

IRRIGATION MANAGEMENT PLAN



Australia

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1. INTRODUCTION

The purpose of the Irrigation Management Plan (IMP) is to ensure that irrigation applied to the soil cover overlying the waste fill does not result in excessive subsurface infiltration and acceleration of leaching of the waste fill.

The plan includes and addresses the following specific items:

- water balance;
- subsurface drainage; and
- overall irrigation strategy

Plant water requirements are site specific, depending on microclimatic conditions. This management plan can make general recommendations and provide a methodology for the management of the turf in the area. The specific irrigation requirement for turf and landscaping at the Midland site will need to be adapted to suit local use and climatic conditions. In order to encourage efficient irrigation the actual use of irrigation water will be monitored monthly.

The IMP has been prepared with reference to the following documentation:

- Water Quality Protection Note – Nutrient Irrigation Management Plans (WRC, 1998);
- Efficiency of Sprinkler Irrigation Systems, Farmnote 48/1992 [Reviewed 2000]; and
- Irrigation Scheduling - How and Why, Farmnote 23/1990.

2. SOIL COVER

2.1 SITE DESCRIPTION

The soil cover will comprise a 1m layer of suitable soil overlying a synthetic geofabric warning barrier in accordance with the recent EPA approval provided for Area BCD. The soil cover applies to residual waste fill in Helena West that will become public open space (POS).

2.2 COVER SOIL TYPE

It should be noted that the soil type is not an important factor from an environmental perspective other than it must comply with the relevant contaminant criteria. The quality of the soil cover will comply with the EIL – Ecological Investigation Level. This will most likely consist of imported sand or clays.

The most suitable soil from a landscaping perspective will be a compromise between the following:

- Good water retention to decrease infiltration into the waste fill material; and
- Sufficient water retention to promote vegetation growth.

Each of these requirements is considered more fully in the following sections.

2.2.1 Soil Ability to Decrease Infiltration to Waste Fill

Net infiltration through a soil profile can be defined as the rainfall plus irrigation minus runoff and evapotranspiration. Water that passes through the clean fill layer will infiltrate into the waste fill material and potentially cause minor amounts of leaching of contaminants. It is clear that the effect of rainfall as well as irrigation water must be considered in controlling the rate of this leaching.

The soil type selected for the soil cover must reduce the amount of infiltration that reaches the waste fill material. The volume of water that infiltrates and recharges the deeper soil profile can be calculated for various soil types using simple equations. The American Petroleum Institute (1996) compiled results from over 100 studies to estimate infiltration for various soil types, assuming a surface cover of grass. Weidemeier *et. al.* (1999) outline a simple method to determine conservative net infiltration values in various soils based on a known rainfall rate.

Assuming an average rainfall of 800 mm per year (Western Australian Bureau of Meteorology), the net infiltration rate would be:

- For sandy soils: 11.5 cm/year (14% of rainfall).
- For silty soils 5.8 cm/year (7% of rainfall).
- For clayey soils: 1.2 cm/year (1.5% of rainfall).

This indicates that the more permeable sandy soils will allow more infiltration and thus not achieve the objective. Therefore a lower permeability soil that contains silt and clay would be preferable.

2.2.2 Soil Ability to Promote Vegetation Growth

The field capacity of a soil is the maximum soil-moisture a soil can hold before gravity drainage causes recharge to the water table. If the soil moisture drops too low, the plant will not obtain sufficient water to survive, this is defined as the wilting point. The wilting point is the soil-moisture content in which the attraction between the moisture and soil is greater than the plants ability to draw water. The available water that can be utilised by a plant is between these two extremes, ie the moisture content between the wilting point and the field capacity.

Coarse grained soils such as sands generally have low field capacities and low wilting points. Clay soils can hold a larger volume of soil moisture than sands however plants cannot utilise most of it due to the high attraction between the small clay particles and the moisture. Soils with textures between sand and clay such as loams and silt loams have the highest available water capacity. In other words the difference between the field capacity and wilting point is greatest (Fetter, 1994).

Therefore the most suitable soil to promote plant growth will have an intermediate texture such as loam or silt loam. The proposed fill to be used as the cover consists of a mixture of sand, clay and ash, which is similar to loam in terms of texture.

The use of a layered soil would also be acceptable such as a heavier clayey soil at the base and a lighter more easily drained sandier soil at the surface. However care should also be taken to ensure that the surface soil has sufficient ability to resist wear.

Care should be taken to ensure that the soil cover has even properties over the entire cover area. Even minor differences in soil physical or chemical properties could result in uneven turf growth resulting in a patchy appearance.

3. IRRIGATION STRATEGY

3.1 CLIMATE

Yearly climate averages for the Perth Airport, the closest recording station to the site, are presented in Table 1. Included is rainfall, and daily and monthly evaporation. Due to the sporadic nature of rainfall during the irrigation season, rainfall is of little value in displacing irrigation demand. This is particularly true for the months where peak irrigation demand is experienced such as December, January and February as rainfall only accounts for approximately 5% of evaporation.

Table 1 - Climatic Averages For Perth Airport

Month	Rainfall	Monthly Evaporation	Daily Evaporation
Jan	9.1	319.3	10.3
Feb	15.3	277.2	9.9
Mar	15.3	248.0	8.0
Apr	41.1	159.0	5.3
May	103.9	93.0	3.1
Jun	171.2	71.3	2.3
Jul	162.2	68.2	2.2
Aug	119.5	83.7	2.7
Sep	71.0	108.0	3.6
Oct	46.8	164.3	5.3
Nov	25.4	219.0	7.3
Dec	11.2	279.0	9.0
Annual	791.9	2090.0	5.8

Note: All data is in mm unless otherwise stated

3.2 IRRIGATION RATE

The appropriate irrigation rate for the Helena West POS must be a balance between supporting plant growth and minimising subsurface infiltration to the waste fill material. Research has been conducted by the University of Western Australia to determine the irrigation rates required to maintain turf (Short and Colmer, 2001). This research, conducted under local conditions, found that the replacement of 50-60% of pan evaporation loss was required to maintain the colour and growth of areas of passive turf. The trial was conducted using a highly efficient irrigation system, so does not take into account inefficiencies in application.

The watering requirements of active areas of turf are greater than passive due to the additional growth required to account for wear and tear. The amount of additional water required depends on the amount of wear. As a base it is recommended that 60% of evaporation is used, with additional water applied if signs of drought stress are noted or there is loss of condition due to wear.

Fixed sprinkler irrigation systems are less efficient, especially in windy conditions, than those used in the research to determine minimum application rates (Short and Colmer, 2001). Therefore additional water may be required to ensure that sufficient water is applied to all areas of turf. Helena West is likely to experience stronger wind conditions over summer in the form of night and morning easterlies. An estimate of the additional water requirements can be made using research conducted by the Western Australian Department of Agriculture, presented in Table 2 (Department of Agriculture, 1990).

**Table 2 - Estimate of Fixed Irrigation System Efficiency
(Department of Agriculture, 1990)**

Depth of water applied	Wind Speed		
	0 to 8 km/h	9 to 16 km/h	17 km/h & above
25 mm	67%	63%	62 %
50mm	69%	67%	65 %
100mm	73%	69%	68%
150mm	78%	72%	70%

As a conservative estimate, a 60% irrigation efficiency will be used. Based on the evaporative regime presented in Table 1, the following irrigation demand has been developed.

Table 3 - Irrigation Requirement for Turf areas

Month	Monthly Evaporation	Average Daily Evaporation	Irrigation Demand ¹	Daily Irrigation Requirement
Jan	319.3	10.3	310.2	10.0
Feb	277.2	9.9	261.9	9.4
Mar	248.0	8.0	232.7	7.5
Apr	159.0	5.3	117.9	3.9
Winter Months- No Irrigation				
Sep	108.0	3.6	37.0	1.2
Oct	164.3	5.3	117.5	3.8
Nov	219.0	7.3	193.6	6.5
Dec	279.0	9.0	267.8	8.6

Note: All data is in mm unless otherwise stated

1 – Irrigation demand is based on replacement of 60% of pan evaporation and 60% irrigation system efficiency.

The irrigation requirements shown in Table 3 are approximately pan evaporation and will therefore include a small amount of leaching approximately equal to rainfall.

3.3 IRRIGATION FREQUENCY

Significant irrigation events are likely to cause infiltration rates that exceed the field capacity of the soil and as a consequence some water will recharge into the waste fill material and some will pond at the ground surface. This may cause potential accelerated leaching of the waste fill material. Therefore a greater number of smaller irrigation events will decrease the potential for subsurface infiltration.

Assuming that the medium used for growing the turf is a sandy loam the amount of available storage is 10-15% of the available soil volume. In the top 20cm of the soil profile this equates to 20 to 30mm of irrigation. Irrigation rates in excess of 20mm should not be applied.

It is suggested that irrigation be scheduled for every second day during the peak irrigation demand of December, January and February. During the other months irrigation on every third day would be acceptable. The irrigation rate would therefore be increased compared to Table 3 depending on the frequency of watering.

4. MANAGEMENT AND MONITORING

4.1 DRAINAGE CONTROLS

Strict drainage controls will be imposed on the site to manage the flow of stormwater from the waste fill area. Details are provided in the *Stormwater Management Plan*.

In addition to the 1m soil cover, a thin geotextile warning barrier (A12 bidim or equivalent) will be placed beneath the cover to prevent contact with the waste fill material.

Testing by dry sieving (AS 3706.7-90) indicated the pore size of the barrier is $220\mu\text{m}$ with a coefficient of permeability (as determined by AS 3706.9-90) of 4.2m/day, which is characteristic of fine sand. Such a thin layer of geotextile should not cause any detectable alterations in drainage flow.

4.2 SOIL ACIDIFICATION

The irrigation schedule devised for the waste fill area is unlikely to result in any leaching of water during the summer months, however in winter there may be leaching due to rainfall. The pH of the water infiltrating through the waste material will effect the potential of the water to leach contaminants, particularly metals, from the waste fill. The pH of the water that reaches the waste fill will be influenced by the condition of the overlying soil cover.

The application of fertilisers (particularly nitrogen) has the potential to cause acidification of soils. It occurs when nitrogen (from ammonium-based fertilisers) converts to ammonium, which in turn converts to nitrate. Anions such as chloride, bicarbonate, sulfate, and in particular nitrate are leached beyond the plant root zone and into the subsoil. Associated cations of calcium and magnesium are also leached out leaving an over-abundance of hydrogen ions in the topsoil. As the hydrogen ion concentration increases, and the soil becomes increasingly acid, infiltrating rainwater may become more acidic, thus potentially leaching metals from the fill material.

Soil acidification can occur in areas with high rainfall (greater than 500 mm) and permeable soils, which allow leaching of nutrients into the subsoil. The potential for acidification will depend on the type of soil, its starting pH and its buffering capacity (buffering capacity refers to systems within the soil that maintain constant pH levels despite the addition of acids or alkalis).

To control this situation, the soil cover must be monitored to ensure it is not becoming more acidic. Lime may be added to the cover to raise the pH closer to neutral at the time of placement.

4.3 ACID SULFATE SOILS

Acid sulfate soils may be generated where development causes certain soils to be exposed to the air causing oxidation of sulphide material and generation of acid. The remediation of the workshops site will principally involve the relocation of contaminated material, rather than the disturbance of natural material and potential aeration of natural soils. Clean fill will be placed on the floodplain soils, however it is unlikely to displace previously saturated sediments and consequently cause aeration of acid sulfate soils because of the firm clay in the floodplain and the depth to groundwater of approximately 3m. For these reasons it is considered unlikely that the development will cause aeration of potential acid sulfate soils.

4.4 MONITORING PROGRAM

As previously indicated the recommendations made in this management plan provide initial settings for the irrigation system. Final management will require on-going adaptations to adjust for specific local conditions.

4.4.1 Irrigation Control

The irrigation schedule should be based on the recommendations of this report, however adaptation will be required to account for local conditions. The schedule will need to take into account variations in climate and in use patterns. The principle aim should be to minimise the amount of water applied, both to reduce leaching and to conserve the resource.

The scheduling of the irrigation should be adjusted on at least a monthly basis. The application can be adjusted by altering the time for which water is applied and also the frequency of irrigation.

The cumulative volume of water pumped by the irrigation system should be recorded on a monthly basis for the first three years. This will be achieved using a water meter on the reticulation system be it a bore or mains water. A record should also be kept of the irrigation schedule.

Soil moisture monitoring devices will be installed within the waste fill to measure moisture content. This will be performed prior to landscaping to assess the current moisture regime and so form a baseline for comparison once irrigation commences.

4.4.2 Soil Acidity

Monitoring of soil acidity will involve both visual observations and soil pH testing. Typically crops that are affected will have visible yellow patches and discolouration. Therefore regular visual investigation of the turf is needed.

Soil testing should be conducted annually or whenever visual observations indicate the turf is unusually patchy or discoloured. A minimum of three soil samples should be taken from within the root zone and sent to a NATA registered chemical laboratory for analysis.

4.5 CONTINGENCY PLAN

Should a decrease in soil pH occur, applying lime is the most practical way of reversing soil acidification. Amounts of lime will vary but it is usually necessary to apply 1-6 tonnes per hectare, followed by lighter applications every 6-8 years. Acidification should not be treated in isolation from other nutritional problems, but form part of a general soil fertility program. As an added preventative measure, acidifying fertilisers such as mono-ammonium phosphate or sulfate of ammonia should also be avoided.

4.6 REPORTING

A report detailing the management of the irrigated area will be prepared following a three year monitoring period for submission to the Department of Environment (DOE). The following items should be included:

- Monthly irrigated volumes;
- Monthly evaporation data from closest climate station;
- Subsurface soil moisture levels;
- Total fertiliser applied to site;
- Results of soil cover pH testing; and
- A general description of any excessive wear, erosion or any other loss of soil from the site.

The need for any further soil monitoring beyond three years would be required only if excessive subsurface drainage is entering the waste fill. .

5. REFERENCES

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