Jensen Deflective Separator

Performance Summary

Unit Description & Brief

The ***Jensen Deflective Separator*** (***JDS***) technology is a non-blocking screening, swirling concentrating treatment process for small as well as extremely large Stormwater flows. This treatment process captures Total Suspended Solids (TSS) and other water quality pollutant constituents of concern. The treatment process of the ***JDS*** technology is unique in its ability to screen any gross solids, trash or debris materials from the Stormwater runoff without blocking its screen. It is a Full Capture trash and debris device. The ***Jensen Deflective Separator*** has no moving parts and is designed in accordance with the continuous deflective separation treatment process[1] of balanced hydraulics to create multiple treatment processes in a very tight footprint: swirl concentration, vortex and toroidal flow paths and screening and sedimentation.

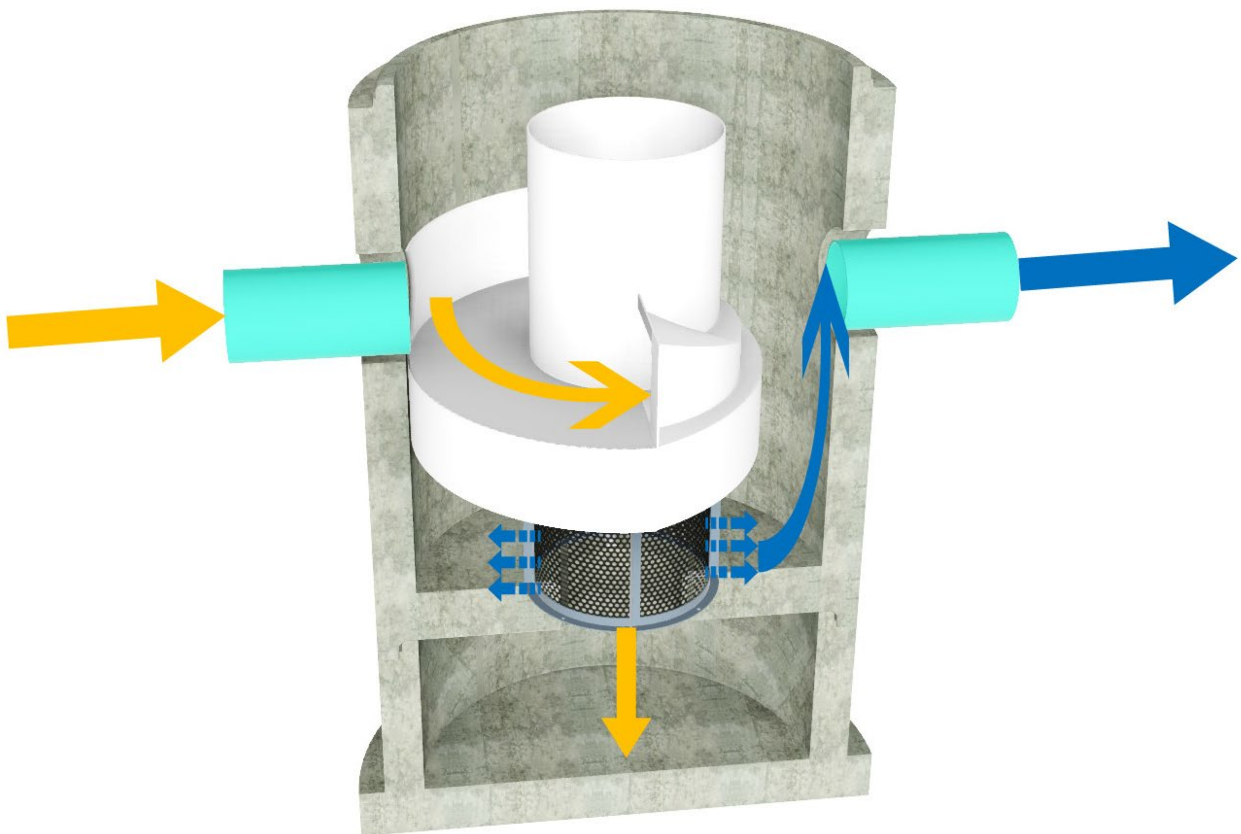

Figure 1. Process Flow of Typical "Inline" ***JDS*** Unit

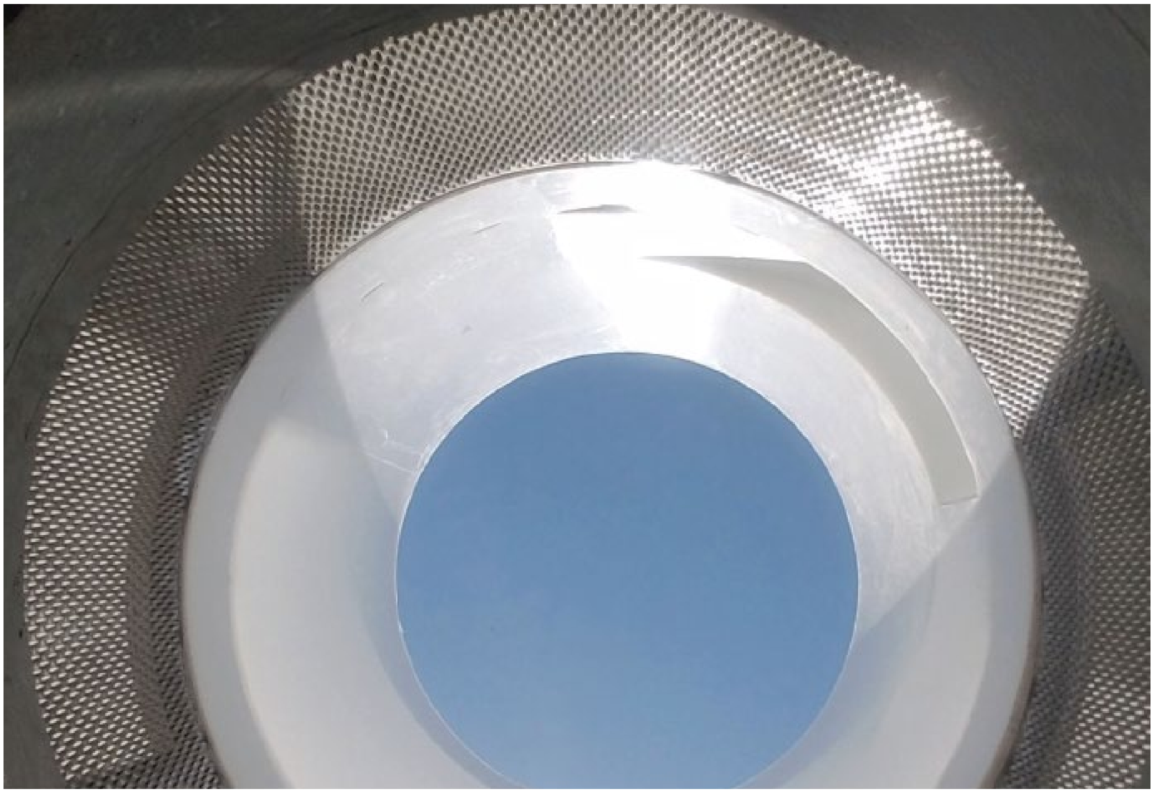

Figure 2. Bottom Up View of Separation chamber, Expanded screen cylinder and HDPE Inlet riser – Inline Unit

The design of each ***Jensen Deflective Separator*** Stormwater treatment unit embodies the essential design aspects of the continuous deflective separation[1] process, which pioneered non-blocking, indirect screening processes for Stormwater treatment. The continuous deflective separation process was refined in Australia in 1992 to remove pollutants from Stormwater runoff. The continuous deflective separation treatment process was introduced in the United States in 1996 and has gained nation wide acceptance.

The continuous deflective separation treatment process successfully captures total suspended solids (TSS), sediments, oils and greases, and trash and debris (including floatables, neutrally buoyant, and negatively buoyant debris) under very high flow rate conditions.

The ***Jensen Deflective Separator (JDS)*** is a proven treatment system for stormwater. This stormwater treatment device has been certified by the New Jersey Department of Environmental Protection (NJDEP), for TSS removal through their extensive verification program administered by the New Jersey Corporation for Advanced Technology (NJCAT). The ***JDS*** is also certified by the California State Water Resources Control Board Trash Implementation Program, as a High Flow Full Capture System.

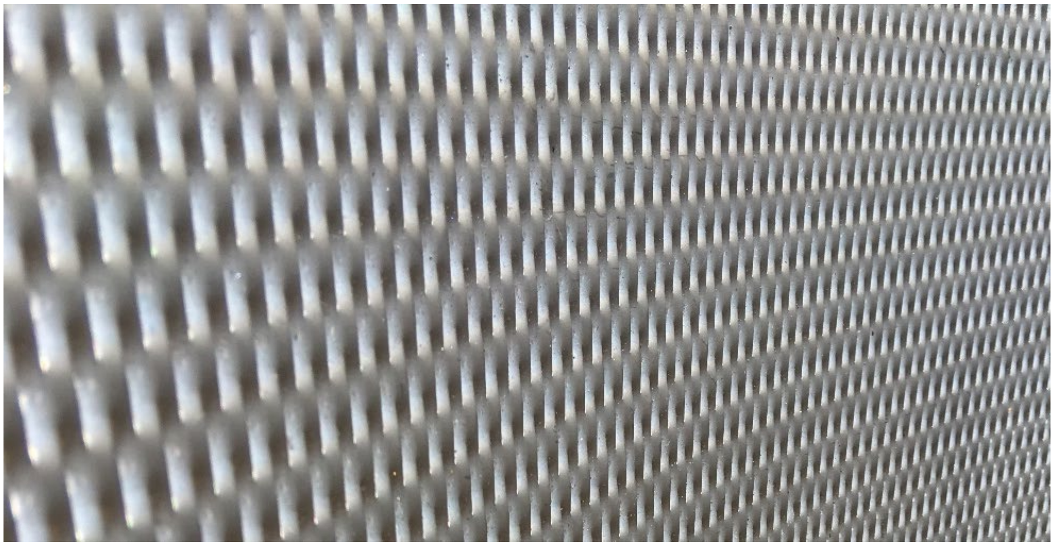

Figure 3. "Blind" Side of 2,400-µm (2.4-mm) screen cylinder

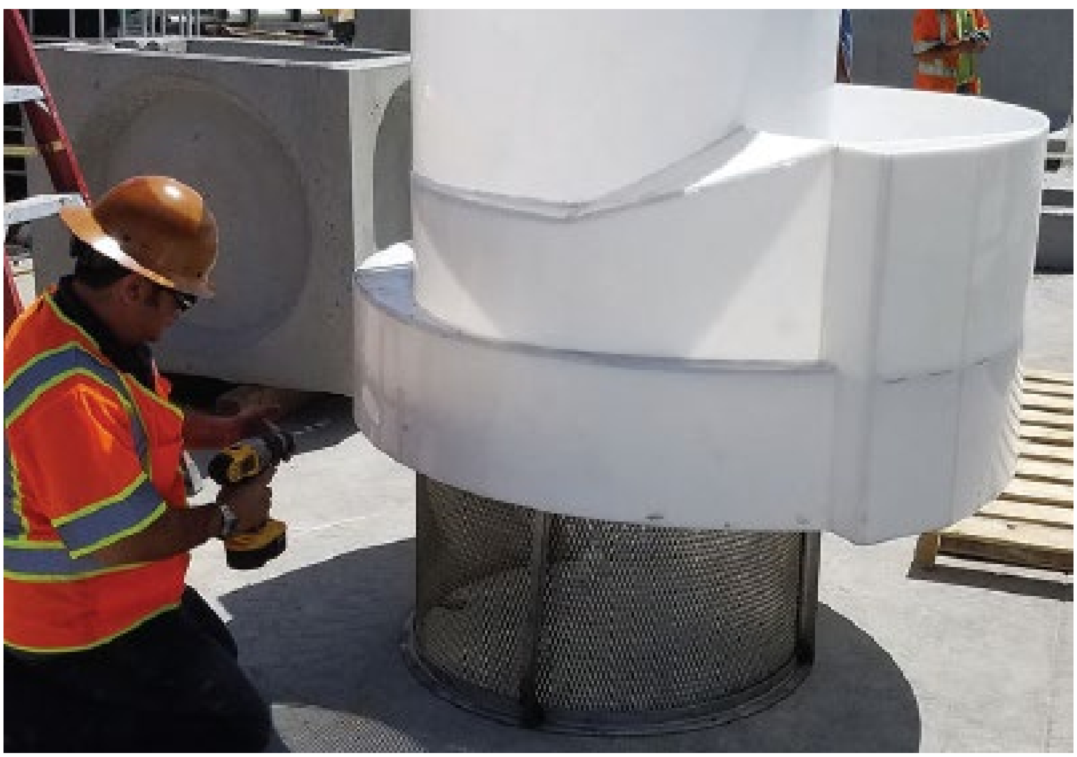

Figure 4. Assembly of screen cylinder and integral inlet and bypass & oil baffle, for insertion in a small 60-in ID Inline ***JDS*** unit

The ***Jensen Deflective Separator*** Stormwater treatment unit can be effectively applied to treat the Stormwater runoff from the following land uses and treatment applications:

- Residential Developments
- Road Way Improvements
- Industrial Sites and Waste Streams
- Commercial Developments
- New and Existing Urban Development
- Parking Lots
- Pre-Treatment for
    - Bio-Retention
    - Infiltration Retention
    - Detention & Infiltration

Unit Operation:

Jensen Deflective Separator units consist of a sump and separation chamber, typically deployed in precast manhole structures. The separation chamber has a stainless steel screening cylinder. Inline units placed within the alignment of the storm drain/channel have internal inlets and bypasses weirs within the separation chamber. While Offline units that are placed immediately adjacent to the storm drain/channel alignment will have a separate diversion structure with diversion weir to divert water quality treatment flows and bypass larger conveyance flows. The ***Jensen Deflective Separator*** units are designed to treat the Water Quality flows and bypass larger flows.

The ***Jensen Deflective Separator*** swirl concentrates, screens, baffles and settles pollutants, water quality constituents of concern from stormwater flows in relatively small manhole structures. To achieve these multiple treatment processes in a balanced hydraulic condition, flows are diverted into the separation chamber in a jet form across the internal face of a stainless steel screen cylinder located immediately beneath the invert of the jet's inlet. The design relies upon the development of balanced hydraulics of the inlet flow versus the flow across the screen cylinder face, which enables this swirl concentrating screening process to also be a non-blocking screening process with no moving parts. Flows across the inside of the stainless steel screen cylinder's surface eliminate clogging.

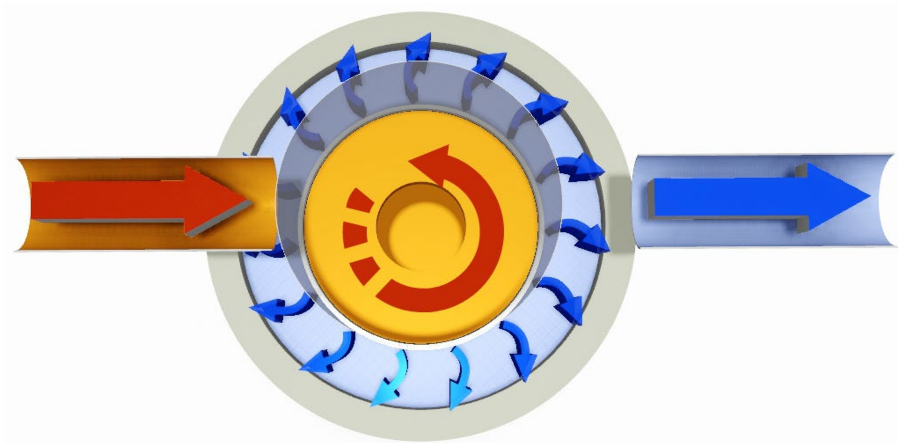

Figure 5. Plan View Treatment Flow Pattern Typical "Inline" ***JDS*** Unit

Swirl concentrating separation is often referred to as vortex separation. In vortex separation, a low energy, quiescent zone is developed in the center of the swirling column of water. Settlement of fines through a large range of flowrates can be achieved in the center of this vortex, its low energy zone, then in a classic settling tank of the same size.

Solid particles in the treatment flow are retained by the deflective screen when they are equal to or larger than the screen aperture regardless of their specific gravity. Particles smaller than the screen aperture are also captured in the swirl concentrating vortex flow. These particles are maintained in a circular, elongated flow path, concentrated towards the low energy zone with the assistance of toroidal forces inherent in the circular motion. This is the essences of the enhanced swirl concentration of solids employing vortex/swirl concentration separation. Particles in the center, low energy zone settle into the sump.

In addition to the classic vortex separation, the hydraulic boundary layer that exists between the surface of the expanded metal screen and the treatment flow, along with some deflective force at the screen face, increase separation efficiency of the swirl concentrating vortex.

Materials captured in the sump at the bottom of the unit, below the separation screening and vortex treatment chamber are physically and hydraulically separated from the high bypass flows through the unit. This physical and hydraulic separation eliminate scouring, washout of previously trapped pollutants. Washout of other structural BMPs occur because their deposition zone of settled material is also an integral part of the treatment flow path.

The ***Jensen Deflective Separator*** separation chamber has lower exit velocities of any vortexing separator. It is simply understood that lower velocities produce superior solid separation efficiencies. Stormwater quality treatment flows are reduced as they pass through the entire surface area of the separation screen cylinder. Once flows cross the screen face, they enter the annular area behind the screen and then discharge from the unit after passing beneath an oil baffle.

Jensen Deflective Separator units provide screening and primary treatment in a tight footprint. These units come in precast manhole structures from 3-ft internal diameter to 16-ft, treating flows from 0.37 to 90 cubic feet per second (cfs), and cast in places designs can be provided to treat larger flows

A few well-placed ***Jensen Deflective Separator*** units can economically provide cost effective treatment for a large watershed at capital costs that are a small percentage of project costs. Additionally, these units can be maintained annually on a reasonable cost. Because they are relatively small and installed underground as a common manhole, development land use can be focused to achieve the primary object of the development rather than dedicating it to larger land based BMPs.

Inline, Offline and Drop Inlet Configurations

Jensen Deflective Separator units are available in three different types of configurations

I. In-Line:

This configuration of ***Jensen Deflective Separator*** is installed within the alignment of the storm drain pipeline of small to mid-size catchment areas. These units have internal bypass weirs to convey large flows around the treatment process. These units may also accommodate multiple inlet pipes as well as flow from a grated drop inlet.

Figure 6. View of Inlet Forebay of "Inline" ***JDS*** Unit

Treatment Flow Process Description

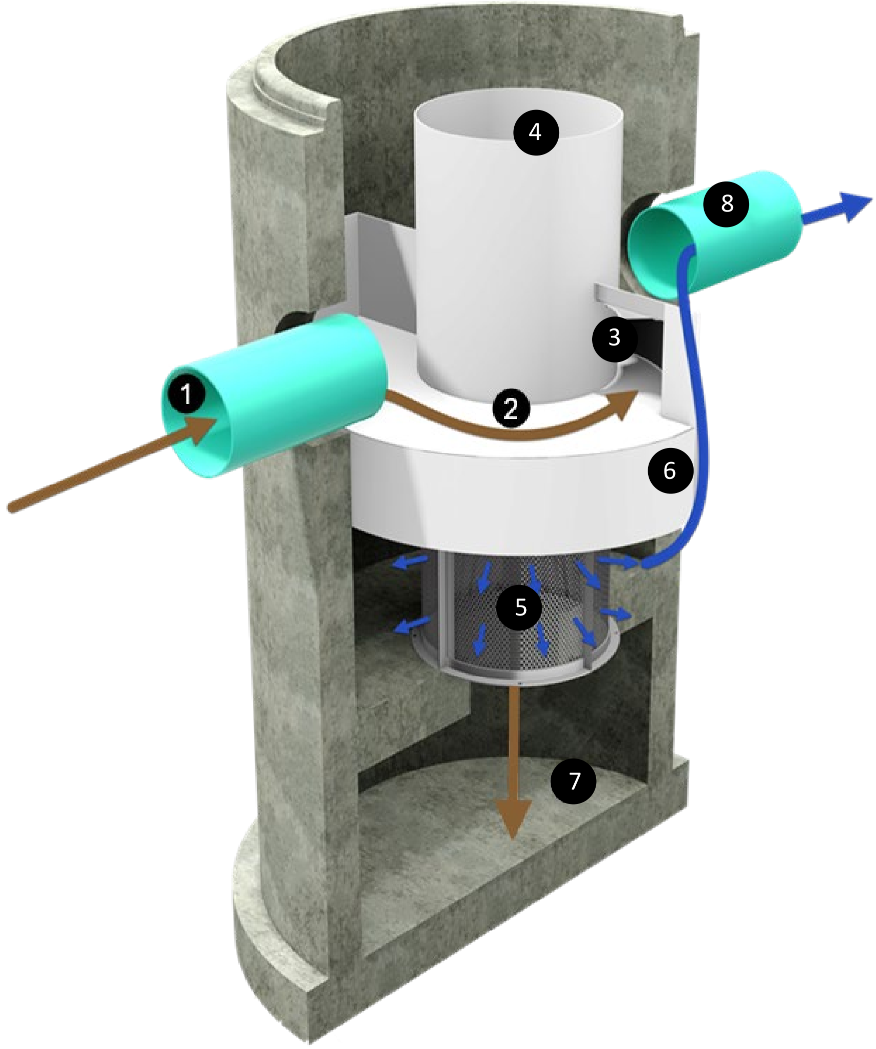

Figure 7. "Inline" ***JDS*** Cut Away Illustration & Treatment Flow Path

1. Stormwater enters the ***JDS*** unit from one or more inlet pipes, a grated drop or curb inlet.
2. Incoming Stormwater collects in the fore bay of the inlet trough.
3. Stormwater enters the separation and screening cylinder through the volute entrance in the diversion weir wall.
4. Water entering the separation cylinder forms a spinning vortex capturing all floatables and swirl concentrating suspended solids to the center of the separation chamber.
5. The vortex flow pattern produces a washing force across the screen face, preventing it from becoming blocked, while allowing Stormwater to pass through the screen and beneath the oil baffle.
6. Oils, greases and other Total Petroleum Hydrocarbons (TPHs) are trapped within the integral oil baffle attached beneath the inlet bay. Screened Stormwater moves toward the outlet pipe.
7. Settled and swirl concentrated suspended solids are captured in the sump which is typically cleaned out by a vactor truck.
8. Flows larger than the ***JDS*** unit's design water quality treatment flow bypasses over the diversion weir. Bypass flows do not scour out previously captured pollutants.

II. <u>Offline</u>:

Offline units are placed immediately adjacent to the storm drain/channel alignment and have a separate diversion structure with a diversion weir. The diversion structure may be designed to accommodate multiple inlet pipes as well.

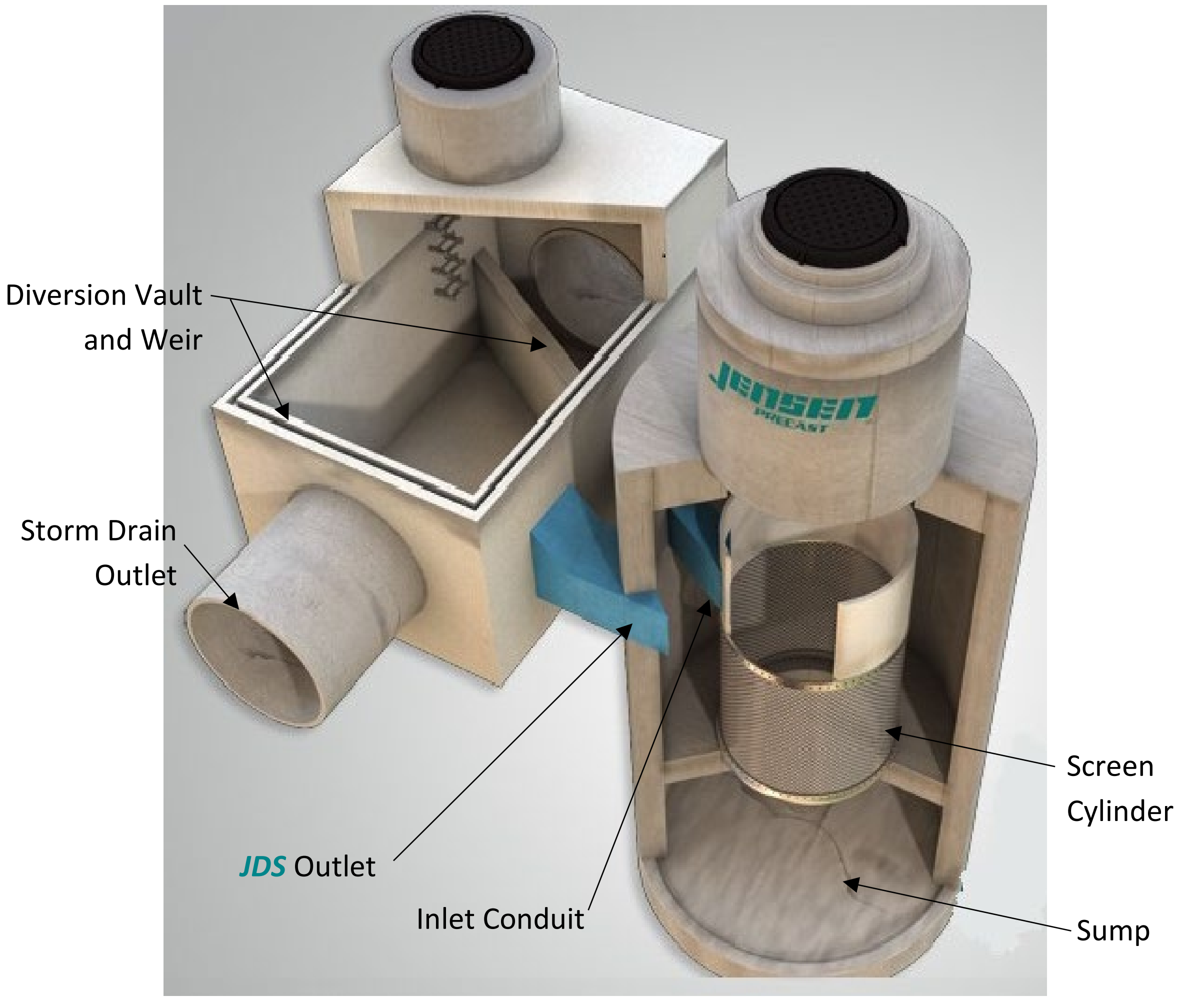

Figure 8. Cut a way view of Offline ***JDS***, Diversion vault structure and offline ***JDS*** unit

III. <u>Drop-Inlet</u>:

These units have a grated inlet to receive inflow directly from the surface and can also simultaneously receive flows from lateral storm drains. Like the In-Line units, these Drop-Inlet units are installed within the alignment of the storm drain pipeline of small to mid-size catchment areas. These units have internal bypass weirs to convey large flows around the treatment process. These function as catch basins or storm inlets, but also provide treatment.

Full Capture Certification – State of California:

The California State Water Resources Control Board has certified the ***JDS*** system as a Full Capture System Device for Trash Treatment Control. This Full Capture Certification independently substantiates the ***JDS***'s extraordinary capacity to completely screen 100% of the trash and debris from stormwater flows.

The ***JDS*** SWTD is the only SWTD that underwent 3rd party verified full scale testing in its Full Capture Certification review and approval process. No other system reviewed and approved by as a Full Capture system conducted an actual full-scale verification test for trash and debris, which also included a full scale scour flow test, verifying 100% retention of previously captured trash and debris during a bypass flow event.

NJCAT and NJDEP Approvals

The ***Jensen Deflective Separator*** has undergone a rigorous testing procedure for repeatable Total Suspended Solids (TSS) removal in a laboratory environment. The New Jersey Corporation for Advanced Technology (NJCAT) has verified the ***Jensen Deflective Separator*** for 50% TSS removal efficiency. The New Jersey Department of Environmental Protection (NJDEP) has certified the ***JDS*** as a result of the NJCAT verification.

The ***Jensen Deflective Separator*** is certified for at least 50% TSS removal efficiency at a surface area loading rate of 33-gpm/ft^2 using a median particle size (d_{50}) of 62-µm. The ***JDS*** is verified to be installed both Online and Offline and does not scour any TSS under high bypass flows.

Solids Removal Performance

The ***Jensen Deflective Separator*** SWTU is capable of trapping silt and clay size particles. This system captures 100% of the floatables and 100% of all particles equal to or greater than 4.7 millimeter (mm) or 2.4-mm screen aperture of the screening cylinder for flow rates up to each ***Jensen Deflective Separator's*** design water quality treatment flowrate. This particular treatment capacity is achieved independent of the particle's specific gravity. The non-blocking screening process of the ***Jensen Deflective Separator*** ensures these capture efficiencies of larger particles and trash and debris. The ***Jensen Deflective Separator's*** design also ensures the permanent retention of all captured material, even when the unit is subject to bypass or tidal tail water conditions.

Through site specific design methodologies, the ***JDS*** can readily be designed to achieve 80% Removal Efficiency (RE%), of TSS. 80% RE% forecasts for TSS are based on the independent evaluations and model calibrations of the continuous deflective separation process. 80 percent removal efficiency forecasts are typical generated for particle size distribution (PSD), having mean particle sizes (d_{50}) of 125, 75 & 50 microns and these forecasts are typically provided on an average annual basis.

The continuous deflective separation process has gone through in-depth third party field performance evaluations and laboratory tests from 1995 to 2017. A list of the publically available independent studies and evaluations and public presentations of the independent studies is attached to this performance summary.

The most pertinent independent solids separation tests for model forecasting purposes of the continuous deflective separation process were performed by Professor John Sansalone, PhD, PE, Jia Ma, PhD, EIT, and Srikanth Pathapaiti, PhD, University Florida, Department of Environmental Engineering Sciences, Gainesville, FL facility from June to July, 2006.

Their full-scale evaluations were performed under controlled laboratory conditions provide the definitive work substantiating the solids removal efficiencies (RE%) and performance modeling and calibration for the continuous deflect separation treatment process.

From these evaluations, standard spec performance language has been developed for:

- 50% removal of total suspended solids with d_{50} of 50-µm
- 80% removal of total suspended solids with d_{50} of 125-µm.

Additionally, in these evaluations solids RE% as a function of discrete particle sizes for various flow rates were measured and regression analysis were completed on the measured RE% curves, which is the empirical data basis for forecasting average annual removal efficiencies (RE%). These data based curves are readily available in several of the evaluations that are publically available from the attached list of references.

A sigmoid function was used in the regression analyses to develop the TSS RE% forecasting model as a function of particle size for various flow rates through the continuous deflective treatment process. The mathematical form of the sigmoid function is shown as in the following equation:

$$y = \frac{a}{1 + e^{-\left(\frac{x - x_0}{b}\right)}} + y_0 \qquad (1)$$

where: y = TSS Removal (%) x = particle size: 10 to 250-µm

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Parameters; a, b, x_0 and y_0 were determined for each flow rates.

The flow rates used in RE% forecasts are developed from a hydrological analysis and development of design storm events of the 1-month through 12-month (1-yr) storm events for each specific installation site.

Oil and Grease Removal Performance

The ***Jensen Deflective Separator*** SWTU is equipped with a conventional oil baffle. It provides an accepted means to capture and retain free oil and grease and Total Petroleum Hydrocarbons (TPH) pollutants from stormwater runoff. The baffle system is also effective at capturing gross oil spills. Oil sorbents, when added to the unit ensure the removal of more than 80% of the typical low concentrations of free oil and grease from stormwater runoff.

The ***Jensen Deflective Separator*** SWTU is also capable of receiving and retaining the addition of Oil Sorbents within its separation chambers. The addition of the oil sorbents can ensure the permanent removal of 80% to 90% of the free oil and grease from the Stormwater runoff. The addition of sorbents enables increased oil and grease capture efficiencies beyond that obtained by conventional oil baffle systems.

1. Foot Notes: No Affiliation to CDS® as provided by Contech Engineered Solutions or its CDS® mark