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Photo by Joe McCarthy

Aggregate processing may begin with drilling and blasting, but blasted material isn’t going anywhere until it is moved from the muckpile to the processing plant. Front-end loaders and excavators usually perform the next step of the process — loading haul trucks. If this stage of the process is not planned effectively, production goes down and costs go up.

Front-end loaders, also called wheel loaders, and hydraulic excavators most commonly scoop blasted material from the quarry face and transfer it to haul trucks. But wheel loaders, because of their mobility, are also used in load-and-carry applications in which the machine loads the bucket and carries the material to an in-pit crusher or a portable screening plant. Similarly, excavators, because of their superior digging power, are sometimes used to load naturally fractured rock and unconsolidated materials directly from the mining face without blasting.

In addition to front-end loaders and hydraulic excavators, a small number of aggregate operations use rope shovels for excavating and loading, and some use draglines for excavating.  This chapter will focus on the more commonly used machines, wheel loaders and hydraulic excavators, as well as dredges, which are used for underwater material extraction.

COMPARING STRENGTHS

The marked differences in front-end loaders and hydraulic excavators — starting with wheels versus tracks — dictate the differences in the strengths of each type of machine. Those strengths and relative weaknesses determine which type of machine works best in a given application.

**Mine conditions favoring wheel loaders include:**
■ Level, dry, smooth, firm floors.
■ Sufficient slope and drainage in wet climates to minimize tire damage.
■ Well-fragmented materials that help minimize crowding (pushing into the pile), particularly in the toe of the loading face.
■ Lower face profile (Bucket hinge pin height at maximum lift is optimal.)
■ Multiple loading faces and frequent travel from one spot to another.

**Opposite conditions are unfavorable to wheel loaders:**
■ Poor underfoot conditions, such as wet, soft ground or jagged rock.
■ Poorly shot material.
■ Tight loading areas that restrict loader movement.

Front-end loaders have wide buckets that spread the digging forces over a wide area. As a result, the digging ability — the ability for the bucket to penetrate the pile — generally is less than a hydraulic excavator handling the same amount of material per pass.

**Mine conditions favoring hydraulic excavators (backhoe configuration) are:**
■ Low to moderate bench heights.
■ Tight loading areas.
■ Selective digging.
■ Multiple truck sizes.
■ Can work in poor floor conditions, but that could limit truck positioning.

**Conditions that are unfavorable for hydraulic excavators include:**
■ High benches.
■ Multiple benches.
■ Excessive tramming.
■ Low angle of repose material.

Hydraulic excavators require sufficient bench height for efficient and safe operation.  The rule of thumb for optimal bench height is the length of the excavator stick.

Hydraulic front shovels offer another configuration of loading and excavating machine, though front shovels are much less common in aggregate applications than are backhoe configurations. Generally, front shovels have the advantage of being able to mine multiple bench heights and to efficiently handle tough digging. Front shovels require moderate to high faces to be most efficient.

Wheel loaders and front shovels load trucks sitting on the same bench, and hydraulic excavators can load trucks on the same bench and trucks on the bench below. The latter is the faster loading layout, because it reduces the time the excavator must spend raising the boom to reach over the side rail of the truck body.

Selecting the types of machines for production loading is the first step in identifying the best equipment for the specific aggregates operation. Next is sizing and equipping each excavating and loading machine for the desired production.

SIZING AND EQUIPPING LOADING AND EXCAVATING MACHINES

Today’s aggregate producers are on a continual search for lowest cost per ton of material produced. Efficient excavating and loading procedures are an important part of achieving this goal. Choosing the right loader or excavator requires research.



Photo by Joe McCarthy

Efficient and productive aggregates production depends, in large part, with equipment selection. A host of factors, including material composition, production requirements, and of course, budget limitations will enter into the decision. The individual at the pit or quarry responsible for making equipment purchasing decisions is best advised to do as much research as possible into the requirements of the operation, existing fleet and the equipment that is currently available on the market.

Loading machine size, bucket capacity, performance and operating costs are critical criteria. Matching the equipment needed for efficient aggregate production is not a simple task. The equipment involved in aggregate production, including mining, transporting, processing, stockpiling and loadout are equally important in ensuring an efficient, productive operation.

There is good reason. The overall cost efficiency and productivity of a quarry operation is the sum of the sequential procedures required for making the finished products. For example, productivity suffers if an 800-ton/hour primary crusher is followed by a 300-ton/hour capacity screen. Likewise, consider the inefficiency in using wheel loaders with 9-ton payloads to load 85-ton-payload off-highway haulers. These examples are exaggerated only to make a point: the aggregate-processing chain is only as efficient as its least efficient link.

Computer programs used by several manufacturers and, in some cases, their dealers, are taking the guesswork out of the equipment selection process and helping aggregates producers provide answers to a lot of questions that begin with “What if?” Most programs enable an equipment representative to go out to a customer’s site and to gather managers’ and engineers’ input to tailor the equipment selection to suit the specific needs of the mine. For a loader/hauler application, for example, variables such as the type of haul road to be traveled, the type of equipment currently in use, equipment options being used, tires and the type of schedule can all be plugged in.

The software then processes the information and runs through a project simulation. Road- and site-induced dependent variables like ambient temperature, fuel consumption, tire life, oil temperatures and major component life are calculated based on the severity of the road profile, which also has an effect on the resultant speeds, cycle times and operating costs. Haul routes can be described in detail, showing curves, bumpiness, traction coefficient, altitude and super elevation, in addition to grade, speed limit and rolling-resistance variables.



Photo by Zach Mentz

Selecting equipment can be particularly challenging in the aggregates industry, because you are always trying to meet a specific production goal. But to keep costs down — to optimize the use of your equipment — your fleet should not be capable of exceeding that goal by a significant amount. If the primary crusher can handle one million tons of material per year and you can sell that much material, then one million tons is your target.

ASSESSING WHEEL LOADER PRODUCTION

In selecting a front-end loader, you should first consider the production capability of other components in the material handling system. Select a loader that can handle slightly more than the capacity of the system/equipment that is receiving the material. Required production rates should be carefully examined prior to making a selection.

Cycle time is a critical consideration. According to Caterpillar, a basic cycle time of 0.45-0.55 min. is average for a wheel loader hauling loose, granular material on a hard, smooth operating surface with an experienced operator.

The basic cycle time for large loaders (4 cu. yd. and up) can be slightly longer. Material type, pile height and other factors may improve or reduce production and should be added to or subtracted from the basic cycle time.



Photo by Joe McCarthy

For example, in its Performance Handbook, Caterpillar suggests adding 0.02 minutes to the basic cycle time for mixed material and for material up to 1/8 in. For 1/8-in. to 3/4-in. material, subtract 0.02 minutes. For material sizes 6 in. and higher, add 0.03 minutes, and for bank or broken material, add 0.04 minutes. For pile factors, add 0.01 minutes for conveyor or dozer piles of 10 ft. or less and 0.02 for piles dumped by a truck. For constant operation, subtract up to 0.04 minutes, and for inconsistent operation, add up to 0.04 minutes. A small loading target will add up to 0.04 minutes, while a more fragile target will add up to 0.05 minutes. Using actual job conditions and the above factors, convert total cycle time to cycles-per-hour using the following formula:

**Cycles-Per-Hour at 100-Percent Efficiency = 60 Min./Total Cycle Time in Minutes**

Required payload per cycle is determined by dividing required hourly production by the number of cycles per hour. Once required payload per cycle has been determined, it should be divided by the loose cu. yd. material weight to determine number of loose cu. yd. required per cycle.

The bucket size required to handle the required volume per cycle can be found by utilizing what Caterpillar calls the “bucket fill factor.”

The fill factor for loose material varies between 85 to 100 percent. Poorly blasted rock has a fill factor between 60-75 percent; average blasted rock, between 75-90 percent; and well-blasted rock, 80-95 percent. The bucket size needed is determined by dividing loose cu. yd. required per cycle by the bucket fill factor.

Fill factors on wheel loaders can be affected by bucket penetration, breakout force, rack-back angle, bucket profile, bucket teeth or bolt-on replaceable cutting edges.  Mathematical formulas can be used to determine the breakout force generated from rack-back and from bucket lift. As these formulas are based on specific loader dimensions and can vary from manufacturer to manufacturer, it is best to consult with the dealer to arrive at an exact calculation.

Practically every wheel loader on the market today offers improved visibility, easy-to-reach, fingertip controls and other performance-enhancing features. Some offer technology that reduces operating effort and lever travel. The unit’s boom lever is equipped with a quick kickdown switch allowing the operator to easily downshift from second to first gear.

Improved designs and better technology have enabled manufacturers to warrant their machines for longer periods of time than in the past. For details on warranties, always check with the dealer.

A number of the machines on the market have in place some form of on-board diagnostic equipment consisting of sensors and transmitters that can detect problems with most of the machine’s major operating systems before they occur — all in the name of eliminating downtime and saving you money.

As producers attempt to get more and more productivity out of a piece of equipment, maintenance has become a primary concern, and manufacturers have taken strides to make maintenance easier. Computer-aided diagnostics are common, allowing operators to run efficiency reports and troubleshoot performance right on the computer screen.

Many manufacturers have in place extensive dealership networks with highly trained personnel that can address and provide guidance on any number of operational issues. Also, a number of manufacturers have instituted seven-day-a-week, around-the-clock parts operations that can receive, fill and turnaround parts orders in less than 24 hours.



Photo by Zach Mentz

Today’s loader manufacturers are placing operator comfort and safety right up there with bucket capacity and breakout force on their list of design features.

**Today’s ergonomically designed loaders include:**
■ A suspension seat that adjusts to reduce strain on the lower back and thighs.
■ A thicker nonmetallic floor; a redesigned operating configuration that removes hydraulics from the cab; and streamlined powertrain components; to reduce noise.
■ Positive pressure ventilation in the cab to keep dust out and automatically controlled air conditioning and heat for increased comfort.
■ Steering systems that reduce the amount of operator movement required to turn the loader.
■ Finger-tip-implement control levers that require very low operator effort.

Quarry operations find that when employees are more comfortable on the job, morale improves, productivity increases and workers’ compensation costs are kept in check.

MATCHING EXCAVATORS TO THE JOB

Choosing the right excavator for a particular application can improve productivity. Material composition and production requirements are two main considerations in choosing an excavator. The type of material to be moved will impact horsepower, torque ratings and digging forces.

Bucket capacity is also important. The starting point is the overall production requirement for the operation, and then you consider the existing fleet you have to work with. That will dictate what size bucket and size of machine you’ll need.

Equipment matching is very important. A simple mathematic calculation can help in this area. Here’s an example: If you have a 50-ton truck and the material weighs 3,000 lb. per yd., you can determine how many passes a loader with a 3-yd. bucket would require to load the truck.  Divide 100,000 lb. of truck payload capacity by 3,000 lb. per yd. for about 33 yd.  Dividing by the capacity of the 3-yd. bucket, it will take 11 passes for you to fill that truck. The excavator is capable of making a complete pass in 20 seconds. So if you multiply 11 passes by 20 seconds, you have 220 seconds, or approximately four minutes to completely load the truck.

Then you have to decide if you can live with that four-minute loading time or if you have enough trucks and crusher capacity that you need a bigger excavator.

It is important to properly equip an excavator for the job it is expected to do in order to maximize its performance. Different arm lengths are available for most excavators. Short arms provide maximum crowd forces and payload capacity and are recommended for production truck loading, mass excavating and tough digging conditions. The appropriate bucket configuration and ground engaging tools (GET), such as teeth and cutting edges, also make a big difference in excavator production and costs.

OPERATING PROCEDURES

Proper operating procedures are key to getting the most from both wheel loaders and hydraulic excavators. In production truck loading, the placement of the truck in relation to the face and the loading machine is critical. There are many different loading geometries that are optimized for the layout of the mining operation.  Those different scenarios are best presented in diagrams and demonstrations. Consult your equipment supplier or engineering group for help in optimizing your truck loading layout.

With the proper loading geometry established, the loading machine operator should always spot the truck with the bucket of the machine. The truck operator merely backs under or pulls under the bucket to be located in the perfect spot for loading.

In terms of productivity, while cycle speed is important to the completion of a project, an operator’s goal should be smoothness of operation. Speed can be gained by addressing individual actions within a cycle and doing away with unnecessary movements. When taking loads of rock from a pile, containment should be the focus. As the loader bucket enters the pile, some of the material will fall into the loader and some will be pushed to the side. As material is pushed farther away from the original pile, more time must be spent retrieving it. Therefore, all forward passes should be taken while pushing the material toward the center of the pile.

When preparing to load a truck, operators should carefully time raising the bucket so it will reach truck height only when they are ready to dump. The first couple of loads should be used as trial runs so that the operator can find the point where the loader should begin being raised. Also, a full bucket should never be raised high in the air while the tractor is advancing toward the truck.

BUCKETS

A bucket’s job is to maximize productivity. To do this, a bucket needs to be matched to the machine and application. Factors such as material weight, material type, machine stability, machine breakout force, visibility requirements and dump-height requirements all play a part in how a bucket should be designed.

From the foundation designs, to the materials used, to the endplates, to the bucket teeth, a bucket built for a specific application will last longer and produce more value than a standard bucket.

Many producers assume that you have to take the bucket that comes with a machine when you buy it. You don’t have to use the standard bucket. Many producers feel that adding wear parts and repairing buckets is just the cost of doing business.

Many producers take the bucket off a new machine, and drop it of at the maintenance shop for modification. It’s common to add wear plates, hard-facing and other life-enhancing elements to the new bucket.

When ordering a new machine, request a bucket built to your specification. It may cost a little more up front, but you will eliminate the need to modify it when you bring it back to the plant.

MAXIMUM MAINTENANCE

Proper maintenance is critical to keep a loader or excavator operating properly. **Here are some standard tips:**

■ Always follow the manufacturer’s recommendations for frequency of oil changes and types of oils used. The different additives used can significantly affect how oils work in different machines. While one oil may be the best choice available for a certain piece of equipment, it may be inappropriate for another.

■ Grease fittings that are not conveniently located are often overlooked. Carefully check and maintain all fittings regularly in accordance with the manufacturer’s recommendations.

■ Lubricate pins and bushings after every shift when working in severe operating environments such as silica sand.

■ Keep radiators and system coolers free of dust and dirt, which can accumulate and reduce air flow, lower efficiency and cause the engine, torque converter and transmission to overheat.

■ Be extremely vigilant with equipment that is exposed to salt, such as winter road-salt operations. Use pressure hoses to remove salt from exterior surfaces so it does not work its way into machines. Keep salt accumulations off electrical connections.

■ Before each shift, inspect tires for any “cutting damage” to sidewalls or tread bars. When tires are under torque, cuts will be stretched and worsened. Chunking (losing chunks of rubber) may ensue, causing greater wear, further chunking and very rapid tire degradation.

■ Draining work “floors” can dramatically increase tire life. Moisture acts as a lubricant, making tires much more susceptible to cutting, chunking and slipping.

■ Maintain proper pressure to increase tire life. Use high-quality, professional air gauges to ensure a correct reading.

■ Follow manufacturer recommendations for specific types of air filters to use, and the correct change intervals. Just because a filter is high quality, it does not necessarily mean that it fits the particular airflow, filtration and other specifications required by your machine.

Capture and disposal of used fluids and waste materials such as oils, coolants, filters, batteries and tires, are part of any good maintenance plan. Here are some additional tips for operating a maintenance shop in an environmentally conscious manner.

■ Whenever possible, select equipment that produces low levels of emissions. Some advanced engines are able to actually produce greater torque at lower RPM than conventional engines, while creating fewer emissions. Changing to a low-emission engine on just one L150-class loader can reduce emissions as much as by installing catalytic converters on 66 passenger cars.

■ If the cooling system works improperly, there may be a leak that is allowing refrigerants to escape into the atmosphere. Select R-134-A refrigerants.

■ Because noise pollution can become an issue in some construction settings, select equipment that produces minimal “drive by” noise. Reduced noise levels also benefit the operator and ground crews.

■ Whenever allowed by a manufacturer, use biodegradable hydraulic fluids. These products are comparable in price, use the same seals and filters, are non-toxic and they can mix with mineral oil to allow for changes in the field.

■ Recycle plastic parts, castings, glass, rubber and metals whenever possible. Plastic parts are coded for future recirculation and safe destruction per ISO 11469.1043-3.

■ Become familiar with, and strictly follow, all federal, state, county, city and local compliance regulations.

■ Keep accurate records in the event they are requested by the EPA.

■ Remember that you are liable for your waste in its lifetime, even after it passes out of your hands.

CLEANER WORKS BETTER

No earthmoving machine is ever 100-percent clean. Contaminants are always present in fluid systems. Where do they come from? Often, they enter while the machine is working or being serviced, especially in the harsh environment of aggregate work. Regardless of the source, when contaminants invade a system, they impair machine performance and reduce component life.



Photo by Kevin Yanik

Machine manufacturers have always recognized the need to minimize contamination. But, in recent years, contamination control has been given even higher priority – and for good reason. Customers are demanding more from their machines – more power, more performance, more production and more life. But bad things can happen when a little dirt gets in the system.

In a sense, an aggressive contamination-control initiative is like starting a serious exercise program. Even if you’ve spent years perpetuating bad habits, making some real changes in your routine can extend your life significantly.

**Here are some ways to guard against contamination:**

■ Clean house internally. Make sure you are doing everything you can to minimize contamination during operation and maintenance.

■ Fix leaks immediately. If oil is leaking out, particles are getting in. Replace worn seals without delay. A seal is inexpensive, but the damage that can be caused through a leak can be very expensive.

■ Keep new filters packaged. Only open them when you are ready to install them.

■ Drain oil when it is warm and agitated.

■ Enroll in a fluid-testing program.

■ Do what your dealer is doing. Your equipment dealer is likely following manufacturers’ specifications for service work. Visit their shop. Inquire about the tools and processes they use.

Wheel loader uptime

Wheel loaders take a pounding. They work in material that wears away the very steel from which they’re built. Wheel loaders lift and carry enormous loads across uneven terrain for hours on end. They fight dust that is determined to go places it shouldn’t.

But the burden on wheel loaders is lessened when owners and operators practice proper maintenance. Here are a few considerations to help maximize your wheel loader’s uptime – and ultimately improve productivity and extend service life.

PRE- AND POST-OPERATION CHECK

A daily wheel loader walk-around inspection, both before and after operation, is an essential part of the day. Before you begin your day, check all routine daily items associated with fluids and filters. As with your personal health, prevention is the best medicine, and spotting something wrong before you begin work will go a long way to prevent further serious issues.

Equally important for quarry and aggregate operations is the need to pay close attention to features of the machine that contribute to safety – both for the machine itself and the people working around it.

Make sure no unnecessary obstructions impair the operator’s visibility. Check for chips and cracks in the windows. The glass should be free of dirt and cleaned frequently, and wiper blades and windshield cleaning fluid levels need to be maintained.

Examples of other safety components to check during the pre- and post-operation walk-around include running lights, rear-view cameras, backup alarms and safety belts. Watch for debris accumulation, too. Are steps cleared to prevent slipping? Are handrails clean? Have air vents been cleared to prevent steaming in the cab?

In addition to safety, focus on wear items. Check ground-engaging tools and buckets during the walk-around for signs of wear or cracking. In addition to the pre-operation check, do the same checks at the end of the shift. That’s often the best time to spot cracks, leaks or other damage that might have occurred that day.

CAPITALIZE ON TECHNOLOGY

Wheel loaders are built with a host of technological advancements. Take advantage of them as part of the equipment maintenance process.

For instance, some wheel loaders use programmable controls to ease the pounding wheel loaders and their operators encounter in pits and quarries. One such feature is the ride control feature found on some wheel loaders. It reduces loader arm bounce during travel – and dampens the vibration that reaches critical machine components. The system is especially beneficial in aggregate applications given the weight the wheel loaders carry, and the uneven terrain over which they transport materials.

Also, take advantage of telematics at every opportunity. Telematics provides actionable information from the wheel loader to your location of choice – including an office computer, laptop or mobile device. Many use telematics to schedule automated maintenance alerts. Telematics can significantly reduce the time involved in the data-collection process, as well as the paperwork that triggers preventive or corrective maintenance.

Users can also quickly pull reports with all of the pertinent information needed to schedule maintenance at the opportune time. Additionally, users can hone in on specific areas that need attention.

NEWER ENGINES, NEWER MAINTENANCE

Many newer wheel loaders in the industry are built with technologically advanced engines that require a different level of maintenance than older wheel loaders. These engines are designed with high-pressure common-rail (HPCR) fuel systems.

Fuel cleanliness is critical with HPCR. The fuel storage tank should be regularly inspected for rust and damage, as well. Another must is to change fuel filters at manufacturer-recommended intervals, or more frequently depending on the work environment. Use OEM filters instead of knockoffs that typically cost more in the long run. Follow manufacturer recommendations on filter types and sizes. Utilize the same micron-size filters on both the fuel system and storage tanks to ensure a clean supply.

Also, remember to drain water from the separator daily – or immediately if a warning light signals trouble. Periodically check the fuel lines for leaks.
Many new loaders are equipped with selective catalytic reduction (SCR) technology to meet Tier 4 mandates. SCR reduces the formation of particulate matter in the combustion chamber and eliminates pollutants by treating exhaust gases with diesel exhaust fluid (DEF). It’s a simple and easy-to-maintain Tier 4 solution.

Filters in the DEF circuit are easily accessible on most machines and come with the same maintenance schedule as engine oil. DEF, which is only needed in relatively small amounts, is easy to locate and replenish. A warning light signals when DEF is running low. The DEF tank can also be refilled as part of regular maintenance when checking fluid levels or refueling.

With an SCR-equipped wheel loader, there’s also no need to use anything other than standard oils and diesel.

DON’T OVERLOOK THE BASICS

Despite a steady stream of advances found on newer wheel loaders, pit and quarry operations can’t lose sight of basic maintenance best practices.



Photo by Kevin Yanik

Every maintenance technician knows filters and fluids need to be changed at the recommended intervals – but it doesn’t always happen. Make sure there’s a routine maintenance plan in place – and make sure it’s followed. Consider filter and fluid changes before recommended intervals given the demands of aggregate applications.

Fluids analysis is also important. The right analysis program will raise an early flag regarding the health of a wheel loader’s engine, planetaries, axles, hydraulic systems and gearboxes. Early discovery can save substantial money and time.

Some machines feature automated maintenance activities, such as self-lubricating grease points that engage at pre-determined intervals. If your wheel loader has such a feature, check to ensure the selected intervals are scheduled according to your application.

The typical aggregates application dictates a higher level of care when it comes to wheel loader tire selection and maintenance. The reason: Key components are susceptible to damage if tires are not properly sized and inflated.

Many pits and quarries choose tires with a radial design to provide a good footprint and tractive effort. This is a good practice, but only part of the equation.

The team should also ensure outside diameters are identical between all tires. Tires with different outside diameters can technically be the same size, yet they won’t feel like a match to your wheel loader. The machine will attempt to compensate, ultimately placing undue and uneven stress on certain parts of the machine. This may lead to unwanted maintenance problems.

Tire inspection should be part of the daily walk-around routine. Make sure pressures are proper and no damage has occurred. This will help to ensure the machine is running on sure footing all day.

Dredging

The removal or excavation, transport and placement of dredged sediments are the primary components of the dredging process. In design and implementation of any dredging project, each part of the dredging process must be closely coordinated to ensure a successful dredging operation.

The excavation process commonly referred to as “dredging” involves the removal of sediment in its natural or recently deposited condition, using either mechanical or hydraulic equipment. (Dredging sediments in their natural condition is referred to as new work construction; dredging recently deposited sediments is referred to as maintenance dredging.) After the sediment has been excavated, it is transported from the dredging site to the placement site or disposal area. This transport operation, in many cases, is accomplished by the dredge itself or by using additional equipment such as barges, scows and pipelines with booster pumps.

Once the dredged material has been collected and transported, the final step in the dredging process is placement in either open-water, near-shore, or upland locations – or, processing as aggregate. The choice of management alternatives involves a variety of factors related to the dredging process, including environmental acceptability, technical feasibility and economic feasibility of the chosen alternative.

The dredging equipment; techniques used for excavation and transport of the material; and the disposal alternatives considered must be compatible. The types of equipment and methods used vary considerably throughout North America. Dredging equipment and dredging operations resist precise categorization. As a result of specialization and tradition in the industry, numerous descriptive, often overlapping, terms categorizing dredges have developed. For example, dredges can be classified according to the basic means of moving material (mechanical or hydraulic); the device used for excavating sediments (clamshell, cutterhead, dustpan and plain suction); the type of pumping device used (centrifugal, pneumatic or airlift); and others. However, for the purpose of this chapter, dredging is accomplished basically by only two mechanisms:

■ **Hydraulic dredging** — Removal of loosely compacted materials by cutterheads, dustpans, hoppers, hydraulic pipeline, plain suction and sidecasters, usually for maintenance dredging projects.

■ **Mechanical dredging** — Removal of loose or hard compacted materials by clamshell, dipper or ladder dredges, either for maintenance or new-work projects.

Hydraulic dredges remove and transport sediment in liquid slurry form. They are usually barge-mounted and carry diesel or electric-powered centrifugal pumps with discharge pipes ranging in diameter from 6 to 48 in. The pump produces a vacuum on its intake side, which forces water and sediments through the suction pipe. The slurry is transported by pipeline to a disposal area. Hopper dredges are included in the category of hydraulic dredges for this report even though the dredged material is simply pumped into the self-contained hopper on the dredge rather than through a pipeline. It is often advantageous to overflow excess water from hopper dredges to increase the sediment load carried; however, this may not always be acceptable owing to water-quality concerns near the dredging site.

Mechanical dredges remove bottom sediment through the direct application of mechanical force to dislodge and excavate the material at almost in situ densities. Backhoe, bucket (such as clamshell, orange-peel and dragline), bucket ladder, bucket wheel and dipper dredges are types of mechanical dredges. Sediments excavated with a mechanical dredge are generally placed into a barge or scow for transport to the disposal site.

**Selection of the dredging equipment and method used to perform the dredging depends on the following factors:**

■ Physical characteristics of the material to be dredged,
■ Quantity of material to be dredged.
■ Dredging depth.
■ Distance to disposal area.
■ Physical environment of the dredging and disposal areas.
■ Contamination level of sediments.
■ Method of disposal.
■ Production rate required (e.g., cubic yards per hour).
■ Types of dredges available.
■ Cost.

Water quality at the dredging and disposal sites is a particularly important consideration in the choice of dredging equipment. Hydraulic dredging can virtually eliminate disturbance and resuspension of sediments at the dredging site, and is often the first choice when dredging occurs in enclosed waterbodies or in locations near aquatic resources that would be especially sensitive to temporary increases in suspended solids or turbidity. However, because hydraulic dredging typically entrains additional water that is many times the volume of sediment removed, water management and water quality must be controlled at the disposal site.

In contrast, mechanical dredging creates little additional water management concern at the disposal site because little additional water is entrained by mechanical dredging equipment; therefore mechanical dredging is usually the first choice when disposal site capacity limitations are a primary concern. However, typical mechanical equipment often creates more disturbance and resuspension of sediments at the dredging site.

Aggregate operations process dredged material either by transporting it to a plant on land or by utilizing a processing facitlity on the dredge itself.

Working safely

It’s important to work safely around loaders, excavators and dredges. **Here are some tips:**

■ Keep ladders clean. Accidents frequently occur when entering and exiting machines.

■ Each operator should adjust the seat to his or her size. If you cannot reach the pedals, you cannot brake properly. If you have to lean over to reach controls, you may strain muscles or suffer fatigue more quickly.

■ Keep all items in the cab securely latched down. A loose thermos bottle rolling on the floor or across the dash can be distracting and cause accidents.

■ Before beginning each shift, operators should check for oil leaks. They should also ensure that the machine has been lubricated, and that system levels (brakes, hydraulics, engine coolant, engine oil and transmission oil) meet the manufacturer’s specified operating levels.

■ Check for excessive wear on bucket teeth, cutting edges and wear plates. Check for structural integrity of buckets, such as weld cracks and over-stressed areas.

■ Do not vary from the manufacturer’s recommended tire pressure. High pressure increases the tires’ spring rate (bounce), while low-pressure increases tire wear and reduces stability.

■ Always travel vertically up and down hills, not diagonally. Most wheeled vehicles become unstable when tilted more than 15 percent.

■ Maintain clean “floors” on the job site. Loose debris on the ground increases the chance of damaging tires and having an accident. Maintaining clean, level floors reduces the chance of spilling material and increases productivity.

■ Every operator should read the manual before using an unfamiliar piece of equipment. Even experienced operators should occasionally review the manuals.

■ Maintain visibility by keeping front and rear windows clean, as well as inside and outside mirrors. Operators often spend as much time moving backward as forward.

■ Do not “ride the brakes” or keep one foot on the brake pedal. This can lead to overheating and excessive brake wear.

■ Do not try to increase productivity by working equipment beyond limits set by the manufacturer. For example, using the wrong bucket size for the weight and type of material being handled can cause an accident, while not necessarily increasing productivity.

■ Whenever possible, utilize equipment with air-conditioned cabs. This allows operators to keep cabs closed, reduce noise levels and maintain a clean, controlled environment.

Coolant maintenance

When someone realizes during the summer that the coolant level in a cooling system is low, it may seem to make sense to add a jug of water to top off the system when the correct fluid is not available. In the winter, the opposite approach might be taken by adding a jug or two of antifreeze/coolant (AF/C) concentrate, when freezing is the primary concern.



Photo by Kevin Yanik

While these apparently common-sense fixes may not scream “bad idea” at the time, they can be detrimental to the health of the entire engine.
It is essential to stick to your usual recommended maintenance schedule and practices as winter weather puts strains on your engine. Don’t let summer thinking get you stuck on a winter road. The functions of AF/C are far more complex than simple freeze and overheating protection. The newest technologies in today’s AF/C provide a layered approach to controlling engine temperatures, as well as protecting engine components from premature damage and excessive corrosion.

If a cooling system is unable to satisfy the essential requirements a heavy-duty engine puts on it, then that vehicle’s horsepower, fuel efficiency, emissions and overall durability may be compromised. So selecting the highest quality AF/C products and replenishing at the recommended interval will ensure operating efficiency and optimal performance. Controlling as many variables and keeping trucks on the road directly affect the bottom line of any operation. These are some of the highest priorities for fleet managers.

**The primary functions of heavy-duty AF/C are these:**

■ Providing efficient heat transfer, transporting engine heat to control critical metal temperatures.
■ Maintaining an optimum engine temperature for fuel and lubrication efficiency.
■ Increasing the cooling index to help prevent boilover and overheating failure.
■ Providing freezing protection to the very lowest temperature encountered.
■ Providing effective corrosion protection or corrosion inhibition for all cooling system metals through a wide range of temperatures.

Sources:

Contributors to this chapter include the following, in alphabetical order:

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[Prestone Command Center](http://www.prestone.com/choose?next=%2F)

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[San Francisco Bay Conservation & Development Commission](http://www.bcdc.ca.gov/)

[Volvo Construction Equipment](http://www.volvoce.com/)

Lesson 5 Quiz

1. What two pieces of equipment typically scoop blasted material from the quarry face and transfer it to haul trucks?

2. What conditions are unfavorable for the use of hydraulic excavators?

3. What conditions are unfavorable for wheel loaders?

4. According to Caterpillar, what is a basic cycle time of a wheel loader hauling loose, granular material on a hard, smooth operating surface?

5. What are six factors of a bucket’s design?

6. How often should operators inspect a wheel loader’s tires?

7. What is dredging?

8. What are the two different types of dredging?

[Click here for the quiz answers.](https://www.pitandquarry.com/pq-university-lesson-5-quiz-answers/)

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