

**Trail Surface Aggregate (TSA):** A specific mixture of aggregate designed for surfacing trails that is designed to achieve very high densities to withstand traffic and erosion better than traditional aggregates.

*Note that this specification was updated in October 2013. TSA changes were made to reduce the amount of loose surface stone in TSA placements. A plasticity index limit was added and a certification form is available.*

## Background:

Trail Surface Aggregate (TSA) is designed for use as a wearing surface for trails. It is different from traditional materials used to surface trails such as “number 10’s”. TSA is designed to have a uniform mixture of a range of rock sizes from 3/8-inch all the way down to fine material. This uniform mix allows excellent compaction to achieve a higher in-place aggregate density than commonly used aggregates to resist wear and erosion. The mix was designed by the PSU Center for Dirt and Gravel Road Studies, and is based on a “downsizing” of the successful and popular Driving Surface Aggregate (DSA) developed for use on roads.

## Specification:

All TSA material is to be derived from natural stone formations. Stone is defined as rock that has been crushed; rock is defined as consolidated mineral matter. Both are restricted to that which has been mined or quarried from existing geologic bedrock formations.

All components of the aggregate mix, including fines passing the #200 sieve, are to be derived by crushing parent rock material that meets TSA purchasing specifications for abrasion resistance, pH, Plasticity, and freedom from contaminants. Determine the amount of particles less than #200 sieve size using the washing procedures PTM No. 100.



Close-up of worker's gloved hand in TSA pile.

TSA can be made using a traditional sieve gradations, or using a “recipe” approach that mixes existing aggregate gradations. The “recipe approach” may be more cost effective for ordering small amounts of TSA for smaller jobs.

### TSA RECIPE:

Combine existing aggregates and water in the ratio:

- 1 part AASHTO # 8
- 4 parts unwashed AASHTO # 10 (or B3 sand)
- 1 part minus #200 fines (collector fines)

### TSA GRADATION:

Sieve Size	TSA Percent Passing
1/2"	100%
3/8"	96-100
#4	75-90
#8	55-75
#16	35-50
#200	12-20

## Additional TSA Specifications:

### Aggregate Properties:

- **Hardness:** The acceptable limit as measured by weight loss is “less than 40% loss”. Los Angeles Abrasion test, AASHTO T-96 [ASTM C 131] shall be used to determine this property. Existing data obtained from tests made for and approved by PENNDOT will be accepted.
- **pH:** Aggregate must be in the range of pH 6 to pH 12.45 as measured by EPA 9045C.
- **Plasticity:** Material must not exceed Plasticity Index (PI) rating of 6 by ASTM D4318 Standard.
- **Parent Material:** TSA can be made from limestone, sandstone, or any other parent material that meets the hardness, pH, gradation, and other requirements as outlined in this document.

## Additional TSA Specifications *(continued)*

- **Optimum Moisture:** Material is to be delivered and placed at optimum moisture content as determined for that particular source. The optimum percentage moisture is to be identified by the supplier in the bid/purchasing documents. The optimum percentage moisture is to be determined using Proctor Test ASTM D698, procedure C, Standard.
- **Transport:** Truck tarps must be used to cover 100% of the load's exposed surface from the time of loading until immediately before dumping, including standing time waiting to dump.
- **Placement:** TSA should be placed from the furthest point working back towards the source to avoid running equipment on the final trail.
  - **Paver:** When possible on large jobs, a small paver should be used to place TSA. This will reduce aggregate segregation by size that occurs when any aggregate is dumped and spread. It is recommended that the minimum depth of placement should be 4 inches loose, 3 inches compacted.
  - **"Dump and Spread":** On small trails, a paver may be cost-prohibitive. TSA can be placed using a "dump and spread" method on small trails. Be sure the aggregate is not "overworked" which may cause size segregation. TSA must be placed in one layer.
  - **Compaction:** A minimum 3 ton vibratory roller is to be used to compact the final surface. The initial pass of the roller should be in static mode. TSA must be compacted while it is at optimum moisture to achieve maximum density. If TSA sticks to the drum of the roller, stop and wait for the surface to dry further.



Paver-placement of TSA is preferred for longer sections of trail as pictured above.



TSA can be successfully placed with small equipment for short sections of trail. Proper compaction at optimum moisture is crucial. Note the crown in the finished surface.

## Other Important TSA Considerations:

- **Mixing fines:** When mixing aggregates to create TSA, take care not to pre-wet any "minus #200" fines before they are added to the mixture. Doing so may cause the fines to clump into balls that can be difficult to break apart by mixing. These "balls" of fines will appear in the final trail, and may cause the rest of the trail to have insufficient fine material.
- **Weather:** Since TSA is to be placed at optimum moisture, TSA placement is not recommended if the forecasted weather is too cold or wet to allow the material to dry for 1-2 days after placement.
- **Trail Closure:** Trail use should be prohibited or restricted for TSA placement and the following day.
- **Site Preparation:**
  - **Drainage:** All trail drainage concerns must be addressed before TSA placement.
  - **Crown:** If possible, TSA (like all trail surfaces) should be placed with a crown or cross-slope of not less than 1/4" per foot 3-4% for drainage. This same crown or cross-slope should be established in the trail base materials **before** TSA placement. Establish side-slope with your base, and reflect it in TSA.
  - **Base material:** On some existing compacted trails, no base modification is required. The ideal base course for TSA is a 2-6 inch thick layer of well graded compacted aggregate such as PennDOT's 2A. TSA placement directly over "open graded" stone (such as railroad ballast) is not recommended. When placing TSA **directly** on fabric, a minimum 6" uncompacted aggregate depth is recommended.
- **ADA accessibility:** Properly placed and compacted TSA will meet all Americans with Disabilities Act requirements for gravel surface on properly designed trails.