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TURF FOR EROSION AND SEDIMENT CONTROL – CONSTRUCTION OF AN AUSTRALIAN NATIONAL DEMONSTRATION FACILITY

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ABSTRACT

Turfgrass has been found to be an effective measure for the control of soil erosion and also for the capture of sediment. Previous research quantifying the capability of turfgrass for this purpose was undertaken and communicated, but did not lead to a substantial increase in market share for erosion control by turfgrass in Australia. The Australian turfgrass production industry has therefore invested substantial resources into the design, construction and operation of a new national Erosion and Sediment Control Demonstration Facility at Cleveland, Queensland, as a technical extension tool. The facility has been designed to demonstrate turf as an erosion control and sediment capture measure compared to other products available on the market including silt fencing, silt socks, coir logs and hydro-seeding. This is the only such facility in Australia and has been met with substantial enthusiasm by the turf and erosion industries as well as local and state government representatives. The construction of this facility presented a number of challenges (described in this paper), and is now becoming a critical extension tool for the turfgrass industry to build the erosion control market share for natural turf.

INTRODUCTION

Turfgrass as an erosion control measure has been found to be effective by a number of studies in Australia and internationally. These include examinations of the effect of vegetative or turfgrass coverage on soil loss in production properties (Martin and Aragao, 1996), in natural areas (Beard and Green, 1994), and forestry plantations (Sheridan et al., 1999) as well as in urban areas such as construction sites (Petrovic and Eastern, 2005, Higginson and McMaugh, 2007; Loch et al., 2010). Australian turfgrass producers through Horticulture Australia Limited (HAL) have funded a number of research projects and development activities aimed at identifying and quantifying the efficacy of turfgrass and also to identify market opportunities available in this area for turfgrass in Australia.

The first specific examination of turfgrass for this purpose in Australia was conducted by Higginson and McMaugh (2007), who reviewed the literature to compare turfgrass coverage to other land use coverage and also against other erosion control measures. Their study identified potential market opportunities for turfgrass in the erosion and sediment control area. They concluded that the major opportunities for turfgrass were that it would be ideally suited to four main applications: as vegetative buffer strips, on cut and fill batters, in drains, and as a vegetative ground cover within the general landscaping of completed construction sites. The final recommendation from the Higginson and McMaugh (2007) study was that these four areas all warranted further consideration and investigation by the turf industry to quantify the performance turfgrasses in that context and to use those data to realise the market potential for their turf products.

These recommendations led the industry to commission a study by LandLoch Pty Ltd which tested and measured performance of turfgrasses against a number of parameters which fundamentally gauged their ability to slow overland flow effectively, to trap sediment; and to resist detachment of sod from large flows of water (Loch et al., 2010). Specifically, this study examined four main areas:

1. Hydraulic roughness of different turfgrass types;
2. Measurement of the sediment trapping capability of turfgrass;
3. Assessment of the ability of higher flows to tunnel under turf sod of differing establishment age; and
4. Rates of root development, including seasonal effects on root development.

In all of these measured areas, turfgrass met or exceeded acceptable levels of performance under given conditions. For example, after an establishment period of eight days no "tunneling" was evident under sod that had been exposed to relatively high overland flows (i.e. 0.2 L/second for 1 hour, and then 5 L/second) on a variety of soil types. Similarly, the ability of turfgrasses to capture sediment was evident from the study for particle sizes >0.05 mm, and turf was also capable of causing some reduction in the loss of smaller particles in the 0.02-0.05 mm range (Loch et al., 2010).

These results and their potential application across the erosion and sediment control industry identified a substantial market opportunity. The report by Loch et al. (2010) acted as a catalyst for the industry to communicate the performance of turf in a number of ways, one of which is to demonstrate physically the performance of turfgrass in reducing soil loss by constructing a dedicated national Erosion and Sediment Control Demonstration Facility. This facility is now being utilised as a demonstration and training tool, and is currently the only facility of this kind in Australia.

FACILITY CONSTRUCTION

The facility is situated over an area of approximately 1 hectare situated at Redlands Research Station (RRS) (27º32'S

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Abbreviations: HAL, Horticulture Australia Limited; QLD, Queensland; RRS, Redlands Research Station; v-h, vertical:horizontal

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lat, 153º15'E long, 40 masl), Cleveland, QLD, Australia. Construction of the facility began in September 2011, with the facility fully functional for the first demonstration event hosted in May 2012.

The facility is situated on yellow Kurasol (podsolic) soil (Isbell, 2002) with a shallow A horizon overlying a mottled clay B horizon. The top soil layer in the erosion bays is very dispersive, erodes easily, and has poor internal drainage.

The facility consists of six erosion demonstration bays and one demonstration channel (see Figure 1). The erosion demonstration bays are each 12 m long and 3 m wide allowing 1 m for run-on water from an outlet trough at the top section of the bay which provides even distribution of water flow across the bay and a 1 m long catchment trough at the end of each bay. It was critically important that plots were level from side to side and that soil should be mounded up along the bay walls so that flow does not concentrate against the plot borders. (Routine maintenance is conducted to return each plot to a satisfactory level prior to each new demonstration date.) Each bay is approximately 10 cm deep and run lengthways down the slope so that, as much as possible, water flows in a sheet manner across the site. Rubber belting was installed as the border to each bay to keep plots separated from the surrounding turfgrass and to maintain preferential water flow within the bay. Between each bay is a 2 m area of turfgrass allowing a 'walk-between' area for maintenance, but more so for observational purposes during demonstration days.

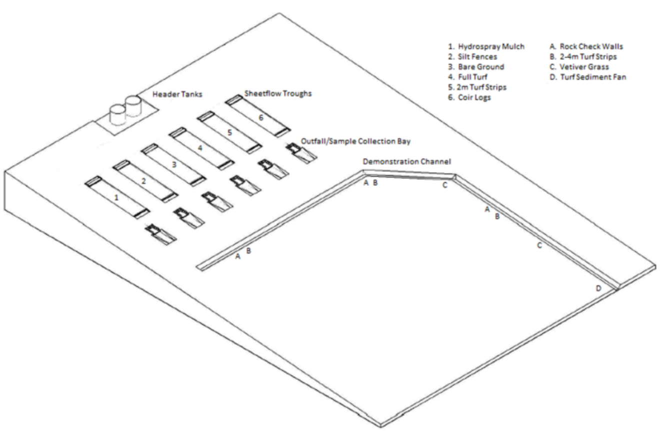

Figure 1. Plan of erosion bays and channel including water tanks collection trough and outfall bays.

The main water supply is located in 2 x 10,000 L polyethylene water tanks situated at the top of the site. The flow discharges into fabricated concrete outfall troughs (see Figure 2) at a higher gradient than the plot surface, and then runs down as a 'sheet' of water simulating overland flow.

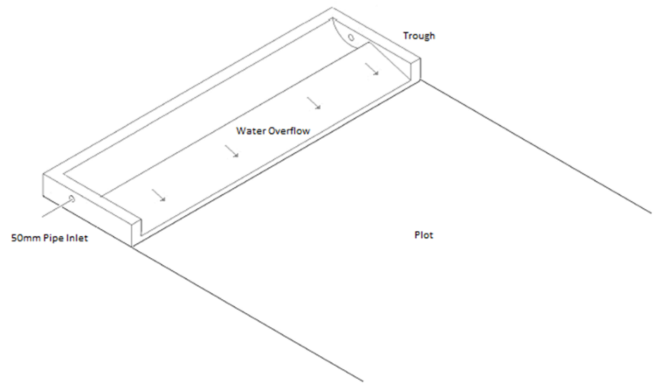

Figure 2. Fabricated concrete outfall troughs installed at the top of each bay.

Water is run onto each plot at similar rate (2 L/second) simulating the kind of run-off that would be expected in approximately 200-240 mm rainfall events, which are not uncommon in tropical and subtropical Australia. All water is gravity fed onto the site with the flow rate regulated by two inline electronic water meters between the water storage tanks and the outfall toughs. On average, each bay is run for 10 minutes to allow water to traverse the bay and then allow sufficient time to collect three samples of run-off water and eroded material at 1 minute intervals.

The bays are designed to be interchangeable and to demonstrate a number of erosion and/or sediment control measures. To date, each demonstration has included bays of full turf, bare earth, 2m strips of turf, coir logs (of various sizes), hydro-seeded material (Hydro Spray Grass, Alderley, Australia), and either silt fencing or silt bags (of various types). It is likely that, within the next 12 months, a variety of geotextiles or geofabrics, reinforced turf products and other measures will also be installed and demonstrated at various events.

Prior to each event, the material installed on each bay is removed; the bay is then rotary cultivated, raked flat, and the each measure reinstalled so that comparisons for demonstration purposes may be made more confidently. This includes the turf (which is replaced) as well as the hydro-seeded material. Exceptions have been made due to poor weather conditions as well as during the Australian spring and early summer to observe establishment of the hydro-seeded grass (i.e. different seed germination rates, percentage coverage, weed competition, breakdown of mulch material and binding agent).

The channel is designed to simulate larger volumes of water with a concentrated faster flow, and snakes down the natural slope of the site over a 90 m length. The trapezoidal shaped channel 500 mm wide in the base and 1500 mm across the top opening with 1:1 v-h (vertical:horizontal) sides at a 0.25% slope (see Figure 3). The channel runs along the contour of the slope for 35 m at a slight (<1%) slope, and then turns across the contour at a 3-4% slope before running the final 35 m down the natural site slope (8%).

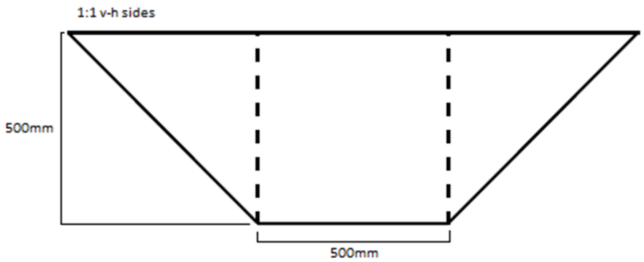

Figure 3. Channel design and dimensions.

The channel was excavated smooth, and erosive material (loose sandy loam) is added prior to each demonstration. Erosion control measures have, to date, been permanently installed in the channel with three sections of turf installations of 3 m length used in combination with rock-check walls before each strip. The channel also contains plantings of vetiver grass (*Vetiveria zizanioides* (L.) Nash) in each of the moderate and high flow areas. The channel opens onto an outfall area where turf is also installed to allow diffusion of the flow, settlement, capture of the larger entrained sediment and infiltration of the remaining silt.

Water is run onto the channel at 15 L/second regulated by an inline electronic water meter. The channel is run for 15 minutes while observers walk its length following the moving water front to observe concentrated flows of water through common control measures. Once the water is turned off, participants walk the length again to observe sediment settlement patterns before and after the rock check walls, sediment captured with the turfgrass and any rilling, scouring, or other observable phenomena of interest.

PRELIMINARY OBSERVATIONS AND CONCLUSIONS

The Erosion and Sediment Control Demonstration Facility has been well received by the turf production industry and attendees. Although it has been operational for less than a year, some preliminary observations can already be made. To date (Feb 2013), 16 demonstration events have been hosted with just over 250 participants from the building, road construction and mining industries, as well as local, state and federal government representatives ranging from cabinet ministers to senior bureaucrats and hands-on council practitioners. From these participants, the most common questions do not relate to the efficacy of the materials used (which are well illustrated by the demonstrations), but revolve around concerns as to the 'best' turfgrass to use and its up-front and on-going costs.

The site surrounds are installed with a 'premium' green couch/bermudagrass (*Cynodon dactylon* (L.) Pers.) variety (Oz Tuff™) which is well maintained to ensure that the site surrounds are presentable and can handle the wear and tear from intensive foot and vehicular traffic. The appearance of this area reinforces particpants' perceptions as to how well-maintained turf should appear. Although Loch et al. (2010) found minor but significant differences across some of the measured parameters between the tested varieties, the underling similarities revealed in their study (i.e. that all of the tested cultivars were effective) has underpinned the decision not to focus on the turf type used in sediment and erosion control in discussions of the site and during demonstration days. Similarly, specialised turf reinforcing products have been developed and marketed for this purpose (e.g. Coughlan et al., 2007), but again have been avoided to reinforce the basic message: natural turf works and is financially competitive against other options.

The turf type actually used for erosion control purposes has varied (according to local availability), but is usually the lowest priced turf available at the time. This is mostly a 'generic' *C. dactylon*: 'Wintergreen' (which can vary considerably in appearance from different growers – Loch, 2008) or 'Hatfield'. This provides an important point of illustration during the discussions at demonstration events by highlighting that 'turf' in the broad generic sense (i.e. all turfgrasses) is an effective erosion and sediment control measure and also provides a more favorable cost comparison with other measures.

Another issue that generates some discussion is the differentiation between functional or environmental turfgrass and aesthetic turfgrass. This mind set is apparent among both turf producers and event participants, and is a limiting factor on the use of turf for erosion and sediment control purposes. Turf establishment and maintenance and the expectation that inputs into that process will be very high initially and a significant ongoing cost thereafter represent a significant barrier to the wider adoption of turfgrass by the erosion and sediment control market. Most perceptions of turfgrass relate to lawns, parks and golf courses and the functional or environmental role that turfgrass plays appears to be taken for granted by many of the participants. Similarly, the ability of turfgrass to survive prolonged periods of stress such as drought or wear (albeit with temporarily reduced aesthetic appearance) is also not properly acknowledged among participants.

Although the value of the Australian turf industry is not well documented with estimates of annual turnover ranging from A$188.4 million to A$235.7 million (Horticulture Australia Limited, 2012), the project proposal predicted a (relatively moderate) market increase of 2% nationally or approximately A$10 million dollars within 5 years of the project's completion. For this to be achieved, the facility and the demonstration events must necessarily focus on effecting a paradigm shift whereby the natural resilience of turfgrass and its ability to function in ways beyond the aesthetic are more widely recognised.

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