# Cobble Embeddedness and Percent Fines Project

# Tucannon River and Tributaries

# 2005

**Report**
**Prepared by**
**Del Groat and Bill Dowdy**

**Surveyors and Data Collection**
**Bryce Mckiernan, Larry Brown and Alexandra Amonette**

**Data Entry and Compilation**
**by Alexandra Amonette**

5/10/2006

**Overview**: The Pomeroy Ranger District conducts regular aquatic sampling surveys within National Forest lands. The surveys include sampling for cobble embeddedness and percent fines. During the summer of 2005, the District contracted with the Columbia Conservation District to conduct these monitoring protocols outside NFS lands on State and Private ground. The attempt here is to establish a baseline for restoration/rehabilitation projects funded and/or promoted by the Conservation and the Snake River Salmon Recovery Board. Site selection on private lands was based upon project locations and recovery planning reaches. Locations on State and Federal lands were derived from previous surveys. Funding always drives the amount of detail and the number of samples collected during surveys. For this reason simple, cheap and repeatable was part of the criteria selected for the protocols. Currently there is no set survey methodology agreed upon by field personnel within the region.

The pebble count is a simple, inexpensive, replicable technique applicable to coarse materials, and can be done on exposed bars or beneath several feet of flowing water. Because little equipment is required other than a measuring tape and appropriately sized templates for classifying particle sizes, the technique can be quickly applied at a large number of sites to provide a representative sample of a stream reach

The primary disadvantage of surface pebble count technique is the inability to account for fine sediment. Surface gravels that a pebble count indicates are relatively free of fine sediment could contain enough fines in the spaces between particles of the underlying gravel to limit salmon spawning success (Kondolf and Wolman 1993). However, if fine sediment is not a concern, and if a good fit between the bulk and pebble count particle size has been determined then pebble counts should be an acceptable future alternative to the more demanding bulk sampling method.

Since fine sediment is a concern and the location of sediment is also a concern, and cobble embeddedness is the limiting factor for salmonid spawning habitat another element needs factored into the monitoring protocol. If the particle size distribution is to be used to evaluate spawning habitat, the depth of the excavation should be based on the maximum depth of the spawning nests.

The degree to which fine sediments surround coarse substrates on the surface of a streambed is referred to as embeddedness. Although the term and its measurement were initially developed to address habitat space for juvenile steelhead trout, embeddedness measures have been used to assess fish spawning, as well as substrate mobility. Embeddedness is an indicator of water quality. In its simplest expression, increased embeddedness, or the intrusion of fines into a coarse streambed, decreases the living space between particles and limits the available area and cover. Embeddedness measures the degree to which larger particles are covered with finer particles – a length term representing a volume of fines surrounding coarser substrates, which is often placed in a relative proportion to rock height in the plane of embeddedness. Fines are commonly not defined even though the nature and degree of impact depend upon the size and the character of the sediments filling interstitial voids. Biologically direct impacts to spawning fish may be impacted by the lack of permeability of dissolved oxygen to reach incubating eggs because of increased fines. Hence it may be practical to merge these two attributes (cobble embeddedness & percent fines) to simple indicate habitat significance to aquatic species.

During data assessment CE, %fines, can be combined with other known parameters to assess aquatic habitat viability for any number of species. This data when combined with other known factors, such as Rosgen channel features, flow, width-depth ratio, pool/rifle ratios, temperature, large woody debris, and other properly functioning channel attributes, may give an adequate picture of the habitat quality.

**Protocols:** Wolman Pebble Counts - The methodology of pebble counting may be employed along each riffle cross-section to characterize substrate at the reach scale (Wolman 1954). One Hundred substrate particles are collected and measured along each cross-section. Data collection starts at a randomly selected point at one of the bankfull elevations along the cross-section. With an averted gaze, the sampler picks up the first particle touched by the tip of the index finger at the toe of the wader (Harrelson et al. 1994). The particle is measured along its b-axis. A substrate particle is 3-dimensional, with a long side, a short side, and an intermediate side. The b-axis is the intermediate dimension that determines if the particle would pass through a sieve of that size. The sampler then steps in the direction of the opposite bank, picking up and measuring another substrate particle. The procedure is repeated until 100 measurements are made. The measurements are assigned to the proper size class and tallied. From the raw data, D35, D50, and D84 values can then be calculated along with percent composition values for six classes of channel materials ranging from fines (silt, clay, and sand) to bedrock. If a "Rosgen" Level II classification is being performed in addition to the sediment protocol assessment, a separate pebble count analysis should be done to account for the larger bankfull widths, increased longitudinal distances, and multiple habitats used in various "Rosgen" protocols.

**Protocols:** Cobble Embeddedness - The methodology was a modified version from Burns (1984) and Burns and Edwards (1985). In their original sampling procedure sampling was conducted at each location by randomly throwing a 60 cm diameter steel hoop into an area of the stream predetermined and the boundary delineated a representing one of the three geomorphological positions pool, riffle or run. Samples were only taken if the area met the following criteria: 1) the hoop must fall in the inner two-thirds of the active channel and 2), the hoop cannot be part of an eddy caused from a pool or on a large boulder. Particles lying inside a 60-cm-diameter steel hoop thrown randomly into specific habitat units are sampled. Particles with >50 percent of their surface lying within the hoop are counted. The hoop determines particles to be measured. Hoops are thrown into the specified unit until measurements have been taken on at least 100 particles. Although the count may exceed 100, all particles are measured in the last hoop. Typically, 3 to 4 hoops constitute a sample of 100 particles. Embeddedness is then measured on single matrix particles, and the entire population is averaged. For each sampled particle, the depth of embeddedness (to the nearest mm) is divided by the particle height. Sampling was conducted on particles that were typically between 6mm and 120mm, those particles that fell within the cobble and gravels that salmonids use for spawning.

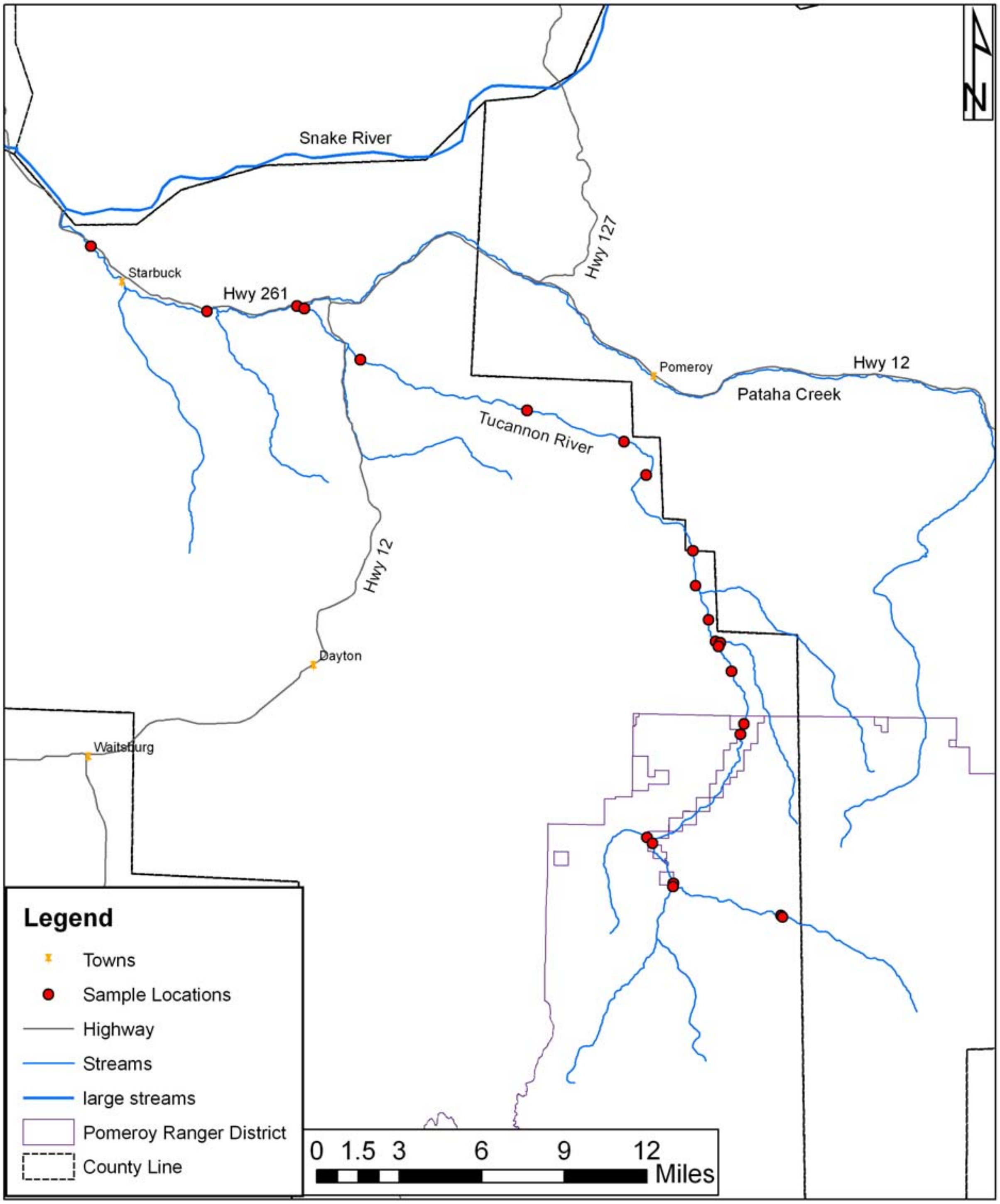
The procedure requires the sampler to begin at one side of the hoop and work across it until each particle including free matrix particles is measured and discarded (free matrix particles are those without any sign of embeddedness). Embeddedness of these particles by definition is zero, and therefore they are not counted unless the total rock count is included in the computational method. Starting back across the hoop, embedded particles are systematically removed. Rocks are generally picked up with the right hand and grasped with the thumb and fingers at plane of embeddedness. The particle is rotated so that the embedded portion is to the left. An index finger is placed on the side away from the eye, and the plane of embeddedness is held against one plate of the plexiglass frame and measured.

As stated earlier the protocol used was a modification of the Burns and Edwards (1985) cobble embeddedness measurement. The Pomeroy Ranger District had previously collected CE using the previously described methodology. In 1997, when Wolmans became a mandatory assessment feature, the District combined the two procedures into one. During the Wolman linear transect the rocks were measured for CE when the stones were found in the inner two-thirds of the wetted stream channel. In that first season the crews also conducted CE using Burn and Edwards's methodology. Nearly 25 stream reaches were sampled using both criteria. The two techniques were compared and the CE numbers were within 5% of each other respectively. From that point forward the District has used that modified protocol measuring CE during linear transect of Wolman Pebble Counts. There still was a minimum of 100 stones measure and no transect could be started unless completed to fruition.

Therefore during one transect, particle size, particle distribution, and cobble embeddedness could be measured. Repeat surveys can be used to indicate potential habitat trends and bed load movement. This data should not be used alone but in combination with other known attributes. It must be remembered that there are limitations to the data use. This data should be used only to characterize the habitat. It should be used not as quantitative, but as a red flag indicating a more detailed study and assessment may be necessary. Cobble embeddedness is usually expressed as a percentage. However, this value does not reflect the amount of exposed rock, which is the critical component of the habitat for aquatic organisms. Cobble embeddedness expressed as a percent is not as sensitive to changes in sediment over time. Rocks that become completely buried in sediment are no longer part of the measurable population. Consequently, the lost "living space" is not reflected in the percent embeddedness figure.

**Site Location Selection**: Site locations were selected by the CCD and the Snake River Salmon Recovery Board Director. These locations were determined by using local knowledge from Biologist and habitat managers and the Salmon Recovery Plans (i.e. EDT Models, Tucannon Subbasin Plan, Tucannon River Model Watershed Plan, WRIA 35 Limiting Factors Assessment and The Snake River Salmon Recovery Plan) that identified priority reaches for recovery, monitoring and assessment. There is some existing data that can be used for some comparative analysis to assess past projects, however this survey is more to establish the baseline for future restoration and recovery projects. Previous data comparisons may made if "like" data was recovered. Therefore some trend factors maybe assessed. This report is not the avenue for that analysis, which is better suited for the collective Regional Technical Team (RTT).

# 2005 Embeddedness Survey Sample Locations



**Wolmans Results**: The most recent survey of all the Tucannon River reaches of the Tucannon Watershed was undertaken from the headwaters to the mouth. A sample of those representative surveys shown in Table 1, indicate that there are between 3% and 35% fines in the classes of pebbles of < 6mm. The survey was completed sampling 26 sites, at three separate transects for each location, using the methodology previously described, in August 2005. An average of those three transects is displayed in Table 1. Shaded in yellow is public land and shaded in blue are tributaries to the Tucannon River. The following table includes the site selection and the average results of the three samples. Each sample is identified in detail in the attachments of this document, individually for each transect at the site location.

The results indicate the sizes of the substrate observed. This can be related back to the size class of the observation that is placed into the separate categories. See Pebble Count Size Class worksheet. To assess whether or not these gravels are suitable enough to be moved by a salmonid for the construction of redds, the size of the framework is of interest. Typically the D values, the sizes at which the percent are finer than the value given (i.e., D15, D35, D50, D84) indicate the amount of the substrate and its size. Example, If Chinook spawning typically occurs in habitat of 6mm to 102mm and the D50 indicated is 116, therefore 50% of the gravels observed were less than 116mm. These values along with percent fines less than 6mm and those of the cobble embeddedness with begin to give you a picture of spawning habitat capability.

**Table 1. Wolman's Pebble Count Survey, conducted within the Tucannon Watershed 2005**

| Site | Date | %Fines <6mm | D15 | D35 | D50 | D84 | % Bed rock |
|---|---|---|---|---|---|---|---|
| Tucannon River at John Wood | 8/9/05 | 11% | 26.8 | 35.5 | 63.9 | 87.1 | 0% |
| Tucannon River at Mead/Smith Gagging Station | 8/9/05 | 16% | 20.6 | 30.9 | 60.6 | 107.5 | 2% |
| Tucannon River below Pataha Creek Confluence | 8/10/05 | 6% | 34.6 | 44.8 | 75.2 | 110.0 | 1% |
| Tucannon River above Pataha Creek Confluence | 8/10/05 | 3% | 36.1 | 46.0 | 72.1 | 89.1 | 0% |
| Tucannon River at Broughton Land Co. intake pump | 8/16/05 | 9% | 33.2 | 41.0 | 70.8 | 101.7 | 0% |
| Tucannon River at King Grade | 8/16/05 | 2% | 52.0 | 66.7 | 115.9 | 159.5 | 0% |
| Tucannon River at D. Howard | 8/15/05 | 11% | 48.2 | 64.2 | 121.4 | 176.0 | 0% |
| Tucannon River at Marengo | 8/15/05 | 10% | 42.0 | 55.5 | 107.7 | 152.1 | 0% |
| Tucannon River at M. Hall | 8/11/05 | 6% | 50.9 | 65.9 | 132.9 | 207.2 | 2% |
| Tucannon River at WDFW Quonset Hut | 8/11/05 | 10% | 44.7 | 57.2 | 107.1 | 163.8 | 1% |
| Tucannon River at Russell | 8/22/05 | 9% | 47.8 | 65.9 | 138.8 | 236.9 | 0% |
| Tucannon River below Cummings Creek Confluence | 8/23/05 | 9% | 59.0 | 78.4 | 162.0 | 268.8 | 0% |
| Cummings Creek | 8/24/05 | 21% | 36.3 | 59.0 | 151.6 | 307.2 | 0% |
| Tucannon River above Cummings Creek Confluence | 8/23/05 | 6% | 52.1 | 73.5 | 151.0 | 266.3 | 0% |
| Tucannon River at Fish Hatch Bridge | 8/24/05 | 8% | 57.7 | 82.4 | 167.3 | 336.6 | 0% |
| Tucannon River at USFS Boundary | 8/5/05 | 6% | 50.9 | 67.2 | 136.0 | 237.5 | 0% |
| Tucannon River at Beaver/Watson Lake | 8/25/05 | 22% | 44.4 | 69.4 | 143.8 | 269.1 | 0% |
| Little Tucannon | 8/25/05 | 11% | 55.9 | 83.6 | 190.8 | 321.6 | 0% |
| Tucannon River Above Little Tucannon | 8/5/05 | 10% | 54.6 | 73.5 | 147.1 | 213.9 | 0% |
| Tucannon River Above Panjab Bridge | 8/1/05 | 3% | 40.4 | 55.1 | 113.3 | 173.0 | 0% |
| Panjab Creek | 8/1/05 | 13% | 34.0 | 44.8 | 105.2 | 171.8 | 0% |
| Sheep Creek | 8/3/05 | 6% | 48.9 | 61.3 | 131.5 | 252.1 | 0% |
| Tucannon River Above Sheep Creek | 8/2/05 | 8% | 28.6 | 40.7 | 83.1 | 120.8 | 0% |

**Substrate Embeddedness - Table 2.** Summarizes Cobble Embeddedness (CE) for the mainstem Tucannon and some tributaries (highlighted in blue). As stated earlier, each site location included three separate complete transects. The table is an average for that particular location. All transects are displayed in their entirety in the appendices. The table is displayed in ascending order from the mouth to the headwaters. Public lands are shaded. Embeddedness was taken during a Wolman's Pebble count inventory on line transects within the wetted 2/3 of the stream channel. Particles in the 6mm to 102mm range are often thought, as Chinook salmon preferred spawning habitat.

Cobble embeddedness is not excessive in most of the salmonid bearing reaches of the Tucannon River watershed. Sand, gravel, and cobble tend to dominate the substrate sample locations of the mainstem Tucannon River. This is expected in systems whose gradient is less than 2%. The dominance of small boulder and cobble in the stream is common in most of the higher gradient streams within the upper reaches of this watershed. The dominance of cobble and small boulder provides complex hiding cover in salmonid rearing areas. This would be opposed to those sections that are very low in gradient where embeddedness would be expected to be higher because these areas are naturally depositional. While CE numbers area higher in these reaches, the desired future condition and expectation for CE is not as critical. CE in the transitional zones may be the most critical area for spawning habitat and the desired condition would be less than those in a depositional zone. Another way to recognize what size class the stream is best suited for, would be to use "Rosgen Stream Classification."

**Table 2. Cobble Embeddedness Survey conducted within the Tucannon Watershed 2005**

| Summary of Stream Site Location | Date | Cobble Embeddedness (%) All particles | Cobble Embeddedness (%) Particles 6mm-102mm * |
|---|---|---|---|
| Tucannon River at John Wood | 8/9/05 | 45.5 | 43.1 |
| Tucannon River at Mead/Smith Gagging Station | 8/9/05 | 34.5 | 32.4 |
| Tucannon River below Pataha Creek Confluence | 8/10/05 | 32.2 | 30.3 |
| Tucannon River above Pataha Creek Confluence | 8/10/05 | 23.5 | 22.1 |
| Tucannon River at Broughton Land Co. intake pump | 8/16/05 | 21.4 | 18.2 |
| Tucannon River at King Grade | 8/16/05 | 17.1 | 15.2 |
| Tucannon River at D. Howard | 8/15/05 | 27.3 | 25.1 |
| Tucannon River at Marengo | 8/15/05 | 20.3 | 16.3 |
| Tucannon River at M. Hall | 8/11/05 | 30.1 | 24.3 |
| Tucannon River at WDFW Quonset Hut | 8/11/05 | 22.5 | 15.4 |
| Tucannon River at Russell | 8/22/05 | 18.9 | 8.3 |
| Tucannon River below Cummings Creek Confluence | 8/23/05 | 18.0 | 9.3 |
| Cummings Creek | 8/24/05 | 20.0 | 14.1 |
| Tucannon River above Cummings Creek Confluence | 8/23/05 | 20.7 | 12.6 |
| Tucannon River at Fish Hatchery Bridge | 8/24/05 | 27.5 | 21.6 |
| Tucannon River at USFS Boundary | 8/5/05 | 30.1 | 26.3 |
| Tucannon River at Beaver/Watson Lakes | 8/25/05 | 25.2 | 23.5 |
| Little Tucannon | 8/25/05 | 36.3 | 31.2 |
| Tucannon River Above Little Tucannon | 8/5/05 | 26.1 | 24.9 |
| Tucannon River Above Panjab Bridge | 8/2/05 | 27.0 | 21.2 |
| Panjab Creek | 8/1/05 | 22.1 | 19.8 |
| Sheep Creek | 8/3/05 | 24.9 | 17.7 |
| Tucannon River Above Sheep Creek | 8/2/05 | 24.9 | 21.5 |

*** Note – Particles of 6mm to 102mm are within known spawning habitat perimeters.**

**Preliminary Discussion:** Mainstem Tucannon reaches within the public land are typically under 10% fines. However the tributaries often exceed and approach 20% fines. This may be attributed to the alluvials observed at the mouth associated with grade change. More than half the private land also had fines of less than 10%. In 1992, Hankin and Reeves surveys indicated that cobble embeddedness exceeded 35% in two three of the lower reaches of the main stem. This was misleading in that only a few stones were measured. More recent surveys (Table 2.) indicate that the embeddedness is less that 25% overall in the forested reaches and have maintained less than 25% average for more than five years. Downstream reaches in the main stem below Forestland often exceed 25%, but this is significantly lower than a few years ago. Lower numbers are probably attributable to the numerous restoration activities in the watershed.

More recent surveys (Table 2.) indicate that the embeddedness is less that 25% overall in the forested reaches and have maintained less than 25% average for more than five years. Downstream reaches in the main stem below Forestland often exceed 25%, but this is significantly lower than a few years ago. Lower numbers are probably attributable to the numerous restoration activities in the watershed.

**Future Analysis:** This information can be used as a snapshot in time for baseline conditions of the "Recovery Plan." These new facts could easily be used to replace numbers that were added to the EDT process. The program could then be rerun to observe potential "changes in condition". Some further analysis is needed to compare the CE numbers to those Wo1man statistics, which can give us the indication of spawning habitat viability in the areas selected for study. However, this data is only a small piece of the big puzzle. The other variables and limiting factors are significant. This project was inexpensive and can be completed on a regular basis, but it should only be intended to observe trends. A more detailed and more expensive survey of the reaches would be needed to make any judgments other than generalizations

## Particle Size Chart:

| Inches | Size Class | Millimeter | Inches | Size Class | Millimeter |
|---|---|---|---|---|---|
| | Silt/Clay | <0.062 | 2.5-3.8 | Small Cobble | 45-64 |
| | Very Fine Sand | 0.062-0.125 | 3.8-5.0 | Small Cobble | 90-128 |
| | Fine Sand | 0.125-.025 | 2.5-3.8 | Large Cobble | 128-180 |
| | Medium Sand | 0.25-0.50 | 7.6-10 | Large Cobble | 180-256 |
| | Coarse Sand | 0.50-1.0 | 10-15 | Small Boulder | 256-362 |
| 0.04-0.08 | Very Coarse Sand | 1.0-2.0 | 15-20 | Small Boulder | 362-512 |
| 0.08-0.16 | Very Fine Gravel | 2-4 | 20-40 | Medium Boulder | 512-1024 |
| 0.16-0.24 | Fine Gravel | 4-5.7 | 40-80 | Large Boulder | 1024-2048 |
| 0.24-0.31 | Fine Gravel | 5.7-8 | 80-160 | Very Large Boulder | 2048-4096 |
| 0.31-0.47 | Medium Gravel | 8-11.3 | | Bedrock | |
| 0.47-0.63 | Medium Gravel | 11.3-16 | | | |
| 0.63-0.94 | Coarse Gravel | 16-22.6 | | | |
| 0.94-1.26 | Coarse Gravel | 22.6-32 | | | |
| 1.26-1.9 | Very Coarse Gravel | 32-45 | | | |
| 1.9-2.5 | Very Coarse Gravel | 45-64 | | | |