

**LABORATORY TESTING OF THE MUNRO  
CONCRETE PRODUCTS LTD. G3 CATCHBASIN  
INSERT**

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**Laboratory Testing of the  
Munro Concrete Products Ltd. "G3"  
Catchbasin Insert**

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## MANAGEMENT PERSPECTIVE

The Aquatic Ecosystems Protection Branch of the National Water Research Institute provides research and development support to manufacturers of environmental technology, through cost-recovery arrangements. The report that follows presents results of one of such projects dealing with the development and testing of a new catchbasin designed to enhance urban stormwater quality and, thereby, to contribute to the protection of receiving waters. The performance of this new design in trapping suspended solids and floatables was evaluated in comparison to the conventional design. After extensive modifications of the original G3 design, some improvement over the conventional design was achieved, but only for smaller flows ( $< 0.013 \text{ m}^3\text{s}^{-1}$ ). The significance of this improvement with respect to long-term performance and cost effectiveness remains to be determined.

## **SOMMAIRE À L'INTENTION DE LA DIRECTION**

La Direction générale de la protection de l'écosystème aquatique de l'Institut national de recherche sur les eaux fournit un appui de recherche et développement aux fabricants de technologie environnementale, par le biais d'accords de recouvrement des coûts. Le rapport qui suit présente les résultats d'un tel projet portant sur la mise au point et l'essai d'un nouveau bassin de retenue conçu pour améliorer la qualité des eaux pluviales urbaines et contribuer ainsi à la protection des eaux réceptrices. La performance de cette nouvelle installation en matière de capture des solides en suspension et des substances flottantes a été évaluée par rapport aux installations conventionnelles. Après d'importantes modifications du concept G3 original, on a obtenu une certaine amélioration par rapport au concept conventionnel, mais seulement pour de faibles débits ( $< 0,013 \text{ m}^3 \text{ s}^{-1}$ ). Il reste à déterminer l'importance de cette amélioration pour ce qui est de la performance et de la rentabilité à long terme.

## ABSTRACT

A new catchbasin design, developed by Munro Concrete Products Ltd. by fitting an insert (G3) into the conventional catchbasin, was tested in the laboratory for effectiveness in trapping floatables and sand. In the comparative testing of the catchbasin with and without the G3 insert, two types of floatables, leaves and small plastic sheets ( $0.2 \times 0.2$  m), as well as sand of various sizes, were used. It was observed that both designs, with and without the G3 insert, did not trap any floatables. With respect to trapping sand, the addition of the G3 insert reduced the amount of sand trapped, compared to the conventional catchbasin, and this reduction was particularly significant for higher flows ( $> 0.005 \text{ m}^3\text{s}^{-1}$ ). Neither of the two designs, with and without the G3 insert, was susceptible to resuspension of sand placed on the catchbasin bottom. In the next phase of testing, the G3 design was further modified by raising the G3 water intake and adding a removable baffle in front of the G3 intake. To reduce costs, the scope of testing was limited to the trapping of plastic sheets and fine sand. The performance of the G3 insert improved by these modifications with respect to both floatables and fine sand. At low ( $< 0.005 \text{ m}^3\text{s}^{-1}$ ) and high ( $> 0.016 \text{ m}^3\text{s}^{-1}$ ) flows, 50% and 4% of sheets were trapped, respectively. The modified G3 design trapped more sand than the original G3 for all discharges, and trapped about 10% more sand than the conventional design, for flows smaller than  $0.012 \text{ m}^3\text{s}^{-1}$ . Finally, the modified design was further adjusted by extending the baffle (in front of the G3 intake) downward. While the trapping of floatables remained unchanged, the trapping of fine sand did improve as a result of these modifications, for flows  $> 0.012 \text{ m}^3\text{s}^{-1}$ . However, for large flows ( $> 0.013 \text{ m}^3\text{s}^{-1}$ ), even this twice-modified design trapped less sand than the conventional design without G3. Thus, in comparison to the conventional design, the twice-modified design produced a better trapping of floatables and a somewhat better trapping of fine sand (by 10%), for flows smaller than  $0.013 \text{ m}^3\text{s}^{-1}$ . To determine, whether these catchbasin modifications are costs effective, it is required to estimate the long-term performance of the G3 design, by using the catchbasin performance data determined in this study and durations (in hours per year) of various catchbasin discharges estimated for typical urban drainage conditions.

## RÉSUMÉ

Au laboratoire, on a testé l'efficacité d'un nouveau bassin de retenue, conçu et mis au point par Munro Concrete Products Ltd. en insérant une unité (G3) dans le bassin de retenue conventionnel, pour capturer les substances flottantes et le sable. Au cours de ces essais comparatifs du bassin de retenue avec et sans unité G3, on a utilisé deux types de substances flottantes (des feuilles et des petits sacs en plastique (0,2 x 0,2 m), ainsi que diverses grosseurs de sable. On a observé qu'aucun des deux concepts, avec et sans unité G3, ne capturait des matières flottantes. En ce qui a trait à la capture du sable, l'ajout de l'unité G3 permettait de réduire la quantité de sable capturé, comparativement au bassin de retenue conventionnel, et cette réduction était particulièrement importante pour les débits élevés ( $> 0,005 \text{ m}^3 \text{ s}^{-1}$ ). Aucun des deux concepts, avec et sans unité G3, n'était susceptible de remettre en suspension le sable placé au fond du bassin. Au cours de la phase suivante de l'essai, l'unité G3 a été modifiée en élevant l'entrée d'eau et en ajoutant une chicane amovible en face de l'entrée d'eau. Afin de réduire le coûts, l'essai a été limité à la capture de feuilles de plastique et de sable fin. Ces modifications ont permis d'améliorer la performance de l'unité G3 relativement aux substances flottantes et au sable fin. On a réussi à capturer respectivement 50 % et 4 % des feuilles de plastique à débit faible ( $< 0,005 \text{ m}^3 \text{ s}^{-1}$ ) et élevé ( $> 0,016 \text{ m}^3 \text{ s}^{-1}$ ). L'unité G3 modifiée a capturé plus de sable que l'unité G3 originale dans tous les débits, et environ 10 % plus de sable que le concept conventionnel, pour des débits inférieurs à  $0,012 \text{ m}^3 \text{ s}^{-1}$ . Enfin, l'unité modifiée a été ajustée davantage en prolongeant la chicane (en face de l'entrée d'eau) vers le bas. Bien que la capture des substances flottantes soient restée inchangée, celle du sable fin s'est améliorée à la suite de ces modifications pour des débits  $> 0,012 \text{ m}^3 \text{ s}^{-1}$ . Dans le cas de débits élevés ( $> 0,013 \text{ m}^3 \text{ s}^{-1}$ ), cependant, même cette unité deux fois modifiée capturait moins de sable que le dispositif conventionnel sans unité G3. Ainsi, comparativement au concept conventionnel, l'unité deux fois modifiée a permis de capturer plus de substances flottantes et un peu plus de sable fin (environ 10 %), pour des débits inférieurs à  $0,013 \text{ m}^3 \text{ s}^{-1}$ . Pour déterminer si ces modifications sont rentables, il faut évaluer la performance à long terme de l'unité G3, en se servant des données sur la performance du bassin de retenue établies dans le cadre de cette étude et des durées (en heures par année) de divers débits de bassin de retenue estimés pour des conditions de drainage urbain types.

### Mots clés

pollution des eaux pluviales, solides en suspension, bassin de retenue, capture de solides, capture de substances flottantes

## INTRODUCTION

Urban stormwater is widely recognized as an important non-point source of pollution. Awareness of the harmful impacts of stormwater discharges on receiving waters has resulted in the development of stormwater management measures, which support the goal of sustainable development of urban areas. Current stormwater management practices are applied in both new and existing developments, and include both quantity and quality control aspects. Best management practices (BMPs) is the term now commonly used for various water quantity control and water quality enhancement facilities designed to reduce adverse impacts of stormwater on urban ecosystems.

BMPs can be effective in removing specific contaminants from stormwater. Combinations of BMPs are needed to address complex pollution problems as no single type represents a universal solution [Ontario MOEE 1994]. BMPs are not necessarily implemented at the same site (e.g., as for end-of-the-pipe solutions), but are positioned throughout the catchment in a treatment train. Thus, a comprehensive program of stormwater management starts with source control in the catchment, and continues through measures implemented along the collection system and in the receiving waters [Marsalek et al. 1992].

Road runoff enters the urban stormwater collection system through sewer inlets, commonly located along curb lines of streets. Sewer inlet structures usually include catchbasins, which serve to catch and retain materials that would contribute to clogging sewers (e.g., street litter, sand and gravel). In this way, the catchbasin protects downstream sewer sections and BMPs.

Munro Concrete Products Ltd. has designed a device intended to enhance the separation of sediments and floatables (e.g., garbage, leaves) from stormwater flow leaving catchbasins. This device, further referred to as the G3 catchbasin insert, is a molded PVC flow orifice that can be retrofitted into a conventional catchbasin outlet or incorporated in new installations. The sub-surface intake location of the G3 should aid in the trapping of floatables; flow restriction should enhance sediment retention by allowing more time for sediments entering the catchbasin to settle to the bottom.

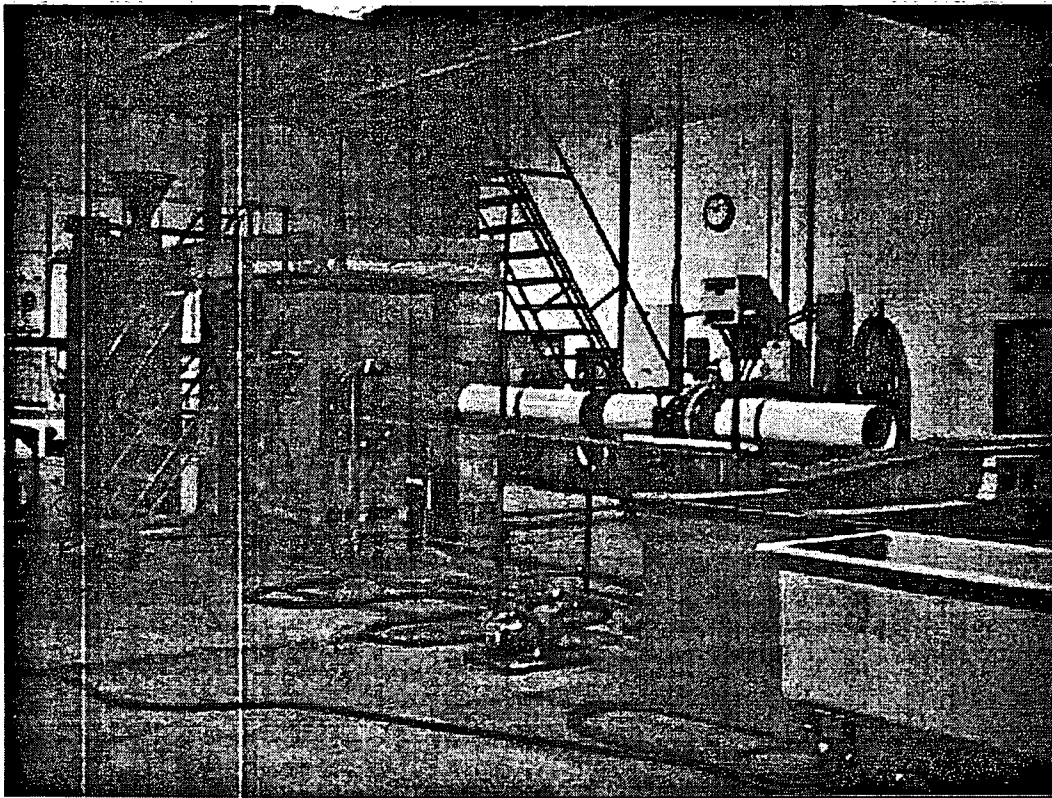
To evaluate the performance of the "G3" catchbasin insert, Munro Concrete Products Ltd. has commissioned the National Water Research Institute (NWRI) in Burlington, Ontario to test the original design in a laboratory installation. Testing was conducted to determine the effectiveness of the G3 at increasing the sand and floatables trapping ability of a standard catchbasin. Results of this testing are described in Section I of this report.

Pursuant to the recommendations from the initial evaluation of the G3 catchbasin insert, modified versions were subjected to additional testing. Results of this testing are described in Section II of this report.

## **SECTION I - TESTING WITH THE ORIGINAL G3 DESIGN**

### **Methods and Results**

Laboratory hydraulic testing was conducted with a standard catchbasin (total height 5 ft (152 cm); sump 2 ft (61 cm)) and a prototype G3 insert, both provided by Munro Concrete Products Ltd. The concrete catchbasin and G3 insert were incorporated into a full size installation (Fig. 1), which included a road drainage section (plywood; 1.5 m width x 3.5 m length) with both grade and crossfall of 2 %. The entrance to the catchbasin was located in the lowest corner of the road, and was fitted with a standard iron grate (DD 713B). Water was fed to the installation via a valve-controlled 0.15 m (6") PVC flow diffuser attached to the overhead water distribution system. Water feed from the diffuser was distributed equally over the road width by a weir counter-sloped to the road. Water exited the catchbasin through the G3 into a 0.25 m (10") drainage pipe discharging into a baffled weir box, which then emptied via a calibrated V-notch weir. The G3 was mounted to the catchbasin by eight bolts, with a rubber sealing ring fitted between the G3 and the catchbasin wall to reduce leakage.

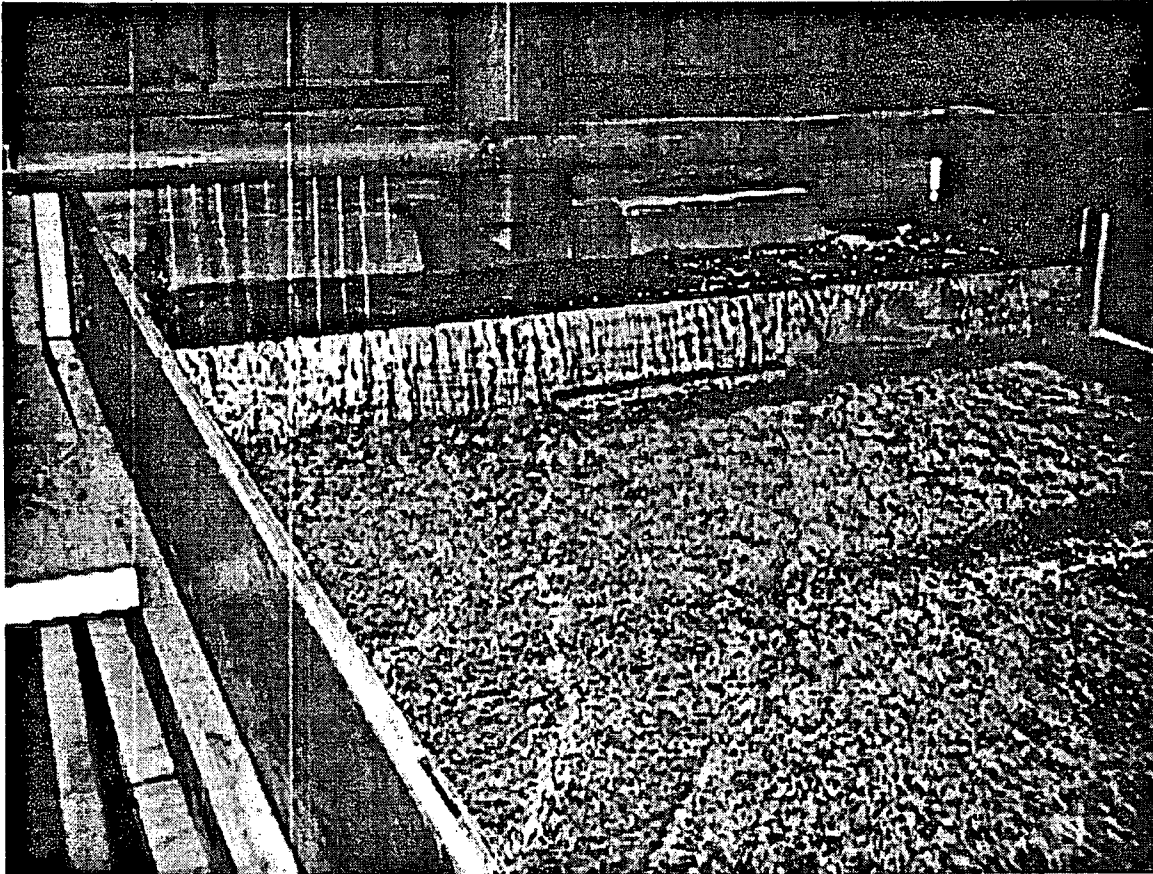


**Figure 1. The laboratory installation used for testing the Munro Concrete Products Ltd. G3 catchbasin insert.**

To enable evaluation of the sand trapping ability of the catchbasin, a sediment delivery system was constructed to distribute sand across the width of the roadway at a known and alterable rate. The delivery system consisted of a Vibra Screw Inc. SCR-20 Feeder

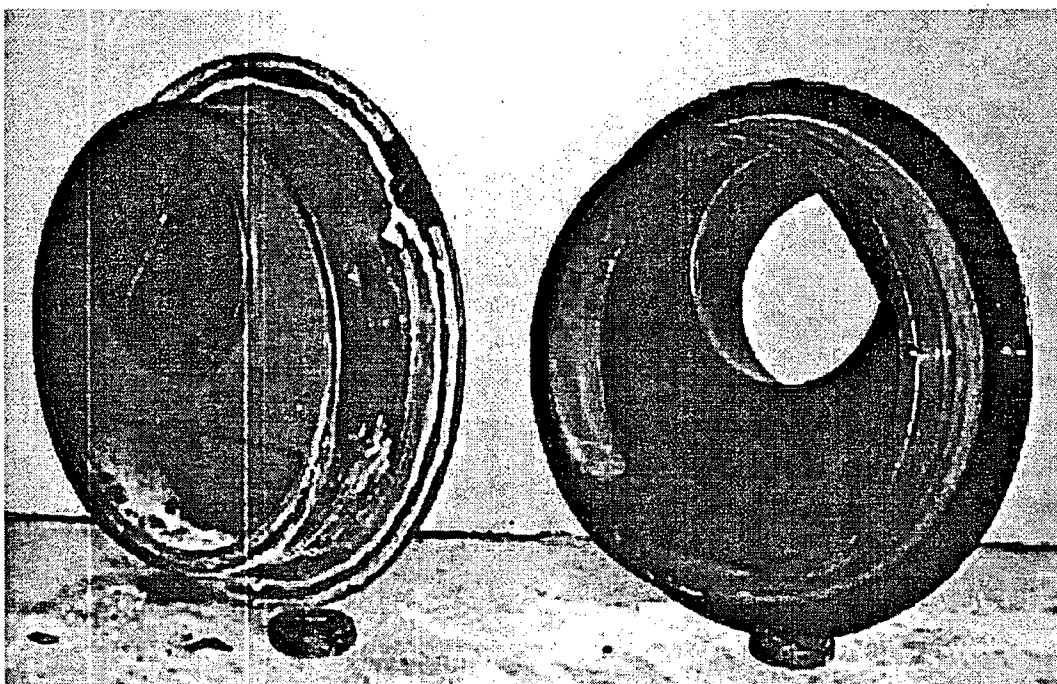


attached to a 5 cm (2") metal pipe extending across the road width (see Fig. 2). Holes drilled along the pipe invert at 2.5 cm (1") intervals allowed the sand to flow out evenly across the width of the water discharge. Sand delivered to the road surface was entrained by the flow of water and transported to the catchbasin.



**Figure 2. The water and sand delivery systems.**

To determine the performance enhancing capabilities of the G3 insert with respect to an unmodified catchbasin, paired tests were performed with two catchbasin configurations. One set of tests was conducted with the G3 inserted into the outlet of the catchbasin. A second set of tests provided information on the performance of the standard catchbasin without the G3 insert. Since the outlet of the catchbasin had been enlarged (to 50 cm (19½")) to accommodate the G3), direct connection of the catchbasin to the 25 cm outflow pipe was not practical. The option of incorporating a new and unmodified catchbasin into the installation would also have been impractical as well as time consuming. To overcome these difficulties, the inner plastic wall of the G3 was removed, leaving only the outside plastic wall with 25 cm pipe outlet (Fig. 3). The data from tests performed with this second catchbasin configuration were considered adequate approximations of the performance of an unmodified standard catchbasin (i.e., with no G3), and were used as baseline data with which to compare the performance of the catchbasin with the G3.



**Figure 3. The G3 catchbasin insert: original design (left), and with inner plastic wall removed to simulate an unmodified catchbasin (right).**

### ***Trapping of floatables***

The ability of the catchbasin to retain floating objects was investigated employing both leaves and small plastic sheets (20 cm x 20 cm) as test floatables. At a selection of discharges between 2 and 20 L·s<sup>-1</sup>, the leaves or plastic were introduced individually to the catchbasin via the sewer grate. At each discharge, 24 items (leaves or plastic squares) were introduced over 5 min, after which the discharge was continued for an additional 15 min.

In tests conducted without the G3, all 24 items (leaves or plastic squares) introduced to the catchbasin in all tests (5 discharges x 2 materials = 10 tests in total) passed through the catchbasin within the 20 min of each test; most leaves or plastic stayed in the catchbasin for 1 min or less. These tests confirm the supposition that the standard catchbasin is ineffective at trapping floating debris. Identical trials were run with the catchbasin incorporating the G3. Again, all 24 items (leaves or plastic squares) introduced to the catchbasin in all tests passed through within the 20 min of each test. These results indicate that at the discharges tested, the addition of the G3 to the catchbasin does not improve its ability to trap floatables. Turbulence caused by the stormwater inflow plunging into the catchbasin from the road surface is presumably sufficient to submerge any floating objects and thereby contribute to their entrainment into the outflow.

### ***Sand trapping efficiency***

Testing for sand trapping efficiency was conducted with two size classes of silica sand (Table 1). According to particle size distributions, these two sand mixtures are classified as fine-medium and medium-coarse sands (Ponce 1989). The two sand mixtures will be referred to herein as “fine” and “coarse”, respectively.

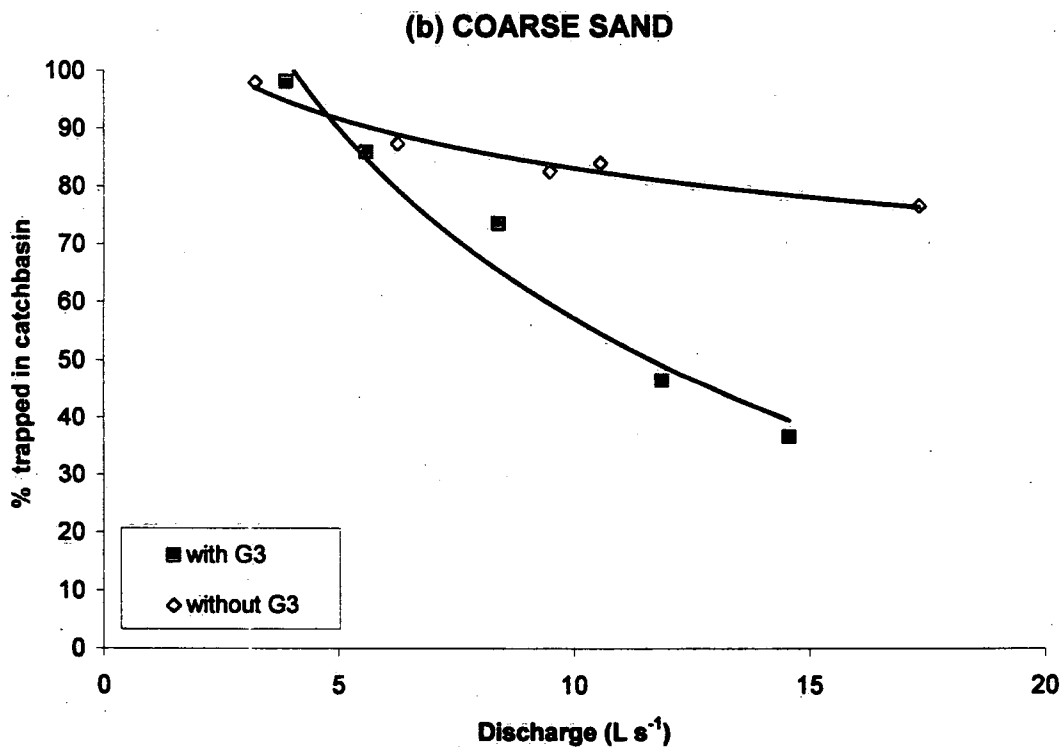
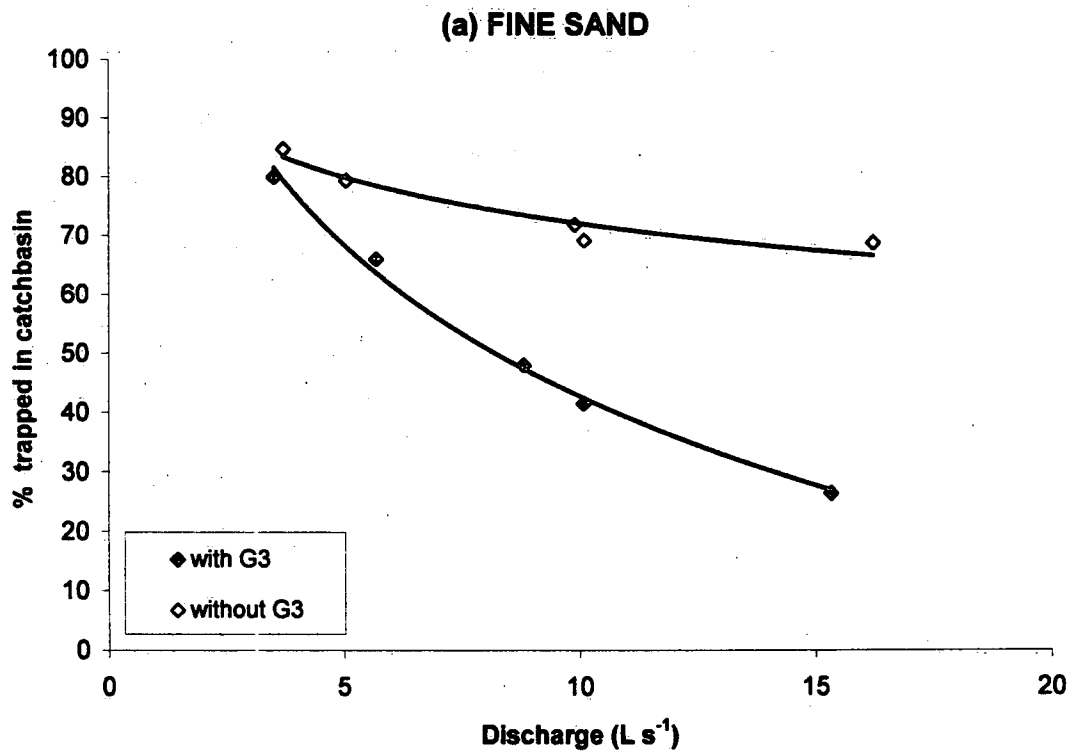
**Table 1. Size distribution in the two sand mixtures employed in laboratory testing**

Sand	% retained on mesh size						
	841 μm	595 μm	420 μm	297 μm	210 μm	149 μm	105 μm
Fine		trace	4	28	51	17	trace
Coarse	Trace	39	56	4	trace	trace	

Sand trapping efficiency of the catchbasin was determined by dispensing sand at a flux of  $200 \text{ mg}\cdot\text{L}^{-1}$  at discharges between 2 and  $20 \text{ L}\cdot\text{s}^{-1}$ . A measured weight of sand was dispensed by the VibraScrew system at a rate appropriate to the given discharge, for approximately 30 min. Sand that traveled through the catchbasin was detained on a  $106 \mu\text{m}$  screen placed at the discharge point of the 25 cm outflow pipe into the weir box, then collected, dried and weighed. At the end of the 30 min of sand feeding, the water was left to run through the installation for an addition 2–3 min. Sand remaining at the bottom of the catchbasin was then collected by means of a pump, dried and weighed. Average mass recovery of sand over all trials was 99.8 %. The results of the sand trapping efficiency testing are summarized in Fig. 4 and Table 2.

**Table 2. Sand trapping efficiency of the catchbasin with and without the G3 insert**

<u>Fine sand</u>				<u>Course sand</u>			
Catchbasin with G3		No G3		Catchbasin with G3		No G3	
Q ( $\text{L}\cdot\text{s}^{-1}$ )	% trapped	Q ( $\text{L}\cdot\text{s}^{-1}$ )	% trapped	Q ( $\text{L}\cdot\text{s}^{-1}$ )	% trapped	Q ( $\text{L}\cdot\text{s}^{-1}$ )	% trapped
3.50	80	3.71	85	3.89	98	3.23	98
5.68	66	5.04	79	5.59	86	6.26	87
8.82	48	9.91	72	8.41	74	9.50	83
10.08	41	10.10	69	11.89	46	10.58	84
15.33	26	16.23	39	14.58	37	17.35	77



**Figure 4. Trapping efficiency of the catchbasin with and without the G3 insert for (a) fine sand and (b) coarse sand.**

Testing to determine the sand trapping ability of the catchbasin with and without the benefit of the G3 insert revealed that the addition of the G3 reduced the sand trapping ability of the catchbasin. For both coarse and fine sands, the trapping efficiencies of the two catchbasin configurations were similar at discharges below  $5 \text{ L}\cdot\text{s}^{-1}$ . However, as discharges increased, more effective trapping was noted for the unmodified catchbasin. The performance difference was substantial at the largest discharges tested, with the unmodified catchbasin trapping approximately 40 % more fine and coarse sand than the catchbasin fitted with the G3 at a discharge  $15 \text{ L}\cdot\text{s}^{-1}$ . It was noted during these tests that sand only passed through the catchbasin during active feeding (i.e., after feeding from the sediment delivery system was stopped, no further sand collected on the screen downstream of the catchbasin).

### ***Scour***

To determine if sand trapped in the catchbasin would remain trapped or be scoured out by subsequent storm flows, the catchbasin was charged with 10 kg of fine sand which was left to settle for several hours. The discharge through the installation was then increased from 0 to approximately  $20 \text{ L}\cdot\text{s}^{-1}$  in stepwise increments. Each discharge was held for 10–15 min before the next increase. During each discharge, the amount of sand appearing on the screen at the downstream end of the installation was considered indicative of scour occurring inside the catchbasin.

Tests conducted without the G3 in place resulted in very little scour of material from the catchbasin. Only a few grains of sand (total  $< 5 \text{ g}$ ) were visible at the end of the stepwise increase of discharges from 0 to  $20 \text{ L}\cdot\text{s}^{-1}$ . Over the course of scour tests conducted with the G3, trace amounts (total  $< 50 \text{ g}$ ) of sand were noted on the screen at the downstream end of the installation. These trace amounts built up quickly at the start of each new discharge increment, but by the end of the 10–15 min, no further sand was accumulating on the screen. These trace amounts passing through the installation were observed in approximately equal quantity at all discharges tested. The small amounts drawn through the outflow at the beginning of each incremental discharge increase may have been due to minor resuspension of sand on the catchbasin bottom caused by changes in the trajectory of discharge from the grate above. Throughout the testing, no catastrophic scouring took place as would have been demonstrated by a large flux of sand out of the catchbasin.

### **Conclusions and Recommendations**

From the tests conducted with the prototype G3, the following conclusions can be drawn with respect to its effect on the performance of a standard catchbasin:

1. An unmodified standard catchbasin is ineffective at retaining debris floating on incoming waters. The addition of the G3 to the catchbasin does not improve its ability to trap floating materials, despite the incorporation of sub-surface withdrawal.
2. The addition of the G3 does not improve, but substantially reduces, the sand trapping efficiency of a standard catchbasin, particularly at discharges above  $5 \text{ L}\cdot\text{s}^{-1}$ .

3. At the discharges tested, there is no significant scour of sand from the catchbasin with or without the G3 installed.
4. The lack of scour with either configuration, combined with the observation that sand only passes through the catchbasin during active feeding, indicates that sand which reaches the catchbasin floor is effectively and permanently trapped.
5. The incorporation of the G3 into the catchbasin effectively lowers the outlet orifice level by a minimum of 8 cm (3"), compared to the unmodified design, and considerably more for higher discharges resulting in higher water levels inside the catchbasin. Since concentrations of sand suspended in water increase with the distance from the water surface, more sand will escape through the new outfall located at a greater depth. This lowering of the outflow withdrawal is presumed responsible for the decrease in sand trapping ability since a greater amount of actively settling sand would be present at depth than at the water surface where the unmodified catchbasin outflow is located.

Since the G3 design as proposed was unsuccessful at improving the performance of a catchbasin with respect to sand and floatables trapping, modifications to the design are recommended, and include:

1. Placing a skimmer baffle in front of the outlet opening to retain floatables;
2. Moving the outlet opening as high as possible;
3. Placing two deflecting walls on the catchbasin's upstream and downstream walls;
4. Making the catchbasin deeper, by approximately 0.3 m; and
5. Using square corners for the catchbasin bottom, since the existing rounded corners may encourage vertical circulation currents.

## **SECTION II - MODIFICATIONS TO THE ORIGINAL G3 DESIGN**

### **A. FIRST MODIFIED DESIGN**

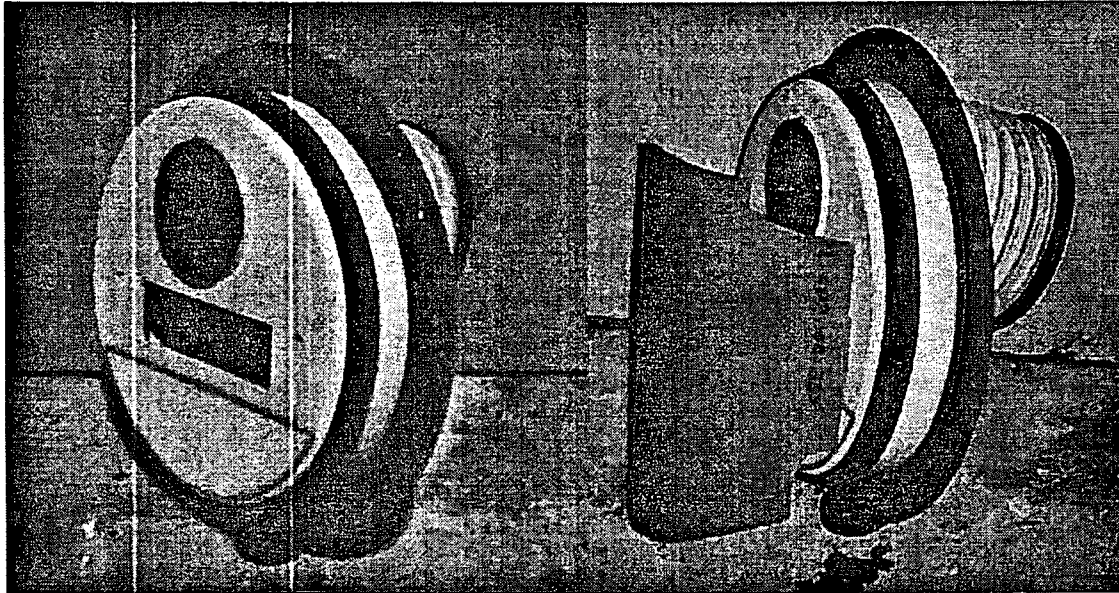
#### **Methods and Results**

Pursuant to the recommendations from the initial evaluation of the G3 catchbasin insert, a modified version of G3 was produced and subjected to additional testing. The new version of the G3 was different from the original design in that (Fig. 5):

1. The water intake was raised to approximately the centre of the inner wall, and changed to a rectangular configuration; and
2. A (removable) baffle was installed in front of the opening.

Since a quick evaluation of the effectiveness of the modifications on performance was desired, only 2 types of tests were run with the modified G3 – trapping of floatables,

evaluated with plastic sheets, and sand trapping efficiency, conducted with only the fine grained sand.



**Figure 5. The modified G3 catchbasin insert: inner wall (left), and with baffle attached (right).**

#### ***Trapping of floatables***

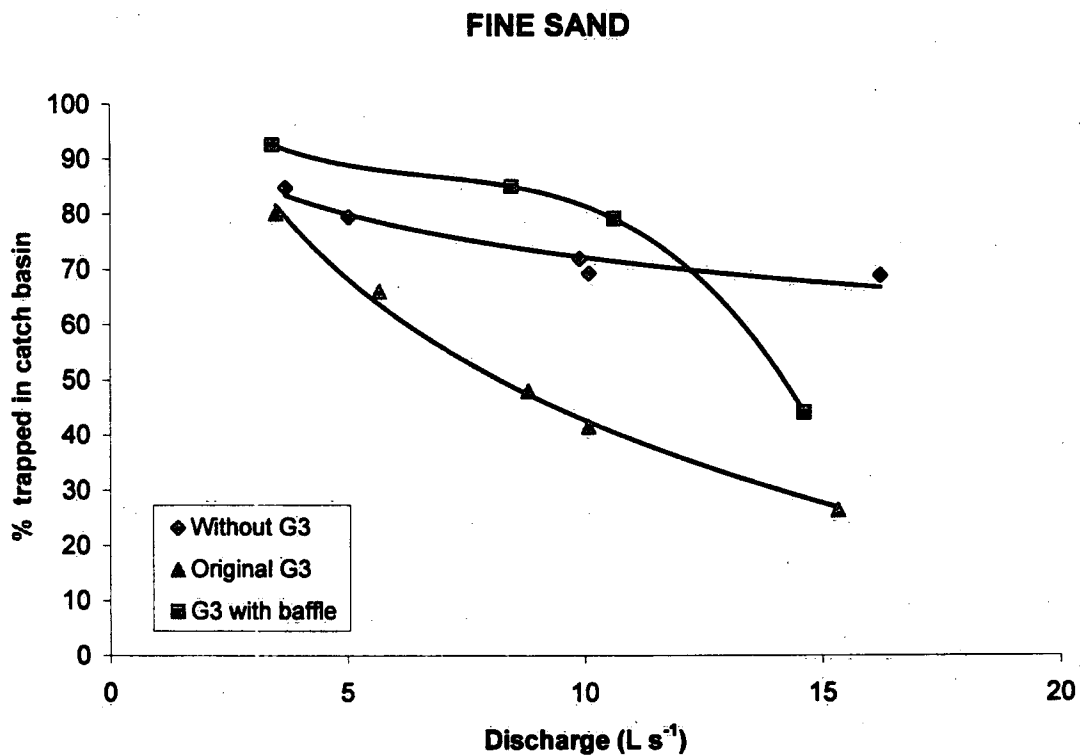
Floatable trapping ability was evaluated with small plastic sheets using protocols identical to previous testing (Section I). In trials conducted with the modified G3 in place, plastic squares were retained in the catchbasin at all discharges tested. In general, the percentage of squares trapped declined as discharges through the installation increased. At a discharge of  $4 \text{ L}\cdot\text{s}^{-1}$ , 12 out of 24 (50 %) of the squares were retained; at a discharge of  $16 \text{ L}\cdot\text{s}^{-1}$ , only 1 square (4 %) was trapped. Thus, the modified G3 seems able to trap some floatables, especially at lower discharges when the height of water in the catchbasin is below the top edge of the baffle. However, the baffle is very large and became dislodged during one of the tests (at  $> 10 \text{ L}\cdot\text{s}^{-1}$ ). Because of its large size, the baffle must be installed from the inside of the catchbasin rather than inserted in one piece with the G3 from the outside. For cleaning, it would also have to be removed from the inside, after pumping water out of the catchbasin.

#### ***Sand trapping efficiency***

Sand trapping tests with the catchbasin incorporating the modified G3 were only conducted with the fine sand. Results as compared to testing with the original G3 and with no G3 in the catchbasin are summarized in Table 3 and Fig. 6 below. Average mass recovery of sand over the trials with the new modified design was 94.7 %.

**Table 3. Fine sand trapping efficiency of the catchbasin installation without the G3, and incorporating the original and modified G3 designs.**

<u>No G3 in catchbasin</u>		<u>Original G3 design</u>		<u>Modified G3 design</u>	
Q (L·s <sup>-1</sup> )	% trapped in catchbasin	Q (L·s <sup>-1</sup> )	% trapped in catchbasin	Q (L·s <sup>-1</sup> )	% trapped in catchbasin
3.71	85	3.50	80	3.43	93
5.04	79	5.68	66	8.47	85
9.90	72	8.82	48	10.63	79
10.10	69	10.08	41	14.62	44
16.23	69	15.33	26		



**Figure 6. Fine sand trapping efficiency of the catchbasin installation without the G3, and incorporating the original and modified G3 designs.**

Compared to a catchbasin with no G3 insert, the design incorporating the modified G3 traps approximately 10 % more fine sand at discharges up to 10 L·s<sup>-1</sup>. However, at discharges larger than 12 L·s<sup>-1</sup>, performance drops off sharply. The loss of sand trapping efficiency at higher discharges may be due to entrainment of sand from the catchbasin bottom by currents rising underneath the baffle. Sand was also observed accumulating between the front and back panels of the G3 as it traveled through the rectangular slot.



## **Conclusions and Recommendations**

The following conclusions can be drawn with respect to the effect of the modified G3 on the performance of a standard catchbasin:

1. The addition of the baffle aids the catchbasin in trapping floating debris, especially at low discharges.
2. A catchbasin incorporating the modified G3 insert traps approximately 10 % more sand at discharges below  $10 \text{ L}\cdot\text{s}^{-1}$  compared to a catchbasin with no G3 insert, but much less sand at higher discharges.
3. Both floatables and sand trapping performance of the catchbasin incorporating the modified G3 were substantially improved over a catchbasin incorporating the original G3 design.

Since sand trapping efficiency of the catchbasin with the modified G3 decreases at higher discharges to below the performance level of an unmodified catchbasin, further design changes are recommended, and include:

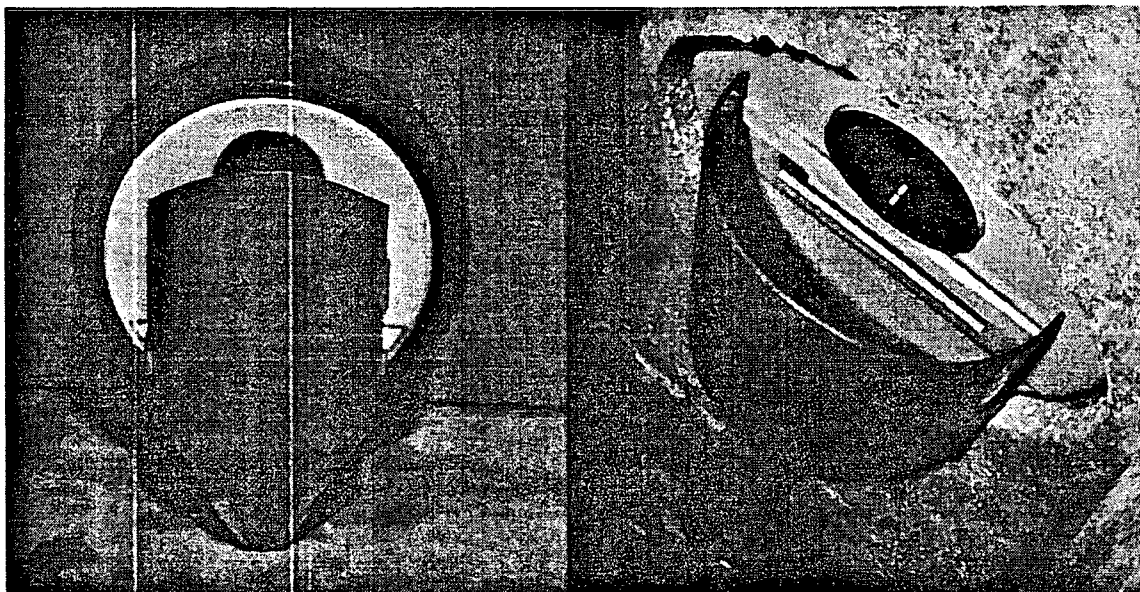
1. Closing the bottom of the baffle to protect it against direct entry of sand, leaving a small hole for balancing hydrostatic pressure;
2. Reducing the size of the baffle to prevent possible installation and maintenance problems;
3. Refining the method of attachment of the baffle to prevent dislodgment during regular use; and
4. Blocking the entry of sand into the gap between the front and back panels of the G3 to prevent its accumulation at low discharges.

## ***B. SECOND MODIFIED DESIGN***

### **Methods and Results**

Pursuant to the recommendations from the testing of the first modified G3 design, a second modified G3 design was prepared, with the following changes as compared to the previous version (Fig. 7):

1. The bottom of the baffle was extended downward in a conical shape, leaving a small hole in the bottom for balancing hydrostatic pressure.
2. A deflector plate was mounted on the catchbasin wall, directly below the opening at the bottom of the conical baffle bottom, to obstruct entrainment of sand from the catchbasin floor.



**Figure 7. The second version of the modified G3 catchbasin insert: baffle with conical bottom edge (left), and inserted into the catchbasin, showing deflector plate (right).**

The second modified G3 design was incorporated into the catchbasin installation, and subjected to the abbreviated testing protocol as per the previous version. It was noted that the addition of the cone to the bottom of the baffle made the mounting of the baffle in the G3 more unstable than in the previous version. The cone forces the flexible baffle to adjust to a specific width and interferes with the attachment of the baffle to the body of the G3. Consequently, measures had to be taken to brace the baffle against the G3 wall to prevent detachment.

### ***Trapping of floatables***

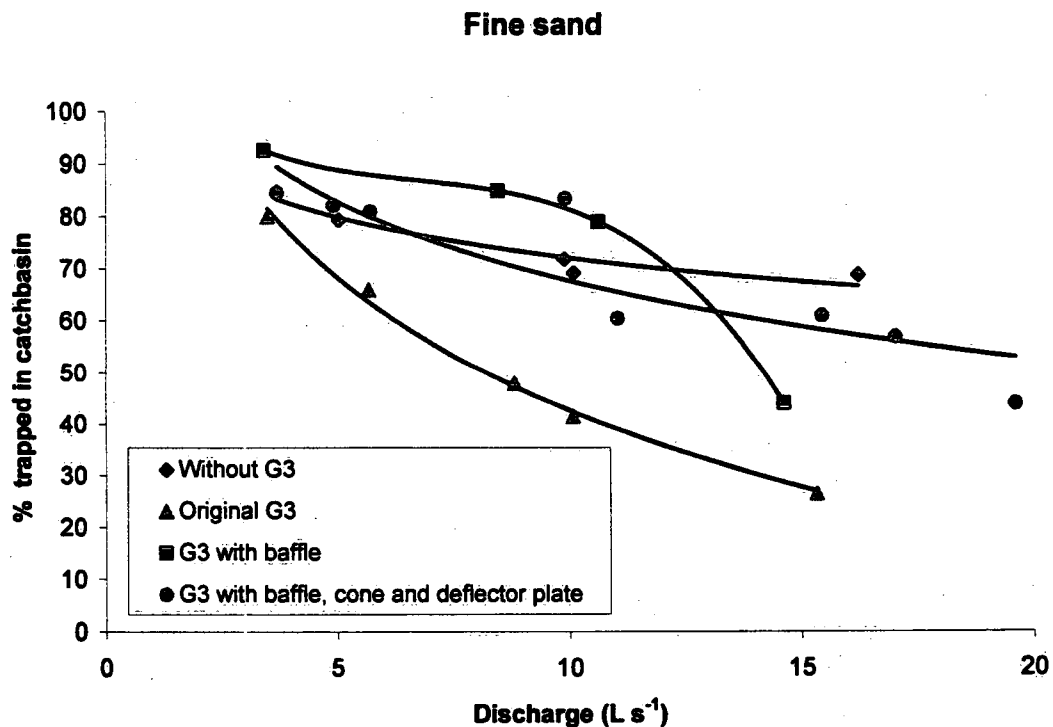
Plastic squares were retained in the catchbasin at all discharges tested. The total squares trapped declined as discharge through the installment increased, with 8 out of 24 (33 %) trapped at  $4 \text{ L}\cdot\text{s}^{-1}$ , and only 1 trapped (4 %) at a discharge of  $23 \text{ L}\cdot\text{s}^{-1}$ . The plastic squares retained in the catchbasin were all trapped between the edges of the baffle and the catchbasin wall. The water level in the catchbasin during active discharge was considerably higher for this configuration than for any of the previous three. Thus during floatable retention testing, many of the plastic squares washed over the top of the baffle and out of the catchbasin, even at low discharges. Those retained in the catchbasin at the end of the 20 min test period had become lodged in the gap between the catchbasin wall and the baffle edge, and presumably otherwise would have been washed over the baffle. The trapping of the plastic squares in this design should thus not be considered reflective of successful floatables retention, but should be cause for concern in baffle design and attachment.

### *Sand trapping efficiency*

Sand trapping testing was again only conducted with the fine sand. The results as compared to fine sand testing with no G3, with the original G3, and with the previous modified version are summarized in Table 4 and Fig. 8. Average mass recovery of sand over the trials with the second modified design was 98.2 %.

**Table 4. Fine sand trapping efficiency of the catchbasin installation incorporating no G3, the original G3, and both modified versions of the G3 design.**

No G3		Original G3 design		G3 with baffle		G3 with baffle, cone, and deflector plate	
Q (L·s <sup>-1</sup> )	% trapped	Q (L·s <sup>-1</sup> )	% trapped	Q (L·s <sup>-1</sup> )	% trapped	Q (L·s <sup>-1</sup> )	% trapped
3.71	85	3.50	80	3.43	93	3.71	84
5.04	79	5.68	66	8.47	85	4.92	82
9.90	72	8.82	48	10.63	79	5.72	81
10.10	69	10.08	41	14.62	44	9.92	83
16.23	69	15.33	26			11.05	60
						15.45	61
						17.03	57
						19.61	44



**Figure 8. Fine sand trapping efficiency of the catchbasin installation incorporating the original G3 design, no G3, and both modified versions of the G3 design.**

Compared to the previous modified version, the second modified G3 traps more sand at discharges above  $13 \text{ L}\cdot\text{s}^{-1}$ , but up to 14 % less at lower discharges. The second modification has sand trapping performance similar to the catchbasin without a G3 inserted, but with slightly higher trapping at low discharges (by 8 % at  $3 \text{ L}\cdot\text{s}^{-1}$ ), and slightly lower trapping at higher discharges (10 % less at  $17 \text{ L}\cdot\text{s}^{-1}$ ).

## **Conclusions and Recommendations**

Tests conducted with this second modified version of the G3 lead to the following conclusions with respect to its effect on the performance of a standard catchbasin, and compared to previous versions:

1. The addition of a deflector plate and a cone to the bottom of the G3 baffle increases the sand trapping performance of the catchbasin at large discharges as compared to the previous G3 version with the simpler baffle.
2. The dynamic water level in the catchbasin was substantially higher when using the baffle incorporating the conical bottom than for previous designs, even at low discharges. Floatables are therefore prone to washing over the top edge of the baffle and out of the catchbasin.
3. Plastic squares which were noted as 'trapped' in the catchbasin during testing had instead been caught between the edge of the baffle and the wall of the catchbasin as they were being washed over.

The sand trapping ability of both modified G3 versions surpassed the performance of the original G3 design. The first modified version, employing only the simple baffle, traps more sand than any other configuration tested, but only up to discharges of approximately  $10 \text{ L}\cdot\text{s}^{-1}$  when its performance drops off sharply. The performance of the second modified version, employing the same baffle but with a conical bottom and deflector plate, does not tail off sharply at large discharges. However, performance at lower discharges is reduced as compared to the version using only the simple baffle.

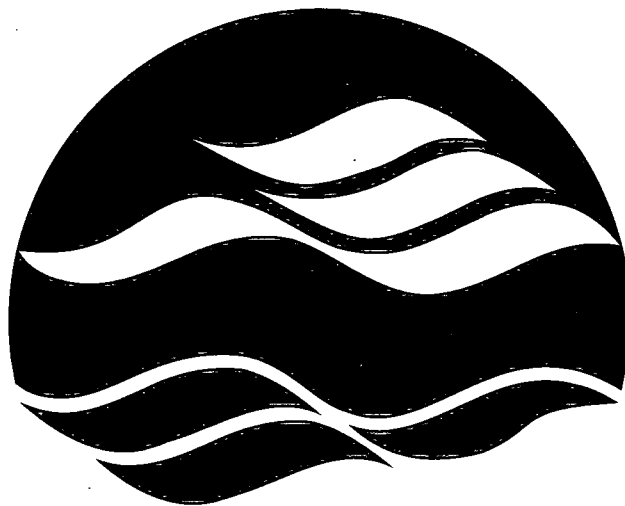
Based on experience testing the three versions of the G3 in the hydraulic laboratory, the following recommendations are offered for consideration before field installation:

1. Close the gap between the front and back walls of the G3 to prevent sand from accumulating.
2. Reduce the size of the baffle to ease installation and maintenance.
3. Refine the angles of the cone on the bottom of the baffle and the method of baffle attachment to prevent dislodgment during regular use.
4. Eliminate the gap between the sides of the baffle and the catchbasin wall to prevent potential jams of floating debris.
5. Increase the size of the opening in the cone on the bottom of the baffle to reduce the dynamic water level in the catchbasin and allow greater trapping of floatables behind the baffle.

6. Increasing the size of the opening in the bottom of the cone may also return the sand trapping performance of the catchbasin at low discharges to levels found for the first modified version with the simple baffle, while not compromising performance at high discharges.
7. Employ the G3 in catchbasins with greater sump depths (i.e., 91 cm (3 ft) vs. 61 cm (2 ft) as in the catchbasin tested).

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