MANTA RAY®
EARTH ANCHOR SYSTEMS

INSTALLATION INSTRUCTIONS

1.0 Description

Manta Ray earth anchors are driven tipping plate soil anchors. The most common anchor models are shown in figure 1. They have working load capacities up to 12 tons and all use the same anchor rod and eye nut or termination hardware. Figure 2 shows how they work. This document describes a basic hand held and mechanized installation of the most common Manta Ray anchors. Deeper installations differ only by requiring longer anchor rods and more drive steel.

Fig. 1 **MR-SR for soft soil** **MR-1 for medium soil** **MR-2 for hard soil**

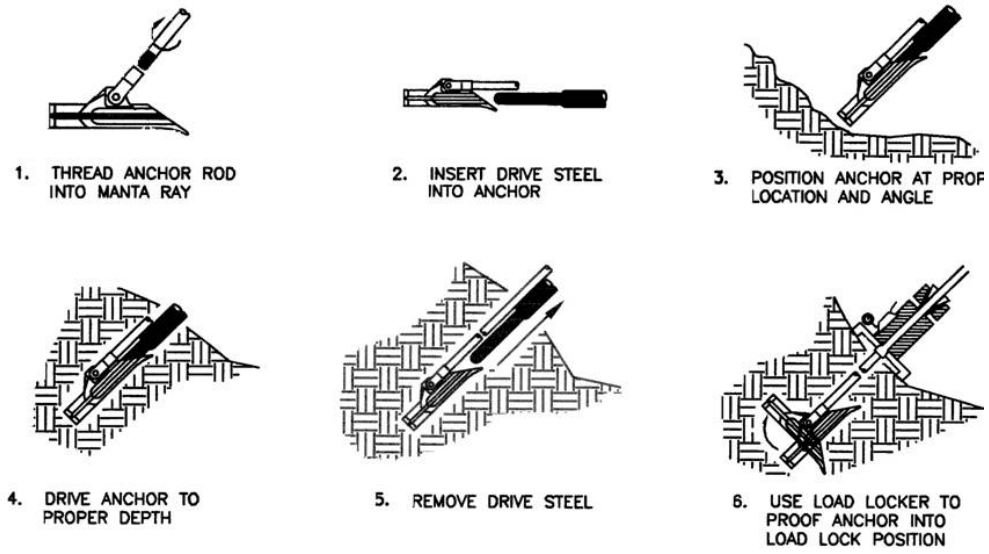


Fig. 2 **How they work**

The Manta Ray anchor is designed to be driven into the ground with a 90 lb (41kg.). hydraulic pavement breaker (hammer). After the anchor has been driven to the depth of the anchor rod, the driving tool (called drive steel) is removed. The anchor is then tipped from its edgewise-driving position to its "load locked" position. This is done with a hydraulic jack called the Load Locker, and provides an immediate proof test of each anchor. The direct reading gauge on the Load Locker makes the proof test easy and fast. There is no guesswork; if the soil is too soft the installer immediately knows to install a second anchor, use a larger anchor, or install to a greater depth.

2.0 Required Tools

All of the required tools fit easily in a small pick up truck.

2.1 Hydraulic Hammer: A 90lb. (41kg.) hand held hydraulic pavement breaker (hammer) is required. Typical performance specifications are 1200 blows per minute at 8gpm and 1500 psi (30 lpm/140 bar). The HB90-14 anchor driving hammer pictured below with 1 ¼" hex x 6" (32mm x 152mm) chuck and HTMA flush face couplers is available from a Manta Ray Distributor.

2.2 Hydraulic Power unit: A hydraulic power unit and hydraulic hoses to power the hammer are required. Typical specifications are 18hp, 8gpm, 2000 psi (30 lpm/140 bar) with hydraulic oil cooler. The GPU18-8CE hydraulic power unit pictured below is available from a Manta Ray Distributor.

2.3 Hydraulic hoses: Should be ½" (12.5mm) nominal size and 25' (7.6m) length with HTMA flush face couplers. 2 sets of hoses may be coupled together to provide a 50 foot (15.2m) reach from the power unit to the anchor installation. HC-16-25 hydraulic hoses that meet all these requirements are available from a Manta Ray Distributor.

2.4 Drive steel

Available from your Manta Ray Distributor, is required. The Manta Ray drive steel is a patented design made of high performance materials. It allows the anchor to be driven to depth in discrete increments to allow installation in tight spaces while the operators remain safely on the ground. The SGC-14 Drive steel kit is the preferred starting set. It is composed of short (about 3 foot long) pieces that are coupled together during installation: The shank (or striking bar) has a 1 ¼" hex x 6" (32mm hex x 152mm) shank configuration on one end to match the HB90-14 hammer and is threaded on the other. The radius tip piece is rounded on one end to fit into the Manta Ray anchor and threaded on the other. Extensions are threaded on both ends. The couplers join the different pieces together. The SGC-14 kit includes 1 shank, 1 radius tip, 2 extensions, 3 couplers, an extractor bar, and a carrying bag. This is enough to drive Manta Ray anchors to about 8'(2.4m) depth. The extractor bar is included to allow the Load locker to be used to extract the drive steel if it gets stuck. Refer to stuck drive steel in the special cases section.

Left: The drive steel kit includes the drive steel pieces, an extractor bar and a carrying bag.
Right: Close up of the Shank, Couplers, Radius Tip and Extensions.

The patented Manta Ray SG drive steel uses a partial left hand thread that allows very efficient impact energy transfer from the hammer to the anchor. All joints should be lubricated with light oil or spray lubricant prior to assembly. After installing an anchor the drive steel joints should be cleaned of dirt which will enter the couplers during driving. Failure to clean and lubricate the drive steel and couplers will result in premature failure. Drive steel parts are available separately and come in lengths of 3, 6, 8 feet (.9, 1.8, 2.4m). Medium and heavy duty couplers are also available. Contact your Manta Ray distributor.

2.5 LL-1 Load Locker

The Manta Ray LL-1 Load Locker is required to load lock and proof test the anchor. It is a double acting hollow hydraulic jack with a base reaction plate and a direct reading gage. Use of this tool provides an immediate proof test of each Manta Ray anchor. It is designed to be powered by the same GPU18-8CE hydraulic power unit that is used to power the HB90-14 anchor driving hammer. The LL-1 uses quick release gripping jaws that grip an Adapter Setting Bar (ASB) that passes through the center of the jack. The ASB extends the anchor rod and precludes any damage to the anchor rod from the gripping jaws. Different models of LL-1 Load lockers to accommodate different anchor rod thread patterns (with different Adapter Setting Bars and gripping jaws) are available. Contact your Manta Ray distributor for the proper model of LL-1 Load Locker. The base plate is designed for anchors that are installed at an angle to the ground: it has a large and a small cross member. For angled guy anchors the shorter of the two cross members should be placed toward the tower and perpendicular to the axis of the anchor rod. The Load locker and base are designed to self align to the actual angle between the anchor and the ground. The vertical legs of the Base cut into the soil during use to help keep the base from skidding. When load locking angled anchors the knife edges of the Load Locker jack should engage the square tabs on the base that are closest to the short cross member.

The LL-1 Load Locker kit includes adapter setting bar, Gripping Jaws and Metal Box. It does not include the Hydraulic Power Unit.

3.0 Step by Step Installation Instructions

CAUTIONS:

ALL SUBSURFACE UTILTIY LOCATION PRECAUTIONS MUST BE OBSERVED PRIOR TO INSTALLATION. DO NOT DRIVE MANTA RAY ANCHORS WITHOUT AN UNDERGROUND UTILITY LOCATION REPORT.

PERSONNEL MUST USE SAFETY GEAR INCLUDING BUT NOT LIMITED TO: HARD HATS, GLOVES, STEEL TOE BOOTS, EYE AND HEARING PROTECTION.

3.1. Assemble the anchor

Thread the anchor rod into the anchor shackle and tighten with a wrench. There are several styles of anchor rods and some require the use of a pipe wrench. Place the anchor at the required location. For guy anchors the anchor should point away from the tower and the anchor rod should point directly at the tower.

This picture shows a Utility Style anchor rod with a wrench hex. Some anchor rods are fully threaded with no hex so a pipe wrench is used to tighten the rod into the shackle.

3.2. Assemble the first section of drive steel

The shank, a coupler and the radius tip are threaded together. Remember the drive steel system has left handed partial threads. When connected properly, the coupler should move back and forth freely (called free float). Always check for this free float. If the coupler is not completely threaded into the free float position it will break when the hammer is turned on. Lubricate the threads prior to assembly with light oil or spray lubricant, then connect shank and radius drive steel tip together with a coupler.

3.3 At anchor location, put drive steel in hammer, put anchor on drive steel

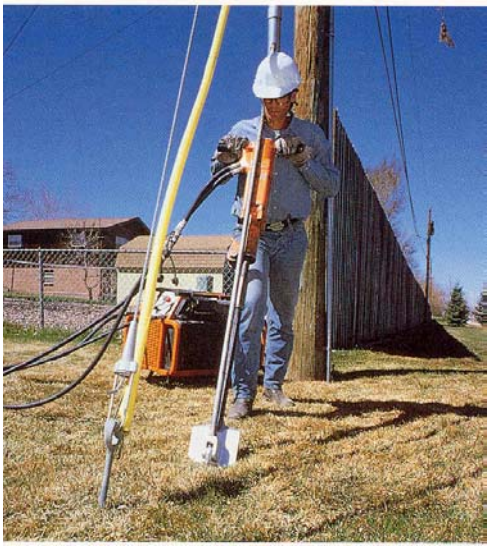
Place the hammer on the ground behind the anchor and insert the drive steel shank into the hammer. Place the anchor onto the radius tip. Position the anchor at the point of entry into the ground.

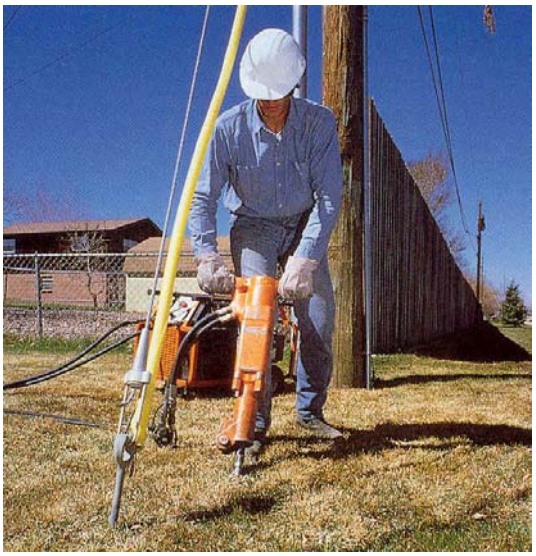
3.4 Make hydraulic power connections

Connect the hammer to the power unit with the hoses, start the power unit and turn the hydraulic circuit on.

3.5 Drive the first section

Raise the hammer to the proper angle and begin to drive the anchor. To avoid "skidding'" at the start of angled drives, start closer to vertical, then lower the hammer to the proper angle as the anchor begins to penetrate the ground. The installer must support the weight of the hammer. Do not let the weight of the hammer apply a side load on the drive steel or premature drive steel failure will occur. Drive the anchor until the first drive steel coupler is approximately at ground level.





3.6 Add drive steel extensions

Open the hammer latch and remove the hammer from the shank, being careful not to remove the radius drive tip from the anchor. CAUTION: THE DRIVE STEEL, ESPECIALLY THE COUPLERS, CAN BE HOT. WEAR GLOVES. Remove the drive steel shank from the coupler. Remember the drive steel has a left hand partial thread. It helps to hold the coupler and pull upward on the shank while turning clockwise (as viewed from above) to the get the partial threads to engage. Place a drive steel extension and another coupler between the original tip and shank. Remember to lubricate the drive steel joints prior to assembly. Replace the hammer on the shank and continue driving the anchor until the second coupler is at ground level. Repeat this step with the second drive steel extension (or as many drive steel extensions as required to achieve the depth required). Drive times for most normal soils are approximately 3 – 5 minutes per 3 foot (.9m) long drive steel section. If at any time the anchor stops moving, perform what is called the 5 minute test. Make a visible mark on the anchor rod and drive the anchor for 5 minutes. If the anchor moves less than ½" (12.5mm) in 5 minutes this is called refusal. Refer to anchor refusal in the special cases section.

3.7 Attach Adapter Setting Bar (ASB) and countersink

When the top of the anchor rod is at ground level, stop driving and thread the Load Locker Adapter Setting Bar (ASB) onto the anchor rod. The purpose of the ASB is to extend the anchor rod so the Load Locker can grip it. Because the anchors pull back upward during load locking, some experience is required to properly estimate how far to drive the anchors to achieve the required minimum finished depth. A good rule of thumb is the anchor will pull back approximately 1 to 2 times its length. After threading on the ASB, drive the anchor until the top of the anchor rod is below grade by approximately the length of the anchor. This is called "countersinking the anchor". The ability to estimate how much to countersink comes only with experience. Softer soils and larger anchors require greater countersink. Some very soft soils will require the installer to countersink 18-36 inches (.45 – .9m). Harder soils require less if any countersink. Some conservative installers drive all anchors 36" (.9m) beyond the minimum required finished depth to be sure to meet the finished depth requirement. This may require additional drive steel extensions and couplers.

Top of anchor rod at grade, and Adapter Setting Bar (ASB) being installed.

3.8 Remove the drive steel.

In most cases the drive steel is simply removed by an upward pull on the hammer. A very rapid upward pull usually breaks the drive steel free. After the steel is broken free, remove the hammer and pull the drive steel out of the hole by hand. CAUTION: THE DRIVE STEEL, ESPECIALLY THE COUPLERS, CAN BE HOT. WEAR GLOVES. If the steel does not break free easily, pull upward while operating the hammer to "vibrate" the steel free. After the steel has broken free, remove the hammer and pull the drive steel out of the hole by hand. In some gravelly or rocky soils the drive steel can become stuck. If this happens, the Load Locker can be used to remove the drive steel. Refer to stuck drive steel in the special cases section.

Note: This picture shows the installer removing the drive steel by hand after it has broken free. It does not show the adapter Setting Bar (ASB) on the anchor rod, but normally it would be on the anchor rod as shown in the previous picture.

3.9 Set up the Load Locker.

Place the base plate over the Adapter Setting Bar (ASB) with the shorter cross member toward the tower and perpendicular to the axis of the ASB. Align and adjust the position of the base plate so that the ASB is even with the square steel tabs closest to the small cross member. Slide the Load Locker jack over the ASB so the knifed edges on the jack engage the square tabs on the base. Place the gripping jaws around the ASB and into the tapered rod end of the jack. Use light oil or spray lubricant on the outside surfaces of the gripping jaws to help them release. New jaws have a tendency to stick. Connect the hydraulic jack to the power unit and turn on the hydraulic circuit.

3.10 Load Lock the anchor.

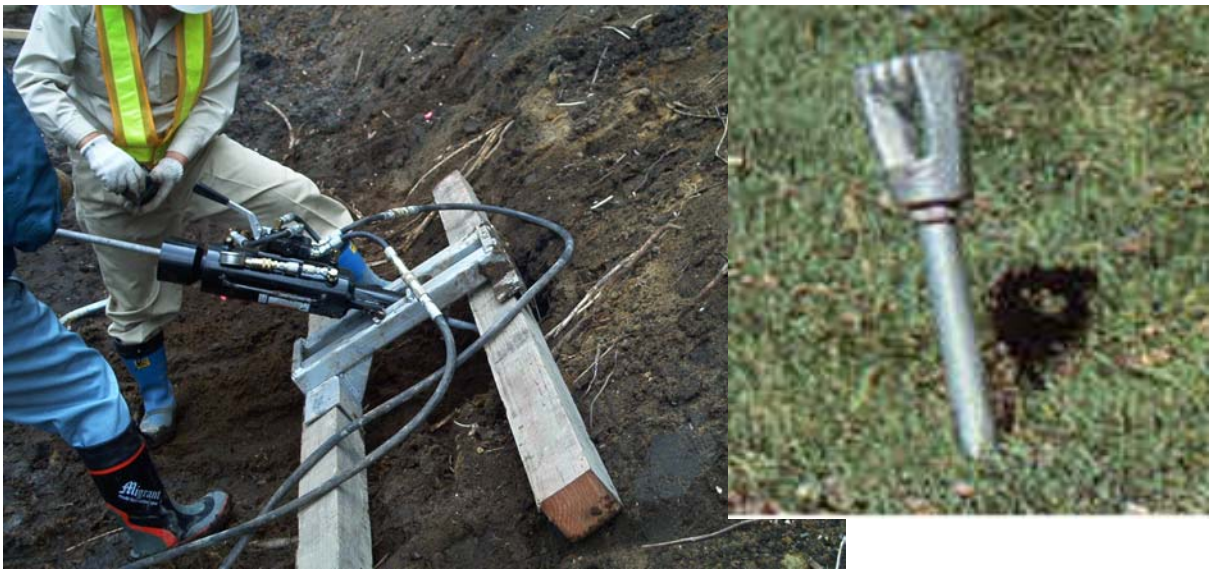
CAUTION: NEVER STAND IN LINE WITH THE ANCHOR ROD DURING LOAD LOCKING.

Be certain that nothing is underneath any part of the base plate. Push the valve handle toward the jack to extend the cylinder and tip the anchor. When the cylinder reaches the top of its stroke it will stop automatically on its own internal stops. When it does, pull the valve handle away from the jack to retract the jack. New jaws have a tendency to stick, so don't be surprised. To release them retract the jack about halfway and give the ASB a very swift side to side jerk. This should release the jaws and the jack should fall back onto the base plate. Fully retract the jack and reset the jaws. A good rule of thumb is to apply 3 full strokes of the jack to the anchor to insure that it is fully tipped.

3.11 Proof test the anchor

Proof test the anchor to the required load. This is done by re setting the jack and the jaws and gradually increasing the load on the anchor to find out the maximum it will hold without movement. With practice and installer can carefully control the pressure on the anchor with the control valve. Hold the load on the anchor as measured on the direct reading gage and monitor the movement of the anchor. If the anchor holds the required load for 1 minute with no more than ½" (12.5mm) of movement then the anchor has passed the proof test. A common way to measure the movement of the anchor is to use a tape measure between the top of the cylinder portion of the Jack and the bottom of the tapered barrel that holds the gripping jaws. The manual included with the Load locker manual has more detail on proof testing methods.

In softer soil the base plate can be set on top of timbers for increased surface area so that any sinking tendency will be eliminated.



Load locker base is placed on timbers in soft soil, and finished anchor with eye nut installed.

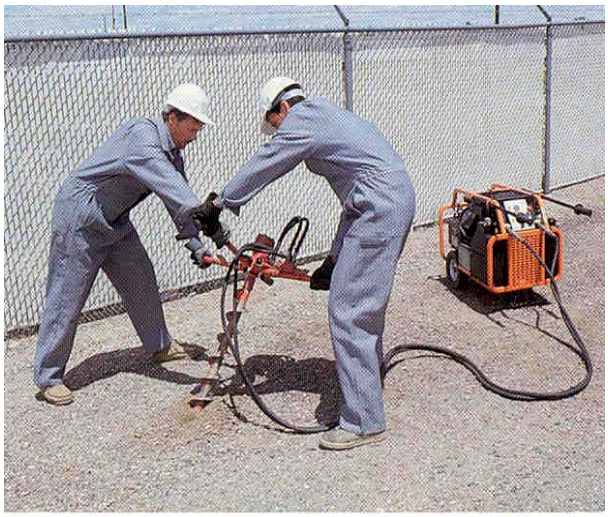
4.0 Special Cases

4.1 Refusal

Refusal is defined a s a penetration rate of 1/2" (12.5 mm) or less in 5 minutes of driving. This can indicate extremely hard soil or an impenetrable object.

4.1.1 Hard soil

The use of a hand held hydraulic auger to drill a pilot hole can help significantly. The hydraulic auger shown below is available from a Manta Ray distributor. Called the LB-1 earth auger it is powered by the same hydraulic power unit and comes with enough 4" (102mm) diameter augers and extensions to drill an 8 foot (2.4m) deep pilot hole.



Deeper pilot holes can be drilled by the addition of more extensions. The Manta Ray can then be driven down the pilot hole to achieve a much faster installation. Always use the auger tailings to backfill and tamp after the anchor has been driven down the pilot hole. Some installers use ¼" (6mm) gravel to backfill after driving the anchors. The use of a pilot hole in hard soils can significantly increase the life of the SG drive steel. In some extremely hard soils the use of a pilot hole and the MR-2 anchor is the right choice. The MR-2 will penetrate the pilot hole with virtually no resistance. The MR-1 and MR-SR anchors can be driven down the pilot hole but the wings will provide some resistance. In most cases, if the soil is hard enough to warrant the use of a pilot hole, the holding capacity is not an issue and the anchors will proof test to their maximum capacity. Because all soils are different, some experimentation is required to effectively use pilot holes. In some extremely hard soils the MR-2 will tend to slide back up the pilot hole during load locking. Sometimes this can be avoided by good backfilling and tamping. Sometimes it can't be avoided, and the possible solutions are: drive the anchor beyond the end of the pilot hole if possible, or try a larger diameter pilot hole. Different diameters augers and extensions are available.

4.1.1 Impenetrable object

If the anchor has hit an impenetrable object the installer has two options:

4.1.1.1 Abandon the anchor but save the anchor rod by unthreading it. Then try a slightly different location or angle with a new anchor to attempt to miss the object.

4.1.1.2 Retrieve the anchor with the Load Locker. This is done by removing the hammer from the drive steel but leaving the drive steel in the anchor. Then place the LL-1 Load locker over the anchor rod and use it to pull the anchor out. Leaving the drive steel in the anchor prevents it from tipping and locking when the LL-1 pulls on the anchor rod. Be careful to stop pulling with the when the anchor gets close to the bottom of the Load Locker. In most cases a bit of shovel work is required to retrieve the anchor. After retrieval try a slightly different location or angle with a new anchor to attempt to miss the object.

4.2 Stuck drive steel

Some gravelly soils or very wet, muddy soils will collapse around the drive steel during driving and make it very difficult to break free by hand. This can also happen when a the anchor hits a small obstruction and penetrates on a slightly curved path. For this reason a Drive Steel Extractor Bar (SG-X) is included with each drive steel set. It is threaded on one end to fit into the drive steel couplers. The other end is designed to be gripped by the gripping jaws of the LL-1 Locker. If steel does not manually break free, simply remove the hammer from the shank, remove the shank piece from the coupler, and thread in SG-X (remember the left hand partial thread). Use the load locker to pull up on the SG-X to break the steel sections free. Usually after the steel breaks free it can be pulled out by hand. The drive steel will fit through the center of the Load locker, but be careful. Sometimes the edges of the couplers can get stuck on the bottom of the load locker jack or base plate.

4.3 Alternate Tools

Pneumatic pavement breakers can be used to drive the anchors, but be sure to use a 90 lb. (41kg.) hammer and the proper compressor. Most installers have found that the hydraulic hammers outperform the pneumatics for driving Manta Rays, especially in the harder soils. A hydraulic power unit will still be required to run the Load Locker and the earth auger. Contact your Manta Ray distributor for details.

4.4 Other Options

Manta Ray anchors can be threaded for many different types of anchor rods and smaller Manta Ray anchors are also available. Contact your Manta Ray distributor for details.

5.0 Driving the anchors with Mounted Hammers

A Hammer mounted to a skid steer, backhoe or excavator makes driving Manta Ray anchors very easy. Be careful to maintain proper alignment as the anchor penetrates the ground. It is easy to move the arms of the vehicle too fast and cause severe misalignment which will cause premature drive steel failure. Many installers use an equipment operator and a helper who can stand to the side for a better view to signal to the operator how to move the arms of the vehicle.

5.1.1 Skid Steer

A Hammer mounted to a skid steer makes driving Manta Ray anchors very easy. 500 ft-lb (369 Joule) rated hammers are common and perform well for driving Manta Ray anchors. A blunt (flat end) tool in the hammer is required. The picture at right shows the socket adapter that threads onto Manta Ray SG drive steel. Socket adapters are sized for the diameter of the blunt tool in the hammer. 6 foot long drive steel pieces are typically used. Use a chain around the socket adapter to remove the drive steel with the vehicle.

The use of optional Medium or Heavy duty Drive steel couplers is recommended. A Heavier Duty SG150 drive steel system is also available. Contact your Manta Ray distributor for details.

5.1.1 Backhoe or Excavator

Use the same socket adapter and drive steel as used with the skid steer method. Note the helpers stand to the side to watch the alignment and signal to the operator.

6.0 Holding Capacities

The holding capacity of Manta Ray anchors is dependant on the soil into which they are placed. Use the charts of Section 6.1 to estimate capacities based upon the Standard Penetration Test (SPT) Blow count, N. The capacities listed in the charts are Ultimate Capacity. In the harder soils the Ultimate holding capacity is the actual Breaking strength of the anchor. In the softer soils the ultimate capacity is the ultimate strength of the soil. In general Manta Ray anchors perform best in mixed soils with Blow counts in the 10 – 40 range. The values listed in the charts represent estimated capacities for anchors with a minimum of 6 feet embedment into the soil in question.

6.1 Holding Capacity Charts for Manta Ray Anchors

Capacities in KIPS (kilopounds, or 1000's of pounds)

Soil Description	Blow count (N)	MR-2 KIPS	MR-1 KIPS	MR-SR KIPS
Very dense/cemented sands; Coarse gravel and cobbles	60-100+	**28-40** (1,3,4)	**40** (1,3,5)	**40** (5)
Dense fine compacted sands, very hard silts or clays	45-60	**21-28** (2,4)	**36-40** (1,3,4)	**40** (1,3,5)
Dense Clays, Sands and gravels, hard silts and clays	35-50	**15-22** (2,4)	**24-36** (2,4)	**32-40** (2,3,4)
Medium dense sandy gravel, stiff to hard silts and clays.	24-40	**12-18** (4)	**18-20** (2,4)	**24-34** (2,4)
Medium Dense Coarse sandy gravel, Stiff to Very stiff silts and Clays	14-25	**9-12** (4)	**15-20** (4)	**18-24** (4)
Loose to Medium Dense Fine to Coarse Sand: Firm to Stiff Clays and Silts	7-14	**7-10** (4)	**10-15** (4)	**14-18** (4)
Loose Fine Sand, Alluvium, Soft Clays, Fine saturated Silty Sand	4-8	**5-8** (4,6)	**8-12** (4,6)	**9-14** (4,6)
Peat, Organic Silts: Inundates Silts Fly Ash	0-5	**2-5** (4,6)	**3-8** (4,6)	**4-12** (4,6)

Capacities in kN (kilonewtons, or 1000's of Newtons)

Soil Description	Blow count (N)	MR-2 KIPS	MR-1 KIPS	MR-SR KIPS
Very dense/cemented sands; Coarse gravel and cobbles	60-100+	**125 - 178** (1,3,4)	**178** (1,3,5)	**178** (5)
Dense fine compacted sands, very hard silts or clays	45-60	**93 - 125** (2,4)	**168 - 178** (1,3,4)	**178** (1,3,5)
Dense Clays, Sands and gravels, hard silts and clays	35-50	**67 - 98** (2,4)	**107 - 160** (2,4)	**142 - 178** (2,3,4)
Medium dense sandy gravel, stiff to hard silts and clays.	24-40	**53 - 80** (4)	**80 - 89** (2,4)	**107 - 151** (2,4)
Medium Dense Coarse sandy gravel, Stiff to Very stiff silts and Clays	14-25	**40 - 53** (4)	**67- 89** (4)	**80 - 107** (4)
Loose to Medium Dense Fine to Coarse Sand: Firm to Stiff Clays and Silts	7-14	**31 - 44** (4)	**44 - 67** (4)	**62 - 80** (4)
Loose Fine Sand, Alluvium, Soft Clays, Fine saturated Silty Sand	4-8	**22 - 36** (4,6)	**36 - 53** (4,6)	**40 - 62** (4,6)
Peat, Organic Silts: Inundates Silts Fly Ash	0-5	**9 - 22** (4,6)	**13-36** (4,6)	**18 - 53** (4,6)

Notes:
1) Drilled pilot hole required for efficient installation
2) Ease of installation may be improved by drilling a pilot hole.
3) Holding capacity limited by ultimate strength of anchors
4) Holding capacity limited by soil failure.
5) Not recommended in these soils
6) Wide variation in soil properties reduces prediction accuracy.