200 in order to perform the locate operation according to the order and date specified thereon. In another example and referring to Figures 3 and 4, a certain locate personnel 528 uses viewer 534 to view information of ticket 526 and to view VWL 311 of multi-generational VWL image 301, VWL 312 of multi-generational VWL image 302, VWL 313 of multi-generational VWL image 303, and VWL 314 of multi-generational VWL image 304 in order to perform the locate operation according to the order and date specified thereon.

[00116] It should be appreciate that while the foregoing example relates to a method of operation and/or of using a multi-generational VWL system, the method may also apply to single stage projects and single VWL image files.

[00117] In summary, multi-generational VWL application 100, multi-generational VWL system 500, and/or method 600 may provide improved tools for clearly documenting plans for staged excavation with respect to, for example, multiple related tickets and/or project tickets that is not otherwise available using current processes.

[00118] Further, multi-generational VWL application 100, multi-generational VWL system 500, and/or method 600 may provide improved communication mechanisms between excavators and locate personnel for synchronizing staged excavation activities and locate operations that are not otherwise available using current processes.

[00119] Yet further, because of the improved communication mechanisms between excavators and locate personnel, multi-generational VWL application 100, multi-generational VWL system 500, and/or method 600 may provide improved operating efficiency for both excavation companies and locate service providers. Still further, because of the improved tools and communication mechanisms between excavators and locate personnel, multi-generational VWL application 100, multi-generational VWL system 500, and/or method 600 may reduce or entirely eliminate the uncertainty for excavators about the status and/or quality of locate operations, which may reduce or entirely eliminate the risk of damage to underground facilities.

[00120] While various inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure. All definitions, as defined and used herein, should be understood to control over dictionary definitions, and/or ordinary meanings of the defined terms. The indefinite articles “a” and “an,” as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean “at least one.”

[00121] The phrase “and/or,” as used herein in the specification and in the claims, should be understood to mean “either or both” of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with “and/or” should be construed in the same fashion, i.e., “one
 5 or more” of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the “and/or” clause, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, a reference to “A and/or B”, when used in conjunction with open-ended language such as “comprising” can refer, in one embodiment, to A only (optionally including elements
 10 other than B); in another embodiment, to B only (optionally including elements other than A); in yet another embodiment, to both A and B (optionally including other elements); etc.

[00122] As used herein in the specification and in the claims, “or” should be understood to have the same meaning as “and/or” as defined above. For example, when separating items in a list, “or” or “and/or” shall be interpreted as being inclusive, i.e., the inclusion of
 15 at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as “only one of” or “exactly one of,” or, when used in the claims, “consisting of,” will refer to the inclusion of exactly one element of a number or list of elements. In general, the term “or” as used herein shall only be interpreted as indicating exclusive alternatives (i.e.
 20 “one or the other but not both”) when preceded by terms of exclusivity, such as “either,” “one of,” “only one of,” or “exactly one of.” “Consisting essentially of,” when used in the claims, shall have its ordinary meaning as used in the field of patent law.

[00123] As used herein in the specification and in the claims, the phrase “at least one,” in reference to a list of one or more elements, should be understood to mean at least one
 25 element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase “at least one” refers,
 30 whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, “at least one of A and B” (or, equivalently, “at least one of A or B,” or, equivalently “at least one of A and/or B”) can refer, in one embodiment, to at least one,

optionally including more than one, A, with no B present (and optionally including elements other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including elements other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other elements); etc.

[00124] It should also be understood that, unless clearly indicated to the contrary, in any methods claimed herein that include more than one step or act, the order of the steps or acts of the method is not necessarily limited to the order in which the steps or acts of the method are recited.

[00125] In the claims, as well as in the specification above, all transitional phrases such as “comprising,” “including,” “carrying,” “having,” “containing,” “involving,” “holding,” “composed of,” and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases “consisting of” and “consisting essentially of” shall be closed or semi-closed transitional phrases, respectively.

CLAIMS:

1. An apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities, the apparatus comprising:
 - a communication interface;
 - a display device;
 - at least one user input device;
 - a memory to store processor-executable instructions; and
 - a processing unit coupled to the communication interface, the display device, the at least one user input device, and the memory, wherein upon execution of the processor-executable instructions by the processing unit, the processing unit:
 - controls the communication interface to electronically receive source data representing at least one input image of a geographic area including a first dig area and at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project;
 - controls the display device to display at least a portion of the at least one input image;
 - acquires at least one first user input from the at least one user input device;
 - generates a first generation marked-up digital image including at least one first indicator overlaid on the at least one input image to provide at least one indication of the first dig area;
 - acquires at least one second user input from the at least one user input device;
 - generates a multi-generational marked-up digital image including at least one additional indicator overlaid on the first generation marked-up digital image to provide at least one indication of the at least one additional dig area; and
 - further controls the communication interface and/or the memory to electronically transmit and/or electronically store information relating to the multi-generational marked-up digital image so as to facilitate the detection of the

presence or the absence of the at least one underground facility within the plurality of dig areas.

2. The apparatus of claim 1, wherein the processing unit:

adds a first indication to the first generation marked-up digital image and/or the multi-generational marked-up digital image that the first dig area corresponds to the first stage; and

adds a second indication to the multi-generational marked-up digital image that the at least one additional dig area corresponds to the at least one subsequent stage.

3. The apparatus of claim 1, wherein the processing unit:

adds a first excavation date, corresponding to the first dig area, to the first generation marked-up digital image and/or the multi-generational marked-up digital image; and

adds a second excavation date, corresponding to the at least one additional dig area, to the multi-generational marked-up digital image.

4. The apparatus of claim 1, wherein the processing unit:

electronically stores, in the memory, the information relating to the multi-generational marked-up digital image with a corresponding descriptor file comprising information identifying at least one ticket number.

5. The apparatus of claim 4, wherein the at least one ticket number comprises a first ticket number corresponding to the first stage of the staged excavation project and at least one additional ticket number corresponding to the at least one subsequent stage of the staged excavation project.

6. The apparatus of claim 4, wherein the descriptor file further comprises a first stage identifier corresponding to the first stage of the staged excavation project and at least one additional stage identifier corresponding to the at least one subsequent stage of the staged excavation project.

7. The apparatus of claim 4, wherein the descriptor file further comprises a first stage date corresponding to the first stage of the staged excavation project and at least one additional stage date corresponding to the at least one subsequent stage of the staged excavation project.

8. At least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities, the method comprising:

A) electronically receiving source data representing at least one input image of a geographic area including a first dig area and at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project;

B) processing the source data so as to display at least a portion of the at least one input image on a display device;

C) receiving at least one first user input via at least one user input device associated with the display device;

D) adding, based on the at least one first user input, at least one first indicator to the displayed at least one input image to provide at least one indication of the first dig area and thereby generate a first generation marked-up digital image;

E) receiving at least one second user input via the at least one user input device;

F) adding, based on the at least one second user input, at least one additional indicator to the first generation marked-up digital image to provide at least one indication of the at least one additional dig area and thereby generate a multi-generational marked-up digital image; and

G) electronically transmitting and/or electronically storing information relating to the multi-generational marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the plurality of dig areas.

9. The at least one computer-readable medium of claim 8, wherein the method further comprises:

adding a first indication to the first generation marked-up digital image and/or the multi-generational marked-up digital image that the first dig area corresponds to the first stage; and

adding a second indication to the multi-generational marked-up digital image that the at least one additional dig area corresponds to the at least one subsequent stage.

10. The at least one computer-readable medium of claim 8, wherein the method further comprises:

adding a first excavation date corresponding to the first dig area to the first generation marked-up digital image and/or the multi-generational marked-up digital image; and

adding a second excavation date corresponding to the at least one additional dig area to the multi-generational marked-up digital image.

11. The at least one computer-readable medium of claim 8, wherein G) comprises:

electronically storing the information relating to the multi-generational marked-up digital image with a corresponding descriptor file comprising information identifying at least one ticket number.

12. The at least one computer-readable medium of claim 11, wherein the at least one ticket number comprises a first ticket number corresponding to the first stage of the staged excavation project and at least one additional ticket number corresponding to the at least one subsequent stage of the staged excavation project.

13. The at least one computer-readable medium of claim 11, wherein the descriptor file further comprises a first stage identifier corresponding to the first stage of the staged excavation project and at least one additional stage identifier corresponding to the at least one subsequent stage of the staged excavation project.

14. The at least one computer-readable medium of claim 11, wherein the descriptor file further comprises a first stage date corresponding to the first stage of the staged excavation project and at least one additional stage date corresponding to the at least one subsequent stage of the staged excavation project.

15. A method for facilitating detection of a presence or an absence of at least one underground facility within a plurality of dig areas comprising a first dig area and at least one additional dig area, wherein at least a portion of the plurality of dig areas may be excavated or disturbed during excavation activities, the method comprising:

A) electronically receiving source data representing at least one input image of a geographic area including the first dig area and the at least one additional dig area, wherein the first dig area corresponds to a first stage of an staged excavation project and the at least one additional dig area corresponds to at least one subsequent stage of the staged excavation project;

B) processing the source data so as to display at least a portion of the at least one input image on a display device;

C) adding, via at least one user input device associated with the display device, at least one first indicator to the displayed at least one input image to provide at least one indication of the first dig area and thereby generate a first generation marked-up digital image;

D) adding, via the at least one user input device, at least one additional indicator to the first generation marked-up digital image to provide at least one indication of the at least one additional dig area and thereby generate a multi-generational marked-up digital image; and

E) electronically transmitting and/or electronically storing information relating to the multi-generational marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the plurality of dig areas.

16. The method of claim 15, wherein A) through D) are performed at a user location remote from the plurality of dig areas.

17. The method of claim 15, further comprising:

adding a first indication to the first generation marked-up digital image and/or the multi-generational marked-up digital image that the first dig area corresponds to the first stage; and

adding a second indication to the multi-generational marked-up digital image that the at least one additional dig area corresponds to the at least one subsequent stage.

18. The method of claim 15, further comprising:

adding a first excavation date, corresponding to the first dig area, to the first generation marked-up digital image and/or the multi-generational marked-up digital image; and

adding a second excavation date, corresponding to the at least one additional dig area, to the multi-generational marked-up digital image.

19. The method of claim 15, wherein E) comprises:

electronically storing the information relating to the multi-generational marked-up digital image with a corresponding descriptor file comprising information identifying at least one ticket number.

20. An apparatus for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities, the apparatus comprising:

a communication interface;

a display device;

at least one user input device;

a memory to store processor-executable instructions; and

a processing unit coupled to the communication interface, the display device, the at least one user input device, and the memory, wherein upon execution of the processor-executable instructions by the processing unit, the processing unit:

controls the communication interface to electronically receive first source data representing a first input image of a geographic area including a

first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project;

controls the display device to display at least a portion of the first input image on the display device;

acquires at least one first user input from the at least one user input device;

generates a first marked-up digital image including at least one first indicator overlaid on the first input image to provide at least one indication of the first dig area;

controls the communication interface to electronically receive second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project;

controls the display device to display at least a portion of the second input image on the display device;

acquires at least one second user input from the at least one user input device;

generates a second marked-up digital image including at least one second indicator overlaid on the second input image to provide at least one indication of the second dig area; and

further controls the communication interface and/or the memory to electronically transmit and/or electronically store first information relating to the first marked-up digital image together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

21. The apparatus of claim 20, further comprising:

adding a first indication to the first marked-up digital image that first dig area corresponds to the first stage of the staged excavation project.

22. The apparatus of claim 21, further comprising:
adding a second indication to the second marked-up digital image that second dig area corresponds to the subsequent stage of the staged excavation project.
23. The apparatus of claim 20, further comprising:
adding a first excavation date corresponding to the first dig area to the first marked-up digital image.
24. The apparatus of claim 23, further comprising:
adding a second excavation date corresponding to the second dig area to the second marked-up digital image.
25. The apparatus of claim 20, wherein further controlling the communication interface and/or the memory comprises:
electronically storing the first and second information with a corresponding descriptor file comprising information identifying at least one ticket number.
26. The apparatus of claim 25, wherein the at least one ticket number comprises a first ticket number corresponding to the first stage of the staged excavation project and at least one additional ticket number corresponding to the subsequent stage of the staged excavation project.
27. The apparatus of claim 25, wherein the descriptor file further comprises a first stage identifier corresponding to the first stage of the staged excavation project and a second stage identifier corresponding to the subsequent stage of the staged excavation project.
28. The apparatus of claim 25, wherein the descriptor file further comprises a first stage date corresponding to the first stage of the staged excavation project and a second stage date corresponding to the subsequent stage of the staged excavation project.

29. At least one computer-readable medium encoded with instructions that, when executed by at least one processing unit, perform a method for facilitating detection of a presence or an absence of at least one underground facility within a dig area, wherein at least a portion of the dig area may be excavated or disturbed during excavation activities, the method comprising:

A) electronically receiving first source data representing a first input image of a geographic area including a first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project;

B) processing the first source data so as to display at least a portion of the first input image on the display device;

C) receiving at least one first user input via at least one user input device associated with the display device;

D) adding, based on the at least one first user input, at least one first indicator to the displayed first input image to provide at least one indication of the first dig area and thereby generate a first marked-up digital image;

E) electronically receiving second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project;

F) processing the second source data so as to display at least a portion of the second input image on the display device;

G) receiving at least one second user input via the at least one user input device;

H) adding, based on the at least one second user input, at least one second indicator to the displayed second input image to provide at least one indication of the second dig area and thereby generate a second marked-up digital image; and

I) electronically transmitting and/or electronically storing first information relating to the first marked-up digital image together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

30. The at least one computer-readable medium of claim 29, wherein the first and second marked-up digital images each comprise geographical metadata, and wherein the method further comprises:

using the geographical metadata, digitally configuring at least a portion of the first and second marked-up digital images in a contiguous manner.

31. The at least one computer-readable medium of claim 29, further comprising:
adding a first indication to the first marked-up digital image that first dig area corresponds to the first stage of the staged excavation project.
32. The at least one computer-readable medium of claim 31, further comprising:
adding a second indication to the second marked-up digital image that second dig area corresponds to the subsequent stage of the staged excavation project.
33. The at least one computer-readable medium of claim 29, further comprising:
adding a first excavation date corresponding to the first dig area to the first marked-up digital image.
34. The at least one computer-readable medium of claim 33, further comprising:
adding a second excavation date corresponding to the second dig area to the second marked-up digital image.
35. The at least one computer-readable medium of claim 29, wherein I) comprises:
electronically storing the first and second information with a corresponding descriptor file comprising information identifying at least one ticket number.
36. The at least one computer-readable medium of claim 35, wherein the at least one ticket number comprises a first ticket number corresponding to the first stage of the staged excavation project and at least one additional ticket number corresponding to the subsequent stage of the staged excavation project.
37. The at least one computer-readable medium of claim 35, wherein the descriptor file further comprises a first stage identifier corresponding to the first stage of the staged excavation project and a second stage identifier corresponding to the subsequent stage of the staged excavation project.

38. The at least one computer-readable medium of claim 35, wherein the descriptor file further comprises a first stage date corresponding to the first stage of the staged excavation project and a second stage date corresponding to the subsequent stage of the staged excavation project.

39. A method for facilitating detection of a presence or an absence of at least one underground facility within a plurality of dig areas comprising a first dig area and a second dig area, wherein at least a portion of the first and second dig areas may be excavated or disturbed during excavation activities, the method comprising:

A) electronically receiving first source data representing a first input image of a geographic area including a first dig area, wherein the first dig area corresponds to a first stage of an staged excavation project;

B) processing the first source data so as to display at least a portion of the first input image on the display device;

C) adding, via at least one user input device associated with the display device, at least one first indicator to the displayed first input image to provide at least one indication of the first dig area and thereby generate a first marked-up digital image;

D) electronically receiving second source data representing a second input image of a geographic area including a second dig area, wherein the second dig area corresponds to a subsequent stage of the staged excavation project;

E) processing the second source data so as to display at least a portion of the second input image on the display device;

F) adding, via the at least one user input device, at least one second indicator to the displayed second input image to provide at least one indication of the second dig area and thereby generate a second marked-up digital image; and

G) electronically transmitting and/or electronically storing first information relating to the first marked-up digital image together with second information relating to the second marked-up digital image so as to facilitate the detection of the presence or the absence of the at least one underground facility within the first and second dig areas.

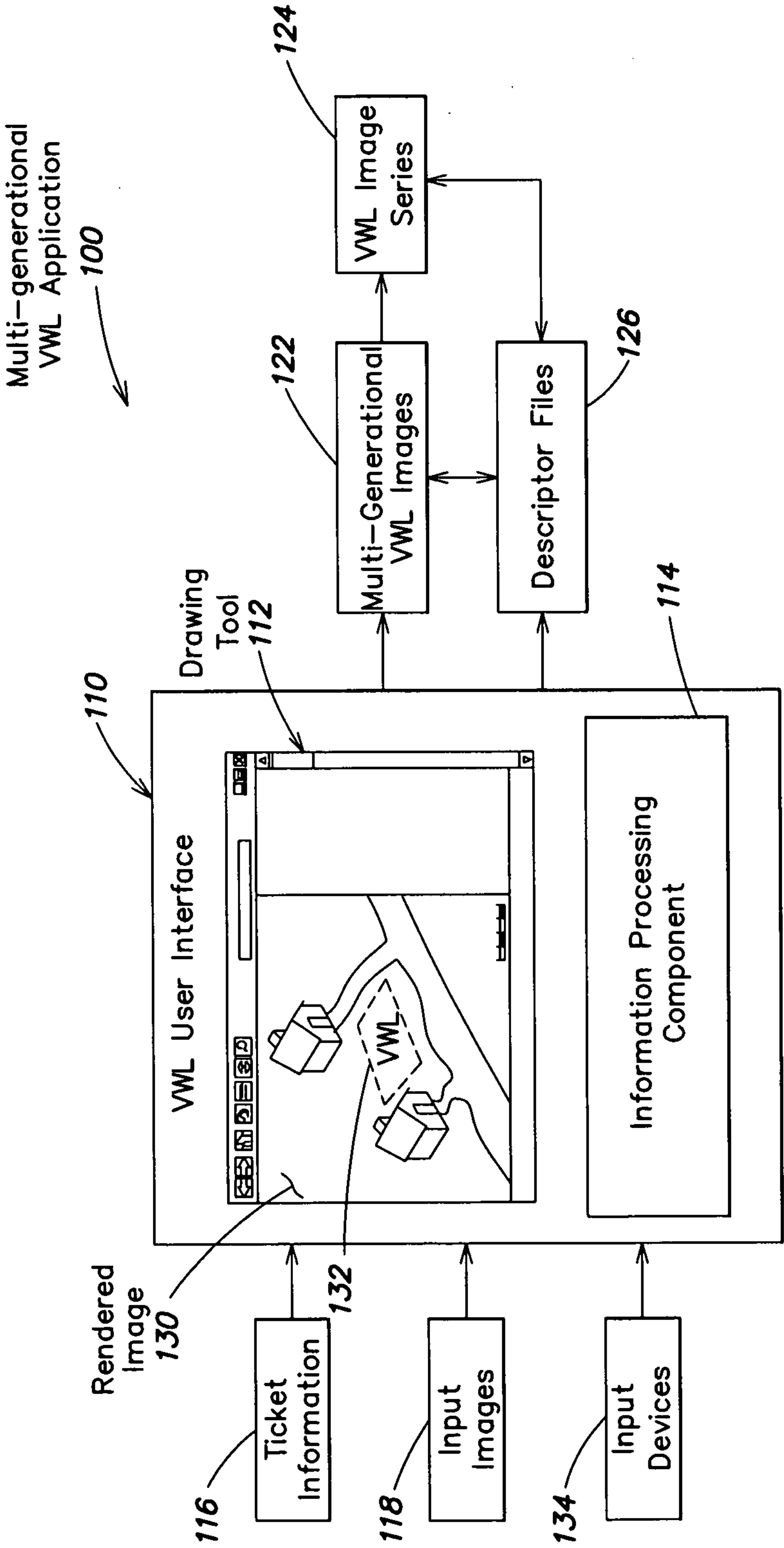
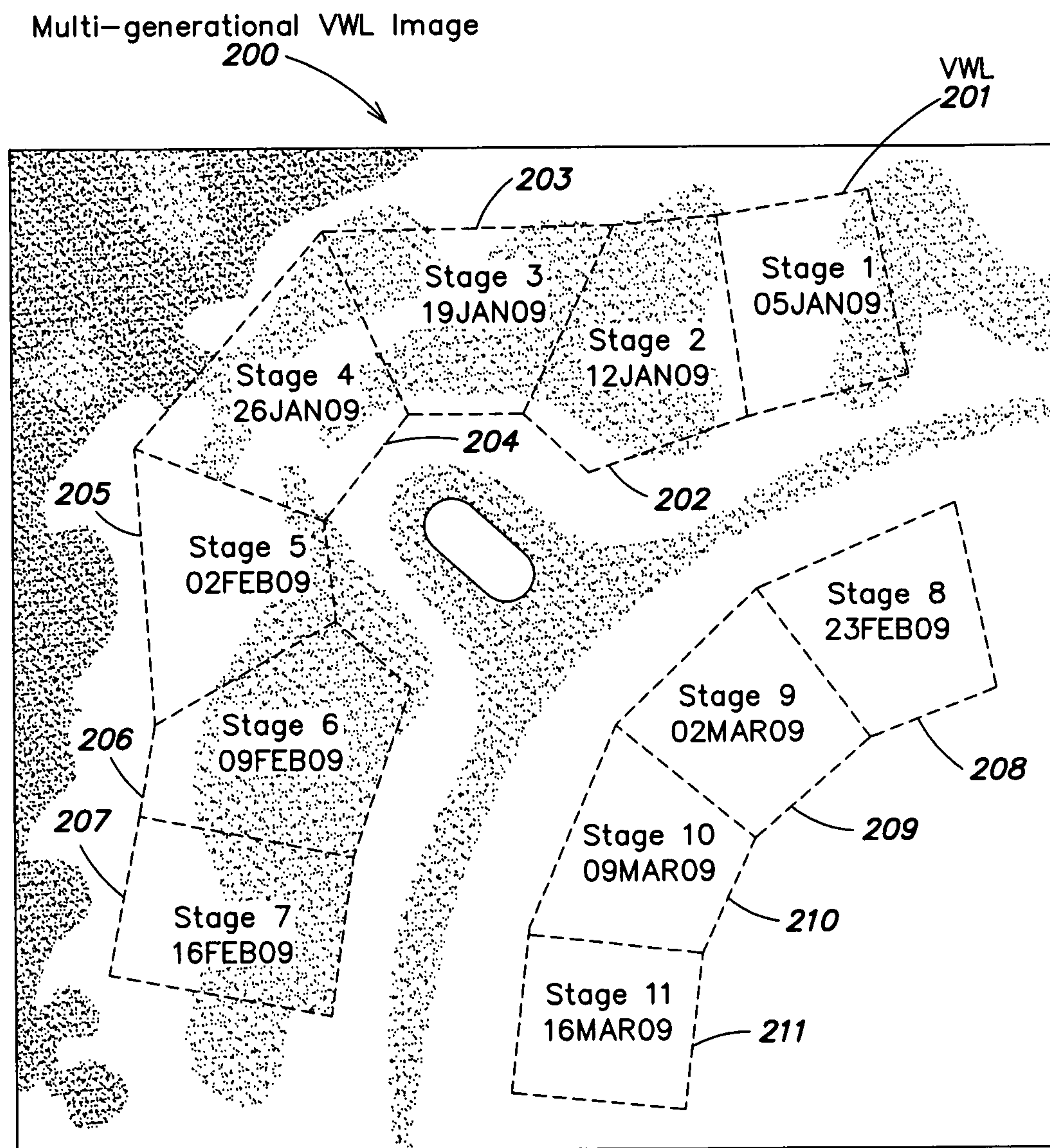
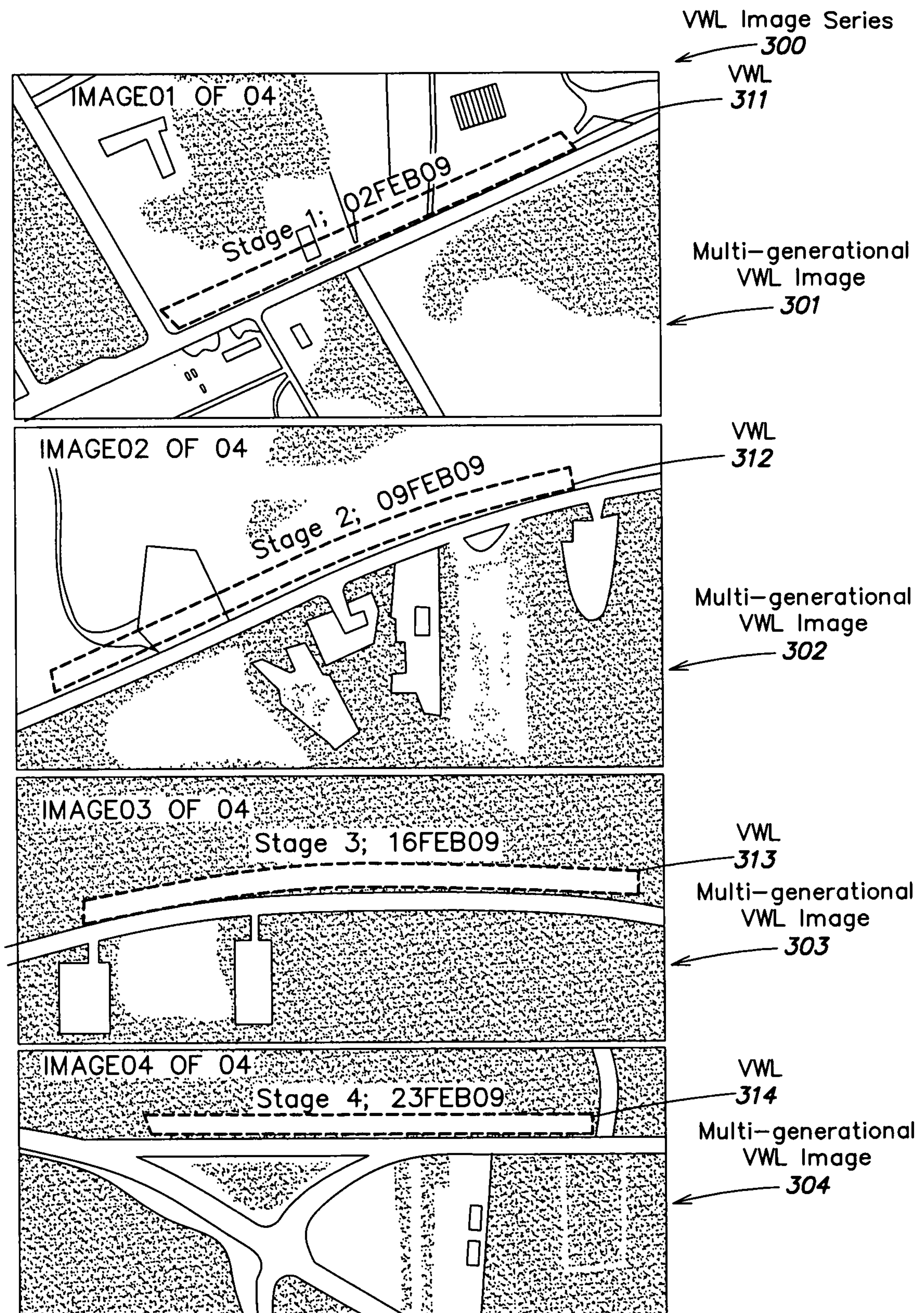


FIG. 1

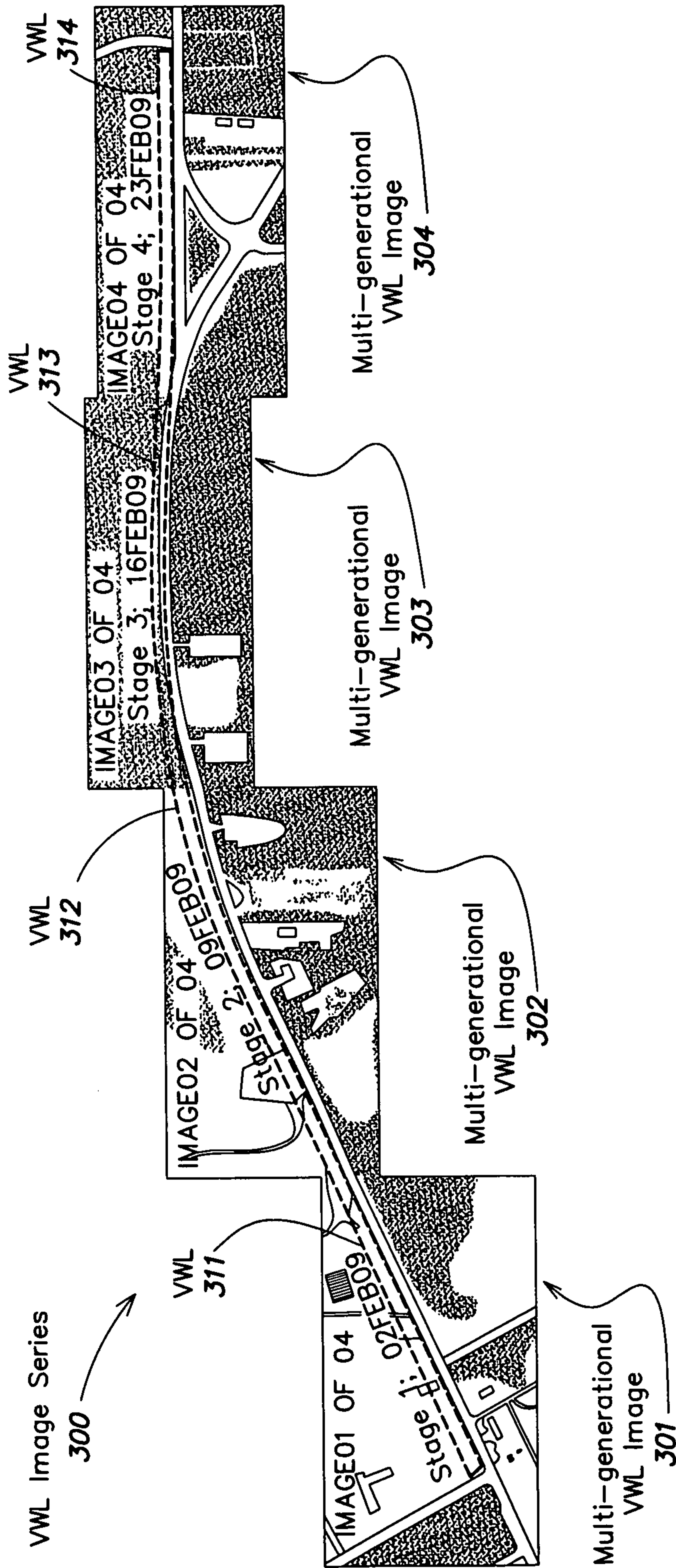
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**FIG. 2**

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**FIG. 3**

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**FIG. 4**

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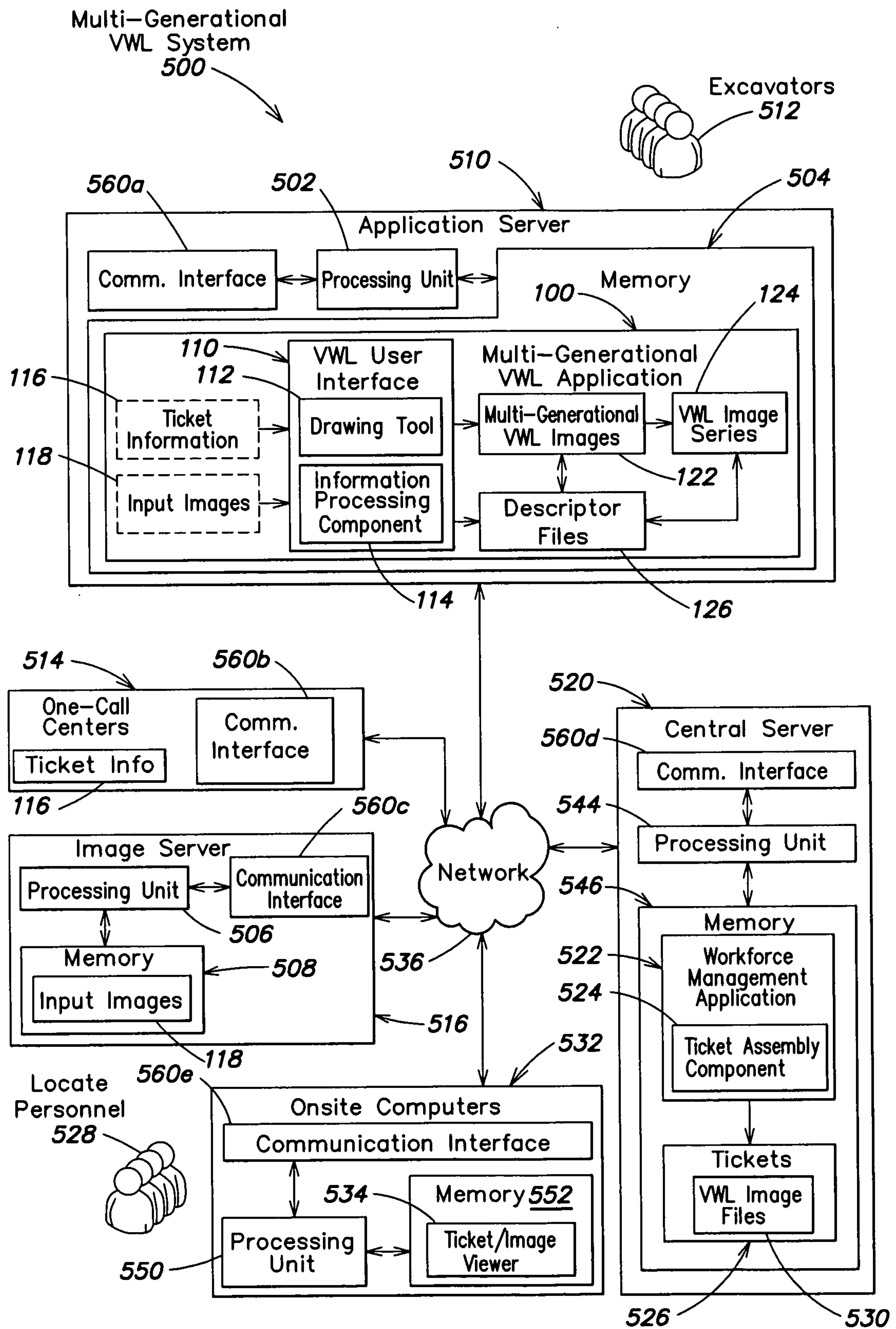


FIG. 5

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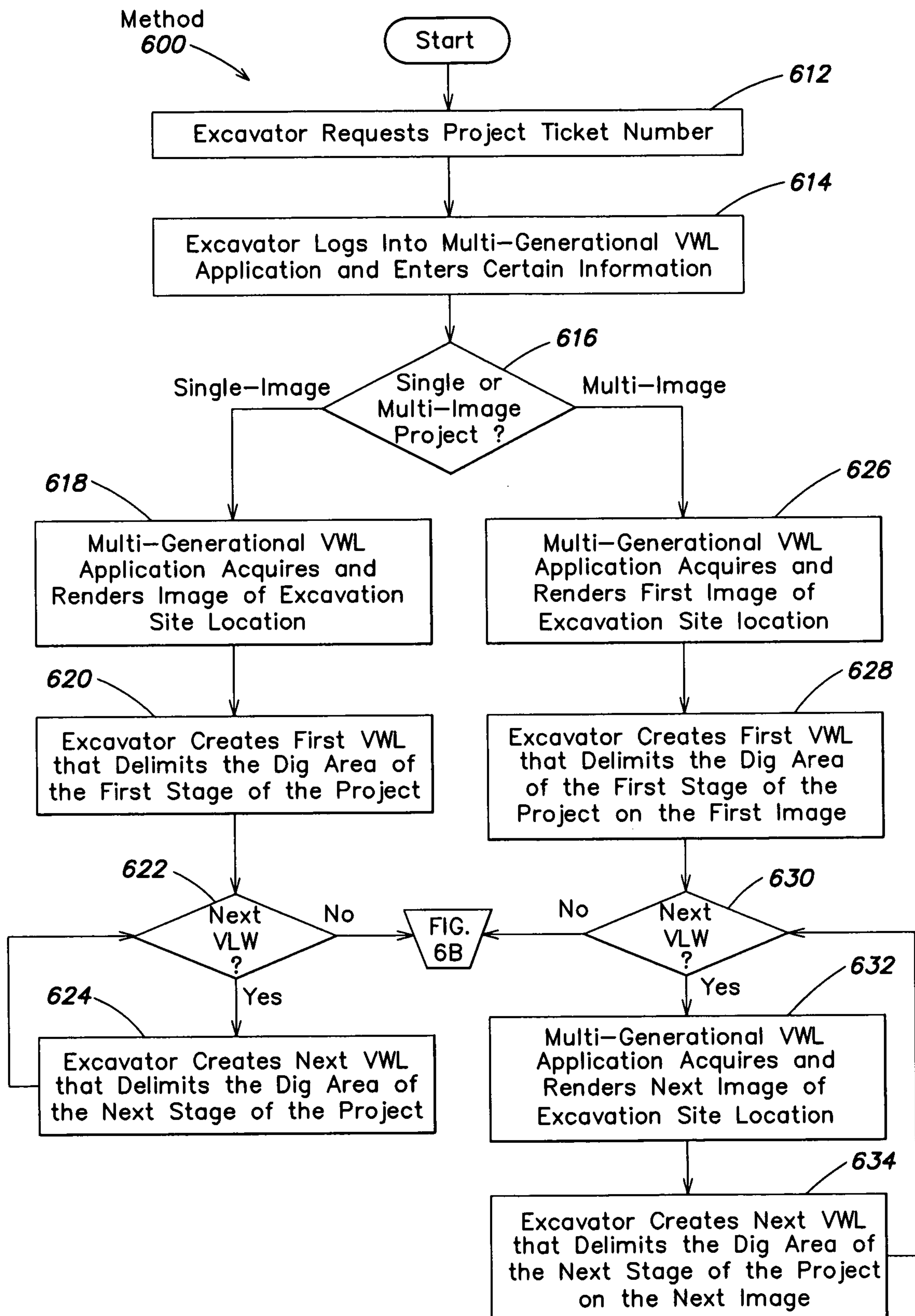
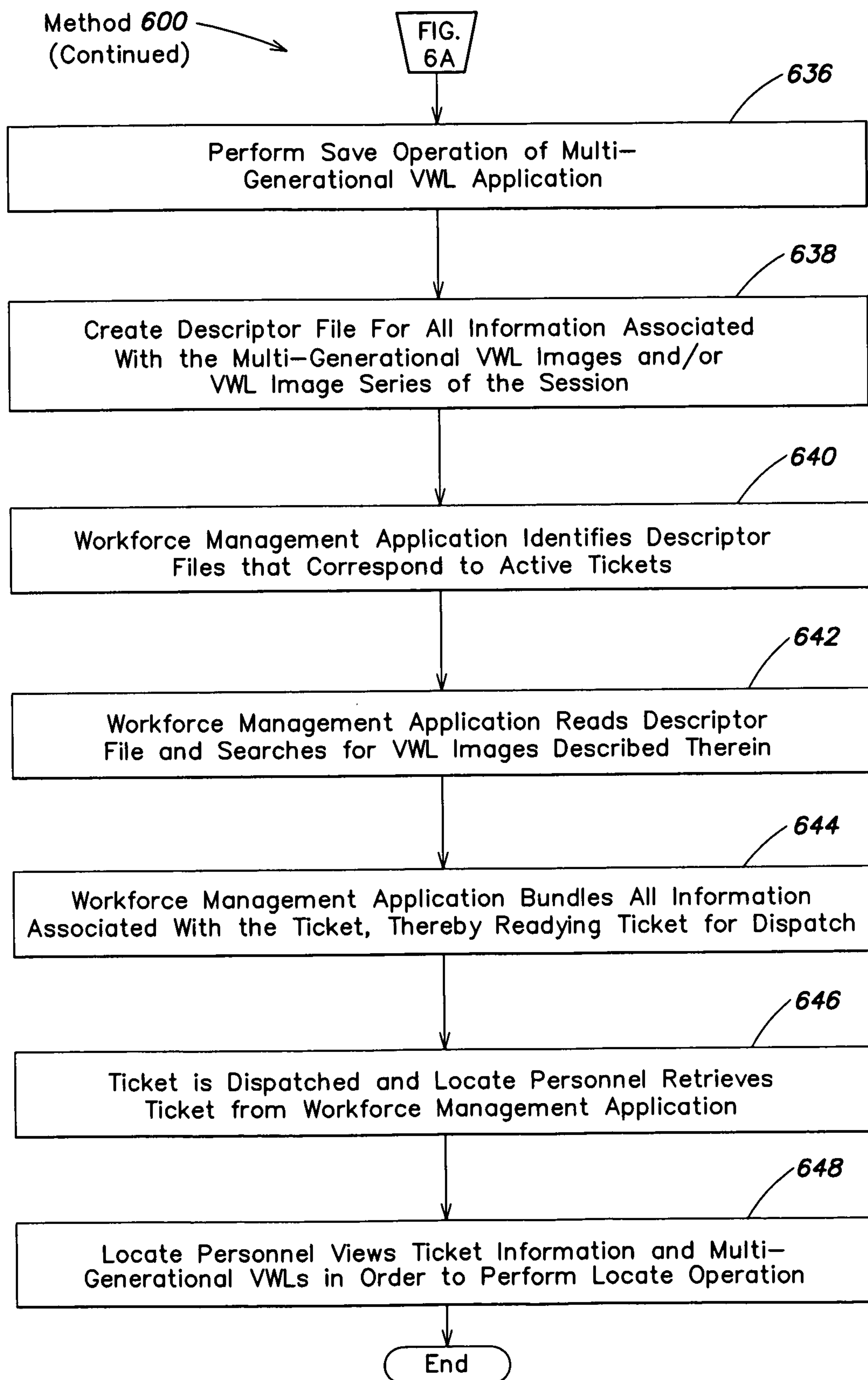
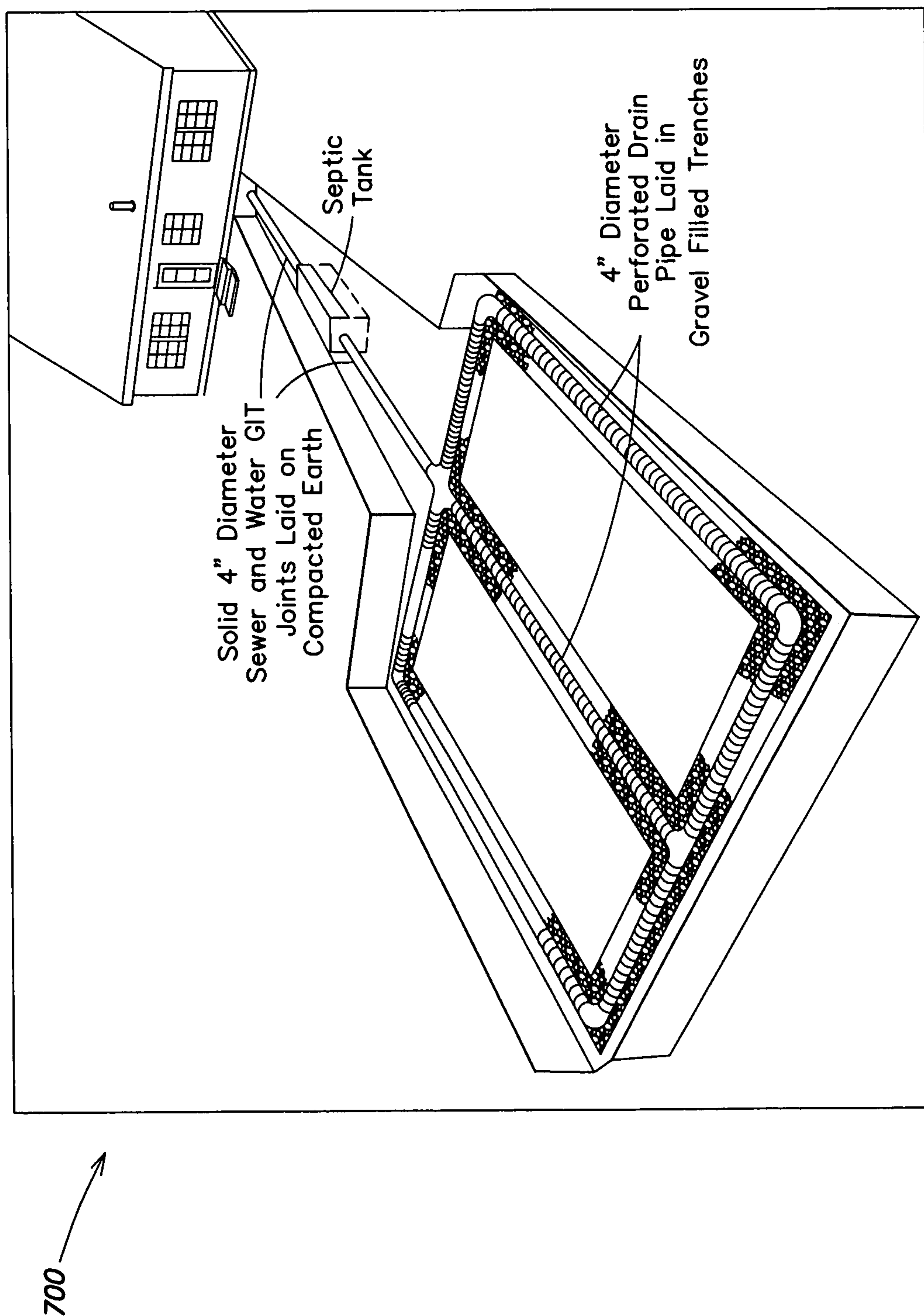


FIG. 6A

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**FIG. 6B**

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800.

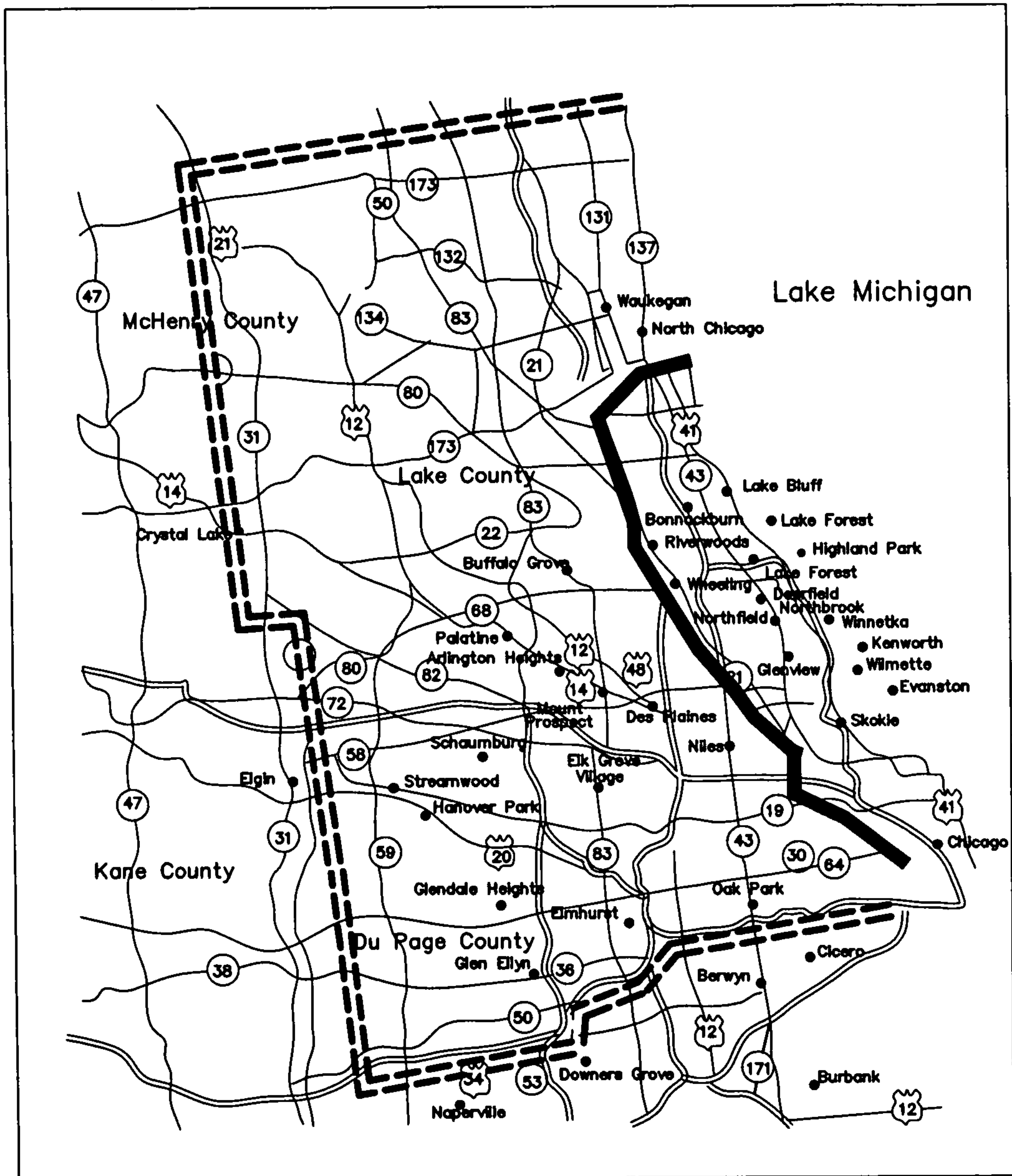
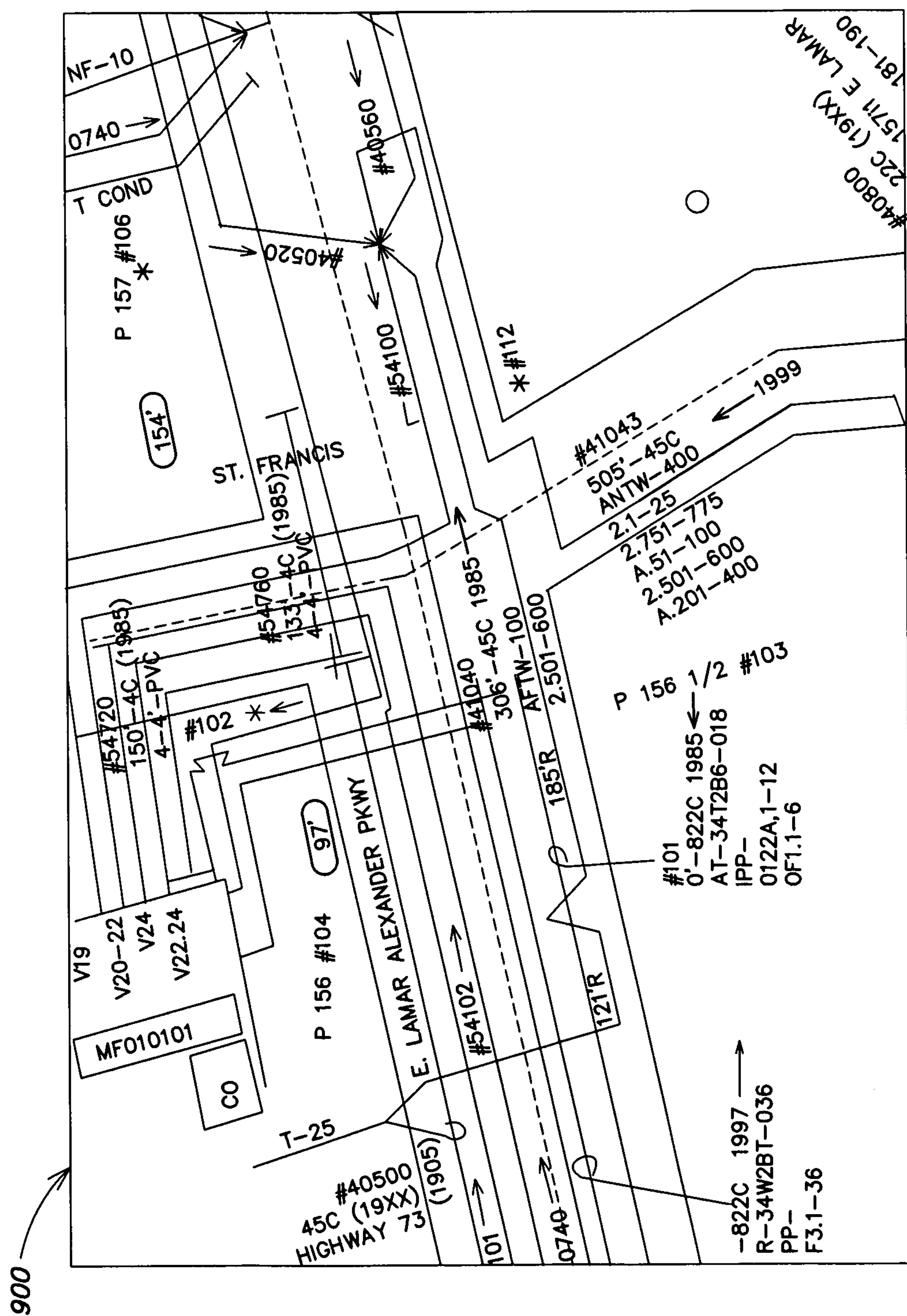
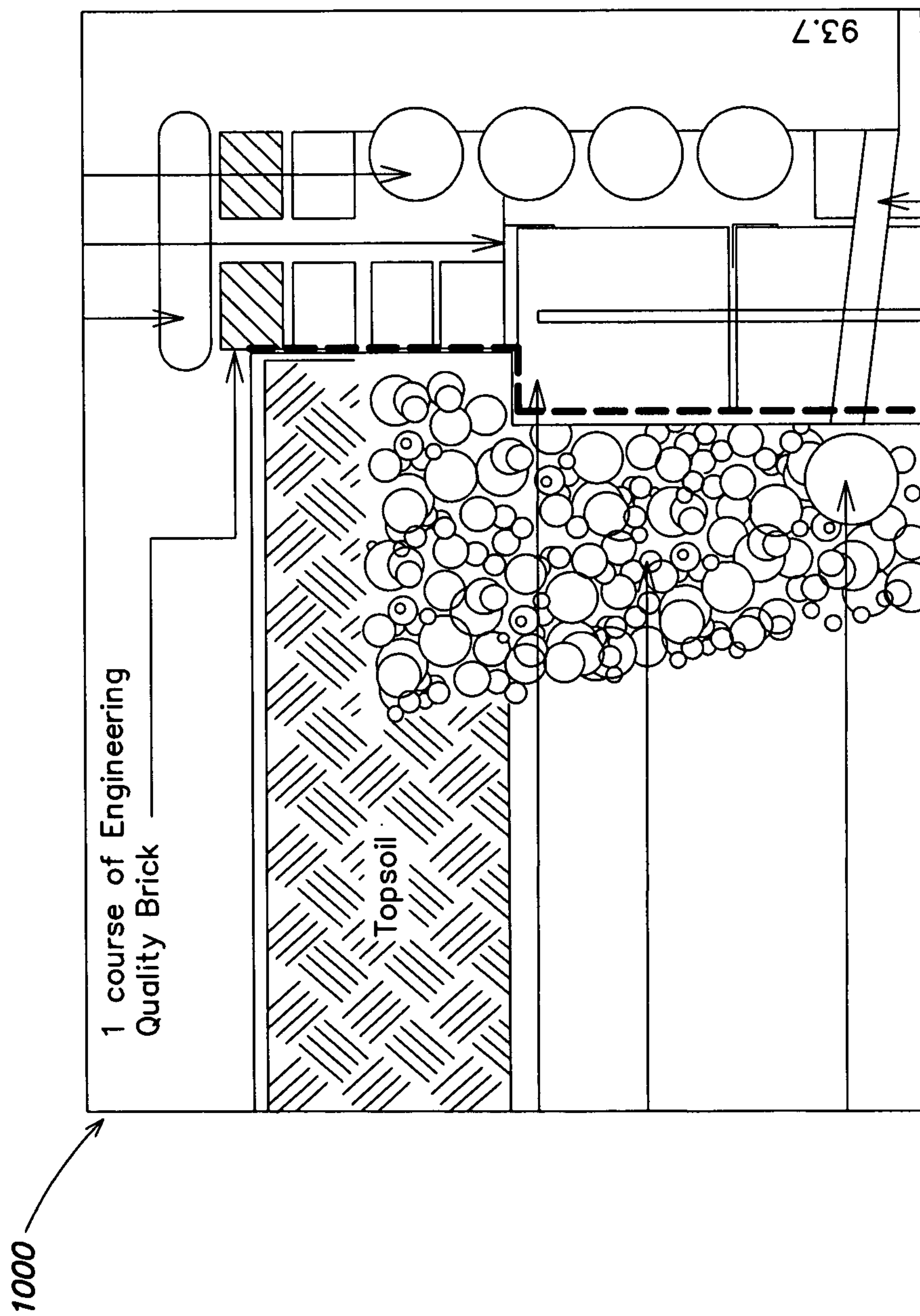


FIG. 8



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*FIG. 10*

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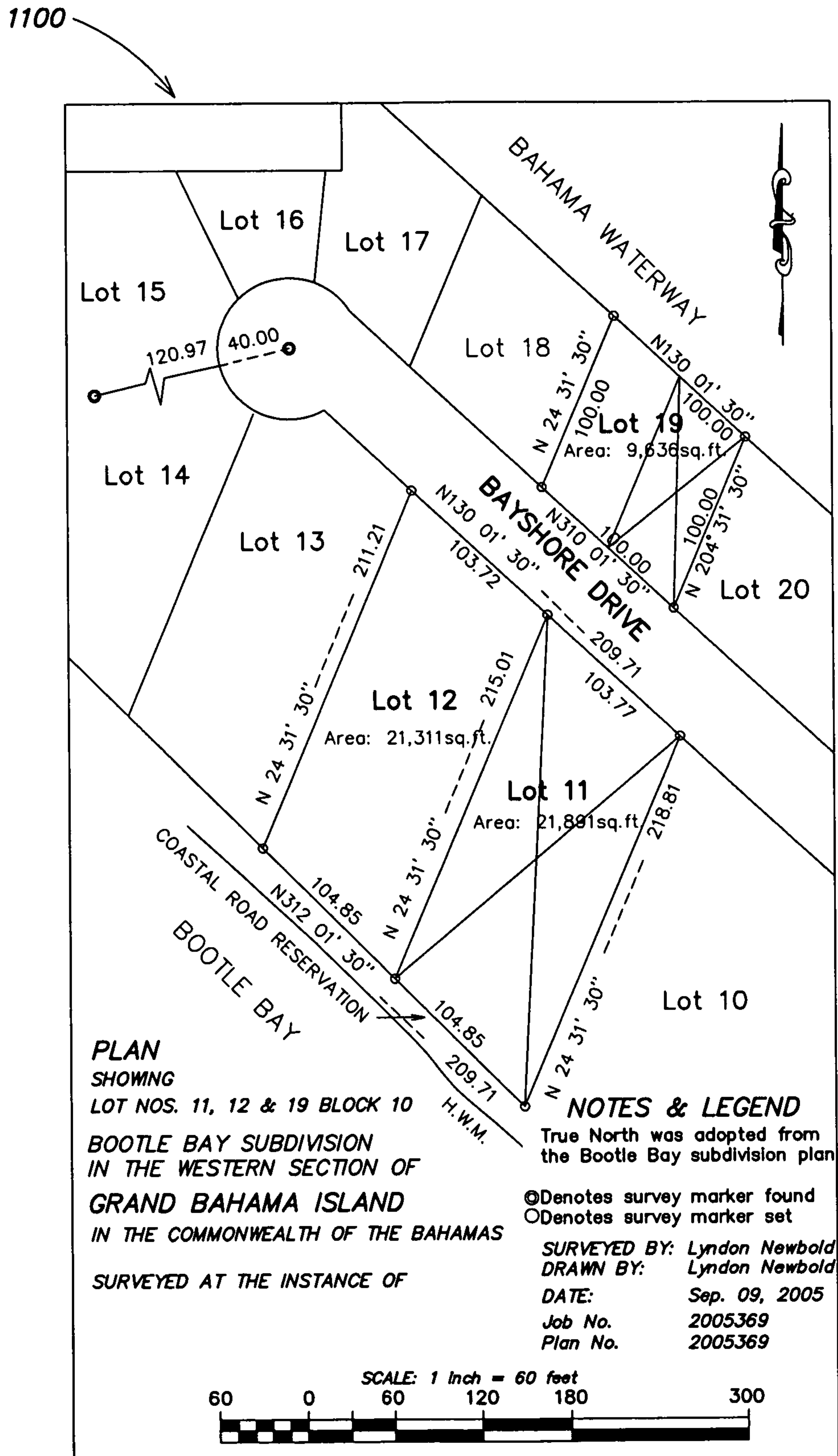


FIG. 11

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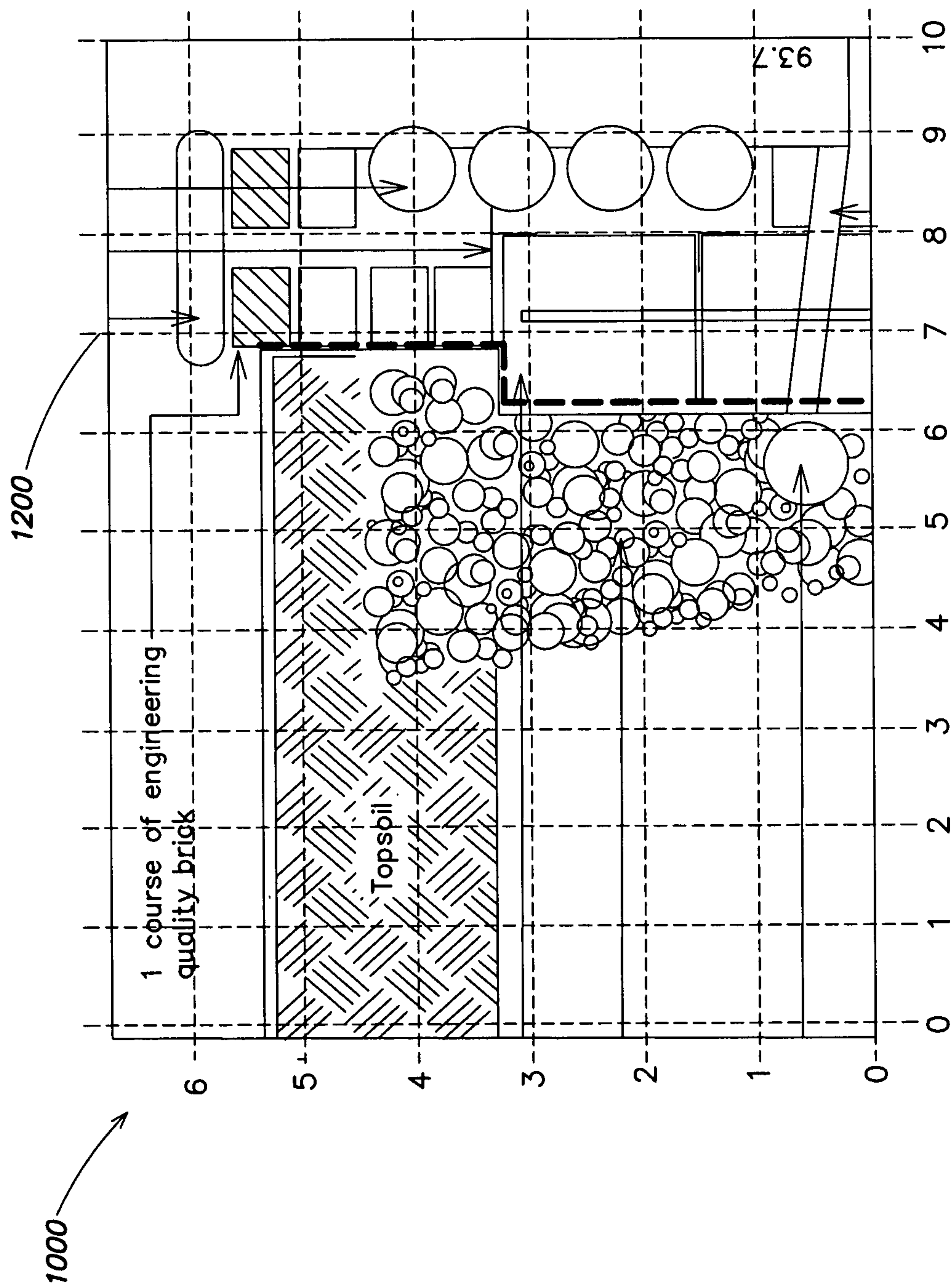
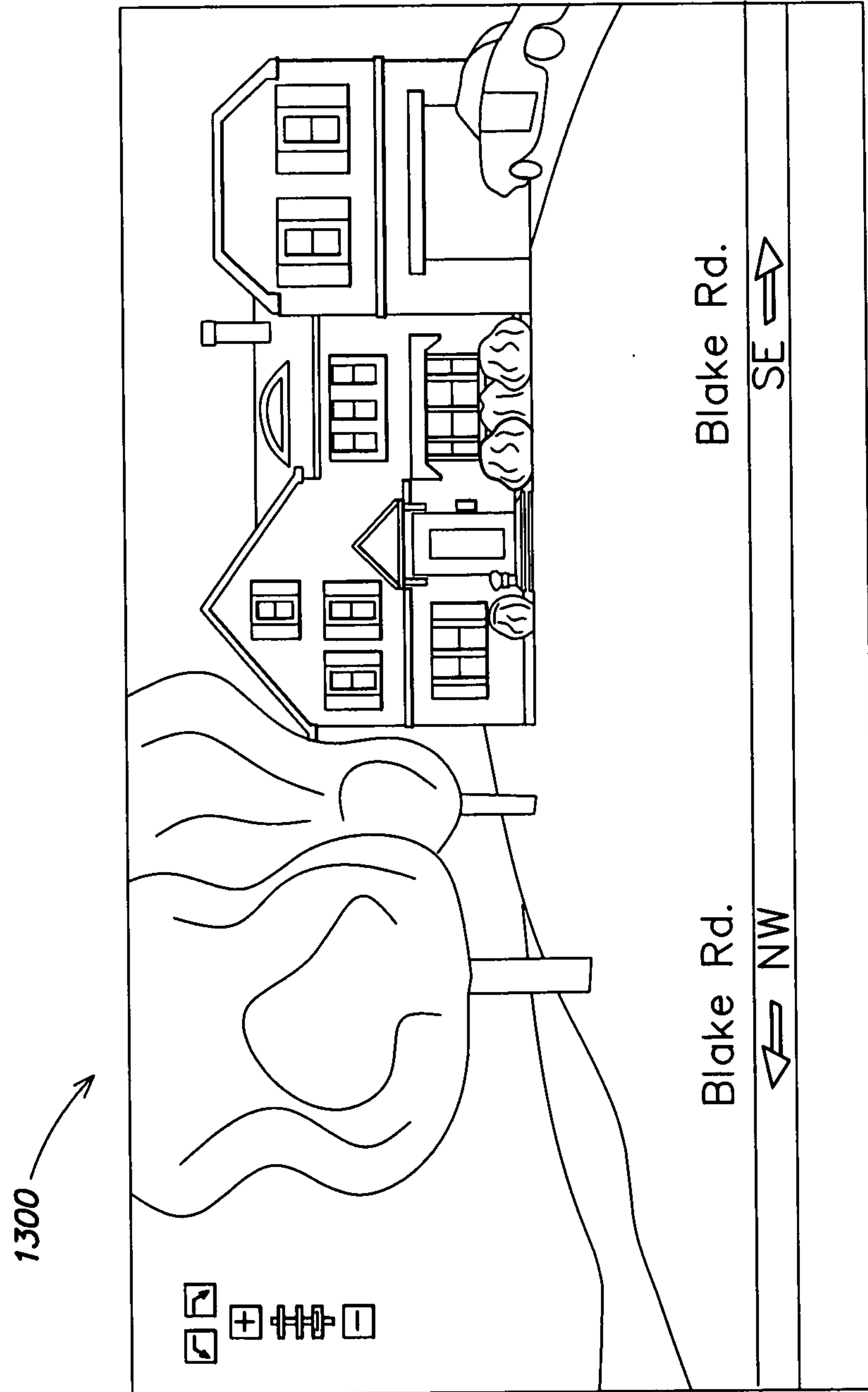


FIG. 12

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**FIG. 13**

Multi-Generational VWL System 500

