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[illegible] ... the most effects of ... especially those that are confined ... the project ... and include ... turbidity ... building, oxygen depletion, removal of ... and suspension of solids. For the ... the effects ... inseparable from ... not possible to conduct a ... from this environment. ... however, ... to ... the ... the [illegible]

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Treatment Before and During Dredging

Spoil materials vary widely in both physical and chemical characteristics. While many types of spoil may be considered "polluted" major problems are generally limited to highly organic, petrochemical-laden silts and clays, and domestic sewage sludges found in waterways bordered by heavy population or industrial concentrations.

AERATION

Aeration of bays, harbors, and other areas is sometimes possible where organic sludges are responsible for noxious, anaerobic conditions. In these instances aeration can result in changeover from anaerobic to aerobic decomposition with a long term elimination of aesthetically displeasing odors. Such techniques can be especially effective if combined with the selective removal of organic bottom sediments by dredging.

CHEMICAL TREATMENT

Chemical treatments to improve spoil prior to dredging are feasible. Chemical oxidizers, such as chlorine, offer the potential for spoil improvement prior to or during dredging, and wetting agents offer a good possibility for increasing the slurry density.

DISPOSAL TREATMENT

Spoil may also be treated before being redeposited. Such treatment, of course, will not effect the dredged site but can aid in improving the spoil deposition area. Methods used in treating spoil before redeposition include:

FLOCCULATION

Flocculation within a diked disposal area has been successful both in speeding the natural precipitating process and in clarifying the resultant effluent; however this technique depends on fairly quiescent water, maximum settling prior to addition of chemicals, and efficient mixing. An open water disposal practice of some promise would utilize a silt barrier to enclose a "treatment area" in which dredges could deposit spoil where, after an initial settling period of 15 or 20 min, flocculents would be applied. Such a technique holds promise of limiting possible undesirable effects of spoil disposal.

VACUUM FILTERS

Since the spoil placed in a confined disposal area is so often similar to domestic sewage, the use of vacuum filters for initial dewatering appears feasible. In this manner, the sludge can be separated out for eventual inland disposal (by other means such as rail or road haul). The

disposal area could be regarded as a treatment plant, the larger solids being separated out by vacuum filters and the liquid effluent being treated by other processes. Pretreatment by chemical aids such as alum or long-chain polymers, may be necessary to aid the dewatering process.

AERATION

Aeration can be utilized to stabilize (oxidize) highly organic dredge spoils. Success will depend on proper application of established sanitary engineering principles including sufficient oxygen/water interaction over an adequate time period. Mechanical aerators and pneumatic bubbler systems are presently in widespread use, also, the addition of chemicals, such as chlorine will also assist the oxidation of sanitary wastes. Satisfactory aeration by mechanical or bubbler (air or oxygen) systems can be expected within either a confined land disposal site or enclosed open water area (bounded by a silt curtain). Basically, the concept would involve spraying (by sidecasting or similar method) the material into a sufficient volume of water surrounded by a silt barrier. The spoil would then be subjected to extended aeration in an effort to satisfy the associated oxygen demand. It is conceivable that aeration could be followed by coagulation. It is questionable as to whether polluted spoil should be

dispersed, thereby allowing a maximum of spoil-water contact, or disposed of in such a manner as to minimize this interaction. The above technique would maximize spoil-water contact while limiting the area over which this action occurs. If this system proves practical, dredging could be used to both improve the area from which the spoil was removed (by virtue of removing unwanted organic spoil) and improve overall water quality (by satisfying the oxygen demand associated with organic materials). Aeration offers the potential to deal with highly polluted spoil in a very progressive, environmentally compatible manner and may give some flexibility with regard to location.

INCINERATION

Much as in a municipal sanitary system, the treatment of highly organic spoil will require a primary (solid) and secondary (liquid) phase. Incineration is a proven technique that can be expected to handle solids disposal. Sludge with a sufficiently high volatile solids content is readily available in a number of harbor areas but would require preliminary dewatering through natural settling, vacuum filtration, or some other technique. Other incineration techniques include wet oxidation and fluid bed incineration. The danger of air pollution must be investigated in all cases.

FILTERS

The use of filters of various types is a possibility. If the spoil is of sufficient size, a screening or centrifuge process car perform a fairly efficient water-solids separation. In the case of finer materials, sand bed filters, as used in municipal water treatment plants, can find application in effluent treatment. Such filters could be built as integral parts of a diked area to either replace or supplement existing weirs.

SEWAGE TREATMENT PLANTS

Disposal of highly organic spoil from waterways into a city interceptor-treatment plant system may be practical in some cases, but expensive and requiring long periods of time to dispose of large quantities of solids. The nature and volume of this spoil material simply overwhelms the capacity of a typical treatment facility to process and dispose of additional sludge. One major limitation inherent in such a system is the requirement to cease dredge operations during high sewage flow, such as following a rainstorm. For large projects such a scheme is unworkable, but smaller projects may find it a viable alternative, particularly if temporary storage facilities are available to hold the spoil effluent for further processing.

Dredge Spoil Disposal Techniques

Dredge spoil can be disposed of on land, on marshes, in estuaries or in open water. Some of the adverse effects can be mitigated or ameliorated by the use of proper disposal site selection to minimize ecological effects. Additionally, modified dredging techniques or the use of peripheral equipment designed to reduce spoil losses can also reduce adverse effects.

OPEN WATER DISPOSAL

Short term open water effects on the benthic biological community from dredge spoil disposal has been found to destroy the less mobile forms whereas some types were able to surface and survive. Apparently the high turbidity did not increase organism mortality.

Methods to minimize the effects of spoil disposal include: the accurate placement of spoil, the use of disposal techniques which minimize resuspension of material and which cause the loss of spoil compaction, and the investigation of current dispersal patterns before site selection.

If the spoil contains pollutants or toxic materials, knowledge of oxygen demands created or the release of such toxic compounds should be accumulated before planning disposal. Site selection or the use of alternative disposal methods may be dictated by the presence of such materials.

LAND DISPOSAL

Land disposal is defined as disposal not in open water and not on marsh land. It includes disposal on upland areas or on bars or islands. Such areas may be confined by dikes or natural barriers or be unconfined. Contained areas are usually equipped with spillways or overflow weirs and occasionally with settling basins.

Dikes are generally constructed on poor foundation materials and require careful design to prevent failure. In many cases dikes have breeched causing extensive losses of spoil materials. In cases where dikes are constructed to contain polluted materials, these dikes may be pervious allowing seepage through and beneath the dikes.

Ground water contamination by the disposal of polluted spoil may also occur. Examination for this potentiality is seldom made. If such contamination is likely the use of liners or other impervious materials may be required.

In order to minimize the effects of spoil disposal methods of improvement and utilization have been developed. Spoil can be characterized as having a significant percentage of fine grained organic materials and high water contents. Such materials possess very poor qualities as a foundation material. Improvement of foundation properties can be accomplished by removing the water and enhancing consolidation. Spoil drainage occurs at a very slow rate because the effect of dikes is to cause perched water tables and water retention.

Several methods have been incorporated into projects to improve dredge spoil engineering properties:

Ditching - The groundwater table can be lowered by ditches which also provide drainage of surface runoff. Removal of the excess water promotes consolidation.

Sand Drains - Vertical sand drains are a cylindrical column of sand or granular material placed in a vertical hole and connected at the original surface with a drainage blanket. These drains provide an avenue of escape for pore water and promote consolidation.

Ground Surface Drains - The disposal site would initially be covered by a layer of sand before applying dredge fill.

The horizontal sand blanket provides a permanent drain of overlying water and promotes consolidation.

Experimental projects have suggested the possible use of vacuum wells, electroosmosis and dessication for improving dredge spoil. Additional research and testing will be required to evaluate these techniques.

MARSHLAND DISPOSAL

Many of the land disposal techniques previously described are applicable to disposal on marshland. Marshland disposal has been common in the past because of accessibility and the inexpensive value of the land. Because of the increasing expense of other land caused by development of coastal areas, these marshlands were frequently the only land disposal sites available.

Such disposal is frequently attacked by conservationists and others because of biological habitat destruction. The use of marsh areas for spoil disposal will probably continue in some areas. Although habitat destruction to some species will always occur, research continues to mitigate these adverse effects as much as possible.

Comparison of diked versus undiked disposal indicates that undiked disposal is more desirable. It appears that marsh recovery in undiked areas occurs at a more rapid rate. Work is also underway to develops systems to grade or rate marshes so that the most productive marshes can be left undisturbed.

Productive Uses of Spoil

Rather than being considered entirely detrimental, spoil can be used advantageously in certain circumstances. Efforts are being expended to determine beneficial uses. Several of these uses are outlined in the following material.

ARTIFICIAL HABITAT CREATION

At the present time the most promising of the artificial habitat creation schemes using dredge spoil are the spoil island and the creation of marshes. Artificially created spoil islands may be naturally colonized by indigenous terrestrial vegetation or specialized waterfowl feed plants may be planted. Within the spoil disposal area itself, small lakes may be created for fish and wildlife habitats.

The use of spoil to construct artificial marshes is also feasible. Careful spoil placement and recolonization of marsh vegetation is required. Since many of the nation's marshes have been destroyed by previous dredging operations and man induced factors, the creation of new marshes in such areas is desirable to provide the ecological nursery and habitat for fish and wildlife.

Other possible artificial habitats include the development of shell fish beds in open water areas. In conjunction with spoil islands and marsh creation whole ecosystem habitats can possibly be recreated.

LAND DEVELOPMENT

Land created by dredge spoil disposal has historically been used in harbor development and for other construction whether deliberately placed or fortuitously located. Piers, access roads and warehouses have been constructed on dredge spoil.

Areas specifically designed for construction use typically select special materials such as sand which has good drainage and structural properties. The use of these materials makes for usable land and because such materials are generally non-polluted, the drainage and runoff cause