

TECHNICAL BULLETIN

Confirming the performance of tire-derived aggregate in landfill leachate collection systems



Tire-derived aggregate (TDA) is an engineered product used for over 20 years as a leachate collection material in Alberta landfills. This bulletin provides an update on TDA testing commissioned by Alberta Recycling to provide new insights into its performance, and how TDA-based systems compare to conventional gravel drainage layers.

Alberta
recycling
MANAGEMENT AUTHORITY

Successfully used in Alberta for over 20 years.

A proven performer.

Since 1996, TDA has been used by 30 Alberta municipalities and waste authorities in landfill leachate drainage blankets. Together these sites have used 515,412 tonnes of TDA or approximately 859,020 m3, recycled from over 51.5 million scrap tires.

In the last 10 years alone, 134 landfill cells were built using TDA. There have no reports of drainage blanket failure in these cells.

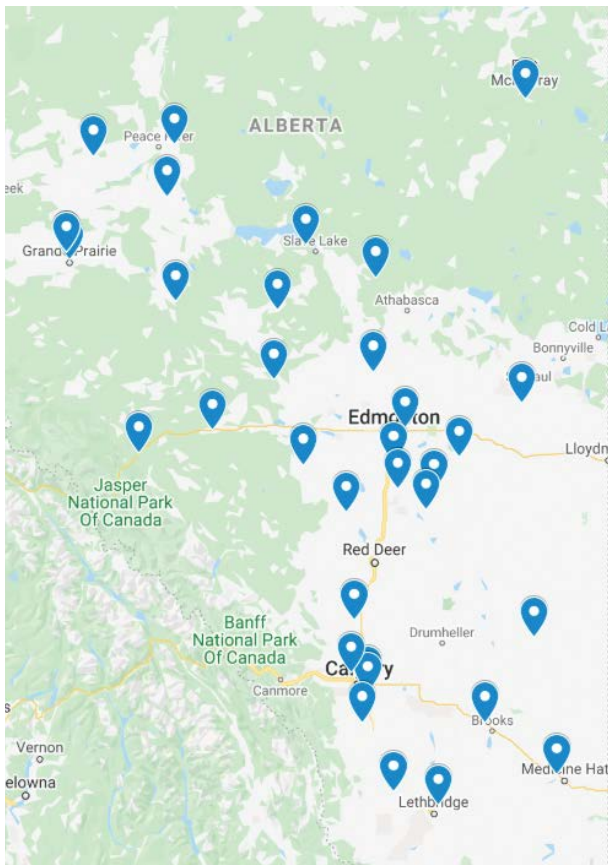
To help landfill owners, designers and regulators understand how TDA compares with gravel in Alberta landfill conditions, Alberta Recycling commissioned the University of Alberta and the University of Saskatchewan to conduct research.

This work has produced valuable new insights which show that TDA can be used in place of gravel as long as care is taken in design, and geomembranes are given equivalent levels of puncture protection from either gravel or TDA.

A cost-effective alternative and an environmental winner.

Using TDA in landfill leachate collection systems not only reduces the demand for gravel (a limited and non-renewable resource that can be difficult and expensive to obtain), but also puts Alberta's scrap tires back to work.

The cost of producing and delivering TDA to eligible landfill projects is largely funded by Alberta's tire recycling program. Cost savings can range up to ~\$30/tonne in some parts of Alberta depending on local conditions. Examples of cost savings for generic smaller and larger landfill cell construction projects are provided in this bulletin.



Locations of TDA landfill leachate drainage systems in Alberta

Not all TDA is created equal.

Just specifying 'good' material is not enough. Quality control and quality assurance processes are still necessary to enforce specifications during production. TDA that does not meet an engineer's specification can be rejected. Alberta Recycling will provide technical guidance if requested.

Tire-derived aggregate



Acceptable



Unacceptable

How the process works.

All parties involved in the landfill construction process have important roles to play to ensure the best possible result.

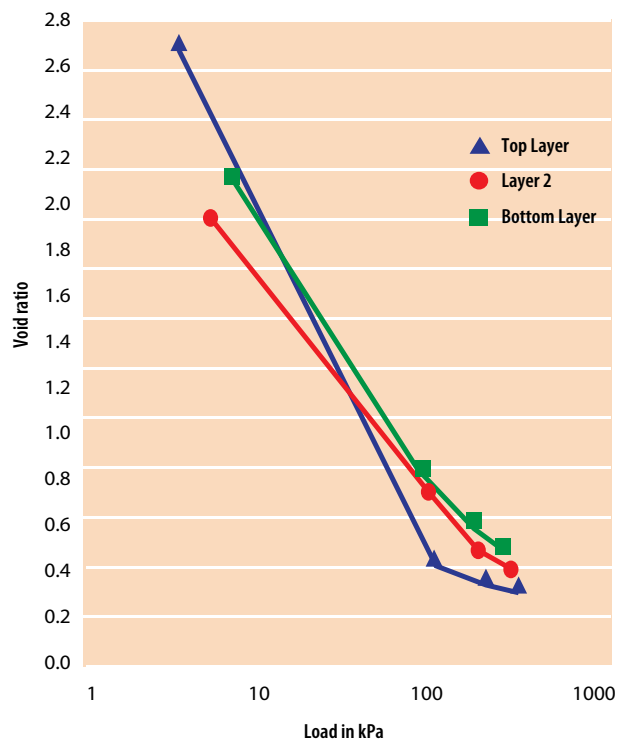
- **The landfill design engineer**, working with the landfill manager, determines the best specification for the TDA to be used in the drainage blanket collection system. The amount of TDA to be ordered (and the cost savings over gravel) is determined using the TDA Calculator. The design engineer establishes a construction quality assurance program to ensure that TDA delivered to site meets their design specifications.
- **The tire recycler** selected for the project produces the TDA to meet the engineer's specifications through proper operational and maintenance practices. "Out-of-spec" TDA (if any) is rejected by the design engineer or the landfill manager, no differently than any other sub-standard material that should not be incorporated into a project.
- **Alberta Recycling** pays the recycler based on the tonnage of acceptable TDA delivered in accordance with the project specification (with a small contribution from the landfill owner).

TDA that does not meet specifications is not eligible for funding by Alberta Recycling.

Compressibility and permeability.

What happens when TDA is compressed in the landfill.

Unlike gravel, TDA leachate collection blankets compress when buried beneath waste in a landfill. Solid material gets deposited in the spaces between the TDA particles (a process known as 'clogging'), and the more the TDA blanket is compressed the smaller these spaces become and the more the clogging can affect leachate drainage performance. The testing work commissioned by Alberta Recycling investigated the compression behaviour of TDA under a variety of simulated landfill conditions using a purpose-built 1-D consolidometer. Testing results showed that even with the reduced particle spacing, the TDA spacing was still sufficient for use in a leachate collection layer.



Permeability

Leachate builds up above a landfill liner unless it is drained to a collection point and removed. One key factor controlling the amount of leachate build-up is the permeability of the leachate blanket, and this is important in Alberta landfills because the amount of build-up is controlled by legislation. The testing work commissioned by Alberta Recycling investigated the permeability of TDA using a purpose-built 2-D permeameter which was designed specifically to accommodate TDA's unique characteristics.

The test equipment applied vertical loads up to 300 kPa, simulating landfill heights of 30 to 40 m. The testing results confirmed that the permeability of TDA compressed under a vertical load of 375 kPa remained above the target value of 10-2 m/s.



Purpose-built 2-D permeameter

Protection for geomembranes.

Plastic liners (geomembranes) are increasingly being used in landfill lining systems. While they are exceptionally effective at containing liquids, they are relatively thin and need to be protected from sharp objects that can puncture them and compromise performance.

The testing commissioned by Alberta Recycling investigated the protection of geomembranes from the protruding wire of TDA particles and the edges of individual gravel particles. Different combinations of geomembranes, protective fabrics (geotextiles) and various types of TDA and gravel were used in testing. TDA particles were tested in winter conditions in a large testing frame outside a laboratory in Saskatoon. The frozen TDA particles were tested in place so the orientation of TDA particles relative to the geomembrane could be assessed.

Results confirmed that geomembrane liners should be separated from both TDA and gravel particles to avoid potentially high rates of puncture. Protruding wires from TDA particles were confirmed to have the potential to cause immediate geomembrane puncture, while gravel particles were confirmed to have the potential to cause excessive local strain in the underlying geomembrane.



Purpose-built large diameter compression chamber

TDA Calculator – Sample Data for a Large Cell.

TDA can offer significant cost savings compared to gravel. Alberta Recycling covers the cost of producing the material along with most of the cost of transportation of TDA to approved projects. The landfill operator is required to cover part of the cost of transportation along with the cost of placing the TDA in the landfill cell. The following examples show the potential cost savings from using TDA in two hypothetical landfill cells.

The required initial thickness of TDA depends on the type of waste in the landfill and the expected final landfill height. TDA compression can be estimated based on test results available from Alberta Recycling.

An online cost calculator is available at www.albertarecycling.ca/TDA. Input your own data and calculate potential cost savings.

Drainage blanket cost comparison, Gravel v. TDA - Large Cell

User inputs				
	Length of landfill cell base	150	m	
	Width of landfill cell base	100	m	
	Required final thickness of drainage blanket	0.30	m	"Final" meaning after placement of overlying waste
	Unit cost of gravel (delivered)	30	\$/tonne	
	Density of gravel	1.80	tonne/m ³	
	Average thickness of overlying waste	50	m	
	Compressibility of TDA	50	%	To be derived from compressibility chart
	Unit cost of placing drainage material	5.00	\$/m ³	
Derived quantities				
	Area of base cell	15,000	m ²	
	Required final volume of drainage medium	4,500	m ³	"Final" meaning after placement of overlying waste
	Required initial thickness of TDA	0.60	m	"Initial" meaning after placement of overlying waste
	Unit cost of gravel (delivered to landfill cell)	54.00	\$/m ³	
Program Outputs				
Material Costs		Gravel		TDA
	Drainage blanket thickness at time of construction	0.30	m	0.60 m
	Drainage blanket volume at time of construction	4,500	m ³	9,000 m ³
	Unit cost of drainage medium (delivered)	54	\$/m ³	0 \$/m ³
	Cost of material	243,000	\$	0 \$/m ³
Placement Costs				
	Total placement cost	22,500	\$	45,000 \$
	Total cost	265,500		45,000

Cost savings due to TDA • Total \$220,500 • Per m² of cell base \$14.70

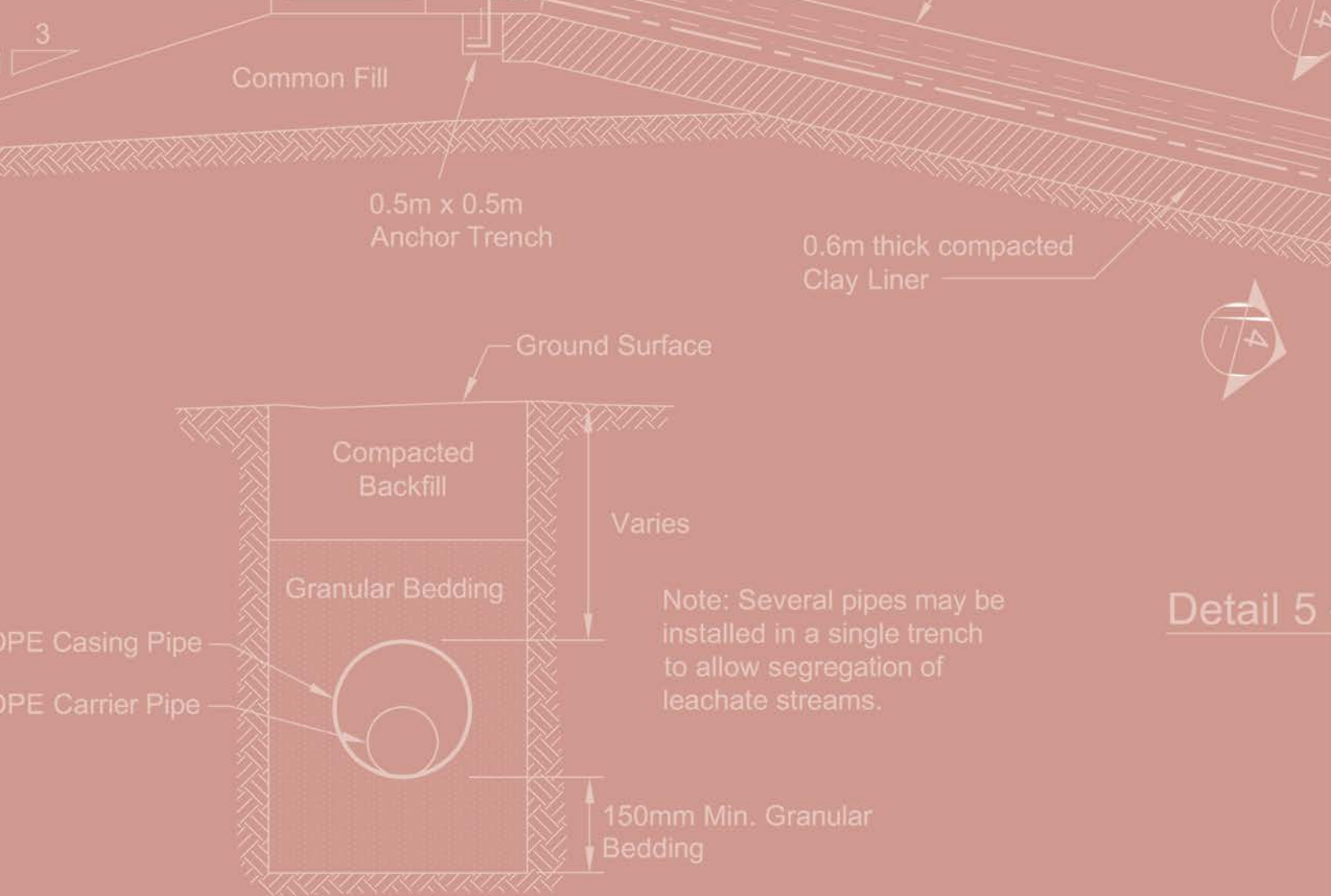
TDA Calculator – Sample Data for a Small Cell.



Drainage blanket cost comparison, Gravel v. TDA - Small Cell

User inputs			
Length of landfill cell base	70	m	
Width of landfill cell base	35	m	
Required final thickness of drainage blanket	0.30	m	"Final" meaning after placement of overlying waste
Unit cost of gravel (delivered)	30	\$/tonne	
Density of gravel	1.80	tonne/m ³	
Average thickness of overlying waste	50	m	
Compressibility of TDA	50	%	To be derived from compressibility chart
Unit cost of placing drainage material	5.00	\$/m ³	
Derived quantities			
Area of base cell	2,450	m ²	
Required final volume of drainage medium	735	m ³	"Final" meaning after placement of overlying waste
Required initial thickness of TDA	0.60	m	"Initial" meaning after placement of overlying waste
Unit cost of gravel (delivered to landfill cell)	54.00	\$/m ³	
Program Outputs			
Material Costs		Gravel	TDA
Drainage blanket thickness at time of construction	0.30 m	0.30 m	0.60 m
Drainage blanket volume at time of construction	735 m ³	735 m ³	1,470 m ³
Unit cost of drainage medium (delivered)	54 \$/m ³	54 \$/m ³	0 \$/m ³
Cost of material	39,690 \$	39,690 \$	0 \$
Placement Costs			
Total placement cost	3,675 \$	3,675 \$	7,350 \$
Total cost	43,365	43,365	7,350

Cost savings due to TDA • Total \$36,015 • Per m² of cell base \$14.70



Detail 5

Detail 7 - Typical Leachate Force Main Section

For more information on TDA, or to discuss any of the information contained in this bulletin, contact Alberta Recycling.

clean-out riser
perforated half
(the side slope)

Min. 450mm Granular
drainage material
cover over pipe

- electronics
- paint
- tires
- used oil

albertarecycling.ca

Phone: Direct (780) 990-1111 or Toll-free 1-888-999-8762 **E-mail:** info@albertarecycling.ca

End Geosynthetic Clay Liner