READY MIX CONCRETE INDUSTRY

ENVIRONMENTAL CODE OF PRACTICE

1993 UPDATE

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READY MIX CONCRETE INDUSTRY ENVIRONMENTAL CODE OF PRACTICE 1993 UPDATE

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DISCLAIMER

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1.0 INTRODUCTION

1.1 Objective

This document is a revision of the 1990 Recommended Waste Management Practices for the Ready Mix Concrete Industry in British Columbia. The purpose of this document is to outline recommended operational practices that will minimize the impact of ready mix facilities on the receiving environment. This revision includes updated practices currently available to the industry and an indication of the expected quality of discharges that may result from state-of-the-art practices. In this way, this technical recommendations document (TRD) can be used by ready mix facility operators as a benchmark for new facilities or the upgrading of existing facilities. The recommendations generally represent good industrial practices that are realistic and economically achievable. In some circumstances, for example for facilities adjacent to very sensitive waters, additional measures may be necessary to further protect the environment.

Environment Canada has commissioned the preparation of this revised document to provide guidance to facility operators in British Columbia who wish to operate, in an environmentally sound manner. This TRD also provides uniform guidance to the B.C. Ministry of Environment as they formulate and administer Waste Management Permits for ready mix concrete facilities. Although the recommendations of the document have no binding legal or regulatory status, they have been drafted in consultation with Environment Canada, the B.C. Ministry of Environment, and industry personnel (including. the B.C. Ready Mixed Concrete Association, selected independent facility owners and operators, and chemical suppliers).

1.2 Background

Environment Canada Regional Program Report 88-03, “Overview of the Ready Mix Concrete Industry in British Columbia, Water and Waste Management Practices (June 1988)” is a detailed evaluation of the industry from which the original TRD was derived, including a description of wastewater treatment and recycling practices. The report included information gathered from visits to 17 plants in the Greater Vancouver area.

This revised TRD includes information from site visits to six sites, five of which were part of the original evaluations, These recommendations are supported by recent discussions with facility operators, industry associations in B.C. and the United States, admixture chemical suppliers, regulatory agency personnel in B.C.

1.3 Environmental Concerns

In the context of primary manufacturing industrial facilities, ready mix concrete plants do not generally pose significant problems in terms of environmental impact. However, concerns may exist at certain facilities, especially where process effluents or contaminated stormwater runoff are discharged into an environment with significant resource value. This may include sensitive fisheries streams or groundwaters used for irrigation or potable water supply. The TRD hopefully will provide guidance to facility operators so that conflicts with other resource stakeholders are minimized.

Table 1 outlines the specific concerns about wastewater and storm water discharges from permanent and portable ready mix concrete facility operations.

TABLE 1

Summary of Potential Environmental Concerns from Ready Mix Concrete Facilities

ISSUE	CAUSE	CONCERN	LEVEL OF CONCERN
pH	Soluble cement constituents will raise pH in effluent and/or stormwater runoff	• High pH is toxic to fish • High pH is corrosive to metal • High pH is undesirable in drinking water	• pH >10 will kill salmonid fish in minutes [1] • pH 6.5 to 8.5 recommended for drinking water supplies
Total Suspended Solids	Cement, sand and fines in effluent and/or stormwater runoff	• Can kill fish/shellfish through abrasive injury or clogging of gills and respiratory passages • May contain leachable toxic substances • Visible Plume in Receiving Waters • Screens light, contributes to oxygen depletion • Destroys fish habitat	• ambient suspended solids highly variable in fish bearing waters, 50 to 125 mg/l desirable
Admixture Chemicals	Spills carried off-site in effluent or stormwater runoff	• High concentrations may injure or kill aquatic organisms by causing high chemical oxygen demand (C.O.D.), high pH, and/or aquatic toxicity	• Specific to active ingredients • MSDS's may indicate aquatic toxicity
Mineral Oil & Grease	Drips off mechanical equipment contaminate stormwater runoff	• Toxic to aquatic organisms [2] • "Oil/grease" can include fuel, lubricants and hydraulic oil	• Highly variable with species • e.g., crude oil is extremely toxic at 0.3 mg/L [2]

References 1 D. McLeay and Associates Ltd., Toxicity of Portland Cement to Salmonid Fish, Vancouver, 1983.
2 Guidance Documents for Effluent Limitations and New Source Performance Standards for the Concrete Products Point Source Category, Effluent Guidelines Div., USEPA, Wash., D.C., Feb., 1978.

1.4 Regulatory Aspects

Ready mix facilities within British Columbia are generally regulated by Environmental Protection (formerly the Waste Management Branch) of the B.C. Ministry of Environment by the use of Permits issued under the Waste Management Act. These Permits are issued by the regional offices and contain operational and monitoring requirements that are determined on a site specific basis. An inter-agency referral process established by the B.C. Ministry of Environment ensures that input and recommendations from federal, provincial and municipal agencies are considered during permit preparation.

In 1975, the B.C. Ministry of Environment published the Pollution Control Objectives for Food Processing. Agriculturally Oriented, and Other Miscellaneous Industries of B.C. covering the ready mix industry. These Objectives stipulate effluent quality requirements and provide guidance to Ministry staff when issuing effluent permits. As of this date, these Objectives have not been revised and re-issued and now are of limited value as they no longer represent minimum achievable practices.

Facilities located on federal Crown lands, such as land leased from the Coast Guard or from a Harbour Commission, will fall under the jurisdiction of Environmental Protection of Environment Canada. These sites are not regulated by Permits but fall under the general conditions of the Canadian Environmental Protection Act and the Fisheries Act.

Discharges to fish-bearing streams or marine waters are subject to the general provisions of the federal Fisheries Act; Section 36(3) of the Act prohibits the "... deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water". Also, Section 35(1) of this Act states, "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat", and is applicable due to the high concentrations of settleable solids in many ready mix plant effluents. This Section of the Fisheries Act is administered by the Department of Fisheries and Oceans (DFO) whereas Section 36(3) is co-administered by DFO and Environment Canada.

The most stringent operational and monitoring requirements are generally applied to facilities which discharge effluent to waterbodies. In such cases, a Waste Mamgement Branch Permit may include limitations on effluent characteristics such as:

Total Suspended Solids or Non-Filterable Residue	50-125	mg/L
pH	6-10	
Temperature	<25-32	^{0}C
Mineral Oil & Grease	<5-10	mg/L
96 hour **LC_{50}** Bioassay	100	effluent concentration

Where discharge is to the ground, such as to an infiltration pit, or where total recycle is carried out, effluent contaminant concentration levels are normally not specified. Under these circumstances, Permits may require that effluents are "equivalent to or better than typical effluents from a ready mix concrete batch plant" as determined from monitoring results obtained by the Ministry staff. In addition, general operating conditions for the settling basin or other works may be stipulated. These might include prohibition of recycling basin overflow to the environment or the prevention of uncontaminated stormwater runoff entering the treatment works.

Waste Management Act Permits may include requirements for effluent monitoring and reporting. Generally, monitoring of effluents by the permittee is required quarterly, but in the case of sensitive environments, monitoring may be required monthly. Reporting is generally on a quarterly or annual basis.

The disposal of settling basin sludge may be addressed in the Permit by indicating that solids disposal must be in a manner or location approved by the Regional Waste Manager. In practice, disposal of sludge and solids are not closely monitored by the regulatory agencies and generally Perrnittees are not obligated in the Permit to report the volume or method of solids disposal.

As part of the regulatory approval process, a ready mix facility operator is advised to be fully aware of the operational and monitoring requirements in the discharge Permit. During the Permit review period, it is advisable for an operator to discuss the site specific features of their operation with the B.C. Ministry of Environment representative so that the Permit accurately reflects their operation. There is also a fee for holding a Waste Mamgement Permit and this fee is based on the volume and quality of effluent released to the environment. Operators should ensure that this information is correct.

2.0 OVERVIEW OF READY MIX OPERATIONAL PRACTICES

2.1 Concrete Composition

The typical components of ready mix concrete are:

TABLE 2

Composition of Typical Air-entrained Concrete

INGREDIENT	TYPICAL COMPOSITION		
	kg/m³	% by wt. (1)	% by vol. (2)
• Coarse aggregate	625	48	31-51
• Fine aggregate	410	31	24-28
. Portland Cement	174	13	7-15
• Water	104	8	14-18
• Admixture Chemicals (control characteristics such as air entrainment, water: cement ration, initial set, compressive strength)	0.26-0.28	< 0.01	
• Air			**4 - 8**

References: (1) Guidance Document for Effluent Limitations and New Source Performance Standards for the Concrete products Point Source Category, Effluent Guidelines Div., USEPA, Wash., D. C., Feb. 1978.
(2) Can. Portland Cement Ass'n. Design and Control of Concrete Mixtures, 1990.

2.2 Process Description and Waste Management Practices

This section summarizes the ready mix process and describes the main components of water use and wastewater generation. Figure 1 illustrates a typical batch mix plant, which uses the truck drum for mixing the concrete ingredients. The batch plant process differs from a central mix process in that a central mix plant uses a freed hopper for mixing ingredients prior to loading the trucks. In a batch plant, the measurement of the ingredients is conducted by an operator from a central control room. Solid components are accurately metered by weight and added to the truck from overhead silos. Water and chemical admixtures (generally liquids) are metered by volume. Ready mix truck capacities are quite variable depending on the expected use of the vehicle and capacity of the plant. Capacities typically range from 5- 12 cubic meters, with larger capacities being more common in urban centres where larger construction projects take place.

With reference to the numbers shown in Figure 1, the main components of the ready mix batching process are:

(1) Concrete Mixing

Ingredients are added to the drum through a metal chute at the upper rear of the truck. Solid ingredients are added dry, and a rubber "sock" is normally used to minimize dust losses during " loading.

(2) ***Exterior Truck Wash***

After loading, the truck moves to a wash area, where overhead sprays or a driver-operated hose is used to wash down the truck exterior. The truck then delivers the concrete load to the customer.

In addition to the routine exterior truck wash described above, weekly (or as required) exterior washing is carried out using a dilute muriatic acid solution to remove persistent concrete residues.

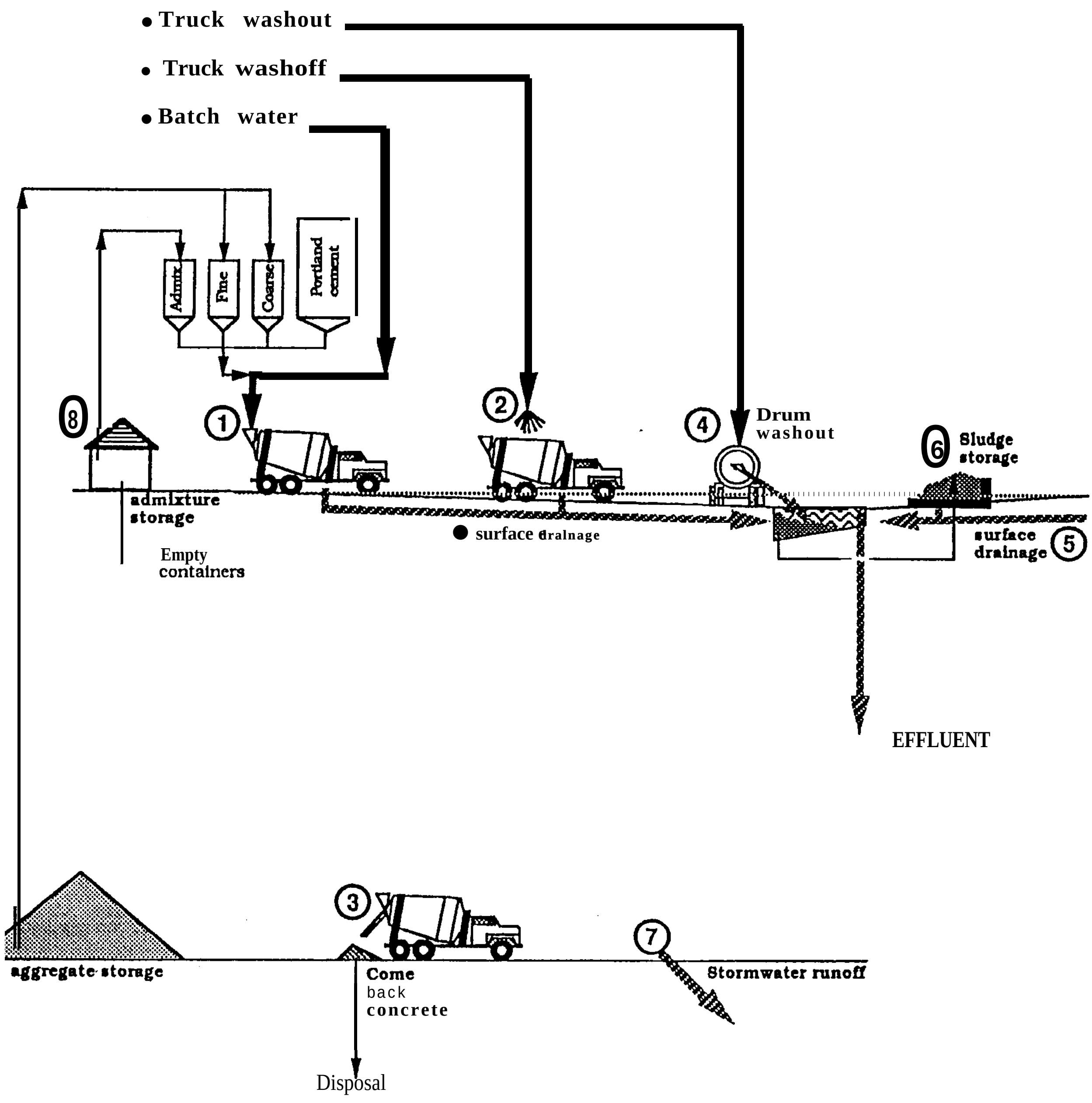

FIGURE 1: Typical components of batch ready mix concrete production

(3) *Disposal of Returned Concrete*

Some portion of the concrete load is often left in the truck following delivery. During operating hours, it is common practice for this residual concrete to remain in the truck drum and to be incorporated into the next concrete load. Where the next load may not be made until the foIlowing day, a few facility operators use retarding agents such as "Delvo" or "Recover" in the come back mix to slow hydration so it may be incorporated in the next day's batch.

When incorporation in the next load is not possible during operating hours and returned concrete must be discharged from the truck, it is generally disposed of by one of the following methods:

- production of precast concrete products, such as highway dividers, lock-blocks or retaining wall blocks
- on-site use in paving yard surfaces or as site fill
- discharge to ground for drying and breaking, then transport to another site for fill
- recycle into cement manufacturing process, where available

Excess concrete is occasionally discharged to the wash water collection system if other disposal options are not available. In most instances, the insoluble concrete ingredients settle and are removed with the washwater sludge. Although mechanical solids reclaim systems are available, they are rarely applied to recover concrete ingredients in B.C. plants. A few plants use mechanical aggregate recovery systems (e.g. drag chains) to provide recovery of coarse aggregate.

(4) Drum Wash

At the end of the operating day, the truck drum must be washed of concrete. This wash is normally completed by the driver, using overhead water racks or hoses. Water is added to the drum, and the drum is rotated. The wash water is then discharged to the wash water collection basin.

(5) ***Surface Drainage and Wastewater Management***

Ready mix concrete plants commonly have paved process areas inorder toallow collection of contaminated process water and surface runoff from truck loading, truck washoff and drum washout areas. Some plants also provide collection of runoff/leachate from sludge storage and drying piles.

Practices vary with respect to effluent disposition. Removal of suspended solids is principally accomplished through the use of settling basins. At most plants, a primary settling basin will overflow to a second settling basin; in some cases, additional basins in series are used. It is common for waste waters to be recycled in some part of the process, but during high rainfall accumulations, some overflow discharge to a ditch or surface drainage system will occur. Where direct discharge to a receiving waterbody is not permitted because of environmental sensitivity, wastewater is often discharged to the ground via an infiltration basin. Only one facility evaluated in 1993 did not reuse the wastewaters and this operator must neutralize the pH of the effluent on an as-needed basis. Effluents with high pH may be classified as Special Waste and require special handling (see section 2.3 .3).

Fresh water is normally used for exterior truck washes and for the production of hot water (for winter batching). Settled process water is used for drum washout. The proportion of fresh water to recycled water depends on the amount of recent rainfall, the quality of the settled effluent and on the concrete specification. Recycling is less common when there is a tight specification on the concrete made at the plant.

(6) ***Solid Waste Management***

Most facilities periodically decant water from the collection basins and remove accumulated sludge to an on-site storage and drainage area for drying. Sludge storage is usually on unpaved ground, often in 3-walled bins constructed from large concrete blocks produced from returned concrete. Less frequently, sludge may be stored in uncontained piles.

Returned concrete may be dumped on the ground on site and broken into small pieces after it is fully hydrated. In urban areas, the sludge and concrete residue is allowed to dry and is periodically removed for use as fill. In remote operations, the amount of returned concrete is generally small with alternate use or disposal occurring near the construction site. Although landfill disposal of hardened cement solids has been used in the past, urban landfill operators generally will no longer accept these wastes since they needlessly consume available landfill volume.

(7) ***Stormwater Management***

Practices to control surface runoff vary widely and are often determined by physical site constraints such as drainage, slope and access to storm runoff systems. At stationary plant sites, the process area is usually paved and sloped to direct process water and stormwater from these areas into the water collection system. In remote locations, it is common practice for the entire site to be unpaved. Segregation of surface runoff between process and wash up areas and aggregate storage and parking areas is helpful in minimizing the amount of contaminated runoff that must be managed; clean water can be discharged directly whereas contaminated water should be used for recycle.

(8) ***Chemical Delivery and Storage***

Chemical admixtures used to control concrete characteristics are predominantly supplied as bulk liquids, although smaller 22 litre plastic containers are still used for specialty mixes and small, remote sites. Bulk admixture chemicals are generally stored in 2,200- 4,400 litre tanks. Historically, steel tanks have been commonly used, although there is now a trend toward corrosion-free plastic tanks. It is still common to find bulk admixture storage tanks on a concrete pad without any curbed containment. Curbed containment would prevent the loss of spilled admixtures from entering the storm drainage system around the loading area.

Calcium chloride ($CaCl_2$) solution is a chemical admixture which is generally stored in exterior upright cylindrical tanks, normally located adjacent to the admixture storage area.

Concentrated muriatic acid (HCl) is used to prepare dilute acid rinse solutions for periodic exterior truck washes. Muriatic acid is supplied as a liquid in standard 205 L plastic drums, and is often stored outside, adjacent to other chemical storage or in the truck wash area. Freezing of the liquid should not be a concern most of the year; the freezing point of 10% muriatic acid is -15”C.

Portland cement is stored in elevated silos (varying widely in size) which are located above the truck loading area. A large main cement silo may be located apart from the loading area and used to feed smaller loading silos. Baghouses are normally used to control cement dust emissions which occur when cement is loaded into the silos.

Aggregates (sand and gravel) are commonly stored in piles on unpaved areas of the site, or in automatic feeding hoppers.

2.3 Waste Management

2.3.1 Water Use

Environment Canada Regional Program Report 88-03 presents information on quantitative water use and wastewater generation in the ready mix industry. This update of the Technical Recommendation Document has found that little has changed since the preparation of the 1988 report with regard to water use by the industry. The data represents a wide range of water use practices, representing the typical variation expected within the B.C. industry. Batch water contained in the concrete product comprises only about 27% of the total plant water use and drum washout has the highest water demand.

2.3.2 Wastewater Volume

As with water use, there is high variation of wastewater generation from plant to plant. Recycling and reuse of process water greatly reduces the volume of waste water that must be discharged. Since drum washout uses a significant volume of water, recycling this water has the greatest overall benefit in terms of water use reduction.

Information on the current specific water treatment and reuse practices at B.C. ready mix facilities is not available on an industry-wide basis. Environment Canada's study summarized practices at 17 facilities (November 1987), and this information was updated in 1989 for 7 facilities which were surveyed for the 1988 evaluations. The 1993 evaluations assessed six facilities.

Discussions with B. C. plant operators, chemical suppliers and other industry personnel indicate that reuse of clarified water for drum washout is commonly practised. Most plants use some proportion of fresh water for exterior truck washing and batch water. Fresh water is used exclusively for hot water for winter concrete production.

Zero discharge batch plants are not common in B.C. A zero discharge facility collects all contamimted runoff and wash waters and recycles the water into the mixing water or into the wash process. A significant reason for the inability of the industry to meet zero discharge operations is the excess water that enters the system from precipitation at most locations in the province. Storage of all the accumulated runoff is often size and cost prohibitive for most operators. Only one plant in the Lower Mainland has attempted to operate as a zero discharge facility under normal rainfall conditions. The operator found no problems with the quality of the product or build-up of residuals in the drum occurred. During high rainfall events, even a zero discharge system will likely have a discharge, although the large dilution has the effect of minimizing any impact.

Waste Management Permits will limit the maximum volume of process and washwater discharged from a facility on a daily basis. In general, most facilities do not have flow measuring devices capable of accurately measuring the process discharge volume on a continuous basis. The volume can be determined by sampling the discharge volume over a short period of time. Since the total volume of discharge is greatly influenced by rainfall and catchment area, it is not useful to compare the discharge volume from site to site unless the effects of rainfall are excluded.

2.3.3 Wastewater Effluent Characteristics

Table 3 below summarizes the fiidings of the effluent quality evaluations undertaken as part of the 1993 Ready Mix Industry in the Lower Mainland. Samples were taken on two occasions at each of the sites. The table indicates the sampling location, but in general the samples represent the process water supernatant present in the setting basin.

pH

Available data for PH of B.C. ready mix facility effluents are based on limited monitoring at individual plants. Determinations made during the 1987 site visits to B.C. facilities indicated that effluent from ready mix plants, including runoff from process areas, is frequently strongly alkaline. The 1993 data confirms this finding, with pH values generally over 10.5 for process water samples taken in the sedimentation basins. However, samples of effluent discharged to the environment showed pH values less than 9.0. Dilution by low pH rainfall and neutralization with hydrochloric acid (HCl) are responsible for the lower pH of these effluents.

The allowable pH of process effluents at B.C. ready mix facilities is normally stipulated in Waste Management Branch Permits for facilities which discharge to waterbodies. Although permits are written on a case-by-case basis, the specified allowable range generally falls within the range of pH 6.0 to 10.0. Discharges to ground may have a greater range, depending on the site. Effluents and slurries with a pH over 12.5 are considered to be Special Wastes and must be neutralized before discharge. The Waste Mamgement Branch Permit also normally requires the permittee to monitor the pH of effluent at least once quarterly. This data is of limited use since there is no control over the sampling circumstances and the results can be greatly affected by dilution. Continuous monitoring producing hourly and daily averages would be necessary to produce environmentally significant data.

The previous site evaluations found that none of the facilities adjusted effluent pH prior to discharge. The 1993 evaluations found one facility monitoring and adjusting the effluent pH in order to maintain the pH less than 9.0,

Sites	Location Notes	pH		TSS		Temp 'C		Oil & Grease		LC_{50}	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	a	10.5	11.4	17	4	2	2	6	<5	60	40
2	b	11.9	8.4	42	39	5	7	5	5	7	18
3	c/b	12.2	12.4	660	24	5	6	25	<5	7	2
4	d	12.5	11.8	351	<1	7	3	6	<5	6	24
5	e	8.8	7.8	7	<1	2	1	<5	<5	>100	>100
6	f	7.7		48		2		<5		>100	-
CRM certified CRM found (avg)		9.1 9.0	9.1 9.0	47 48	47 46			spike 127%	spike 112%	control >100%	control > 100%

TABLE NOTES:

pH = Hydrogen ion concentration; relative units
TSS = Total suspended solids; milligrams per litre
O&G = Oil & Grease; milligrams per litre
LCW = 96 Hour Lethal Concentration for 50% fish mortality
CRM = Certified reference material
TEMP = Temperature of effluent sample. Temperature generally 2-3 °C above or below air temperature.

a = reclaim water; periodic discharge to environment
b = reclaim water; no discharge to environment
c = yard stormwater runoff; periodic discharge to environment
d = yard stormwater runoff& reclaim; no discharge to environment
e = yard & offsite stormwater runoff & reclaim; discharge to environment
f = yard stormwater runoff; discharge to environment

TABLE 3: Summary OF READY MIX PLANT EFFLUENT SAMPLING RESULTS

SUSPENDED SOLIDS

The allowable level of total suspended solids in process effluents from B.C. ready mix facilities is normally stipulated in Waste Management Branch Permits for facilities which discharge to waterbodies. Permits are written on a case-by-case basis, and the specified allowable suspended solids concentrations range from 50 to 125 mg/L for surveyed permits in Lower Mainland facilities. As with other effluent characteristics, the Waste Management Branch Permit may also require the permittee to monitor the suspended solids level of effluent at least once quarterly. As with pH however, effluent suspended solids levels are not correlated with wastewater flow, thereby making the results of limited statistical value.

The results of the 1993 evaluation found a large range of suspended solids in the samples of settling pond supernatant. The samples representing discharges to the environment (Site 5) had suspended solids levels less than 50 mg/l.

A survey of permittee monitoring data for ready mix facilities in the Lower Mainland of B.C. indicates that some facilities discharge effluent within the terms for. suspended solids imposed by their permit, while others discharge effluent which is well outside allowable levels. Measured suspended solids levels range from <5 to 205 mg/L.

OIL & GREASE

Mineral oil and grease are associated with both mobile and stationary equipment. Mobile equipment, including cement mixing trucks, delivery trucks and front end loaders has the potential to lose oil throughout the yard as small drips or as sudden, large volume losses from hydraulic system rupture. Spill response kits, containing booms, absorbent and other response equipment, should be available to address a mobile equipment spill.

Stationary equipment include the cement plant and air compressors. Containment of potential sources of oil can be provided around stationary equipment. Typical containment consists of a concrete slab under the equipment with a concrete curb high enough to contain 110% of the liquid in the equipment. Cover is necessary to maintain the containment free from precipitation.

Oil and grease are not evaluated as part of normal plant operations. However, regulatory limits are becoming more stringent with regard to the loss of oil in stormwater and to the sanitary sewer. The target oil and grease concentration for a facility should be less than 10 mg/l for all discharges from a site to the environment.

2.3.4 Waste Solids Disposal

Ready mix facilities produce sludges from the cleanout of settling basins, and waste solids from returned concrete. There are no available data for the quantities of sludges or solids generated by B.C. facilities.

Some Ministry of Environment permits for ready mix facilities specify that waste solids "shall be disposed of to a site" and/or "in a manner approved by the Reginal Waste Manager. " In general, the 1993 evaluations found that waste solids are being handled in an environmentally sound manner agreeable to the Ministry. Returned concrete is mostly used in the manufacture of secondary products, such as Lock-Blocks. Several of the ready mix operators have installed or are investigating aggregate recycling systems which will allow the reuse of returned concrete aggregate in fresh concrete. Few operators waste returned concrete in a landfill.

Settling basin sludge is generally allowed to dry and is broken up for construction fill or disposal in a landfill. It is important that the sludge be fully set (hydrated) prior to disposal. If the sludge is not fully hydrated, it is likely that the pH of the water will be above 12.5 and therefore the waste will be a Special Waste. Once fully hydrated however, the dried solids will generally not produce a high pH runoff once exposed to water and therefore are acceptable for landfilling.

Sites	1989 Audit	Concrete Market	Stabilizer Use	Solids Reclaim System	Effluent Reuse Batch Mix	Yard Runoff Collection	Best Treatment Technology solid	Best Treatment Technology liquid	Operation Type	Effluent Discharge to Watercourse
1	Y	R	Y	N	N	N	N	N	T	N[c]
2	N	R	Y	Y	Y	N	Y	N[b]	NT	N[c]
3	Y	C	N	N	Y	N	N	Y	T	Y
4	Y	R	Y	N	Y	Y	N	Y	NT	N
5	Y	R	N	N	N	Y	N	N	NT	Y
6	Y	C	N	N[a]	Y	Y	N[a]	Y	NT	Y

TABLE NOTES

BTT = Best Treatment Technology
N = No
Y = Yes
R = Residential
C = Commercial
T = Typical
NT = Not typical

a = treatment system installation planned for solids reclaim
b = treatment system installation planned for contaminated stormwater runoff
c = contaminated stormwater discharged to drainage ditch

TABLE 4: SUMMARY OF READY MIX PLANT ENVIRONMENTAL AUDIT INFORMATION

3.0 RECOMMENDED DESIGN AND OPERATING PRACTICES

Recommended design and operating practices are intended to minimize the environmental impact of the ready mix concrete industry. The recommendations have been developed from existing environmentally friendly practices demonstrated by the industry and include new and innovative waste minimization and recycling techniques that represent best practical technology. The application of the recommendations will depend on the specifics of each site. In some cases, the recommended practice may have to be modified to suit a particular operation. It is important to recognize that the main objective of good operating practice is the protection of the environment around a ready mix facility; hopefully this document will assist operators in meeting this objective,

3.1 Process Effluent Management

3.1.1 Minimizing Wastewater Volume

The most effective technique to reduce the cost of managing any waste is to prevent its generation in the first place. This rule of thumb is particularly applicable to the generation of waste waters from process effluents. In the ready mix concrete industry, preventing the generation of effluent includes minimizing the volume of water from washing truck exteriors and minimizing the volume of drum wash water that must be wasted. Practical solutions include flow restrictions on the fresh water supply and reuse of treated drum wash water for subsequent , drum washing. Careful control of fresh water supply into a facility has the potential of producing a zero discharge operation under normal rainfall conditions. Table 5 summarizes some of the most practical approaches commonly used to minimize water use at an industrial operation.

For several years, ready mix plant operators have experimented with the use of recycled water for batch water. Although the use of settled, recycled water for drum washout is common at B.C. plants, reuse of water for batch water is less common. The main reason for this is likely the existing CSA standard that recommends against the reuse of this water in the batch. It appears that concerns relate to inferior product quality that may result from washwater reuse.

Unfortunately, this recommendation is not consistent with the observed practice in the industry nor with current waste minimization techniques being implemented. If quality of the recycled , water can be maintained by eliminating unwanted contaminants, such as oil and grease, and by controlling the concentration of solids in the recycled water, it is good environmental practice that recycle water be considered for use as batch water, especially where a surplus of available recycled water exists at a facility.

Another option available to reduce the volume of waste water generated is through the use of chemical stabilizers in the drum wash water. These products are used at some facilities to hold the wash water overnight in the drum. This water is then incorporated into the mix at the start of the following day. This procedure has the potential to substantially reduce waste water and waste solids volumes that must be handled. However, during the 1993 evaluations, operators indicated that this practice is not possible in winter when freezing conditions exist unless the drum cleaning water is heated, or when the concrete specification is for a high strength mix. Based on this information, it would appear that the industry preference is to recycle the drum wash water through a treatment system rather than by holding it in the drum overnight.

3.1.2 Waste Water Collection and Treatment

Table 6 outlines the recommended operational practices for the collection and treatment of process effluents that have become contaminated by the ready mix process.

Efficient collection of effluents, with a minimum of inflow of uncontaminated water to the system, is important. Paving, curbing and sloping can be used individually or in combination to produce a catchment area for process effluents. A large catchment area will increase the amount of water that enters the system, generally as a result of precipitation, and which will have to subsequently be treated and/or recycled. Collection basins must be sized according to the catchrnent area and anticipated rainfall during the operational months so that sufficient storage is provided. A design rainfall event is based on historical data for the nearest weather station to the site. As a guide, a minimum 10 year return period, 30 minute duration storm should be used for the design storm. Environment Canada's Atmospheric Environment Service may have an Intensity-Duration-Frequency (IDF) curve, for the nearest station, that will give the design rainfall in millimetres per hour. For B. C., the range could be from 3 mm/hr to about 15 mm/hr, depending on the geographic location.

In the event of extreme rainfall events, there may be insufficient storage volume to contain the entire runoff volume. Normally this will not be a concern, however, since there will be sufficient clean water to dilute the contaminated water, rendering it relatively innocuous.

The main treatment strategy used for contaminated ready mix facility runoff is settling. Collected effluent is allowed to remain in a calm, low velocity basin for a period of time to allow the settleable solids fall out. The rate of settling is dependent on the size of the solids particle; the smaller the particle, the slower the rate of settling. While settling tests are recommended to determine the necessary basin size, generally over one hour settling or retention time will provide 80% to 90% reduction in settleable solids loadings. This type of effluent treatment is the most common in the industry.

An innovative approach to effluent management that greatly reduces the amount of settled solids that have to be cleaned out of the basin uses mixers to maintain the solids in suspension. Several techniques are available including using mechanical propeller-type mixers or using bubbling air. The solids are then incorporated into the mixing water for the next batch. This same system also incorporates a centrifugal separation aggregate recovery system as the initial treatment stage.

3.2 Solid Waste Management

The disposal of returned concrete and waste solids generated by wastewater settling systems is an expensive and troublesome problem for ready mix plant operators. This is particularly true for facilities located in congested urban areas. Appropriate disposal options are increasingly difficult to find, and the cost of concrete disposal has approached or exceeded the value of the concrete product in some areas. To address a pressing need for improved solids management, some facilities are installing a solids reclaim system while some others are utilizing chemical stabilizers or making alternative concrete products. Table 7 indicates acceptable methods for managing solid wastes.

TABLE 5

Minimizing Water Use at Ready Mix Facilities

WATER USE	OBJECTIVE: Minimize contaminated effluent by minimizing net water use
Minimize the need for wash waters	Minimize truck exterior contamination by controlling dust losses during loading by continuous metered water spray on loading chute opening. Minimize contamination of surfaces by controlling dust release (Section 3.5) and sludge storage pile drainage (Table 7).
Minimize net water use	Restrict fresh water uses to: .truck exterior washoff hot water production .batch water Use recycled process water and stormwater from paved process areas for: .truck drum washout .miscellaneous washdown operations If possible, use recycled water for batch water, subject to operational and product quality constraints. Reduce truck exterior wash volumes by using a spray instead of hose wash Install flow controls on freshwater sources .install flow restricting nozzles/spring-loaded triggers at wash stations .eliminate uncontrolled and unattended discharge of water spray .consider mechanical control systems Employee training will minimize water use: .ensure workers understand proper water reduction techniques available at the site .monitor/supervise water use to reinforce the importance of controls and verify effectiveness
Minimize contaminant loadings	Minimize contamination of surface runoff by controlling dust release and sludge storage pile drainage. Control contaminant dispersal through good housekeeping and by minimizing vehicle traffic on contaminated site surface.
Maximize water reuse	Minimize drum washout water volume: .use reclaimed water .use multiple small-volume rinses rather than single large-volume rinses; series rinses are more effective and reduce total rinse volume .consider the use of stabilizers to minimize washes

TABLE 6

Waste Water Collection and Treatment

Waste Water Collection	**OBJECTIVE:** **Efficiently segregate and collect all contaminated waters**
Collect all wastewaters and contaminated surface runoff for treatment	Pave all site surfaces which are subject to contamination by concrete and ingredients, including truck loading, slump racks, washout racks, sludge storage areas. Aggregate storage areas should not normally require paving. However, surface runoff which is discharged to waterbodies from aggregate storage areas must meet regulatory suspended solids limitations. Curb and grade paved surfaces to collect all wastewaters and contaminated runoff. Direct all contaminated waters to a wastewater collection basin/treatment system. Prevent uncontaminated water from entering water treatment system catchment through the use of curbing, sloping or drainage channels. Segregate paved process areas from plant areas not subject to surface contamination Minimize traffic through contaminated waters by providing segregated drainage channels or by careful layout of traffic areas and collection basin location.
Provide adequate wastewater holding basins	Provide sufficient collection volume for contaminated waters to manage effluent in high precipitation periods. Design and construct basins to minimize subsurface leakage (except where exfiltration is intended).
Waste Water Treatment	**OBJECTIVE:** **Treat contaminated waters to effluent standards**
Treat uncontaminated effluents	Provide effective solids removal for collected wastewaters. This may include a sloped concrete settling basin overtlowing into a second basin, or install solids suspension system and water reuse in the batch. Neutralize discharges to surface waters to meet regulatory requirements for pH. Provide equipment and training for effective routine pH monitoring. Discharge effluents to sewer rather than directly to the environment, where allowed.
Optimize treatment effectiveness	Properly design and operate treatment systems within effective operating limits for hydraulic an solids loading. Regularly clean treatment systems to ensure efficient operation. Monitor the performance of treatment systems to ensure effectiveness and compliance with regulatory requirements.
Contain and control storrnwater	Control drainage (slopes, curbs) to collect contaminated storrnwater in a separate, properly sized settling basin to provide settling for a maximum 10 year return, 30 minute duration precipitation event. Obtain actual data from IDF curve for the nearest weather station. Contain clarified stormwater and recycle. An engineered infiltration basin is an alternative to unavoidable discharge of contaminated stormwater off-site.

TABLE 7

Solid Waste Management Practices

Solid waste generation	**OBJECTIVE:** **Minimize solid waste volumes**
Management of Returned Concrete	***During daily operation:*** ***Incorporate*** returned concrete in succeeding batches where consistent with product specifications and quality standards. ***At day end:*** .Use returned concrete for forming precast concrete products .Recycle returned concrete (dried and ground) as roadbed or other fill .If unavoidable, find approved disposal for returned concrete (see below).
Minimize Waste Solids	.Eliminate or minimize the discharge of returned concrete to water recovery systems. .Consider installing solids reclaim systems to recover solids from wastewater
Solid Waste Handling & Storage	**OBJECTIVE:** **Provide secure storage/handling** for waste solids
Sludge Storage	Contain sludge storage piles from cleanout of settling basins and aggregate recovery systems: .Locate in paved areas with controlled drainage. .Confine sludge piles with retaining walls such as walls constructed of pre-cast concrete blocks .Cover the piles to minimize drainage and leachate in regions of high precipitation. Design and operate sludge storage piles to prevent or minimize sludge dispersal by vehicle traffic. Collect leachae and drainage from sludge storage piles and return to process water recycle/treatment systems. Immediately collect and contain spilled solids in ready mix truck loading areas.
Solid waste disposal	**OBJECTIVE:** **Provide sound, approved disposal for waste** solids
Disposition of Sludge	Use only approved methods of sludge disposition. .Dispose of sludge as roadbed or other till. .Find approved disposal for unavoidable sludge; do not contract for removal to unknown disposal sites.
Other Solid Wastes	Obtain regulatory approval for disposal of any residue/sludge from bulk admixture chemical tanks. Consult admixture/chemical suppliers for proper rinsing and disposal of chemical containers. Recycle containers via supplier or reputable container recycler. Do not discard contaminated chemical containers to conventional solid waste disposal bins without approval. Provide proper collection and storage of Special Waste. For example, lead batteries, solvent and waste oil must be properly contained and can be recycled. Provide conventional refuse containers as required to maintain a tidy site.

3.2.1 Solids Reclaim Systems

Commercially available systems range from simple aggregate recovery to complete solids reclaim units. A large variety of systems are in widespread use throughout North America. These include drag chain systems (generally no longer popular) and cyclone separation systems. While mechanical systems have high capital and operating costs, the financial benefit of reclaiming material has not always been given due consideration. The 1993 evaluations found that few facilities in British Columbia have formal solids reclaim systems in place. It would appear that the current practice of settling solids and recycling the water is the simplest and most effective method. The use of solids reclaim systems from wastewaters and returned concrete will increase as environmental discharge Permits become more difficult and costly to obtain and maintain. The existing CSA standard that discourages the use of recycled water from a solids reclaim system in the batch water may have to be re-valuated.

The British Columbia Ready Mix Association has indicated that there have been discussions between the ready mix industry and the cement manufacturing industry regarding the recycling of settling basin solids into the manufacture of cement. This option was found to be impractical because of the large distance to cement manufacturing facilities from most of ready mix operations in British Columbia.

3.2.2 Chemically Stabilized Returned Concrete

Suppliers of admixture chemicals have developed procedures for stopping the set of returned concrete (with chemical stabilizers) to allow holding of the concrete in the truck for several hours. An activator can then be added to the mix to counteract the action of the stabilizer so the come-back concrete can be incorporated into the next batch. In practice, this is seldom done by ready mix plant operators. The 1993 evaluations found anecdotal evidence that incorporating stabilized concrete has caused quality problems with the subsequent batch. The procedure is sensitive to the quantity and characteristics of the stabilized concrete and requires careful control in the mixing process. Because of these difficulties, it is unlikely that the industry will adopt this practice on a large scale.

3.2.3 Manufacture of Secondary Products

Returned concrete, also known as come-back concrete, poses a problem for each facility operator. As indicated above, stabilizing the concrete for later use is not popular with the industry or their customers. Using the concrete as fill at the construction site or at another suitable landfill is one possibility for disposal of this material. Where possible, come-back concrete should be immediately incorporated into a subsequent batch.

Many operators are now using come-back concrete in the manufacture of other concrete products. Some of these products include precast parking lot barriers and curbs, lock-blocks for retaining walls and flat patio pavers. Generally the products are limited in size in order to allow the product to be completed before the concrete sets. The recommended practice is to manufacture secondary products since there is the potential for these products to be sold and provide the operators with some financial return for the concrete.

Another alternative product currently being developed is Controlled Density Fill (CDF). Essentially this is a low strength concrete mix that can be used to backfill trenches and excavations where settling may be a problem. Since strength is of minor importance, settled solids and stabilized come-back concrete may be suitable for use in CDF. This product can be manufactured at any ready mix facility, making it a practical alternative throughout the province. The manufacture of CDF is currently limited by market demand. However, industry expects the use of this product to increase in the future.

3.2.4 Disposal of Other Solid and Miscellaneous Wastes

The disposal of other waste solids, including empty chemical containers, paper, vehicle maintenance wastes and other refuse should be carried out consistent with typical waste management practices within that municipality or Regional District. Care is necessary to ensure that waste leaving the site is acceptable for disposal in local landfills. Some products used at ready mix facilities, such as waste oil, high pH solutions and automotive batteries, may qualify as Special Wastes and therefore must be handled accordingly.

Where recycling opportunities exist, it is recommended that efforts be made to utilize these services. For example, waste oil and solvent is now easily recycled through reputable recyclers Paper and plastic can usually also be recycled. Chemical suppliers typically require a deposit on bulk chemical containers to encourage their return. Ready mix facility operators should encourage all their suppliers to accept returned empty bulk product containers. Table 7 provides some guidance with respect to general waste management techniques. For specific waste mamgement issues, it is recommended that the facility operators contact their local municipal office or Ministry of Environment office.

3.3 Chemical Storage and Handling

In addition to Portland cement, ready mix facilities use a variety of admixture chemicals as ingredients in concrete. In general, these chemicals are liquids which are supplied in bulk and stored in tanks in the batching area of the plant. Although many of these chemicals present relatively low hazard to the environment and workers, some admixture chemicals do have high aquatic toxicity and/or require worker protection and precautions in the event of spills or direct worker contact. Furthermore, concentrated muriatic (hydrochloric) acid is commonly used at facilities for preparing dilute acidic wash solutions. Consequently, careful attention to chemical storage and handling of these chemicals is important.

Table 8 represents recommended design practices for the admixture chemical storage areas at ready mix facilities, based on good practices commonly applied for chemical handling and storage areas at other industrial facilities. The provision of adequate containment volume for stored liquids is fundamental to a good design. However, worker training in spill response according to an established contingency plan are other ways to protect the site from accidental release. Every site should be equipped with emergency spill response equipment designed to address potential spills of products in use at the site.

TABLE 8

Chemical Storage and Handling

Design Features	**OBJECTIVE** **To provide proactive spill prevention and spill containment features for stored admixtures**
Tanks	•Select strong corrosion resistant materials of construction (consult with chemical suppliers). Immediately reinforce or replace damaged tanks •Mount tanks in stable position and anchor securely. •If possible, locate storage tanks inside a structure Protect tanks from vehicle impact. •Calibrate tanks and install accurate fluid level indicator •Install shut-off valves on all rupturable lines and tank gages. Identify the contents of all tanks and indicate hazards. •Provide good lighting in tank storage area.
Spill Containment	•Tanks should be installed within structurally sound, paved containments Containment should contain 110% of one tank liquid volume or 25% of total volume of tanks, whichever is greater •Eliminate floor drains from tank containment areas (to prevent release). •Ensure that incompatible chemicals are not placed in the same containment area. •Ensure that chemical release to a containment area will not darnage equipment, tankage or piping •If required, provide protection from freezing for chemical storage tanks.
Piping	•Design according to all applicable codes. •Select materials of construction in consultation with chemical suppliers. •Use above ground, visible, permanent piping throughout chemical delivery systems. •Provide impact protection for vulnerable piping. •Clearly label piping systems and valves for each chemical. •If required, provide protection from freezing for piping.
Operating Practices	**OBJECTIVE** **Use operating practices which protect worker health and the environment**
Personnel training	•Provide appropriate training for supervisors and designated personnel who handle chemicals. •Provide Material Handling Data Sheets for all hazardous chemicals stored and used on site. •Provide explicit written safety and handliig procedures for chemical storage and handling practices.
Security	•Provide security precautions to prevent vandalism or access by unauthorized persons. •Install locking valves on all side or bottom drai/fill valves.
Emergency Response	•Prepare a written contingency plan for chemical spill response. •Train and rehearse personnel to implement the contingency plan. •Ensure appropriate spill response and personal protection equipment is readily available on-site. •Advise local fire department of the location and contents of chemical storage areas.
Chemical Delivery	•Provide a curbed, impervious loading pad which drains to a containment area and/or which can be blocked from releasing spills to water collection systems. •Locate chemical loading areas away from high yard vehicle traffic areas. •Restrict access to loading area during chemical delivery. •Use dripless camlock connections for lines between delivery vehicles and tanks. •Provide good visibility of the delivery system from the point of delivery (to avoid overflow). •Require that chemical delivery is undertaken only by personnel who arc trained and qualified in chemical handling and emergency response procedures.
Housekeeping	•Define and practice good housekeeping practices for keeping the site clean and free of debris. •Routinely inspect the chemical storage area for leaks or spills. Daily inspection is recommended. Immediately contain leaks and repair the source.

3.4 Stormwater Management

Table 9 contains recommendations for managing stormwater at ready mix facilities. The main objective is preventing the contamination of clean runoff. This is accomplished by directing clean surface water off the site via drainage systems, site sloping or by curbs and avoiding any mixing with contaminated wash waters or processing area runoff.

Where stormwater and other surface runoff has become contaminated by the ready mix facility operations, it should be collected into the recycling system for treatment and reuse. The volume of contaminated water that will have to be managed will depend directly on the size of the catchrnent area. Therefore, operators should attempt to minimize the size of the process area to minimize volume. Also, operators should provide frequent clean up of areas outside of the area catchment to ensure non-recycled runoff is not contaminated.

Where aggregate has been washed prior to storage on site, storrnwater from the aggregate storage areas should not contain high levels of suspended solids. Unpaved aggregate storage areas will improve storrnwater management on site by allowing some of the runoff to infiltrate the ground. However, if paving is necessary, operators should take care to ensure that suspended solids discharge criteria are met.

TABLE 9

Stormwater Management Practices

Stormwater Management	**OBJECTIVE:** **Minimize stormwater contamination**
Isolate Contaminants from Stormwaters	•Pave all process areas where concrete ingredients are stored or handled, including truck loading, slump racks, washout racks and sludge storage. •Segregate and collect drainage from the process area with curbs or drains. •Prevent or promptly control releases of portland cemnet, concrete tines, and admixture chemicals to avoid dispersal. Minimize and promptly clean up spills
Minimize Stormwater Volume	•Divert uncontaminated stormwater from the process areas of the site with perimeter ditches. •Minimize the size of the process area of the plant. •Where possible, allow infiltration of uncontaminated stormwater into the ground to minimize discharge volume.

3.5 Control of Dust Emissions

Poor control of dust emissions at ready mix facilities can create a nuisance air emissions problem which will also contribute to the contamination of washwater and surface runoff. Plant operators should strive to reduce both point source and non-point source dust emissions throughout the facility. The recommended measures are outlined in Table 10.

Point source emissions are typically controlled by baghouse. A baghouse is a dry dust collection system that typically recycles collected dust into the product. The baghouse must be engineered relative to the exhaust gas flow rate and particulate concentration for efficient removal to be achieved. An properly sized and maintained baghouse should be able to produce a particulate emissions better than 50 mg/m^3.

It is also recommended that plant operators take measures to prevent dusts or solids from being dispersed throughout the plant site by vehicular traffic. Permanently sited ready mix facilities or facilities in close proximity to residential development should have high-traffic areas paved. Immediate clean-up of spilled solids and frequent sweeping of the yard to collect accumulated dust.

The allowable dust releases from a ready mix facility will depend greatly on the location of the facility. Within the Greater Vancouver Regional District, point source particulate emission limits are becoming more stringent; a limit of 120 mg particulate/m^3 air discharged is standard and a limit of 50 mg/m^3 is becoming more common for general industry. In areas under the jurisdiction of the B.C. Ministry of Environment, emissions limits range from 120 mg/m^3 to 230 mg/m^3. The more stringent level is applied in developed areas with a potential for impact on adjacent properties whereas the less stringent level may be applied for remote sites.

Often, it is difficult to accurately measure emissions from a silo or baghouse because the size and shape of the vent does not permit sampling according to the specified sampling methodology. A proper sampling location will be at least 2 stack diameters downstream of a disturbance (such as an elbow or venturi) and at least 0.5 stack diameters upstream of the discharge or another disturbance.

Ambient dustfall levels are measured using simple dustfall canisters or with high volume samplers and filters. The regulatory limits for dustfall also depend on the location of the facility. For remote areas, the ambient air quality limit is normally 25 tons per square mile per month and is reduced to 15 tons per square mile per month for urban areas. In future, there will be increasing use of more sophisticated dust measuring techniques, including measuring for inhalable particulate. Commonly called PM_{10}, inhalable particulate is less than 10 microns in size, and is felt to be the particulate size of greatest concern to human health. Although there are currently no limits on PM_{10}, it is likely that limits will be developed and implemented in the future.

TABLE 10

Air Emissions Management Practices

Air Emissions Management	**OBJECTIVE:** **Minimize dust emissions on and off site**
Control Point Source Emissions	•install an effective dust removal device, such as a baghouse, on vents from pneumatic or mechanical transfer systems. •use curtains or socks for truck loading operations. •use water sprays to remove fugitive emissions during truck loading operations.
Control Fugitive Dust Production	•minimize the surface area of aggregate storage piles. •use aggregate storage bins or covers where possible. •locate storage piles in area of site sheltered from wind. •pave high vehicle traffic areas of the yard. •sweep paved portions of yard frequently to remove accumulated dust.

4.0 CONCLUDING REMARKS

The 1993 update of the ready mix industry environmental code of practice provided an opportunity to examine the state of the industry five years after the first edition. The industry was found to be well aware of the potential environmental problems inherent to the ready mix process and have made improvements in some areas of wastewater and solid waste management. In general, however, the industry as a whole has been inconsistent in meeting the recommended design and operational practices set out in the original code.

Waste water management remains the most significant issue of environmental concern. Preventing contamimtion of storrnwater and the collection and treatment of contaminated storrnwater and process waters is now much more common in the industry, Minimizing wastewater generation is the area where additional improvements will be made.

Solid waste management appears to be generally acceptable at the facilities evaluated. Progress is being made to minimize the generation of solid waste through the manufacture of secondary concrete products with come back concrete and through the use of aggregate recovery systems.