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(54) **DEBRIS AND SEDIMENT REDUCTION APPARATUS FOR WATER DRAINAGE SYSTEMS**

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(57) **ABSTRACT**

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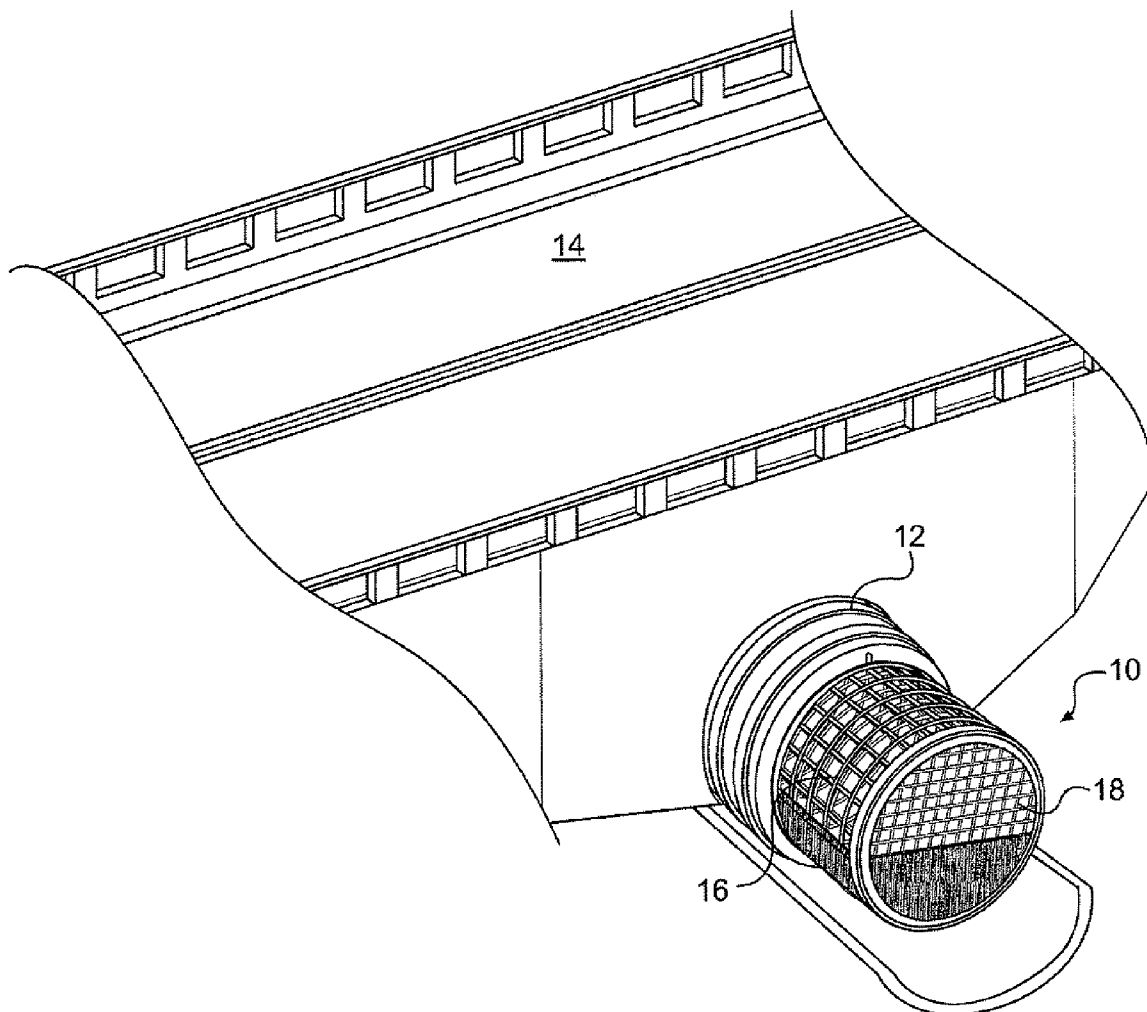
Debris and sediment reduction apparatus and method is provided. The apparatus and method include the insertion of a support member into a culvert or drainage pipe with a portion of the support member extending from the intake end of the culvert. A debris cap comprising a plurality of apertures is selectively placed on and secured to the support member. Fluid entering the culvert is filtered via the debris cap. The support member includes optional tabs to maintain a portion of the support member to the exterior of the pipe wherein the debris cap fits over the portion of the support member located to the exterior of the culvert. In one embodiment, the debris cap further comprises upper and lower portions wherein the apertures of the upper and lower portions are distinctly sized with the apertures of the lower portion being smaller than the apertures of the upper portion.

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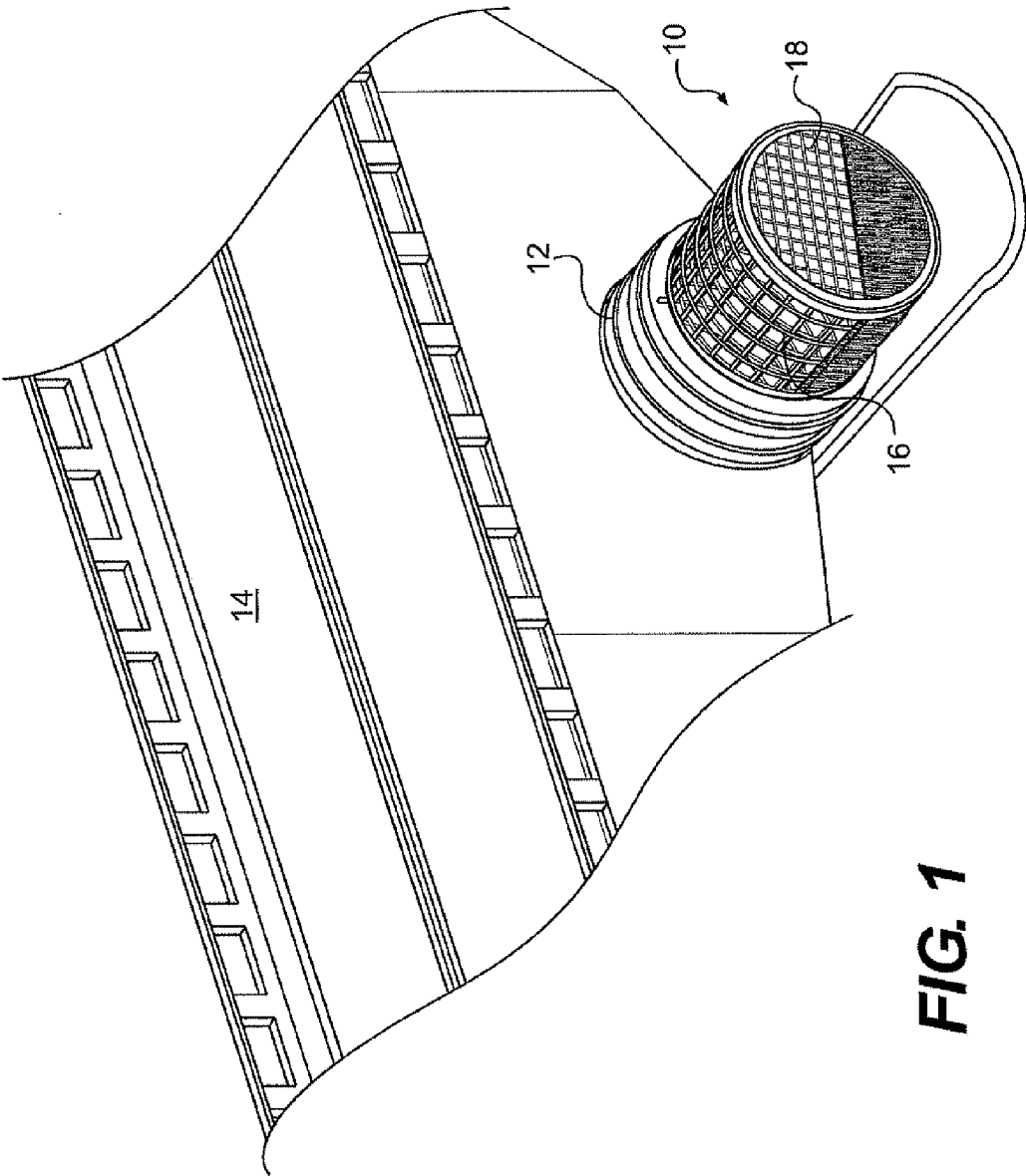


FIG. 1

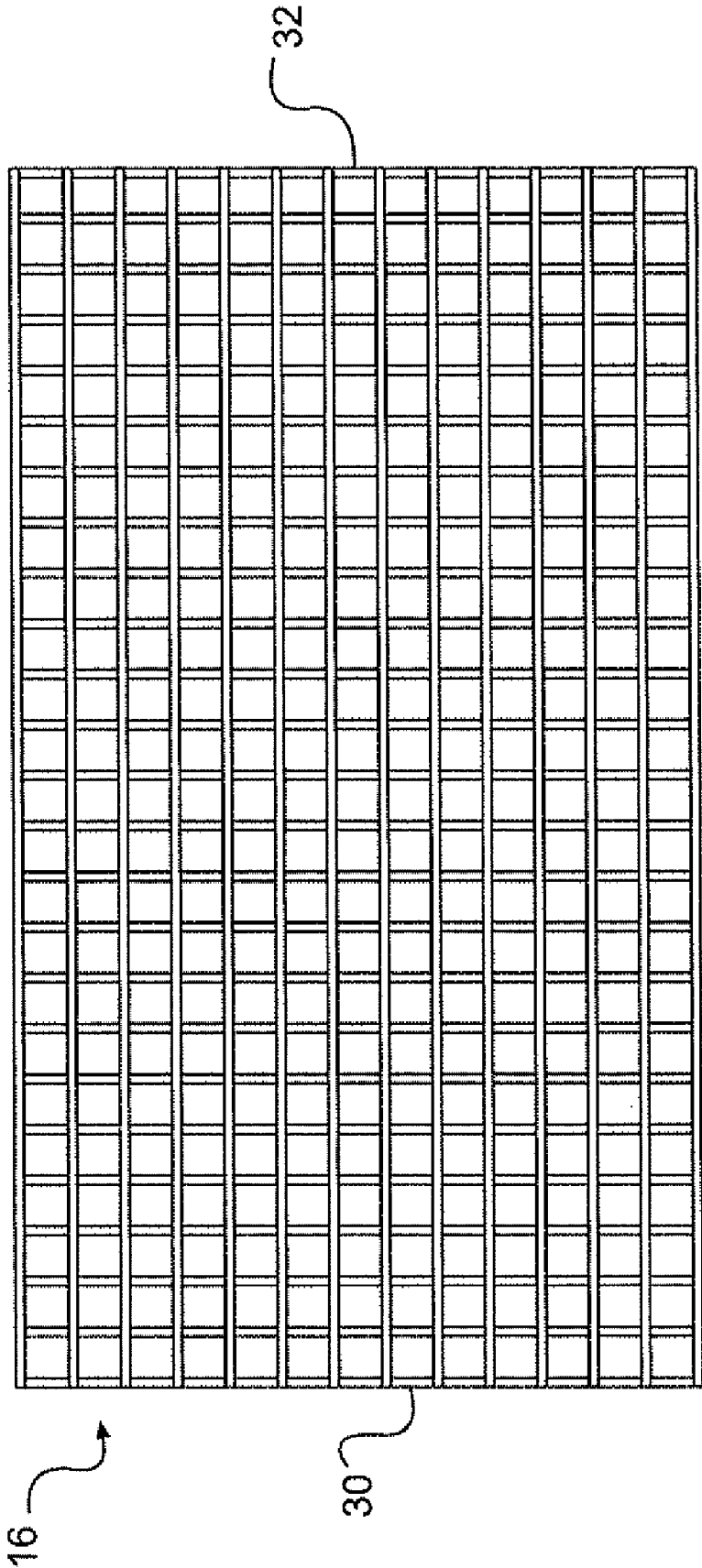


FIG. 2

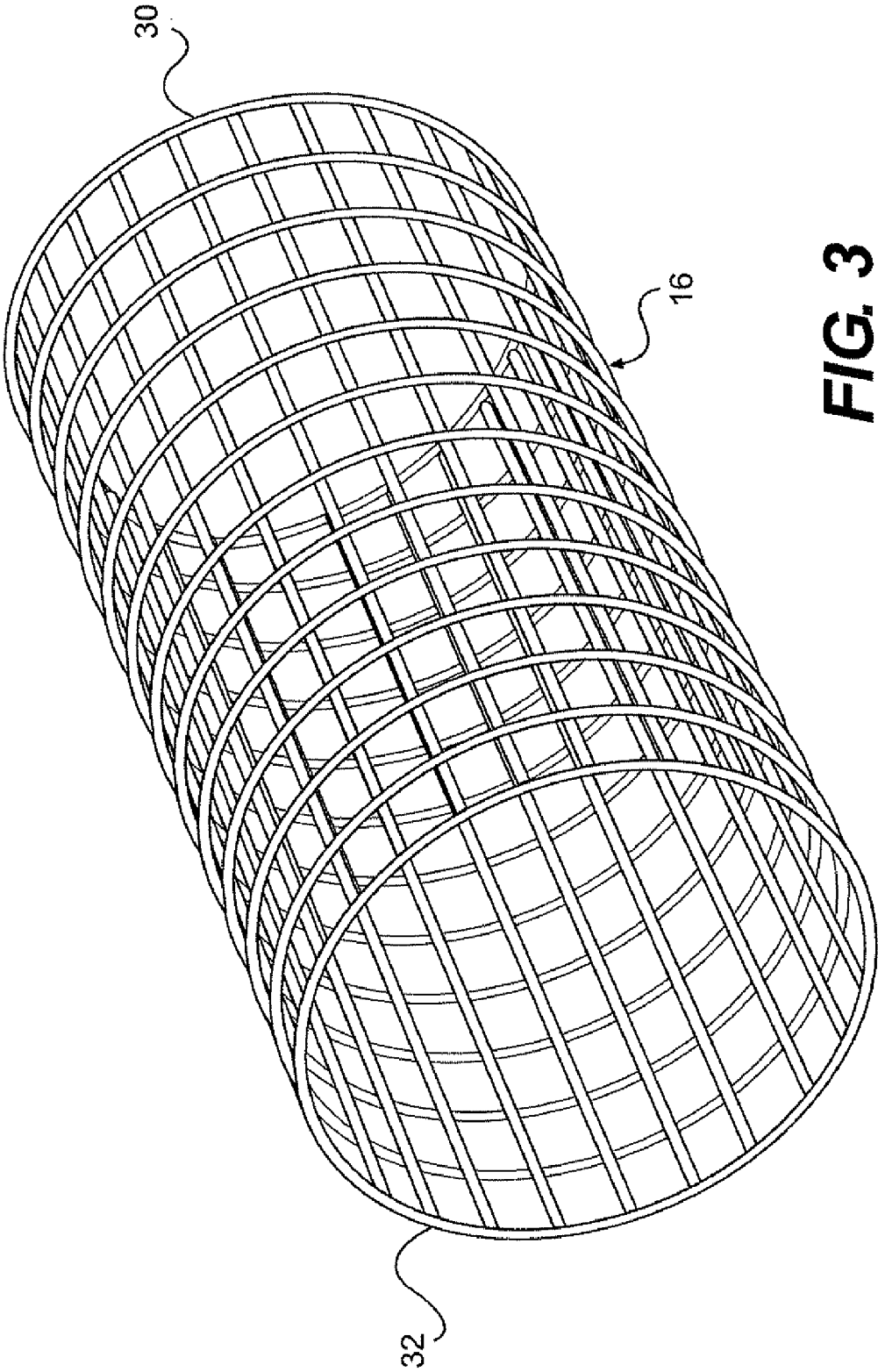


FIG. 3

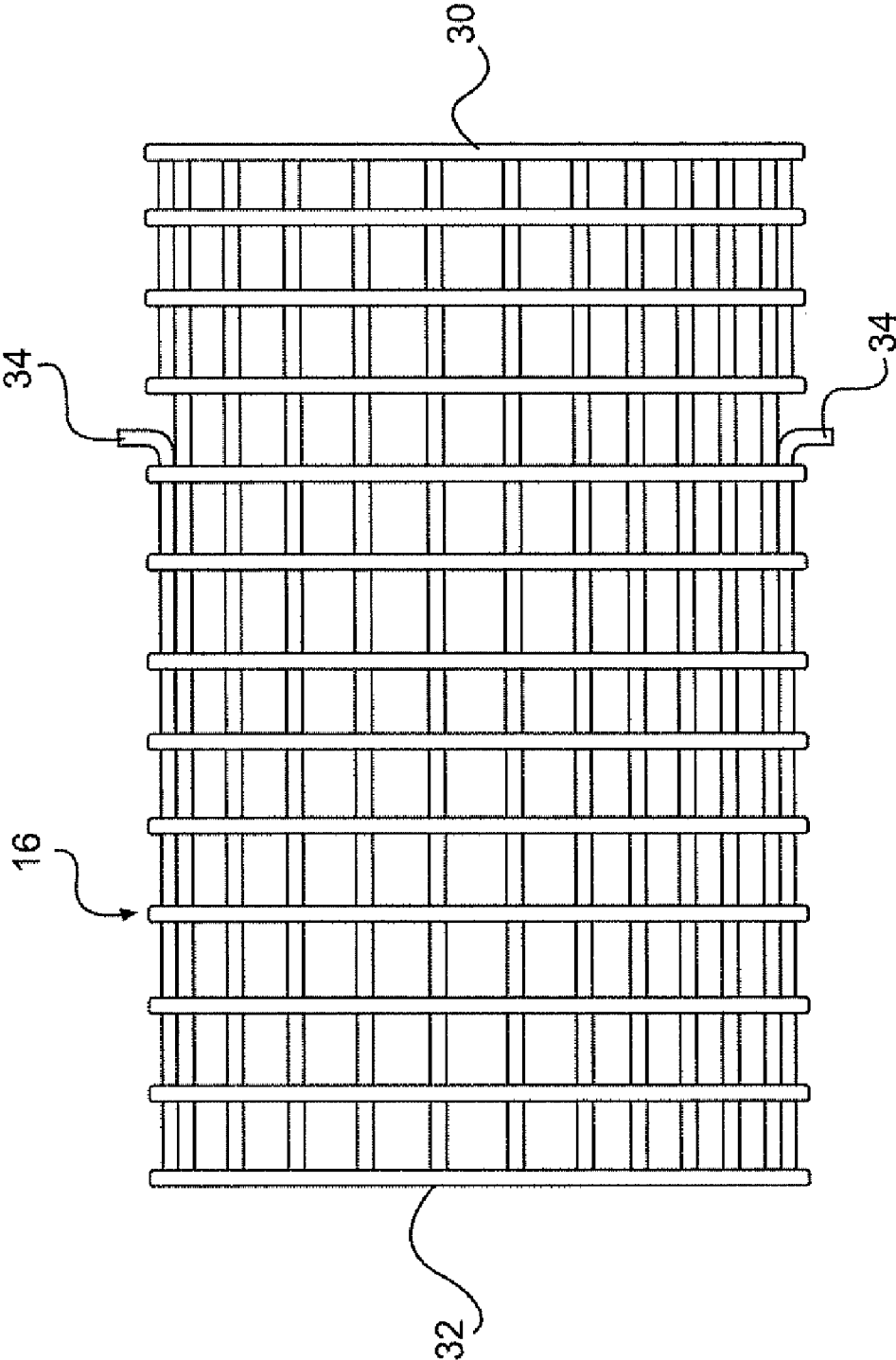


FIG. 4

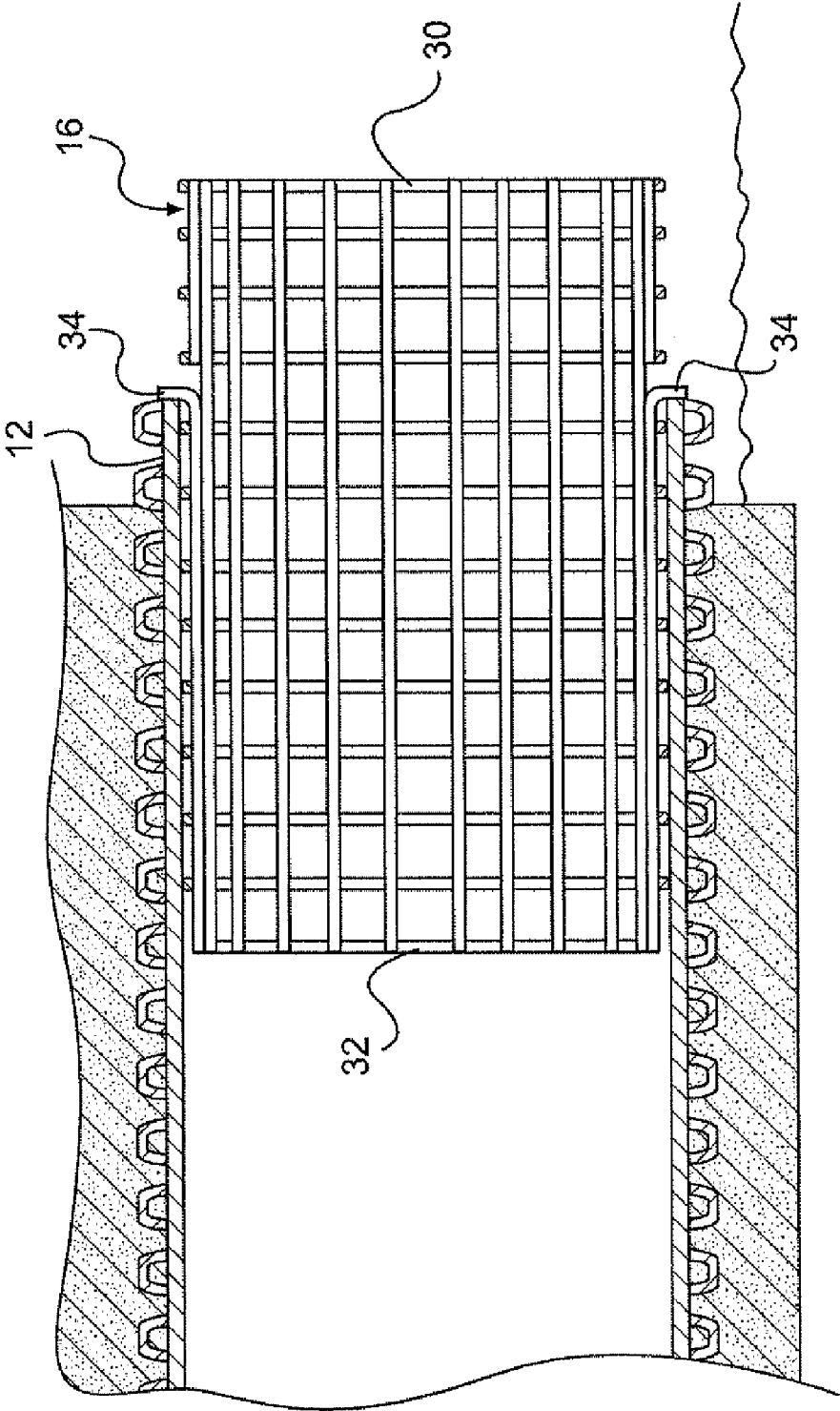
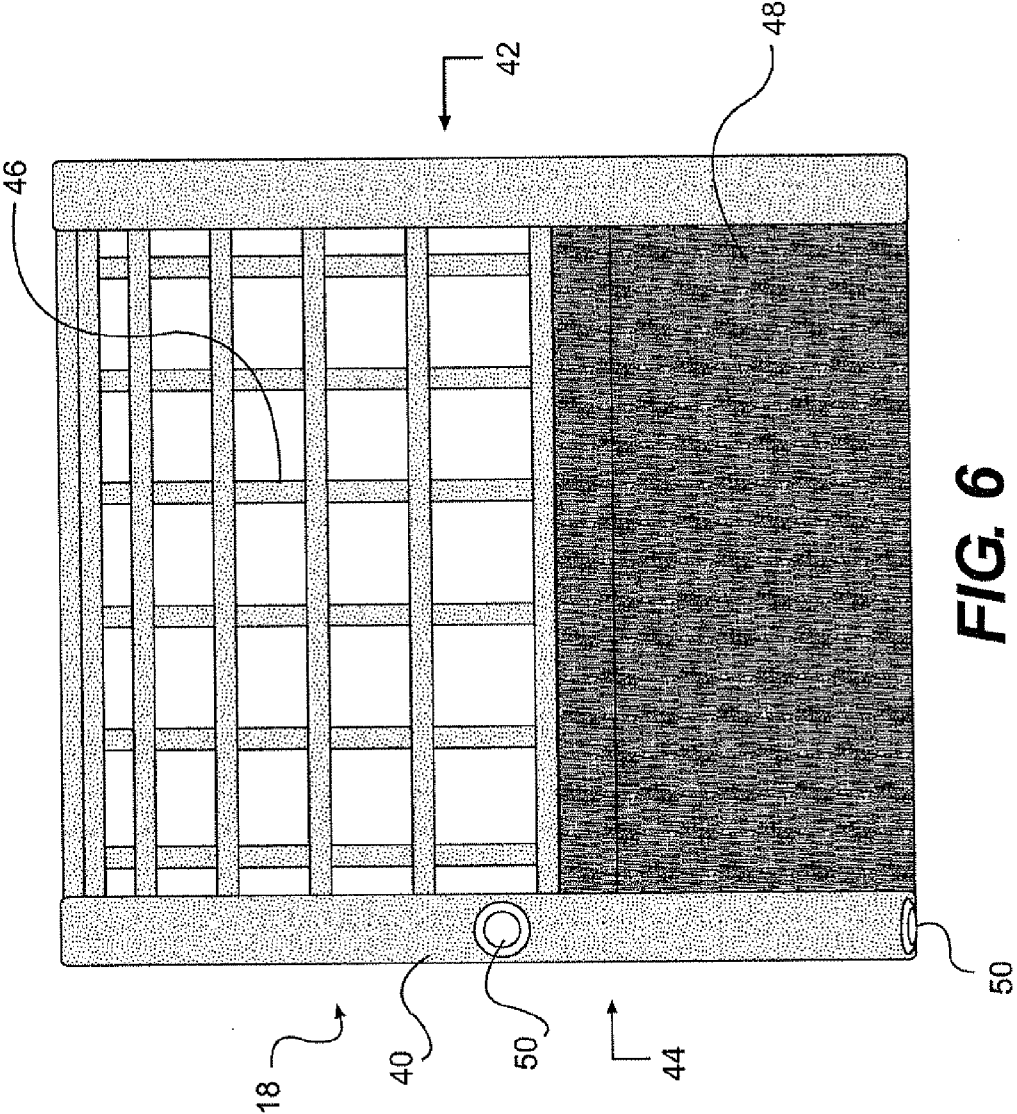


FIG. 5



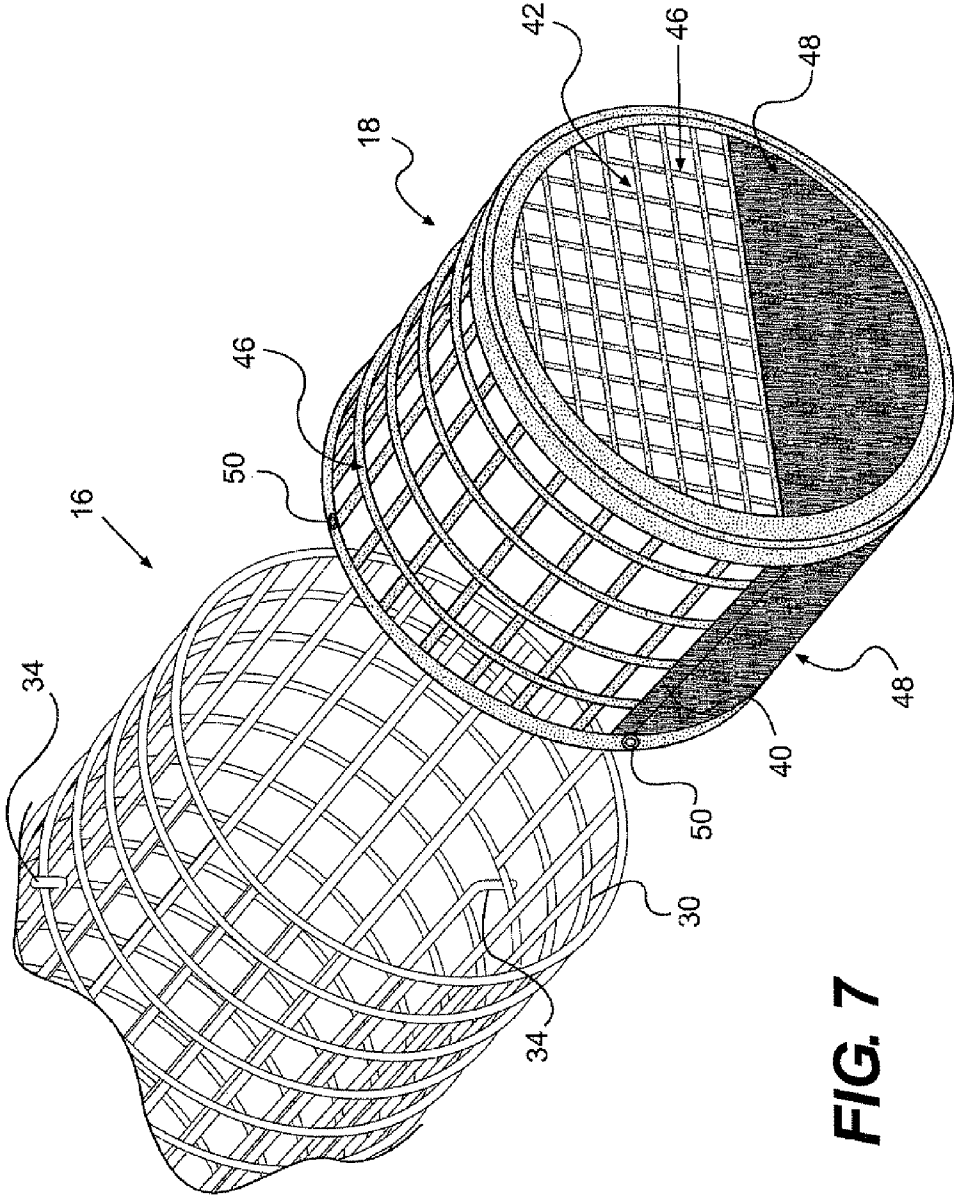


FIG. 7

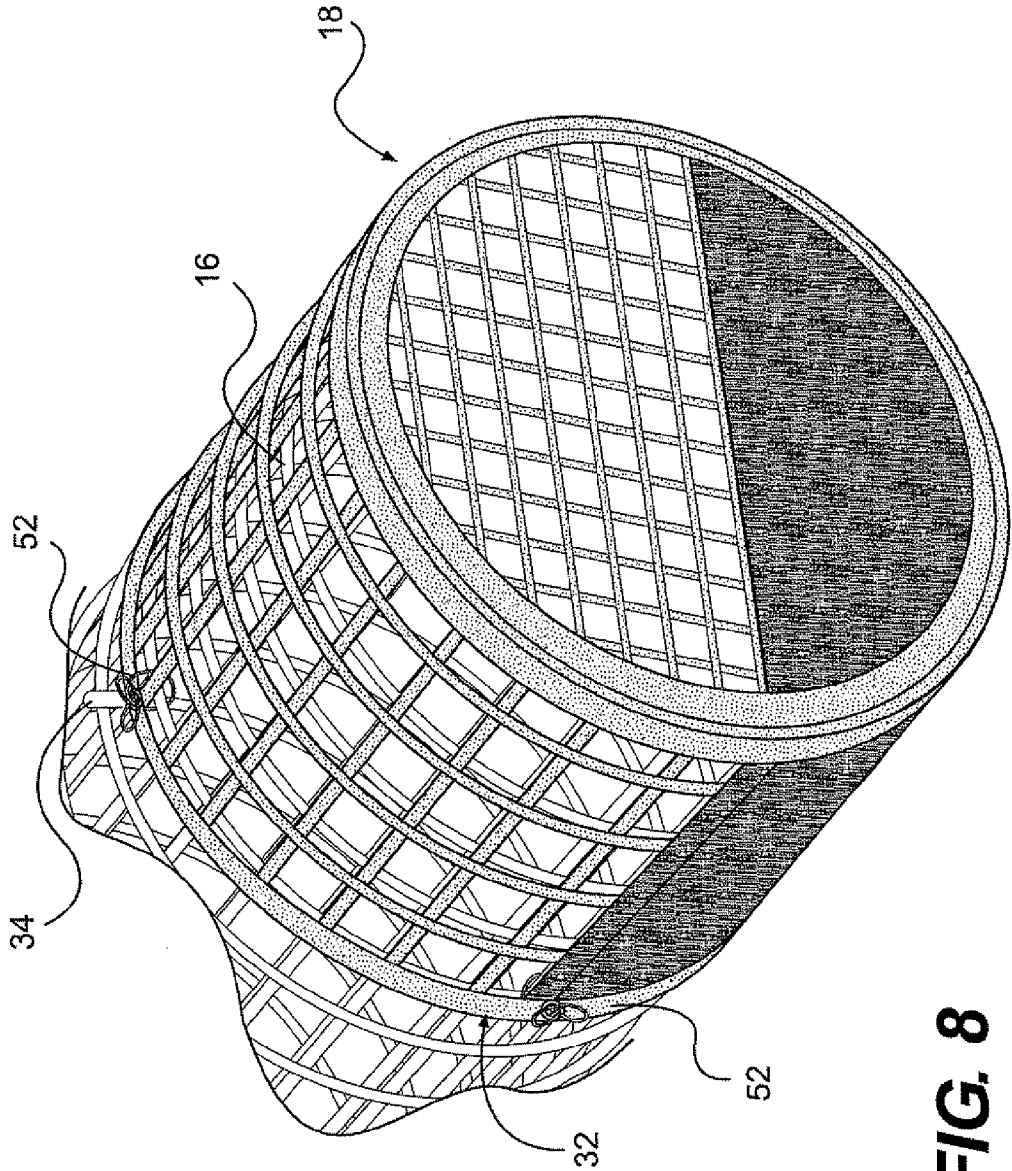


FIG. 8

DEBRIS AND SEDIMENT REDUCTION APPARATUS FOR WATER DRAINAGE SYSTEMS

[0001] This invention relates to a debris and silt/sedimentation preventing apparatus for water drainage systems. More specifically, the apparatus disclosed herein reduces or eliminates litter, sediments, yard waste, and the like from entering a water drainage system through entry culverts and for preventing or reducing the clogging of said culverts.

BACKGROUND OF THE INVENTION

[0002] A culvert is a conduit used to convey water from one area to another with each end of the culvert being open. For instance, a culvert could be used to transport water from one side of a road to another by providing a conduit beneath the road surface. Culverts also collect runoff and direct the runoff to natural waterways, marshes, or the like. The fluid flows in one direction through the culvert. Countermeasures have been developed to prevent debris from blocking or clogging the entries to culverts, which are often used for flood control.

[0003] Typically, countermeasures for culverts include structural measures/barriers that prevent debris from reaching the culvert entry point. These measures include debris deflectors, debris racks, debris risers, debris cribs, debris fins, debris dams and basins, or some combination thereof. For silt reduction or prevention, current structural countermeasures resort to dams or traps. Otherwise, structural countermeasures are concerned with very large debris members, such as logs or boulders, and are built accordingly. Non-structural measures consist of routine maintenance to remove the debris.

[0004] Culverts are increasingly used with water retention systems in residential and commercial real estate developments. These culverts collect runoff during a precipitation event and transport the water to a holding tank or storage reservoir. The reservoirs or tanks provide temporary storage to decrease the impact of a sudden precipitation event. The volume of fluid in the reservoir decreases between precipitation events, either through a physical reservoir outlet, evaporation, seepage, or the like. The retention systems can retain runoff so that existing storm, flood, or drainage systems stay within their designed capacity despite the addition of a newly developed area. These reservoirs are often open and accessible. However, underground water retention systems, wherein the reservoir acts as an underground storage tank, are becoming increasingly favored and important. With underground retention, more land is available for development. The danger of an open body of water, say for children in a residential development, is also eliminated. Some jurisdictions may even require fencing around such open man-made reservoirs. The fencing can be expensive to build and maintain.

[0005] Underground water retention reservoirs are, on the other hand, more difficult to maintain as any trash, yard waste, sediment, or the like cannot easily be accessed. It is not possible to simply dredge an underground water retention reservoir. Instead, trash, tree branches, and the like can clog the water retention culvert or eventually build up within the water retention reservoir. Sediment can also be transported to the reservoir via the culvert. Over time, the sediment and/or debris can reduce the overall storage capacity of the reservoir meaning the run-off culvert is more likely to 'back up' (i.e., fail to convey water from a run-off point to the reservoir).

Catastrophic flooding can result from such a backup. It is essential that engineered storm solutions work effectively and efficiently with relatively little or no maintenance required.

[0006] Culverts of all types divert water to allow access to areas or otherwise prevent flooding. Therefore, it is important that culverts for any purpose remain unclogged. As culverts can feed into natural waterways, marshes, or the like, it is also important to prevent the transportation of debris (trash, yard waste, etc.) or silt/sedimentation. Existing culverts often lack any debris or sedimentation reduction apparatus despite the critical need for effective culvert operation. An apparatus that is capable of retroactively fitting to existing culverts to reduce debris and settlement intake is needed.

[0007] Fluid dynamics for collecting runoff often leads to unforeseen problems. The problem of reducing debris and sedimentation intake into culverts is ongoing. Screens and known countermeasures are ineffective in many instances. Screens quickly become blocked and ineffective, filters clog, and structural countermeasures do not block the fine silt or debris, as needed. Known measures fail to provide dual protection from larger debris members while screening fine debris matter, such as silt. In other instances, traps or dams for silt and/or debris build up over time and are difficult to maintain.

[0008] There is a need for debris and silt preventing apparatus for culverts wherein the apparatus provides a high fluid intake volume to the culvert and the ability to reduce or prevent both large debris and silt. Ideally, such a solution would retroactively fit to existing culverts. The apparatus would also provide a low maintenance or self-cleaning construction. Preferably, the material, size and shape of the culvert should be inconsequential to the operation and efficacy of the new debris and silt preventing apparatus. The apparatus could be selectively removed entirely or in-part from the subject culvert. The apparatus taught and disclosed herein solves one or more of the above or other needs.

SUMMARY OF THE INVENTION

[0009] The apparatus disclosed herein overcomes one or more of the foregoing or other drawbacks with known culvert debris and sedimentation countermeasures. The apparatus comprises a mesh member inserted into but extending from a culvert and a cap secured over the mesh member. The apparatus is removably placed in a fluid inlet end of the culvert. The cap is selectively removable from the mesh member.

[0010] In further detail, the mesh member comprises a first end and a second end. The shape of the member conforms or corresponds to the shape of the culvert. In use, the second end of the member is inserted into the inlet end of the culvert. The member includes tabs or other structure that determine the distance into which the member can be inserted into the culvert. The tabs deter or prevent the member from being forced into the culvert due to hydrostatic or hydrodynamic pressure. In this embodiment, the member is not fastened to the culvert so that the member can be removed, repaired, cleaned, and/or reinstalled as needed. Installation is simple and inexpensive. It is also envisioned that other fastening mechanisms for connecting the member to the culvert might be used, including brackets, fasteners, or the like.

[0011] The first end of the member extends from the first (inlet) end of the culvert. In a preferred embodiment, the member comprises a mesh cylinder, such as a metal mesh cylinder. In another embodiment, the member extends at least

ten inches from the culvert. Some extension from the culvert is desired to increase the inlet surface area, as described below. The member can be rigid or resilient structure made form various known materials. In other words, the member is a rigid frame or it exhibits resiliency in that it can be bent and returned to its original shape. Overall, the member acts as a support frame to be enclosed within the cap.

[0012] The cap comprises a body with a first closed end, a second open end, an upper portion and a lower portion. The shape of the cap body conforms or corresponds to the shape of the mesh member. In one preferred embodiment, the cap body defines an inside diameter or dimension greater than the outside diameter or dimension of the mesh member. The open end of the cap is inserted over the member, and the cap is selectively secured in place.

[0013] The cap body and first closed end comprise a plurality of apertures. For instance, in an embodiment, the cap comprises panels of a flexible, woven material. The weave includes apertures between the vertical and horizontal woven components. The apertures can be one or more sizes based on the weave pattern. The panels are joined to each other, as needed, to create the body, closed end, upper portion and lower portion. The apertures of the cap's lower portion being smaller than the apertures of the upper portion. In this manner, sediment carried into the culvert via runoff is reduced via the small apertures of the lower portion. The larger apertures of the upper portion allow a high flow rate while blocking floating debris. Debris can be any item in a fluid stream that would advantageously be excluded from a culvert or drainage pipe.

[0014] The relatively open structure of the upper portion allows a relatively higher flow rate into the upper portion of the cap. It is thought that some back pressure on the lower portion will be created. Therefore, silt that has collected against the outside of the lower portion may be washed away. Dynamic fluid flow around and over the upper, relatively open portion should also provide a self cleaning mechanism to remove leaves, trash, and the like that may otherwise obstruct the apertures of the upper portion. A second end of the culvert is fluidly connected to a natural or artificial reservoir or other waterway, including swamps, steams, marshes, ditches, rivers, or the like.

[0015] The debris and silt reduction apparatus of the present invention effectively addresses at least one of the problems associated with prior art debris and sedimentation countermeasure systems. For instance, the system of the present invention is selectively removable entirely or in-part from the culvert. In other words, the apparatus can be removed, repaired, or replaced, as desired. The apparatus reduces both large debris and sedimentation. It is easily, retroactively fit to existing culverts. The apparatus also provides a low maintenance or self-cleaning construction. The material, size and shape of the culvert it thought to be inconsequential to the operation and efficacy of the new debris and silt preventing apparatus.

[0016] The foregoing and additional features and advantages of the present invention will become apparent to those of skill in the art from the following detailed description of a preferred embodiment taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a perspective view of a preferred embodiment of the debris and sedimentation reducing apparatus disclosed herein;

[0018] FIG. 2 is a top view of one embodiment of mesh member for use with the apparatus disclosed herein;

[0019] FIG. 3 is a perspective view thereof wherein the member is placed into a cylindrical shape;

[0020] FIG. 4 is a side view of one embodiment thereof;

[0021] FIG. 5 is a side, cross-sectional view of the mesh member as inserted into a culvert in accordance with one embodiment of present invention;

[0022] FIG. 6 is a side view of a debris cap in accordance with one embodiment of the present invention; and

[0023] FIG. 7 is an exploded view of a debris cap and mesh member in accordance with one embodiment of the disclosed apparatus.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0024] The method and apparatus for the debris and sediment reduction apparatus for water drainage systems as disclosed herein efficiently addresses one or more shortcomings of the prior art, including the inability to provide a high fluid intake volume to a culvert while simultaneously reducing the intake of large debris and silt. The solution taught herein would retroactively fit to existing culverts. The apparatus would also provide a low maintenance or self-cleaning construction. The material, size and shape of the culvert is inconsequential to the operation and efficacy of the new debris and silt preventing apparatus. The apparatus is selectively removable entirely or in-part from the subject culvert. The subject apparatus provides one or more of the above or other advantages.

[0025] Referring now to FIG. 1, the debris and silt reduction apparatus 10 for water drainage systems is envisioned as a two-piece assembly. The assembly is inserted into a newly installed or existing culvert 12. The culvert may comprise corrugated plastic, cement piping, or the like. Basically, the culvert transfers fluid from an intake opening to a secondary location, such as a waterway, above- or below-ground reservoir, holding tank, or the like.

[0026] Culverts, in general are used for flood control or to otherwise divert fluid so as to maintain access to roadways, such as road 14, and property during a precipitation event. Often, water drainage systems, which include culverts, are installed in new residential and commercial developments to supply a means to prevent storm run off from flooding or damaging properties. Roads, structures, and parking lots built to support such developments reduce the ability of storm water to drain or seep into natural ground water reservoirs or waterways. Water drainage systems are necessary to compensate and to protect the development's infrastructure and the people living or working in the development.

[0027] The size and shape of the culvert may vary based upon the design and needs of the water drainage and control system. Typically, culverts will comprise cylindrical conduits of various diameters. The subject apparatus is adaptable to all sizes and shapes of culvert designs.

[0028] Broadly, apparatus 10 comprises a mesh member 16 inserted into but extending from culvert 12. Member 16 acts as the support or frame for a debris cap 18. Debris cap 18 is selectively secured over mesh member 16. Apparatus 10 is removably placed in a fluid inlet end of the culvert. As illustrated in FIG. 1, cap 18 substantially encloses all of the portion of member 16 that extends from culvert 12.

[0029] In further detail, and with reference to FIG. 2, mesh member 16 comprises a planar grid or screen. In the illus-

trated embodiment, the grid is formed from longitudinal and transverse segments aligned perpendicularly from each other at set intervals. However, variations are possible and would be suitable as a frame for cap 18.

[0030] Member 16 comprises first end 30 and a second end 32 connected by opposing sides. For a cylindrical culvert 12, member 16 can be square-shaped or rectilinear with the ends 30, 32 being longer than the sides or vice versa. The 'grid' or mesh structure of member 16 is comprised of a flexible or resilient material. In one embodiment, member 16 comprises metal wire of a bendable or resilient gauge that would allow the member to be formed into a shape. Plastic or other materials would also be suitable. In use, an installer would shape member 16 to conform to the shape of the culvert to which the member would be inserted. Member 16 nests or frictionally fits within the culvert. Culvert 12 holds member 16 in the shape to which it has been formed.

[0031] Member 16 might also be pre-formed for specific culvert installation projects. Instead of presenting a flat grid that is formed into the shape of the culvert, a preformed culvert can be built as a rigid body. In other words, member 16 could be constructed or welded into a cylindrical or other shape with given or predetermined dimensions. Preformed member 16 would fit within a corresponding culvert 12 but, because the member is rigid, the culvert would not necessarily hold the member's shape.

[0032] Overall, the type of material or metal, gauge of the mesh, and other parameters would be selected on a case-by-case basis. The size of the culvert, the predicted volume of water to be conveyed through the culvert, whether the member is formed on-site or preformed, and other considerations are relevant to selecting the member's configuration. For instance, a relatively large culvert would be installed where a large volume of water would be predicted. The hydrodynamic and hydrostatic pressure of a fluid associated with an apparatus 10 installed into a relatively large culvert would typically necessitate a more robust member 16 capable of withstanding those forces. Therefore, member 16 might be a metal structure with large diameter segments forming the grid. Culverts designed to transport a relatively low volumes would permit the use of smaller size member and a relatively smaller diameter for the longitudinal and transverse segments 16.

[0033] To form member 16 on-site for use with cylindrical culverts, member 16 is 'rolled' into a cylindrical shape with a first end 30 and a second end 32, as illustrated in FIG. 3. Each end of the cylinder is open. Cylindrical member 16 is selectively inserted into a cylindrical culvert of corrugated plastic, cement, or the like. The interior diameter of the culvert is only marginally larger than the outer diameter of the member. The flexibility or resiliency of the member can cause it to expand within the culvert to cause a frictional fit.

[0034] As illustrated in FIG. 4, member 16 can be modified in another embodiment to include at least one tab 34. Tab 34 is formed by cutting one of the elongated segments forming the grid of member 16. The cut segment can be a transverse or longitudinal segment. If a plurality of tabs 34 are employed, tabs 34 are positioned equidistantly between first end 30 and second end 32. Tab(s) 34 extend outwardly from the axis of member 16 and are in contact with the first end of culvert 12 when the member is inserted into the culvert. Tabs 34 act as "stops" that prevent member 16 from being pushed into culvert 12 beyond the location of tab(s) 34.

[0035] In more detail, second end 32 of the member is inserted into the inlet end of the culvert. Member 16 can be

held in place via frictional forces. In another embodiment, member 16 is inserted until tab(s) 34 engage the outer edge of culvert 12. The location of tabs 34 determine the distance into which the member can be inserted into the culvert. The tabs deter or prevent the member from being forced into the culvert due to hydrostatic or hydrodynamic pressure. In this embodiment, the member is not fastened to the culvert so that the member can be removed, repaired, cleaned, and/or reinstalled as needed. Installation of the apparatus is simple and inexpensive. With or without tabs, the member 16 can be selectively removed to facilitate repair, maintenance, or replacement. It is also envisioned, in another embodiment, that other, more permanent fastening mechanisms for connecting member 16 to culvert 12 might be used, including brackets, fasteners, or the like.

[0036] Once inserted into the culvert, the first end of the member extends from the first (inlet) end of the culvert. In one embodiment, the member extends at least ten inches from the culvert. As explained further below, the distance the member extends establishes the surface area available for filtering incoming fluid. At least some extension from the culvert is desired to increase the inlet surface area. It is also necessary to maintain a portion of member 16 to the exterior of culvert 12 so as to allow the placement of debris cap 18 over member 16. The distance the member extends should substantially correspond to the length of cap 18, as described below.

[0037] Debris cap 18, as further illustrated in FIG. 6, comprises a body 40 with a first closed end 42, a second open end 44, an upper portion 46 and a lower portion 48. The length of the body is the shortest line that intersects the plane of the first and second ends. The shape of the cap body conforms or corresponds to the shape of the mesh member. For a cylindrical culvert, and in one preferred embodiment, cap body 40 defines a cylinder with an inside diameter or dimension greater than the outside diameter or dimension of the mesh member. Open end 44 of cap 18 is inserted over member 16, and cap 18 is selectively secured in place via one or more grommets 50.

[0038] In one embodiment, cap 18 comprises panels of a flexible, woven material. Cap body 40 and first closed end 42 comprise a plurality of apertures. The apertures comprise the space between the warp and weft of the woven material. The apertures can be one or more sizes based on the weave pattern. The panels are joined to each other, as needed, to create body 40 including closed end 42, upper portion 46 and lower portion 48. As illustrated, the apertures of the cap's lower portion 48 are smaller than the apertures of the upper portion.

[0039] Lower portion 48 comprises relatively tightly woven panels. This weave pattern creates a filter through which water flows. The fabric of lower panel 48 will capture relatively small particles, such as silt (i.e., dirt particles suspended in the fluid flowing through culvert 12). In this manner, sediment carried into the culvert via runoff is reduced via the small apertures of the lower portion. The larger apertures of the upper portion allow a high flow rate while blocking floating debris (i.e., leaves, sticks, trash, etc.).

[0040] The relatively open structure of the upper portion allows a relatively higher flow rate into the upper portion of the cap in comparison to the relatively closed structure of the lower portion. The higher influx of fluid into the upper portion during a storm event will create some back pressure on the lower portion. Therefore, silt that has collected against the outside of the lower portion may be cleared as a self-cleaning mechanism. Dynamic fluid flow around and over the upper,

relatively open portion should also provide a self-cleaning mechanism to remove leaves, trash, and the like that may otherwise obstruct the apertures of the upper portion. Cap is also selectively removable from member 16 so that cleaning, maintenance or replacement of the cap are easily accomplished. A second end of the culvert is fluidly connected to a natural or artificial reservoir or other waterway, including swamps, steams, marshes, ditches, rivers, or the like.

[0041] Cap 18 can be built from any material suitable to withstand the hydrodynamic pressure of an application. The panels of cap 18 can comprise fabric panels of woven polypropylene, nylon, a combination of fibers, or the like. In another embodiment, cap 18 might also comprise a resilient or rigid material. For instance, lower portion 48 could consist of a fine, metal mesh joined to an open grid forming the upper portion of body 40. As one of skill in the art will appreciate in light of the disclosure herein, other equivalent and operable materials are available.

[0042] In the exploded view of FIG. 7, cap 18 is illustrated in a spaced arrangement from member 16. Both cap body 40 and member 16 are illustrated as being cylindrical. Cap body 40 defines an inside diameter greater than the outside diameter of the cylindrical member 16. Closed end 42 of cap 18 is also further illustrated with the open structure of upper portion 46 and relatively closed structure of lower portion 48 further illustrated. Cap 18 fits over first end 30 of member 16, FIG. 8 illustrates tie downs 52 that selectively secure cap 18 to member 16 via grommets 50. Tie downs 52 can comprise bailing wire, compression straps, or the like so long as tie downs 52 selectively secure cap 18 to member 16. Permanent fasteners could also secure cap 18 to member 16 but are not illustrated herein. Second end 32 of cap 18 would abut or be adjacent to the first end of culvert 12. Fluid entering member 16 through cap 18 would be filtered. Silt is captured by the smaller apertures of the lower portion while larger, floating debris is filtered by the larger openings of the upper portion.

[0043] Numerous characteristics and advantages of the invention have been set forth in the foregoing description. It will be understood, of course, that this disclosure is, in many respects, only illustrative. Changes can be made in details, particularly in matters of shape, size, in arrangement of parts without exceeding the scope of the invention. The invention's scope is defined by the language in which the appended claims are expressed.

That which is claimed is:

1. A debris and silt reduction apparatus for water retention systems comprising:

a culvert, the culvert comprising a fluid conduit with a first end and a second end, the first end comprising a fluid inlet;

a support member comprising a first end and a second end, the second end of the member inserted into the first end of the culvert the first end of the member located to the exterior of the culvert;

a cap comprising a body with a first closed end and a second open end, the cap placed around the first end of the member via the open end of the cap; and

wherein the cap body and first closed end comprise a plurality of apertures whereby a fluid entering the culvert is filtered via the apertures.

2. The apparatus of claim 1, wherein the cap further comprises an upper portion and a lower portion, the upper and lower portion including a plurality of apertures; and

wherein the apertures of the lower portion are smaller than the apertures of the upper portion.

3. The apparatus of claim 2, wherein the upper and lower portions comprise a woven structure.

4. The apparatus of claim 1, wherein the cap is selectively secured to the member.

5. The apparatus of claim 1, wherein the member is selectively removable from the culvert.

6. The apparatus of claim 1, the member further comprising at least one tab, the tab extending outwards from the member; and wherein the tab is in contact with the culvert when the member is inserted into the culvert.

7. The apparatus of claim 1, wherein the culvert includes an inside diameter;

the member defining a cylindrical shape with an outside diameter less than the culvert inside diameter;

the cap further comprising a cylindrical body; and

the cap body defining an inside diameter greater than the outside diameter of the member.

8. The apparatus of claim 2, the upper portion allowing a higher flow rate into the cap via the closed end and body of the cap relative to the flow rate allowed by the lower portion into the cap via the closed end and body of the cap.

9. The apparatus of claim 8, wherein the relatively higher flow rate into the upper portion of the cap creates a back pressure through the lower portion of the cap; and

whereby debris or silt filtered by the lower portion is washed from the lower portion apertures due to the back pressure.

10. The apparatus of claim 1, wherein the member is selectively removable from the culvert and the cap is selectively secured to the member.

11. A debris and silt reduction apparatus operable to filter sedimentation or debris in a water drainage system, the apparatus comprising:

a cylindrical support member with an outside diameter comprising a first end and a second end;

a cylindrical cap comprising a body with a first closed end and a second open end, the cap further comprising an upper portion and a lower portion, the upper and lower portions including a plurality of apertures, the cap body defining an inside diameter greater than the outside diameter of the support member, the cap selectively secured on the support member; and

whereby the cap filters a fluid moving through the cap body.

12. The apparatus of claim 11, the cylindrical support member further comprising at least one tab, the tab extending outwards from the circumference of the member.

13. A method of reducing debris and sedimentation intake into a water drainage system, the method comprising:

providing a culvert, the culvert comprising a conduit with a first intake end and a second outlet end;

inserting a support member into the intake end of the culvert, the support member extending from the intake end of the culvert;

selectively securing a debris cap over a portion of the support member extending from the culvert; and

filtering a fluid passing through the debris cap and into the culvert via a plurality of apertures provided by the cap.