

2021 Guide Specification for Gravel Road Surfacing

This document contains a user guide (4 pages) and specification (3 pages) for gravel road surfacing that will provide better gravel for Counties and Federal Land Agencies. The user guide covers background information and the intent of each of the pertinent clauses so that more intelligent editing can be done to fit agency needs.

The user note and specification are normally edited annually after user feedback is received, processed and then reviewed by a user group.

Please share your edits and questions by contacting the following individual.

Stephen Monlux, PE

steve@monlux.com

406-544-1919

LVR Consultants Missoula MT

2021 GUIDE SPEC FOR CRUSHING GRAVEL ROAD SURFACING AGGREGATE

(11-19-2020 – Note that 2020 edits are in Red font)

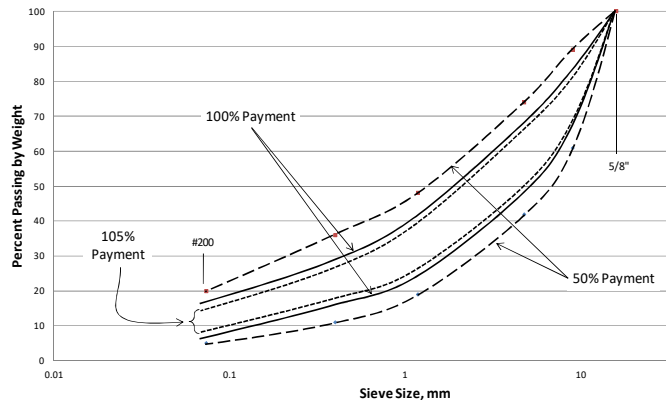
DO NOT put the following four pages of this document in a contract

Specification User Guide: The three-page gravel crushing spec at the end of this document is intended to produce gravel that will have the following benefits: develop a good road crust that reduces dust; reduce raveling, wash boarding and gravel loss; and retain chloride and other dust abatement materials. This guide spec has been changed annually since 2014. Feedback comes from counties, testing firms and contractors. The first three pages are a user guide to help agencies decide what parts of the spec they should or should not use. The last part of the guide contains suggestions for lowering crushed gravel bid prices. Please contact me (stevemonlux@gmail.com 406-544-1919) for a MSWord version for editing, additional info, feedback or assistance.

Critical elements of this specification include the following:

Subsection 2.2A

- Gradation curves for three of the six Pay Adjustment Factors are shown at right.
- The pay adjustment factor improves gradation results and reduces disputes when materials are out of specification. **For the pay adjustment to be effective there must be a 10% limitation on the mobilization bid item to prevent unbalanced bidding.**
- Gradation, fracture and plasticity index test requirements **must be tailored** to materials sources that are owned by counties or local commercial sources.



Before contract advertisement, sample and test designated sources, and then change Table 1 requirements to make sure spec limits are realistic. If you establish different gradation limits for the 1.0 pay factor column, note that the gradations for the other pay factor columns differ by 2%, except for the minus #200 that differs by 1%. The spec contains a gradation table for ¾ minus – you can cut that table out and paste in the 1” minus or 5/8” minus tables shown on page three of the user note. You may want to delete the requirements for PI and % Fracture if you know the designated source contains the right amount of clay and has large rock. **Deleting the plasticity requirements will reduce bids and is suggested when (1) clay in the source is known to be adequate or (2) two percent bentonite or four percent stockpiled clay is specified – be aware that although deleting requirements lowers bids, there are risks – it is safer to keep the requirements in the spec to be sure you get the desired end product.** Yet another strategy is to figure out how much clay is needed before crushing, and make adding clay while crushing an additive bid item – after seeing bids decide if bids for adding clay while crushing are lower cost than adding clay on the road with your road crew. Contact me about methods to add clay on the road or to the stockpile.

Subsection 2.2B. Basing acceptance on the average of all acceptance test results will lower bids and better represents gravel placed on the road since mixing occurs while loading out stockpiles. If hauling and placing gravel on the road during crushing, change acceptance and payment to individual **acceptance** test results – make edits to Subsection 4.2(A).

Subsection 2.2C. Since contractor testing controls the quality of gravel, the splitting of samples and testing must be done correctly. The County consultant lab is the most qualified party to check out the Contractor’s test procedures and equipment. This checking process builds relationships between the two parties ahead of disputes over test results. Maximum allowable differences between test results are shown in parenthesis in the first column of Table 1.

Subsection 2.3A. The daily acceptance sample process helps avoid bias in sampling by taking large bucket loader samples throughout the day that form a composite sample that represents the daily production much better than a typical “snapshot” belt sample. This approach also reduces testing costs. Normally 10 to 20 acceptance samples are enough for crushing contracts up to 30,000 cubic yards. The 200-ton interval for bucket loads can be changed to other tonnages or changed to five per shift or 5 per day depending on how much rock is crushed per hour and the total contract quantity. Many options exist.

Subsection 2.3B. Comparing Contractor test results on acceptance samples with the results from the Consultant lab will help assure that crusher adjustments are based on reliable information. This comparison should be done each day during the first several days of crushing to gain confidence in Contractor testing. Since final acceptance and

payment is based on the Consultant lab results, all testing and pay adjustment calculations should be done promptly to avoid problems.

Subsection 3.1A. The stockpile floor requirements are included where Counties do not have the resources or time to prepare a proper floor. The four-inch layer of crushed aggregate on the floor may not be necessary when a stable pit run floor is available. Normally at the start of crushing, some crushed aggregate is out of spec and is used to build the floor and reduces the chance for contamination.

Subsection 3.1B. This subsection intends to reduce segregation.

Subsection 3.2A. Selecting one of the five options for clay binder in the gravel depends on the materials source and how much you want to pay to achieve a gradation that builds a good road crust that reduces gravel loss, raveling and wash boarding. If the gravel source is non-plastic, adding 2% bentonite or 4% bank run clay is normally safe – higher amounts will build a better road crust, but could be slippery after rains and may rut in the spring. Change requirements in Table 1 to be consistent with the option selected. Option V can be cost-effective if you spread gravel more than 2 inches thick, and want to add clay in-place on the road with your road crew. Dry bentonite has been spread with belly dumps after mixing 2:1 with gravel and has also been spread in a slurry form with water trucks (more details are available). Some commercial sources of Bentonite are listed below. Costs at the source are usually \$65/Ton in bulk pneumatic shipments and \$120/Ton in bulk bags. Shipping costs can exceed that of Bentonite.

Bentonite Sources

Performance Minerals, Lovell WY 82431 (307) 548-2271

Performance Minerals, Belle Fourche SD (307) 896-2596

Black Hills Bentonite, Casper WY 82601 (307) 265-3740

BLM, Salmon ID 83467 (208) 756-5495

Canadian Clay Products, Wilcox SK S0G 5E0 (306) 732-2085

Central Oregon Bentonite, Prineville OR 97754 (541) 477-3351

Minerals Technologies, Lovell WY 82431 (303) 551-5529

Redmond Minerals, Aurora UT 84670 (866) 440-2529

Teague Mineral Products, Adrian OR 97901 (541) 339-3940

Tolsa Wyoming Bentonite, Casper WY 82604 (307) 224-5114

Western Clay Co, Aurora UT 84620 (888) 377-3719

Wyo-Ben, Greybull WY 82426 (406) 652-6351

[CM1]

Subsection 3.2C. This paragraph contains the typical disclaimer language needed when a county source is designated. Normally, if good source investigation methods are used and specs are tailored to the source, problems will be avoided.

Subsection 3.3A. The best of all worlds is for the owner to make the source meet MSHA requirements. Periodic digital photos of the high wall will help document source quality which can help resolve disputes. These photos can also be used during the next crushing contract to give prospective bidders a better idea of how to bid on your contract.

Subsection 4.1A. The cubic yard payment has several advantages now that accurate survey software and drones exist. This approach avoids contractor manipulation of belt or loader scales and also makes it easier to determine the stockpile quantity for internal annual audits required by most counties.

Subsection 4.1B. The 90 to 110 percent range for acceptable quantity was established to reduce bidding contingencies associated with the Contractor not getting paid for the quantity that was actually crushed.

Subsection 4.2A. The payment adjustment factor may be the most important part of this specification for both the County and the Contractor. Marginally qualified Contractors or those that traditionally bid low and submit numerous claims will typically bid higher because the payment process for out of spec gravel is not negotiable.

Subsection 4.2B. The purpose of this paragraph is to guard against bias sampling that could take place during the daily acceptance sampling process in Subsection 2.3A. Following ASTM D75-19 procedures are critical.

Subsection 4.2C. The five percent bonus for good stockpiling techniques and equipment was added to reflect the benefits of reduced segregation.

Specification Subsection references that refer to the drawings:

Subsection 3.1A. Pit plan drawings should show stockpile locations for top-soil, overburden and crushed aggregate.

Subsection 3.2A, C & D: Pit plan drawings should include the following: mining area boundaries, vertical and horizontal excavation limits, clay or other additive stockpile location (if applicable), cross-sections through each test pit hole location and test data, as well as stripping depths for top-soil and overburden that will ensure the project quantities and County source utilization objectives will be met.

Subsection 3.3: Pit reclamation requirements- indicate if a high wall is to be removed or left in place for later removal and reclamation by County. If desired, include complete pit reclamation (spreading topsoil, etc) as a separate bid item in the last crushing contract.

Suggestions that can lower crushed gravel bid prices:

- **Increase quantity** of crushed rock will reduce cost per cubic yard by offsetting mobilization costs.
- **Multi-year contracts** may allow contractors to work during winter months when they would normally be shut down, or permit more flexible scheduling of work.
- **A good investigation** of material source and adjustment of gradation limits to make them realistic.
- **Delete PI and % Fracture requirements** if you know by past testing that the source produces adequate binder and % fracture.
- **Overburden stripping and stockpiling** that is consistent with a long term pit plan.
- **Allow the Contractor to determine the size of oversize to reject.** If sources contain large rock, costs can be reduced by allowing the contractor to determine the size & amount of reject. This can also benefit the county if they use large rock for erosion control, rip rap, buttress walls, etc. Do not delete % fracture spec.
- **Stockpiling contracts** are lower cost than having rock placed on the road. Another advantage with stockpiling contracts is that acceptance is simplified and quantity determination is less likely to result in disputes
- **Better Specifications:** Daily acceptance sample testing; Final acceptance on average gradation for stockpile contracts; Simple pay adjustment system with bonus; 10% flexibility on quantity based on actual measurement.
- **Gradations test data** from previous crushing contracts – indicate the data is available.
- **Relationship with the Contractor.** Meet individually with local crushing contractors to discuss spec changes and ask for input before putting out the contract.

Alternative to Table 1 requirements for 5/8" minus gravel

Pay Adjustment Factor	1.05	1.00	0.95	0.75	0.50	0.00
Sieve Size	Percent Passing					
3/4 inch	100	100	100	100	100	100
5/8 inch	97-100	97-100	97-100	97-100	97-100	<97
3/8 inch (8)	72-85	70-87	68-89	66-91	64-93	<64 or >93
No. 4 (6)	49-64	47-66	45-68	43-70	41-72	<41 or >72
No. 16 (4)	27-40	25-42	23-44	21-46	19-48	<19 or >48
No. 40 (3)	18-27	16-29	14-31	12-39	10-35	<10 or >35
No. 200 (2)	10-16	8-18	7-19	6-20	5-20	<5 or >20
% Fracture, one face, min (15)	75	65	60	55	50	<50
Plasticity Index (5)	4-10	4-10	2-10	0-10	0-12	0 or >12
Values within parenthesis are maximum allowable differences between Consultant and Contractor Test results						

Alternative to Table 1 requirements for 1" minus gravel

Pay Adjustment Factor	1.05	1	0.95	0.75	0.5	0
Sieve Size	Percent Passing					
1-1/2 inch	100	100	100	100	100	100
1 inch	97-100	97-100	97-100	97-100	97-100	<97
3/8 inch (8)	70-83	68-85	66-87	64-89	62-91	<62 or >91
No. 4 (6)	47-62	45-64	43-66	41-68	39-70	<39 or >70
No. 16 (4)	27-40	25-42	23-44	21-46	19-48	<19 or >48
No. 40 (3)	18-27	16-29	14-31	12-33	10-35	<10 or >35
No. 200 (2)	10-16	8-18	7-19	6-20	5-20	<5 or >20
% Fracture, one face, min (15)	75	65	60	55	50	<50
Plasticity Index (5)	4-10	4-10	2-10	0-10	0-12	0 or >12
Values within parenthesis are maximum allowable differences between Consultant and Contractor Test results						

GUIDE SPEC FOR CRUSHING GRAVEL ROAD SURFACING AGGREGATE (11-19-2020)

PART 1: GENERAL

1.1 DESCRIPTION

- A. This work is the crushing and stockpiling of gravel road surfacing aggregate composed of crushed gravel, stone or other similar materials meeting the gradation and other quality criteria specified herein.

1.2 REFERENCES

ASTM D75-19 Sampling of Aggregates
AASHTO T11 Amount Finer than No 200 (0.075mm) Sieve in Aggregate
AASHTO T27 Sieve Analysis of Fine and Coarse Aggregates
AASHTO T89 Determining Liquid Limit of Soils
AASHTO T90 Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T146 Wet Sample Preparation (Required when clay balls encountered)
AASHTO T248 Reducing Samples of Aggregate to Testing Size
ASTM D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate

PART 2: PRODUCT

2.1 CRUSHED SURFACE MATERIAL QUALITY

- A. Furnish crushed aggregate that meets requirements in TABLE 1 Section 2.2A.
B. Provide fine and coarse fragments of crushed stone or crushed gravel and/or natural gravel, and when approved, blended with sand or clay, finely crushed stone, crusher screenings, recycled concrete and/or asphalt or other similar materials.
C. Use crushed stone or gravel consisting of hard, durable particles or fragments of stone, free of excess flat, elongated, soft or disintegrated pieces, or other deleterious matter.

2.2 GRADATION, PLASTICITY AND PERCENT FRACTURE

- A. Furnish material meeting requirements in TABLE 1 below. Pay Adjustment Factors are explained in Subsection 4.2A.

TABLE 1 REQUIREMENTS. GRADATION, % FRACTURE AND PLASTICITY INDEX

Pay Adjustment Factor	1.05	1	0.95	0.75	0.5	0
Sieve Size	Percent Passing					
1inch	100	100	100	100	100	100
3/4 inch	97-100	97-100	97-100	97-100	97-100	<97
3/8 inch (8)	72-85	70-87	68-89	66-91	64-93	<64 or >93
No. 4 (6)	49-64	47-66	45-68	43-70	41-72	<41 or >72
No. 16 (4)	27-40	25-42	23-44	21-46	19-48	<19 or >48
No. 40 (3)	18-27	16-29	14-31	12-33	10-35	<10 or >35
No. 200 (2)	10-16	8-18	7-19	6-20	5-20	<5 or >20
% Fracture, one face, min (15)	75	65	60	55	50	<50
Plasticity Index (5)	4-10	4-10	2-10	0-10	0-12	0 or >12
Values within parenthesis are maximum allowable differences between Consultant and Contractor Test results						

- B. Acceptance of aggregate is based on the average test result from acceptance samples obtained during crushing unless samples from finished work differ by more than the maximum allowable differences shown in Table 1.
- C. Prior to crushing, demonstrate all sampling, splitting and testing to be done on-site. Provide contact information for any testing to be done by consultants off-site.

2.3 SAMPLING, SAMPLE PREPARATION AND TESTING OF DAILY ACCEPTANCE SAMPLES

- A. Build daily acceptance sample stockpiles by taking full bucket load samples with a front-end loader for every 200 tons crushed. Follow ASTM D75-19 Section 5.3.3.1. procedures. Sample from fixed rotary stacking conveyors by sampling from the fresh pile face between the coarse and fine sides of the pile. Sample from telescoping rotary stacking conveyors by diverting the stream to fill up a loader bucket. When stockpiling with hauling vehicles, take bucket loads from the surge pile or by filling the bucket from the surge bin before loading hauling vehicles. At the end of the day or shift, mix the sampling stockpile with a front-end loader, and then flatten to a 12 to 15-inch-thick layer by back dragging the bucket cutting edge. Make a daily acceptance sample from an equal number of shovelfuls from each of the four quadrants of the flattened surface such that the sample weight exceeds 132 pounds for one-inch minus or 77 pounds for ¾ inch minus aggregate. Take[CM2] two acceptance samples, one for Contractor testing and one for the County Consultant lab testing. If a County representative is not present during sampling (1) photograph the sample area with a camera that is programmed to record date and time of day photo was taken, and (2) send a text message along with the photo to the County representative.
- B. Provide[CM3] and utilize on-site testing equipment for running tests on daily acceptance samples. Test samples immediately so that timely adjustments can be made to the crushing operation, source utilization, etc. to ensure future materials are within specification limits. Save all sample splits for “retesting” at a later date if that becomes necessary. Label all samples with sample number, date and time sample was taken and tonnage from the belt scale totalizer (if available).
- C. Stop crushing and submit a written plan detailing operational changes when the following occurs:
 - a. Pay adjustment factor becomes less than 1.0
 - b. Contractor and County Consultant lab test results are not within maximum allowable differences shown in parenthesis in Table 1.

PART 3: EXECUTION

3.1 STOCKPILE SITE PERPARATIONAND STOCKPILING

- A. Strip and stockpile top-soil and overburden separately unless otherwise indicated on the drawings. Clear stockpile sites of weeds, roots, stumps, large rock and other contaminating matter. Dispose of this material as directed. Make the stockpile floor firm, smooth, well-drained, uniform in cross-section, and able to support the stockpile. Water and compact the stockpile floor to prevent rutting and settlement and where filling is necessary, place and compact material in layers no greater than eight-inch depths. Place a four-inch-thick layer of one inch minus crushed aggregate on the floor to reduce stockpile contamination. Contact the County representative before crushing gravel for payment.

- B. Stockpile with equipment and by methods that control segregation, degradation and contamination. If using a traditional rotary stacking conveyor, do not allow drop height to exceed five feet after the initial conical pile is built. If using trucks or front-end loaders to stockpile, do not dump or push material over the stockpile sides.

3.2 CRUSHING.

- A. (Option I – for pits with no clay): Uniformly add material containing clay in the amount needed during crushing to meet requirements in Table 1. Clay may need to be pulverized such that the crushed gravel has no more than two percent clay lumps retained on the No. 4 sieve. The plasticity index requirement can also be achieved by adding processed clay or bentonite from private offsite sources.
- A. (Option II – for gravel sources where the amount of clay is unknown): If necessary, add offsite clay or processed bentonite to meet plasticity index specifications in Table 1. Clay may need to be pulverized such that the crushed gravel has no more than two percent clay lumps retained on the No. 4 sieve.
- A. (Option III – where the Agency provides a stockpile of clay): While crushing and stockpiling aggregate, load, haul and uniformly add stockpiled clay shown on the drawings in the amount needed during crushing to meet requirements in Table 1. Clay may need to be pulverized such that the crushed gravel has no more than two percent clay lumps retained on the No. 4 sieve.
- A. (Option IV – where the Agency designates a clay source and specifies a by weight percentage to add to the aggregate – plasticity index requirement in Table 1 is deleted): Add clay from the designated source in the percent by weight of aggregate indicated on the drawings or in the schedule of items.
- A. (Option V – where the Agency knows clay is present in the desired amount in the source or the Agency plans to add clay to the stockpile or to gravel on the road after placement): Delete this Subsection and also delete requirements for plasticity index in Table 1.
- B. Utilize necessary methods and equipment to meet gradation and percent fracture requirements such as reducing production rates, tertiary stage crushing, additional screening capacity, etc.
- C. The quality of material in provided sources is acceptable in general but may contain layers or pockets of unacceptable materials. It is not feasible to ascertain from test hole samples the quality of materials for an entire deposit, and variations should be expected. Materials source investigation data is available upon request, including sample site locations, depth of samples, and test results. The contractor must determine the quantity and type of equipment and work necessary to produce acceptable materials. Private off-site gravel sources or additive materials may be used to meet specifications provided the crushed gravel is stockpiled at location(s) indicated in the contract documents.
- D. Stay within the mining area staked on the ground and cross-sections shown on the drawings for agency provided sources. Comply with all mining area requirements shown on the drawings and in applicable regulations.
- E. Calculate pay adjustment factors immediately after test results are available.

3.3 PIT RECLAMATION.

- A. Unless noted otherwise on the drawings reclaim pit and remove high wall under the direction of the County representative. Prearrange date(s) for reclamation so that the County representative can be onsite.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Determine cubic yard quantities of crushed aggregate by conducting measurements before and after stockpiles are built by employing a licensed surveyor to conduct measurements via a 3D or 2.5D reconstruction. Determine volume using unmanned aerial vehicle photogrammetric processes that capture a ground sample distance (GSD) of no more than 5 cm. Adequate ground control points (GCP) and check points (CP) must be incorporated whereby all points are collected according to industry-standard survey practices. Provide all survey data to the County for verification.
- B. Cubic Yard quantities between 90 and 110 percent of the specified quantities will be paid for according to the quantities determined as indicated above. No payment will be made for quantities exceeding 110 percent of the specified quantity.

4.2 PAYMENT.

- A. Payment is determined by multiplying the lowest pay adjustment factor (See Table 1 in Subsection 2.2) times the unit price times the total cubic yard quantity determined under Subsection 4.1 MEASUREMENT. The lowest pay adjustment factor is determined by (1) averaging all of the acceptance sample test results, (2) determining the pay adjustment factor for each of the requirements in Table 1 and (3) selecting the lowest pay adjustment factor from Step 2.
- B. Take three to five samples of finished work from the stockpile or road surface in accordance with ASTM D75-19, compare the average of daily acceptance samples to the average of finished work samples. If the averages do not compare within tolerances shown in parenthesis in Table 1, the County may elect to base payment on the finished work sample test results using the procedure in Subparagraph 4.2A.
- C. Final payment will be increased by five percent when: (a) telescoping rotary stacking conveyors (“Telestacker®” by Superior Industries or equal) are used for stockpiling, or (b) stockpiles are built in three or more layers of relatively similar depth.