Primary treatment

Pre-treatment, screening, pre-aeration, primary sedimentation tanks

Wastewater information sheet 3

The most modern of Watercare's wastewater treatment plants – including the plants at Mangere and Rosedale – use primary (mechanical), secondary (biological), tertiary (filtration) and ultraviolet (radiation) methods to treat domestic and industrial wastewater (sewage) and storm water. The average volume of wastewater treated is 300,000 cubic metres per day. Wastewater treatment is designed to safeguard public health and to protect the environment. Wastewater (sewage) is 99 percent water and usually contains:

- *Organic material* – solid organic wastes such as food scraps, toilet wastes, paper etc. (including leaves/wood etc from storm water infiltration). Food processing and textile industries contribute large quantities of organic materials, ie fruit/vegetable pulp, wool etc.
- *Grease and oils* – household wastes contain cooking oil/fat, soap and body oils from baths / showers. Industrial wastes can contain greasy organic compounds and inorganic (mineral) oils.
- *Inorganic material* – wastewater contains sand, silt and gravel (grit). Most of this comes from stormwater infiltration.
- *Nutrients* – our bodies need nutrients like phosphorus and nitrogen and these are naturally excreted in our wastes. Some industrial wastes also contain nutrients.
- *Metals* – tiny amounts of metals, ie iron, copper and zinc, are naturally present in human wastes. Others such as lead, chromium and cadmium can be present from stormwater run-off and industry.
- *Chemicals* – as a result of household cleaning (eg dish washing detergents and shampoos) or through process wastes from industry, many different chemicals are contained in wastewater, some of which are toxic.
- *Micro-organisms* – bacteria, viruses and other micro-organisms that live in the human gut and are excreted in large numbers. Most of these organisms are harmless and some are even beneficial. Sick people, however, can excrete large numbers of pathogenic (disease-causing) micro-organisms, which end up in the wastewater flow.

The contents of the stream will vary depending on the season, day, time and the type of industries being served.

Pre-treatment

Pre-treatment, which includes screening and grit removal, is carried out at the start of the treatment process. Pre-treatment is designed to remove solid objects, along with grease and oil, which impede efficient wastewater treatment and are undesirable in the end product biosolids.

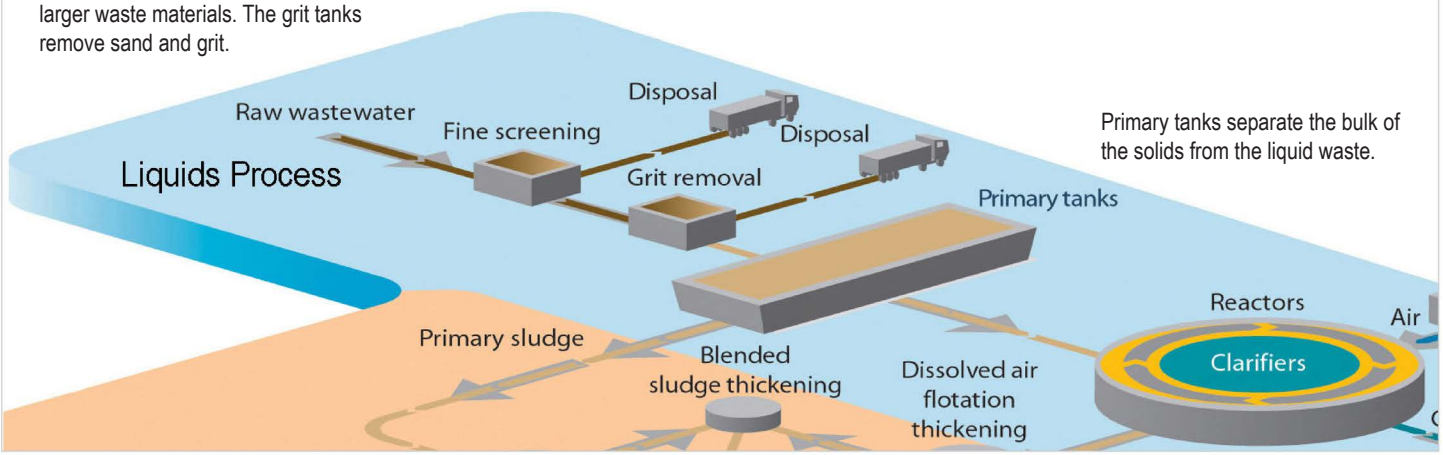
Removal of solid objects is also undertaken to protect machinery (especially pumping equipment) and to prevent blockages in smaller pipes and channels, which transport the wastewater around the treatment plant.

Pre-treatment also reduces the biochemical oxygen demand (BOD) of the wastewater. BOD is a measure of the strength or pollution potential of the wastewater.

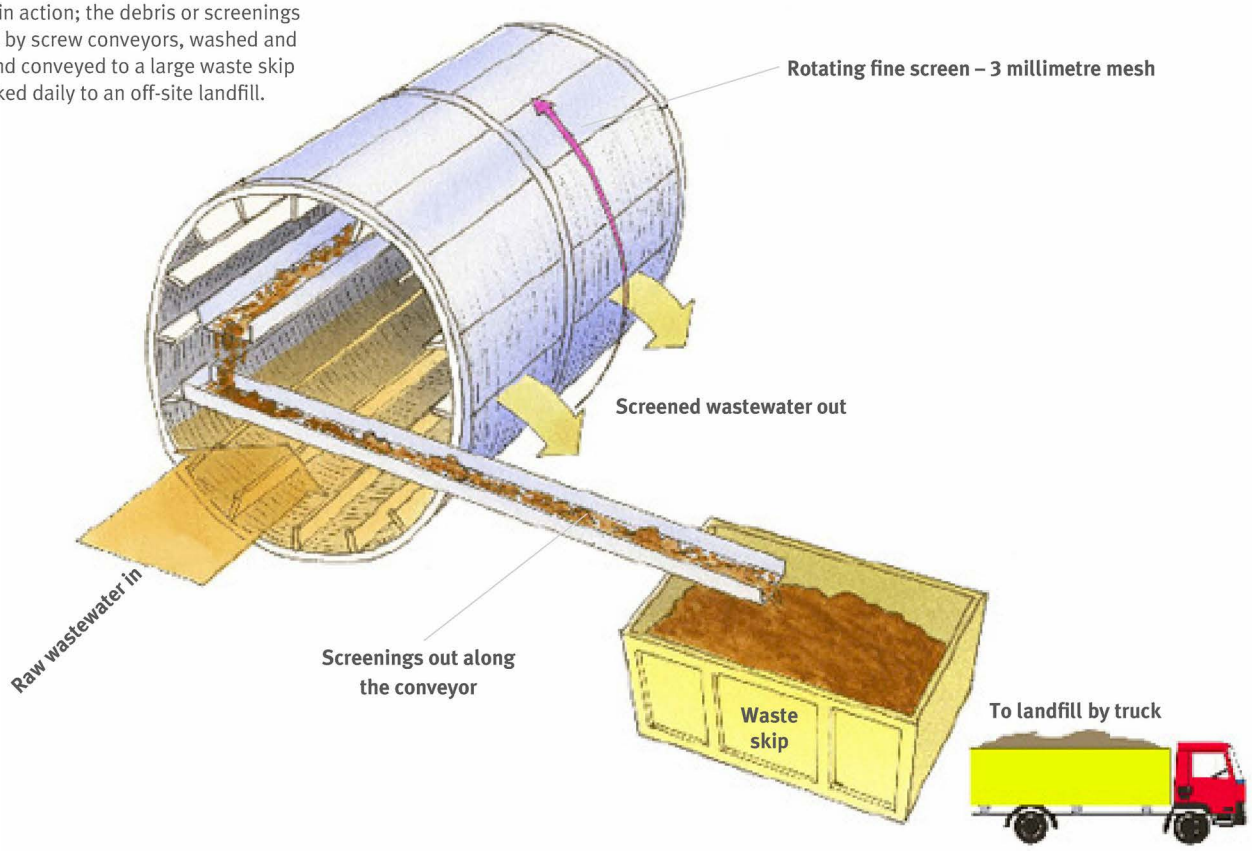
Pre-treatment occurs when wastewater from Auckland's wastewater interceptors enters a mixing chamber at the start of processing. The interceptors – Western, Eastern, Southwestern and Southern interceptors – are Auckland's main sewers (the Southern interceptor combines with the Eastern before it enters the treatment plant.) Odorous air and gases are extracted at this point and at numerous stages throughout the treatment process and passed through odour control biofilters. After the mixing chamber, the wastewater flows into six channels, each capable of taking 2,700 litres per second.

The primary treatment process

Primary treatment process – raw water first passes through screens which extract larger waste materials. The grit tanks remove sand and grit.



Fine screens in action; the debris or screenings are extracted by screw conveyors, washed and dewatered and conveyed to a large waste skip which is trucked daily to an off-site landfill.



Screening

Screening is the first line of treatment at the entrance to the wastewater treatment plant where six new fine screens, arranged in parallel channels, intercept solid material in the influent wastewater.

The fine screens replace the old-technology (19 millimetre bar screens) and have a stainless steel mesh with apertures of three millimetres. The drum-shaped screens are not static pieces of equipment but are large revolving mechanisms, constantly rotated by hydraulic drives. The screens break up the raw sewage flowing into the plant and extract material such as paper, fruit and vegetable pulp, plastic, wood and sanitary items.

Banks of water jets within the rotating screens constantly blast the debris from the mesh. The debris or screenings (up to eight tonnes per day) are extracted by screw conveyors, washed and dewatered and conveyed to a large waste skip which is trucked daily to an off-site landfill.

Pre-aeration tanks

The 12 grit removal tanks, also known as pre-aeration tanks, are 14 metres x 12 metres with a water depth of 4.6 metres. Each tank has a volume of 703 cubic metres and is partially divided into two sections (north and south) with one air sparge pipe and one grit ejector in each section.

Air, pumped from a perforated pipe running along the side of the tank floors, generates a swirling motion which reduces the effective density of the wastewater. This encourages the inorganic material (finer than three millimetres), namely, sand, silt and fine gravel to settle out.

The aeration process also adds oxygen to the wastewater which, by the time it reaches the treatment plant, can be oxygen deficient.

The organic solids remain in suspension. The settled grit is collected in a hopper at one end of the steeply sloping floor. Here grit pumps automatically extract the grit and transfer it through a pipe network to grit washing facilities above the truck loading bay. It is then removed by water ejection to a washing tank and fed into another hopper by a screw conveyor where it is dewatered. The extracted grit is trucked off-site for disposal in landfills.

Incoming screened sewage is sent to one of 12 grit removal tanks which are at the head of each primary sedimentation tank.

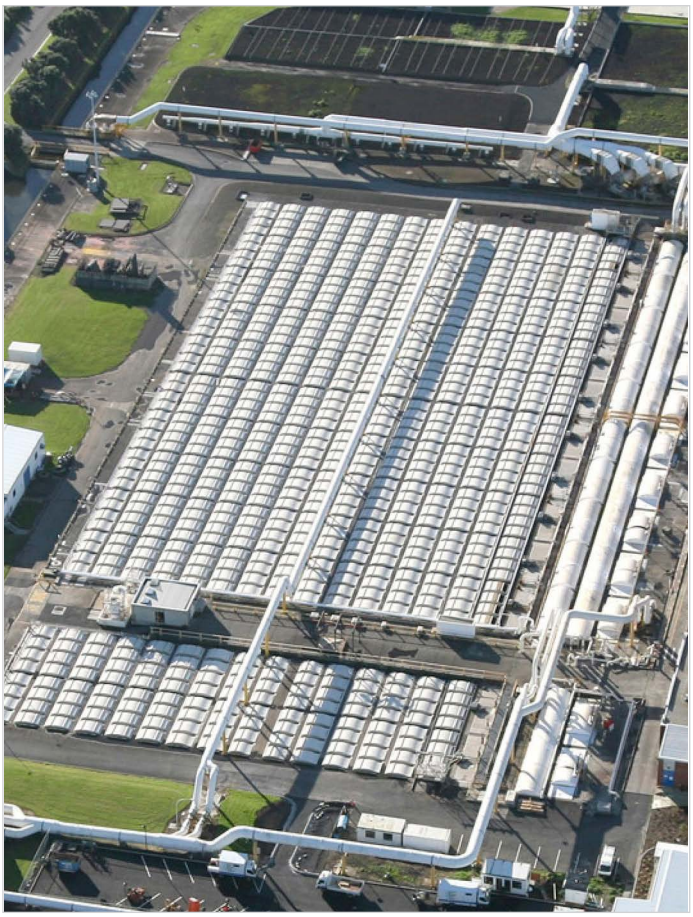
Primary sedimentation tanks

The 12 primary sedimentation tanks are each 70 metres long and 12 metres wide, with an average water depth of 2.8 metres. These are large tanks which are designed to allow the wastewater to flow slowly through in a smooth motion, free from turbulence – enabling the organic solids to settle to the bottom. Retention time in the primary tanks is two to three hours.

The sludge is collected by two parallel, chain-driven flight scrapers. These move continuously along the sloping floors of the tanks, slowly ploughing the sludge towards the end of the tank where a cross collector (also chain and flight) moves the sludge into a deep hopper. From here, it is removed by new centrifugal pumps to a sludge sump.

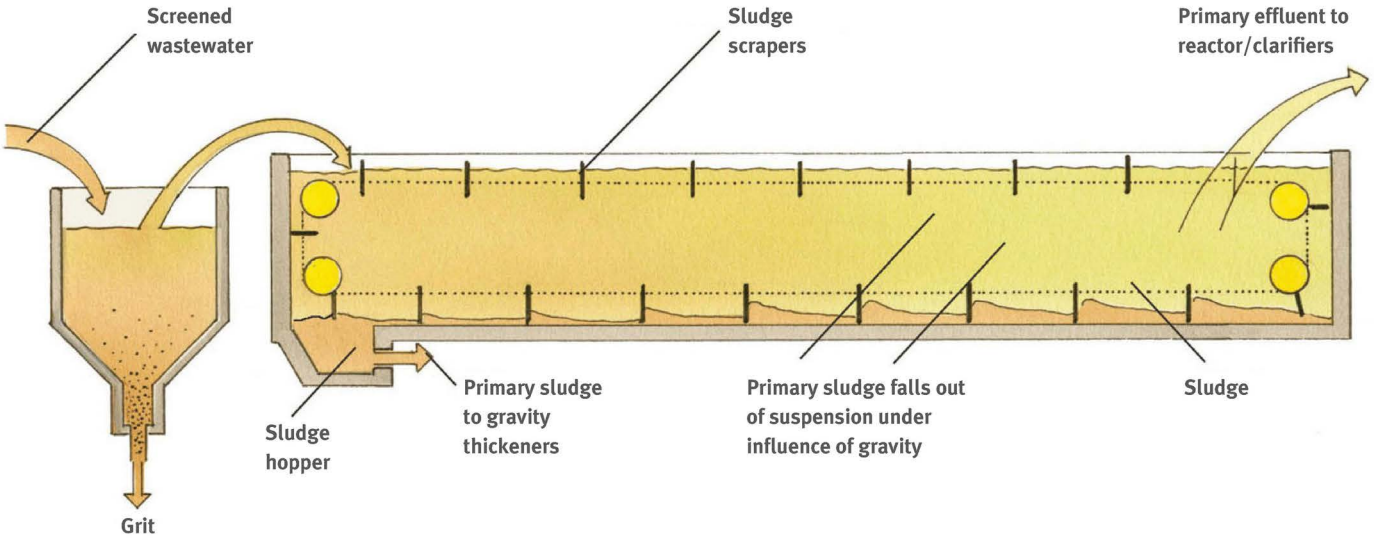
Scum, which rises to the surface of the tanks, is directed by fan-shaped water jets to the inlet end of the tank. Here, it is lifted over a wall and into a trough by rotating scum collectors and carried into the sludge sump. The sludge and scum from the primary sedimentation tanks are pumped to the gravity thickeners. After the sludge has been thickened in the gravity thickeners, it is sent to the gravity belt thickeners for further thickening before being sent to the digesters. At this stage, over 70 percent of the suspended solids have been separated from the liquid waste stream with 40 percent of the BOD removed.

After separation in the primary sedimentation tanks, the liquid stream is conveyed via the interstage pump station at a rate of up to nine cubic metres per second to the reactor/clarifiers for secondary treatment. (See the information sheet *Secondary treatment – liquid*).



A view of the primary sedimentation tanks.

The diagram below shows how the grit removal process works in conjunction with the primary sedimentation tank. There are 12 large primary sedimentation tanks and associated grit tanks which cover more than one hectare.



Odour control

Odour control is an important aspect of the wastewater treatment process. Odorous air is collected at various stages of treatment by ventilation fans and ducted to booster fans, which pass it through earth filters (biofilters).

There are six earth filter beds covering the primary treatment stage. Each filter bed is 800 millimetre deep and divided in two sections. The filters cover a combined area of about 6,200 square metres.

Each filter has been upgraded with new media (designed by Watercare scientists) made up of scoria and bark instead of scoria and soil. Bark has the advantage over soil in that its quality is more easily controlled and it allows for a less dense mixture, giving less resistence to airflow.

The new improved biofilter media is more effective and has a longer working life.

Odorous air is evenly distributed beneath the media by a system of header and distribution pipes. As it percolates upwards, the odorous compounds are treated by bacteria within the media. Odorous compounds are removed by physical and bacterial processes before being discharged to air.

Biofilters also treat air extracted from other areas of the treatment plant including the pre-treatment mixing chamber, gravity thickeners, the splitter boxes and the biosolids dewatering building.

Earth filter No. 5 treats odorous gases from the primary sedimentation tanks. The fibreglass ducting extracts foul air from the primary tanks and passes it to the filter bed.

How the biofilter operates