




2226 Directional Drill

Model No. 23803—Serial No. 40000000 and Up

Quick Start Guide

This machine is a prototype unit.

Safety

Improper use or maintenance by the operator can result in injury. To reduce the potential for injury, comply with these safety instructions and the safety instruction throughout this document, denoted by the safety-alert symbol , which means: *Caution, Warning, or Danger*—personal safety instruction. Failure to comply with the instruction may result in personal injury or death.

This product is capable of amputating hands and feet. Follow all safety instructions to avoid serious injury or death.

The owner/user can prevent and is responsible for accidents or injuries occurring to people, or damage to property.

Important: Before operating in an area with high-voltage lines or cables, contact a “One-Call System Directory” service. In the USA, call 811 or your local utility company. If you do not know your local utility company’s phone number, call the national number (USA and Canada only) at 1-888-258-0808. Also, contact any utility companies that are not participants of the “One-Call System Directory” service.

- Read and understand the contents of the manual before you start the machine. Make sure everyone using this machine knows how to use it and understands the warnings.
- Do not put hands or feet near moving components on the machine.
- Keep bystanders a safe distance from the machine.
- Do not operate machine without all guards and other safety protective devices in place and working on the machine.
- Keep children out of the operating area and under the watchful care of a responsible adult other than the operator. Never allow children to operate the machine.
- Shut the machine off before servicing, fueling, or unplugging.

Training

- Read the *Operator's Manual* and other training material.
 - Note:** If the operator(s) or mechanic(s) cannot read English, it is the owner's responsibility to explain this material to them.
- Become familiar with the safe operation of the equipment, operator controls, and safety signs.
- All operators and mechanics should be trained. The owner is responsible for training the users.
- Do not let children or untrained people operate or service the equipment. Local regulations may restrict the age of the operator.

Preparation

- Evaluate the terrain to determine what accessories and attachments are needed to properly and safely perform the job. Only use accessories and attachments approved by the manufacturer.
- Wear appropriate clothing; including a hard hat, safety glasses, long pants, safety shoes, and hearing protection.
- Tie back long hair. Do not wear jewelry. Secure loose clothing.
- Inspect the area where the equipment is to be used and ensure that all objects are removed from the machine before use.
- Use extra care when handling fuels. They are flammable and vapors are explosive.
 - Use only an approved container.
 - Do not remove the fuel cap or add fuel with the engine running. Allow the engine to cool before refueling. Do not smoke near the machine when the engine is running.
 - Do not refuel or drain the machine indoors.
- Check that the operator's presence controls, safety switches, and shields are attached and functioning properly. Do not operate the machine unless they are functioning properly.



General Operation

- Do not run the engine in an enclosed area.
- Do not operate without the guards securely in place. Be sure all interlocks are attached, adjusted, and functioning properly.
- Do not change the engine governor setting or overspeed the engine.
- Keep away from moving machine parts and pipes.
- Do not operate the machine when ill or under the influence of alcohol or drugs.
- Do not leave the machine running unattended. Stop the engine and remove the key before leaving.
- Locate the pinch-point areas marked on the machine and attachments and keep hands and feet away from these areas.
- Lightning can cause severe injury or death. If lightning is seen or thunder is heard in the area, do not operate the machine; seek shelter.

- Operate the drive pendant alongside the machine outside of the danger zone (Figure 1).
- Keep all bystanders away while moving the machine.
- Do not carry passengers on the machine.
- Watch for the turning-radius sweep of the drill frame, as the center of the turning radius is the end of the track.
- Moving the machine with the tethered remote can be erratic; move slowly when using the remote for movement.
- Use care when loading or unloading the machine onto a trailer.
- Watch for traffic when crossing roadways.
- Check for overhead clearances (i.e. branches, doorways, electrical wires) before driving under any objects and do not contact them.
- When driving on a slope, the operator should be up-slope from the machine.

Driving Safety

You drive the machine to and from the work site with the use of a tethered remote. When driving the machine, observe the following safety precautions:

The following illustration displays the safe distance that all individuals must maintain while moving the machine.

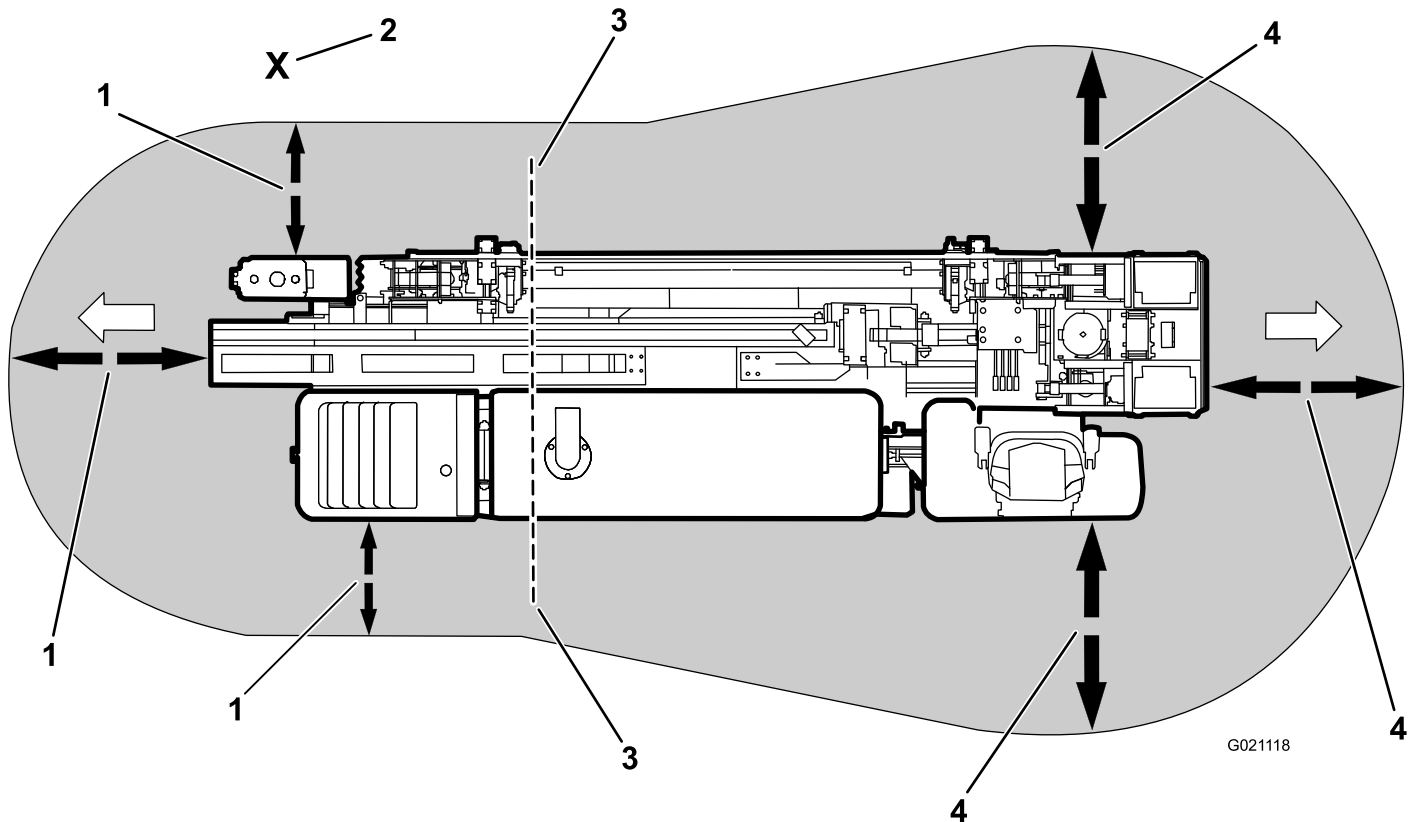


Figure 1
Driving Danger Zone

- | | |
|---------------------------------|---------------------------------|
| 1. 1.8 m (6 ft) safety distance | 3. Turning-radius center |
| 2. Operator | 4. 2.4 m (8 ft) safety distance |

Drilling Safety

Ensure that no one approaches a pipe while it is spinning. The pipe can snag on clothing and cause amputation or death. Always engage the Exit-side Lockout before anyone approaches the front of the machine, bit, reamer, or pipe.

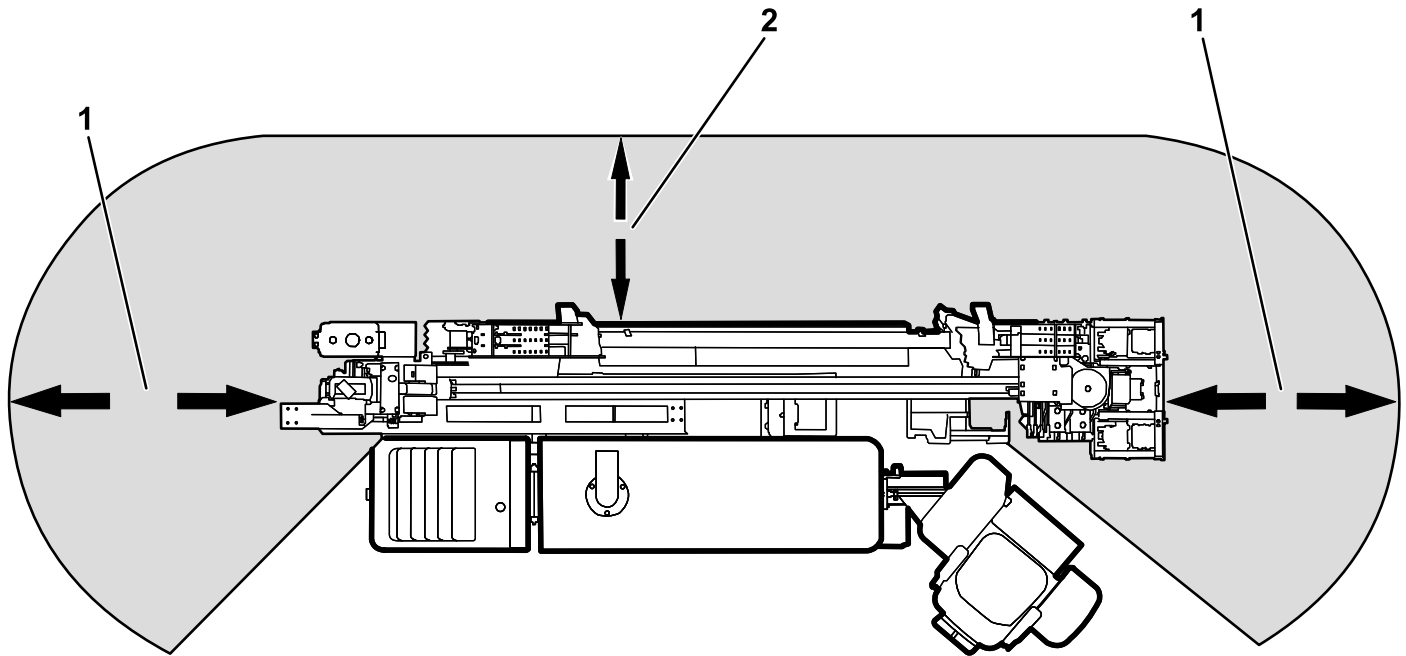
Drilling Danger Zone

The danger zone is the area within and around the machine where a person is exposed to the risk of injury. This proximity

includes where a person can be reached by operational movement of the machine, its working devices, auxiliary equipment, or swinging/falling equipment.

Note: The danger zone defines the amount of space needed for safe drilling operation, including movement of the carriage.

The following illustration displays the safe distance that must be kept by all individuals while drilling.



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Figure 2
Drilling Danger Zone

1. 3 m (10 ft) safety distance

2. 1.8 m (6 ft) safety distance

Drilling Near Utility Lines

When working near buried utility lines, safety precautions must be taken.

Important: Before operating in an area with high-voltage lines or cables, contact a “One-Call System Directory” service. In the USA, call 811 or your local utility company. If you do not know your local utility company’s phone number, call the national number (USA and Canada only) at 1-888-258-0808. Also, contact any utility companies that are not participants of the “One-Call System Directory” service. Please refer to [Drilling Near Utility Lines \(page 3\)](#) for more information.

Utility Line Color

Refer to the following table for the proper utility line and the corresponding utility line color (USA and Canada).

Utility Line	Utility Line Color
Electric	Red
Telecommunication, alarm or signal, cables, or conduit	Orange
Natural gas, oil, steam, petroleum, or other gaseous or flammable material	Yellow
Sewer and drain	Green
Drinking water	Blue
Reclaimed water, irrigation, and slurry lines	Purple
Temporary survey markings	Pink
Proposed excavation limits	White

Electrical Line Safety

⚠ WARNING

If you leave the seat of the machine or touch any part of the machine when it is charged with electricity, serious injury or death could result.

Do not leave the seat of the machine if the machine is charged with electricity.

In the event of an electric strike that charges the machine, the Zap-Alert Electric Strike alarm system will sound for as long as the machine is charged with power.

Note: Immediately contact the proper emergency and utility authorities to secure the area in the case that the machine is charged and you cannot leave the seat of the machine.

Note: It is possible to strike a utility line without the machine becoming charged.

- The alarm will sound if the drill contacts an electrical power source.
- It is likely (but not always the case) that the power-source interrupter or breaker will trip, but to ensure your safety, consider that the machine may be conducting electricity.
- Do not attempt to leave the machine.

Note: You will be safe as long as you do not leave the seat of the machine.

- Touching any part of the machine may ground you.
- Do not allow another individual to touch or approach the machine when charged.
- The alarm may sound if a communication line is broken, but until you are certain, you must consider the alarm to be an electric strike.

Gas Line Safety

⚠ WARNING

If you damage a gas line, an immediate explosion and fire hazard could occur. Leaking gas is both flammable and explosive and may cause serious injury or death.

- Do not smoke while operating the machine.
- Shut off the machine and remove the key.
- Remove all individuals from the work area.
- Immediately contact the proper emergency and utility authorities to secure the area.

Water Line Safety

If you damage a water line, a potential flood hazard could occur.

- Shut off the machine and remove the key.
- Remove all individuals from the work area.
- Immediately contact the proper emergency and utility authorities to secure the area.

Communication Line Safety

Important: Refer to [Electrical Line Safety \(page 4\)](#) if a communication line is damaged.

⚠ CAUTION

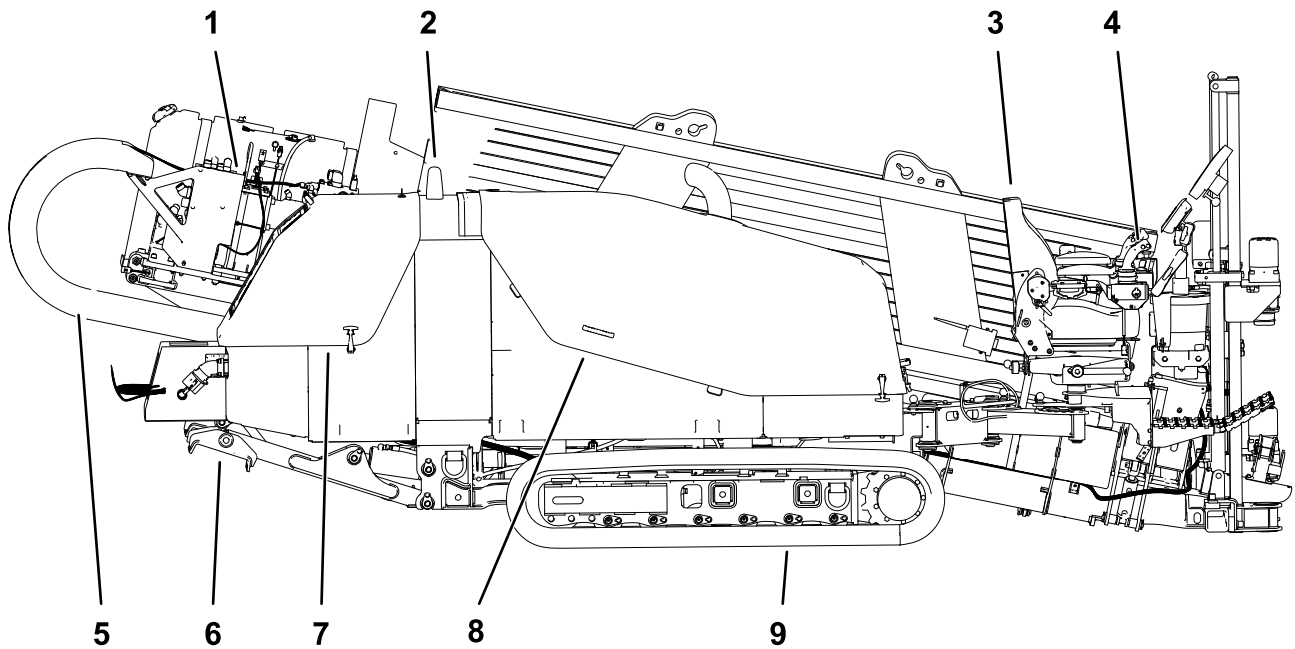
If you damage the fiber-optic cable and look into the exposed highly-intense light, you may harm your eyes.

- Shut off the machine and remove the key.
- Remove all individuals from the work area.
- Immediately contact the proper emergency and utility authorities to secure the area.

Maintenance and Storage

- Do not touch parts which may be hot from operation. Allow them to cool before attempting to maintain, adjust, or service.
- Lower the thrust frame, stop the engine, and remove the key. Wait for all movement to stop before adjusting, cleaning, or repairing.
- Clean debris from attachments, drives, mufflers, and engine to help prevent fires. Clean up oil or fuel spillage.
- Let the engine cool before storing and do not store near flame.
- Do not store fuel near flames or drain indoors.
- Park the machine on level ground.
- Do not allow untrained personnel to service the machine.
- Carefully release pressure from components with stored energy.
- Keep hands and feet away from moving parts. If possible, do not make adjustments with the engine running.
- Disconnect the battery before making any repairs. Disconnect the negative terminal first and the positive last. Reconnect positive first and negative last.
- Charge batteries in an open, well ventilated area, away from spark and flames. Unplug the charger before connecting or disconnecting it from the battery. Wear protective clothing and use insulated tools.
- Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.
- Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
- Keep all parts in good-working condition and all hardware tightened. Replace all worn or damaged decals.
- If any maintenance or repair requires the frame to be in the raised position, secure the frame in the raised position with the hydraulic cylinder lock.
- Keep nuts and bolts tight.
- Keep equipment in good condition.
- Do not tamper with safety devices.
- Keep the machine free of grass, leaves, or other debris build-up. Clean up oil or fuel spillage. Allow the machine to cool before storing.
- Use extra care when handling fuels. They are flammable and vapors are explosive.
 - Use only an approved container.
 - Do not remove the fuel cap or add fuel when the engine is running. Allow the engine to cool before refueling. Do not smoke.
 - Do not refuel the machine indoors.
- Do not store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
- Do not fill a container while it is inside a vehicle, trunk, pick-up bed, or any surface other than the ground.
- Keep container nozzle in contact with the tank during filling.
- Use only genuine Toro replacement parts to ensure that original standards are maintained.
- Keep your body and hands away from pin hole leaks or nozzles that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks; do not use your hands. Hydraulic fluid escaping under pressure can penetrate skin and cause injury requiring surgery within a few hours by a qualified surgeon or gangrene may result.

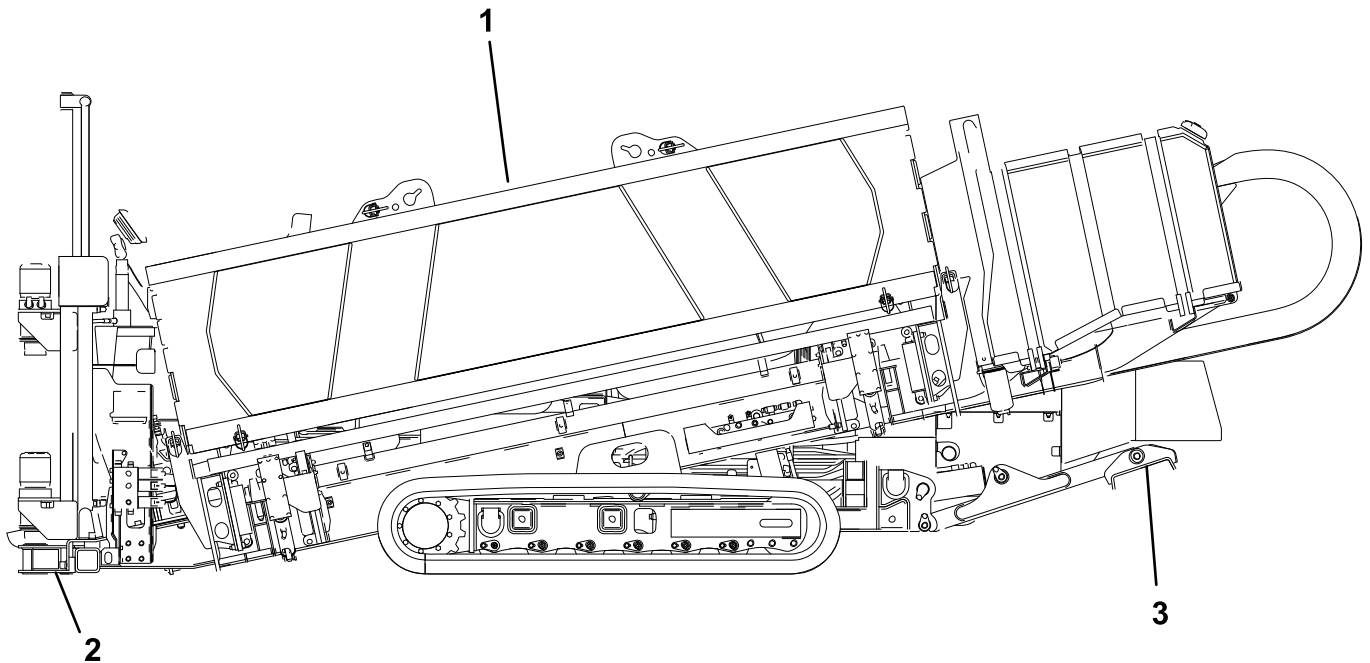
Product Overview



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Figure 3

- | | |
|---------------------|---------------------|
| 1. Drill carriage | 6. Right Stabilizer |
| 2. Zap alert strobe | 7. Rear hood |
| 3. Operator seat | 8. Front hood |
| 4. Control panel | 9. Track |
| 5. Thrust frame | |



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Figure 4

- | | |
|---------------------|--------------------|
| 1. Pipe holder | 3. Left stabilizer |
| 2. Stake down plate | |

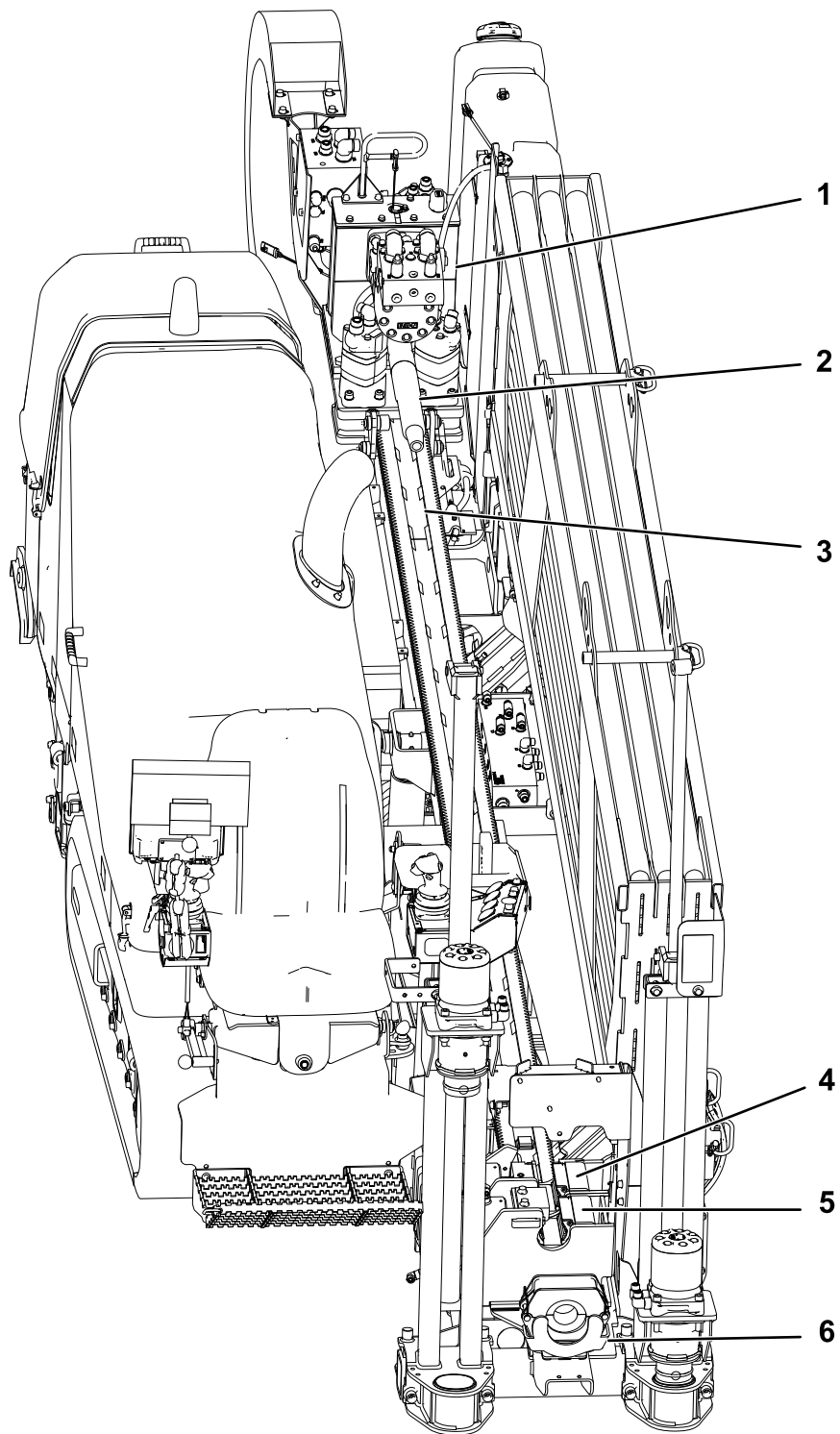


Figure 5

- 1. Drill carriage
- 2. Drill spindle
- 3. Thrust frame

- 4. Upper wrench
- 5. Lower wrench
- 6. Pipe wiper

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Operation

Understanding Horizontal Directional Drilling

Horizontal directional drilling is a process used for drilling a horizontal bore through the soil and under obstructions such as roads, buildings, bodies of water, etc. Once you drill the bore, you pull back the utility lines or pipes through the bore and connect them as needed. Because it does not require very much disturbance of the surface, installation of utilities using directional drilling preserves the environment and saves both time and money over traditional installation methods such as trenching.

When installing cabling or pipe using a directional drill, you complete the following steps:

1. Gather site information.

Before operating in an area with high-voltage lines or cables, contact a “One-Call System Directory” service. In the USA, call 811 or your local utility company. If you do not know your local utility company’s phone number, call the national number (USA and Canada only) at 1-888-258-0808. Also, contact any utility companies that are not participants of the “One-Call System Directory” service. Please refer to [Drilling Near Utility Lines \(page 3\)](#) for more information.

Before fully planning the bore, you must gather information about the job site such as the location of other utilities, obstacles at the site, and what regulations and permits you will need to complete the job; refer to [Gathering Site Information \(page 9\)](#).

2. Plan the bore.

Before you can drill, you must first plan the bore path based on the information you gathered. Refer to [Planning the Bore Path \(page 11\)](#).

3. Prepare the job site and the machine.

Before drilling, you prepare the job site with an entry point, depth-gauge hole (optional), and an exit hole. You also need to drive the unit to the site, set it up for drilling, and connect it to a drilling-fluid mixer.

Note: When drilling, you connect the machine to a drilling-fluid mixer that mixes water with bentonite clay and other ingredients. The machine pumps this mixture, referred to as drilling fluid or “Mud”, through the drill pipe and out the drill bit. The drilling fluid lubricates the bit, helps to hold the bore open while drilling, and mixes with the spoils, flushing them out of the bore through the entry point.

Refer to [Preparing the Job Site and the Machine \(page 18\)](#) for instructions on preparing the job site and the machine.

4. Drill the bore.

You drill the bore in three stages:

A. Entry

In the entry phase of the bore, you push the drill bit and head into the ground at an angle of up to 16 degrees. After pushing in one or more pipes, you begin drilling down and forward until you reach the desired depth or depth-gauge hole (if used).

B. Horizontal Reach

After reaching the desired depth, you push the bit forward, steering the bit to a horizontal depth. The drill bit emits a radio signal from the sonde housing, which allows a crew member on the surface to track the location and depth of the head using the sonde receiver as you drill and steer it along a planned route.

C. Exit

Once you have attained the planned horizontal reach, you steer the head up at an angle similar to your entry angle bringing the bit into the exit hole or trench.

Refer to [Drilling the Bore \(page 25\)](#).

5. Backream the bore and pull back the cabling or pipe.

After entering the exit hole, the end crew detaches the drill bit and sonde housing from the drill pipe. In its place, they attach a reaming bit and the end of the cable or pipe to be pulled through the bore. The reaming bit is designed to enlarge the bore as you pull it back. As before, you pump drilling fluid through the pipe to the reaming bit as you pull the cable or pipe back through the bore to lubricate the reamer and allow the cable or pipe to slide easily through the bore. You continue pulling the pipe back until the reamer reaches the depth-gauge hole or exits at the entry point. There you remove the reamer and product from the drill pipe, pulling the pipe the rest of the way back to the machine.

Refer to [Backreaming and Pullback \(page 28\)](#) for instructions on backreaming and pulling cable or pipe.

6. Finish the bore and leave the job site.

After completing the operation, you need to disconnect and clean the machine and load it on the trailer; refer to [Finishing the Job \(page 30\)](#).

Gathering Site Information

Planning the Initial Route

Before you can begin boring, you need to plan the route you will bore and prepare as follows:

- Create a basic plan for the bore, mapping out the proposed route.
 - Note any obstacles which may affect the bore such as large trees, bodies of water, buildings, etc.
 - Plan the route of the bore to avoid as many obstacles as possible.
 - Determine the depth of any bodies of water to be crossed to ensure that you can get deep enough under them.
- Determine the depth you need to install the material at and the minimum bend radius both of the drill pipe and of the material being installed. This will seriously affect how long the bore needs to be and at what angle you can begin and end; refer to [Planning the Bore Path \(page 11\)](#).
- Have the area of the bore marked for utility lines (in the US call 811). Ensure that all lines are marked on your blueprints/bore plan as well.
- Contact the local authorities to arrange for any permits and traffic control that you will need to conduct the job.

Inspecting the Proposed Job Site

Physically inspect the site as follows:

- Note the terrain, slopes, valleys, hills, and any features not planned for previously.

Determine the degree of slope at both the proposed entry point and exit point.
- Determine what the soil types are in the area and, if possible, what they are at the depth you will be boring. You may need to dig test holes at intervals along the bore path to fully determine this.
- Walk the area of the bore looking for any possible unmarked obstructions. Look for manholes, pedestals, old foundations, etc.
- Identify all hazards of which you will be passing within 3 m (10 ft).

⚠ DANGER

Contacting underground hazards with the machine while drilling or reaming can cause explosion, electrocution, breathing problems, severe trauma, and death to you or bystanders.

- Ensure that all personnel at the job site wear personal protective equipment including a hard hat, eye protection, and hearing protection.
- Keep bystanders and spectators away from the job site, including the complete bore path.
- Locate and expose all electric and gas lines that you will be crossing by careful hand digging.
- Ensure that you use the Zap-Alert system whenever operating the machine.

Common hazards include the following:

- Gas lines

⚠ DANGER

Drilling into a gas line can cause an explosion or fire, burning, injuring, or killing you or others in the vicinity of the break.

- ◇ Do not smoke or have any source of flame near gas lines or at either end of a bore that will be crossing a gas line.
- ◇ Keep bystanders and spectators away from the job site, including the complete bore path.
- ◇ Locate and expose all gas lines that you will be crossing by careful hand digging.
- ◇ Have the gas company turn off the gas to any lines you will be crossing before drilling.
- ◇ Use the receiver to track the exact position of the drill head when approaching gas lines.

- Electrical power lines

⚠ DANGER

Drilling into an electric power line will cause the machine to become electrified and may electrocute you or any bystanders.

- ◇ Keep bystanders and spectators away from the job site, including the complete bore path.
- ◇ Locate and expose all electric lines that you will be crossing by careful hand digging.
- ◇ Have the electric company turn off the power to any lines you will be crossing before drilling.
- ◇ Use the receiver to track the exact position of the drill head when approaching electric lines.
- ◇ Before drilling, setup and use the Zap-Alert system which is designed to notify in the case of an electric strike and electrically isolate the machine operator from the machine. If the Zap-Alert alarm triggers, stop what you are doing and do not leave the operator's position. Refer to [Deploying the Zap-Alert System \(page 24\)](#) for detailed instructions on using the Zap-Alert system.

- Crystalline silica and other dust

If you will be drilling through or cutting concrete, sand, or other substances that create dusts or fumes, you need to ensure that you and all workers wear breathing protection to protect your lungs from the dust.

⚠ WARNING

Machining or handling stone, masonry, concrete, metal, and other materials can generate dust, mists, and fumes containing chemicals, such as silica, known to cause serious or fatal injury or illness, such as respiratory disease, silicosis, cancer, birth defects, or other reproductive harm.

- ◇ Control dust, mist, and fumes at the source where possible. Water should be used for dust suppression when feasible.
- ◇ Use good work practices and follow the recommendations of the manufacturer or suppliers, OSHA, and other occupational and trade associations.
- ◇ When the hazards from inhalation cannot be eliminated, the operator and any bystanders should wear a respirator approved by OSHA for the material being handled.

⚠ WARNING

Silicosis Warning: Grinding, cutting, or drilling stone, masonry, concrete, metal, and other materials with silica in their composition may give off dust or mist containing crystalline silica. Silica is a basic component of sand, quartz, brick, clay, granite, and numerous other minerals and rocks. Repeated and/or substantial inhalation of airborne crystalline silica can cause fatal respiratory diseases, including silicosis. In addition, some other authorities have listed respirable crystalline silica as a substance known to cause cancer. When cutting such materials, follow respiratory precautions.

Planning the Bore Path

Before setting up the job site, you need to plan the bore path, including the following:

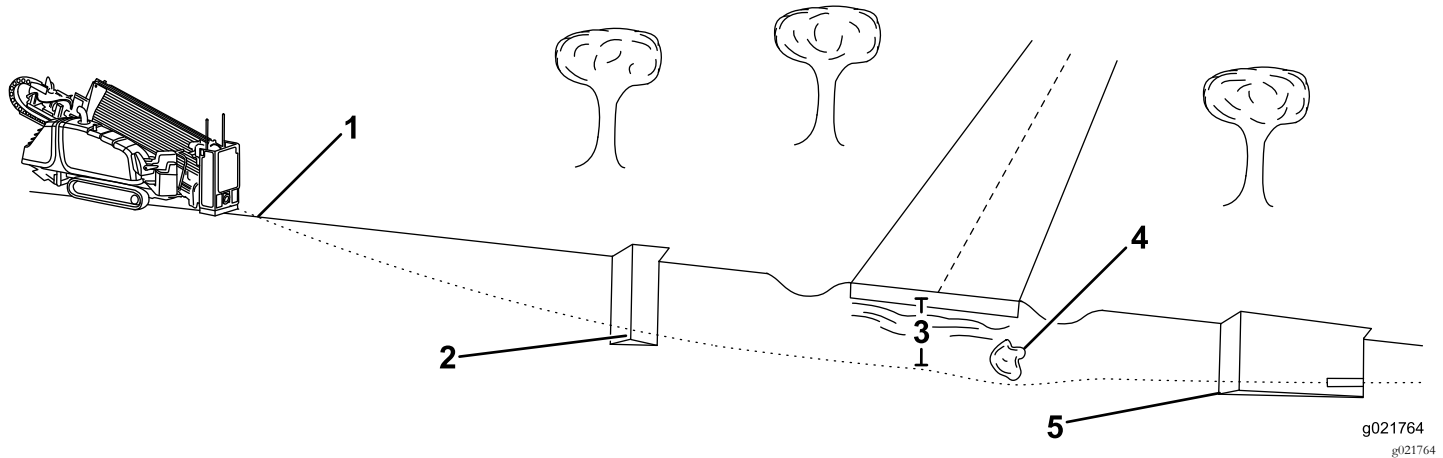


Figure 6

1. Bore entry
2. Beginning-of-bore-at-depth point
3. Bore depth
4. Obstacle
5. End-of-bore-at-depth point and bore exit

- **Bore entry**

This is the location where you setup the machine and the drill bit enters the ground. Depending on conditions, this will typically be set back 9 to 15 m (30 to 50 ft) from the beginning-of-the-bore-at-depth point.

- **Beginning-of-bore-at-depth point**

This is the point where you want the utility line or pipe to end after installation is complete. It is typically the point at which the bore levels out and begins to bore horizontally. This may be the same as the entry point, or you may dig a separate depth-gauge hole at this point (Figure 6).

- **Bore depth**

This is the depth at which you want to install the utility line or pipe. This machine is designed primarily for installations between 1 and 3 m (3.5 to 10 ft).

- **Obstacles in the path**

It is important to know where the known obstacles are that you will need to steer around or under before starting so that you can plan where to begin steering prior to reaching the obstacle.

- **End-of-bore-at-depth point**

This is the point where you want the utility line or pipe to begin after installation is complete. Often this will also be the bore exit.

- **Bore exit**

This is the location where the drill head will exit the ground and the point at which you will pull the utility lines or pipe into the bore. If this point will be at the surface instead of at installation depth, you will need to determine the distance from the end-of-bore-at-depth location

needed for steering the drill to the surface, typically 9 to 15 m (30 to 50 ft) from the end-of-the-bore-at-depth point.

Determining the Bore Entry Point

One of the more challenging aspects of planning the bore path is to determine the entry point of the bore. You need to take the following traits into account when determining the location of the entry point:

- **Bore depth**

This is the depth at which you want to install the utility line or pipe. This machine is designed primarily for installations between 1 and 3 m (3.5 to 10 ft).

- **Pipe and material flexibility**

The 3 m (10 ft) pipes used on this machine can flex to an 8% pitch over the length of the pipe; this equates to a bend of no more than 20 cm (8 inches) off of a straight path (Figure 7).

Important: If you steer the pipe to bend sharper than 20 cm (8 inches) per pipe, you may damage the pipes and their connections. You must also make steering changes gradually over the entire length of each pipe. If you steer the whole 20 cm (8 inches) in only 25 to 50 cm (1 to 2 ft) of travel, you will permanently damage the pipes.

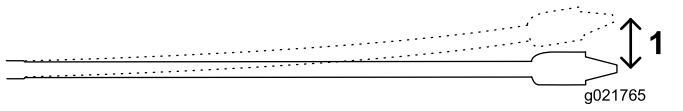


Figure 7

1. 20 cm (8 inches)

This flexibility is often rated in materials as a minimum bend radius, which is the radius of the circle formed if the material or pipes, connected together, were bent to form a giant circle. The minimum radius of a circle made with the pipe used with this machine is 36.6 m (102 ft).

• **Entry pitch**

The entry pitch is the angle at which the machine enters the ground. With the tracks on level ground, the stabilizers down, and the stake-down plate on the ground, the drill frame angle is about 15 degrees or a 27% pitch. This pitch will change depending on the slope of the ground and other factors of the job site. You can also reduce this pitch a bit by building up the ground under the stake-down plate before positioning the machine. You can determine the actual pitch of the drill frame by placing the drill bit and sonde housing on the frame and then use the receiver to display the pitch.

The steeper your entry pitch is, the deeper your bore will have to be due to the limitations of the pipe flexibility. Typically you need to insert the drill and at least 1/3 of a pipe into the ground before you can start steering toward the beginning of the bore point. [Figure 8](#), [Figure 9](#), and the following table illustrate the relationship between entry pitch and depth.

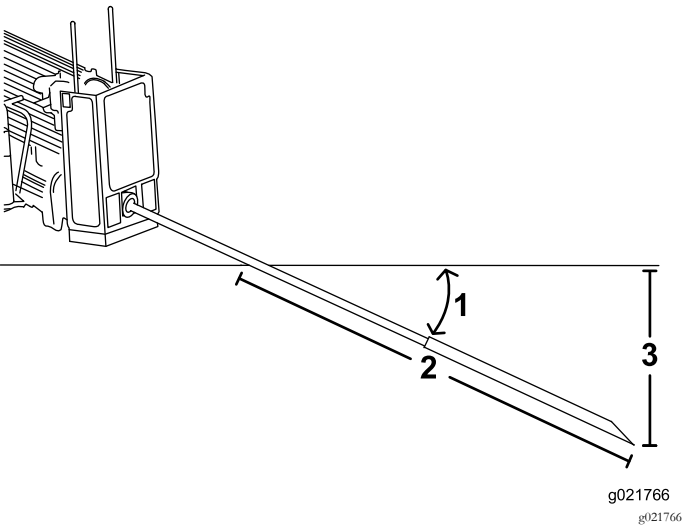


Figure 8

1. 26% pitch
2. 3 m (10 ft)
3. 76 cm (30 inches)

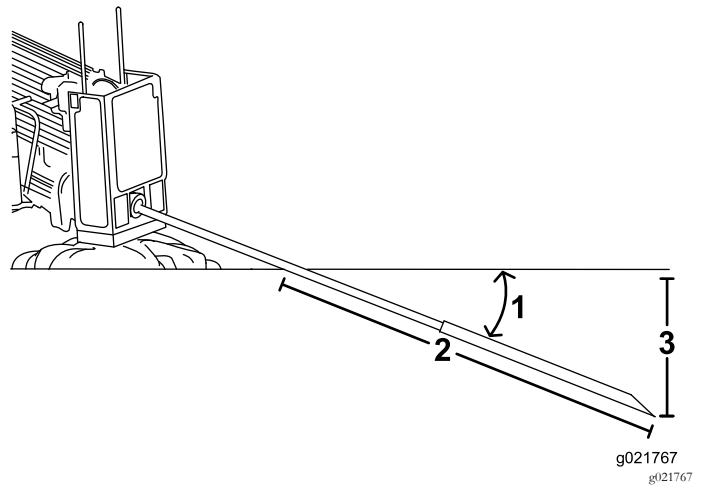


Figure 9

1. 18% pitch
2. 3 m (10 ft)
3. 53 cm (21 inches)

Note: The depths given in the following table are for 3 m (10 ft) of combined drill head and pipe. As you steer up, the pitch of the steered section will change and can be monitored with the receiver. Use the following table to identify how many lengths of pipe will be necessary to insert and steer to the beginning point and help you choose an entry point.

Pitch	Depth Change per 10 feet	Pitch	Depth Change per 10 feet
1%	2 cm (1 inch)	26%	76 cm (30 inches)
2%	5 cm (2 inches)	27%	79 cm (31 inches)
3%	10 cm (4 inches)	28%	81 cm (32 inches)
4%	13 cm (5 inches)	29%	84 cm (33 inches)
5%	15 cm (6 inches)	30%	86 cm (34 inches)
6%	18 cm (7 inches)	31%	91 cm (36 inches)
7%	20 cm (8 inches)	32%	94 cm (37 inches)
8%	25 cm (10 inches)	33%	97 cm (38 inches)
9%	28 cm (11 inches)	34%	99 cm (39 inches)
10%	30 cm (12 inches)	35%	102 cm (40 inches)
11%	33 cm (13 inches)	36%	104 cm (41 inches)
12%	36 cm (14 inches)	37%	107 cm (42 inches)
13%	39 cm (15 inches)	38%	109 cm (43 inches)
14%	43 cm (17 inches)	39%	112 cm (44 inches)
15%	46 cm (18 inches)	40%	114 cm (45 inches)
16%	48 cm (19 inches)	41%	117 cm (46 inches)
17%	51 cm (20 inches)	42%	117 cm (46 inches)
18%	53 cm (21 inches)	43%	119 cm (47 inches)
19%	56 cm (22 inches)	44%	122 cm (48 inches)
20%	61 cm (24 inches)	45%	124 cm (49 inches)
21%	64 cm (25 inches)	46%	127 cm (50 inches)
22%	66 cm (26 inches)	47%	130 cm (51 inches)
23%	69 cm (27 inches)	48%	133 cm (52 inches)
24%	71 cm (28 inches)	49%	135 cm (53 inches)
25%	74 cm (29 inches)	50%	137 cm (54 inches)

All measurements are approximate and will vary depending on soil conditions.

Note: These values and more can be found in the *Driller's Handbook & Daily Log* by Digital Control Incorporated.

Given the above information, you can calculate the number of rods required to reach your beginning point at the appropriate depth. Toro recommends that you start the entry point a distance back from your beginning-at-depth point by the same distance as the length of pipes you will need to reach that point. This will ensure that you have enough extra space so you will not need to over-steer and damage the pipes.

The following example illustrates the process given an installation using the maximum entry pitch of the machine (26%) on level ground:

- You insert the first 3 m (10 ft) of drill bit/pipe into the ground with no steering. The end of the drill bit will be 76 cm (30 inches) deep (Figure 7).

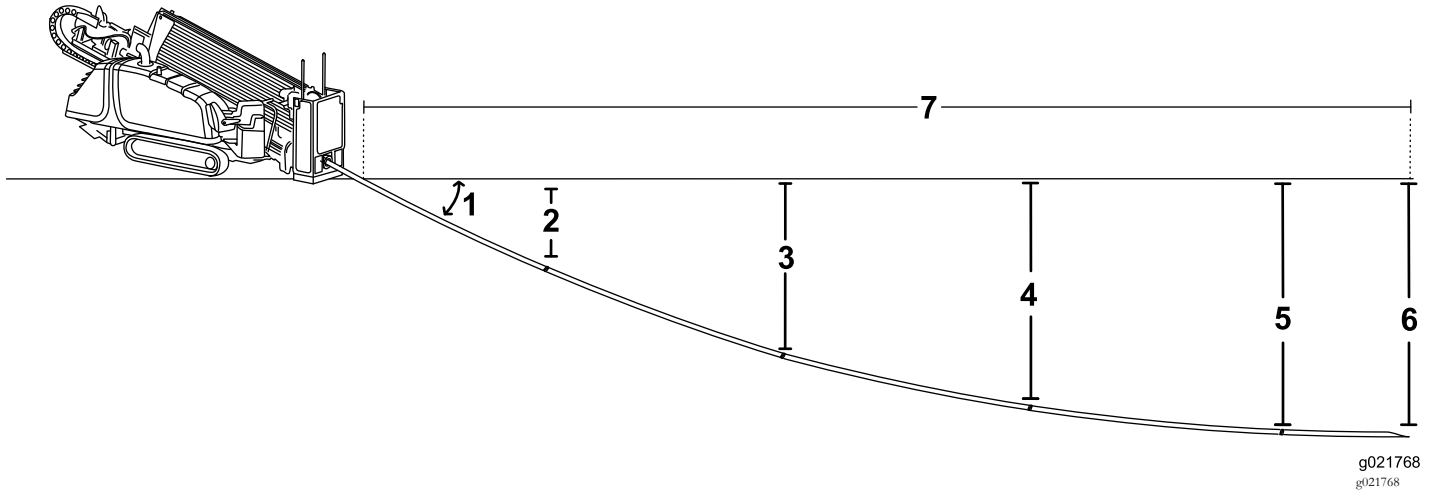


Figure 10

- | | | |
|-----------------------|-----------------------|-------------------|
| 1. 26% pitch | 4. 185 cm (73 inches) | 7. 14.7 m (45 ft) |
| 2. 76 cm (30 inches) | 5. 203 cm (80 inches) | |
| 3. 142 cm (56 inches) | 6. 208 cm (82 inches) | |

- You begin steering up for the next 3 m (10 ft), pushing the pipes in at the maximum pitch change of 8%. This results in a change of pitch from 26% at the beginning of the 3 m (10 ft) to 18% at the end of the 3 m (10 ft) for an average pitch of 22%. Given that, the drill head lowers another 66 cm (26 inches) and is now 142 cm (56 inches) deep.
- Continuing steering up for the next 3 m (10 ft) at an 8% pitch change, your pitch will change from 18% to 10% for an average pitch of 14%. Given that, the drill head lowers another 43 cm (17 inches) and is now 185 cm (73 inches) deep.
- Continuing steering up for the next 3 m (10 ft) at an 8% pitch change, your pitch will change from 10% to 2% for an average pitch of 6%. Given that, the drill head lowers another 18 cm (7 inches) and is now 203 cm (80 inches) deep.
- Leveling the drill head from 2% to 0% takes less than 1.5 m (5 ft) more for a final depth of 208 cm (82 inches). Reaching this final point took four and a half, 3 m (10 ft) pipes. So for this example your entry point should be 14.7 m (45 ft) back from the beginning-at-depth point of your installation.

The following example illustrates the process given an installation using the machine at an 18% pitch on level ground:

- You insert the first 3 m (10 ft) of drill bit/pipe into the ground with no steering. The end of the drill bit will be 53 cm (21 inches) deep (Figure 11).

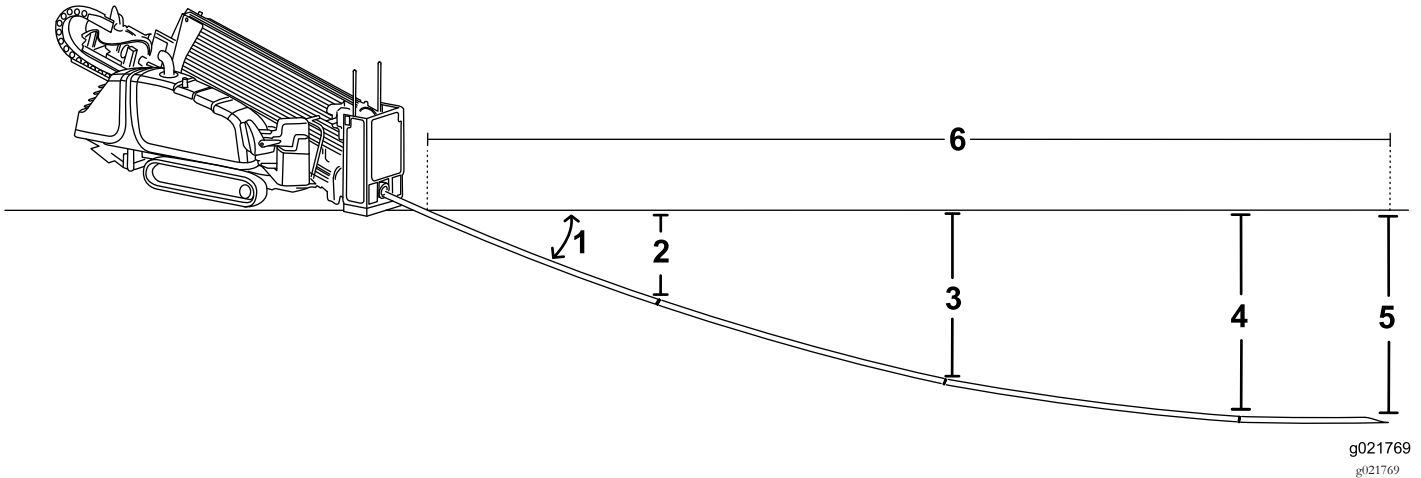


Figure 11

- | | | |
|----------------------|-----------------------|-----------------------|
| 1. 18% pitch | 3. 96 cm (38 inches) | 5. 119 cm (47 inches) |
| 2. 53 cm (21 inches) | 4. 114 cm (45 inches) | 6. 10.6 m (35 ft) |

- You begin steering up for the next 3 m (10 ft), pushing the pipes in at the maximum pitch change of 8%. This results in a change of pitch from 18% at the beginning of the 3 m (10 ft) to 10% at the end of the 3 m (10 ft) for an average pitch of 14%. Given that, the drill head lowers another 43 cm (17 inches) and is now 96 cm (38 inches) deep.
- Continuing steering up for the next 3 m (10 ft) at an 8% pitch change, your pitch will change from 10% to 2% for an average pitch of 6%. Given that, the drill head lowers another 18 cm (7 inches) and is now 114 cm (45 inches) deep.
- Leveling the drill head from 2% to 0% takes less than 1.5 m (5 ft) more for a final depth of 119 cm (47 inches). Reaching this final point took three and a half, 3 m (10 ft) pipes. So for this example your entry point should be 10.6 m (35 ft) back from the beginning-at-depth point of your installation.

Important: You can use the information contained in this section to determine both the space needed to steer up to the exit point if needed and also to steer around obstacles.

Mapping the Bore

With the information you gathered previously, map out the route of the bore, identifying the following so that you can mark the site later:

- Entry point
- Location of the machine and supporting equipment
- Beginning of bore at depth
- Any obstacles that you need to steer around and the locations where you need to start steering to get around or under them
- Any utility lines you will need to cross
- Slope and soil changes along the path that will affect the bore
- End of the bore at depth
- Exit location if different than the end of the bore

Understanding and Using the Exit-side-lockout System (Standard Range)

Exit-side-lockout System (Standard Range)

The exit-side-lockout system provides the individuals working around the machine with a means to disable the drill pipe from rotating and thrusting.

This system consists of a receiver mounted on the machine and a transmitter (Figure 12) that must be held by a designated individual working around the machine.

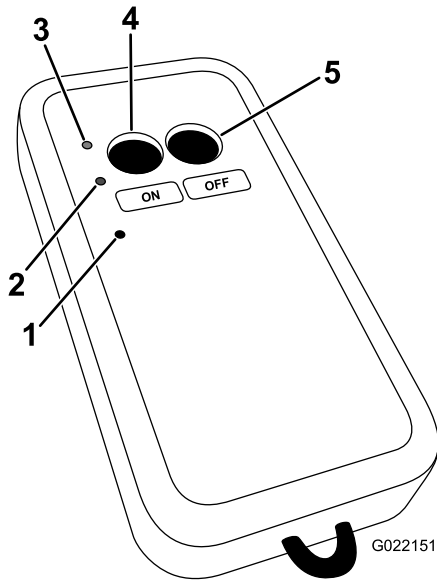


Figure 12

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- | | |
|---------------------------|---------------|
| 1. Red indicator light | 4. On button |
| 2. Yellow indicator light | 5. Off button |
| 3. Green indicator light | |

button sends a signal to the receiver that allows the machine operator to reset the system and restore the thrust and rotary functions.

The following table lists the various states of the indicator lights on the handheld transmitter (Figure 13) and their meanings:

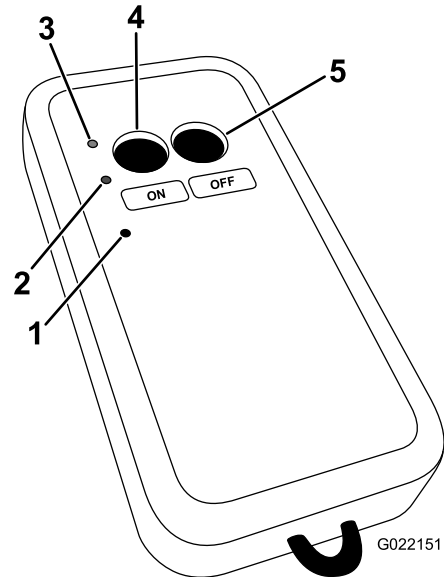


Figure 13

g022151

- | | |
|---------------------------|---------------|
| 1. Red indicator light | 4. On button |
| 2. Yellow indicator light | 5. Off button |
| 3. Green indicator light | |

Understanding and Using the Handheld Transmitter (Standard Range)

The individual holding the transmitter can push the Lock Drill (Off) button to stop the drill rotation and thrust. This is primarily used to stop/lockout the drill operations in the following situations:

- When installing or removing a drill head or reamer
- Whenever someone needs to approach the drill pipe or head anywhere in front of the machine
- Placing a wiper on the drill pipe
- When the location receiver operator identifies a problem requiring immediate shutdown of drilling

When it is safe to resume drilling, the individual holding the transmitter can press the Unlock Drill (On) button. This

Indicator Light State	Meaning
Green light is blinking rapidly	The transmitter is transmitting to the base unit
Green light is illuminated without blinking	A button on the transmitter is currently pressed
Yellow light is blinking slowly	The batteries are low; change the batteries. If you do not change the batteries soon, the handheld will power down.
Red light is blinking	The transmitter is actively receiving messages from the base unit.

Replacing the Handheld Transmitter Batteries (Standard Range)

1. Loosen the 4 screws securing the battery cover (Figure 14).

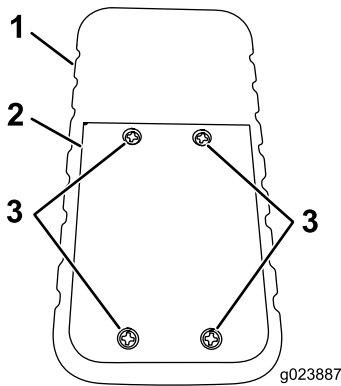


Figure 14

1. Handheld transmitter
2. Battery cover
3. Screws

2. Remove the cover (Figure 15).

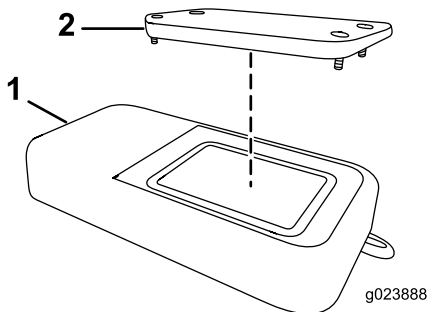


Figure 15

1. Handheld transmitter
2. Battery cover

3. Remove the existing batteries.
4. Install 3 new, AAA batteries in the orientation shown in Figure 16.

Important: Ensure that you install the batteries in the correct polarity orientation or you could damage the transmitter.

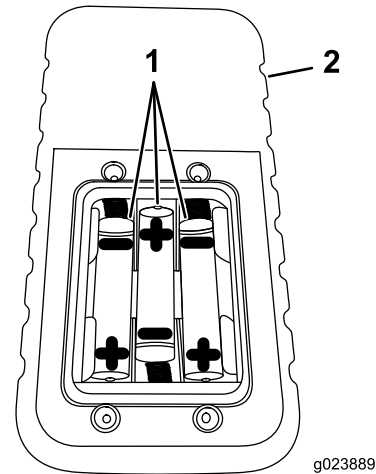


Figure 16

1. Handheld transmitter
2. AAA batteries

5. Replace the cover and secure it with the screw removed previously.

Tighten the screws enough to ensure that the sealing gasket is compressed, but do not over tighten them.

Associating the Handheld Transmitter with the Base Unit (Standard Range)

If the handheld transmitter ever stops communicating with the base unit, or if you replace it with a new transmitter, you need to associate the transmitter to the base unit as follows:

1. Ensure that the machine is turned off.
2. Ensure that the handheld transmitter is not active (i.e., no lights are on).
3. Stand near the rear control panel of the machine.
4. Simultaneously press and hold the On and Off buttons.
The Green light illuminates.

5. Continue holding the buttons until the Yellow light begins flashing, then release the buttons.
The Red light begins flashing allowing you 2 seconds to press the next button.

6. Press and hold the On button

The Red light turns off and the Green and Yellow lights illuminate.

Important: If you do not press this button within 2 seconds, you will have to start this procedure over again.

7. Continue holding the On button and turn on the machine to power the base unit.

The base unit and handheld establish a communication link while you hold the button. Once the process is

complete, the Yellow light turns off, the Red light begins flashing, and the Green light illuminates. All lights remain as mentioned until you release the button.

8. Release the On button.

The Red light turns off and the Green light flashes for a few seconds.

Disassociating all Handheld Transmitters from the Base Unit (Standard Range)

Important: Completing this procedure will disassociate all transmitters from the base unit, which will need to be associated again before they will function.

1. Ensure that the machine is turned off.
2. Ensure that the handheld transmitter is not active (i.e., no lights are on).
3. Stand near the rear control panel of the machine.
4. Simultaneously press and hold the On and Off buttons.

The Green light illuminates.

5. Continue holding the buttons until the Yellow light begins flashing, then release the buttons.

The Red light begins flashing allowing you 2 seconds to press the next button.

6. Press and hold the Off button

The Red light turns off and the Green and Yellow lights illuminate.

Important: If you do not press this button within 2 seconds, you will have to start this procedure over again.

7. Continue holding the Off button and turn on the machine to power the base unit.

The base unit and handheld establish a communication link while you hold the button. Once the process is complete, the Yellow light turns off, the Red light begins flashing, and the Green light illuminates. All lights remain as mentioned until you release the button.

8. Release the Off button.

The Red light turns off and the Green light flashes for a few seconds.

Preparing the Job Site and the Machine

Before drilling, prepare the job site and machine as follows:

- Mark and prepare the bore path [Planning the Bore Path \(page 11\)](#).
- Test the Zap-Alert system; refer to [Testing the Zap-Alert System \(page 19\)](#).
- Load the drill pipes into the pipe holder if needed.
- Add fuel to the machine; refer to [Adding Fuel \(page 20\)](#).
- Check the oil level in the engine.
- Check the engine coolant level.
- Check the hydraulic oil level.
- Check the oil level in the drilling-fluid pump.
- Load/unload the machine; refer to [Loading and Unloading the Machine \(page 22\)](#).
- Drive the machine to the entry point; refer to [Understanding Horizontal Directional Drilling \(page 8\)](#).
- Connect the machine to a drilling-fluid source; refer to [Connecting to a Drilling-fluid Source \(page 23\)](#).
- Set up the drill bit(s) and tracking electronics; refer to [Setting Up the Drill Head and Tracking System \(page 22\)](#).
- Set up the machine for drilling; refer to [Setting up the Machine for Drilling \(page 23\)](#).
- Deploy the Zap-Alert system; refer to [Deploying the Zap-Alert System \(page 24\)](#).

Testing the Zap-Alert System

The Zap-Alert system is an electric strike sensing device on the machine that triggers a strobe light and audible alarm in the event that the drill bit, reamer, or stake breaks into an energized power line. In the event of an electric strike, the machine will become energized, setting off the alarm.

▲ DANGER

If the Zap-Alert system activates while drilling, the machine, except for the operator's platform, will become energized. If you step off the operator platform or if someone touches the machine or wet ground near the machine or in the bore, you or they could be electrocuted causing serious injury or death.

- Test the Zap-Alert system before drilling.
- Deploy the grounding stake before drilling. Ensure that the stake is fully inserted into moist soil.
- If the Zap-Alert is triggered:
 - Stay in the seat and do not touch the ground or any other part of the machine until the power has been turned off. Do not pour liquids or urinate from the operator platform onto the ground.
 - Stop drilling, stop the drilling-fluid flow, and retract the drill out of the ground.
 - Keep everyone away from the machine.
 - Keep standing or running water and drilling fluid contained close to the machine. Keep water and drilling fluid sources away from the broken line.
 - Contact the utility company to have power shut off to the broken line. Do not reset the Zap-Alert system until the power has been turned off.

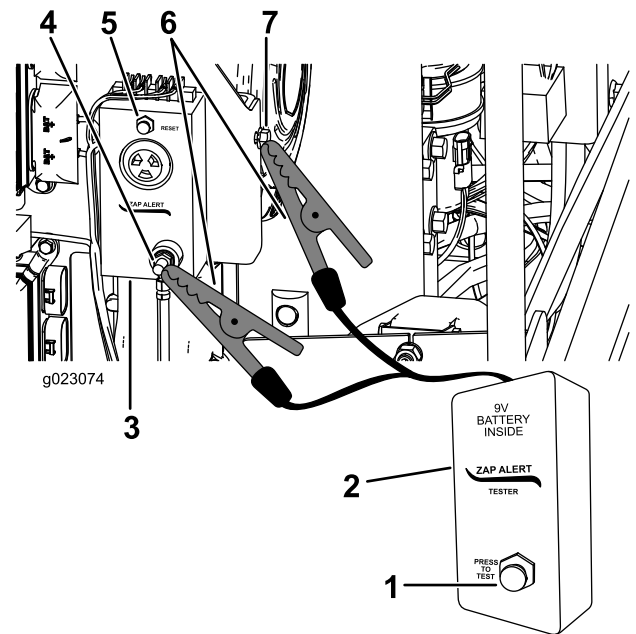


Figure 17

- | | |
|------------------------------------|----------------------------|
| 1. Test button | 5. Reset button |
| 2. Zap-alert tester | 6. Alligator clips |
| 3. Zap-alert system | 7. Machine grounding point |
| 4. Zap-alert system grounding stud | |

4. Connect the other alligator clip to a metal component of the machine frame.
5. Press the Test button on the Zap-Alert tester (Figure 17).

The Zap-Alert alarm should sound, and the strobe on top of the front hood should flash.
6. Press the Zap-Alert reset button to stop the alarm (Figure 17).

Test the Zap-Alert system before using the drill each day, as follows:

1. Open the front hood.
2. Lay the grounding stake flat on the ground away from the machine. Do not drive the stake into the ground.

Important: Do not allow the stake to touch any part of the machine.

3. Connect an alligator clip from the Zap-Alert tester to the grounding stud on the Zap-Alert system (Figure 17).

7. Disconnect the alligator clips from the grounding stud and the machine.
8. Store the grounding stake in the holder on the operator platform as shown in Figure 18.

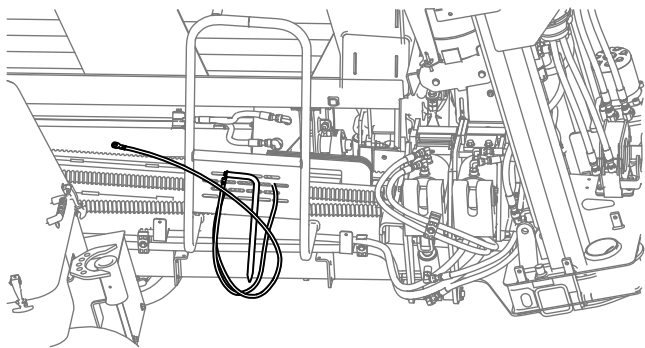


Figure 18

⚠ WARNING

Fuel is harmful or fatal if swallowed. Long-term exposure to vapors can cause serious injury and illness.

- Avoid prolonged breathing of vapors.
- Keep face away from nozzle and gas tank or conditioner opening.
- Keep fuel away from eyes and skin.

Biodiesel Ready

This machine can also use a biodiesel blended fuel of up to B20 (20% biodiesel, 80% petrodiesel). The petrodiesel portion should be low or ultra low sulfur. Observe the following precautions:

- The biodiesel portion of the fuel must meet specification ASTM D6751 or EN14214.
- The blended fuel composition should meet ASTM D975 or EN590.
- Painted surfaces may be damaged by biodiesel blends.
- Use B5 (biodiesel content of 5%) or lesser blends in cold weather.
- Monitor seals, hoses, gaskets in contact with fuel as they may be degraded over time.
- Fuel filter plugging may be expected for a time after converting to biodiesel blended.
- Contact your dealer if you wish for more information on biodiesel.

In certain conditions during fueling, static electricity can be released causing a spark which can ignite the fuel vapors. A fire or explosion from fuel can burn you and others and can damage property.

- Place fuel containers on the ground away from your vehicle before filling.
- Do not fill fuel containers inside a vehicle or on a truck or trailer bed because interior carpets or plastic truck bed liners may insulate the container and slow the loss of any static charge.
- When practical, remove equipment from the truck or trailer and refuel the equipment with its tracks on the ground.
- If this is not possible, then refuel such equipment on a truck or trailer from a portable container, rather than from a fuel dispenser nozzle.
- If a fuel dispenser nozzle must be used, keep the nozzle in contact with the rim of the fuel tank or container opening at all times until fueling is complete.

If either the audible alarm or the strobe light failed to trigger when you pressed the test button, have them repaired before drilling with the machine.

Mounting a Fire Extinguisher

Mount your fire extinguisher.

Note: A fire extinguisher is not provided with the machine.

The recommended fire extinguisher is a dry chemical fire extinguisher approved for class B and C fires.

Adding Fuel

Service Interval: Before each use or daily—Check the fuel level.

Use only clean, fresh diesel fuel or biodiesel fuels with ultra low (<15 ppm) sulfur content. The minimum cetane rating should be 40. Purchase fuel in quantities that can be used within 180 days to ensure fuel freshness.

Fuel tank capacity: 38 L (10 US gallons)

Use summer grade diesel fuel (No. 2-D) at temperatures above -7° C (20° F) and winter grade (No. 1-D or No. 1-D/2-D blend) below that temperature. Use of winter grade fuel at lower temperatures provides lower flash point and cold flow characteristics which will ease starting and reduce fuel filter plugging.

Use of summer grade fuel above -7° C (20° F) will contribute toward longer fuel pump life and increased power compared to winter grade fuel.

Important: Do not use kerosene or gasoline instead of diesel fuel. Failure to observe this caution will damage the engine.

▲ DANGER

In certain conditions, fuel is extremely flammable and highly explosive. A fire or explosion from fuel can burn you and others and can damage property.

- Fill the fuel tank outdoors, in an open area, when the engine is cold. Wipe up any fuel that spills.
- Do not fill the fuel tank inside an enclosed trailer.
- Do not smoke when handling fuel, and stay away from an open flame or where fuel fumes may be ignited by a spark.
- Store fuel in an approved container and keep it out of the reach of children. Do not buy more than a 30-day supply of fuel.
- Do not operate without entire exhaust system in place and in proper working condition.

1. Park the machine on a level surface.
2. Using a clean rag, clean the area around fuel tank cap.
3. Remove the cap from the fuel tank.
4. Fill the tank until the level is to the bottom of the filler neck with diesel fuel.
5. Install fuel tank cap tightly.

Note: If possible, fill the fuel tank after each use. This will minimize possible buildup of condensation inside the fuel tank.

Checking the Engine-Oil Level

Before you start the engine and use the machine, check the oil level in the engine crankcase. The oil should just touch the end of the dipstick. See your Authorized Toro Dealer.

Checking the Cooling System

Before you start the engine and use the machine, check the cooling system.

Checking the Hydraulic-fluid Level

Before you start the engine and use the machine, check the hydraulic fluid level; refer to [Checking the Hydraulic-fluid Level \(page 21\)](#).

Starting/Stopping the Engine

To start the engine, complete the following:

1. Open the front hood.
2. Turn the battery disconnect switch to the On position.
3. Close and latch the hood.
4. Turn the ignition key, on the rear control panel, to the Run position.

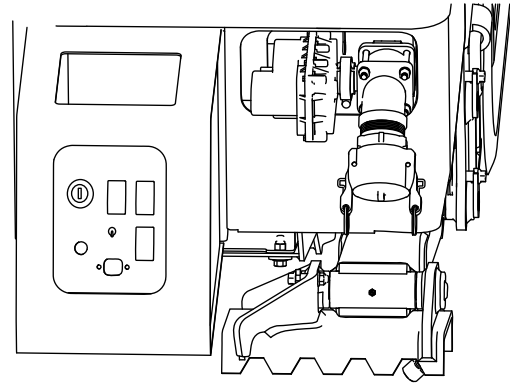


Figure 19

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If the Wait-to-Start light illuminates, wait until it turns off before proceeding.

5. Turn the ignition key to the Start position until the engine starts, then release it.

To stop the engine, turn the ignition key to the Off position. In an emergency, you can also stop the engine and all processes by pressing the Engine-stop button on either the drive pendant or the control panel.

Driving the Machine

1. Walk around the machine to ensure that no one is near it. Ensure that all bystanders are clear of the area where you will be moving the machine.
2. Connect the drive pendant to the right receptacle on the bottom of the rear control panel.
3. With the pendant in hand, walk at least 6 feet to the side of the machine. Be sure to keep this safe distance whenever moving the machine.
4. Press and hold the operator presence button on the drive pendant.
5. Use the speed switch on the pendant to increase or decrease the engine speed as desired.
6. Set the desired travel speed, using the speed switch.
7. Use the joy stick to move the machine as desired.

Loading and Unloading the Machine

⚠ WARNING

Moving a machine of this size on a trailer over public roads carries risks to those around the machine if it should come loose, be involved in an accident, or hit a low hanging structure.

- Follow the tie-down procedures described in this section when moving the machine.
- Follow all local traffic regulations governing the hauling of large equipment. This manual cannot adequately cover all laws and safety regulations; it is your responsibility to know and follow the laws and regulations that pertain to you.

⚠ WARNING

The machine can slip and fall from a trailer or ramp, crushing anyone caught beneath it and causing serious injury or death.

- Keep all bystanders away from the machine and trailer.
- Ensure that the trailer and ramp are not slippery and are free of ice, grease, oil, etc.
- Move the machine onto the ramp at slow speed with the engine at slow speed.
- Ensure that you have the machine centered on the ramp and trailer.

1. Ensure the ramp and the trailer or truck bed can support the weight of the machine.
2. Ensure that the upper and rear pipe-holder pins are installed.
3. Place a block at the front and rear of the trailer and/or truck tires.
4. Using the drive pendant, set the engine speed to slow and the drive speed to slow.
5. Using the drive pendant, carefully drive the machine forward or rearward up the ramp and into position on the trailer.
6. Lower the stake-down plate to the deck of the trailer.
7. Turn off the engine.
8. Use appropriately rated chains and binders to secure the rings on the left and right track frames and the stake-down plate to the trailer.
9. Measure the distance from the ground to the highest point on the machine for reference to ensure that you do not collide with low hanging obstacles.

10. Remove the block from the trailer tires, and stow them with the machine for use when unloading it.
11. After driving a few miles, pull over and check to ensure that all chains are still tight and that the machine has not moved.

To unload the machine, reverse the above procedure.

Setting Up the Drill Head and Tracking System

The drill head consists of two parts, the drill bit and the sonde housing (Figure 20).

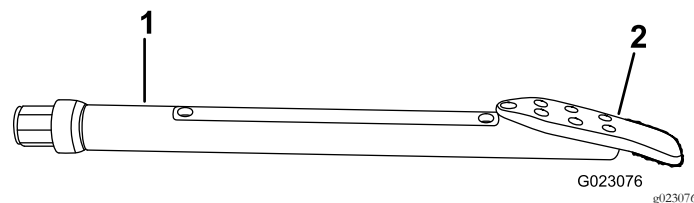


Figure 20

1. Sonde housing
2. Drill bit

Drill bits vary in size and type to meet the various soil conditions you may need to drill through. Some of the possibilities are as follows:

- **Straight blade**—Used in a wide range of medium density soils.
- **Bent blade**—Used in medium to soft soils. This bit has an added 20° bend to increase steering performance in soft soils.
- **Triangle point blade**—Use in hard and rocky soils. This bit has carbide edges to reduce wear.

All of the above bits come in varying widths. A wider blade increases your ability to steer in soft soils. A narrower blade moves through hard soils better. Contact your Authorized Toro Dealer for a complete list of available blades.

The sondes and receivers are essential to track the position of the drill head throughout the drilling operation. The sonde housing on the drill head opens up to accept the sonde beacon which works with the receiver to track the location, pitch, direction, head orientation, and more of the drill head. Refer to the *Tracking System Operator's Manual* for instructions on using the system.

To install the sonde beacon into the sonde housing on the drill head, complete the following:

1. Replace the batteries in the sonde beacon as described in the *Tracking System Operator's Manual*.
2. Loosen the screws securing the housing cover to the housing and remove the cover (Figure 21).

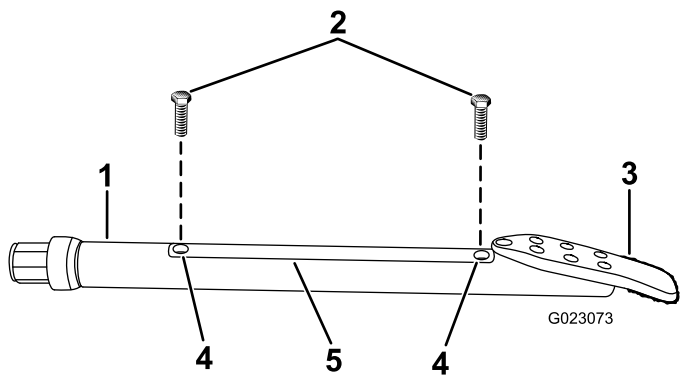


Figure 21

3. Insert the sonde beacon with the forward end toward the drill bit into the sonde housing (Figure 22).

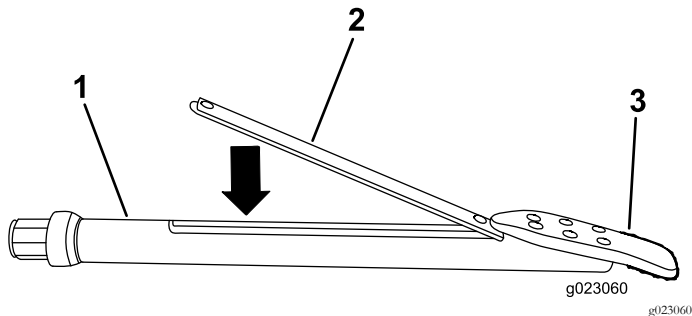


Figure 22

1. Sonde housing
2. Sonde beacon
3. Drill bit

4. Install the housing cover and secure it with the screws (Figure 21).

Setting up the Machine for Drilling

1. Using the drive pendant, drive the machine to the location that you have prepared for it, ensuring that the front of the machine is the proper distance back from entry point and the drill frame is in line with the bore path.
2. Drive up to the location and make sure that all utilities are located and marked prior to drilling.
3. Move the operator station to the desired angle, switch the Drill/Drive switch to the Drill position, and raise the pipe elevators, so that the pipe is resting on the elevators; refer to [Starting the First Pipe](#) (page 25).
4. Load the first pipe and install the sonde and the drill head; refer to [Starting the First Pipe](#) (page 25).
5. Place the drill head on the drill frame, and take a pitch reading using the receiver; refer to the *Tracking System Operator's Manual*.
6. Lower the thrust frame, tilting the drill frame until the plate contacts the ground (Figure 23).

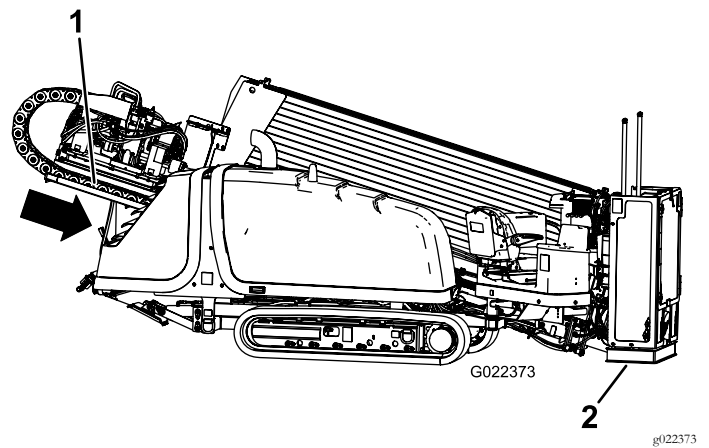


Figure 23

1. Thrust frame
2. Stake-down plate

7. Lower the rear stabilizers until they contact the ground firmly, or until the desired entry angle is achieved (Figure 24).

Note: The rear of the tracks should just start to lift off the ground.

Note: If the ground is soft, place timber below the stabilizers, and lower the stabilizers.

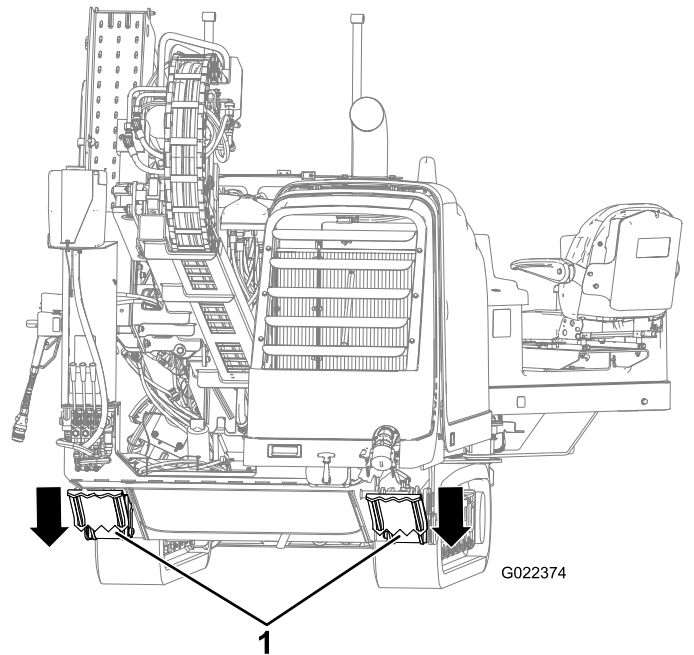


Figure 24

1. Rear stabilizers
8. Press the 2 right stake levers in to lower and spin the right stake auger until it seats fully.
9. Repeat step 8 for the left-side stake.

Connecting to a Drilling-fluid Source

When drilling and reaming, you pump a mixture of bentonite clay, water, and sometimes other ingredients, collectively

called drilling fluid or “Mud”, through the pipe and into the bore. This drilling fluid, or “Mud”, does the following for your bore:

- Lubricates the drill head
- Loosens the soil into which the drill is cutting
- Penetrates and binds loose soil to keep them from collapsing on the bore pipe.

The specific mixture you need will vary depending on your soil type and the operation you are performing; refer to your mixing system *Operator’s Manual* for details.

Conversely, for some jobs (depending on the soil type and distance), you can pump screened water from a natural water source, such as a lake or river, through the drill in lieu of mixed drilling fluid.

- To connect the machine to a mixing system, refer to [Setting Up the Mixing System \(page 24\)](#)
- To connect the machine to a natural water source, refer to [Setting Up the Pump to Use a Natural Water Source \(page 24\)](#)

Setting Up the Mixing System

Set up your mixing system near the directional drill location, preferably down wind so fumes from the mixing system engine will not bother you while drilling. Follow the instructions provided in the mixing system *Operator’s Manual* for setting it up and using it.

Complete the following to connect the exit hose from the mixing system to the drilling-fluid pump on the machine:

1. Raise the cam-lock levers on the pump-inlet cap and remove the cap ([Figure 25](#)).

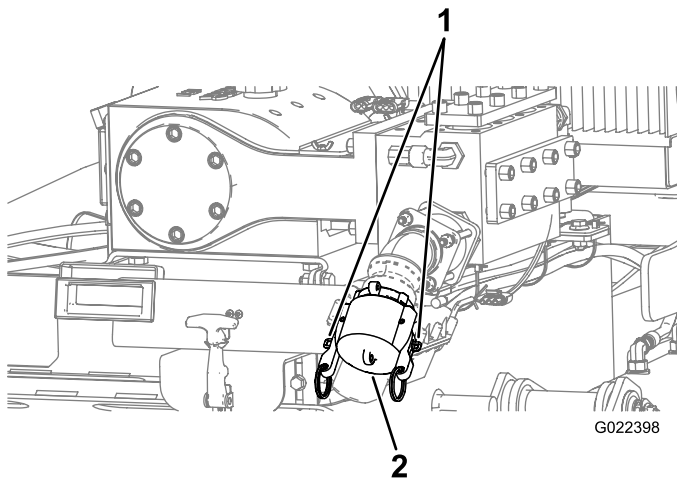


Figure 25

1. Cam-lock levers
2. Pump-inlet cap

2. Insert the hose from the mixing system over the pump inlet and secure it with the cam-lock levers.

Setting Up the Pump to Use a Natural Water Source

To set up a pump to use a natural water source, you must ensure that you use the Y-screen to filter all materials other than water.

To install the Y-screen perform the following tasks:

1. Remove the pump-inlet cap ([Figure 26](#)).

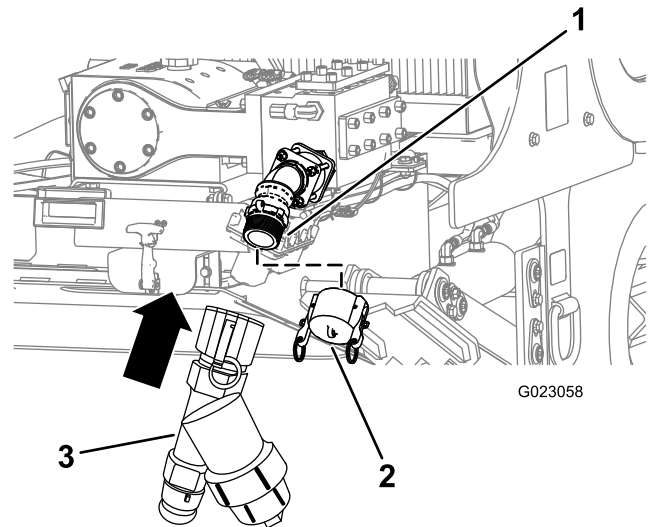


Figure 26

1. Pump threads
2. Pump-inlet cap
3. Y-screen

2. Align the Y-screen with the threads on the pump ([Figure 26](#)).
3. Rotate and tighten the Y-screen onto the pump.
4. Attach the hose to the Y-screen, and begin pumping from the natural water source.

Deploying the Zap-Alert System

The Zap-Alert system is an electric strike sensing device on the machine that triggers a strobe light and audible alarm in the event that the drill bit, reamer, or stake breaks into an energized power line. In the event of an electric strike, the machine will become energized, setting off the alarm. The operator’s platform is electrically isolated from the rest of the machine to protect you.

⚠ DANGER

If the Zap-Alert system activates while drilling, the machine, except for the operator's platform, will become energized. If you step off the operator platform or if someone touches the machine or wet ground near the machine or in the bore, you or they could be electrocuted causing serious injury or death.

- Test the Zap-Alert system before drilling.
- Deploy the grounding stake before drilling. Ensure that the stake is fully inserted into moist soil.
- If the Zap-Alert is triggered:
 - Stay in the seat and do not touch the ground or any other part of the machine until the power has been turned off. Do not pour liquids or urinate from the operator platform onto the ground.
 - Stop drilling, stop the drilling-fluid flow, and retract the drill out of the ground.
 - Keep everyone away from the machine, wet ground near the machine or running from the machine, and any open sources of water/mud that is in the bore and contacting the broken line.
 - Contact the utility company to have power shut off to the broken line. Do not reset the Zap-Alert system until the power has been turned off.

1. Remove the grounding stake from the holder on the side of the operator platform (Figure 27).

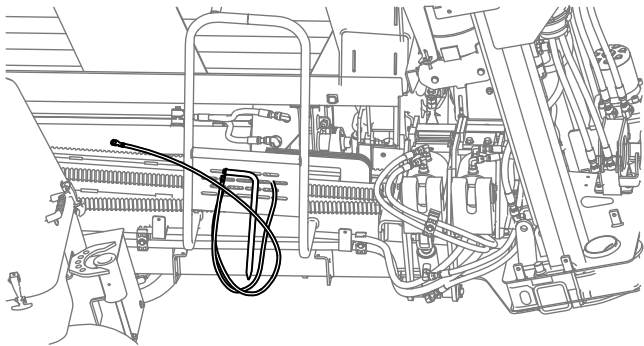


Figure 27

g194740

1. Grounding stake
-
2. Move the stake directly away from the machine, perpendicular to the drill frame and drive it into the ground until the handle touches the ground.
 3. If the ground is dry where you put the stake, soak it with water before using the machine to ensure good electrical contact.

Drilling the Bore

Starting the First Pipe

1. Ensure that all bystanders are away from the machine and that the exit-side lockout is On.
2. Move the drill carriage fully down the drill frame and spray the spindle threads with thread joint compound, then return the drill carriage to the upper end of the frame (Figure 27).

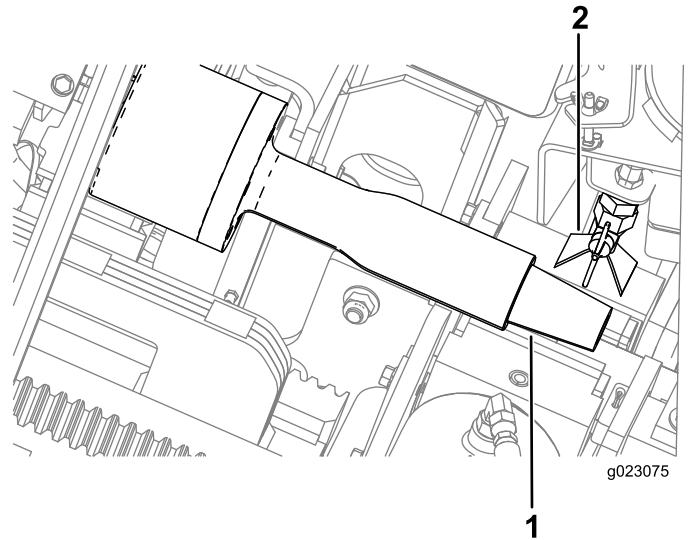


Figure 28

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1. Drill spindle
 2. TJC-applicator nozzle
-
3. Rotate the pipe gripper to the first row of pipes in the pipe holder by aligning the row indicator to row number 1.
 4. Lower the pipe elevators to load a pipe into the pipe gripper.
 5. Rotate the pipe gripper with the pipe toward the drill frame, and extend the pipe until the pipe is centered over the frame and in front of the spindle on the drill carriage.
 6. Rotate the drill spindle clockwise and move the carriage slowly forward to insert the spindle into the female end of the pipe (Figure 29).

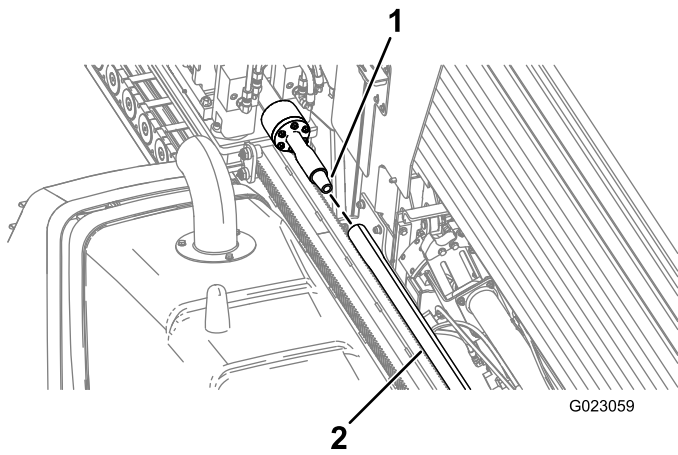


Figure 29

1. Drill spindle 2. Pipe

7. Continue to move the drill carriage slowly down the frame until the male threads on the pipe are under the thread-joint-compound applicator and apply thread-joint compound to the threads.
8. Release and retract the pipe gripper, rotating it all the way out to the third row of pipes.

Important: Ensure that you fully retract the pipe gripper and rotate it all the way out or the carriage may collide with the gripper, damaging the machine.

9. Continue to rotate the drive spindle clockwise, until the male pipe threads are fully seated into the sonde housing or the lead bar.

Note: Torque the threads to 2305 N-m (1700 ft-lb).

Installing the Drill Head

1. Using the exit-side-lockout transmitter, enable the exit side lockout.

⚠ WARNING

If the drill rotates or extends while you or others are manually working on the drill bit or pipe in front of the machine, the worker could get caught in the bit or pipe causing serious injury, amputation, or death.

- Enable the exit-side lockout on the exit-side-lockout transmitter before approaching the drill bit or pipe when attached to the machine. This will disable the drill carriage.
 - Do not wear loose clothing or jewelry when working on a drill bit or pipe attached to the machine. Tie long hair up.
2. Hand thread the lead bar onto the pipe threads then clear away from the front of the machine.

3. When the area is clear of people, disable the exit-side lockout using the exit-side-lockout transmitter (the OK-to-Drill light on the control panel should illuminate); press the exit-side-lockout, reset switch on the control panel.
4. Pull the drill pipe and lead bar back through the pipe guide and into the wrenches, aligning the thickened upper joint of the lead bar with the upper wrench (Figure 30).

Important: Do not clamp the wrench on the body of a pipe or it may damage the pipe. Grip the pipes on the shoulder near the joint.

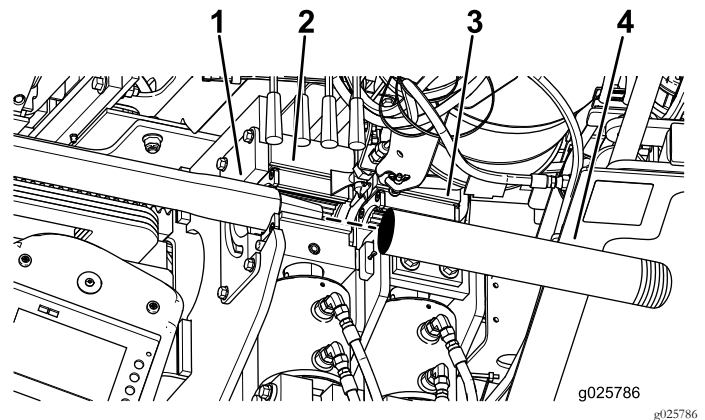


Figure 30

1. Drill pipe 3. Lower wrench (stationary wrench)
2. Upper wrench (makeup/breakout wrench) 4. Lead bar

5. Using the upper wrench, clamp the lead bar and tighten it to full machine torque.
6. Using the exit-side-lockout transmitter, enable the exit-side lockout.
7. Double check the drill head and bit to ensure that the fluid ports are clean and free from obstructions.
8. Install the drill head onto the end of the lead bar as directed by the drill head manufacturer, then clear away from the front of the machine.

Important: Do not pull the drill head into the pipe guide or you may damage the machine or the drill head.

Boring the Entry Shaft

The first boring step is to create the entry shaft. In this step, you push and bore the drill bit and first few pipes into the ground at an angle from 0 to 16 degrees (with the tracks flat on the ground) until you reach the desired depth of your installation.

Important: Drill and ream in a clockwise rotation. If you use a counterclockwise rotation the pipe will

disconnect from each other and may be disconnected underground.

1. When the area is clear of people, disable the exit-side lockout using the exit-side-lockout transmitter (the OK-to-Drill light on the control panel should illuminate); press the exit-side-lockout, reset switch on the control panel.
2. Turn on the drilling fluid pump switch and allow the fluid pressure to build to 200 to 300 psi.
3. Rotate the drill head until the bit is at the 6 o'clock position.
4. Move the carriage forward driving the bit straight into the ground until the entire drill housing is underground.
5. Continue pushing forward and begin rotating the drill spindle clockwise to initiate the drilling action.
6. Drill forward until the carriage reaches the end of the frame, then retract it about 6 mm (1/4 inch).

Adding Drill Pipes

1. Align the pipe joint in the wrench assembly.
2. Close the lower wrench (stationary wrench) onto the first pipe.

Note: The drilling fluid will automatically shut off when you activate the lower wrench (makeup/breakout wrench).

3. Pull back the carriage approximately 12.7 mm (0.5 inch).

Note: This will allow the carriage to float, and will not damage the pipe threads.

4. Rotate the drill head counterclockwise until the spindle is completely removed from the pipe.
5. Spray the spindle with thread joint compound, then return the drill carriage to the upper end of the frame.
6. Rotate the pipe gripper to the closest row of pipes in the pipe holder.
7. Lower a pipe into the pipe gripper and grip it in place.
8. Rotate the pipe gripper toward the thrust frame, and extend it until the pipe is centered over the frame and in front of the spindle on the drill carriage.
9. Rotate the drill spindle clockwise and move the carriage slowly forward to insert the spindle into the female end of the pipe (Figure 29).

Note: Tighten the joint until the pipe is rotating with the spindle.

10. Move the drill carriage slowly down the frame until the male threads on the pipe are under the thread-joint-compound applicator and apply thread-joint compound to the threads.
11. Rotate the drill spindle clockwise and move the carriage slowly forward to insert the male end of the pipe into

the female end of the previous pipe. Tighten the joint until you reach no more than 2,304 N-m (1,700 ft-lb).

12. Release and retract the pipe gripper, rotating it all the way out past the third row of pipes.

Important: Ensure that you fully retract the pipe gripper and rotate it all the way out or the carriage may collide with the gripper, damaging the machine.

13. Release the wrench and continue the drilling operation.

Steering the Drill Head

The drill bit is shaped like a wedge, angled from one side of the bit to the other. When you push the bit through the soil without rotating it, it will veer toward the direction the wedge is pointing. When you rotate the pipe and drill head it bores through the soil in a straight path.

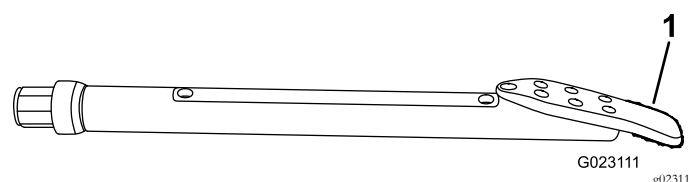


Figure 31

1. Drill bit

When drilling, the receiver operator follows the drill head as it progresses. The receiver receives signals from the sonde in the drill head identifying its position, depth, pitch, direction, transmitter temperature, and orientation in the soil. The remote console is a screen that remains near you (the drill operator) to show you the information from the receiver while drilling so you can make steering decisions.

For detailed information on using the receiver and remote console to guide the drill head, refer to the *Operator's Manual* that came with your receiver.

Important: Do not steer the drill head more than 20 cm (8 inches) off center for every 10 feet of forward travel. If you steer more than this you will damage the drill pipes.

Boring the Horizontal Shaft

After creating the entry shaft, you gradually steer the drill head up while pushing forward, following the planned bore path. When you reach the desired depth, level out the drill head and bore the horizontal shaft, adding pipes as you go. While boring, pay close attention to the information relayed back to you by the receiver operator about the status and location of the drill head to ensure that you are following the planned path.

Important: While drilling, watch the sonde temperature. All sondes have a maximum temperature above which they will be damaged. Friction between the drill head and the soil will cause the temperature to raise. To reduce the temperature, slow down, decrease forward

pressure, and increase the drilling fluid flow. If the drill head is entering a soil type other than what it is designed for, that can also raise temperature. Assess the situation and pull out the drill head and change it if necessary.

If you run into an obstruction, do the following:

1. Increase the flow of the drilling fluid for a few seconds without drilling, then attempt to continue drilling forward.

This may loosen the obstruction and allow you to push past it.

2. If the obstruction persists, try one or more of the following options:
 - If the obstruction is in an area where you can dig, stop the drill head with the Exit Side Lockout and dig down to the obstruction to identify it and remove it if possible.
 - Pull the drill head back 15 m (50 ft) or more and steer the drill head to the side, marking a new drill path around the obstacle.

Important: Do not steer the drill head more than 20 cm (8 inches) off center for every 10 feet of forward travel. If you steer more than this you will damage the drill pipes.

- If the obstruction is actually a change in soil types, such as a zone of rocky soil, pull the drill head all the way back and change to a drill bit appropriate for drilling through the new soil type.

Exiting the Ground

As you approach the end of the bore, steer the drill head to the exit point, keeping the steering limits in mind as you do so. Before exiting the ground, ensure that everyone is away from the exit point. As soon as you break through, stop the drilling-fluid flow. Extend the drill forward until the entire drill head is out of the ground.

Backreaming and Pullback

After drilling the initial bore, you attach a reamer to the pipe which is then connected to the product you are installing. The reamer is designed to widen the bore, pack the walls and lubricate the passage of the product into the bore.

The following reamers are available from your Authorized Toro Dealer in various sizes to meet your needs and soil conditions:

- **Carbide step-wing cutter**—Use this reamer in sandy and medium clay soil conditions to mix the drilling fluid with the soil, making a mixture that flows easily around the product being pulled.

- **Cast cone packer**—Use this reamer in soils that pack easily, such as soft clay, peat, and loam, to pack the sides of the bore, maintaining the bore opening.
- **Fluted reamer**—Use this reamer in hard clay and rocky soils; it combines the features of the other two reamers.

Connecting the Reamer and Product

⚠ WARNING

If the drill rotates or extends while you or others are manually working on the drill bit or pipe in front of the machine, the worker could get caught in the bit or pipe causing serious injury, amputation, or death.

- **Enable the exit-side lockout on the exit-side-lockout transmitter before approaching the drill bit or pipe when attached to the machine. This will disable the drill carriage.**
 - **Do not wear loose clothing or jewelry when working on a drill bit or pipe attached to the machine. Tie long hair up and out of the way.**
1. Using the exit-side-lockout transmitter, enable the exit side lockout.
 2. Remove the drill head from the lead bar.
 3. Double check the reamer to ensure that the fluid ports are clean and free from obstructions.
 4. Install the reamer and swivel onto the end of the lead bar as directed by the reamer manufacturer
 5. Connect the product to the reamer using an appropriate pulling connection; refer to your Authorized Toro Dealer to acquire the appropriate puller to meet your requirements.

Removing Drill Pipes

1. Using the exit-side-lockout transmitter, enable the exit side lockout.
2. Install a drill-pipe wiper around the pipe and into the retaining bracket on the front of the machine.

This will remove most of the dirt and mud from the pipe as you pull it back into the machine, keeping the machine clean. Contact your Authorized Toro Dealer to purchase drill-pipe wipers.

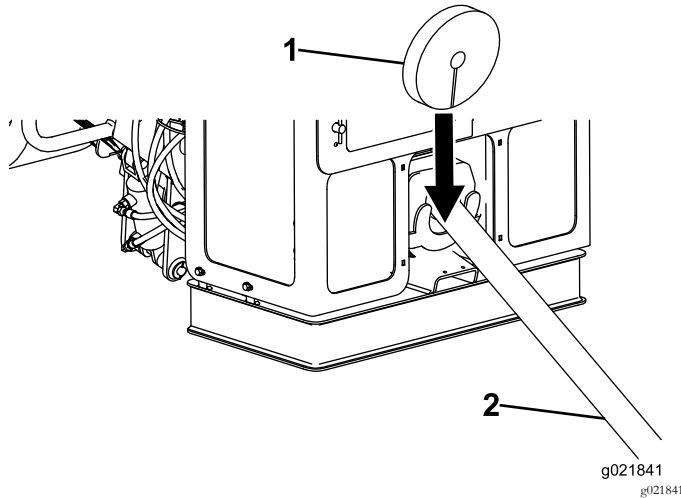


Figure 32

1. Drill-pipe wiper
2. Drill pipe

3. Disengage the exit-side lockout and reset the system.
4. Begin rotating the drill spindle clockwise and slowly retract the drill carriage to pull the pipe back into the machine.
5. When the joint between the pipes is centered between the two wrenches, the drill carriage will stop, and a green light will illuminate below the spray valve.
6. Close the lower wrench onto the pipe joint.
Note: The drilling fluid will automatically shut off when you close the lower wrench.
7. Rotate the pipe gripper to the drill frame, extend the pipe-gripper arms to the pipe, and grip the pipe to support it.
8. Close the upper wrench onto the pipe joint.
9. Rotate the upper wrench counterclockwise until the joint is loosened.
10. Release the upper wrench.
11. Pull back the carriage approximately 12.7 mm (0.5 inch).
Note: This will allow the carriage to float, and will not damage the pipe threads.
12. Rotate the drill spindle counterclockwise moving rearward slowly until the pipes are separated.

13. Move the drill carriage back until the male-pipe threads just clear the female end of the lower pipe, then close the upper wrench onto the shoulder of the pipe, but not on the threads.
14. Rotate the drill spindle counterclockwise until the upper-pipe joint is loose but not separated.
15. Release the upper wrench.

Note: The machine will stop at the carriage at the load position and illuminate another green light under the spray valve.

16. Rotate the drill spindle counterclockwise moving rearward slowly until the spindle fully separates from the pipe.
17. Retract the pipe gripper arms.
18. Rotate the pipe cam to the selected row.
Note: Fill the outside rows first.
19. Release the pipe gripper.
20. Raise the pipe into the pipe basket with the pipe elevators.
21. Rotate the pipe gripper past the third row of pipes.

Important: Ensure that you fully retract the pipe gripper and rotate it all the way out or the carriage may collide with the gripper, damaging the machine.

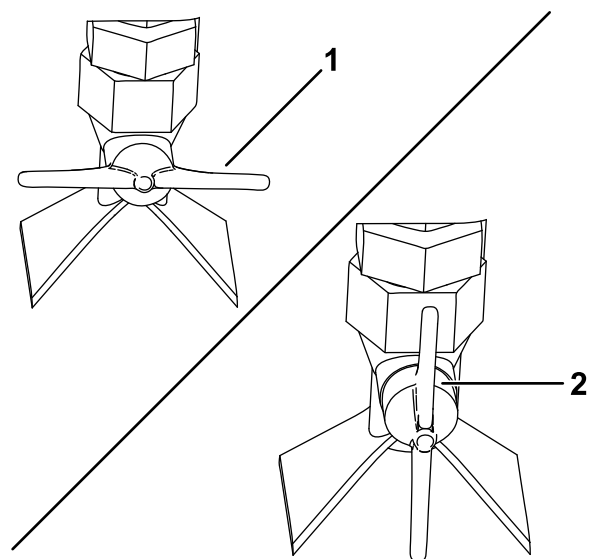
22. Move the drill spindle down the frame under the thread-joint-compound applicator, and spray the spindle with thread joint compound.
23. Rotate the drill spindle clockwise and move the carriage slowly forward to insert the spindle into the female end of the pipe secured in the lower wrench.
Note: Tighten the joint until you reach no more than 2,304 N-m (1,700 ft-lb).
24. Release the wrench and continue reaming/retraction as needed.

Removing the Last Pipe and the Reamer

Important: Do not pull the drill head into the pipe guide or you may damage the machine or the drill head.

1. Using the exit-side-lockout transmitter, enable the exit side lockout.
2. After the reamer has cleared the ground, if you have not already done so, disconnect the product being installed from the reamer.
3. Connect the drilling fluid pump to a source of clean water.
4. Turn the pump on to flush clean water through the pump, spindle, and reamer until the water runs clear.

5. Remove and store the last pipe; refer to [Removing Drill Pipes \(page 29\)](#).
6. Leave the lead bar clamped in the lower wrench, but do not connect the drill spindle to the lead bar.
7. Remove the reamer from the end of the lead bar as directed by the reamer manufacturer.
8. Release the lower wrench and pull the lead bar out of the pipe guide.



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Figure 33

1. Spray valve—fan-shaped spray (horizontal)
2. Spray valve—stream (vertical)

Finishing the Job

Complete the following after each day of use:

- Connect the hand spray gun to the pump and clean the machine with clean water; refer to [Finishing the Job \(page 30\)](#).
- Add grease to the grease fittings.
- If the air temperature is below freezing or will be before the next use, prepare the system for cold weather.
- Install the controls covers.
- Flush the drilling fluid out of the drilling-fluid pump with water or antifreeze.

Note: The drilling-fluid pump may be damaged if the drilling-fluid dries up in the pump.

Using the TJC Applicator

Adjusting the Applicator Nozzle

You can adjust the applicator nozzle to spray thread-joint compound (TJC) either in a fan-shaped spray or as a stream.

- For fan-shaped spray—turn the spray valve on the side of the nozzle horizontal ([Figure 33](#)).
- For a stream—turn the spray valve on the side of the nozzle vertical ([Figure 33](#)).

Adjusting the TJC-spray Volume

To adjust the volume of thread-joint compound that is delivered by the applicator, complete the following:

1. Loosen the jam nut on the adjustment bolt located on top of the TJC-applicator piston (Figure 34).

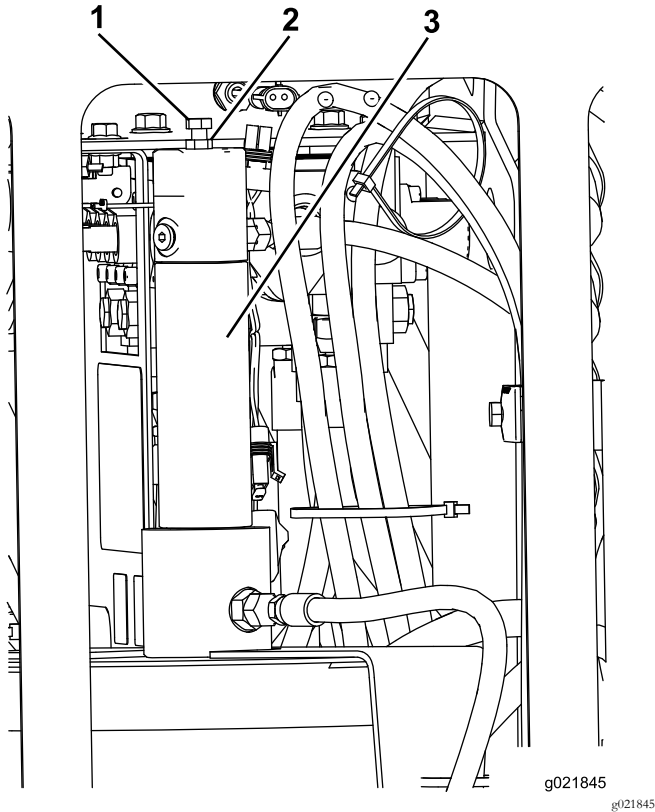


Figure 34

- | | |
|--------------------|--------------------------|
| 1. Adjustment bolt | 3. TJC-applicator piston |
| 2. Jam nut | |

2. Adjust the bolt as follows:
 - To increase the applied volume of compound, thread the bolt out (up).
 - To decrease the applied volume of compound, thread the bolt in (down).
3. When you have attained the desired application volume, tighten the jam nut to secure the adjustment.

Filling the TJC Applicator

1. Stop the machine and stop the engine.
2. Open the stake-down-guard door.
3. Loosen the wing nuts securing the cover straps to the machine (Figure 35).

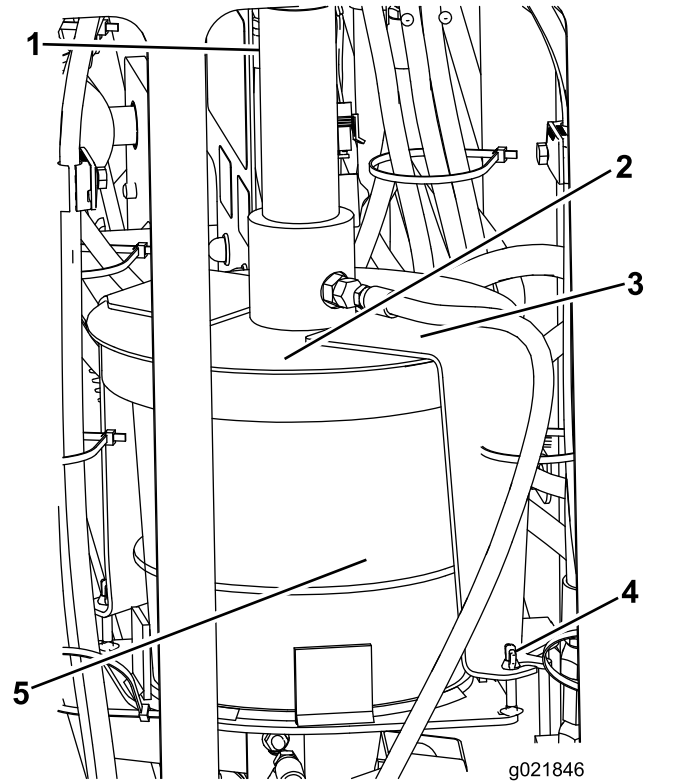


Figure 35

- | | |
|--------------------------|---------------|
| 1. TJC-applicator piston | 4. Wingnut |
| 2. Cover | 5. TJC bucket |
| 3. Strap | |

4. Rotate the cover and pull the cover straps off the retaining bolts (Figure 35).
5. Lift the cover assembly off and out of the empty thread-joint-compound bucket (Figure 35).
6. Replace the empty bucket with a new full bucket.
7. Place the plunger into the new bucket and lower the cover assembly onto the bucket (Figure 35).
8. Slide the cover straps over the retaining bolts and rotate the cover to seat the straps on the bolts (Figure 35).
9. Tighten the wing nuts.

Moving a Disabled Machine

Whenever the machine is stopped and the engine is not running, the hydrostatic brakes automatically engage. Do not attempt to tow the machine if it cannot move under its own power. If possible, repair the machine at the site. If this is not possible, use a crane and a spreader bar to lift the machine onto a trailer, using the lift points.



Count on it.