Hudson River
PCBs SUPERFUND SITE

Engineering Performance Standards

Technical Basis and Implementation of the Productivity Standard

April 2004

Volume 4 of 5

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ATTACHMENTS

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List Of Acronyms

AMN	Water treatment facility (*formerly known as* SRMT)
ARARs	Applicable or Relevant and Appropriate Requirements
ATL	Atlantic Testing Labs
CAB	Cellulose Acetate Butyrate
CAMU	Corrective Action Management Unit
Cat 350	Caterpillar Model 350
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	cubic feet
cfs	cubic feet per second
CLP	Contract Laboratory Program
cm	centimeter
CPR	Canadian Pacific Railroad
CSO	Combined Sewer Overflow
CU	certification unit
CWA	Clean Water Act
cy	cubic yard(s)
DDT	Dichlorodiphenyltricholorethane
DEFT	Decision Error Feasibility Trials
DGPS	Differential Global Positioning System
DMC	Dredging Management Cells
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DQOs	Data Quality Objectives
DSI	Downstream of the dredge area inside the silt curtain
DSO	Downstream of the dredge area outside the silt curtain
EDI	Equal Discharge Interval
EMP	Environmental Monitoring Plan
EPS	Engineering Performance Standards
EQUIL	Software model used to determine chemical equilibrium between the particle-bound solid and the water column or aqueous phase
ESG	ESG Manufacturing, LLC
EWI	Equal Width Interval
FIELDS	Field Environmental Decision Support
FISHRAND	USEPA's peer-reviewed bioaccumulation model

FJI	Fort James Water Intake
fps	feet per second
FRRAT	Fox River Remediation Advisory Team
FS	Feasibility Study
ft	foot
ft^2	square feet
GE	General Electric Company
GEHR	General Electric Hudson River
GCL	Geosynthetic Clay Liner
g/cc	grams per cubic centimeter
g/day	grams per day
GIS	Geographic Information Systems
GM	General Motors
gpm	gallons per minute
GPS	Global Positioning System
HDPE	High Density Polyethylene
HUDTOX	USEPA's peer-reviewed fate and transport model
IDEM	Indiana Department of Environmental Management
JMP	a commercial software package for statistical analysis
kg/day	kilograms per day
lbs	pounds
LWA	length-weighted average
MCL	Maximum Contaminant Level
MCT	Maximum Cumulative Transport
MDEQ	Michigan Department of Environmental Quality
MDS	ESG Manufacturing model #. For example, MDS-177-10
MFE	Mark for Further Evaluation
MGD	million gallons per day
ug/L	micrograms per liter
mg/kg	milligrams per kilogram (equivalent to ppm)
mg/L	milligrams per liter
MPA	Mass per Unit Area
MVUE	minimum unbiased estimator of the mean
ng/L	nanograms per liter
NBH	New Bedford Harbor
NJDEP	New Jersey Department of Environmental Protection
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List

NTCRA	Non-Time-Critical Removal Action
NTU(s)	Nephelometric Turbidity Units
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OBS	Optical Backscatter Sensor
O&M	Operations and Maintenance
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCDFs	Polychlorinated Dibenzofurans
pcf	pounds per cubic foot
PL	Prediction Limit
ppm	part per million (equivalent to mg/kg)
PVC	Polyvinyl Chloride
Q-Q	Quantile-Quantile
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
QRT	Quality Review Team
RCRA	Resource Conservation and Recovery Act
RDP	Radial Dig Pattern
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
RMC	Reynolds Metals Company
ROD	Record of Decision
RS	Responsiveness Summary
Site	Hudson River PCBs Superfund Site
SLRP	St. Lawrence Reduction Plant
SMU	Sediment Management Unit
SOP	Standard Operating Procedure
SPI	Sediment Profile Imaging
SQV	Sediment Quality Value
SRMT	St. Regis Mohawk Tribe Water treatment facility (*former name for* AMN)
SSAP	Sediment Sampling and Analysis Program
SSO	Side-stream of the dredge area outside of the silt curtain
SVOCs	Semi-Volatile Organic Compounds
TAT	Turn-around Time
TDBF	Total Dibenzofurans
TG	turbidity generating unit
TI	Thompson Island
TIP	Thompson Island Pool

TM	turbidity monitoring
TOC	Total Organic Carbon
Tri+	PCBs containing three or more chlorines
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USI	Upstream of the dredge area outside the silt curtain
USO	Upstream of dredge area outside the silt curtain
USS	US Steel
VOC	Volatile Organic Compound
WDNR	Wisconsin Department of Natural Resources
WINOPS	Dredge-positioning software system used to guide the removal of contaminated sediment
WPDES	Wisconsin Pollutant Discharge Elimination System
WSU	Wright State University

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Hudson River PCBs Superfund Site
Volume 4: Technical Basis and Implementation of the Productivity Standard

1.0 Technical Background and Approach

1.1 ROD Requirements Related to Performance Standard for Dredging Productivity

The United States Environmental Protection Agency's (USEPA's) Record of Decision (ROD) for the Hudson River PCBs Superfund Site (USEPA, February 2002) specifies a number of conditions that influence the development of the Productivity Standard. For the purposes of developing the Productivity Standard, the ROD's mandates were placed into two categories:

- Requirements that relate directly to productivity and schedule
- Factors that influence or constrain productivity

The principal elements of the remedy that directly influence the Productivity Standard are as follows (ROD at pp. ii to iii and 94 to 95):

- An estimated 2.65 million cubic yards (cy) of sediment are to be removed from the Upper Hudson River. This estimate was initially developed in the Feasibility Study (FS) (USEPA, 2000).
- Of the 2.65 million cy, an estimated 341,000 cy will be removed for purposes of improving project-related navigation.
- Dredging will occur in two phases: Phase 1 and Phase 2.
- Phase 1 dredging will be conducted initially at a reduced rate, and the results of monitoring during Phase 1 will be used to make any necessary adjustments to operations in Phase 2.
- Phase 2 dredging will be conducted at full scale.
- The design for the project will plan for a construction period of six years.
- The first year will be at less than full scale and the next five years will be at full scale.

In summary, USEPA's objective is to remove sufficient polychlorinated biphenyl (PCB) contaminated sediment from the Upper Hudson River, estimated at 2.65 million cy, in a period of six years in order to meet the objectives stated in the ROD. The initial year of work will entail considerable monitoring of dredging operations to allow evaluation of and adjustments to the dredging program. Full-scale removal operations will then be conducted for five years, during which the remaining targeted contaminated sediment will be removed.

1.2 Direct Implications of ROD Requirements for Productivity

To develop the Productivity Standard for Phase 1 and Phase 2, and to confirm the feasibility of accomplishing the remedy in accordance with the Productivity Standard, it is necessary to view the ROD requirements from the perspective of developing and implementing a construction and materials handling operation. The requirement to remove an estimated 2.65 million cy of sediment establishes the overall scale of the effort but does not, in and of itself, set measurable targets for the remedial work as the project progresses. In addition, although the 2.65 million cy figure is the current best approximation of the volume of sediment to be dredged, this estimate is expected to be revised during the remedial design.

The volume of contaminated sediment referred to in this Productivity Standard is the volume as measured *in situ* in the riverbed. It is estimated to be approximately 2.65 million cy based on sediment sampling data available through the end of 2001. New data from the ongoing sediment sampling program and other analyses begun by GE in 2002 may result in a revision of this volume estimate. A change of 10 percent or less in the overall volume will be addressed by revising the required volume for the final year of Phase 2. However, if the volume of sediment to be dredged changes by more than 10 percent as a result of the current sampling program and final design considerations, the Phase 2 required and target volumes will be adjusted based on the guiding principles and approach that were used to develop the Productivity Standard (refer to Volume 1 Section 4.3). To develop a quantitative and measurable Productivity Standard, the following assumptions were made and applied throughout this chapter:

- The estimated volume of sediment that will be removed is 2.65 million cy, as stated in the ROD.
- Dredging during Phase 1 will require the removal of about 200,000 cy of sediment, with a target for removal of 265,000 cy.
- An average of approximately 490,000 cy of sediment will have to be removed during each of five full-scale dredging years (Phase 2). A target removal objective is set at 530,000 cy per year for the first four seasons of Phase 2 and 265,000 cy for the final season of dredging.
- In the ideal case, there will be a minimum of 30 weeks available each year to conduct dredging operations, and dredging operations will occur seven days per week, as per the FS and the Responsiveness Summary (RS). However, the project schedule will include provisions for some downtime that might result from high river flows and other uncontrollable events.
- Transfer, processing, and transportation (for disposal) facilities will be available to manage dredged sediments at the rate implied by the Productivity Standard.
- The sequence in which the various sediment deposits are dredged will not be influenced by whether the sediment is considered a waste as defined under the Toxic Substance Control Act (TSCA) (*i.e.* contains ≥ 50 mg/kg Total PCBs) or non-TSCA waste (contains <50 mg/kg Total PCBs). A determination of the regulatory status of the sediment will be made by sampling processed sediment prior to loading rail cars or barges for shipment to the disposal site.

Given the above assumptions, it is possible to consider general productivity parameters for the project's full-scale production years. Table 1-1 presents a gross calculation of generalized production rates required to meet the six-year schedule specified by the ROD. These generalized rates are obtained by dividing the total estimated volume to be dredged in a season by the total estimated available calendar time in a season.

Dividing total estimated volume to be dredged per season by the total estimated available calendar time in a season = generalized production rates needed to meet the 6-yr ROD-mandated schedule.

While these generalized rates are presented for illustrative purposes as a starting point for evaluating the equipment and facilities necessary to achieve the Productivity Standard, the actual average weekly and average daily production rates will have to be increased to account for a lack of production on holidays and downtime due to high flow events in the river, breakdowns of equipment, the need to remove unanticipated submerged obstacles, and similar disruptions in the project schedule.

From the perspective of meeting the project's overall goals, the seasonal production rate is most critical. The average monthly rate may be used as a basis for monitoring whether the project is on track toward achieving the seasonal target. The average daily production rate will have the greatest impact on setting requirements for the capacity of transfer, processing, and transportation facilities. Knowing the project's average daily effective time (percent of time the dredge is actually dredging and delivering sediment to the processing/shipping site), it is also possible to estimate the hourly throughput that will have to be handled by various conveyance and processing subsystems. The capacities and redundancies to be designed and built into these subsystems should be based on an assessment of the peak daily and hourly loads that are likely to be generated by the dredging equipment.

Seasonal production rate is critical to meeting the project's overall goals.

1.3 Indirect Implications of ROD Requirements for Productivity

In addition to those elements of the ROD that have a direct bearing on productivity, there are several facets of the ROD that may have an indirect impact on project output. Among the most significant of these are the following:

- Backfilling dredged areas with approximately one foot of clean fill, to isolate PCB residuals and to expedite habitat recovery, where appropriate
- Removal of all PCB-contaminated sediments in areas targeted for remediation with an anticipated residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling)
- Limiting allowable dredging related resuspension rates

The additional equipment and time needed to backfill dredged areas is factored directly into the Productivity Standard. Backfilling is planned for and is treated as one component of the construction activities that comprise the overall program; it will impact project output much the way the other activities do.

The requirements identified in the second and third bullets above are reflected in the Resuspension Standard (see Volumes 1 and 2) and the Residuals Standard (see Volumes 1 and 3). The Resuspension Standard and Residuals Standard will influence productivity and, ultimately, the Productivity Standard. For instance, conforming to the Resuspension Standard may result in the following actions being taken, as appropriate:

- Selecting different dredging equipment
- Implementing contingency measures such as modifying dredge operating procedures or collecting samples more frequently
- Postponing or reducing operations until more favorable river conditions are present
- Delaying operations while monitoring data are evaluated
- Installing turbidity containment barriers around the dredging site, if such barriers are not already in use

Similarly, the Residuals Standard may result one of the following actions being taken:

- Selecting different dredging equipment
- Conducting additional dredging passes within targeted areas or redredging of areas that fail to meet the Residuals Standard
- Constructing an engineered cap over residual sediments in extreme cases where the Residuals Standard is not met despite best efforts to remove the sediments

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1.4 Other Factors Influencing Productivity

A number of other factors, beyond those considered above, may impact project productivity. Among the more significant of these are the following:

- The distribution of targeted sediments within the Upper Hudson River
- Limitations on in-river work imposed by river conditions and the need to maintain traffic on the canal system
- Limitations on in-river work as a result of standards set on equipment noise and air emissions
- The interrelationship of dredging productivity to the location and capacities of transfer, processing and transportation facilities

The first two of these additional factors are addressed in the analysis presented below. The remaining two factors are not evaluated in this document but will be addressed in the project design. With regard to noise, it is assumed that the noise standards set by USEPA will not constrain the productivity of the dredging operations (*i.e.*, noise abatement will either not be necessary or noise abatement technology installed on dredging equipment will not significantly affect the productivity of the equipment). Furthermore, consistent with the ROD, it is assumed that in-river activities and sediment processing and transportation operations are not restricted to certain days or hours.

Since the location(s) and characteristics of sediment processing/transfer facility(ies) are not known at this time, it is not possible to factor into the productivity analysis any constraints on the ability of those facilities to handle dredged sediments. Rather, it is assumed that once the location(s) of the processing/transfer facility(ies) is(are) identified, the facilities will be designed to ensure adequate processing capability to handle incoming sediments at rates commensurate with USEPA's project goal of completing the project in six years. However, processing and shipping considerations have not been ignored in developing the Productivity Standard. Instead, the Productivity Standard has been developed with consideration of the design team's need for flexibility to avoid the problems associated with radical, short-term fluctuations in the volume of sediment sent to the processing/transfer facilities, so that on-site sediment staging requirements can be reduced and off-site transportation needs can be anticipated and coordinated.

1.5 Approach to Development of Standard

The approach taken to develop the Productivity Standard is to:

- Establish minimum productivity requirements for Phases 1 and 2 of the project that meet the requirements of the ROD.
- Identify and evaluate the anticipated field conditions that will impact productivity.
- Obtain, where possible, reports or other information on projects that are similar to the Upper Hudson River environmental dredging project and can provide support to the Productivity Standard.
- Identify typical production rates for available dredging equipment that has been demonstrated to function successfully under the field conditions anticipated in the Upper Hudson River.
- Prepare an example production schedule based upon use of the identified plant and equipment that supports the assumption that the proposed Productivity Standard can be met and the project completed within the time frame established by the ROD.

While the development of the Productivity Standard includes an example production schedule, the design team will develop the actual project schedule as a separate activity. The purpose of the example production schedule is to demonstrate that the performance standards are feasible and can be met using conservative assumptions and at least one selection of equipment from the wide array of such equipment currently available and in use on environmental dredging projects.

2.0 Supporting Analyses

2.1 Recent Projects and Developments in Dredging Technology

To take into account the most current technologies and information available from other dredging sites, a search was conducted on the USEPA web site, and parties associated with other sediment remediation/dredging projects were contacted to update the database developed during preparation of the FS and RS. In addition, follow-up conversations were held with site managers contacted during completion of the FS and RS where it was thought that additional information with regard to dredging, equipment, schedules, constraints, and the like could be obtained. The information obtained from these sources is presented in Volume 5: *Appendix: Case Studies of Environmental Dredging Projects*.

The review of recent projects and developments in dredging technology revealed a number of points that are of interest in developing the productivity standard. Some of the more significant findings are as follows:

Numerous sediment remediation projects employ mechanical dredges with buckets designed to minimize resuspension, and GPS to optimize positioning.

- A large number of sediment remediation projects have been completed or are being designed using mechanical dredges equipped with special buckets designed to minimize resuspension and to produce a flat bottomed cut. Positioning of the dredge and bucket to ensure that sediment is not "missed" is accomplished with global positioning system (GPS) equipment linked to computers on board the dredging vessel. This equipment has been demonstrated to achieve cut tolerances of less than 6 inches when properly operated.

- Many, if not most, projects reviewed made use of some type of containment structure around the dredges to minimize the loss of resuspended sediments to downstream areas. Containment systems ranged from interlocking steel sheet piling to traditional silt curtains.

Resuspension has been addressed through containment systems or careful control of the dredging operation.

- Resuspension has not been a major problem in most instances where containment systems have been used. Where such systems have not been employed, resuspension has been addressed through careful control of the dredging operation and limiting dredging operations during adverse weather or high flow periods. A decision as to whether it is more cost-effective to spend part of a dredging season installing an engineered containment system around an area to be dredged, or to depend on careful operation of the dredges and ancillary equipment to control resuspension, must be made on a site-specific basis and should be addressed in final design.

- Achieving low cleanup levels (*e.g.*, <1.0 mg/kg) has proven difficult under certain circumstances, for example where boulders or other obstacles are present in or underlying the sediment to be removed. In many of the projects reviewed, it was necessary to redredge at least some areas to achieve the target cleanup level, and on some projects the target cleanup level was not reached in limited, extremely difficult areas despite multiple passes of the dredging equipment.

Achieving low cleanup levels has proven difficult in some cases, resulting in the need for re-dredging.

2.2 Analysis of Factors Affecting Productivity

A number of factors may affect the length of time required to complete the Upper Hudson River environmental dredging project, including:

- The actual volume of sediments to be dredged.
- The capacity and production rates of dredging equipment selected.
- The sediment processing/transfer facility(ies) (including the water treatment system).
- The distance from the dredging areas to the sediment processing/transfer facility(ies).
- Any physical limitations on reaching areas targeted for dredging.
- The potential need to conduct a number of passes with the dredge to achieve target clean up goals.
- The rate at which backfill can be placed over dredged areas.
- Engineering constraints imposed on the construction manager regarding resuspension.
- Potential bottlenecks in the transportation networks required for shipping sediments to off-site disposal facilities.
- Poor weather.
- High river flows.

These factors must be taken into account in developing the Productivity Standard to demonstrate that the standard can be met. Some of the more critical factors are discussed below.

2.2.1 Dredging Equipment

Four general types of dredging systems are considered here:

- Mechanical dredges with scow transport
- Hydraulic dredges with hydraulic transport
- Mechanical dredges with hydraulic transport
- Hydraulic dredges with scow transport

Alternative equipment may also be required in some areas, such as around docks, locks, retaining walls, submerged utility lines, and bridge piers, and in shallow water along the shoreline where access by large equipment is limited. This equipment may include small, diver-assisted dredges, amphibious excavators and trucks capable of working in shallow water and on beaches and conveying sediment to scows located in deeper water, and similar equipment not usually associated with major dredging projects.

2.2.2 In-River Factors

Factors affecting the productivity of the various types of dredges and auxiliary operations that are likely to be considered and used in the Upper Hudson are described below.

2.2.2.1 Need to Minimize Resuspension and Residuals

Refer to Volume 1: *Statement of the Engineering Performance Standards for Dredging*, Volume 2: *Technical Basis and Implementation of the Resuspension Standard*, and Volume 3: *Technical Basis and Implementation of the Residuals Standard.*

> *Properly operated hydraulic dredges can function with limited resuspension of particulate matter into the water column.*
>
> *Improvements in bucket design and electronic controls, and properly designed silt barriers also minimize the problem of resuspension.*

Environmental dredging to remove contaminated sediments is inherently slower than navigational dredging because of the care that must be taken to avoid excessive resuspension and ensure that sediment is not "missed" by the dredge. Numerous projects conducted over the past decade show that properly operated hydraulic dredges can function with limited resuspension of particulate matter into the water column. Recent improvements in bucket design and electronic controls have significantly reduced the problem of resuspension when using mechanical dredges (See Volume 5: *Appendix: Case Studies of Environmental Dredging Projects*). The use of properly designed silt barriers to isolate areas being dredged has been demonstrated to prevent the loss of resuspended sediment downstream. Although not required by the Productivity Standard, it is assumed that silt barriers will be considered for control by the design team.

> *GPS and on-board computer positioning software increase accuracy in overlapping cuts, thus reducing risk of missed sediment.*

The use of GPS, coupled to an on-board computer running WINOPS or a similar software package, has been shown to be effective in assisting dredge operators to position a dredge head or bucket to ensure overlapping cuts and reduce the probability of missing contaminated sediment.

However, recent experience has shown that, even where these devices have been used, the problem of residual contamination has not been completely eliminated. In some instances, most notably the 1999-2000 dredging of PCB-contaminated sediments and paper mill sludges in Cumberland Bay in Lake Champlain, inspection of the lake bottom following initial dredging showed that windrows (long heaped rows) and pockets of undredged material remained, despite the fact that GPS equipment was used to control and map dredge passes. Further investigations revealed that the GPS equipment suffered from numerous failures and that wind gusts, which blew the dredge off station, were a problem on a number of days (Earth Tech, 2002).

In the St. Lawrence River, opposite the former Reynolds Metals Primary Aluminum Extraction Plant where PCB-contaminated sediments were dredged from a 35-acre area using derrick dredges equipped with cable arm environmental buckets during the summer of 2001, sampling following initial dredging showed that the dredging had successfully removed the contaminated sediment to the target cleanup level set for the project in 134 of 268 "cells" established at the start of the project for control purposes. The WINOPS system was used to control the derrick dredges and the placement of the buckets, and the initial dredging included some over-cut in an attempt to avoid leaving contaminated material behind.

In this case, fully 50 percent of the cells had to be redredged to remove residual contamination a slightly different situation was thought to be responsible for the need to redredge. This problem of residual contamination apparently resulted from the inability of the bucket used to remove the final layer of PCB-contaminated sediment above a compacted glacial till. Redredging successfully remediated 78 additional cells in one additional pass of the dredge. A second attempt at redredging succeeded in remediating 22 more cells, and 34 cells were redredged three or more times. One cell was dredged a total of ten times and still did not achieve the target cleanup level. A report on the project (Bechtel, 2002) concluded that, in addition to the problem encountered in removing all of the sediment overlying a compacted till, large rock fragments and other obstructions in the dredging area hindered the clean up work. Whatever the reason, the records for this project show that redredging was very time consuming and resulted in very low overall dredge production rates.

2.2.2.2 Shallow Water Depth

The draft of a small hydraulic dredge is usually in the 30-inch range, while larger hydraulic dredges and mechanical dredges have drafts of 3 feet or more. Although a dredge can work from deep water toward the shore or shallow areas of the Upper Hudson River, it will not be able to operate where the post-dredging water depth is less than about 3 feet. The use of a hydraulic excavator or crane with a relatively long boom can extend the range of the mechanical dredge into shallow water to a limited extent but, even under these conditions, some areas of the river cannot be accessed by either a mechanical or hydraulic dredge unless some over-cutting of the riverbed is done.

Material removed by a mechanical dredge typically is deposited in a scow for transport to the treatment and shipping location. Typical scows designed for use on the Champlain Canal have a maximum draft, when loaded, of up to 12 feet and can accommodate a load of about 3,000 tons. An empty scow has a draft of about 1 foot. While a mechanical dredge can operate in post-dredging water depths of around 3 feet, a scow moored in 3 feet of water could not be loaded with more than about 500 tons of sediment and water. A scow located in 6 feet of water could be loaded with a little over 1,000 tons of sediment and water, and this is probably the practical minimum load that could economically be transported from a dredge site to an on-shore treatment and shipping location. Because the scow must be positioned within the reach of the dredge's derrick, excavator arm, or crane boom for loading, the area where a mechanical dredge can function effectively is constrained by the water depth required for the loaded scow.

To overcome this difficulty, some dredging companies, notably Bean Environmental and Dry-Dredge Systems, Inc., have constructed dredges that receive mechanically dredged sediment in a hopper, where it is slurried and pumped through a dredge pipeline to the disposal or materials dewatering site. Such mechanical dredges with hydraulic transport may be useful in remediating portions of the Upper Hudson where the water is too shallow to provide access for loaded scows.

Where contaminated sediments extend to the shoreline or are found along the narrow beaches that line portions of the Upper Hudson, their removal may require the use of land-based equipment or amphibious equipment capable of operating either on land or in water, such as that manufactured by Marsh Buggy, Inc. In some instances where access to the shoreline is relatively easy, the excavated material could be loaded onto trucks for delivery to the sediment processing site. Where access cannot be obtained along the shore, the sediment may have to be loaded onto amphibious carriers and transferred to shallow draft scows located as close to the shoreline as possible.

Small hydraulic cutterhead dredges typically have a draft of from 24 to 30 inches. These dredges can also work from deeper water to shallow areas to create the water depth required to prevent grounding and, because the slurry is pumped through a pipeline, the area in which they operate is not constrained by a need for sufficient water depth to float a scow.

2.2.2.3 Distance to Treatment and Shipping Site

In the FS, it was assumed that two on-shore sediment processing/transfer facilities would be constructed for the project. One facility was assumed to be located near the northern reach of the project and the second facility would be located in the Albany area. While the availability of two separate on-shore sediment processing/transfer facilities might provide more flexibility in the design of the dredging program and facilitate a higher productivity rate, the Productivity Standard was developed with consideration that only one sediment processing/transfer facility (located in River Section 1) might be available. The assumption of one facility was made to be conservative with respect to the schedule, in that it would factor in sufficient time for sediments removed from any location within the Upper Hudson to be transported to one location. Note, however, that the assumption does not reflect a worse case based on available information, which would be one facility at or below the southern extreme of the project area.

There is a practical limit to the distance any given hydraulic dredge can pump sediments through a pipeline without the need for booster pumping stations. This limit is a function of:

- The dredge pump and horsepower.
- The density of the slurry being pumped.
- The diameter of the dredge pipe.
- Any change in elevation between the dredge and the pipeline discharge point.

As the distance pumped increases, the pump discharge rate decreases. Furthermore, to avoid plugging the dredge pipeline, it must be flushed of slurry before shutting down the dredge pump for maintenance, for moving the dredge to a new location, or for adding slurry pipe. The time required to flush the pipeline increases with pipeline length and must be factored into any production schedule that anticipates shutting down the dredge for a period of time each day. Finally, the use of multiple booster pumping stations to extend the distance from the on-shore treatment and shipping location that a hydraulic dredge can work has some additional limiting factors. Multiple booster pumping stations:

- Require additional time in a dredge production schedule for starting, stopping, and refueling.
- Add to the potential for operating problems that may stop production entirely until corrections can be made.
- Increase the time needed for mobilization and demobilization at the beginning and end of each dredging season.

Experience has shown that each in-line booster pump can reduce the effective dredging time by from 5 to 10 percent.

Where the distance from the dredging location is too great for a hydraulic dredge and booster pumps to operate effectively, the dredge can pump to a scow located in deep water at the end of the dredge pipeline. However, the slurry contains a high percentage of water (usually from 85 to 90 percent of the flow), so the scows will only carry a small percentage of their normal load in terms of solids. Thus, hydraulic dredging with scow transport of the sediment will likely be restricted to small areas that are difficult to access, if the method is used at all.

The production rate of mechanical dredges using scows to transport the sediment to the on-shore treatment and shipping locations and hydraulic dredges pumping to scows, which in turn are towed to the treatment and shipping sites, is only affected if an insufficient number of scows is available to ensure that the dredge is able to work continuously while scows are in transit. Provided that the movement of scows through the locks is not unduly restricted by the canal operating schedule or by other navigation on the canal, the distance from the dredge to a sediment processing/transfer facility should not have a major impact on production rates for a mechanical dredge or a hydraulic dredge with scow transport. However, as is noted above, the use of a hydraulic dredge with scows to transport the slurry will require a significantly greater number of scows, as each load will have a low solids content.

2.2.2.4 Sediment Characteristics

The physical characteristics of the sediment are an important factor in selecting the type of dredges to be employed and the method of transporting and dewatering the dredged sediments. A summary of the most recent geotechnical data on sediment characteristics, collected in 2002 and 2003 by General Electric (GE) (GE, 2003; 2004), is shown in Table 2-1. The data cover all the recent sampling results, including the analyses of samples in areas that may not be dredged, and show the range of particle size distribution, plasticity index, bulk density and true specific gravity to be encountered during the project.

2.2.2.5 Thickness of Sediment Layer to be Dredged

Both mechanical and hydraulic dredges are designed with an optimal depth of cut in mind. If a hydraulic dredge is designed to achieve optimal production at a cut of 2 feet per pass of the dredge head, it will not be as efficient at deeper or shallower cut depths. At deeper cut depths, the operator may find that the cutterhead is overloaded or may clog the dredge discharge pipe by trying to pump too dense a slurry at too low a velocity. At a shallower cut, the dredge head will not be completely immersed in the sediment and the slurry will contain a much higher ratio of water to solids than when in a production cut.

Similarly, the bucket on a mechanical dredge is designed for a depth of cut that just fills the bucket when the jaws are moved from a fully open to a closed position. Allowing the bucket to penetrate further into the sediment before closing the jaws will cause the bucket to overflow, increasing the potential for resuspension or, if a completely enclosed bucket type is employed, possibly preventing the bucket from closing tightly. If a thinner layer of sediment is to be removed, the bucket will not be completely filled when it is closed, which would also reduce efficiency and productivity.

The depth of contamination in the Upper Hudson River sediments varies from less than 1 foot to over 6 feet. If a hydraulic, cutterhead dredge designed for an optimal cut of 2 feet per pass is working in an area where 3 feet of sediment is targeted for removal, it may achieve a high production rate when removing the first two feet but a substantially lower production rate when it removes the remaining 1-foot layer. The same will be true for a mechanical dredge using an environmental bucket: it will be most efficient when operating at its optimal cut depth and less efficient when operating at shallower cut depths, as the bucket will not be completely filled when it closes.

2.2.2.6 Boulders, Cobbles, and Debris

Most of the dredging required to remediate the Upper Hudson River will occur in areas outside the navigation channel. The areas outside the channel have not been dredged in the past and are likely to contain a significant amount of debris.

Boulders, cobbles, and debris in the sediments significantly impact dredge production rates.

The presence of boulders, cobbles, and debris in the sediments has a significant impact on dredge production rates, especially for hydraulic dredges. Boulders, large numbers of cobbles, sunken logs, abandoned vehicles, and other debris that cannot be pumped interfere with the progress of a hydraulic dredge. Other debris, such as tree roots and limbs, heavy growths of underwater weeds, old fence wire, cables and similar material can clog the cutterhead, intake pipe, or main pump on a hydraulic dredge and force the operator to shut the dredge down until the material can be cleared.

Boulders and debris can also interfere with mechanical dredge operations by preventing the bucket from closing tightly. If the bucket is not closed when retrieved, the sediment will fall back into the water and cause resuspension. If an environmental bucket is used, with controls and alarms to warn the operator when the bucket is not closed, the operator must reopen the bucket, shift its location, and attempt to close it again until he is sure that it is sealed before lifting it from the river bottom.

For the most part, loose cobbles in the one-foot diameter and smaller range do not interfere with mechanical dredges. Occasional cobbles in this size range will be tossed aside by the cutter on a cutterhead dredge, but numerous stones of this size will make it very difficult for the dredge to retrieve the sediment that generally surrounds the cobbles.

To minimize delays in dredging related to the presence of boulders and debris, visual surveys conducted by divers, ground penetrating radar, and side scan sonar surveys are frequently used to determine where these adverse dredging conditions exist and to plan in advance for coping with them. Hydraulic excavators mounted on workboats and equipped with grapples or other material handling devices are generally used to remove sunken logs, appliances, and other debris, while heavy growths of weeds can be removed with weed harvesters. Boulders and cobbles can be moved to areas outside of the navigation channel that have already been dredged by a workboat operating in close coordination with the dredge, but a loss of production inevitably occurs under these conditions. Environmental buckets mounted on hydraulic excavator booms and equipped with hydraulic pistons to close the bucket can minimize the problem of debris for mechanical dredges but may have secondary problems of maintenance and repair that can impact overall production.

2.2.2.7 Presence of Bedrock and Highly Compacted Sediments

Undulating and scalloped bedrock surfaces and compacted glacial till, which usually contains boulders and cobbles in the Hudson River valley, can impede dredge production rates if found at the base of a layer of contaminated sediment. It is very difficult to remove sediment from the uneven surface of water-eroded bedrock outcrops in the riverbed without leaving some material behind, regardless of the type of dredge employed. Following an uneven, hard surface with the dredgehead on a hydraulic dredge is very difficult and slow. The bucket on a mechanical dredge cannot remove sediment from small pockets and crevices in a bedrock surface and is not designed to sweep a hard, uneven surface clean of sediment. The problem of dealing with residual contamination located in a thin layer over a hard base material is a difficult one and multiple passes of a low production dredge or the need for small, diver-assisted dredges should be expected in such areas if the target cleanup level is to be met.

Highly compacted glacial till located immediately below the contaminated sediment can also decrease dredge production rates. The environmental buckets currently in use for removing contaminated sediments by mechanical dredges are not efficient at cutting into highly compacted material. They are particularly inefficient when employed on a derrick dredge or crane, as these machines depend upon the weight of the bucket to penetrate the sediment. These buckets are more effective if they are mounted on the boom of a hydraulic excavator that can apply downward pressure on the bucket to force it into the compacted material.

2.2.2.8 Interference with Navigation

The Champlain Canal is a popular route for travelers to and from Canada, Lake Champlain, and Albany. Freight traffic has all but ceased on the canal in the last decade due, in part, to the fact that dredging by the New York State Canal Corporation to maintain a 12-foot minimum navigation depth has not been performed because of PCB contamination. Inasmuch as a number of communities and marinas along this route are dependent upon the dollars spent by tourists using the canal system, the dredging operations associated with PCB remediation will have to be conducted in a manner that minimizes interference with boat traffic. This includes:

- Sinking hydraulic dredge pipelines beneath the navigation channel.
- Allowing tourists' boats to pass through locks if they reach them ahead of scows carrying contaminated sediments.
- Avoiding blocking the channel with work boats.
- Maintaining buoys, navigation lights, and markers to identify work zones and protect against accidents.

The extent to which interference with navigation will impede dredging progress and productivity is very difficult to gauge, as it is not known whether the fact that a major sediment remediation project is underway along the canal will discourage tourists from using this route during the project or attract curiosity seekers who want to observe the work. Nevertheless, some delays must be expected due to navigation issues and should be considered when estimating probable dredge production rates for development of a project schedule. An evaluation of the impact on navigation of scows carrying dredged sediment and backfill material through the locks is provided in Attachment A.

2.2.2.9 Length of Dredging Season and Daily Operating Hours

The annual production rate during dredging is dependent upon the length of the dredging season. At present, the New York State Canal Corporation opens the Champlain Canal during the first week of May each year, provided the high flows characteristic of spring runoff from the Adirondack Mountains have subsided, and closes the canal to traffic in early November. Ice does not normally form until mid to late December, and it may be possible to extend the dredging season into early December if the Canal Corporation will agree to keep the locks staffed or by organizing the work such that all of the dredging takes place in a single pool between locks following closure of the canal to normal traffic.

The daily production rate during dredging is affected by the number of hours the dredges can work in a day. Dredging projects frequently continue around the clock, seven days per week, although maintaining, refueling, and moving the dredges to new areas usually require that they be shut down for some time period on a periodic basis. The Canal Corporation establishes the lock operating schedule each year and currently staffs the locks on the Champlain Canal from 7:00 A.M. until 5:00 P.M each day between opening day and about the middle of May, from 7:00 A.M. until 10:00 P.M. from the middle of May to about the middle of September, and from 7:00 A.M. to 5:00 P.M. from that date until the canal closes for the winter. Arrangements would have to be made to staff these locks during the night if transit through the locks is needed beyond the usual schedules (see Attachment A, Evaluation of In-River Transportation).

The daily production rate during dredging is affected by the number of hours the dredges can work in a day.

2.2.3 Implications of Post-Dredging Sampling and Redredging

Sampling of the river bottom will be conducted when contaminated sediment has been removed from an area to the elevation established during design. If this sampling shows that residual contamination above the Residuals Standard criterion of 1 mg/kg PCB still exists, the contaminated areas can be redredged as discussed in the Residuals Standard. It is expected that, in order to avoid delays in the overall program, sampling will be conducted as soon as the design elevation has been achieved and dredging will continue while the samples are being analyzed.

Sampling of the river bottom will be conducted when contaminated sediment has been removed from an area to the elevation established during design.

If extensive redredging is found to be necessary in an area, and if the remaining sediments are amenable to removal by the equipment employed for the initial, production dredging work, that equipment may be used for the redredging process and the project will experience some delay. If the sampling indicates that the residual contamination exists as a thin layer of sediment or small pockets of sediment surrounding obstacles such as large boulders, a different dredge may be employed to remove it while the primary dredging equipment proceeds to other areas of the river targeted for dredging. If the river is to be remediated within the time frame established in the ROD, the project schedule must account for delays resulting from the need to redredge an area. The schedule should reflect the fact that silt barriers and other structures erected to prevent the loss of resuspended sediments downstream, if used, will remain in place until an area has been completely remediated.

2.2.4 Backfilling of Dredged Areas and Stabilizing Disturbed Shorelines

If backfill material is fine-grained soil, backfilling should occur while silt barriers are in place.

The ROD requires that dredged areas be backfilled, where appropriate, with one foot of clean soil. In addition, where dredging has resulted in undercutting banks along the shore, stone fill, gravel, or other stabilizing material will have to be placed to prevent erosion and cave-ins. If the backfill material is fine-grained soil, placing this material is expected to create turbid conditions, and should be done while any silt barriers that may have been erected to isolate an area for dredging are still in place. The rate at which backfill or shoreline stabilizing material can be installed may be affected by:

- The method of placing the material.
- Whether the water depth is sufficient to allow barges loaded with soil to be moored within easy reach of the equipment used to place it.

All disturbed shorelines and all dredged areas should be backfilled before the work is shut down for the winter.

In order to minimize delays in dredging, it will be necessary for placement of the backfill and shoreline stabilization work to begin as soon as an area is deemed clean. This work is likely to have an impact on the rate that dredging can proceed, particularly toward the end of the dredging season, as all disturbed shorelines and all dredged areas should be backfilled before the work is shut down for the winter. Otherwise, banks areas may be eroded and residual contamination in sediments loosened by the dredges may be scoured and transported to downstream areas when high flows occur during the following spring runoff period.

2.2.5 Sediment Dewatering, Water Treatment, and Shipping

Production bottlenecks often occur in dewatering dredged sediments and treating the resulting water.

Experience on other projects has shown that production bottlenecks often occur in the dewatering of dredged sediments and treatment of the resulting water. In fact, many dredging projects involving small volumes of contaminated sediments have been designed such that the rate at which dredging can proceed is limited to the rate that the sediment can be dewatered. For these projects, it has been judged to be more economical to erect small, low-capacity dewatering and water treatment facilities that operate 24 hours per day and limit dredging to less than 8 hours per day rather than to invest in large capacity dewatering and water treatment facilities capable of keeping up with the dredge over a 24 hour dredging period.

Given the scale of the Upper Hudson River project, it is consistent with the ROD and should be economical to erect large, temporary dewatering and water treatment facilities with a capacity that is closely aligned to that of the dredge production rate so that the dredges can operate on a nearly continuous basis. A conceptual design of a dewatering system capable of handling mechanically dredged sediments and of achieving the high production rates required for the project is presented in Attachment B.

2.2.5.1 Mechanical Dewatering of Hydraulically Dredged Sediments

It is expected that the sediment will be mechanically dewatered or otherwise treated for immediate shipment from the area. A number of mechanical systems have been proven effective for dewatering hydraulically dredged sediments. One system, used in a number of recent sediment remediation projects including Cumberland Bay, Deposit N and Sediment Management Unit (SMU) 56/57 on the Fox River, and the General Motors Powertrain facility on the St. Lawrence River (Earth Tech, 2002; Foth and Van Dyke, 2001, and BB&L, 1996), employed shaker screens and hydrocyclones to separate sand and gravel from the dredge slurry and either belt filter presses or recessed cavity filter presses to dewater the silt and clay sized fraction. In this type of system, the dredge slurry is discharged onto a series of shaker screens consisting of a coarse bar screen to remove stones and debris, followed by finer screens that remove gravel and coarse sand.

The effluent from the screens is discharged into a large hopper. From the hopper, the slurry is pumped through a series of hydrocyclones sized to remove the sand fraction, which is discharged onto another shaker screen equipped with a fine screen. The overflow from the hydrocyclones contains the silt and clay sized particles and is usually discharged into tanks where chemicals are added to promote dewatering. From these tanks, the conditioned slurry is pumped into filter presses to separate the solids from the water. These presses can usually produce a filter cake containing over 50 percent solids, by weight. The filtrate water is discharged to a water treatment system for additional treatment prior to discharge back to the river.

Dewatering non-cohesive sediments is relatively easy, as the sediments drain rapidly and are readily removed from the flow.

A condition typically imposed on the dewatering system by designers and by operators of disposal facilities is that the solids must be dewatered to the point where they pass a paint filter test, *i.e.* the solids must be dry enough so that no free water will drip from them when placed in a paint filter (USEPA Method 9095). This is relatively easy and inexpensive to achieve when dewatering non-cohesive sediments consisting of sand and gravel, because these materials drain rapidly and are readily removed from the flow using hydrocyclones and shaker screens. Slurry can be pumped onto a shaker screen and through high capacity hydrocyclone at rates of 2,500 gallons per minute and higher, so only a limited number would be required to handle the flow from a hydraulic dredge pumping 8,000 to 9,000 gallons per minute of slurry. However, nearly all sediments contain some amount of silt and clay sized particles, which must be dewatered using some type of filter press, a centrifuge, or other device designed specifically to handle fine-grained material.

Dewatering hydraulically dredged sediments containing a high percentage of silts and clays is slower, more labor intensive, and more costly.

Hydraulically dredged sediments containing a high percentage silts and clays are much more difficult and expensive to dewater than non-cohesive sediments because most of the dewatering must be accomplished in the filter presses. Capturing and dewatering the fine-grained sediments in recessed cavity filter presses or belt filter presses require careful attention to the chemical conditioning of the slurry and the operation of the equipment. It is slow and labor intensive when compared to using screens and hydrocyclones. Furthermore, the capacity of individual presses is low and cycle times can be long, so a large number of presses are usually needed to keep up with the volume of slurry produced by the dredge.

Data indicate that Upper Hudson River dredged material will be about 60 percent sand and gravel and 40 percent silts and clay.

As might be expected, the sediments targeted for remediation in the Upper Hudson River include some deposits consisting of a high percentage of silts and clays and others that are primarily sand and gravel. Available data on the grain size distribution of the targeted sediments indicate that, on average, approximately 60 percent of the dredged material will be sand and gravel that can be dewatered using screens and hydrocyclones while 40 percent will be silts and clays that will have to be dewatered using filter presses or a similar technology (see Section 2.2.2). However, each deposit is different, and when the dredge is operating in an area where the sediment consists primarily of silt and clay, most of the material processed will have to be dewatered in the filter presses. Thus, if hydraulic dredging is used, the filter presses or other equipment selected to dewater the fine grained sediments should be sized to handle the maximum amount of fine material expected to be dredged on any given day.

Because the slurry produced by a hydraulic dredge usually contains from 85 to 90 percent water, by weight, a great deal of water must be treated prior to returning it to the Upper Hudson River. Water treatment systems typically used in conjunction with mechanical dewatering systems for the remediation of PCB-contaminated sediments employ chemical mixing tanks for coagulants, settling tanks with skimmers to remove settleable solids and any floating oils or foam, mixed media pressure filters to remove particulates, and granular activated carbon pressure filters to remove dissolved PCBs. These treatment systems generally produce an effluent with turbidity of less than one Nephelometric Turbidity Unit (NTU) and PCB concentrations less than 0.064 parts per billion, the normal limit for discharge to a surface water in New York State.

The area requirements for dewatering and water treatment systems associated with a hydraulic dredging project are governed more by space needed for temporary staging of TSCA and non-TSCA sediments, and for rail or truck loading areas, than for the actual dewatering and water treatment equipment. Typically, a mechanical dewatering system capable of handling 4,000 to 5,000 cy of sediment per day requires about 3 acres of usable space, and a water treatment system with a capacity of around 9,000 gallons per minute can be constructed on 1.5 to 2 acres. Buffer space surrounding the facility, construction trailers, decontamination areas, equipment wash down areas, temporary staging areas, rail sidings and loading areas, etc, may require up to 10 additional acres, depending upon topography and layout. Overall, a location with about 15 to 20 acres of useable space will be needed if hydraulic dredging and mechanical dewatering is employed for those portions of the work within pumping distance of the material to be dredged.

2.2.5.2 Dewatering of Mechanically Dredged Sediments

Mechanical dredges are capable of removing sediment at close to its *in situ* solids content. As a result, the amount of water collected with the sediment is significantly less than with hydraulic dredges. Nevertheless, the dredged sediment delivered to the material processing site will be too wet to load directly into rail cars for shipment, and some dewatering and water treatment will be required.

Mechanically dredged sediment will be delivered to the processing facility location by scow. If the trip from the dredging area to the site is long enough for the solids to settle in the scow, some of the supernatant water can be pumped off to a water treatment plant similar to that described for treating water from a hydraulic dredging operation. If the supernatant contains too high a concentration of suspended solids, the liquid can be passed through a filter press prior to delivery to the water treatment system. However, decanting supernatant from the scows will not eliminate enough water to allow the sediment to pass the paint filter test, and additional dewatering steps will be necessary.

The FS described a method of physically stabilizing mechanically dredged sediments by adding Portland cement to bind up the water and change the material into a low grade concrete. It was estimated that the amount of Portland cement needed would be approximately 8 percent of the weight of the sediment. A significant advantage of this method comes from the fact that storage silos for the cement and pug mills or other mixing equipment can be erected on a relatively small facility. The major disadvantage of this method of dewatering is that the weight of the material to be shipped to the disposal site is increased by the amount of cement added and the amount of water that is bound up in the mixture by the cement. Nevertheless, the addition of cement or another binder material to make the sediment pass a paint filter test can be a cost-effective method of reducing the free water if transportation and tipping costs at the receiving facility are low.

Other methods of removing water from mechanically dredged sediments include:

- Processing the sediment in the same manner as used for hydraulically dredged sediments.
- Spreading the sediment on sand beds constructed over a grid of perforated pipe and allowing it to drain by gravity prior to shipping.
- Modifying the transport scows by installing false bottoms and underdrains to promote better drainage during the trip from the dredging location to the unloading site.

The area required for dewatering mechanically dredged sediments is normally less than that required for hydraulically dredged sediments. As in the case of hydraulically dredged sediments, much of the area needed is for staging, loading, and shipping facilities, and support facilities. Where mechanical dredging is employed and the scows are to be unloaded with clamshells, the sediment processing/transfer facility should be immediately adjacent to the Hudson River to avoid the necessity of double handling the sediment. While mechanically dredged sediments can be unloaded from scows using a solids handling pump and piped to a dewatering site some distance from the river, it may be necessary to add water to the sediment to create a pumpable slurry. However, pumping adds to the cost of the project and the added water, if any, must be removed from the sediment or bound up using chemical additives prior to shipping. Where hydraulic dredging is used, the facility can be located away from the Hudson River and the sediment pumped inland through the slurry pipeline.

2.2.5.3 Rail Shipping of Processed Sediment

The ROD calls for the transportation of processed sediments by rail or barge to licensed off-site landfills. Rail facilities in the Upper Hudson River corridor were considered adequate to handle the additional traffic associated with the dredged sediments although there is limited room in existing local rail yards to make up a full train of loaded gondolas or shipping container cars.

An evaluation of the ability to process, load rail cars, and transport processed sediment from a candidate sediment transfer/processing facility at the northern end of the Thompson Island Pool, the Old Moreau Landfill, was presented in the FS and RS. The evaluation concluded that transporting 1,600 tons per day from this location should be possible. This evaluation has been revised to reflect the possibility of transporting all sediments - up to 4,500 tons per day - from this one location. The revised evaluation is presented in Attachment C[1]. This revised assessment indicates that there is sufficient land area available at this location to construct rail sidings capable of holding 45 rail cars simultaneously, together with the necessary sediment processing and water treatment facilities, but cautions that the ability of the Canadian Pacific Railroad to transfer the loaded cars[1] to a local rail yard for assembly into a train needs to be confirmed.

The ability to construct rail loading facilities of an adequate size and capacity to handle the expected volume of sediments will be dependent upon the location(s) ultimately selected for the sediment processing/transfer facility(ies), but it is expected that potential transportation problems can be satisfactorily addressed during facility selection and design. If necessary, processed sediment could be loaded into barges carrying 2,000 tons or more each and transported to another facility with adequate rail sidings and transfer equipment to meet the schedule. Even at a production rate of 6,000 tons of dewatered sediment per day, only three barges would be required, and this should not interfere significantly with the current low level of traffic on the canal.

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[1] This revised evaluation was performed to illustrate the feasibility of achieving the Performance Standard for Dredging Productivity under conservative assumption of one location, rather than a less conservative assumption of two or more locations. The location was selected near majority of dredging (in River Section 1). This evaluation does not suggest that USEPA has selected this location or that the location is considered preferable. Facility siting will be conducted in accordance with the procedures set for in Facility Siting, Concept Document (USEPA, December 2002).

2.2.6 Quality of Life Factors

Quality of life issues that may affect the time needed to complete the project include noise and lights from the dredges and ancillary equipment working on the Hudson River and from the sediment processing/transfer facility(ies), traffic delivering chemicals and fuel to the facility(ies), and similar factors. These factors are the subject of a separate study and report being performed by the USEPA. Quality of Life performance standards will be established (under separate cover) to limit disturbance to the lifestyle of people and businesses along the river and in the immediate surroundings as much as practical. The effect of these "quality of life" standards on the dredging, treatment, and shipping of contaminated sediments is not currently known, but will be taken into account in the schedule for the project as they are developed. The dredging sequence and operations may require adjustment in areas adjacent to population centers and operating marinas.

2.3 Example Production Schedule

> *The actual project schedule will be developed during the design of the project.*

An example production schedule has been prepared to illustrate the feasibility of achieving the Productivity Standard using relatively conservative assumptions and at least one selection of equipment from the wide array of such equipment currently available and in use on environmental dredging projects. It should be clearly understood that the actual project schedule will be developed during the design of the project and may be very different from this example. The actual volumes and locations of sediment to be dredged, the location(s) of the processing and transfer site(s), the need for containment of the dredging areas, the type and capacity of dredging equipment, among other major factors for which assumptions have been made in developing the example schedule, will all be determined during final design. The example schedule is discussed in some detail and presented in Attachment D. Backup for the example schedule is presented in Attachment E. A summary of the major assumptions that were made in developing this schedule and the results of this work is presented below while a more detailed list of the assumptions used is presented in the attachments.

2.3.1 Major Assumptions used in Development of Example Production Schedule

- The volume and location of the sediments to be dredged are as presented in the FS and are based on the analytical results for samples collected during a number of sampling events conducted over the last 25 years. The example schedule assumes that the volume will be 2.65 million cy. However, a new sampling program is nearing completion and it is expected that the locations and volumes used for the example schedule will change when this work is complete.

- A single, sediment processing and transfer facility has been assumed to be located at the northern end of the Thompson Island Pool. Although the FS assumed that two such facilities would be constructed, one at the northern end of the project area and one at the southern end, a single site has been assumed for development of the example schedule based on a belief that this would be a more conservative assumption.

- The sediment processing and shipping facilities will be designed with sufficient capacity keep up with the rate at which sediment is delivered to the sediment processing and transfer facility.

- Dredging and similar work on the river will be conducted 24 hours per day, six days per week. Conducting routine weekly maintenance tasks on dredges and ancillary equipment is anticipated to occur on the seventh day of the week. This is considered to be a conservative assumption since it does not rely on a seventh day of dredging activity. If dredging were to occur seven days per week, a higher rate of production would be achievable.

- Overall, it has been assumed that the effective time available for dredging will average 13 hours per day. No dredging will take place at all on many working days during a construction season, as a significant amount of time is needed to relocate the equipment from one dredging site to another, install and remove sediment barriers, etc.

- The New York State Canal Corporation normally opens the Champlain Canal to traffic during the first week of May and closes the system in the first week of November. It has been assumed that the arrangements can be made with the Canal Corporation to extend the operating season until the end of November, and possibly longer during mild years, and that 24–hour per day access through the locks will be arranged to allow floating equipment to navigate the system. It has also been assumed that, following closure of the locks in the fall, work will still be permitted within a pool between locks for as long as weather and river conditions permit.

- For development of the example production schedule, it has been assumed that silt barriers would be used for all dredging work outside of the navigation channel and would not be removed until the dredging of that area was complete and backfill and shoreline stabilization work was finished.

  This assumption was made so that a conservative scenario could be developed to estimate productivity. The installation and use of silt barriers delays the start of dredging each spring, causes delays in production due to the need to enter the enclosed area through gates in the barrier, and requires the dredging contractor to cease dredging and place backfill over a dredged area early enough in each dredging season to be able to remove the silt barriers before ice forms on the river. Although the use of silt barriers should make it possible to remove debris from the river and dredge at a relatively high rate without as much concern about meeting the Resuspension Standard, the time required to install and remove the barriers detracts from the number of days available for dredging each season. A detailed evaluation of the cost effectiveness of installing silt barriers and a decision on their use will be made as part of the final design process.

- Mechanical dredging has been assumed for the development of the example production schedule under the belief that mechanical dredging will be slower than hydraulic dredging in most instances where hydraulic dredging might be possible (see Attachment F for an evaluation of applicable dredging equipment). Two different size mechanical dredges have been assumed to be available:

  - A dredge consisting of a hydraulic excavator with an extended boom fitted with a 4 cy, hydraulically activated environmental bucket has been assumed to be the primary production dredge used where the depth of water is at least 3 feet following dredging and the thickness of the contaminated sediment layer and volume of sediment to be removed are great enough to warrant such a dredge. A production rate of 82 cy per hour of actual dredging work has been assumed for mechanical dredges of this size and type.

  - A dredge similar to that described above but with a 2 cy, hydraulically activated environmental bucket has been assumed to be used in areas where the sediment layer to be dredged is less than about 2 feet, the water depth is less than that needed for the larger dredge, or the area and volume of sediment to be dredged is small. This dredge would also be used for redredging, if post-dredging sampling indicates that additional sediment must be removed from an area.

    A production rate of 27 cy per hour has been assumed for this smaller dredge when dredging to achieve the original design cut lines. No production rate has been assumed for redredging an area using this dredge, as any production rate would be dependent upon the thickness of the sediment layer to be removed, the total area to be covered by the dredge, and the characteristics of the material to be removed. Rather than assuming a product rate for redredging in terms of cy per hour and making additional assumptions regarding the amount of redredging that might be needed, the example production schedule assumes that redredging will require about one half as much time as needed to achieve the original design cuts established for the project, *i.e.,* if 30 days are required to dredge an area to the design cut lines, 15 additional days have been allowed for redredging work in the same area following sampling and analysis of the initial results.

- The dredged sediment would be placed in scows located where a post-dredging water depth of 6 feet or more is available to provide the necessary draft. The extended booms on the dredges will make it possible for these machines to excavate sediments located at a distance of up to 30 feet from the dredge in shallow water. Where the post-dredging water depth is too shallow to permit scows to be placed in reach of the dredge, it is assumed that other dredging equipment, such as described in Section 2.2.1, and small, shallow draft scows will be used. The assumed production rate for this equipment is 27 cy per hour of actual dredging work.

- Post-dredging soundings to confirm that the sediment has been removed to the design depth and sampling to determine the level of residual contamination remaining, if any, will be carried out as soon as a sufficient area has been dredged to the design grade to permit this work to be done without interfering with the dredging effort. The example production schedule assumes that post-dredging sampling will be completed within a few days of completion of dredging in a particular area and prior to the removal of any silt barriers or other containment structures.

- If all the original inventory of contaminated sediment has been removed in accordance with the final design, and sampling and analysis of the remaining sediment indicates that redredging is required to achieve compliance with the Residuals Standard, the redredging effort will be limited to two attempts at achieving compliance. As has been noted above, for the purposes of preparing an example production schedule it has been assumed that the time required to redredge an area is equal to 50 percent of the time required for removal of the original inventory.

- Although the ROD states that dredged areas will be backfilled, as appropriate, the example production schedule assumes that all dredged areas will be backfilled. It is not possible to know, in advance, how much of the areas targeted for dredging will have to be backfilled, so a very conservative assumption has been made for the extent of this work.

- The shipping of dewatered or otherwise processed sediments from the processing and transfer site to a final disposal site is assumed to be done continuously to meet the requirement that no processed sediments be stockpiled on the site at the end of a construction season for disposal the following year.

2.3.2 Results of Example Production Schedule

The example production schedule, presented in Attachment D, indicates that four primary (4-cy bucket) and six alternative (2-cy bucket) dredges will be needed for a significant portion of the time if the project is to be completed in the six-year period stated in the ROD. However, the number of dredges in operation simultaneously may vary from zero to as many as ten, exclusive of any redredging equipment, for short periods of time. While this upper number could be reduced by using larger dredges in some areas, it indicates that very careful control and scheduling of the dredging effort will be required to minimize delays at locks, a backup of scows at the unloading location, and similar problems.

The example also illustrates that if redredging is required in a given area, it should take place while the production dredges continue to work downstream. If the dredging is stopped to await post-dredging sampling, analysis, and evaluation, and a decision as to whether redredging will be necessary in a given area, the project will not be completed on time.

> *Cessation of dredging to await post-dredging sampling, analysis, and evaluation would prevent on-time completion of the overall project.*

Phase 1 work is anticipated to begin on or around the first of May and be completed by the early December. However, the example production schedule indicates that actual dredging would not begin until mid-June and would be completed by November 7. Mobilization and site preparation would be accomplished during the first six weeks of the Phase 1 construction season and shoreline stabilization, completion of backfilling, winterizing equipment to be left on site, and demobilization would occur during the last four weeks or so.

The example schedule indicates that, during the second year of the project when full scale dredging is underway, actual dredging should begin in early May and be completed by mid October. In the third year of the project, the dredging would begin by May 2 and end by November 12. In the next two years, dredging would begin in the first week of May and end by November 6 and September 29, respectively. In the last year of the project, dredging would be completed by the end of August. The fact that dredging continues late into the fall in some years, and ends sooner in others, results from the selection of areas to be dredged in a given year. A different sequence of dredging would result in different beginning and ending dates than those shown in the example, and any changes in the volume of material to be dredged in a given target area would extend or shorten the time needed to complete that area.

A summary of the volumes assumed to be dredged, the area remediated, and completion date for work each calendar year, taken from the example schedule is presented in Table 2-2.

The example schedule was developed to meet or exceed the Productivity Standard. Table 2-3 compares the volumes dredged in the example production schedule with the Productivity Standard and illustrates that the schedule meets these standards in all years.

While the example production schedule presented herein is based on a large number of assumptions, all of which will have to be confirmed during design of the project, it supports the belief that the project can be completed in the six-year time frame set forth in the ROD. It is anticipated that a final schedule for the project that meets these goals will be developed once sampling of the sediments has been completed, final designs have been prepared, and the work under Phase 1 has been completed and evaluated.

3.0 Rationale for the Development of the Performance Standard

The Productivity Standard - Phase 1 is based on achieving 200,000 cy of production, as measured in the river. The Productivity Standard - Phase 1 is based on a dredging goal that will facilitate the collection of sufficient data to validate the Residuals Standard and the Resuspension Standard. This dredging goal is within the range noted in the ROD of 150,000 to 300,000 cy, and is approximately 40 percent of the average annual production rate for Phase 2. Furthermore, the Productivity Standard - Phase 1 is based on the fact that, as identified in the ROD, Phase 1 will span one construction season and Phase 2 activities will span five construction seasons. Utilizing 2.65 million cy as the total estimated project volume, the total production rate for Phase 2 activities was calculated as follows:

- Phase 1 Required Production Volume = 200,000 cy
- Phase 2 Required Production Volume = 2,650,000 – 200,000 = 2,450,000 cy over 5 years, or 490,000 cy annually

A target dredging rate has also been developed and included in the standard. The project must be designed and scheduled to meet the cumulative annual target volumes, with approximately one-half a typical season's worth of work being completed in the final season. The annual target productivity rate was calculated as follows:

The Phase 2 target annual production volume (seasons 1 through 4 of Phase 2) is (2,650,000 cy – 265,000 cy)/4.5 = 530,000 cy. Therefore, the cumulative target volumes are structured so that 265,000 cy will be designed and scheduled to be removed in the final season of Phase 2

4.0 Implementation of the Performance Standard for Dredging Productivity

4.1 Productivity Threshold Criteria

4.1.1 Productivity Standard – Phase 1

The Productivity Standard – Phase 1, reduced scale dredging, is as follows:

1. The minimum volume of sediment to be removed, processed, and shipped off site during Phase 1 shall be 200,000 cy. Phase 1 must be designed and scheduled to meet the targeted removal volume of 265,000 cy.

2. For a period of at least one month during Phase 1, the minimum production rate shall be the rate required to meet the Phase 2 Performance Standard in order to demonstrate the capabilities of the dredging equipment and the sediment processing and transportation systems.

3. Stabilization of shorelines and backfilling of areas dredged during Phase 1, as appropriate, shall be completed by the end of the calendar year and prior to the spring high flow period on the river. Processed sediment shall not be stockpiled and carried over to Phase 2 for disposal.

4.1.2 Productivity Standard – Phase 2

The Productivity Standard – Phase 2, full scale dredging, is as follows:

1. Based on an estimate of 2.65 million cy of sediment, the minimum volume of sediment to be removed, processed and shipped off site during each of the five years of Phase 2 (full scale dredging) shall be as shown in the middle column of Table 4-1. Furthermore, Phase 2 must be designed and scheduled to meet the targeted removal volumes shown in the right-hand column of Table 4-1. The project must be designed to be completed with a reduced annual volume for the final season of the project (Phase 2, Year 6).

2. Stabilization of shorelines and backfilling, as appropriate, of areas dredged during a dredging season in Phase 2 shall be completed by the end of the work season and prior to the spring high flow period in the river.

3. All dredged material should be processed and shipped for disposal by the end of each calendar year. Processed sediment shall not be stockpiled for disposal the following dredging season.

Phase 1 activities will not only accomplish a portion of the work required to remediate the River, but will also provide data that will be useful for planning the work in subsequent years. USEPA will select the areas to be dredged during Phase 1. It is expected that Phase 1 dredging will be performed in areas exhibiting a range of dredging conditions that might be expected during the full scale project, including dredging in both deep and shallow areas of the river and in areas with differing bottom characteristics. It is further expected that the monitoring program conducted during this phase will provide sufficient productivity and other performance data to refine the project design or the performance standard, as necessary, for the full scale dredging work to be done in Phase 2 (years 2 through 6).

If the total volume of sediment to be removed varies by more than 10 percent from the current estimate of 2.65 million cy, it is expected that the Productivity Standard for Phase 2 and the targeted productivity volumes will be recalculated. The formulas used to develop the Productivity Standard for Phase 2 and the target productivity volumes are described in Section 3 of this document and should be used for recalculating these volumes.

4.2 Monitoring and Reporting Requirements

Implementation of the Productivity Standard will require certain monitoring, record keeping, and reporting activities. At a minimum, the following requirements should be met:

- Dredging productivity shall be monitored and detailed records shall be maintained to document production throughout the duration of the project. Specific monitoring and record keeping requirements will depend upon the dredging methodology employed and will be determined during final design. At a minimum, daily reports of dredging operations shall be maintained on U. S. Army Corps of Engineers (USACE) daily dredging report forms appropriate to the type of dredges in use and summarized at the end of each week and each month.

  At a minimum, the weekly and monthly summaries shall provide information on:

  - locations dredged.
  - number of hours of actual dredging time and gross volume dredged each day and each reporting period.
  - cumulative amount dredged for the season.
  - time required for off-loading scows, if used.
  - weight and moisture content of the dredged sediments.

  Similar information shall be maintained on redredging efforts. In addition, records shall be kept of:

  - locations of backfill and sediment caps placed.
  - volumes of backfill or capping material placed and the hours spent in placing backfill and sediment caps.

- locations and details of shoreline work including shoreline dredging and restoration rates.

The weekly and monthly dredging production summaries shall also provide details on any delays encountered in the work, the reasons for the delays (*i.e.* weather, high river flows, equipment problems, canal traffic problems, quality of life standards, etc.) and the hours lost to production as a result of these delays.

- Overall project productivity shall be recorded daily and summarized weekly and monthly. Weekly and monthly summaries shall provide information on:

  - total tonnage of material processed, shipped from the processing site and stored on the site; concentration and mass of PCBs in the processed sediments.
  - volume of water treated and returned to the river.
  - delays encountered in the overall project including information on the reasons for the delays.

- By March 1 of each year, the construction manager shall provide USEPA with a production schedule showing anticipated monthly sediment production for the upcoming dredging season. The schedule must meet or exceed the cumulative productivity target volume defined by the standard.

- Monthly and annual productivity progress reports shall be submitted to the USEPA for determining compliance with the Productivity Standard. Monthly productivity progress reports will be compared to the production schedule submitted by the construction manager and will be the primary tool for demonstrating whether the project is on schedule. Annual production progress reports will determine compliance with the Productivity Standard and will be used to plan subsequent seasons' dredging work.

- At the end of each month, a monthly progress report shall be prepared and submitted to USEPA for review and comparison to expected production rates as described by the construction manager in his anticipated schedule and required to meet the Productivity Standard. Monthly reports shall be submitted by the 15th day of the following month and shall present weekly, monthly, dredging season, and project totals information.

- Annual reports shall be submitted within 30 days of the end of work each season. The reports shall include, but need not be limited to:

  - a summary of the estimated total volume of sediment dredged, as measured *in situ* in the river.
  - a map showing the locations where dredging, confirmatory sampling and backfilling have been completed and where work is ongoing. The map shall display the general type of ongoing work in each area under

remediation, confirmatory sampling, redredging, backfilling, shoreline excavation and stabilization, containment installation or removal work, etc.

- total weight and average moisture content of sediments shipped off site or added to the temporary stockpiles on the site.
- a graph showing the anticipated cumulative dredging production as necessary to meet the productivity performance standard and the actual cumulative production achieved to date.
- a table, graph or other means of showing the cumulative total mass of PCB released to the lower river from the beginning of the project through the date of the monthly report, and a projection as to whether the cumulative PCB loss to the lower river will be below the of 650 kg restriction for the six-year scheduled duration of the project.
- identification of any problems encountered in meeting the Productivity Standard and steps taken to overcome these problems.

For annual reports only, a copy of each daily dredge production report form and each weekly report in an appendix or appendices to the report document.

4.3 Action Levels

As described in Volume 1 of this document, two action levels for Productivity have been identified: a concern level and a control level. Implementation of the Productivity Standard requires the following actions if these action levels are exceeded.

4.3.1 Concern Level

In any given dredging season, whenever the monthly dredging productivity falls below the scheduled productivity for that month by 10 percent or more, the construction manager shall identify the cause of the shortfall and take immediate steps to correct the situation by adding additional equipment and crews, working extended hours, modifying his plant and equipment or approach to the work, or other steps needed to achieve the necessary production rate and erase the deficit in productivity over the following two months or by the end of the dredging season, whichever occurs sooner.

4.3.2 Control Level

If the monthly productivity falls below the scheduled productivity by 10 percent or more for two or more consecutive months, the construction manager shall provide a written report to USEPA's site manager detailing steps underway or to be taken to erase the shortfall in production that season. If the construction manager fails to erase the shortfall at the end of the dredging season, the construction manager will be subject to action taken by USEPA.

5.0 References

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Tables

Table 1-1
Phase 2 Productivity Parameters

Timeframe	Required Production Rate	Target Production Rate
Dredging Season	490,000 cy/season	530,000 cy for first four seasons of Phase 2, 270,000 cy for final season of Phase 2
Average Weekly [1]	16,300 cy/week	17,700 cy/week [3]
Average Daily [2]	2,300 cy/day	2,500 cy/day [3]

[1] Based on a 30-week schedule.

[2] Based on a 7-day work week.

[3] These are the rates for the 530,000-cy/year seasons.

Table 2-1

Geotechnical Characteristics of Upper Hudson River Sediments

Geotechnical Characteristics of Upper Hudson River Sediments											
Parameter	Units	Number	Mean	Std Dev	Minimum	10%	25%	Median	75%	90%	Maximum
Bulk Density	g/cc	27985	1.1	0.46	0.03	0.5	0.69	1.09	1.49	1.7	2.27
Clay	%	1803	11.8	11.8	0	1.2	2.5	8.3	18	26.4	80
Silt	%	1803	25.7	20.7	0	2.1	5.6	21.8	42.8	55.8	84.9
Fine Sand	%	1803	36.7	21.8	0	9.8	19	34	52.7	68.4	96.7
Coarse Sand	%	1803	3.9	6.4	0	0	0	0.3	5.7	13.7	46.5
Medium Sand	%	1803	14.5	17.3	0	0.8	1.9	6	23	41.2	81
Gravel	%	3161	6.5	13.4	0	0	0	0	5.9	24.5	99.2
Liquid Limit	%	1358	16.9	26.3	0	0	0	0	38	58	166
Plastic Limit	%	1358	2.6	9.8	0	0	0	0	0	0	87
Plasticity Index		115	18.6	12.7	3	7.6	11	16	21	31	92
Specific Gravity	g/cc	1358	2.5	0.2	1.4	2.309	2.42	2.56	2.68	2.7	3.0

Table 2-2
Mechanical Dredging Schedule by Phase and Year

Season	Volume Remediated (cubic yards)	Area Remediated (acres)	Dredging Completion Date	Work Completion Date
Phase 1 (Year 1)	268,977	50	11/07/06	12/14/06
Phase 2 (Year 2)	529,440	78	10/15/07	12/20/07
Phase 2 (Year 3)	601,810	86	11/12/08	12/22/09
Phase 2 (Year 4)	564,533	62	11/06/09	12/22/09
Phase 2 (Year 5)	447,387	53	9/29/10	11/12/10
Phase 2 (Year 6)	237,860	63	8/30/11	11/12/11

Table 2-3
Cumulative Dredge Volumes

Season	Cumulative Volume From Example Production Schedule (cubic yards)	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	268,977	200,000	265,000
Phase 2 (Year 2)	798,417	690,000	795,000
Phase 2 (Year 3)	1,400,227	1,180,000	1,805,000
Phase 2 (Year 4)	1,964,760	1,670,000	1,855,000
Phase 2 (Year 5)	2,412,147	2,160,000	2,385,000
Phase 2 (Year 6)	2,650,000	2,650,000	2,650,000

Table 4-1
Productivity Requirements and Targets

Project Phase and Year [1]	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	approximately 200,000	265,000
Phase 2 (Year 2)	690,000	795,000
Phase 2 (Year 3)	1,180,000	1,325,000
Phase 2 (Year 4)	1,670,000	1,855,000
Phase 2 (Year 5)	2,160,000	2,385,000
Phase 2 (Year 6)	2,650,000 [2]	2,650,000 [2]

(1) The overall completion schedule, if appropriate, will be adjusted in accordance with the USEPA-approved remedial design schedule.

(2) All productivity requirements and target volumes discussed herein are based on the volume estimate presented in the ROD (USEPA, 2001, 2002). The volume estimate of 2.65 million cubic yards is expected to be refined, as described in Volume 1 Section 4.3, as new sampling data are obtained and analyzed during remedial design.

Attachment A
Evaluation of In-River Transportation

1.0 Introduction

The locks on the Champlain Canal have maximum usable dimensions of 300 feet in length by 43.5 feet in width and 12 feet in depth. The normal length of time required to pass through a lock is estimated by the New York State Canal Corporation at 25 to 30 minutes. The New York State Canal System Annual Traffic Report for 2002 indicates that recreational traffic accounted for over 90 percent of the vessels that passed through the locks on the Champlain Canal in that year. About 5 percent of the vessels were state owned, presumably Canal Corporation boats, and the remainder were tour boats, canal boats hired by vacationers, and cargo boats. The month with the most traffic was July.

The lock experiencing the greatest number of vessels was Lock 5 at Schuylerville; 968 vessels, including 940 recreational vessels, 18 tour boats, 1 cargo vessel, and 9 hired boats passed through the lock there. In many, if not most, instances, a number of recreational vessels were passed through the lock at one time, but this information is not broken out in the report. A white paper included in the responsiveness summary that is part of the ROD reports that as many as 20 small recreational vessels have been observed passing through the lock simultaneously. (Master Comment/Response 337804). The reader is referred to this white paper for more information on the impact of project-related vessels on normal river traffic.

The locks on the Champlain Canal are operated on an as-needed basis during regular working hours. In 2002, the regular working hours were from 7:00 AM to 10:30 PM. However, commercial users may arrange for passage through the locks at other times with advance notice to the Canal Corporation. It is anticipated that during the dredging project, arrangements will be made to operate the locks 24 hours per day to accommodate the increased traffic generated by the work boats, scows, sampling vessels and other floating plant needed. Assuming a 24-hour operating schedule and an average of 30 minutes to pass a vessel through a lock in one direction, referred to as a single lockage, 48 lockages are possible in a day.

2.0 Process, Productivity, and Potential Impact to River Traffic

The example production schedule presented in Attachment D indicates that as many as eight mechanical dredges might be operating at one time during the remediation project. Four of these dredges were assumed to be equipped with 2-cubic yard (cy) buckets at an effective production rate of 27 cy per hour for 13 hours per day. The other four dredges were assumed to have 4-cy buckets and an effective production rate of 82 cy per hour for 13 hours per day. A scow would be located at each dredge to receive the excavated sediment, while other scows would be being unloaded at a shore-based processing and transfer site or in transit between the dredges and the processing site.

A typical materials handling scow used for a project of this magnitude should be designed to carry the maximum practical load through the locks. Such a scow, with its attendant push boat, should be about 300 feet in length so that both the scow and push boat can lock through as one unit. In this case, the scow would be about 250 feet long, 40 to 43.5 feet wide, with a draft when fully loaded of no more than 12 feet. A scow of this size will carry a load of between 2,500 and 3,000 tons.

The sediment to be dredged has an average bulk density of 1.1 gram per cubic centimeter (g/cc) and an average true specific gravity of 2.5 g/cc. This translates to an average *in situ* specific weight of about 2,800 pounds per cy of wet sediment. During mechanical dredging, some water will become mixed with the sediment. Experience has shown that the added water is usually in the range of 20 percent of the *in situ* weight. Thus, a cubic yard of wet sediment weighing 2,800 pounds *in situ* on the river bed will weigh 1.2 X 2,800 lbs. = 3,360 lbs, or 1.68 tons, when the added water is taken into account. A scow with a capacity of 2,500 tons will, therefore, hold about 1,500 cy of sediment as measured *in situ* in the riverbed.

The example production schedule assumes that the 4-cy dredges will operate in areas with sufficient water depth to permit a scow to be filled to its capacity with 1,500 cy of sediment as measured *in situ*, while the 2-cy dredges would work in shallow water where the scow could only be filled to approximately 50 percent of its capacity, or 750 cy of *in situ* sediment. At an effective production rate of 82 cy of *in situ* sediment per hour, a 4-cy dredge will fill a scow in slightly over 18 hours, while a 2-cy dredge would fill a 750-cy scow in about 28 hours.

Since the example production schedule assumes 13 hours of effective dredging per day, each 4-cy dredge should be able to fill a scow in 1.4 days, while each 2-cy dredge should fill its scow in 2.1 days. Therefore, on average, four 4-cy dredges would produce 2.8 scow loads per day and four 2-cy dredges would produce 1.9 scow loads per day, for a total of 4.7 scow loads per day.

These figures, however, represent long-term averages. The example production schedule shows that eight dredges are not always operating simultaneously, so in some time periods less than 4.7 scow loads per day will be generated. On the other hand, it is possible that all eight dredges might fill their respective scows on the same day, and that eight scow loads would have to be pushed through the canal system to the processing site, while eight empty scows would have to be delivered to the dredges to allow them to continue work. In addition, it can be assumed that at least one scow load of backfill material will be arriving at the work area most days and at least one materials-handling barge carrying debris from the river will be active. Therefore, on days when the sequence of filling and unloading scows produces the maximum number of passages by these large vessels, as many as 20 scows might have to traverse portions of the canal system to enter or leave the on-shore processing site. If all these vessels must pass through a lock, approximately ten hours of lockage time will be required.

In addition to the passage of scows and push boats through the canal system, a substantial fleet of support vessels will be required to complete the project, including, among others:

- Fuel boats.
- Work boats for installing containment structures.
- Pontoon boats used for sediment and water sampling.
- Survey vessels.
- Boats carrying workers to and from the dredges.

It is anticipated that as many as 20 to 25 additional vessels will to be needed to support the work, and all of these vessels will have to be accommodated in the canal system without unduly interfering with normal traffic. Although most of these support vessels will be much smaller than the scows, and many will be able to pass through a lock together, some impact on canal operations will be unavoidable.

The example production schedule is based on the assumption that a sediment processing site will be located at the northern end of the Thompson Island Pool (TI Pool), and that this site will be constructed with sufficient capacity to handle the full daily dredging production rate established for the full scale project. If so, the sediment dredged from the TI Pool will not have to traverse any of the locks on the canal system unless it is shipped out of the area for disposal by barge. Since approximately 1,560,000 cy, or 59 percent, of the estimated 2,650,000 cy of sediment targeted for dredging is located in the TI Pool (USEPA, 2000), the majority of the traffic will not have to pass through a lock while this area is being remediated. Even if the processed sediment is shipped out by barge rather than by train, the impact on the locks should not be great.

If the processed sediment from the TI Pool is shipped for disposal by barge, it is likely that any barge sent south to the deep channel of the lower Hudson River would be fully loaded. Three fully loaded scows could transport 7,500 tons of processed sediment to the lower river per day, while four scows would be able to transport 10,000 tons per day. Assuming that processing would remove at least the additional water added to the sediment during mechanical dredging, 7,500 tons of dewatered sediment would represent about 5,350 cy of *in situ* sediment, while 10,000 tons per day would be equal to about 7,140 cy, both greater than the average volume and tonnage that would be processed in a typical day. An additional three or four barges per day moving through the seven locks between the TI Pool and the deep water channel in Albany and returning would require about four hours of additional lockage time at each lock and should not significantly impact normal navigation through those locks given the current usage rate. If necessary, the barges could make the passage during the night during times of lower recreational craft usage of the system.

3.0 Area-Specific Assessment

3.1 Lock C-5, Schuylerville

As is noted above, 968 vessels passed through Lock C-5 at Schuylerville in July 2002, or an average of 31.2 vessels per day. If each of these vessels were passed through the lock individually at 30 minutes per lockage, the lock would have been in continuous operation for slightly over 15.5 hours. Since the lock only operated from 7:00 AM to 10:30 PM, or 15.5 hours per day, it would appear that this lock was operating at its full capacity during that time period. However, this analysis is based on an average number of watercraft passing through a lock in a day and ignores the fact that traffic on holidays and weekends is usually higher than on weekdays. Furthermore, a number of recreational vessels can be locked through at one time and it appears that this is usually the case. If, on average, two recreational vessels passed through the lock together, the number of lockages needed would have been reduced from 968 to 498, and the average number of lockages per day would have been 16. If three recreational vessels were locked through together, the number of lockages needed would have been reduced to 341, or an average of 11 lockages per day out of a potential 31 lockages in 15.5 hours of operation.

The actual number of times each lock is filled or emptied per day is not reported in the Canal Corporation's annual report, so statistics on the number of hours each day that a given lock is in continuous operation, either filling or emptying, is not known. However, discussions with staff assigned to oversee the sediment sampling program conducted in 2002 and 2003 indicate that the locks are not, in fact, operating at near their full capacity.

3.2 River Section 2 and Lock C-6

River Section 2, between the Northumberland Dam and the Thompson Island Dam (TI Dam), contains an estimated 502,000 cy of sediments targeted for dredging (USEPA, 2000). Of this amount, approximately 53,500 cy are located in the landlocked section of the river between the Fort Miller Dam and the TI Dam. The 53,500 cy in the landlocked section of the river may be loaded into scows stationed in the land-cut portion of the canal north of Lock 6 and transported to the processing site at the north end of the TI Pool. This material will not have to go through any locks, but may create a minor impediment to vessels moving through the land-cut section, as they will have to maneuver around the moored scows. It may be advisable to widen the land cut somewhat to create additional width at the point selected to load the scows.

The remainder of the 502,000 cy, approximately 448,500 cy, will have to pass through Lock C-6 and the land-cut section of the canal to reach the processing site. Assuming a maximum rate of eight loaded and 8 empty scows passing through this lock on a peak day, approximately 8 hours of lockage time will be required. If an additional 2 or 3 other large work boats and up to 25 smaller support vessels must also traverse this lock in each direction on the peak day, the lock could be tied up with project related traffic for as much as 15 hours. In 2002, the peak monthly usage at Lock C-6 occurred in July, when 873 vessels passed through this lock.

Project-related vessels could have a measurable impact on recreational and other traffic at this lock, particularly on holidays and weekends when it sees the most traffic from local recreational users of the canal. To minimize this impact, it may be necessary to provide a dock for some of the support vessels such as construction inspector's boats, sampling boats, and other small craft south of Lock C- 6 and carry workers to and from the dock by car or van rather than sailing all of these vessels north to a dock in the TI Pool each day. The movement of critical scows, debris barges, and backfill barges through the lock should be possible in 10 to 12 hours of lockage time and could, if necessary, all be done during the evening and night when other traffic is limited or non-existent.

3.3 River Section 3

Approximately 562,000 cy of sediment are targeted for dredging in River Section 3 (USEPA, 2000) , generally located as follows:

- About 224,800 cy between Locks C-4 and C-5
- About 172,000 cy between Locks C-3 and C-4
- About 83,900 cy between Locks C-2 and C-3
- About 18,500 cy between Locks C-1 and C-2
- About 9,000 cy between Lock C-1 and the Federal Dam at Troy

Dredging in these areas of the river is expected to occur during the last two years of the project when the work north of Lock C-5 has been completed.

If all of the dredged sediment from River Section 3 is transported north to a processing site at the northern end of the TI Pool, it will have to pass through all locks upstream of each dredging location. The barging of 9,000 cy of sediment north from below Lock C-1 will have little noticeable impact on traffic at Lock C-1, as only 6 or 7 scow loads are targeted for dredging between Lock C-1 and the Federal Dam. Between Locks C-1 and C-2, approximately 18,500 cy are targeted for dredging and will result in from 12 to 13 scow loads passing through C-2, in addition to the six or seven scows arriving from south of Lock C-1. Locks C-3, C-4, and C-5 will see increasingly more scow traffic, but no lock is expected to be overtaxed.

3.4 Summary

In summary, it is judged that the lock capacity along the Champlain Canal is currently adequate to handle the increased traffic related to the remediation of the river without unduly interfering with other traffic, provided that arrangements are made to operate the locks 24 hours per day and provisions are made to moor the large fleet of support vehicles overnight within the pools in which the dredges are operating. Congestion and delays at locks can be minimized by limiting the movement of project related vessels through the locks to essential trips by scows, debris barges, backfill barges, and other equipment that must traverse the canal system and scheduling at least some of the trips by large vessels for nighttime hours on holidays and weekends during the peak recreational season.

Attachment B
Conceptual Design of On-Shore Dewatering and Water Treatment Processes

1.0 Introduction

In developing the example production schedule described in Attachment D, it was assumed that on-shore processing and shipping facilities would be designed with sufficient capacity to handle the maximum daily output from the dredges. In order to support this assumption, and at the recommendation of the peer review panel, a conceptual design of an on-shore sediment processing facility has been developed for the mechanical dredging scenario described in the example production schedule. As in the development of the example production schedule, it has been assumed that only one site for processing sediment might ultimately be developed, even though the ROD anticipates that two or more sites might be used. The assumption that all sediment unloading and processing must be conducted at one site is judged to be more conservative than an assumption that two or more sites will be available to reduce transport distances along the river and unload and process the wet sediment.

A schematic process flow diagram has been developed for the sediment dewatering process and is included herein as Figure B-1. The water treatment plant concept is described without the presentation of a process flow diagram, as this plant is relatively simple and the technology is well known. Inasmuch as the site(s) has not yet been selected for sediment processing, no site layout has been attempted. However, the area required for the equipment and facilities proposed in this conceptual design have been estimated and shows that the necessary facilities can be accommodated on a site of about 20 acres.

It should be emphasized that General Electric (GE) is currently preparing designs for the project that may vary significantly from that which is discussed in this attachment. This conceptual site design should not have bearing on the design selected by GE and its consultants. It is merely presented to show that at least one method of processing the sediments is available and that the project is feasible.

2.0 Sediment Processing Facility Design Considerations

2.1 Sediment Processing Rates

The rates at which sediment is dewatered and water is treated are dependent upon the type of dredges used and the method of transporting the sediment to the processing site. For consistency with the example production schedule, the conceptual design described herein assumes that mechanical dredges will be employed and that the sediment will be transported to the processing site in hopper scows. In developing the conceptual design the following rates have been assumed:

- A maximum of eight scows could arrive at the processing site in a day, four carrying 1,800 cy each and four carrying 900 cy each, for a total of 10,800 cy of slurry. Each scow will contain about 80 percent sediment as measured *in situ* with 20 percent additional water, by volume, added during dredging.

- A "typical" production day would produce about 5,670 cy of *in situ* sediment and send about 6,800 cy of slurry to the processing site, after accounting for the water mixed with the *in situ* sediment during mechanical dredging. This calculation assumes that four dredges are achieving a production rate of 82 cy /hour, four dredges are producing 27 cy/hour, and all eight dredges operate effectively 13 hours per day. (For comparison purposes, a nominal target dredging production rate of 500,000 cy/year of *in situ* sediment would produce an average daily sediment volume of 2,857 cy of *in situ*, or 3,428 cy of slurry based on 175 days of dredging.)

- The specific weight of the slurry delivered to the processing site in the scows will be approximately 95.8 pounds per cubic foot (pcf) and its solids content will be about 58 percent. These calculation is based on an average bulk density of the *in situ* sediment of 1.1 grams per cubic centimeter (g/cc) and a true specific gravity of the solids of 2.5 g/cc, the mean values measured by GE during the 2002 and 2003 sampling program. The specific weight of the slurry and solids content has been adjusted for the water added to the *in situ* sediment during dredging. This translates into the following weights and volumes for the typical day:

Volume of slurry delivered to site:	6,800 cy/day
Weight of solids delivered to site:	10,201,550 lb/day = 5,100 tons/day
Weight of water delivered to site:	7,387,330 lb/day = 885,770 gal/day
Total weight of slurry delivered:	17,588,880 lb/day =8,794 tons/day

2.2 Disposal Site Docking, Unloading, Desanding, and Flow Equalization Facilities

2.2.1 Docking

The docking and unloading facilities at the processing site must be adequate to receive and unload a maximum of eight scows in one day. While the arrival of eight scows at the site in one 24-hour period is expected to be a rare event, it is important that there be no delay in unloading, as empty scows must be returned to the dredges if they are to keep working. If a maximum of eight scows must be docked, unloaded, and sent on their return trip to the dredges in 24 hours, each scow must be unloaded in less than three hours, on average. It should be noted, however, that some of the scows will carry 1,800 cy, while some arrive with only 900 cy of slurry.

Even if scows are to be unloaded in three hours or less, the docking area should provide room for at least four scows. Assuming that the total length of a scow and push boat together is 300 ft, the portion of the dock allocated to unloading should be at least 1,200 ft long. This would provide room for up to four scows to be docked simultaneously. When one scow is unloaded, it would be moved away from the dock by a push boat and retuned to the dredging area. The remaining scows at the dock would be moved along the wharf by push boat or electric winches to the unloading station.

2.2.2 Unloading and Desanding

The conceptual design for the docking and unloading facilities includes:

- A hydraulic pump-out system to remove the slurry from the scows.
- A hydrocyclone and screening tower to remove sand and gravel from the slurry.
- An equalization basin to receive the desanded slurry.

Inasmuch as the slurry in the scows is expected to contain about 58% solids, by weight, it will be necessary to dilute this slurry prior to pumping it. Accordingly, the conceptual design provides for recycling supernatant from the equalization basin to the pump-out unit to reduce the percentage of solids to a range of from 30 to 40%. This recycled water must also be pumped, and the pump-out system must be sized to account for it.

In selecting the capacity of the hydraulic pump-out system, it has been assumed that the slurry arriving at the site will be diluted from a solids content of about 58%, by weight, to about 30%. This dilution requires the addition of approximately 1.4 cy of recycle water to each cubic yard of slurry in the scow. Therefore, 10,800 cy of slurry delivered to the dock will require the pumping of about 25,920 cy (2.4 X 10,800 cy) of slurry. This is equivalent to about 5,235,000 gallons of slurry. Allotting 20 hours to pumping out the scows and the remaining four hours to docking and pulling the scows away from the dock after unloading, the pump-out unit's capacity should be about 4,400 gpm.

In the conceptual design, the hydraulic off-loader pumps the diluted slurry from the scows to the top of a hydrocyclone and screening tower designed to remove sand and gravel from slurry. The top of this tower contains a shaker screen sized to remove vegetation, roots, bottles, and other material, including stones, in excess of one inch in diameter. The slurry that passes through this screen enters a battery of hydrocyclones sized to separate gravel and coarse sand from the flow. The overflow from these hydrocyclones falls to a second battery of hydrocyclones sized to remove medium and fine sand from the flow. The overflow from this second battery of hydrocyclones contains the silt and clay-sized particles, wood chips, and other material with a low specific gravity, and discharges into an equalization basin.

The gravel and sand removed in the hydrocyclones fall through chutes onto a second shaker screen where any free water drains to the equalization basin. The shaker screens discharge to a conveyor, which places the sand, gravel, and oversized debris into a stockpile or containers. This material should pass a paint filter test for free water and be suitable for shipping to disposal without further processing.

2.2.3 Flow Equalization

The equalization basin should be sized to receive at least one day's production by the dredges, plus an allowance for water from decontamination stations and storm water runoff from stockpiles and other areas of the site where PCB-contaminated sediments are handled. On the rare days that eight dredges containing a total of 10,800 cy of slurry must be unloaded in a 24-hour period, the net volume of slurry discharged to the basin would be 2,181,000 gallons. The volume of storm water runoff produced during a one-inch rainfall on 15 acres (that portion of the 20 acre site that will be used for handling PCB-contaminated sediment), assuming that 90 percent runs off into the basin, is approximately 406,000 gallons. For conceptual design purposes, a 3 million-gallon basin has been selected to provide somewhat more than a full day's storage on those days. On a more typical day when about 6,800 cy (1,374,000 gallons) of slurry are delivered and there is no significant rainfall, a 3 million-gallon basin will provide slightly over two days' holding capacity.

The basin would be constructed by excavating a depression and using the excavated soil to construct low earthen berms. The basin would then be lined with a heavy duty, high-density polyethylene geomembrane. Assuming that the basin is designed to hold an eight-foot depth of slurry, with two ft of freeboard to the tops of the berms, it would occupy an area of about 1.5 acres.

2.3 Fine Sediment Dewatering Facilities

The equalization basin described above will provide for storage of excess slurry on days when the dredges produce more sediment then expected under "typical" operating conditions. This storage capacity reduces the processing rate required of all processes downstream from the basin, including the dewatering of fine sediment and treatment of the resulting water. Furthermore, the screening and hydrocyclone tower included in the conceptual design removes a portion of the sediment from the flow stream and diverts it to the stockpiles of material ready for shipping to a disposal site.

Hydrocyclones and screens are very efficient at removing sand and gravel from a slurry stream, provided that they are operated correctly, and can separate sand and gravel from a slurry containing a large proportion those sediments from the finer silts and clay particles. The slurry remaining after desanding with screens and hydrocyclones will contain a preponderance of silt and clay and will be difficult to dewater. This is the slurry that will be temporarily stored in the equalization basin for further processing.

Typically, for projects where mechanical dewatering of the fine sediment is necessary, it is accomplished using filter presses or centrifuges. The conceptual design proposed herein employs recessed-cavity filter presses that depend upon water pressure to compress and dewater the silt and clay. These filter presses contain a series of cavities or pockets that are lined with fine screens. Chemicals, usually lime or a synthetic polymer, are added to the slurry to improve its dewatering characteristics and the slurry is pumped into the press cavities by a feed pump.

The solids are trapped by the screens in the cavities while the water passes through the screens and out of the press to a water treatment plant. As the cavities become filled with solids, the screens become plugged, the pressure drop across the screens and trapped solids increases, and the amount of slurry pumped by the feed pump diminishes rapidly. When the pressure drop across the screen cavity has risen to a high level, usually in excess of 100 to 200 pounds per square inch, a pressure switch is tripped to shut the pump off. The filter press is then opened and the solids trapped in the cavities fall out onto a conveyor belt. The feed lines are then blown clean with compressed air, the press closed, and the feed pump restarted to begin a new cycle. The time needed to fill, empty, and prepare the press for the next fill cycle is referred to as the press cycle time.

Filter presses are available in a wide variety of capacities and styles. The capacity of a truck mounted, portable press is usually in the range of 100-cubic feet (cf) and would be too small for a project of the magnitude considered herein. Larger presses, which must be assembled on site from component parts, are available, and presses that produce at least 200 cf of dewatered filter cake per cycle have been selected for this conceptual design. Experience has shown that these filter presses can generally produce a filter cake containing 60% solids, by weight, from a clay and silt slurry.

The amount of silt and clay that must be dewatered in a day, the solids content of the slurry, and the time required to fill, empty, and prepare a filter press for the next fill cycle are all important in determining the number of filter presses required for a particular project. The physical properties of the sediment in the Hudson River vary from nearly all sand and gravel to nearly all silt and clay, depending upon whether the sediment is found in a region of high stream velocity where only the heaviest particles will settle out or in a backwater area where silts and clays may be deposited.

As seen in the Productivity Standard volume, the mean clay content of all the samples analyzed by GE during the 2002 and 2003 sediment sampling program was 11.9%, while the mean silt content was 25.7%. The maximum clay content of any sample was 80%, while the maximum silt content measured in any sample was 84.9%. For conceptual design purposes, the filter presses have been sized to dewater sediment containing 80% silt and clay-sized particles, assuming a typical day when 6,800 cy of slurry arrive at the processing site unloading facilities. This is considerably above the silt and clay content found for the average sediment sample and is judged to be conservative, particularly since it is unlikely that eight dredges would all be operating simultaneously in areas where the silt and clay content are considerably above the mean for the river as a whole. This high silt and clay content gives rise to some particular problems as will be described below.

A typical day's delivery of 6,800 cy of sediment equates to a weight of solids in the sediment of approximately 10,201,550 lb/day, or 5,100 tons/day. The weight of water delivered would be 7,387,330 lb/typical day. Assuming that the slurry contains 80% silt and clay-sized solids and 20% sand and gravel, and that essentially all of the sand and gravel but none of the silt and clay are removed from the slurry in the hydrocyclone and screening tower, the slurry reaching the equalization basin will contain 0.80 X 10,201,550 lb = 8,161,240 lbs of solids.

Although the sand and gravel removed from the stream by the hydrocyclones and screens will contain some moisture, the amount of water diverted with the sand and gravel is considered negligible and has been ignored. Therefore, the silt and clay slurry will still contain essentially all of the water delivered in the scows, or close to 7,387,330 lbs, and the total weight of fine sediment slurry that will have to be processed in the filter presses will be 8,161,240 lbs solids + 7,387,330 lbs water = 15,548,570 lbs total. The solids content of this slurry in the equalization basin will be 8,161,240/15,548,570 = 52.5 %, assuming that the basin is not receiving a substantial amount of storm water runoff at the same time.

The conceptual design assumes that the solids content of the filter cake produced by the presses will be 60%. To achieve this, some water must be removed by the presses and sent on to the water treatment plant. If the solids content of the filter cake is 60% and equals 8,161,240 lbs of solids, the total weight of the filter cake is 13,602,067 lbs. The amount of water in the filter cake will be 5,440,827 lbs. Since the slurry sent to the presses contained 7,387,330 lbs of water, the water removed by the presses during this typical day would be 1,946,503 lbs.

While this estimate is simplistic, since it ignores the addition of some storm water, backwash water, and clarifier blow-down from the water treatment plant, water from decontamination procedures, and chemicals added to the slurry to condition it for dewatering, it is sufficiently close to what is expected to permit an estimate of the number of filter presses required. If the additional water and solids from extraneous sources were

accounted for, the amount of water sent on to the water treatment plant and the amount of filter cake produced would actually be somewhat greater.
In estimating the number of filter presses required to process the silt and clay sediments delivered to the site, the volume of filter cake produced must be estimated. As noted above, the filter cake contains an estimated 5,440,827 lbs of water. This is equivalent to approximately 87,193 cf. Assuming that the solids in the cake have a true specific gravity of 2.5 g/cc, or 156 lbs/cf, the volume of the silt and clay will be 52,316 cf and the volume of the filter cake will be the sum of the volumes of water and solids, or 139,509 cf.

In order to produce a volume of 139,509 cf of filter cake in one day using filter presses that produce only 200 cf per press cycle, approximately 698 press cycles will be required. GE is currently planning a number of treatability studies to determine the time required to complete a press cycle using different dewatering chemicals and the solids content of the filter cake, but this information is not available as yet. Therefore, for conceptual design purposes, a press cycle time of one hour has been estimated based on past experience with dewatering dredged sediments.

Assuming that each press can achieve 24 press cycles/day and produce 200 cf of filter cake per cycle, a single press will produce 4,800 cf of filter cake per day. To produce 139,509 cf of filter cake in one day, 29 filter presses of this capacity would be required. For conceptual design purposes, it has been assumed that 30 presses would be installed to provide capacity to dewater the extra solids contributed to the process by the addition of dewatering chemicals to the slurry, water treatment plant residuals, and solids contained in storm water runoff and decontamination procedures. If presses with a higher capacity were installed, or the cycle time can be reduced, the number of presses required would be less.

It should be noted that the estimate of the number of presses required has been made for a day during which 6,800 cy of slurry is unloaded from the scows and the sediment contains 80% silt and clay-sized particles. If, on the rare day when a maximum of 10,800 cuds of slurry might be delivered to the site and the slurry contained 80% silt and clay-sized particles, the presses would not be able to process all of the sediment. The excess sediment would be stored in the equalization basin until the following day when less slurry arrived for processing. As is noted above, the possibility that any day’s dredging production will contain 80% silt and clay sized particles is very low, and it would be extremely unusual for this condition to exist on a day when 10,800 cy of slurry arrives for processing. In any event, the filter presses would operate seven days per week, while dredging would be done six days per week, so any accumulation of slurry in the equalization basin due to an occasional high production day should be eliminated by the end of each week.

Whenever the sediment arriving at the site for processing contains a high percentage of silt and clay, the percentage of the sediment that must be dewatered in the filter presses will be high. The geotechnical data indicate that, on most days, the sediment will contain less than 50% silt and clay and more than 50% sand and gravel. Since the sand and gravel will be removed at the hydrocyclone and screening tower, the slurry reaching the equalization basin will contain less solids and less use of the filter presses will be needed. A special problem that will arise on those days when the slurry contains a high percentage of silt and clay concerns the means of transferring the desanded slurry from the equalization basin to the chemical mixing tanks at the head of the filter press process. As noted in the preceding example, if the slurry contains 80% silt and clay, the solids content in the equalization basin will be approximately 52.5%. This is a thick slurry and will be difficult to pump. To transfer this slurry to chemical mixing tanks, the conceptual design employs a small hydraulic dredge with a pump capacity of approximately 1,500 gpm.

To avoid damaging the basin liner, a plain suction dredge or a horizontal auger dredge with the auger equipped with tires to prevent it from touching the liner would be required. This dredge would travel up and down the length of the basin on a cable and would operate automatically. However, the dredge might have difficulty pumping a slurry containing 52.5% solids, by weight, and it is anticipated that the slurry in the basin may have to be diluted somewhat by recycling water discharged from the filter presses to the basin (rather than sending it directly on to the water treatment plant) until such time as the solids content in the basin is reduced to more normal levels.

Since recycling cannot be continued for a long period of time without completely filling the equalization basin, this problem could conceivably create a bottleneck in the system that would force a reduction in the rate of dredging. When GE completes its review of the sediment sampling data from the 2002 and 2003 sampling program, identifies the areas to be dredged, evaluates the silt and clay content of each area, and develops a tentative schedule for the dredges working in each area, the significance of this potential problem should be evaluated further.

2.4 Water Treatment Plant

The conceptual design includes a 2.0 million gallons per day (MGD) water treatment plant to treat water from the dewatering operations and an estimated 400,000 gallons per day of storm water runoff during a one-inch rainstorm. It should be noted that a plant this size is adequate for mechanical dredging operations, where the slurry does not contain a large amount of entrained water. A plant for a hydraulic dredging operation would require six or eight times more capacity, but could be constructed with the same unit processes.

A typical water treatment plant used for dredging projects consists of a rapid mixing basin, flocculation chamber, settling basin, and mixed media filters to remove solids from the stream and granular activated carbon filters to remove dissolved PCB. Such plants can be purchased from the manufacturers of packaged water treatment systems or assembled from diverse components available for lease from a number of companies. The water treatment technology is well known and has been used on so many PCB contaminated sediment remediation projects that it will not be described further.

2.5 Site Area Requirements

As noted above, the docking and unloading facilities should include at least 1,200 ft of dock area along the river. In order to provide space for the hydraulic pump-out equipment, unloading occasional scow loads of debris removed from the river, and accessing the floating equipment at the dock, the dock should extend at least 75 ft back from the water's edge. Assuming dimensions of 1,200 ft by 75 ft, the dock area will occupy approximately 2.1 acres.

The hydrocyclone and screen tower will have a footprint of approximately 400 sq ft and will need an associated stock pile or container area to receive the sand and gravel removed from the slurry. A total area of approximately 100 by 150 ft, or 0.34 acres, is estimated for the tower and stockpile or container parking area.

The proposed equalization basin size was described in subsection 2.2.3 as requiring an area of approximately 1.5 acres. The area occupied by the filter presses, chemical storage, chemical mixing tanks, filter press feed tanks and filter press feed pumps is estimated at 1.3 acres, while a storage pad to receive the filter cake as it is dumped from the presses is estimated to occupy about 0.75 acres. The water treatment plant will occupy an area of approximately 0.25 acres.

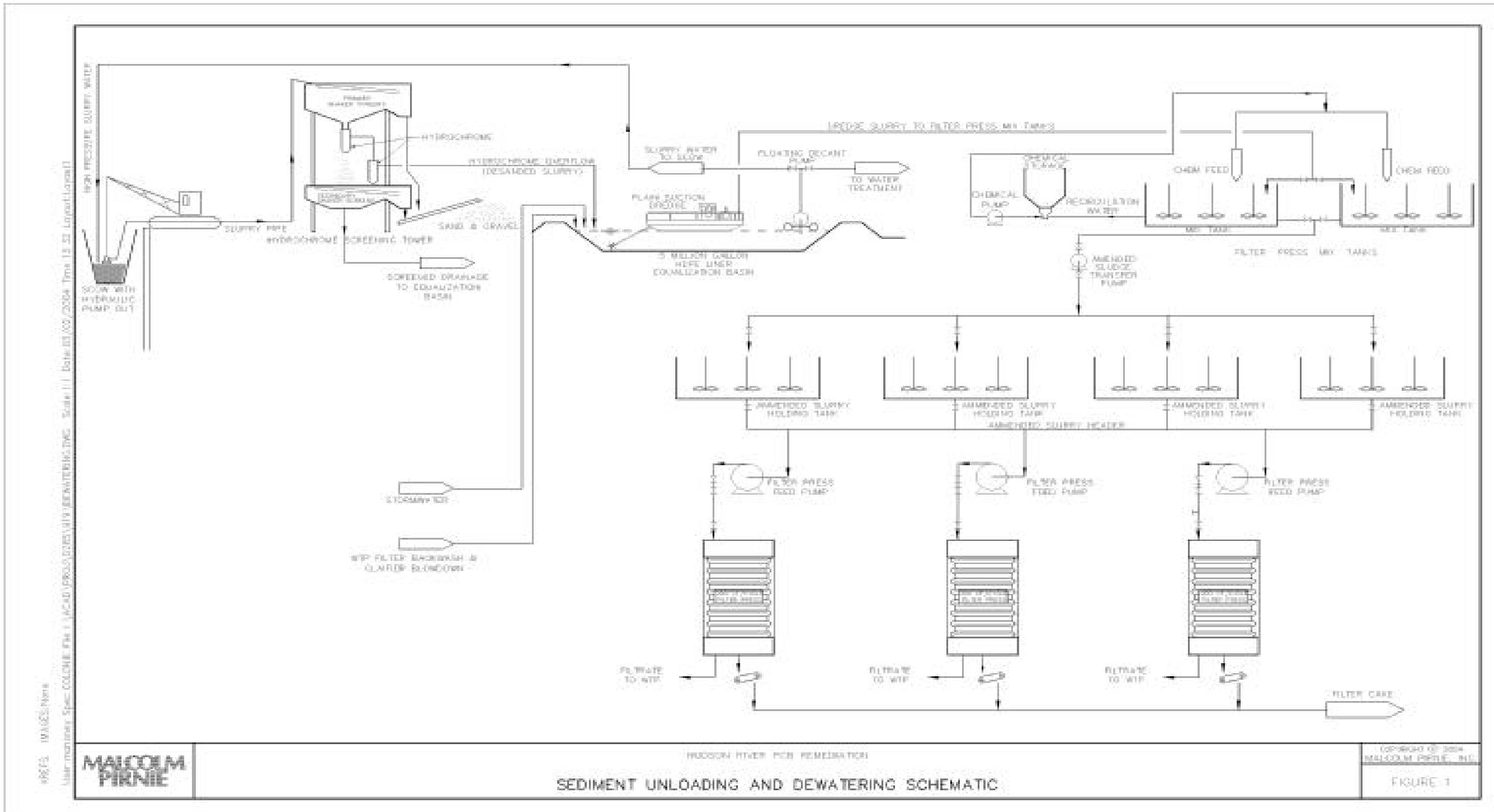
Office trailers and worker parking will be required on the site, although the area needed for parking could be reduced by off-site parking arrangements. Assuming that five office trailers will be located at the site and that parking space for up to 50 cars at one time would be provided, the area required for these facilities will be approximately 0.75 acres.

The largest area requirements are associated with the need to stockpile processed sediment for loading onto railcars or barges, and the railroad sidings needed to load rail cars, if that mode of transporting the sediment to an off-site disposal area is selected by GE. A stockpile capable of holding at least 20,000 cy of dewatered sediment should be available to provide for a steady loading rate. Such a stockpile, with sufficient room to maneuver loading equipment around it, would require about two acres and a larger area would be desirable. A railroad siding capable of holding up to 45 gondolas or container cars at a time is estimated to occupy nearly three acres, provided that the site topography does not require a large embankment or cut to install the siding.

A summary of the areas required for the various processing equipment, stockpiles, and ancillary uses is presented in the table below. As shown in this table, the total area required would be about 18 acres. The sites under consideration provide for at least this much area and most sites are considerably larger.

Table B-1
Summary of Area Requirements for Sediment Processing Site

Description	Area Required, Acres
Docking and Scow Unloading at River	2.1
Hydrocyclone and Screening Tower with Associated Storage Pad	3.4
Equalization Basin	1.5
Filter Presses and Associated Tankage	1.3
Filter Cake Storage Pad	0.75
Water Treatment Plant	0.25
Office Trailers and Worker Parking	0.75
Processed Sediment Stockpile Area	2.0
Rail Siding and Loading Equipment	3.0
Miscellaneous Pipelines, Lighting Poles, Roadways, Drainage Swales, etc.	3.0
Total Estimated Area	18.05 Acres


HYDROCHROME SCREENING TOWER
SLURRY PIPE
SAND & GRAVEL
CHEM FEED
FILTER PRESS MIX TANKS
AMMENDED SLURRY HEADER
FILTER PRESS FEED PUMP
FILTRATE TO WTP
FILTER CAKE
MALCOLM PIRNIE
HUDSON RIVER PCB REMEDIATION
SEDIMENT UNLOADING AND DEWATERING SCHEMATIC
FIGURE 1

Attachment C
Issues Associated with Processing Full Production Volumes at the Old Moreau Landfill Candidate Processing/Transfer Facility Site

1.0 Introduction

During preparation of the Feasibility Study (FS) and Responsiveness Summary (RS), consideration was given to the availability and capacity of sites for transferring and processing dredged sediments. The conclusion reached at that time was that it would be preferable to identify at least two transfer/processing sites so that both in-river transport difficulties and the scale of on-site operations would be reduced in comparison to the situation wherein only one site were available.

However, from the standpoint of demonstrating that the productivity standard can be attained, an analysis based on one operational transfer/processing site would be more conservative than an analysis based on two functioning sites. This is particularly the case if the transfer/processing site were to be situated at either the northern or southern limit of the upper Hudson remedial work zone.

The discussion that follows presents issues associated with processing and exporting 4,500 tons per day of stabilized or dewatered sediment from the Moreau site, which has been referred to, in the FS and RS as the northern transfer/processing facility. At 4,500 tons per day, the Moreau site would essentially be handling sediments at the average rate required by the performance standards developed herein. No assessment is provided for a southern transfer/processing site in the Port of Albany area since a single full-scale processing operation at that location would preclude use of hydraulic dredging technology, a potentially viable technology for removing targeted sediments in River Section 1.

At this time, the selection of transfer/processing site(s) has not been finalized. USEPA is following the site selection process as defined in the Facility Siting Concept Document (USEPA, December 2002).

2.0 Issues Considered

2.1 Site Area

As presented elsewhere in this report, a single site providing about 15 to 20 acres of usable area is required to transfer and process sediments at a rate that would meet the required average productivity performance standards (about 4,500 tons per day). The key issue here is that the area be usable and configured so that waterfront transfer and landside processing operations can be optimally situated in relationship to the site's rail load-out facilities. The required increase in site throughput, from approximately 1600 tons per day (as per the FS and RS for Moreau) to about 4,500 tons per day, increases the required usable site area by about one-third. However, the Moreau locale, which includes old Moreau landfill and additional properties south of the landfill, has adequate area to accommodate transfer/processing operations with a throughput of 4,500 tons pr day. A key issue here is the availability of the properties south of the old landfill.

2.2 Waterfront Requirements

As site throughput increases from about 1,600 tons per day to 4,500 tons per day, it becomes necessary to expand waterfront transfer capacity, particularly for the mechanical dredging alternative. Figure C-1 shows two active, hopper-barge unloading positions for 4,500 tons per day throughput whereas the FS and RS indicated that the northern transfer facility could function with one active barge unloading position (at 1,600 tons per day).

To accommodate two hopper barges, the site's wharf would be expanded to a length of approximately 400 feet, about 50 feet more than had been previously shown. In addition, operations at the waterfront appear to become somewhat more complex given the limited space within which barges can be maneuvered and the considerable time needed to remove (pump) excess water and unload dredged sediment. A detailed waterfront operational analysis is needed to fully evaluate reliable transfer of 4,500 tons per day.

2.3 Processing and Storage Facilities

Previous reports indicated that it would be beneficial to provide limited on-site storage for processed sediments to accommodate inconsistencies in rail operations (mechanical dredging) or rail and barging operations (hydraulic dredging). The scale of on-site storage would have to more than double should throughput be increased from 1,600 to 4,500 tons per day. Since it is expected that the primary storage facility would be enclosed to control fugitive dust, the cost associated with storage and materials reclamation (see next item) will increase significantly.

2.4 Materials Handling

It is anticipated that loading 4,500 tons per day of processed sediment into gondolas, would best be accomplished by a fully automated system using enclosed or covered conveyors. The FS and RS analysis assumed that dumpsters could be used, at Moreau, to haul material from the storage area to the on-site rail yard. Rail car loading would then be accomplished by front-end loaders. However, once handling requirements reach 4,500 tons per day, it is not likely that trucking will be found efficient. In addition, at 4,500 tons per day, the level of trucking activity, and associated air emissions, may prove to be unacceptable at Moreau. In order to provide a more thorough assessment of materials handling needs there, it would be necessary to perform additional, detailed engineering analyses.

2.5 Rail Yard

The scale of the on-site rail yard increases significantly when throughput is expanded from 1,600 tons per day to about 4,500 tons per day. The enclosed illustration shows the yard to consist of three tracks of adequate length to store up to 15 gondolas each. While it appears that the Moreau site has room for the yard on its upper terrace (the old Moreau landfill), a geotechnical evaluation will be needed to ascertain the stability of the old landfill in relationship to the load imposed by rail operations. Historically, a smaller rail yard had been situated on the old landfill and the scale of yard illustrated in the FS and RS was not altogether different than that former facility.

2.6 Rail Operations

At the FS and RS stage, USEPA had discussed Hudson Valley rail operations with the Canadian Pacific Railroad (CPR). The CPR indicated that they could pick up eight loaded rail cars twice each day and haul them to either the Ft. Edward or Saratoga yards for temporary storage while a full train (75 cars or more) of stabilized sediments is made-up. In order to move 4,500 tons per day out of Moreau, it will be necessary for the CPR to pick up (and drop off) 15 cars, three times each day and bring them to temporary storage at either yard location. As of this date input has not been obtained from the CPR as to whether or not they would have any difficulty in handling the expanded throughput of a single processing facility being situated at Moreau.

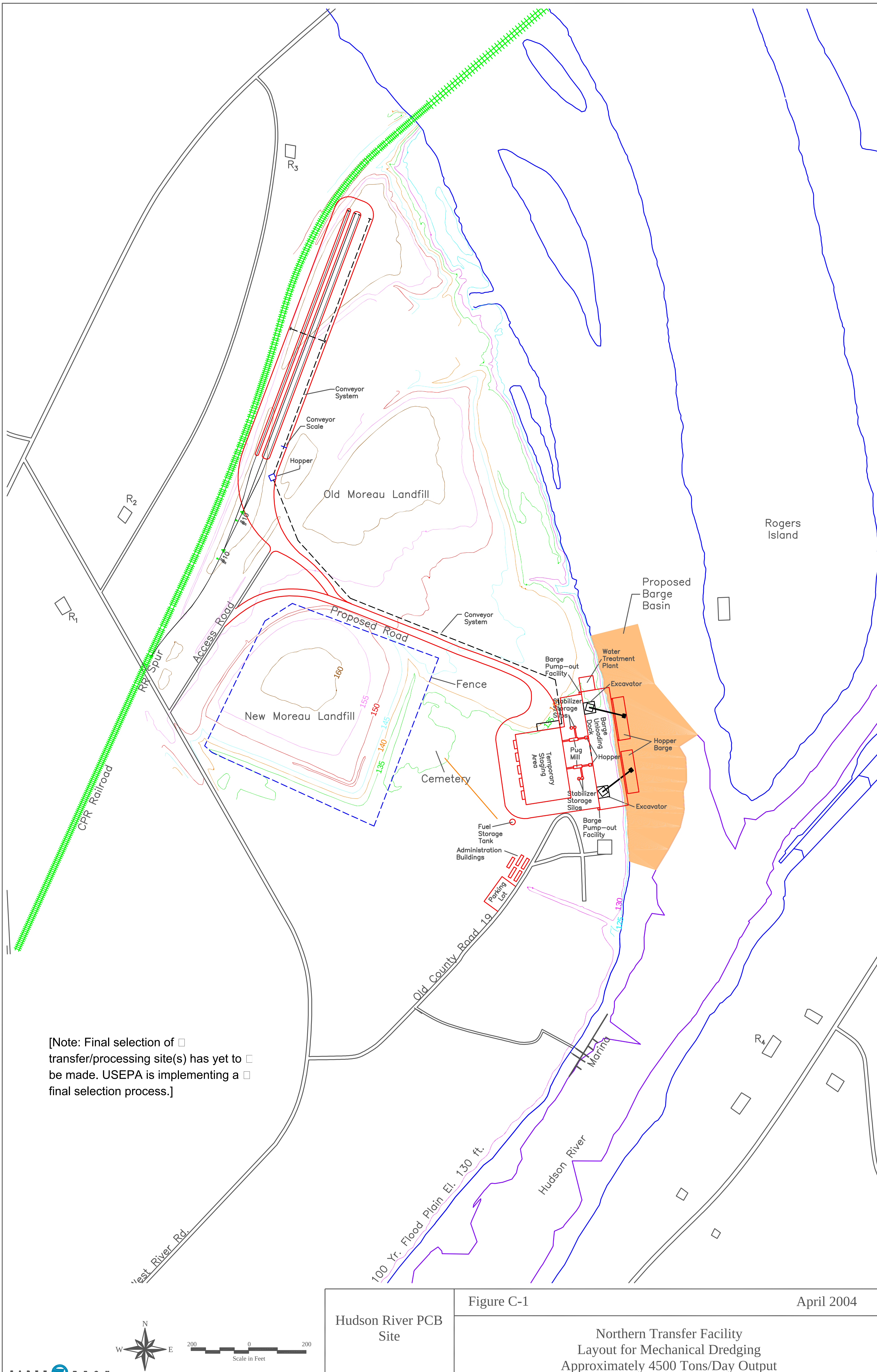
3.0 Summary

Adequate land area appears to be available at the Moreau site (northern transfer facility) to situate the facilities needed to transfer and process 4,500 tons per day of dredged sediments. However, it is unknown whether engineering and operational constraints will permit that scale of throughput there.

At the waterfront, management of several, sediment-laden barges simultaneously may prove a challenge to attaining the project's productivity goals. Barges have to be maneuvered within a relatively confined basin, tied up to the new wharf, and then undergo removal of excess water (by pumping). Operations at the waterfront have to be consistent with water quality criteria, a circumstance that may slow and, therefore, extend unloading operations.

Neither processing nor materials handling systems are expected to limit the ability to handle 4,500 tons per day at Moreau. However, the technologies that will be needed to do so are likely to be significantly more sophisticated than those described in the FS and RS. One advantage in using automated materials handling systems is that fugitive emissions can be better controlled than would be possible under a trucking alternative.

The viability of developing a rail yard to accommodate 4,500 tons per day output needs to be evaluated further from both geotechnical and operational perspectives. Ultimately, it will be necessary to discuss the increased level of operations with the CPR to ascertain the plausibility of moving 4,500 tons per day reliably from Moreau.



Hudson River PCB Site

Figure C-1 April 2004

Northern Transfer Facility
Layout for Mechanical Dredging
Approximately 4500 Tons/Day Output

Attachment D
Example Production Schedule

1.0 Example Production Schedule

In order to evaluate the feasibility of achieving the Productivity Standard, an example production schedule was prepared using Primavera Systems®, Inc. project scheduling software. This production schedule is provided as a series of pullout sheets at the end of this attachment. It should be clearly understood that an actual production schedule will be developed during final design of the project and may be significantly different from this example.

In developing this example schedule, a large number of assumptions have been made that have an impact on dredging productivity. These assumptions are based on available information and, in some instances, are expected to change as the project is further developed during design. Where production rates have been assigned to particular aspects of the work, an attempt has been made to recognize the difficulty of the project and to be conservative in estimating the amount of work that can be accomplished in a given time period.

2.0 Assumptions Relating to Productivity

2.1 Locations and Volume of Sediment to be Dredged

A major assumption that affects the time required to dredge the Upper Hudson is related to the actual volume of sediment to be dredged and the depth of water in which these sediments are located. The delineation of sediment to be removed was taken from the Feasibility Study (FS) and was based on the analytical results for samples collected during a number of prior sampling events. The delineation may vary based on the outcome of General Electric's (GE's) sampling efforts, and the volume estimates will be adjusted accordingly.

Given the distribution of targeted sediments presented in the FS, a preliminary assessment has been performed of the practical working limits of the dredging technologies that appear to be relevant to remedial work in the Upper Hudson River. For a mechanical dredging system it was assumed it could function in proximity to the river shoreline in those areas where there would be at least 6 feet of water after dredging. Also, it was further assumed that a mechanical dredge could effectively reach and remove sediments lying 30 feet beyond its location in shallow water.

For a hydraulic dredging system is has been assumed that the system could successfully remove shoreline sediments where there would be as little as 3 feet of water in the post-dredging condition. Material not accessible by conventional mechanical and hydraulic technologies would have to be excavated by alternative specialty dredging systems.

2.1.1 River Section 1

In River Section 1 (River Mile 188.5 upstream to the area around Rogers Island), a total of approximately 1.56 million cy of sediment will be removed. Approximately 1.25 million cy (about 80 percent) of this material could be removed using a mechanical dredge, while a hydraulic dredge could remove 1.39 million cy (about 89 percent). An alternative dredge, capable of working in shallow water, would be required for the remaining material (approximately 20 percent, or 0.31 million cy, for mechanical dredging and 11 percent, or 0.17 million cy, for hydraulic dredging).

2.1.2 River Section 2

In River Section 2 (River Mile 183.24 to River Mile 188.5), approximately 0.50 million cy of sediment will be removed. Approximately 0.48 million cy, or 95 percent of this material, can be removed using either a mechanical or hydraulic dredge. The remainder would have to be dredged using equipment capable of working in shallow water.

2.1.3 River Section 3

For River Section 3 (River Mile 163.25 to 170.25), approximately 0.56 million cy of sediment will be removed. Of this, approximately 0.37 million cy (about 65 percent) can be removed using a mechanical dredge, with the remaining 0.20 million cy (35 percent) removed by an alternative dredge. The entire 0.56 million cy of the material can be removed using a hydraulic dredge if processing and shipping sites are available within pumping distance of the dredge.

A summary of dredge volumes (cyds) by location and method is provided in Table D-1 and in Tables F-1A and F-1B in Attachment F.

2.2 Location of Processing Facilities

The Record of Decision (ROD) assumed the establishment of two processing facilities, one near the northern extent of the project area and one near the southern extent of the project area. However, for the purpose of a conservative production estimate, it was assumed that only one facility would be available at the northern end of the project River Mile 194 on or near the Old Moreau Landfill or New Moreau Landfill. Under this assumption, all dredged sediments will have to be delivered to this one site for processing and shipping. The location was selected near the majority of dredging (in River Section 1). This selection does not suggest that United States Environmental Protection Agency (USEPA) has selected this location or that the location is considered preferable. Facility siting will be conducted in accordance with the procedures set forth in Facility Siting, Concept Document (USEPA, 2002).

2.3 Need for Silt Barriers/Curtains

Silt barriers/curtains are most appropriate in water depths less than 21 feet and flow velocities less than 1.5 feet per second. For the purpose of the example production schedule development, it was assumed that silt barriers would be used for all dredging work outside of the navigation channel. This assumption was made so that a conservative, if not worse case, scenario could be developed to estimate productivity. The need for silt barriers/curtains should be determined during the design phase. The silt barrier type selected for preparation of the schedule presented herein consists of steel sheet piling at the upstream and downstream limit of the active work area. In shallow water areas, Jersey barrier or a similar portable barrier may be used.

The steel sheeting would extend perpendicularly from the high water mark on the shoreline to the navigation channel or the limits of the active work area. The sheeting would then be installed parallel to the river channel and extended an additional 30 to 50 feet. The steel sheeting on the upstream end of the active work area would extend in a downstream direction and the steel sheeting on the downstream end of the active work area would extend in an upstream direction.

High-density polyethylene (HDPE) geomembrane would be installed between the ends of the sheet piling. The HDPE sheeting would be supported at the top by a floatation boom and anchored or weighted to the riverbed to hold it in position. A sketch of an assumed silt barrier installation is presented in Figure D-1. This type of barrier differs from the conventional silt curtain in that its mode of failure is through submergence of the floatation boom rather than a lifting of the bottom of the curtain in response to pressure waves.

2.4 Dredging Procedure

In developing tentative dredge production rates, it has been assumed that, where the thickness of the sediment layer exceeds 2 feet for hydraulic dredging or 1 foot for mechanical dredging, multiple passes of the dredge will be required to achieve the target removal depth, referred to herein as the “design cut.” By removing the sediment in two or more passes, taking shallow cuts each time rather than dredging to the design depth at one setup of the dredge, contaminated material that sloughs from the face of the cut during the first pass of the dredge will be excavated on the second pass. This reduces, but does not eliminate, the potential for contaminating the surface of the riverbed exposed by the dredge with contaminated material from above. Under this assumption, the dredge will make passes covering at least an acre before returning to begin another pass or passes as needed to achieve the design cut.

2.5 Need for Redredging

Regardless of the dredging technology that is used, it should be assumed that some redredging would be required to achieve target cleanup levels in some areas of the river. It is very difficult to estimate the potential time required to redredge areas that do not achieve the performance standard for residuals after initial dredging. The *Project Completion Report* on remediation of the St. Lawrence River at the former Reynolds Metals site indicates that about 50 percent of the areas targeted for dredging achieved the target cleanup level of 1.0 mg/kg during initial dredging. A first attempt at redredging succeeded in achieving cleanup targets in an additional 30 percent of the areas, while two redredging attempts were needed to raise the total to 88 percent. Some areas were redredged 3 or more times and failed to meet the cleanup requirements. Ultimately, it was necessary to change the dredging method to achieve the target cleanup level in some areas with rocky and/or compacted till underlying the sediment (See *Volume 5, Appendix: Case Studies of Environmental Dredging Projects*).

Satisfactory completion of the initial dredging to achieve the design cut and remediation goals will be determined based on the requirements set forth in the Residuals Standard. For the purposes of this productivity estimate, it has been assumed that redredging will require 50 percent of the time required to dredge to the design elevation, *i.e.* if 30 days are required to dredge a given subarea to the design elevation, an additional 15 days will be needed to redredge portions of this area to meet the target cleanup level. The validity of this assumption will be tested during Phase 1 of the project, provided that some areas require a second attempt at dredging during Phase 1.

In order to evaluate whether the 50 percent time allowance for redredging included in the example production schedule is reasonable, however, an analysis was undertaken of the time needed to make a complete dredging pass over a given area under the assumption that the depth of cut during that pass would be about 6 inches. Since most environmental buckets are designed such that the bucket jaws open wide enough to completely fill the bucket at a depth of cut of about 1 foot, the area of the river bottom encompassed by the open jaws can be estimated. For example, a 4-cy bucket designed to remove a layer 1 foot deep would cover a "footprint" of 108 square feet (sq ft) with the jaws wide open (108-sq-ft X 1-ft depth = 108 cubic feet = 4 cy).

2.5.1 Assumptions

To prepare this analysis, the following assumptions have been made:

- Dredges to be used for re-dredging in areas with 6 feet or more of water depth would have a 4-cy hydraulically activated environmental horizontal profiler bucket. A dredge with a 2-cy hydraulically activated environmental horizontal profiler bucket would be used where redredging must be done in water depths of less than 6 feet.

- The 4-cy bucket has an area footprint of 108 sq ft per cut when fully open. The 2-cy bucket has an area footprint of 56 sq ft when fully open.

- The 4-cy dredge will have an average operating time of 23 cycles per hour while the 2-cy dredge will operate at 15 cycles per hour. The longer cycle time has been assumed for the 2-cy dredge because it has been assumed that this dredge will be working along the shoreline and around docks, walls, and other obstructions that may slow the production process.

- Each cycle will overlap the area covered by the previous cycles by 20 percent (based on conversations with Bean Environmental).

- Since 20 percent of each cycle is used to overlap the area covered by previous cycles, 64 percent of new ground is covered per cycle. (0.8 length X 0.8 width = 0.64)
- A dredge operates 13 hours at full production per day consistent with the assumption used to develop the Productivity Standard.

2.5.2 Calculations

Using these assumptions, the rate of area coverage for redredging is determined to be approximately 27 dredge hours per acre for a 4-cy bucket and approximately 81 dredge hours per acre for a 2-cy dredge bucket. Applying the assumed factor of 13 full production hours per day, a 4-cy dredge will require 2.1 dredge days to dredge 1 acre, while a 2-cy dredge will require 6.2 days.

An example redredging calculation for a 4-cy dredge is shown as follows. The calculation for a 2-cyd dredge would be similar and would yield 6.2 days to cover an acre.

(108 sq ft) (0.64) = 69.1 sq ft/cycle
(23 cycles/hr) (69.1 sq ft/cycle) = 1,589 sq ft/hr
(43,560 sq ft/acre)/(1589 sq ft/hr) = 27.4 hr/acre
(27.4 hr/acre) / (13 hr/day) = 2.1 days/acre

The rate of area coverage during production dredging to reach the design cut lines can be calculated using the following assumptions:

- Dredges with a 4-cy bucket have an assumed volumetric production rate of 82 cy per hour, while 2-cyd dredges have an assumed production rate of 27 cy per hour.

- Design cuts will average 3 feet deep, the average depth of contaminated sediment as reported in the FS.

- A 4-cy dredge will have an operating time of 23 cycles per hour (2.6 minutes per cycle), while a 2-cy dredge will have an operating time of 15 cycles per hour (4.0 minutes per cycle).

Using these assumptions, a 4-cy dredge will require approximately 59 dredge hours per acre, or 4.5 dredge days per acre, to remove a 3-foot-thick layer of sediment as shown below.

(43,560 sq ft/acre) (3-ft cut depth) = (130,680 cubic feet [cu ft]/acre)
(82 cy/hr) (27 cu ft/cy) = 2,214 cu ft/hr
(130,680 cu ft/acre)/(2,214 cu ft/hr) = 59 hr/acre
(59 hr/acre)/(13 hr/day) = 4.5 days/acre

A 2-cy dredge operating at a production rate of 27 cy per hour would require 179 hours per acre or 13.8 dredge days per acre.

Based on the case studies described previously, it has been assumed that, on average, approximately 50 percent of an area targeted for dredging will fail to meet the target cleanup standard of 1 milligram per kilogram (mg/kg) Tri-plus PCBs in the 6-inch residual layer and will require redredging. It is further assumed that the first redredging attempt will achieve the target in 50 percent of the area redredged and that a second attempt will be required to meet the target in the area that failed. Since the Residuals Standard limits the number of re-dredging passes to two, the estimated total time spent on redredging for a hypothetical 1-acre area using a 4-cy dredge is shown below.

Total area dredged:	1 acre
Area requiring redredging:	0.5 acre
Time required for first redredging attempt:	(0.5 acre) (2.1 days/acre) = 1.05 days
Area requiring second redredging attempt:	0.25 acre
Time required for second redredging attempt:	(.25 acre) (2.1 days/acre) = 0.53 days
Total redredging time:	1.05 days + 0.53 days = 1.58 days
Percentage of redredging days to original production dredging days:	(1.58 days/4.5 days) (100) = 35 percent

A similar calculation can be made for redredging using a 2-cy bucket.

Total area dredged:	1.0 acre
Area requiring redredging:	0.5 acre
Time required for first redredging attempt:	(0.5 acre) (6.2 days/acre) = 3.1 days
Area requiring second redredging attempt:	0.25 acre
Time required for second redredging attempt:	(0.25 acre) (6.2 days/acre) = 1.55 days
Total redredging time:	3.1 days + 1.55 days = 4.65 days
Percentage of redredging days to original production dredging days:	(4.65 days/13.8 days) (100) = 34 percent

Inasmuch as the length of time needed to redredge an acre is shown in the above calculations to be around 35 percent of the time needed to dredge to the original design cut lines, the allowance of 50 percent used for the example production schedule appears to be reasonable, if not somewhat conservative. It should be noted, however, that the need for re-dredging all or part of an area and the time required to complete a maximum of two re-dredging attempts will be influenced by a large number of variables and experience gained during Phase 1 should be the real test of the reasonableness of this allowance.

2.6 Redredging Sensitivity Analysis

In order to determine the effect that redredging would have on total project duration, a sensitivity analysis was performed that compared three different scenarios to the example production schedule. The example production schedule was developed based on the assumption that redredging would take 50% of the number of dredge days. The three scenarios assumed that redredging would take 25%, 75%, or 100% of the total number of dredge days required to achieve the design cuts established for a given site. The duration of the 25% and 50% scenarios is equal, since it is assumed that redredging cannot finish earlier than ten working days after the completion of design dredging to allow for post-dredge surveying, confirmatory sampling, and completion of redredging. The duration of the 75% and 100% scenarios are 0.6 and 1.7 years longer, respectively, than the 6-year duration presented in the example production schedule, assuming that additional dredges are not added to the redredging effort.

2.7 Wetland Restoration

To estimate the effort associated with wetland restoration, it has been assumed that following dredging activities, those areas identified as wetlands will be backfilled with a mixture of sand and fine material to achieve a water depth approximately equal to the pre-dredging depth. These areas will then be planted with appropriate wetland vegetation.

2.8 Weather and River Flow Issues

Low temperatures, high winds, and high flow rates or flooding may occur during the dredging season. Based on meteorological data from the Glens Falls (Warren County) and Albany Airports for the years 1991 through 2000, it appears that low temperatures should not limit work during the proposed period. In fact, based on temperature data alone, it would appear that productive work could occur for 33 to 34 weeks per construction season (RS, White Paper #313398).

The Upper Hudson River is relatively sheltered compared to a bay or a sound, and is not prone to wave formation. It is not expected that significant wind-related delays will occur.

Between 1997 and 2001, the Canal Corporation issued one Memo to Mariners indicating that the canal system between Lock C-1 and Lock C-4 would be closed for a few days until water levels receded to safer levels and debris could be removed. Based on estimated river velocities and associated water depths, it has been assumed that dredging activities can be effectively conducted in river flows up to 10,000 cubic feet per second (cfs) as measured at Fort Edward. Based on flow data collected at the USGS Fort Edward gauging station from 1978 to 2000, river flows in excess of 10,000 cfs occur approximately 5 percent of the time during the proposed dredging season (Responsiveness Summary (RS), White Paper #313398).

2.9 Canal Operating Schedule

The canal operates approximately 29 weeks per year and generally has daily limits on passage through the Champlain Canal lock system. It has been assumed that the Canal Corporation will extend their operating season to provide a minimum of 30 weeks per year (and possibly longer during mild years) and that 24-hour-per-day access through the locks will be provided to allow loaded and empty scows to navigate the system. It is further assumed that working within a pool between locks will be permitted even after the canal is closed to normal traffic in the fall (RS, White Paper #313398).

The Canal Corporation conducts most major rehabilitation and repair activities on the lock system during the winter months to avoid impeding boat traffic. Repairs, largely limited to above-water work, are performed on a maintenance cycle throughout the operating season of the canal. These repairs are not expected to inhibit travel. It is expected that the only repairs or maintenance activities that may inhibit use of the lock system would be emergency repairs, which have typically been very few. In addition, periodic events such as boat parades and land-based emergencies may also impede navigation.

2.10 Equipment-Related Delays

Some level of downtime due to equipment malfunction is unavoidable. However, the duration of the downtime and the affect on the overall schedule can be largely overcome through proper planning and design. For the purpose of this productivity assessment, the production hours (effective time) for the most critical mechanical equipment (e.g., dredging equipment) have been de-rated to account for typical downtime (for further information see RS White Paper #313398).

2.11 Processing and Shipping Assumptions

It has been assumed that the on-shore treatment and shipping facilities will be designed with adequate capacity to process the maximum daily output from the dredges. No separate allowance for additional lost production has been made for breakdowns in the scow unloading or sediment processing facilities. Lost dredging time resulting from downtime at the on-shore processing site is accounted for in the assumption that the effective dredging production will only be 13 hours per day.

2.12 Sequence of the Work

In order to identify the major pieces of equipment needed to complete the project and develop a preliminary schedule to evaluate the feasibility of remediating the river within the time frame defined in the ROD, a plan must be developed regarding the sequence of work. The following sequence of work has been assumed for the full-scale dredging program. Only the major, definable features of the work are listed, as these features generally control the overall production schedule. For the purposes of this example schedule, it has been assumed that turbidity barriers will be installed around each dredging area, as this is a time consuming operation and will result in a conservative estimate of the amount of work that can be accomplished each season. If turbidity barriers are not used on the project and the equipment selected for dredging is capable of being operated in conformance with the Resuspension Standard for, it should be possible to shorten the schedule.

- It has been assumed that mobilization will begin as soon as weather permits each spring, usually by the first week of April, and will concentrate on making the on-shore facilities ready for the dredging season. Dredges that were demobilized and removed from the site the previous winter will be mobilized on the first day that the canal opens in May.

- The installation of turbidity barriers, if used, and monitoring equipment will begin as soon as flows in the river permit. It is assumed that equipment needed to install these structures will have been trucked to the site prior to the opening of the canal, and installation is assumed to start on or about the first of May each year. A gate will be constructed in any barrier around each major work area. Installation of a turbidity barrier around the next area designated for dredging will be done while the first area is being dredged.

- Where hydraulic dredging is proposed, dredge pipe will be installed as the turbidity barrier is being constructed so that the necessary penetration of the barrier can be made. The pipe will be submerged where it crosses the navigation channel or obstructs private docks and marinas but will be floating or laid in shallow water along the riverbank in most other areas.

- Clearing and snagging fallen trees from the waters edge will be accomplished at the same time the turbidity barrier is installed so that dredging will not be delayed by this work.

- Dredging will begin within one to two days of the arrival of the dredges on the site and will continue until the area enclosed by the turbidity barrier is dredged to the design elevations. Unless post-dredging sampling indicates that the production dredges will be required for redredging portions of the area that did not meet the residuals standards, they will move immediately to the next area designated for dredging.

- Soundings will be taken at least weekly to confirm that the design elevations are being met as dredging proceeds in a given area. When a sufficient area is dredged to the design elevations, samples will be collected and analyzed for residual PCBs. Sampling should be done while the dredges are still working in an area and should follow the dredges by no more than a week.

- The dredging will be divided into certification units for sampling of residuals. If redredging is required in a certification unit, but sampling indicates that it should consist of a very shallow cut or of removing a very limited amount of residual sediment overlying clean sediment, or from a small portion of the acceptance area, the production dredges will move to the next acceptance area to be dredged and a smaller, alternative dredge will be employed for the redredging effort. It has been assumed that redredging will begin as soon as the need for it is identified in a certification unit rather than after an entire river reach has been completely dredged to the design elevations and all sampling has been completed in the large reach area.

- Soundings will be taken as redredging proceeds in an area, and a second round of post-dredging samples will be collected as soon as the dredge completes a defined area.

- Backfilling and shoreline stabilization will begin as soon as a portion of a work area has been determined to meet cleanup levels and generally while the production dredges are still working in the area. The example production schedule assumes that the backfill and shoreline stabilization work will be isolated from the dredging effort by conventional silt curtains installed within the overall area surrounded by the turbidity barrier.

- As soon as a work area has been completely backfilled and shoreline stabilization work has been completed, removal of the turbidity barrier surrounding that work area will begin.

- As the dredging season draws to a close, dredging will cease in time to permit backfilling and shoreline stabilization work to be completed in all areas dredged prior to demobilization for the winter.

- Unless there is a specific reason for leaving a particular section of silt barrier in place over the winter and it can be shown that the barrier can withstand the spring runoff and ice movement, all silt barriers will be removed from the river at the end of each dredging season.

- It has been assumed that demobilization of major pieces of dredging equipment that cannot be moved by truck will be moved out of the area on the last possible day of the canal operating season but that smaller dredges and work boats that can be transported by truck will remain on the site to complete any required work such as completing backfill and shoreline stabilization work, removing turbidity barriers, and dismantling dredge pipe for storage on site for the following year's work. It has also been assumed that demobilizing and winterizing on-shore treatment and shipping facilities will occur after the canal has closed for the season.

3.0 Selection of Equipment and Estimates of Production Rates

3.1 Silt Barrier Installation and Removal

Equipment required to install and remove the turbidity barrier consists of a workboat with a flat deck at least 100 feet long, equipped with a light crane for handling the HDPE barrier material. A hydraulic excavator type machine similar to a Caterpillar 350 Materials Handler would be mounted on a deck barge and equipped with a vibratory hammer or pile driver for installing steel sheet piling. The assumed production rate for this work is as follows:

- Installing sheet piling - 90 linear feet per day of wall per crew
- Installing HDPE barrier - 200 linear feet of barrier per day per crew
- Removing sheet piling - 130 linear feet per day per crew
- Removing HDPE barrier - 300 linear feet per day per crew

3.2 Mechanical Dredging

Two different size mechanical dredges have been selected for use wherever the water depth is great enough to permit access for scows. These are the same dredges as described in the FS (Appendix E-1) and are as follows:

- A dredge consisting of a hydraulic excavator with an extended boom and fitted with a 4-cy hydraulically actuated horizontal profiler bucket. The assumed effective production rate of this piece of equipment is 82 cy per hour.

- A dredge consisting of a hydraulic excavator with an extended boom and fitted with a 2-cyd hydraulically actuated horizontal profiler bucket. The assumed effective production rate of this piece of equipment is 27 cy per hour.

3.3 Hydraulic Dredging

The hydraulic dredge selected for evaluation is the same dredge described in the FS (Appendix H-1) and consists of a 12-inch cutterhead dredge with a 600-horsepower (HP) pump, 200 HP auxiliaries, and 900 HP booster pumps where required. Typically, a dredge of this size has a capacity of from 400 to 575 cy per hour, depending upon the distance pumped and whether it is pumping sand and gravel or silt and clay sediments. However, because dredging contaminated sediments requires careful attention to cut depths and location, resuspension of sediments other special issues, it has been assumed that the effective production rate for this dredge would be from 260 to 275 cy per hour, depending upon the type of sediment and distance pumped.

3.4 Alternative Dredging Equipment

Alternative dredging equipment will be required for use:

- In areas where the post-dredging water depth is less than about 3 feet.
- For redredging areas where post-dredging diver inspections and/or sampling indicate that a very shallow layer of sediment must still be removed.
- Where sediment remains in pockets in bedrock or is surrounded by boulders or other obstructions.

Two types of equipment have been considered: an amphibious, hydraulic excavator with a hydraulically actuated, horizontal profiler bucket with a capacity of about 1 cy, and a small, probably 8- or 10-inch, hydraulic dredge fitted with a cleanup dredge head or a plain suction mouth for cleanup work.

The amphibious excavator would be used in conjunction with a scow with a capacity of from 500 to 1000 cy and a draft, when empty, of less than 1 foot. The scow would be equipped with a hopper containing a screen to remove debris and would be towed into the shallow water and loaded with the hydraulic excavator until it sits on the river bottom. It would be unloaded in place using a Toyo Pump that would transfer the sediment to a second scow located in the navigation channel, which would in turn carry the sediment to the on-shore processing facility. Alternatively, mechanical dredges that utilize a hopper and hydraulic dredge pump to transfer mechanically dredged sediments to a scow located in deep water could be used. This equipment typically incorporates specific gravity loops with provisions for adjusting the water content of the slurry as needed.

Small hydraulic dredges fitted with cleanup dredge heads have been used to remove unconsolidated sediment deposits with high, *in situ* moisture contents. These dredges are capable of effective production rates in the 100 to 120 cy per hour range but would probably average no more than 40 to 60 cy per hour under difficult dredging conditions or when used to redredge an area where the layer of sediment to be removed is less than one foot.

Hydraulic dredges usually do not operate continuously for extended periods of time. Some downtime, usually on the order of 8 hours per week, is necessary for routine maintenance. It is also necessary to stop dredging to add slurry pipeline and booster pumping units as the equipment moves down the river, to remove debris that has become lodged in the intake, to relocate the dredge from one work area to another, and or for other reasons. Accordingly, an allowance must be made for the time that the dredge is not actively removing sediment.

In preparing the example production schedule, it has been assumed that dredging will be permitted 24 hours per day, six days per week and that routine weekly maintenance on the equipment will be accomplished on Sundays. Thus, the total time available for dredging would be 24 hours per day times 6 days per week, or 144 hours per week. The length of the dredging season has been assumed to be 30 weeks, so the total available time for dredging over the entire season would be 30 weeks at 144 hours per week, or 4,320 hours per year.

In order to meet the Productivity Standard of 490,000 cy per year during Phase 2 of the project, a single production dredge working at a reduced rate of 260 cy per hour would have to operate for 1,884 hours out of the 4,320 hours available, or about 44 percent of the total available time. To meet a target removal of 530,000 cy in a year, the dredge would have to operate effectively for 2038 hours per year, or about 47 percent of the time. In actuality, with one "production" hydraulic dredge operating at about 260 cy per hour and one alternative hydraulic dredge operating at about 50 cy per hour, the two dredges would only have to operate about 37 percent of the time to meet the 490,000-cyd-per-year dredging productivity standard and 40 percent of the time to meet the 530,000-cy-per-year target productivity rate.

3.5 Backfilling

Two methods of placing backfill have been considered: mechanical placement using a clamshell bucket on a crane, and hydraulic placement with a sand spreader. Placement of backfill with a clamshell bucket has been demonstrated to be feasible at the Grasse River near Massena, New York, and achieved a production rate of approximately 1200 sq ft of coverage per hour for a 1-foot lift of backfill. The material was brought to the work area by barge and spread with a 2.5-cy clamshell bucket on a crane. The crane boom was moved to spread the material as the bucket was opened and produced a cap varying in thickness from about 6 to 18 inches, with an average thickness of 1 foot. Use of WINOPS global positioning system (GPS) equipment to identify the location of each bucket full of soil placed assisted in attaining complete coverage of the river bottom. Proper placement of the backfill material at a reasonable production rate was highly dependent upon the skill of the crane operator.

Hydraulic equipment especially designed to spread backfill or capping material over a dredged bottom is available and has been used successfully on a number of projects. Typically, this equipment consists of a dredge pump to pump a sand slurry from a scow or a shoreline materials preparation area, dredge pipeline from the dredge pump to the spreader barge, and a spreading device mounted on a deck barge. The backfill material is hauled to the site in a barge or placed in a basin on shore close to the area to be backfilled. River water is pumped through high-pressure nozzles located at the dredge pump suction intake to create a slurry, and the slurry is pumped through a pipeline to the spreader.

The spreader consists of a deck barge with a spreader pipes arrayed like fingers on a hand and connected to a splitter box. The slurry of backfill material is pumped into the splitter box and flows out through the spreader pipes. The spreader pipes protrude over the end of the deck barge and discharge below the water surface as the spreader barge is slowly moved over the area to be backfilled. Hydraulic spreaders are easily capable of placing sand or a silt-sand mixture of backfill at effective production rates in the 250-cy-per-hour range and can cover over an acre per day or more with a 1-foot thick layer of backfill.

For the purposes of this document, it has been assumed that the river bottom can be backfilled at an effective production rate of 1.0 acres per day and 0.5 acres per day for critical backfill areas. It has also been assumed that backfilling will begin as soon as work in a certification unit has been determined to be complete.

4.0 Conceptual Production Schedule

Utilizing the production rates developed and presented above, an example production schedule has been developed for the mechanical dredging option using Primavera Systems©, Inc. software. This example schedule portrays the conceptual sequence and duration of one possible approach. The mechanical dredging option was selected for use in preparing a schedule because mechanical dredging is typically a slower process, and therefore more conservative, than hydraulic dredging. To verify the assumption that mechanical dredging is the slower option, a schedule of similar level of detail was developed that incorporates hydraulic dredges for use in River Section 1 only, and mechanical dredges in all other river sections and any areas in River Section 1 that contain boulders or excessive debris. Further, this example schedule was developed under the assumption that there would be only one processing site and that it would be located at the northerly limit of the Thompson Island Pool.

The results of this analysis indicated that hydraulic dredging (including the additional effort of installing/removing dredge pipeline) is significantly faster than mechanical dredging, thus verifying the assumption. This holds true until distances from the dredge to the processing facility approach about five miles, the approximate distance from the Thompson Island Dam to the assumed processing site at the northerly end of the Thompson Island Pool.

This example production schedule is provided as a series of pullout sheets at the end of this attachment. Attachment E contains the production schedule backup, including estimates of volumes of sediment to be dredged mechanically, by phase and river mile, site preparation quantities, and site restoration (backfill) quantities, and maps of each one-mile reach of the river. Attachment F contains the estimated volumes of sediment to be dredged, by river mile, whether the sediment consists of cohesive or non-cohesive soil, and information on pre- and post-dredging water depths, together with maps of each one-mile reach of the river.

Information on water depths, types of sediment, probable volumes to be dredged, etc, are all preliminary in nature and must be confirmed as part of the design. However, this information is judged to be accurate enough to support the development of an example schedule that illustrates the feasibility of completing the project in the time frame defined by the ROD. While changes in the percentage of cohesive or non-cohesive sediment, for instance, will affect the design of the sediment processing facility, they will have a relatively minor effect on the rate at which the sediment can be dredged.

Table D-2 summarizes the seasonal activities that would be completed if the project were implemented as shown on the example production schedule. The dredging work generally proceeds from upstream to downstream, and the work would be completed in six construction seasons. The volume remediated includes all targeted remediation and navigational dredging areas. The area remediated includes both standard and critical backfill areas. Critical backfill areas are defined as wetland areas that require additional backfill. These areas will take longer to backfill due to their sensitive nature.

The dredging completion date reflects the date when all dredging activities (including redredging after confirmatory sampling) would be completed. The work completion date reflects the time needed after dredging completion to complete site restoration activities (backfilling, post backfill surveying, obstruction replacement, shoreline stabilization, and containment removal) and all demobilization activities.

Table D-3 shows the amounts of dredging that would be completed during Phase 1 broken down by different river conditions, taken from the example production schedule. Of the 268,980 cy assumed to be dredged during Phase 1, about 246,065 cy could be accomplished with the 2-cyd and 4-cy mechanical dredges devoted to production work. Approximately 22,910 cy are located in shallow areas where alternative dredging equipment would be required. About 80,370 cy of the "production" dredging is located in the navigation channel of the canal. The amount completed during Phase 1 in the example production schedule exceeds the 200,000 cy established as the productivity standard for Phase 1.

Table D-4 presents the overall performance as shown in the example production schedule. The cumulative volume shown in the example production schedule exceeds the target cumulative volume requirement for both phases of dredging. The cumulative volumes presented in Table D-4 include remediation and navigational dredging areas.

The key assumptions and parameters used in developing the example production schedule are as follows:

- All three river sections (R1, R2, & R3), (total estimated volume of 2.65 million cy, covering approximately 40 miles) are presented in the example production schedule.
- Mechanical dredging scenario is presented in the production schedule.
- Dredging activities will generally proceed from upstream to downstream.
- Where possible, contiguous dredge certification units are dredged sequentially.
- Phase 1 will be completed during the first season.
- The dredging crews must achieve the full production dredging rate for at least a 30-day period by end of the Phase 1 season (min 200,000 cy, dredging starting late ~ mid June 2006).
- Phase 2 will be completed during years 2 through 6 (min 490,000 cy/year, work season from May 1 - Nov 30, 2007 to 2011).
- Dredging work will be done six working days/week, and at least 13 hours of dredging can be achieved during a work day when dredging is taking place.

- Winterization of equipment can begin ten days after completion of season's dredging.

- The production rate for critical area backfilling (1/2 acre/day) is based on half of the production rate for general backfill areas (1 acre/day) due to additional time needed for shallow backfill areas and preparation time for future shoreline planting.

- The same crew(s) used for containment barrier placement will be used for containment barrier removal.

- Different crews will be used for shoreline stabilization/restoration tasks: backfilling, shoreline stabilization, and containment removal.

Production rate assumptions for site preparation, mechanical dredging, and site restoration activities are presented in Table D-5. These rates were used in the critical path schedule for each dredge certification unit. Depending on scheduling, work can be performed on more than one certification unit at a time; therefore the number of crews needed for site preparation, dredging, and site restoration activities can vary at any one point in the schedule (the average number of crews is presented in the key assumptions). Production rates based on linear footage of shoreline and shoreline obstacles were based on the figures presented in Attachment E.

Table D-1
Hydraulic and Mechanical Dredge Volumes by Location

	Mechanical Dredge					Hydraulic Dredge				
River Section	4-cy Dredge		2-cy Dredge		Total	Main Production Dredge		Small, Cleanup Dredge		Total
1	1,256,000	(80%)	309,000	(20%)	1,565,000	1,390,000	(89%)	174,000	(11%)	1,564,000
2	475,000	(95%)	27,000	(5%)	502,000	480,000	(96%)	22,000	(4%)	502,000
3	366,000	(65%)	196,000	(35%)	562,000	562,000	(100%)	0	(0%)	562,000
Total	2,097,000	(80%)	532,000	(20%)	2,629,000	2,432,000	(93%)	196,000	(7%)	2,628,000

* Total volumes may not equal across dredging methods due to operational requirements of the equipment

Table D-2
Mechanical Dredging Schedule by Phase

Phase and Year	Volume Remediated (cy)	Area Remediated (acres)	Dredging Completion Date	Work Completion Date
Phase 1 (Year 1)	268,977	50	11/07/06	12/14/06
Phase 2 (Year 2)	529,440	78	10/13/07	12/19/07
Phase 2 (Year 3)	601, 810	86	11/12/08	12/22/08
Phase 2 (Year 4)	564,533	62	11/06/09	12/22/09
Phase 2 (Year 5)	447,387	53	9/29/10	11/12/10
Phase 2 (Year 6)	237,860	63	11/10/11	12/29/11

Table D-3
Phase 1 Dredging Quantities

Phase 1 Activities	Amount Completed During Phase 1 Demonstrated by Production Schedule	Phase 1 Performance Standard Requirement
Total Dredging	268,977 cy	Approximately 200,000 cy
Production Dredging	246,065 cy	Approximately 146,000 cy
Alternative Dredging Equipment (Shallow areas)	22,911 cy	Approximately 12,000 cy
Uncontained Dredging (Navigational Dredging)	80,366 cy	Approximately 42,000 cy

Table D-4
Cumulative Dredge Volumes

Phase and Year	Cumulative Volume Shown in Example Production Schedule (cy)	Required Cumulative Volume (cy)	Target Cumulative Volume (cy)
Phase 1 (Year 1)	268,977	200,000	265,000
Phase 2, (Year 2)	798,417	690,000	795,000
Phase 2, (Year 3)	1,400,227	1,180,000	1,325,000
Phase 2, (Year 4)	1,964,760	1,670,000	1,855,000
Phase 2, (Year 5)	2,412,147	2,160,000	2,385,000
Phase 2, (Year 6)	2,650,000	2,650,000	2,650,000

Table D-5
Example Production Schedule Production Rates

Site Preparation		
Work Element	**Production Rate**	**Key Assumptions**
Installing Containment Barriers:		Jersey barriers may be used in lieu of sheet piling in areas < 2' deep. HDPE silt barrier and steel sheet piling are not needed for navigational dredging areas or in areas of rock outcrops.
Steel Sheet Piling	90 l.f./day	Steel sheet piling installation assumes 1 crew (max 2 crews), 8 hours production time per day. [1]
HDPE Barriers	200 l.f./day	HDPE silt barrier installation assumes 2 crews (minimum 1 crew, maximum 4 crews), 8 hours production time per day.[2]
Clearing and Snagging Shoreline	400 l.f./day	Assumes <2 trees/down trees/logs on average per 100 l.f. shoreline. Assumes 8 hours production time per day. Clearing and Snagging Shoreline assumes 1 crew (maximum 2 crews).[3]
Remove Obstacles	1/2 day/ obstruction plus 1 day/ dock removal	Assumes 8 hours production time per day, assumes 1 crew.[3]
Dredging		
Work Element	**Production Rate**	**Key Assumptions**
Mechanical Dredging		
Production Equipment Dredging	82 cy/hr or 1066 cy/day[4]	Schedule based on 13 hr day Schedule based on 13 hr day of effective dredging time when dredging is actually under way.
Alternative Equipment Dredging[1]	27 cy/hr or 351 cy/day [4]	Alternative dredge(s) start work in an area 3 days after production dredge.
Additional Duration for Obstruction Dredging		1/2 day delay per obstruction.

[1] As discussed in Attachment F, for the mechanical dredging scenario presented in the Productivity Schedule, it is assumed that areas with a post-dredging water depth of 6' or greater (deep areas) would be performed by the large production dredge and areas with shallow post-dredging water depth of less that 6' (shallow areas) would be performed by the small alternative dredge. Due the large volume (approximately 155,000 cy) of

Table D-5
Example Production Schedule Production Rates

Confirmatory Testing and Surveying	Calculated lag	Starts 2 days after Alternative dredge starts and finishes 2 days after dredging is completed. Schedule assumes 1 crew, 13 hour days. Minimum one day for surveying for all areas less than 30 acres (approximately 30 acres/day).
Redredging	Calculated lag	Re-dredging (equipment will vary) schedule equal to ½ the total number of days required for design cut with the primary and alternative dredges. Re-dredging finishes 10 days after sampling completed. Schedule assumes 13 hours of effective dredging per day.
Additional Confirmatory Testing and Surveying	Calculated lag	Starts 2 days after Redredging starts and finish 2 days after re-dredging is completed. Schedule assumes 1 crew, 13 hour days.
Site Restoration		
Work Element	Production Rate	Key Assumptions
Backfilling		Backfilling finishes 7 days after re-confirmatory testing and surveying ends. Assumes closure areas managed in less than 5 acre areas.
Non-Critical Sub-sites	1 acre/day[5]	Schedule assumes maximum 2 crews for non-critical backfill areas, 8 hours per day.
Critical Sub-sites	1/2 acre/day[6]	Schedule assumes maximum 3 crews for critical backfill areas, 8 hours per day.
Shoreline Stabilization/ Restoration	150 l.f./day	Assumes 8 hours production time per day. Assumes fine stone fill, 50 cy/day; 9 c.f. per linear foot of shoreline; placed from water. Shoreline

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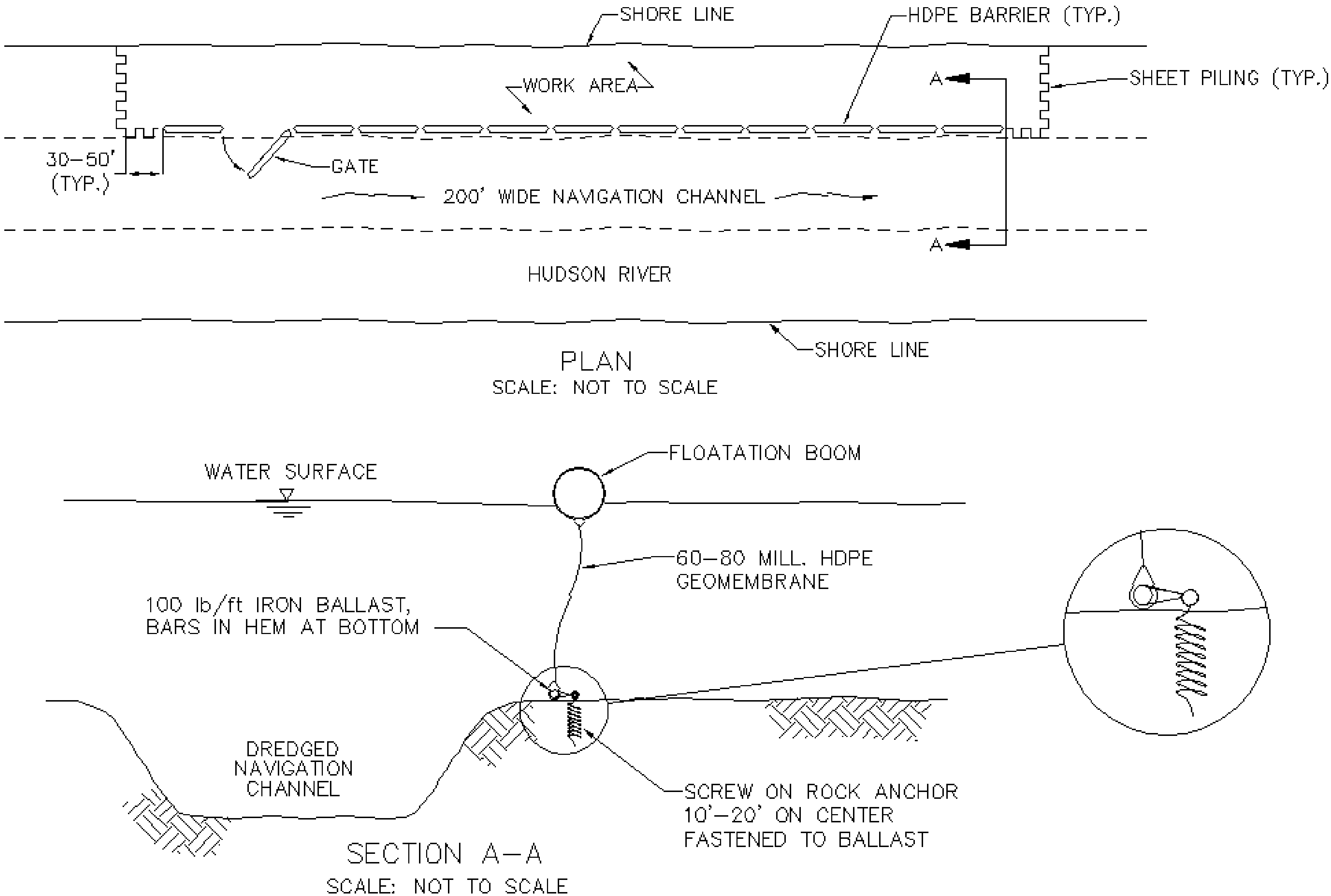
shallow area material in the backwater area behind (west) of Griffin Island, an exception to this assumption was made in development of the Productivity Schedule. Specifically, we have assumed the utilization of a production dredge, or a different dredge with a production rate equal to or greater than the production dredge's 82 cy/hour rate. Furthermore, transport of the sediment would be accomplished using a technique such as pumping to scows in deeper water, pumping to the processing/transfer facility, partially loading scows, using enhanced-floatation deck barges, hauling in trucks across Griffin Island to load onto scows in deeper water, or some combination of these techniques. The underlying assumption is that these modified techniques would be less costly and more practical than having numerous (up to 4) small alternate dredges to accomplish the same volume.

Table D-5
Example Production Schedule Production Rates

		restoration assumes maximum 2 crews. Assumes 8 hours per day. Shoreline restoration included for navigational dredging areas that are not contained but are adjacent to the shoreline.
Post Backfill Surveying Non-Critical Sub-sites Critical Sub-sites	Calculated lag	Starts 2 days after the start of backfilling. Schedule assumes 1 crew (maximum 2 crews) 8 hours per day. Schedule assumes 1 crew (maximum 3 crews) 8 hours per day.
Removing Containment Barriers Steel Sheet Piling HDPE Barrier	 130 l.f./day[7] 300 l.f./day[7]	Removal of containment barriers will occur after backfill stabilization. Containment will be extracted and salvaged. Schedule assumes 1 crew (maximum 2 crews) will be used for Steel Sheet Piling removal. Assumes 8 hours per day. Schedule assumes 2 crews (minimum 1 crew, maximum 4 crews) will be used for Steel Sheet Piling removal. Assumes 8 hours per day.
Obstruction Replacement	1 day/dock[3]	Obstruction Replacement assumes 1 crew 8 hours per day.
Shoreline Stabilization/ Restoration	150 l.f./day	Assumes 8 hours production time per day. Assumes fine stone fill, 50 cy/day; 9 c.f. per linear foot of shoreline; placed from water. Shoreline restoration assumes maximum 2 crews. Assumes 8 hours per day. Shoreline restoration included for navigational dredging areas that are not contained but are adjacent to the shoreline.
Post Backfill Surveying Non-Critical Sub-sites Critical Sub-sites	Calculated lag	Starts 2 days after the start of backfilling. Schedule assumes 1 crew (maximum 2 crews) 8 hours per day. Schedule assumes 1 crew (maximum 3 crews) 8 hours per day.
Removing Containment Barriers Steel Sheet Piling	 130 l.f./day	Removal of containment barriers will occur after backfill stabilization. Containment will be extracted and salvaged. Schedule assumes 1 crew (maximum 2 crews) will be used for Steel Sheet Piling removal. Assumes 8

HDPE Barrier	300 l.f./day	hours per day. Schedule assumes 2 crews (minimum 1 crew, maximum 4 crews) will be used for Steel Sheet Piling removal. Assumes 8 hours per day.
Obstruction Replacement	1 day/dock	Obstruction Replacement assumes 1 crew 8 hours per day.

References for Productivity Rates
1. Draft Interim Completion Report for the St. Lawrence River Remediation Project at the Alcoa, Inc. Massena East Smelter Plant, New York; Bechtel Associates Professional Corporation, NY; March 3002.
2. Personal Communication between John Mulligan and Steven Laszewski, PhD, Foth and VanDyke Engineers, Green Bay, Wisconsin regarding silt barrier installation and removal rates at Fox River Deposit N project.
3. Allowance based on experience in removing and replacing private docks and removing snags from waterways.
4. Rates are based on a count of dredge bucket cycles per hour at remediation projects and telephone calls to remedial dredging contractors.
5. & 6. Discussions with John Lally, P.E., Program Manager, Bean Environmental regarding backfill placement rates using hydraulic spreading equipment.
7. RS Means Heavy Construction Cost Data, 16th Edition.



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HUDSON RIVER PCB PROJECT

SILT BARRIER

FIGURE NO. D-1

Production Schedule:

Phase 1 (Year 1)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase I						
Around Rogers Island RM 193.75 - 194.5						
Site Summary						
00000	Phase I (Year 1) (Summary)	195*	195*	0	02MAY06	14DEC06
00040	Site 1 (Summary)	149*	149*	0	02MAY06	21OCT06
Mobilization						
00005	Mobilization (Summary)	30	30	0	02MAY06	05JUN06
00020	Mobilize Equipment	20	20	0	02MAY06	24MAY06
00030	Activiate Infrastructure	30	30	0	02MAY06	05JUN06
Site Preparation						
00050	Site Preparation (Summary)	9	9	0	06JUN06	15JUN06
00060	Install Steel Sheet Piling	9	9	0	06JUN06	15JUN06
00070	Install HDPE Silt Barriers	2	2	0	14JUN06	15JUN06
00080	Clearing and Snagging Shoreline	1	1	0	15JUN06	15JUN06
00090	Remove Obstacles	3	3	0	13JUN06	15JUN06
Dredging						
00100	Dredging (Summary)	76	76	0	16JUN06	12SEP06
00110	Design Cut(s) - (1) Primary Dredge	61	61	0	16JUN06	25AUG06
00120	Design Cut(s) - (1) Alternate Dredge	36	36	0	20JUN06	31JUL06
00130	Add. Alternate Dredging Around Obstructions	2	2	0	01AUG06	02AUG06
00140	Confirmation Testing/Surveying - Primary Dredge	61	61	0	19JUN06	28AUG06
00150	Confirmation Testing/Surveying - Alt. Dredge	36	36	0	24JUN06	04AUG06
00160	Redredging	49	49	0	14JUL06	08SEP06
00170	Additional Confirmation Testing/Surveying	49	49	0	18JUL06	12SEP06
Restoration						
00180	Restoration (Summary)	44	44	0	01SEP06	21OCT06
00190	Backfill Non-Critical Areas	11	11	0	02SEP06	14SEP06
00200	Backfill Critical Areas	8	8	0	06SEP06	14SEP06
00210	Post Backfilling Survey (Non Critical Areas)	11	11	0	05SEP06	16SEP06
00220	Post Backfilling Survey (Critical Areas)	8	8	0	08SEP06	16SEP06
00225	Replace Obstructions	1	1	0	01SEP06	01SEP06
00230	Restore Shoreline	44	44	0	01SEP06	21OCT06
00240	Remove Sheet Piling	6	6	0	18SEP06	23SEP06
00250	Remove HPDE Silt Fences	1	1	0	18SEP06	18SEP06

Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:39

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HPCB

Sheet 1 of 4

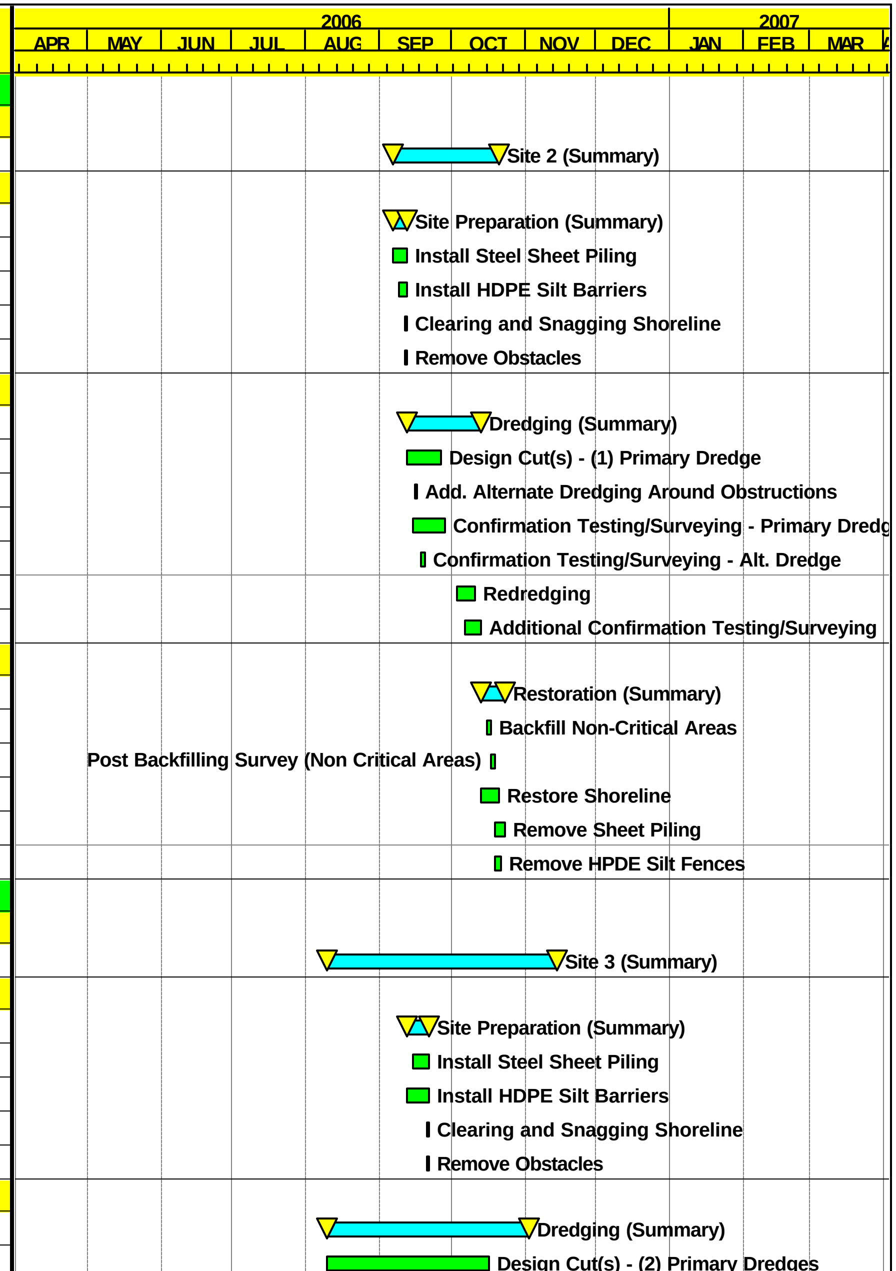
Example Production Schedule

Hudson River PCB Dredging

Phase I (Year 1)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
RM 193.5 - 193.75						
Site Summary						
00260	Site 2 (Summary)	38*	38*	0	07SEP06	20OCT06
Site Preparation						
00270	Site Preparation (Summary)	5	5	0	07SEP06	12SEP06
00280	Install Steel Sheet Piling	5	5	0	07SEP06	12SEP06
00290	Install HDPE Silt Barriers	3	3	0	09SEP06	12SEP06
00300	Clearing and Snagging Shoreline	1	1	0	12SEP06	12SEP06
00310	Remove Obstacles	1	1	0	12SEP06	12SEP06
Dredging						
00320	Dredging (Summary)	27	27	0	13SEP06	13OCT06
00330	Design Cut(s) - (1) Primary Dredge	12	12	0	13SEP06	26SEP06
00350	Add. Alternate Dredging Around Obstructions	1	1	0	16SEP06	16SEP06
00360	Confirmation Testing/Surveying - Primary Dredge	12	12	0	15SEP06	28SEP06
00370	Confirmation Testing/Surveying - Alt. Dredge	1	1	0	19SEP06	19SEP06
00380	Redredging	6	6	0	04OCT06	10OCT06
00390	Additional Confirmation Testing/Surveying	6	6	0	07OCT06	13OCT06
Restoration						
00400	Restoration (Summary)	8	8	0	14OCT06	23OCT06
00410	Backfill Non-Critical Areas	2	2	0	16OCT06	17OCT06
00430	Post Backfilling Survey (Non Critical Areas)	2	2	0	18OCT06	19OCT06
00450	Restore Shoreline	6	6	0	14OCT06	20OCT06
00460	Remove Sheet Piling	3	3	0	20OCT06	23OCT06
00470	Remove HPDE Silt Fences	2	2	0	20OCT06	21OCT06
RM 192.5 - 193.5 W						
Site Summary						
00480	Site 3 (Summary)	83*	83*	0	10AUG06	14NOV06
Site Preparation						
00490	Site Preparation (Summary)	8	8	0	13SEP06	21SEP06
00500	Install Steel Sheet Piling	6	6	0	15SEP06	21SEP06
00510	Install HDPE Silt Barriers	8	8	0	13SEP06	21SEP06
00520	Clearing and Snagging Shoreline	1	1	0	21SEP06	21SEP06
00530	Remove Obstacles	1	1	0	21SEP06	21SEP06
Dredging						
00540	Dredging (Summary)	73	73	0	10AUG06	02NOV06
00550	Design Cut(s) - (2) Primary Dredges	58	58	0	10AUG06	16OCT06



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:39

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HPCB

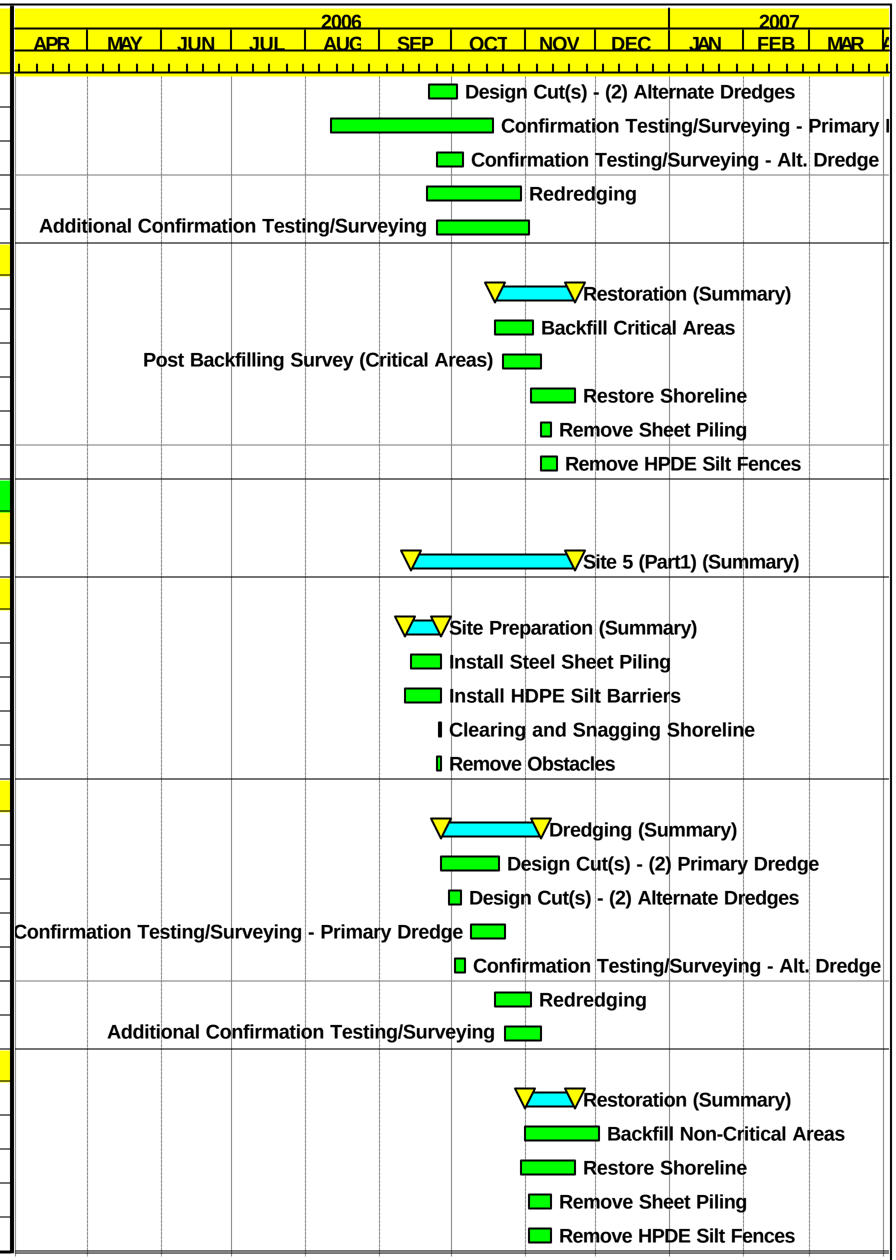
Example Production Schedule

Hudson River PCB Dredging

Phase I (Year 1)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
00560	Design Cut(s) - (2) Alternate Dredges	10	10	0	22SEP06	03OCT06
00580	Confirmation Testing/Surveying - Primary Dredge	58	58	0	12AUG06	18OCT06
00590	Confirmation Testing/Surveying - Alt. Dredge	10	10	0	25SEP06	05OCT06
00600	Redredging	34	34	0	21SEP06	30OCT06
00610	Additional Confirmation Testing/Surveying	34	34	0	25SEP06	02NOV06
Restoration						
00620	Restoration (Summary)	28	28	0	20OCT06	21NOV06
00640	Backfill Critical Areas	14	14	0	20OCT06	04NOV06
00660	Post Backfilling Survey (Critical Areas)	14	14	0	23OCT06	07NOV06
00670	Restore Shoreline	15	15	0	04NOV06	21NOV06
00680	Remove Sheet Piling	4	4	0	08NOV06	11NOV06
00690	Remove HPDE Silt Fences	6	6	0	08NOV06	14NOV06
RM 191.5 - 192.5 W Part 1						
Site Summary						
07000	Site 5 (Part1) (Summary)	59*	59*	0	14SEP06	21NOV06
Site Preparation						
07010	Site Preparation (Summary)	13*	13*	0	12SEP06	26SEP06
07020	Install Steel Sheet Piling	11	11	0	14SEP06	26SEP06
07030	Install HDPE Silt Barriers	13	13	0	12SEP06	26SEP06
07040	Clearing and Snagging Shoreline	1	1	0	26SEP06	26SEP06
07050	Remove Obstacles	2	2	0	25SEP06	26SEP06
Dredging						
07060	Dredging (Summary)	36*	36*	0	27SEP06	07NOV06
07070	Design Cut(s) - (2) Primary Dredge	21	21	0	27SEP06	20OCT06
07075	Design Cut(s) - (2) Alternate Dredges	4	4	0	30SEP06	04OCT06
07090	Confirmation Testing/Surveying - Primary Dredge	12	12	0	10OCT06	23OCT06
07100	Confirmation Testing/Surveying - Alt. Dredge	4	4	0	03OCT06	06OCT06
07110	Redredging	13	13	0	20OCT06	03NOV06
07120	Additional Confirmation Testing/Surveying	13	13	0	24OCT06	07NOV06
Restoration						
07130	Restoration (Summary)	18*	18*	0	01NOV06	21NOV06
07140	Backfill Non-Critical Areas	27	27	0	01NOV06	01DEC06
07160	Restore Shoreline	19	19	0	31OCT06	21NOV06
07170	Remove Sheet Piling	8	8	0	03NOV06	11NOV06
07180	Remove HPDE Silt Fences	8	8	0	03NOV06	11NOV06



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:39

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HPCB

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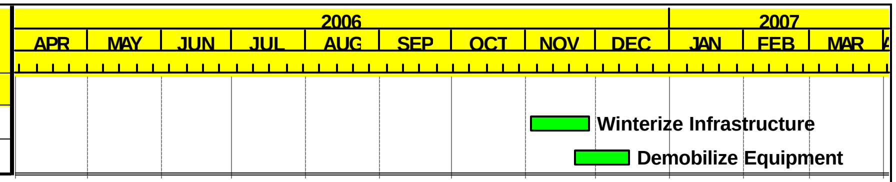
Example Production Schedule

Hudson River PCB Dredging

Phase I (Year 1)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Demobilization						
00695	Winterize Infrastructure	20	20	0	04NOV06	27NOV06
00696	Demobilize Equipment	20	20	0	22NOV06	14DEC06



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:39

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Example Production Schedule

Hudson River PCB Dredging

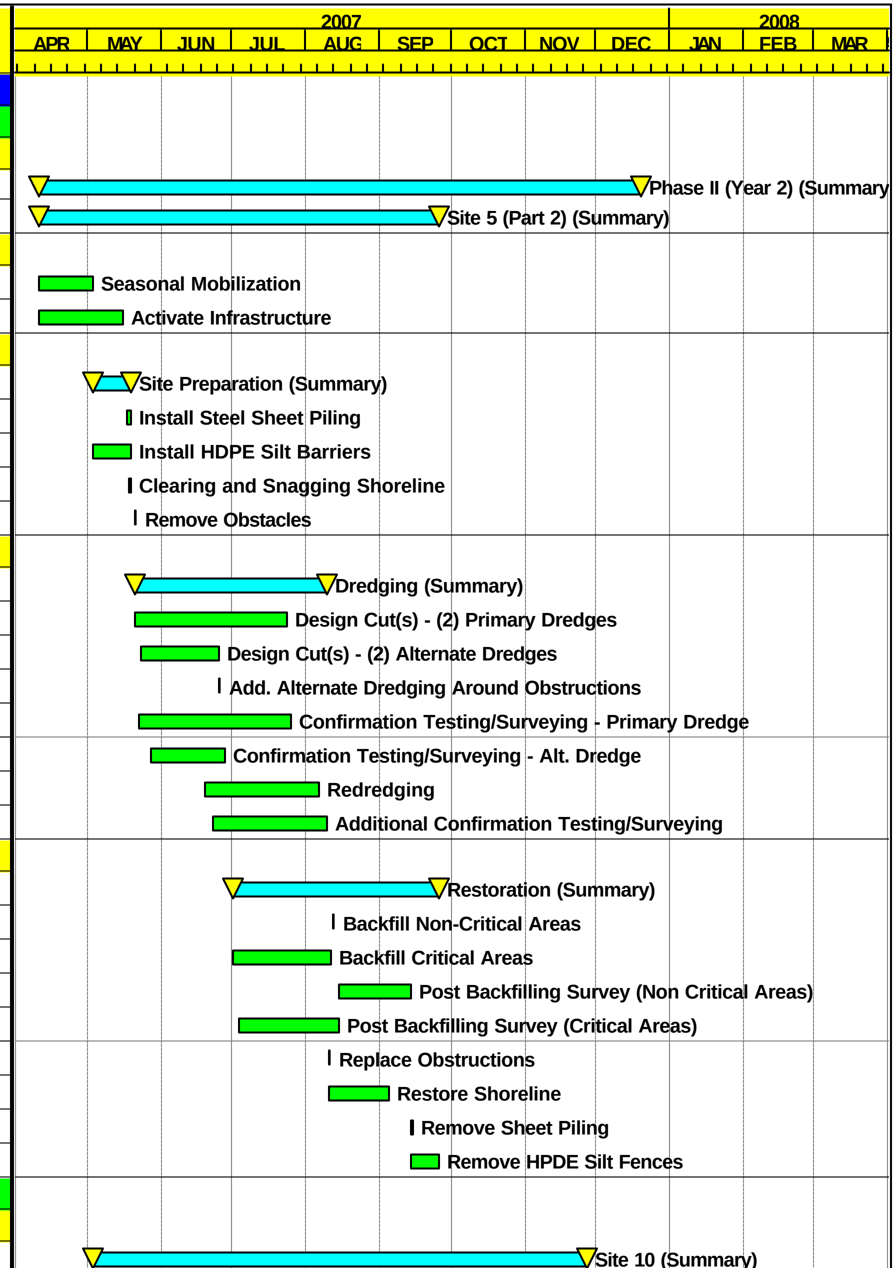
Phase I (Year 1)

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 2)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase II						
RM 191.5 - 192.5 W Part 2						
Site Summary						
00918	Phase II (Year 2) (Summary)	217*	217*	0	11APR07	19DEC07
00920	Site 5 (Part 2) (Summary)	144	144	0	11APR07	25SEP07
Mobilization						
00702	Seasonal Mobilization	20	20	0	11APR07*	03MAY07
00704	Activate Infrastructure	30	30	0	11APR07	15MAY07
Site Preparation						
00930	Site Preparation (Summary)	14	14	0	04MAY07	19MAY07
00940	Install Steel Sheet Piling	2	2	0	18MAY07	19MAY07
00950	Install HDPE Silt Barriers	14	14	0	04MAY07	19MAY07
00960	Clearing and Snagging Shoreline	1	1	0	19MAY07	19MAY07
00970	Remove Obstacles	0	0	0	21MAY07	19MAY07
Dredging						
00980	Dredging (Summary)	70	70	0	21MAY07	09AUG07
00990	Design Cut(s) - (2) Primary Dredges	55	55	0	21MAY07	23JUL07
01000	Design Cut(s) - (2) Alternate Dredges	28	28	0	24MAY07	25JUN07
01010	Add. Alternate Dredging Around Obstructions	0	0	0	26JUN07	25JUN07
01020	Confirmation Testing/Surveying - Primary Dredge	55	55	0	23MAY07	25JUL07
01030	Confirmation Testing/Surveying - Alt. Dredge	27	27	0	28MAY07	27JUN07
01040	Redredging	41	41	0	20JUN07	06AUG07
01050	Additional Confirmation Testing/Surveying	41	41	0	23JUN07	09AUG07
Restoration						
01060	Restoration (Summary)	74	74	0	02JUL07	25SEP07
01070	Backfill Non-Critical Areas	0	0	0	13AUG07	11AUG07
01080	Backfill Critical Areas	36	36	0	02JUL07	11AUG07
01090	Post Backfilling Survey (Non Critical Areas)	26	26	0	15AUG07	13SEP07
01100	Post Backfilling Survey (Critical Areas)	36	36	0	04JUL07	14AUG07
01105	Replace Obstructions	0	0	0	11AUG07	10AUG07
01110	Restore Shoreline	21	21	0	11AUG07	04SEP07
01120	Remove Sheet Piling	1	1	0	14SEP07	14SEP07
01130	Remove HPDE Silt Fences	10	10	0	14SEP07	25SEP07
RM 189.5 - 190.5 W						
Site Summary						
01800	Site 10 (Summary)	177	177	0	04MAY07	26NOV07



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:37

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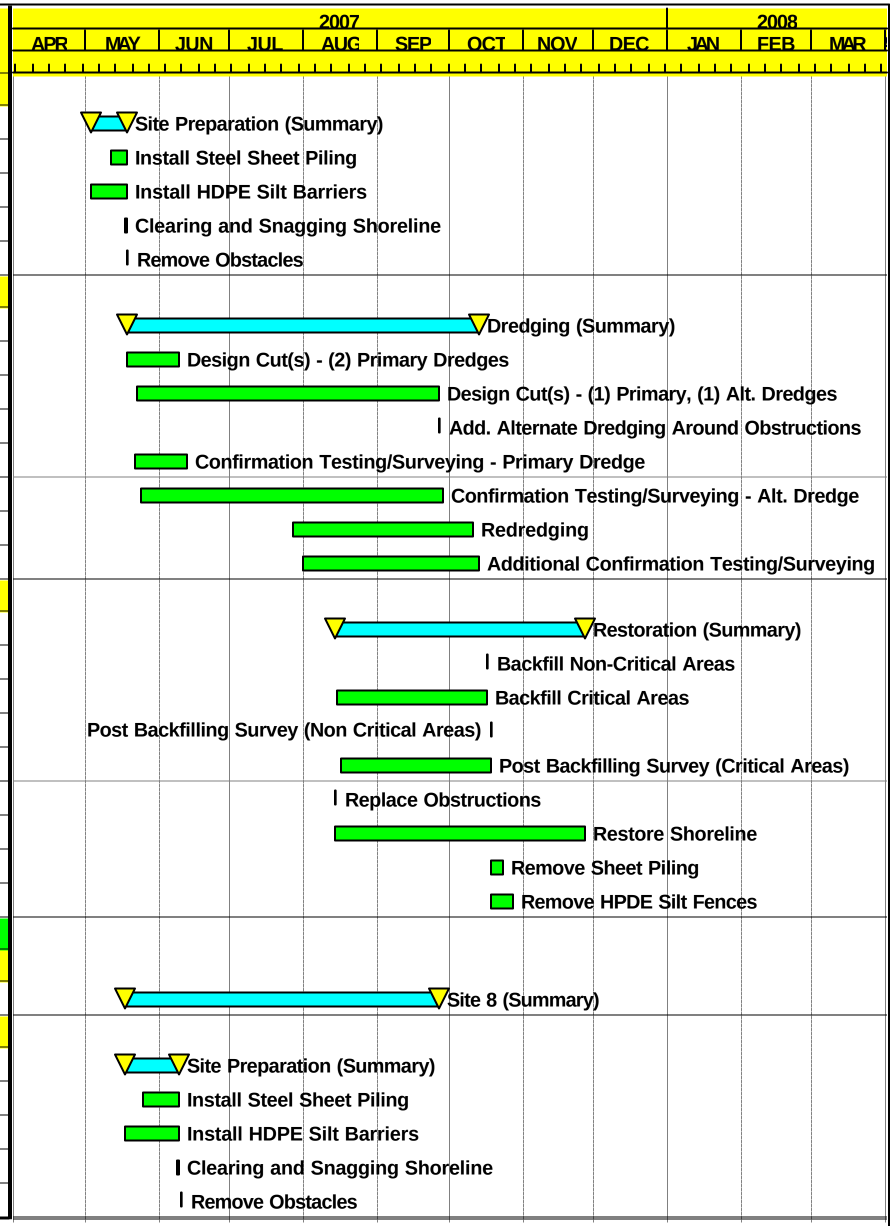
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 2)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
01810	Site Preparation (Summary)	13	13	0	04MAY07	18MAY07
01820	Install Steel Sheet Piling	6	6	0	12MAY07	18MAY07
01830	Install HDPE Silt Barriers	13	13	0	04MAY07	18MAY07
01840	Clearing and Snagging Shoreline	1	1	0	18MAY07	18MAY07
01850	Remove Obstacles	0	0	0	19MAY07	18MAY07
Dredging						
01860	Dredging (Summary)	127	127	0	19MAY07	13OCT07
01870	Design Cut(s) - (2) Primary Dredges	19	19	0	19MAY07	09JUN07
01880	Design Cut(s) - (1) Primary, (1) Alt. Dredges	109	109	0	23MAY07	26SEP07
01890	Add. Alternate Dredging Around Obstructions	0	0	0	27SEP07	26SEP07
01900	Confirmation Testing/Surveying - Primary Dredge	19	19	0	22MAY07	12JUN07
01910	Confirmation Testing/Surveying - Alt. Dredge	109	109	0	25MAY07	28SEP07
01920	Redredging	64	64	0	28JUL07	10OCT07
01930	Additional Confirmation Testing/Surveying	64	64	0	01AUG07	13OCT07
Restoration						
01940	Restoration (Summary)	90	90	0	14AUG07	26NOV07
01950	Backfill Non-Critical Areas	0	0	0	17OCT07	16OCT07
01960	Backfill Critical Areas	54	54	0	15AUG07	16OCT07
01970	Post Backfilling Survey (Non Critical Areas)	0	0	0	19OCT07	18OCT07
01980	Post Backfilling Survey (Critical Areas)	54	54	0	17AUG07	18OCT07
01985	Replace Obstructions	0	0	0	14AUG07	13AUG07
01990	Restore Shoreline	90	90	0	14AUG07	26NOV07
02000	Remove Sheet Piling	4	4	0	19OCT07	23OCT07
02010	Remove HPDE Silt Fences	8	8	0	19OCT07	27OCT07
RM 190.5 - 191.5 W						
Site Summary						
01580	Site 8 (Summary)	113	113	0	18MAY07	26SEP07
Site Preparation						
01590	Site Preparation (Summary)	20	20	0	18MAY07	09JUN07
01600	Install Steel Sheet Piling	13	13	0	26MAY07	09JUN07
01610	Install HDPE Silt Barriers	20	20	0	18MAY07	09JUN07
01620	Clearing and Snagging Shoreline	1	1	0	09JUN07	09JUN07
01630	Remove Obstacles	0	0	0	11JUN07	09JUN07



Start Date	18APR05	HPCB	Sheet 2 of 4
Finish Date	29DEC11	Example Production Schedule	
Data Date	18APR05	Hudson River PCB Dredging	
Run Date	01APR04 10:37	Phase II (Year 2)	

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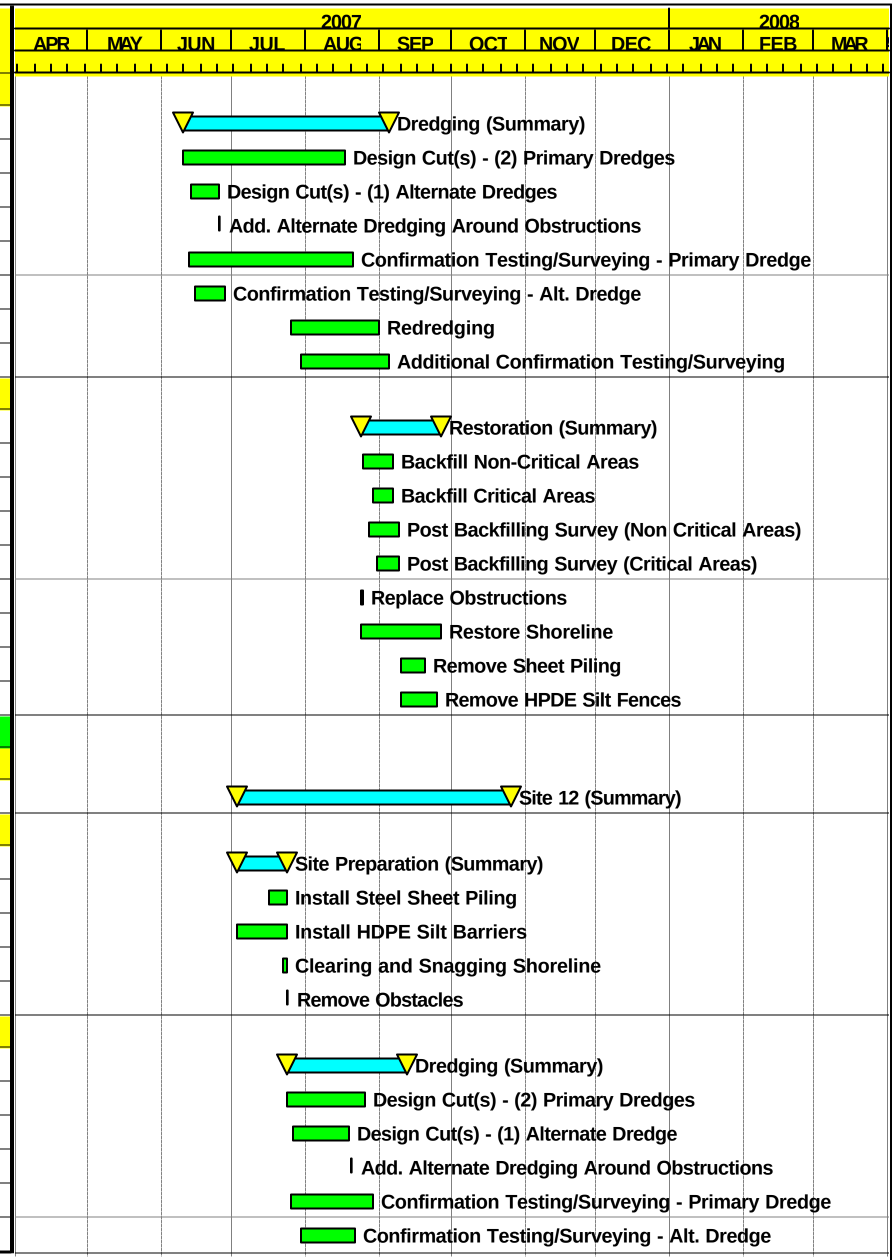
Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Dredging						
01640	Dredging (Summary)	74	74	0	11JUN07	04SEP07
01650	Design Cut(s) - (2) Primary Dredges	59	59	0	11JUN07	17AUG07
01660	Design Cut(s) - (1) Alternate Dredges	10	10	0	14JUN07	25JUN07
01670	Add. Alternate Dredging Around Obstructions	0	0	0	26JUN07	25JUN07
01680	Confirmation Testing/Surveying - Primary Dredge	59	59	0	13JUN07	20AUG07
01690	Confirmation Testing/Surveying - Alt. Dredge	10	10	0	16JUN07	27JUN07
01700	Redredging	32	32	0	26JUL07	31AUG07
01710	Additional Confirmation Testing/Surveying	32	32	0	30JUL07	04SEP07
Restoration						
01720	Restoration (Summary)	29	29	0	24AUG07	26SEP07
01730	Backfill Non-Critical Areas	11	11	0	25AUG07	06SEP07
01740	Backfill Critical Areas	8	8	0	29AUG07	06SEP07
01750	Post Backfilling Survey (Non Critical Areas)	11	11	0	28AUG07	08SEP07
01760	Post Backfilling Survey (Critical Areas)	8	8	0	31AUG07	08SEP07
01765	Replace Obstructions	1	1	0	24AUG07	24AUG07
01770	Restore Shoreline	29	29	0	24AUG07	26SEP07
01780	Remove Sheet Piling	9	9	0	10SEP07	19SEP07
01790	Remove HPDE Silt Fences	13	13	0	10SEP07	24SEP07
RM 188.5 - 198.5 W						
Site Summary						
02460	Site 12 (Summary)	99	99	0	03JUL07	25OCT07
Site Preparation						
02470	Site Preparation (Summary)	18	18	0	03JUL07	23JUL07
02480	Install Steel Sheet Piling	6	6	0	17JUL07	23JUL07
02490	Install HDPE Silt Barriers	18	18	0	03JUL07	23JUL07
02500	Clearing and Snagging Shoreline	1	1	0	23JUL07	23JUL07
02510	Remove Obstacles	0	0	0	24JUL07	23JUL07
Dredging						
02520	Dredging (Summary)	44	44	0	24JUL07	12SEP07
02530	Design Cut(s) - (2) Primary Dredges	29	29	0	24JUL07	25AUG07
02540	Design Cut(s) - (1) Alternate Dredge	20	20	0	27JUL07	18AUG07
02550	Add. Alternate Dredging Around Obstructions	0	0	0	20AUG07	18AUG07
02560	Confirmation Testing/Surveying - Primary Dredge	29	29	0	26JUL07	28AUG07
02570	Confirmation Testing/Surveying - Alt. Dredge	20	20	0	30JUL07	21AUG07



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
Run Date	01APR04 10:37

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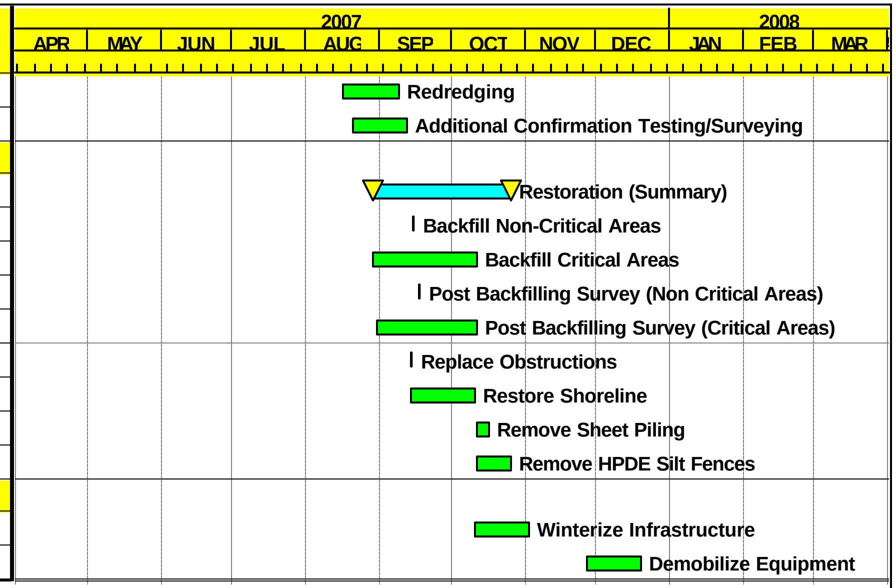
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 2)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
02580	Redredging	20	20	0	17AUG07	08SEP07
02590	Additional Confirmation Testing/Surveying	20	20	0	21AUG07	12SEP07
Restoration						
02600	Restoration (Summary)	50	50	0	29AUG07	25OCT07
02610	Backfill Non-Critical Areas	0	0	0	15SEP07	14SEP07
02620	Backfill Critical Areas	38	38	0	29AUG07	11OCT07
02630	Post Backfilling Survey (Non Critical Areas)	0	0	0	18SEP07	17SEP07
02640	Post Backfilling Survey (Critical Areas)	36	36	0	31AUG07	11OCT07
02645	Replace Obstructions	0	0	0	14SEP07	13SEP07
02650	Restore Shoreline	23	23	0	14SEP07	10OCT07
02660	Remove Sheet Piling	4	4	0	12OCT07	16OCT07
02670	Remove HPDE Silt Fences	12	12	0	12OCT07	25OCT07
Demobilization						
02232	Winterize Infrastructure	20	20	0	11OCT07	02NOV07
02234	Demobilize Equipment	20	20	0	27NOV07	19DEC07



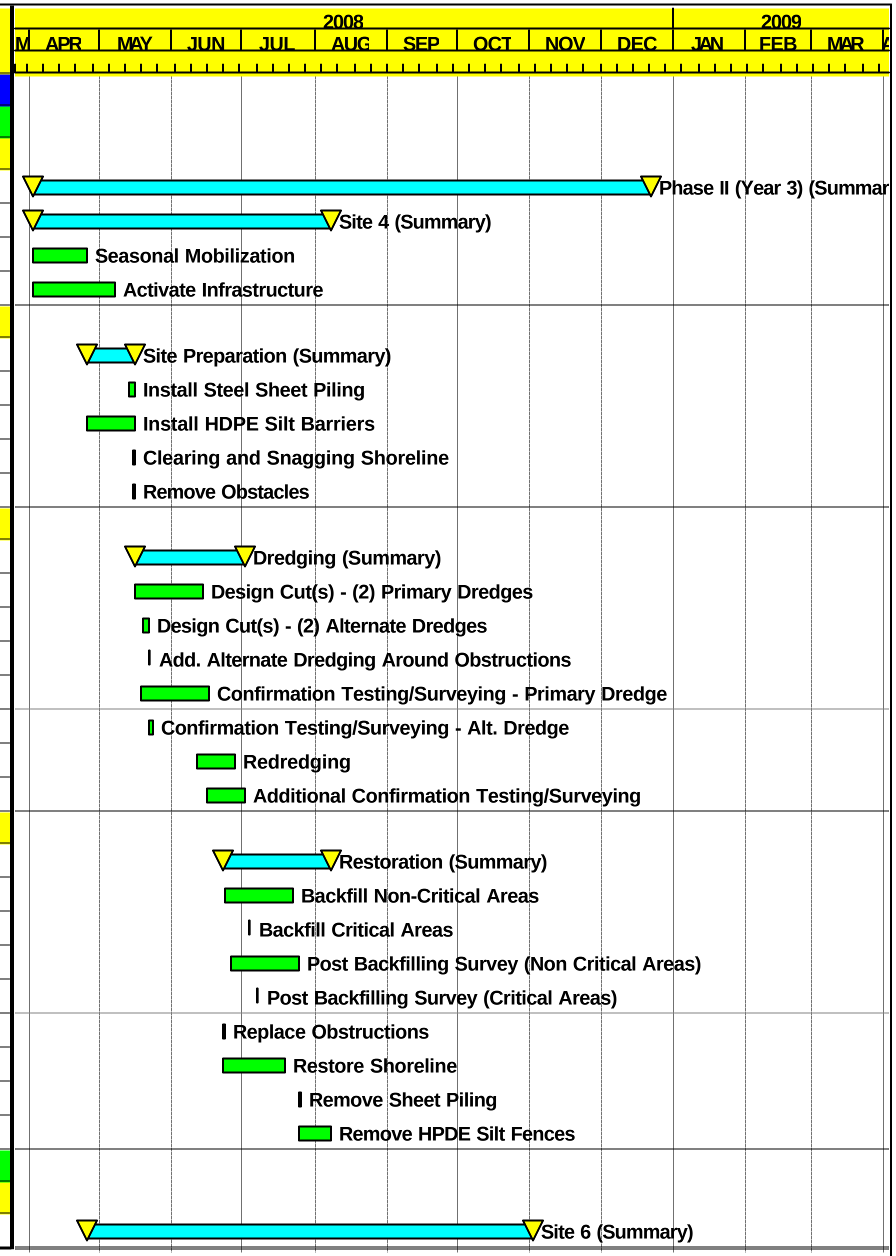
Start Date 18APR05 Finish Date 29DEC11 Data Date 18APR05 Run Date 01APR04 10:37	MALCOLM PIRNIE	HPCB Sheet 4 of 4 Example Production Schedule Hudson River PCB Dredging Phase II (Year 2)	

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 3)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase II						
RM 192.5 - 193.5 E						
Site Summary						
00699	Phase II (Year 3) (Summary)	226*	226*	0	03APR08	22DEC08
00700	Site 4 (Summary)	109	109	0	03APR08	07AUG08
01801	Seasonal Mobilization	20	20	0	03APR08*	25APR08
01802	Activate Infrastructure	30	30	0	03APR08	07MAY08
Site Preparation						
00710	Site Preparation (Summary)	17	17	0	26APR08	15MAY08
00720	Install Steel Sheet Piling	2	2	0	14MAY08	15MAY08
00730	Install HDPE Silt Barriers	17	17	0	26APR08	15MAY08
00740	Clearing and Snagging Shoreline	1	1	0	15MAY08	15MAY08
00750	Remove Obstacles	1	1	0	15MAY08	15MAY08
Dredging						
00760	Dredging (Summary)	40	40	0	16MAY08	01JUL08
00770	Design Cut(s) - (2) Primary Dredges	25	25	0	16MAY08	13JUN08
00780	Design Cut(s) - (2) Alternate Dredges	2	2	0	20MAY08	21MAY08
00790	Add. Alternate Dredging Around Obstructions	0	0	0	22MAY08	21MAY08
00800	Confirmation Testing/Surveying - Primary Dredge	25	25	0	19MAY08	16JUN08
00810	Confirmation Testing/Surveying - Alt. Dredge	2	2	0	22MAY08	23MAY08
00820	Redredging	14	14	0	12JUN08	27JUN08
00830	Additional Confirmation Testing/Surveying	14	14	0	16JUN08	01JUL08
Restoration						
00840	Restoration (Summary)	40	40	0	23JUN08	07AUG08
00850	Backfill Non-Critical Areas	25	25	0	24JUN08	22JUL08
00860	Backfill Critical Areas	0	0	0	04JUL08	03JUL08
00870	Post Backfilling Survey (Non Critical Areas)	25	25	0	26JUN08	24JUL08
00880	Post Backfilling Survey (Critical Areas)	0	0	0	07JUL08	05JUL08
00885	Replace Obstructions	1	1	0	23JUN08	23JUN08
00890	Restore Shoreline	23	23	0	23JUN08	18JUL08
00900	Remove Sheet Piling	1	1	0	25JUL08	25JUL08
00910	Remove HPDE Silt Fences	12	12	0	25JUL08	07AUG08
RM 191.5 - 192.5 E						
Site Summary						
01140	Site 6 (Summary)	163	163	0	26APR08	01NOV08



Start Date	18APR05
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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 3)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
01150	Site Preparation (Summary)	25	25	0	26APR08	24MAY08
01160	Install Steel Sheet Piling	11	11	0	13MAY08	24MAY08
01170	Install HDPE Silt Barriers	25	25	0	26APR08	24MAY08
01180	Clearing and Snagging Shoreline	1	1	0	24MAY08	24MAY08
01190	Remove Obstacles	7	7	0	17MAY08	24MAY08
Dredging						
01200	Dredging (Summary)	110	110	0	26MAY08	30SEP08
01210	Design Cut(s) - (2) Primary Dredges	84	84	0	26MAY08	30AUG08
01220	Design Cut(s) - (2) Alternate Dredges	94	94	0	29MAY08	15SEP08
01230	Add. Alternate Dredging Around Obstructions	0	0	0	16SEP08	15SEP08
01240	Confirmation Testing/Surveying - Primary Dredge	84	84	0	28MAY08	02SEP08
01250	Confirmation Testing/Surveying - Alt. Dredge	94	94	0	31MAY08	17SEP08
01260	Redredging	89	89	0	16JUN08	26SEP08
01270	Additional Confirmation Testing/Surveying	89	89	0	19JUN08	30SEP08
Restoration						
01280	Restoration (Summary)	73	73	0	09AUG08	01NOV08
01290	Backfill Non-Critical Areas	0	0	0	03OCT08	02OCT08
01300	Backfill Critical Areas	46	46	0	11AUG08	02OCT08
01310	Post Backfilling Survey (Non Critical Areas)	0	0	0	06OCT08	04OCT08
01320	Post Backfilling Survey (Critical Areas)	46	46	0	13AUG08	04OCT08
01325	Replace Obstructions	7	7	0	09AUG08	16AUG08
01330	Restore Shoreline	73	73	0	09AUG08	01NOV08
01340	Remove Sheet Piling	8	8	0	06OCT08	14OCT08
01350	Remove HPDE Silt Fences	17	17	0	06OCT08	24OCT08
RM 109.5 - 191.5 E						
Site Summary						
01360	Site 7 (Summary)	101	101	0	14JUN08	09OCT08
Site Preparation						
01370	Site Preparation (Summary)	16	16	0	09JUL08	26JUL08
01380	Install Steel Sheet Piling	8	8	0	18JUL08	26JUL08
01390	Install HDPE Silt Barriers	16	16	0	09JUL08	26JUL08
01400	Clearing and Snagging Shoreline	1	1	0	26JUL08	26JUL08
01410	Remove Obstacles	0	0	0	28JUL08	26JUL08

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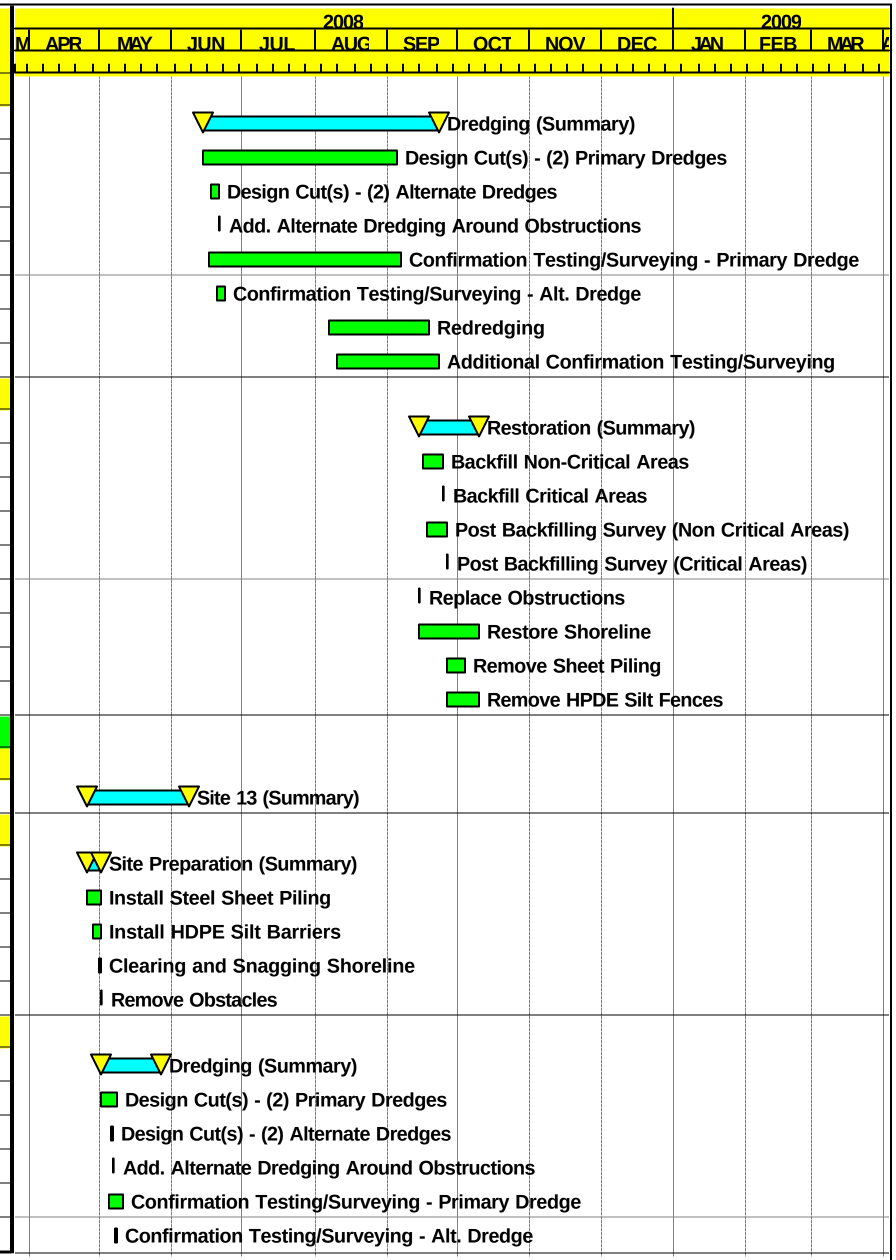
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 3)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Dredging						
01420	Dredging (Summary)	86	86	0	14JUN08	22SEP08
01430	Design Cut(s) - (2) Primary Dredges	71	71	0	14JUN08	04SEP08
01440	Design Cut(s) - (2) Alternate Dredges	3	3	0	18JUN08	20JUN08
01450	Add. Alternate Dredging Around Obstructions	0	0	0	21JUN08	20JUN08
01460	Confirmation Testing/Surveying - Primary Dredge	71	71	0	17JUN08	06SEP08
01470	Confirmation Testing/Surveying - Alt. Dredge	3	3	0	20JUN08	23JUN08
01480	Redredging	37	37	0	07AUG08	18SEP08
01490	Additional Confirmation Testing/Surveying	37	37	0	11AUG08	22SEP08
Restoration						
01500	Restoration (Summary)	22	22	0	15SEP08	09OCT08
01510	Backfill Non-Critical Areas	8	8	0	16SEP08	24SEP08
01520	Backfill Critical Areas	0	0	0	25SEP08	24SEP08
01530	Post Backfilling Survey (Non Critical Areas)	8	8	0	18SEP08	26SEP08
01540	Post Backfilling Survey (Critical Areas)	0	0	0	27SEP08	26SEP08
01545	Replace Obstructions	0	0	0	15SEP08	13SEP08
01550	Restore Shoreline	22	22	0	15SEP08	09OCT08
01560	Remove Sheet Piling	6	6	0	27SEP08	03OCT08
01570	Remove HPDE Silt Fences	11	11	0	27SEP08	09OCT08
RM 187.5 - 188.5 W						
Site Summary						
02680	Site 13 (Summary)	37	37	0	26APR08	07JUN08
Site Preparation						
02690	Site Preparation (Summary)	5	5	0	26APR08	01MAY08
02700	Install Steel Sheet Piling	5	5	0	26APR08	01MAY08
02710	Install HDPE Silt Barriers	4	4	0	28APR08	01MAY08
02720	Clearing and Snagging Shoreline	1	1	0	01MAY08	01MAY08
02730	Remove Obstacles	0	0	0	02MAY08	01MAY08
Dredging						
02740	Dredging (Summary)	21	21	0	02MAY08	26MAY08
02750	Design Cut(s) - (2) Primary Dredges	6	6	0	02MAY08	08MAY08
02760	Design Cut(s) - (2) Alternate Dredges	1	1	0	06MAY08	06MAY08
02770	Add. Alternate Dredging Around Obstructions	0	0	0	07MAY08	06MAY08
02780	Confirmation Testing/Surveying - Primary Dredge	6	6	0	05MAY08	10MAY08
02790	Confirmation Testing/Surveying - Alt. Dredge	1	1	0	08MAY08	08MAY08



Start Date	18APR05
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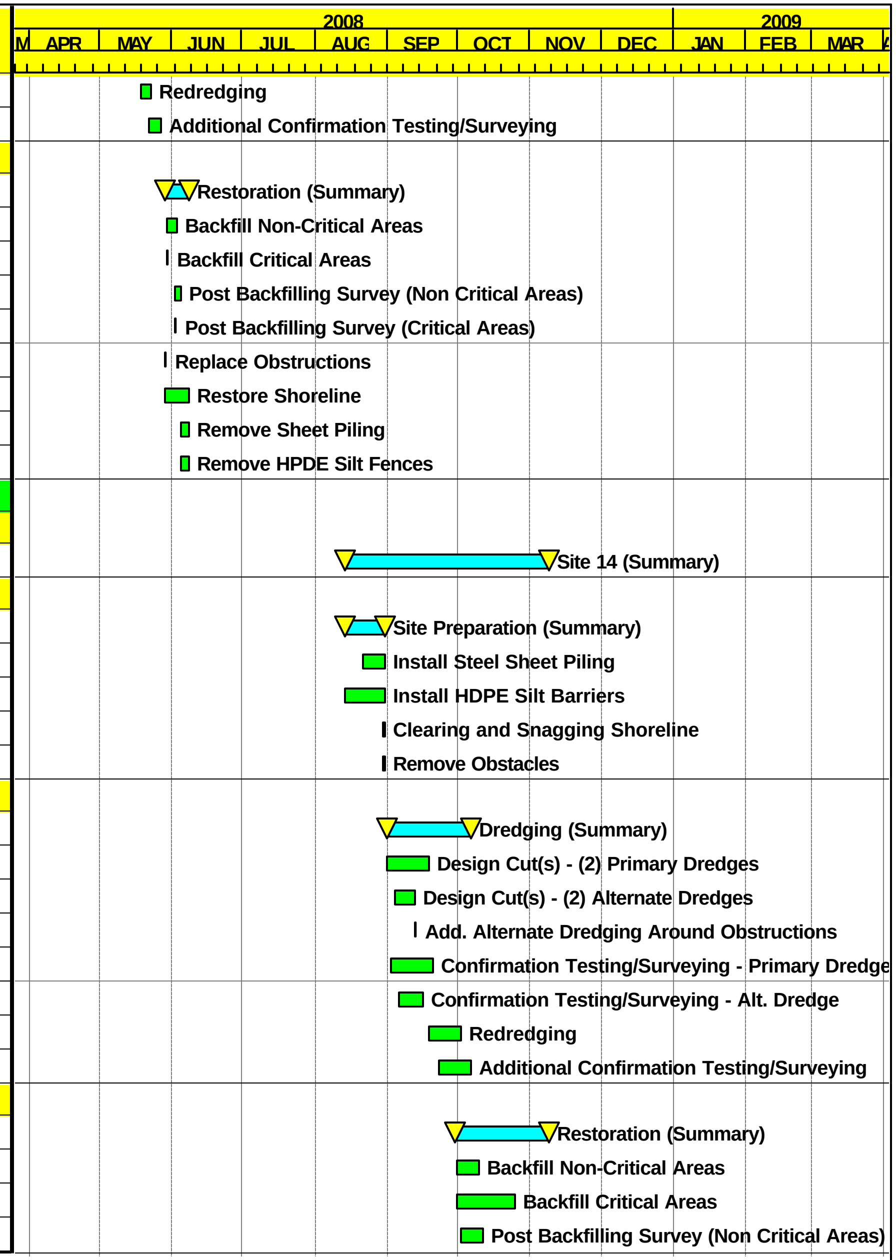
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 3)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
02800	Redredging	4	4	0	19MAY08	22MAY08
02810	Additional Confirmation Testing/Surveying	4	4	0	22MAY08	26MAY08
Restoration						
02820	Restoration (Summary)	9	9	0	29MAY08	07JUN08
02830	Backfill Non-Critical Areas	3	3	0	30MAY08	02JUN08
02840	Backfill Critical Areas	0	0	0	30MAY08	29MAY08
02850	Post Backfilling Survey (Non Critical Areas)	3	3	0	02JUN08	04JUN08
02860	Post Backfilling Survey (Critical Areas)	0	0	0	02JUN08	31MAY08
02865	Replace Obstructions	0	0	0	29MAY08	28MAY08
02870	Restore Shoreline	9	9	0	29MAY08	07JUN08
02880	Remove Sheet Piling	3	3	0	05JUN08	07JUN08
02890	Remove HPDE Silt Fences	3	3	0	05JUN08	07JUN08
RM 186.5 - 187.5 W						
Site Summary						
02900	Site 14 (Summary)	75	75	0	14AUG08	08NOV08
Site Preparation						
02910	Site Preparation (Summary)	15	15	0	14AUG08	30AUG08
02920	Install Steel Sheet Piling	8	8	0	22AUG08	30AUG08
02930	Install HDPE Silt Barriers	15	15	0	14AUG08	30AUG08
02940	Clearing and Snagging Shoreline	1	1	0	30AUG08	30AUG08
02950	Remove Obstacles	1	1	0	30AUG08	30AUG08
Dredging						
02960	Dredging (Summary)	31	31	0	01SEP08	06OCT08
02970	Design Cut(s) - (2) Primary Dredges	16	16	0	01SEP08	18SEP08
02980	Design Cut(s) - (2) Alternate Dredges	8	8	0	04SEP08	12SEP08
02990	Add. Alternate Dredging Around Obstructions	0	0	0	13SEP08	12SEP08
03000	Confirmation Testing/Surveying - Primary Dredge	16	16	0	03SEP08	20SEP08
03010	Confirmation Testing/Surveying - Alt. Dredge	8	8	0	06SEP08	15SEP08
03020	Redredging	12	12	0	19SEP08	02OCT08
03030	Additional Confirmation Testing/Surveying	12	12	0	23SEP08	06OCT08
Restoration						
03040	Restoration (Summary)	35	35	0	30SEP08	08NOV08
03050	Backfill Non-Critical Areas	8	8	0	01OCT08	09OCT08
03060	Backfill Critical Areas	22	22	0	01OCT08	25OCT08
03070	Post Backfilling Survey (Non Critical Areas)	8	8	0	03OCT08	11OCT08



Start Date	18APR05
Finish Date	29DEC11
Data Date	18APR05
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HPCB

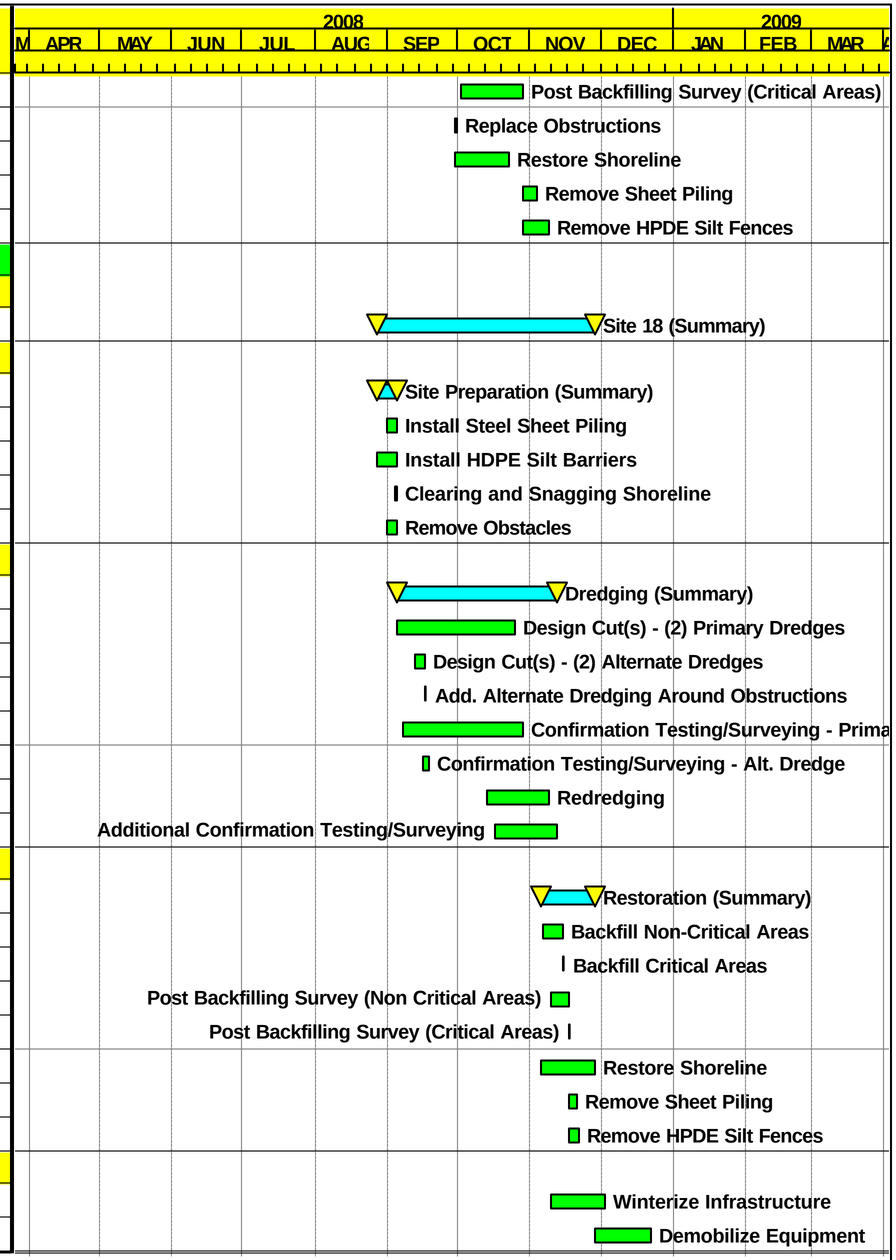
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 3)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
03080	Post Backfilling Survey (Critical Areas)	22	22	0	03OCT08	28OCT08
03085	Replace Obstructions	1	1	0	30SEP08	30SEP08
03090	Restore Shoreline	20	20	0	30SEP08	22OCT08
03100	Remove Sheet Piling	5	5	0	29OCT08	03NOV08
03110	Remove HPDE Silt Fences	10	10	0	29OCT08	08NOV08
RM 183.25 - 184.25 W						
Site Summary						
03780	Site 18 (Summary)	80	80	0	28AUG08	28NOV08
Site Preparation						
03790	Site Preparation (Summary)	7	7	0	28AUG08	04SEP08
03800	Install Steel Sheet Piling	4	4	0	01SEP08	04SEP08
03810	Install HDPE Silt Barriers	7	7	0	28AUG08*	04SEP08
03820	Clearing and Snagging Shoreline	1	1	0	04SEP08	04SEP08
03830	Remove Obstacles	4	4	0	01SEP08	04SEP08
Dredging						
03840	Dredging (Summary)	59	59	0	05SEP08	12NOV08
03850	Design Cut(s) - (2) Primary Dredges	44	44	0	05SEP08	25OCT08
03860	Design Cut(s) - (2) Alternate Dredges	3	3	0	13SEP08	16SEP08
03870	Add. Alternate Dredging Around Obstructions	0	0	0	17SEP08	16SEP08
03880	Confirmation Testing/Surveying - Primary Dredge	44	44	0	08SEP08	28OCT08
03890	Confirmation Testing/Surveying - Alt. Dredge	3	3	0	16SEP08	18SEP08
03900	Redredging	23	23	0	14OCT08	08NOV08
03910	Additional Confirmation Testing/Surveying	23	23	0	17OCT08	12NOV08
Restoration						
03920	Restoration (Summary)	20	20	0	06NOV08	28NOV08
03930	Backfill Non-Critical Areas	7	7	0	07NOV08	14NOV08
03940	Backfill Critical Areas	0	0	0	15NOV08	14NOV08
03950	Post Backfilling Survey (Non Critical Areas)	7	7	0	10NOV08	17NOV08
03960	Post Backfilling Survey (Critical Areas)	0	0	0	18NOV08	17NOV08
03970	Restore Shoreline	20	20	0	06NOV08	28NOV08
03980	Remove Sheet Piling	3	3	0	18NOV08	20NOV08
03990	Remove HPDE Silt Fences	4	4	0	18NOV08	21NOV08
Demobilization						
01572	Winterize Infrastructure	20	20	0	10NOV08	02DEC08
01574	Demobilize Equipment	20	20	0	29NOV08	22DEC08



Start Date	18APR05	HPCB	Sheet 5 of 5
Finish Date	29DEC11		
Data Date	18APR05		
Run Date	01APR04 10:34		

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Example Production Schedule

Hudson River PCB Dredging

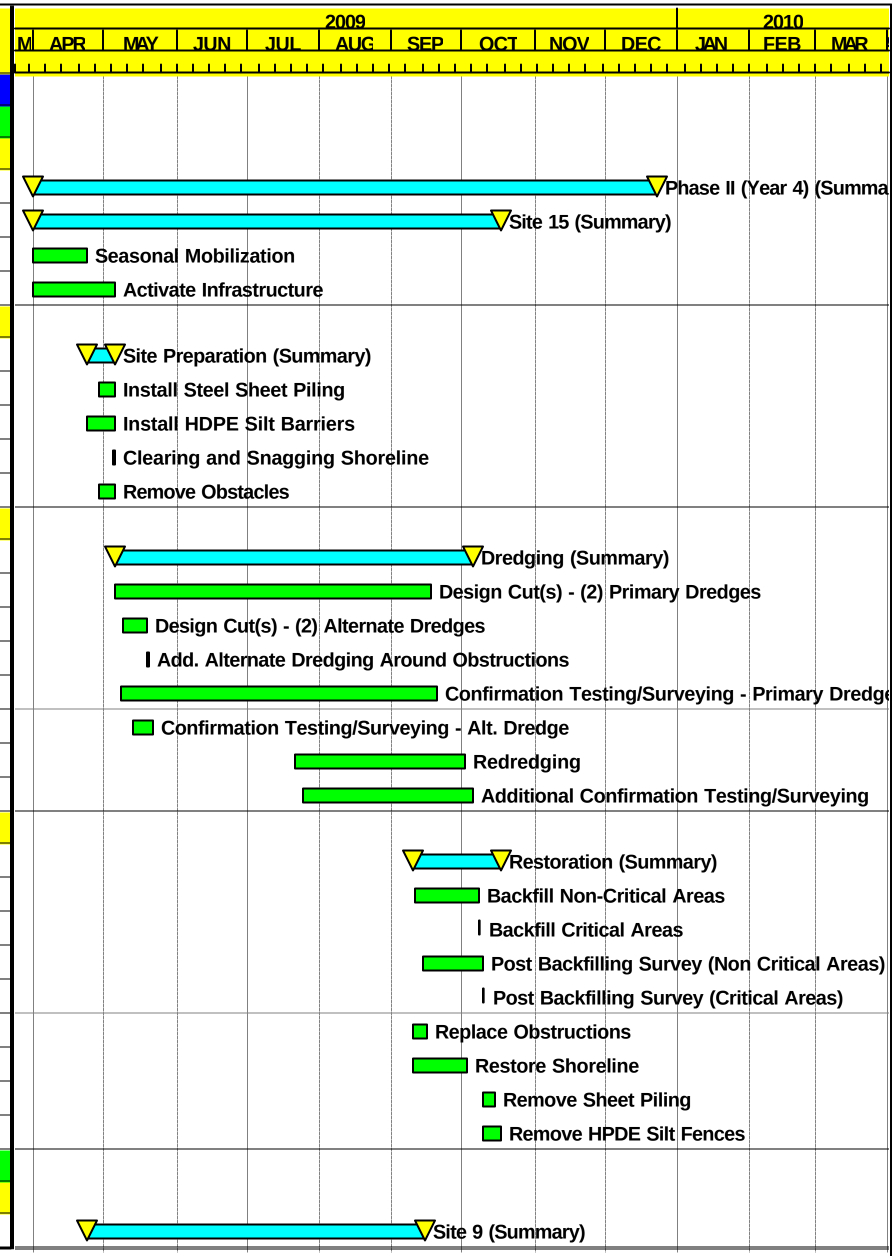
Phase II (Year 3)

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 4)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase II						
RM 185.25 - 186.25 E						
Site Summary						
02019	Phase II (Year 4) (Summary)	228*	228*	0	01APR09	22DEC09
03120	Site 15 (Summary)	172	172	0	01APR09	17OCT09
03121	Seasonal Mobilization	20	20	0	01APR09*	23APR09
03122	Activate Infrastructure	30	30	0	01APR09	05MAY09
Site Preparation						
03130	Site Preparation (Summary)	10	10	0	24APR09	05MAY09
03140	Install Steel Sheet Piling	6	6	0	29APR09	05MAY09
03150	Install HDPE Silt Barriers	10	10	0	24APR09	05MAY09
03160	Clearing and Snagging Shoreline	1	1	0	05MAY09	05MAY09
03170	Remove Obstacles	6	6	0	29APR09	05MAY09
Dredging						
03180	Dredging (Summary)	131	131	0	06MAY09	05OCT09
03190	Design Cut(s) - (2) Primary Dredges	116	116	0	06MAY09	17SEP09
03200	Design Cut(s) - (2) Alternate Dredges	8	8	0	09MAY09	18MAY09
03210	Add. Alternate Dredging Around Obstructions	1	1	0	19MAY09	19MAY09
03220	Confirmation Testing/Surveying - Primary Dredge	116	116	0	08MAY09	19SEP09
03230	Confirmation Testing/Surveying - Alt. Dredge	8	8	0	13MAY09	21MAY09
03240	Redredging	62	62	0	22JUL09	01OCT09
03250	Additional Confirmation Testing/Surveying	62	62	0	25JUL09	05OCT09
Restoration						
03260	Restoration (Summary)	33	33	0	10SEP09	17OCT09
03270	Backfill Non-Critical Areas	23	23	0	11SEP09	07OCT09
03280	Backfill Critical Areas	0	0	0	08OCT09	07OCT09
03290	Post Backfilling Survey (Non Critical Areas)	23	23	0	14SEP09	09OCT09
03300	Post Backfilling Survey (Critical Areas)	0	0	0	10OCT09	09OCT09
03305	Replace Obstructions	5	5	0	10SEP09	15SEP09
03310	Restore Shoreline	20	20	0	10SEP09	02OCT09
03320	Remove Sheet Piling	4	4	0	10OCT09	14OCT09
03330	Remove HPDE Silt Fences	7	7	0	10OCT09	17OCT09
RM 189.5 - 190.5 E						
Site Summary						
02020	Site 9 (Summary)	123	123	0	24APR09	14SEP09



Start Date	18APR05
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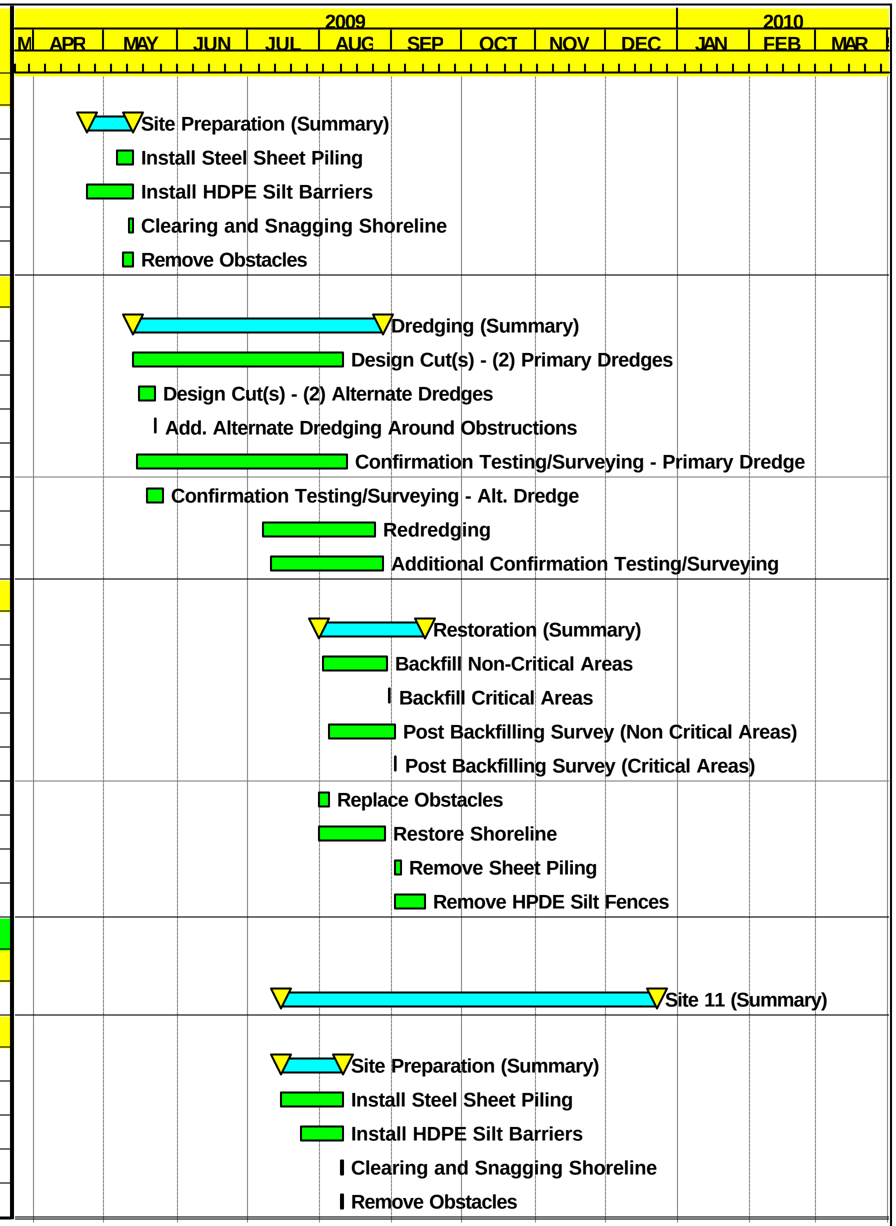
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 4)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
02030	Site Preparation (Summary)	16	16	0	24APR09	12MAY09
02040	Install Steel Sheet Piling	5	5	0	07MAY09	12MAY09
02050	Install HDPE Silt Barriers	16	16	0	24APR09	12MAY09
02060	Clearing and Snagging Shoreline	1	1	0	12MAY09	12MAY09
02070	Remove Obstacles	3	3	0	09MAY09	12MAY09
Dredging						
02080	Dredging (Summary)	92	92	0	13MAY09	27AUG09
02090	Design Cut(s) - (2) Primary Dredges	77	77	0	13MAY09	10AUG09
02100	Design Cut(s) - (2) Alternate Dredges	6	6	0	16MAY09	22MAY09
02110	Add. Alternate Dredging Around Obstructions	0	0	0	23MAY09	22MAY09
02120	Confirmation Testing/Surveying - Primary Dredge	77	77	0	15MAY09	12AUG09
02130	Confirmation Testing/Surveying - Alt. Dredge	6	6	0	19MAY09	25MAY09
02140	Redredging	41	41	0	08JUL09	24AUG09
02150	Additional Confirmation Testing/Surveying	41	41	0	11JUL09	27AUG09
Restoration						
02160	Restoration (Summary)	38	38	0	01AUG09	14SEP09
02170	Backfill Non-Critical Areas	24	24	0	03AUG09	29AUG09
02180	Backfill Critical Areas	0	0	0	31AUG09	29AUG09
02190	Post Backfilling Survey (Non Critical Areas)	24	24	0	05AUG09	01SEP09
02200	Post Backfilling Survey (Critical Areas)	0	0	0	02SEP09	01SEP09
02205	Replace Obstacles	3	3	0	01AUG09	04AUG09
02210	Restore Shoreline	24	24	0	01AUG09	28AUG09
02220	Remove Sheet Piling	3	3	0	02SEP09	04SEP09
02230	Remove HPDE Silt Fences	11	11	0	02SEP09	14SEP09
RM 188.5 - 189.5 E						
Site Summary						
02240	Site 11 (Summary)	137	137	0	16JUL09	22DEC09
Site Preparation						
02250	Site Preparation (Summary)	22	22	0	16JUL09	10AUG09
02260	Install Steel Sheet Piling	22	22	0	16JUL09	10AUG09
02270	Install HDPE Silt Barriers	15	15	0	24JUL09	10AUG09
02280	Clearing and Snagging Shoreline	1	1	0	10AUG09	10AUG09
02290	Remove Obstacles	1	1	0	10AUG09	10AUG09



Start Date	18APR05
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Data Date	18APR05
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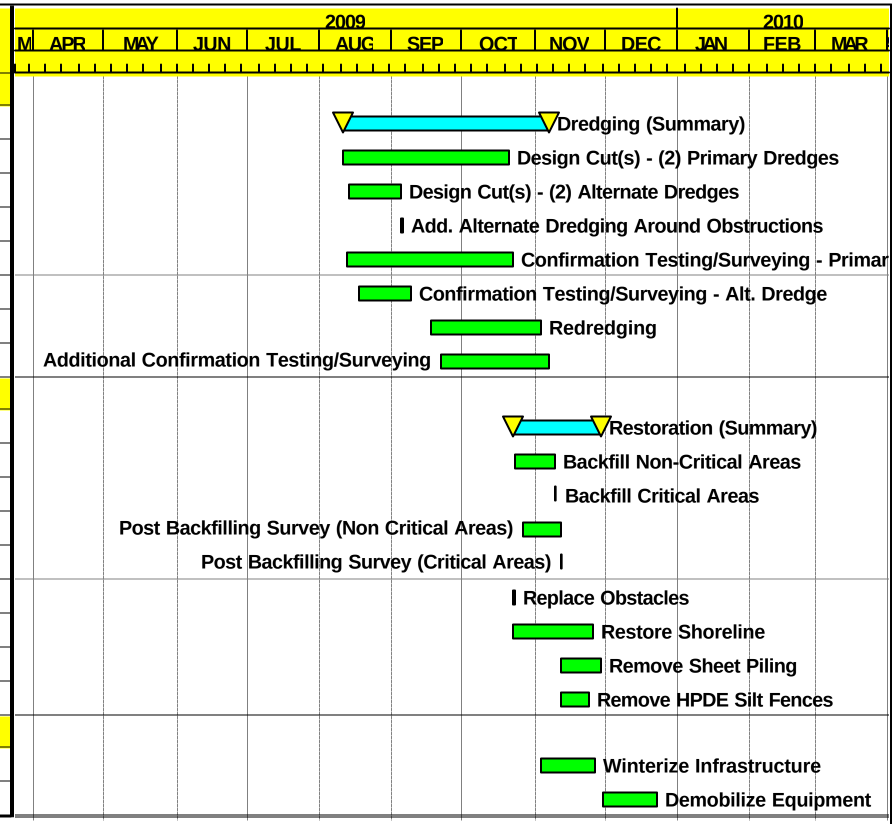
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 4)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Dredging						
02300	Dredging (Summary)	76	76	0	11AUG09	06NOV09
02310	Design Cut(s) - (2) Primary Dredges	61	61	0	11AUG09	20OCT09
02320	Design Cut(s) - (2) Alternate Dredges	19	19	0	14AUG09	04SEP09
02330	Add. Alternate Dredging Around Obstructions	1	1	0	05SEP09	05SEP09
02340	Confirmation Testing/Surveying - Primary Dredge	61	61	0	13AUG09	22OCT09
02350	Confirmation Testing/Surveying - Alt. Dredge	19	19	0	18AUG09	08SEP09
02360	Redredging	40	40	0	18SEP09	03NOV09
02370	Additional Confirmation Testing/Surveying	40	40	0	22SEP09	06NOV09
Restoration						
02380	Restoration (Summary)	32	32	0	23OCT09	28NOV09
02390	Backfill Non-Critical Areas	14	14	0	24OCT09	09NOV09
02400	Backfill Critical Areas	0	0	0	10NOV09	09NOV09
02410	Post Backfilling Survey (Non Critical Areas)	14	14	0	27OCT09	11NOV09
02420	Post Backfilling Survey (Critical Areas)	0	0	0	12NOV09	11NOV09
02425	Replace Obstacles	1	1	0	23OCT09	23OCT09
02430	Restore Shoreline	29	29	0	23OCT09	25NOV09
02440	Remove Sheet Piling	15	15	0	12NOV09	28NOV09
02450	Remove HPDE Silt Fences	10	10	0	12NOV09	23NOV09
Demobilization						
04872	Winterize Infrastructure	20	20	0	04NOV09	26NOV09
04874	Demobilize Equipment	20	20	0	30NOV09	22DEC09



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Finish Date	29DEC11
Data Date	18APR05
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Example Production Schedule

Hudson River PCB Dredging

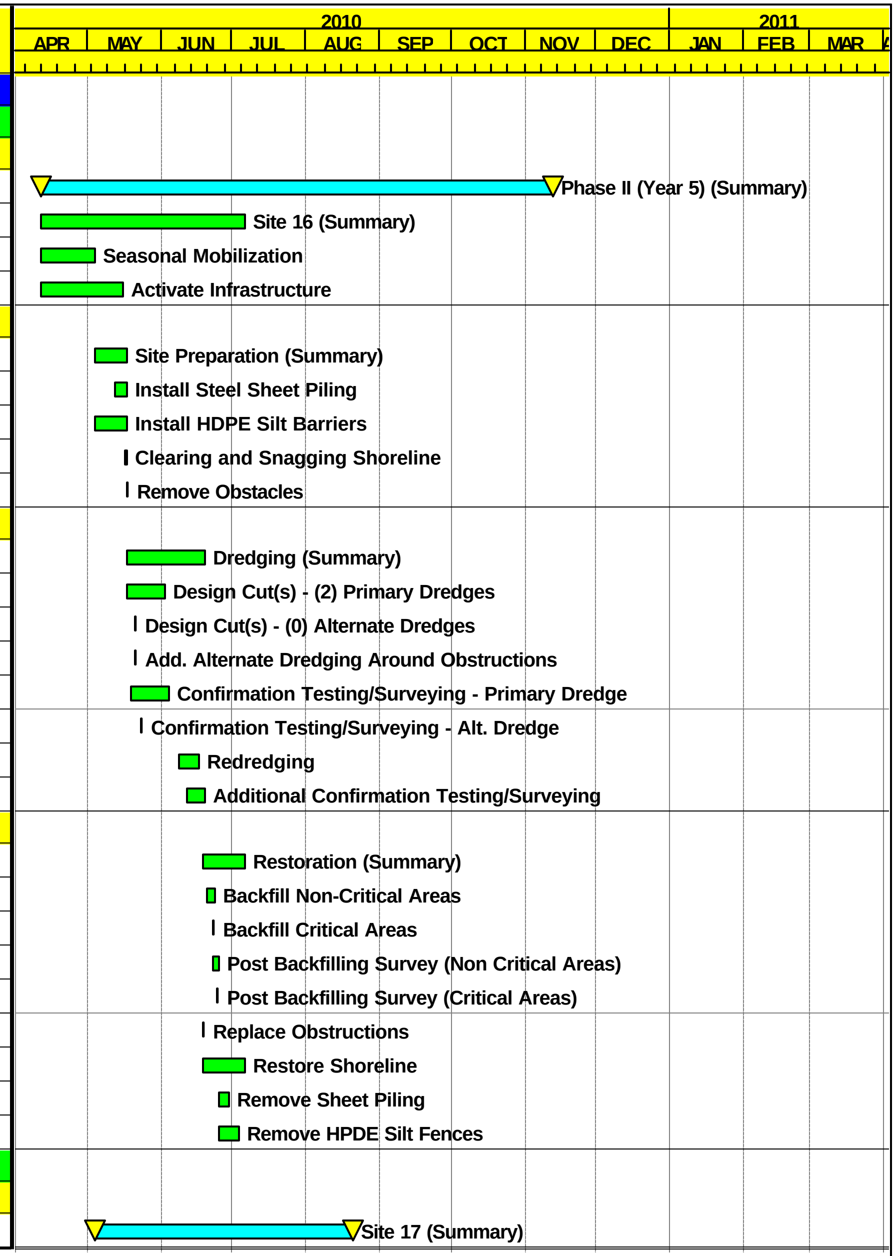
Phase II (Year 4)

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 5)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase II						
RM 184.25 - 185.25 E						
Site Summary						
03339	Phase II (Year 5) (Summary)	185*	185*	0	12APR10	12NOV10
03340	Site 16 (Summary)	74	74	0	12APR10	06JUL10
03562	Seasonal Mobilization	20	20	0	12APR10*	04MAY10
03564	Activate Infrastructure	30	30	0	12APR10	15MAY10
Site Preparation						
03350	Site Preparation (Summary)	11	11	0	05MAY10	17MAY10
03360	Install Steel Sheet Piling	4	4	0	13MAY10	17MAY10
03370	Install HDPE Silt Barriers	11	11	0	05MAY10	17MAY10
03380	Clearing and Snagging Shoreline	1	1	0	17MAY10	17MAY10
03390	Remove Obstacles	0	0	0	18MAY10	17MAY10
Dredging						
03400	Dredging (Summary)	29	29	0	18MAY10	19JUN10
03410	Design Cut(s) - (2) Primary Dredges	14	14	0	18MAY10	02JUN10
03420	Design Cut(s) - (0) Alternate Dredges	0	0	0	21MAY10	20MAY10
03430	Add. Alternate Dredging Around Obstructions	0	0	0	21MAY10	20MAY10
03440	Confirmation Testing/Surveying - Primary Dredge	14	14	0	20MAY10	04JUN10
03450	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	24MAY10	22MAY10
03460	Redredging	7	7	0	09JUN10	16JUN10
03470	Additional Confirmation Testing/Surveying	7	7	0	12JUN10	19JUN10
Restoration						
03480	Restoration (Summary)	15	15	0	19JUN10	06JUL10
03490	Backfill Non-Critical Areas	3	3	0	21JUN10	23JUN10
03500	Backfill Critical Areas	0	0	0	23JUN10	22JUN10
03510	Post Backfilling Survey (Non Critical Areas)	3	3	0	23JUN10	25JUN10
03520	Post Backfilling Survey (Critical Areas)	0	0	0	25JUN10	24JUN10
03525	Replace Obstructions	0	0	0	19JUN10	18JUN10
03530	Restore Shoreline	15	15	0	19JUN10	06JUL10
03540	Remove Sheet Piling	3	3	0	26JUN10	29JUN10
03550	Remove HPDE Silt Fences	7	7	0	26JUN10	03JUL10
RM 183.25 - 184.25 E						
Site Summary						
03560	Site 17 (Summary)	93	93	0	05MAY10	20AUG10



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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
03570	Site Preparation (Summary)	13	13	0	05MAY10	19MAY10
03580	Install Steel Sheet Piling	13	13	0	05MAY10	19MAY10
03590	Install HDPE Silt Barriers	13	13	0	05MAY10	19MAY10
03600	Clearing and Snagging Shoreline	1	1	0	19MAY10	19MAY10
03610	Remove Obstacles	0	0	0	20MAY10	19MAY10
Dredging						
03620	Dredging (Summary)	52	52	0	20MAY10	19JUL10
03630	Design Cut(s) - (2) Primary Dredges	37	37	0	20MAY10	01JUL10
03640	Design Cut(s) - (2) Alternate Dredges	20	20	0	24MAY10	15JUN10
03650	Add. Alternate Dredging Around Obstructions	0	0	0	16JUN10	15JUN10
03660	Confirmation Testing/Surveying - Primary Dredge	37	37	0	22MAY10	03JUL10
03670	Confirmation Testing/Surveying - Alt. Dredge	20	20	0	26MAY10	17JUN10
03680	Redredging	28	28	0	14JUN10	15JUL10
03690	Additional Confirmation Testing/Surveying	28	28	0	17JUN10	19JUL10
Restoration						
03700	Restoration (Summary)	49	49	0	25JUN10	20AUG10
03710	Backfill Non-Critical Areas	0	0	0	22JUL10	21JUL10
03720	Backfill Critical Areas	38	38	0	25JUN10	07AUG10
03730	Post Backfilling Survey (Non Critical Areas)	0	0	0	24JUL10	23JUL10
03740	Post Backfilling Survey (Critical Areas)	38	38	0	28JUN10	10AUG10
03750	Restore Shoreline	26	26	0	21JUL10	19AUG10
03760	Remove Sheet Piling	9	9	0	11AUG10	20AUG10
03770	Remove HPDE Silt Fences	9	9	0	11AUG10	20AUG10
RM 176.75 - 177.25 NAV						
Site Summary						
04000	Site 19 (Summary)	26	26	0	05MAY10	03JUN10
Site Preparation						
04010	Site Preparation (Summary)	0	0	0	05MAY10	04MAY10
04020	Install Steel Sheet Piling	0	0	0	05MAY10	04MAY10
04030	Install HDPE Silt Barriers	0	0	0	05MAY10	04MAY10
04040	Clearing and Snagging Shoreline	0	0	0	05MAY10	04MAY10
04050	Remove Obstacles	0	0	0	05MAY10	04MAY10
Dredging						
04060	Dredging (Summary)	19	19	0	05MAY10	26MAY10

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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
04070	Design Cut(s) - (2) Primary Dredges	4	4	0	05MAY10	08MAY10
04080	Design Cut(s) - (0) Alternate Dredges	0	0	0	08MAY10	07MAY10
04090	Add. Alternate Dredging Around Obstructions	0	0	0	10MAY10	08MAY10
04100	Confirmation Testing/Surveying - Primary Dredge	4	4	0	07MAY10	11MAY10
04110	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	11MAY10	10MAY10
04120	Redredging	2	2	0	21MAY10	22MAY10
04130	Additional Confirmation Testing/Surveying	2	2	0	25MAY10	26MAY10
Restoration						
04150	Backfill Non-Critical Areas	0	0	0	02JUN10	01JUN10
04160	Backfill Critical Areas	0	0	0	02JUN10	01JUN10
04170	Post Backfilling Survey (Non Critical Areas)	0	0	0	04JUN10	03JUN10
04180	Post Backfilling Survey (Critical Areas)	0	0	0	04JUN10	03JUN10
04190	Restore Shoreline	0	0	0	01JUN10	31MAY10
04200	Remove Sheet Piling	0	0	0	04JUN10	03JUN10
04210	Remove HPDE Silt Fences	0	0	0	04JUN10	03JUN10
RM 175.00 - 175.25 NAV						
Site Summary						
04220	Site 20 (Summary)	26	26	0	05MAY10	03JUN10
Site Preparation						
04230	Site Preparation (Summary)	0	0	0	05MAY10	04MAY10
04240	Install Steel Sheet Piling	0	0	0	05MAY10	04MAY10
04250	Install HDPE Silt Barriers	0	0	0	05MAY10	04MAY10
04260	Clearing and Snagging Shoreline	0	0	0	05MAY10	04MAY10
04270	Remove Obstacles	0	0	0	05MAY10	04MAY10
Dredging						
04280	Dredging (Summary)	19	19	0	05MAY10	26MAY10
04290	Design Cut(s) - (2) Primary Dredges	4	4	0	05MAY10	08MAY10
04300	Design Cut(s) - (0) Alternate Dredges	0	0	0	08MAY10	07MAY10
04310	Add. Alternate Dredging Around Obstructions	0	0	0	10MAY10	08MAY10
04320	Confirmation Testing/Surveying - Primary Dredge	4	4	0	07MAY10	11MAY10
04330	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	11MAY10	10MAY10
04340	Redredging	2	2	0	21MAY10	22MAY10
04350	Additional Confirmation Testing/Surveying	2	2	0	25MAY10	26MAY10
Restoration						
04370	Backfill Non-Critical Areas	0	0	0	02JUN10	01JUN10

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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
04380	Backfill Critical Areas	0	0	0	02JUN10	01JUN10
04390	Post Backfilling Survey (Non Critical Areas)	0	0	0	04JUN10	03JUN10
04400	Post Backfilling Survey (Critical Areas)	0	0	0	04JUN10	03JUN10
04410	Restore Shoreline	0	0	0	01JUN10	31MAY10
04420	Remove Sheet Piling	0	0	0	04JUN10	03JUN10
04430	Remove HPDE Silt Fences	0	0	0	04JUN10	03JUN10
RM 171.5 - 172.00 NAV						
Site Summary						
04440	Site 21 (Summary)	26	26	0	10MAY10	08JUN10
Site Preparation						
04450	Site Preparation (Summary)	0	0	0	10MAY10	09MAY10
04460	Install Steel Sheet Piling	0	0	0	10MAY10	08MAY10
04470	Install HDPE Silt Barriers	0	0	0	10MAY10	08MAY10
04480	Clearing and Snagging Shoreline	0	0	0	10MAY10	08MAY10
04490	Remove Obstacles	0	0	0	10MAY10	08MAY10
Dredging						
04500	Dredging (Summary)	19	19	0	10MAY10	31MAY10
04510	Design Cut(s) - (2) Primary Dredges	4	4	0	10MAY10	13MAY10
04520	Design Cut(s) - (0) Alternate Dredges	0	0	0	13MAY10	12MAY10
04530	Add. Alternate Dredging Around Obstructions	0	0	0	14MAY10	13MAY10
04540	Confirmation Testing/Surveying - Primary Dredge	4	4	0	12MAY10	15MAY10
04550	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	15MAY10	14MAY10
04560	Redredging	2	2	0	26MAY10	27MAY10
04570	Additional Confirmation Testing/Surveying	2	2	0	29MAY10	31MAY10
Restoration						
04590	Backfill Non-Critical Areas	0	0	0	07JUN10	05JUN10
04600	Backfill Critical Areas	0	0	0	07JUN10	05JUN10
04610	Post Backfilling Survey (Non Critical Areas)	0	0	0	09JUN10	08JUN10
04620	Post Backfilling Survey (Critical Areas)	0	0	0	09JUN10	08JUN10
04630	Restore Shoreline	0	0	0	05JUN10	04JUN10
04640	Remove Sheet Piling	0	0	0	09JUN10	08JUN10
04650	Remove HPDE Silt Fences	0	0	0	09JUN10	08JUN10
RM 169.25 - 170.25 E						
Site Summary						
04660	Site 22 (Summary)	142	142	0	08MAY10	20OCT10

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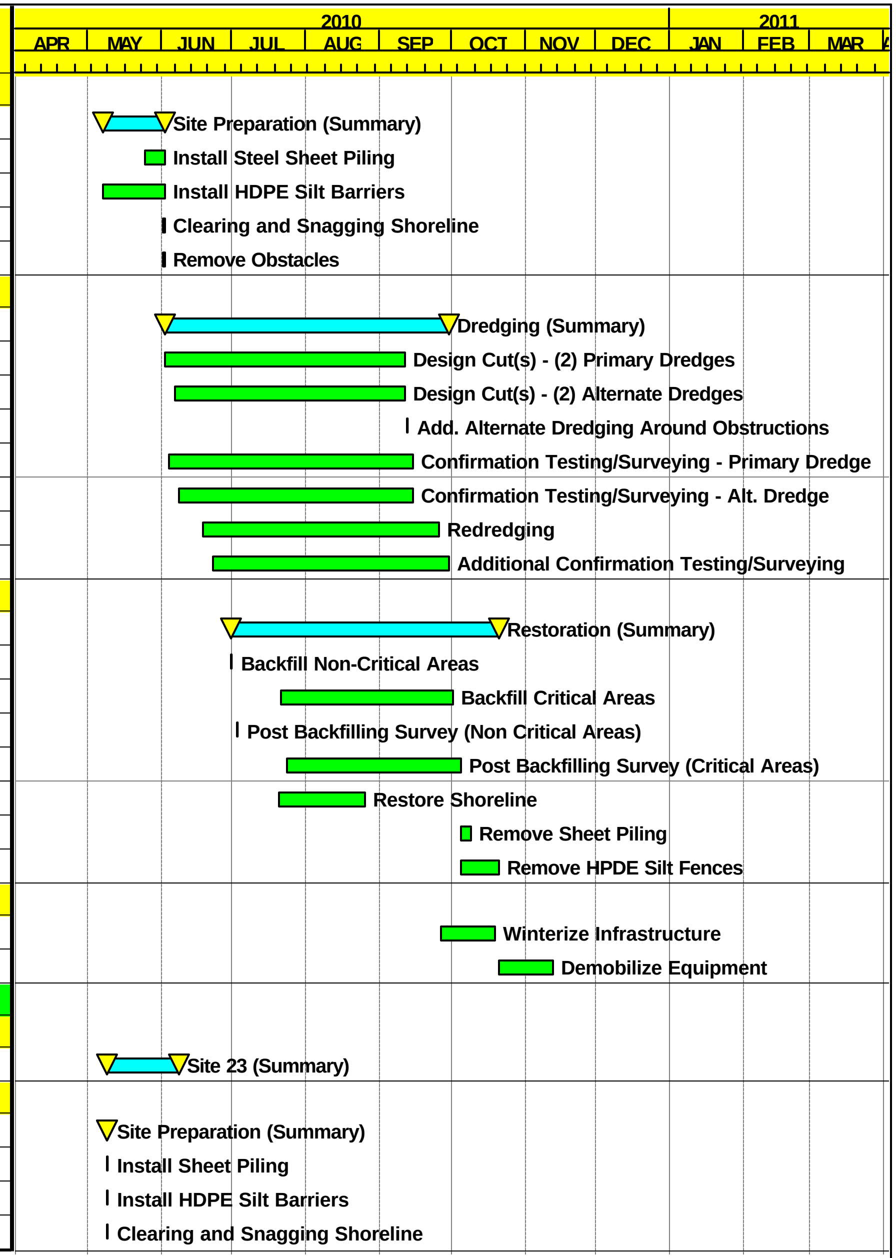
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
04670	Site Preparation (Summary)	22	22	0	08MAY10	02JUN10
04680	Install Steel Sheet Piling	7	7	0	26MAY10	02JUN10
04690	Install HDPE Silt Barriers	22	22	0	08MAY10	02JUN10
04700	Clearing and Snagging Shoreline	1	1	0	02JUN10	02JUN10
04710	Remove Obstacles	1	1	0	02JUN10	02JUN10
Dredging						
04720	Dredging (Summary)	102	102	0	03JUN10	29SEP10
04730	Design Cut(s) - (2) Primary Dredges	87	87	0	03JUN10	11SEP10
04740	Design Cut(s) - (2) Alternate Dredges	84	84	0	07JUN10	11SEP10
04750	Add. Alternate Dredging Around Obstructions	0	0	0	13SEP10	11SEP10
04760	Confirmation Testing/Surveying - Primary Dredge	87	87	0	05JUN10	14SEP10
04770	Confirmation Testing/Surveying - Alt. Dredge	84	84	0	09JUN10	14SEP10
04780	Redredging	85	85	0	19JUN10	25SEP10
04790	Additional Confirmation Testing/Surveying	85	85	0	23JUN10	29SEP10
Restoration						
04800	Restoration (Summary)	96	96	0	01JUL10	20OCT10
04810	Backfill Non-Critical Areas	0	0	0	01JUL10	30JUN10
04820	Backfill Critical Areas	62	62	0	22JUL10	01OCT10
04830	Post Backfilling Survey (Non Critical Areas)	0	0	0	03JUL10	02JUL10
04840	Post Backfilling Survey (Critical Areas)	62	62	0	24JUL10	04OCT10
04850	Restore Shoreline	31	31	0	21JUL10	25AUG10
04860	Remove Sheet Piling	5	5	0	05OCT10	09OCT10
04870	Remove HPDE Silt Fences	14	14	0	05OCT10	20OCT10
Demobilization						
03552	Winterize Infrastructure	20	20	0	27SEP10	19OCT10
03554	Demobilize Equipment	20	20	0	21OCT10	12NOV10
RM 167.0 - 167.5 NAV						
Site Summary						
04880	Site 23 (Summary)	26	26	0	10MAY10	08JUN10
Site Preparation						
04890	Site Preparation (Summary)	0	0	0	10MAY10	09MAY10
04900	Install Sheet Piling	0	0	0	10MAY10	08MAY10
04910	Install HDPE Silt Barriers	0	0	0	10MAY10	08MAY10
04920	Clearing and Snagging Shoreline	0	0	0	10MAY10	08MAY10



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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
04930	Remove Obstacles	0	0	0	10MAY10	08MAY10
Dredging						
04940	Dredging (Summary)	19	19	0	10MAY10	31MAY10
04950	Design Cut(s) - (2) Primary Dredges	4	4	0	10MAY10	13MAY10
04960	Design Cut(s) - (0) Alternate Dredges	0	0	0	13MAY10	12MAY10
04970	Add. Alternate Dredging Around Obstructions	0	0	0	14MAY10	13MAY10
04980	Confirmation Testing/Surveying - Primary Dredge	4	4	0	12MAY10	15MAY10
04990	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	15MAY10	14MAY10
05000	Redredging	2	2	0	26MAY10	27MAY10
05010	Additional Confirmation Testing/Surveying	2	2	0	29MAY10	31MAY10
Restoration						
05030	Backfill Non-Critical Areas	0	0	0	07JUN10	05JUN10
05040	Backfill Critical Areas	0	0	0	07JUN10	05JUN10
05050	Post Backfilling Survey (Non Critical Areas)	0	0	0	09JUN10	08JUN10
05060	Post Backfilling Survey (Critical Areas)	0	0	0	09JUN10	08JUN10
05070	Restore Shoreline	0	0	0	05JUN10	04JUN10
05080	Remove Sheet Piling	0	0	0	09JUN10	08JUN10
05090	Remove HPDE Silt Fences	0	0	0	09JUN10	08JUN10
RM 164.25 - 165.0 NAV						
Site Summary						
05320	Site 25 (Summary)	26	26	0	14MAY10	12JUN10
Site Preparation						
05330	Site Preparation (Summary)	0	0	0	14MAY10	13MAY10
05340	Install Steel Sheet Piling	0	0	0	14MAY10	13MAY10
05350	Install HDPE Silt Barriers	0	0	0	14MAY10	13MAY10
05360	Clearing and Snagging Shoreline	0	0	0	14MAY10	13MAY10
05370	Remove Obstacles	0	0	0	14MAY10	13MAY10
Dredging						
05380	Dredging (Summary)	19	19	0	14MAY10	04JUN10
05390	Design Cut(s) - (2) Primary Dredges	4	4	0	14MAY10	18MAY10
05400	Design Cut(s) - (2) Alternate Dredges	0	0	0	18MAY10	17MAY10
05410	Add. Alternate Dredging Around Obstructions	0	0	0	19MAY10	18MAY10
05420	Confirmation Testing/Surveying - Primary Dredge	4	4	0	17MAY10	20MAY10
05430	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	20MAY10	19MAY10
05440	Redredging	2	2	0	31MAY10	01JUN10

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Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
05450	Additional Confirmation Testing/Surveying	2	2	0	03JUN10	04JUN10
Restoration						
05470	Backfill Non-Critical Areas	0	0	0	11JUN10	10JUN10
05480	Backfill Critical Areas	0	0	0	11JUN10	10JUN10
05490	Post Backfilling Survey (Non Critical Areas)	0	0	0	14JUN10	12JUN10
05500	Post Backfilling Survey (Critical Areas)	0	0	0	14JUN10	12JUN10
05510	Restore Shoreline	0	0	0	10JUN10	09JUN10
05520	Remove Sheet Piling	0	0	0	14JUN10	12JUN10
05530	Remove HPDE Silt Fences	0	0	0	14JUN10	12JUN10
RM 164.0 - 164.25 NAV						
Site Summary						
05540	Site 26 (Summary)	26	26	0	02JUL10	31JUL10
Site Preparation						
05550	Site Preparation (Summary)	0	0	0	02JUL10	01JUL10
05560	Install Steel Sheet Piling	0	0	0	02JUL10	01JUL10
05570	Install HDPE Silt Barriers	0	0	0	02JUL10	01JUL10
05580	Clearing and Snagging Shoreline	0	0	0	02JUL10	01JUL10
05590	Remove Obstacles	0	0	0	02JUL10	01JUL10
Dredging						
05600	Dredging (Summary)	19	19	0	02JUL10	23JUL10
05610	Design Cut(s) - (2) Primary Dredges	4	4	0	02JUL10	06JUL10
05620	Design Cut(s) - (0) Alternate Dredges	0	0	0	06JUL10	05JUL10
05630	Add. Alternate Dredging Around Obstructions	0	0	0	06JUL10	05JUL10
05640	Confirmation Testing/Surveying - Primary Dredge	4	4	0	05JUL10	08JUL10
05650	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	08JUL10	07JUL10
05660	Redredging	2	2	0	19JUL10	20JUL10
05670	Additional Confirmation Testing/Surveying	2	2	0	22JUL10	23JUL10
Restoration						
05690	Backfill Non-Critical Areas	0	0	0	30JUL10	29JUL10
05700	Backfill Critical Areas	0	0	0	30JUL10	29JUL10
05710	Post Backfilling Survey (Non Critical Areas)	0	0	0	02AUG10	31JUL10
05720	Post Backfilling Survey (Critical Areas)	0	0	0	02AUG10	31JUL10
05730	Restore Shoreline	0	0	0	29JUL10	28JUL10
05740	Remove Sheet Piling	0	0	0	02AUG10	31JUL10
05750	Remove HPDE Silt Fences	0	0	0	02AUG10	31JUL10

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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
RM 162.25 - 162.75 NAV						
Site Summary						
05980	Site 28 (Summary)	33	33	0	07JUL10	13AUG10
Site Preparation						
05990	Site Preparation (Summary)	0	0	0	07JUL10	06JUL10
06000	Install Steel Sheet Piling	0	0	0	07JUL10	06JUL10
06010	Install HDPE Silt Barriers	0	0	0	07JUL10	06JUL10
06020	Clearing and Snagging Shoreline	0	0	0	07JUL10	06JUL10
06030	Remove Obstacles	0	0	0	07JUL10	06JUL10
Dredging						
06040	Dredging (Summary)	21	21	0	07JUL10	30JUL10
06050	Design Cut(s) - (2) Primary Dredges	6	6	0	07JUL10	13JUL10
06060	Design Cut(s) - (0) Alternate Dredges	0	0	0	10JUL10	09JUL10
06070	Add. Alternate Dredging Around Obstructions	0	0	0	14JUL10	13JUL10
06080	Confirmation Testing/Surveying - Primary Dredge	6	6	0	09JUL10	15JUL10
06090	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	13JUL10	12JUL10
06100	Redredging	3	3	0	24JUL10	27JUL10
06110	Additional Confirmation Testing/Surveying	3	3	0	28JUL10	30JUL10
Restoration						
06120	Restoration (Summary)	9	9	0	04AUG10	13AUG10
06130	Backfill Non-Critical Areas	0	0	0	05AUG10	04AUG10
06140	Backfill Critical Areas	0	0	0	05AUG10	04AUG10
06150	Post Backfilling Survey (Non Critical Areas)	0	0	0	07AUG10	06AUG10
06160	Post Backfilling Survey (Critical Areas)	0	0	0	07AUG10	06AUG10
06170	Restore Shoreline	0	0	0	04AUG10	03AUG10
06180	Remove Sheet Piling	0	0	0	07AUG10	06AUG10
06190	Remove HPDE Silt Fences	0	0	0	07AUG10	06AUG10
RM 159.25 - 159.75 NAV						
Site Summary						
06200	Site 29 (Summary)	27	27	0	14JUL10	13AUG10
Site Preparation						
06210	Site Preparation (Summary)	0	0	0	14JUL10	13JUL10
06220	Install Steel Sheet Piling	0	0	0	14JUL10	13JUL10
06230	Install HDPE Silt Barriers	0	0	0	14JUL10	13JUL10
06240	Clearing and Snagging Shoreline	0	0	0	14JUL10	13JUL10

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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
06250	Remove Obstacles	0	0	0	14JUL10	13JUL10
Dredging						
06260	Dredging (Summary)	21	21	0	14JUL10	06AUG10
06270	Design Cut(s) - (2) Primary Dredges	6	6	0	14JUL10	20JUL10
06280	Design Cut(s) - (0) Alternate Dredges	0	0	0	17JUL10	16JUL10
06290	Add. Alternate Dredging Around Obstructions	0	0	0	21JUL10	20JUL10
06300	Confirmation Testing/Surveying - Primary Dredge	6	6	0	16JUL10	22JUL10
06310	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	20JUL10	19JUL10
06320	Redredging	3	3	0	31JUL10	03AUG10
06330	Additional Confirmation Testing/Surveying	3	3	0	04AUG10	06AUG10
Restoration						
06340	Restoration (Summary)	2	2	0	12AUG10	13AUG10
06350	Backfill Non-Critical Areas	0	0	0	12AUG10	11AUG10
06360	Backfill Critical Areas	0	0	0	12AUG10	11AUG10
06370	Post Backfilling Survey (Non Critical Areas)	0	0	0	14AUG10	13AUG10
06380	Post Backfilling Survey (Critical Areas)	0	0	0	14AUG10	13AUG10
06390	Restore Shoreline	0	0	0	11AUG10	10AUG10
06400	Remove Sheet Piling	0	0	0	14AUG10	13AUG10
06410	Remove HPDE Silt Fences	0	0	0	14AUG10	13AUG10
RM 158.5 - 159.25 NAV						
Site Summary						
06420	Site 30 (Summary)	27	27	0	21JUL10	20AUG10
Site Preparation						
06430	Site Preparation (Summary)	0	0	0	21JUL10	20JUL10
06440	Install Steel Sheet Piling	0	0	0	21JUL10	20JUL10
06450	Install HDPE Silt Barriers	0	0	0	21JUL10	20JUL10
06460	Clearing and Snagging Shoreline	0	0	0	21JUL10	20JUL10
06470	Remove Obstacles	0	0	0	21JUL10	20JUL10
Dredging						
06480	Dredging (Summary)	21	21	0	21JUL10	13AUG10
06490	Design Cut(s) - (2) Primary Dredges	6	6	0	21JUL10	27JUL10
06500	Design Cut(s) - (0) Alternate Dredges	0	0	0	24JUL10	23JUL10
06510	Add. Alternate Dredging Around Obstructions	0	0	0	28JUL10	27JUL10
06520	Confirmation Testing/Surveying - Primary Dredge	6	6	0	23JUL10	29JUL10
06530	Confirmation Testing/Surveying - Alt. Dredge	0	0	0	27JUL10	26JUL10

2010: APR MAY JUN JUL AUG SEP OCT NOV DEC — 2011: JAN FEB MAR

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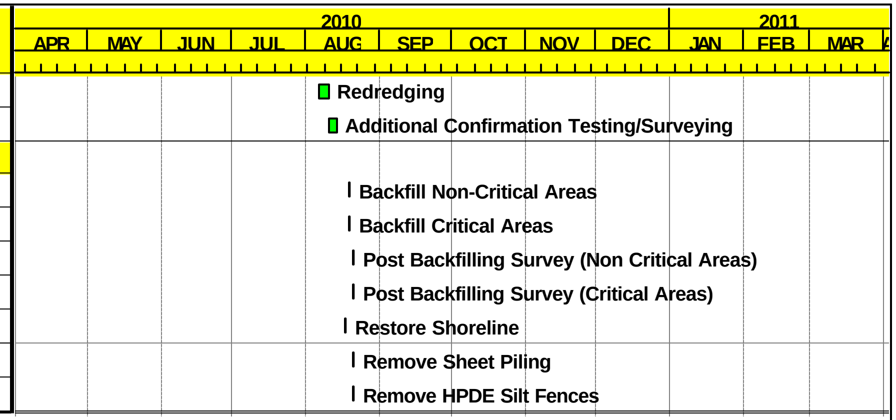
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 5)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
06540	Redredging	3	3	0	07AUG10	10AUG10
06550	Additional Confirmation Testing/Surveying	3	3	0	11AUG10	13AUG10
Restoration						
06570	Backfill Non-Critical Areas	0	0	0	19AUG10	18AUG10
06580	Backfill Critical Areas	0	0	0	19AUG10	18AUG10
06590	Post Backfilling Survey (Non Critical Areas)	0	0	0	21AUG10	20AUG10
06600	Post Backfilling Survey (Critical Areas)	0	0	0	21AUG10	20AUG10
06610	Restore Shoreline	0	0	0	18AUG10	17AUG10
06620	Remove Sheet Piling	0	0	0	21AUG10	20AUG10
06630	Remove HPDE Silt Fences	0	0	0	21AUG10	20AUG10



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Example Production Schedule

Hudson River PCB Dredging

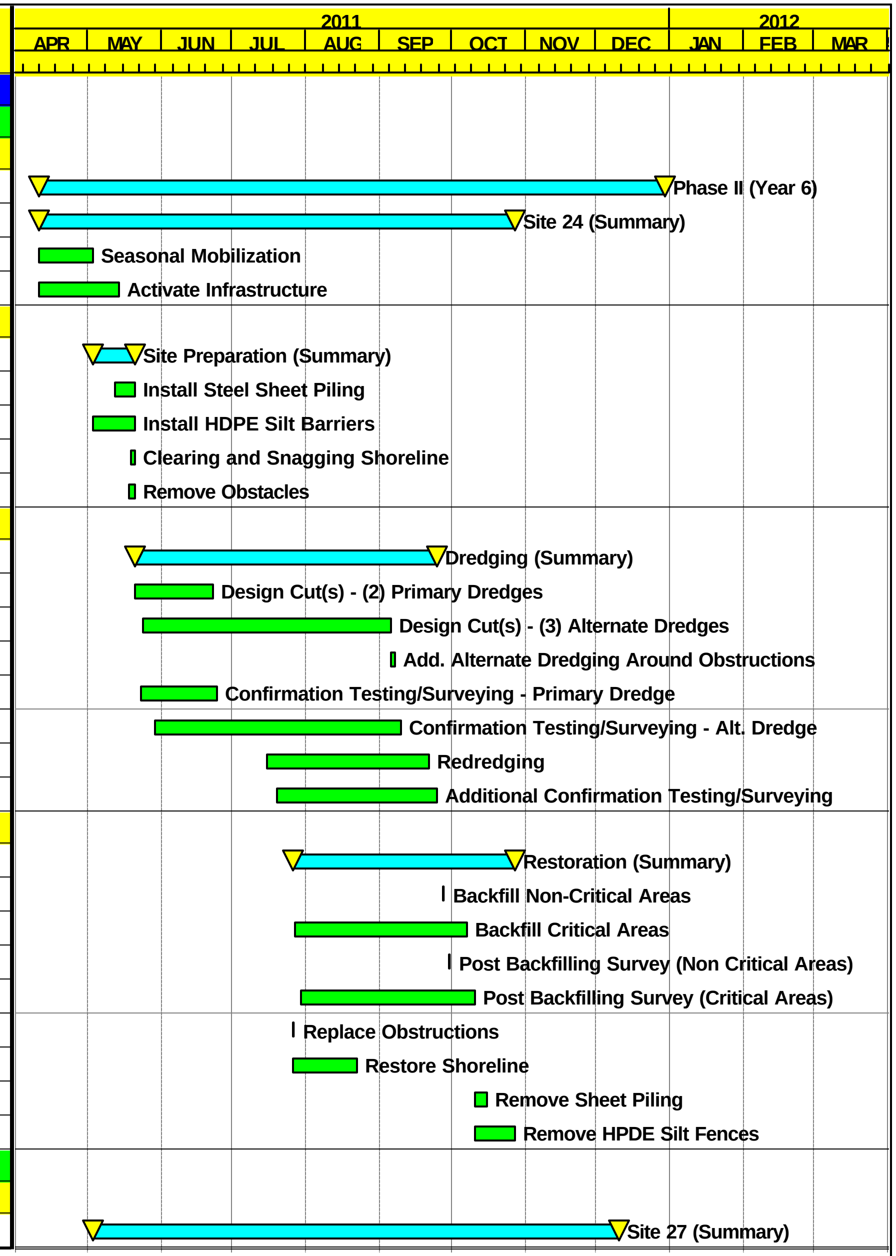
Phase II (Year 5)

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 6)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Phase II						
RM 165.75 - 166.75 W						
Site Summary						
05099	Phase II (Year 6)	226*	226*	0	11APR11	29DEC11
05100	Site 24 (Summary)	172	172	0	11APR11	27OCT11
05101	Seasonal Mobilization	20	20	0	11APR11*	03MAY11
05102	Activate Infrastructure	30	30	0	11APR11	14MAY11
Site Preparation						
05110	Site Preparation (Summary)	15	15	0	04MAY11	20MAY11
05120	Install Steel Sheet Piling	7	7	0	13MAY11	20MAY11
05130	Install HDPE Silt Barriers	15	15	0	04MAY11	20MAY11
05140	Clearing and Snagging Shoreline	1	1	0	20MAY11	20MAY11
05150	Remove Obstacles	2	2	0	19MAY11	20MAY11
Dredging						
05160	Dredging (Summary)	109	109	0	21MAY11	24SEP11
05170	Design Cut(s) - (2) Primary Dredges	28	28	0	21MAY11	22JUN11
05180	Design Cut(s) - (3) Alternate Dredges	89	89	0	25MAY11	05SEP11
05190	Add. Alternate Dredging Around Obstructions	2	2	0	06SEP11	07SEP11
05200	Confirmation Testing/Surveying - Primary Dredge	28	28	0	24MAY11	24JUN11
05210	Confirmation Testing/Surveying - Alt. Dredge	89	89	0	30MAY11	09SEP11
05220	Redredging	58	58	0	16JUL11	21SEP11
05230	Additional Confirmation Testing/Surveying	58	58	0	20JUL11	24SEP11
Restoration						
05240	Restoration (Summary)	80	80	0	27JUL11	27OCT11
05250	Backfill Non-Critical Areas	0	0	0	28SEP11	27SEP11
05260	Backfill Critical Areas	62	62	0	28JUL11	07OCT11
05270	Post Backfilling Survey (Non Critical Areas)	0	0	0	30SEP11	29SEP11
05280	Post Backfilling Survey (Critical Areas)	62	62	0	30JUL11	10OCT11
05285	Replace Obstructions	0	0	0	27JUL11	26JUL11
05290	Restore Shoreline	23	23	0	27JUL11	22AUG11
05300	Remove Sheet Piling	5	5	0	11OCT11	15OCT11
05310	Remove HPDE Silt Fences	15	15	0	11OCT11	27OCT11
RM 163.25 - 164.25 W						
Site Summary						
05760	Site 27 (Summary)	190	190	0	04MAY11	10DEC11



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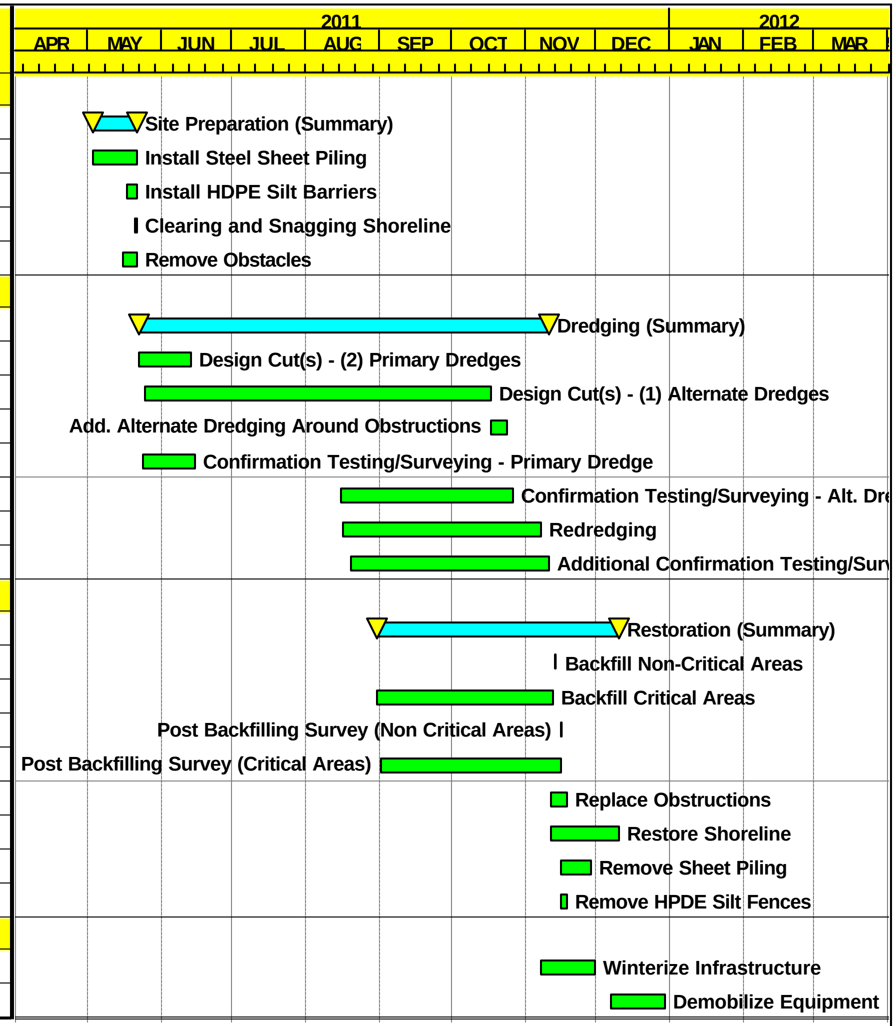
Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 6)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Site Preparation						
05770	Site Preparation (Summary)	16	16	0	04MAY11	21MAY11
05780	Install Steel Sheet Piling	16	16	0	04MAY11	21MAY11
05790	Install HDPE Silt Barriers	4	4	0	18MAY11	21MAY11
05800	Clearing and Snagging Shoreline	1	1	0	21MAY11	21MAY11
05810	Remove Obstacles	6	6	0	16MAY11	21MAY11
Dredging						
05820	Dredging (Summary)	148	148	0	23MAY11	10NOV11
05830	Design Cut(s) - (2) Primary Dredges	19	19	0	23MAY11	13JUN11
05840	Design Cut(s) - (1) Alternate Dredges	124	124	0	26MAY11	17OCT11
05850	Add. Alternate Dredging Around Obstructions	6	6	0	18OCT11	24OCT11
05860	Confirmation Testing/Surveying - Primary Dredge	19	19	0	25MAY11	15JUN11
05870	Confirmation Testing/Surveying - Alt. Dredge	62	62	0	16AUG11	26OCT11
05880	Redredging	71	71	0	17AUG11	07NOV11
05890	Additional Confirmation Testing/Surveying	71	71	0	20AUG11	10NOV11
Restoration						
05900	Restoration (Summary)	88	88	0	31AUG11	10DEC11
05910	Backfill Non-Critical Areas	0	0	0	14NOV11	12NOV11
05920	Backfill Critical Areas	64	64	0	31AUG11	12NOV11
05930	Post Backfilling Survey (Non Critical Areas)	0	0	0	16NOV11	15NOV11
05940	Post Backfilling Survey (Critical Areas)	64	64	0	02SEP11	15NOV11
05945	Replace Obstructions	6	6	0	12NOV11	18NOV11
05950	Restore Shoreline	25	25	0	12NOV11	10DEC11
05960	Remove Sheet Piling	11	11	0	16NOV11	28NOV11
05970	Remove HPDE Silt Fences	3	3	0	16NOV11	18NOV11
Demobilization						
06632	Winterize Infrastructure	20	20	0	08NOV11	30NOV11
06634	Demobilize Equipment	20	20	0	07DEC11	29DEC11



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Example Production Schedule

Hudson River PCB Dredging

Phase II (Year 6)

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Attachment E
Example Production Schedule Backup

1.0 Introduction

Key inputs to the project schedule include production rates for various tasks or activities and quantities. This attachment discusses the development of quantities used for input to the project schedule. Table E-1 contains the quantities associated with site preparation, dredging, and site restoration.

To develop the schedule and associated quantities, the upper Hudson River site was first segmented into smaller "sites," which generally are indicated by river mile and a shoreline qualifier, which indicates if the site is on the eastern or western shore of the river. A sequence of remediation was developed, and where appropriate, each river mile site was further divided into sub-sites, or dredging management cells (DMC). Figure E-1 depicts the DMCs.

2.0 Categories Considered

2.1 Dredging Equipment

Attachment F summarizes an evaluation of applicable dredge equipment for the Hudson River. For the purposes of this production schedule, the working limits of large mechanical dredging equipment were identified and associated quantities estimated.

2.2 Dredging Quantities

For the development of the project schedule, quantities for each site or DMC, where appropriate, were determined using Arc View geographic information system (GIS) information from the Feasibility Study (FS) and by visual inspection of black and white aerial photography (1 inch = 400 feet) taken in the spring of 2002 to facilitate site preparation and restoration quantities for the project schedule. Site preparation, mechanical dredging, and site restoration, and total dredging quantities are presented in Table E-1. Figure E-1 depicts DMCs.

2.3 Containment Barriers

Placement of containment barriers was configured conceptually and is shown on Figure E-1. Sheet piling is depicted perpendicular to flow and HDPE is shown parallel to flow. It is anticipated that containment would not be used within the navigational channel or at the mouth or any significant tributary.

2.4 Obstructions

Obstructions that would be expected to be encountered during dredging such as bridges, docks, sewer/storm water outfalls, boat launches, power lines, lock walls, and lock ballards were identified and quantified through inspection of the spring 2002 black and white aerial photographs. These quantities were then used to calculate the additional duration needed for site preparation and site restoration.

2.5 Shoreline Characteristics

Shoreline features, such as trees, large rocks/rip rap, small rocks/ sand, residential/man made structures, concrete structures, and stream/river inlets were determined through visual inspection of the black and white aerial photographs. Using the calculated shoreline length from Arc View GIS, an estimate of each quantity was made (see Table E-1).

Table E-1
Productivity Schedule Backup Table

Dredging Year	Seasonal Volume Dredged (CY)	Cumulative Volume Dredged (CY)	Site Location: Dredge Site Number	Site Location: Site Location E=East, W=West, NAV=Nav. Channel	Site Location: Location by River Mile	Site Location: Dredge Management Cell (DMC)	Site Location: River Section	Site Location: Pool Location Description	Dredging: Total Volume of Dredging (CY)	Dredging: Volume By Production Equipment (CY)	Dredging: Volume By Alternative Equipment (CY)	Dredging: Additional Dredging Around Obstructions (Days on Critical Path)	Restoration: Total Standard Backfill (AC)	Restoration: Total Critical Backfill (AC)	Restoration: DMC Backfill (AC)	Restoration: Does DMC contain "critical" area that requires additional backfill to meet pre-dredge grade?	Restoration: Restore Shoreline (LF)	Restoration: Remove Containment (LF)	Restoration: Additional Duration for Replacing Obstructions (Days on Critical Path)
Phase 1 (Year 1)	268,977	268,977	1	E & W	Around Rogers Island (RM 193.75 - 194.5)	1	1	Thompson Island Pool	77,261	64,517	12,743	1	39	11	4	Yes	2,119	527	0
						1a						0					Included in above	513	0
						2						1			11	No	4,432	207	1
			2	W	RM 193.5 - 193.75	3			13,193	13,193	0	1			2	No	872	1,096	0
			3	W	RM 192.5 - 193.5 W	4a			50,000	42,964	7,036	0			7	Yes	2,287	2,225	0
						5			80,336	80,336	0	0			0	No			
			5	W	RM 191.5 - 192.5 W	9			48,188	45,055	3,132	0			12	No	460	468	0
						10						0			12	No	956	1,425	1
						11						0			3	No	1,461	1,650	1
Phase 2 (Year 2)	529,440	798,417	5	W	RM 192.5 - 193.5 W	4b	1	Thompson Island Pool	137,476	118,131	19,345	0	11	67	18	Yes	3,131	3,042	0
			8	W	RM 190.5 - 191.5 W	15			128,807	125,207	3,600	0			5	No	1,137	1,552	0
						16						0			6	No	1,866	2,025	0
						17						0			4	Yes	1,421	1,527	0
						18						0			0	No			
			10 (1)	W	RM 189.5 - 190.5 W	17a			194,682	39,939	154,743	0			27	Yes	13,430	3,048	0
			12	W	RM 188.5 - 189.5 W	17b			68,475	61,396	7,079	0			13	Yes	2,375	2,618	0
						29						0			3	Yes	884	1,019	0
						30						0			0	No			
						31						0			3	Yes	222	607	0
Phase 2 (Year 3)	601,810	1,400,227	4	E	RM 192.5 - 193.5 E	6	1	Thompson Island Pool	54,409	52,828	1,581	0	52	34	25	No	3,424	3,629	1
			6	E	RM 191.5 - 192.5 E	7			244,803	179,746	65,057	0			23	Yes	10,910	6,075	7
						8						0			0	No			
			7	E	RM 190.5 - 191.5 E	12			153,868	151,662	2,207	0			5	No	2,414	2,714	0
						13						0			0	No			
						14						0			3	No	950	1,191	0
			13	W	RM 187.5 - 188.5	32	2	TI Dam to Fort Miller Dam / Lock 6	13,026	12,936	90	0			4	No	1,386	1,254	0
			14	W	RM 186.5 - 187.5	33			40,461	34,682	5,779	0			11	Yes	1,277	1,786	1
						34						0			8	No	1,763	1,852	0
			18	W	RM 183.25 - 184.25 W	40		Fort Miller Dam / Lock 6 to Northumberland Dam	95,243	93,402	1,840	0			3	No	1,561		1
						41						0			4	No	1,397	1,703	3
Phase 2 (Year 4)	564,533	1,964,760	9	E	RM 189.5 - 190.5 E	19	1	Thompson Island Pool	168,129	163,985	4,143	0	62	0	5	No	709	931	0
						20						0			2	No	407		
						21						0			16	No	2,582	2,660	2
						22						0			2	No	1,010	1,010	1
			11	E	RM 188.5 - 189.5 E	22a			142,611	129,564	13,047	0			4	No	980	1,333	1
						23						0			0	No	290		
						24						0			4	No	1,406	1,737	0
						25						1			4	No	305	1,391	0
						26						0			0	No	696		
						27						0			2	No	614	559	0
						28						0			0	No			
			15	E	RM 185.25 - 186.25	35	2	Fort Miller Dam / Lock 6 to Northumberland Dam	253,793	247,865	5,928	1			23	No	3,006	2,557	5
						36						0			0	No			
Phase 2 (Year 5)	447,387	2,412,147	16	E	RM 184.25 - 185.25	37	2	Fort Miller Dam / Lock 6 to Northumberland Dam	30,168	30,168	0	0	3	50	3	No	2,241	2,459	0
			17	E	RM 183.25 - 184.25 E	38			93,160	79,307	13,853	0			13	Yes	1,845	2,321	0
						39						0			6	Yes	2,027	1,365	0
			19	NAV	RM 176.75 - 177.25	42*	3	Lock 5 to Lock 4 / Stillwater Dam	9,023	9,023	0	0			0	No			
			20	NAV	RM 175.0 - 175.25	43*			9,023	9,023	0	0			0	No			
			21	NAV	RM 171.5 - 172.0	44*			9,023	9,023	0	0			0	No			
			22	E	RM 169.25 - 170.25	45*			9,023	9,023	0	0			0	No			
						46*			9,023	9,023	0	0			0	No			
						47			224,806	166,434	58,372	0			31	Yes	4,640	4,936	1
			23	NAV	RM 167.0 - 167.5	48*		Lock 4 / Stillwater Dam to Lock 3	9,023	9,023	0	0			0	No			
			25	NAV	RM 164.25- 165.0	51*			9,023	9,023	0	0			0	No			
			26	NAV	RM 164.0 - 164.25	52*		Lock 3 to Lock 2	9,023	9,023	0	0			0	No			
			28	NAV	RM 162.25 - 162.75	56*		Lock 2 to Lock 1	9,023	9,023	0	0			0	No			
			29	NAV	RM 159.25 - 159.75	57*			9,023	9,023	0	0			0	No			
			30	NAV	RM 158.5 - 159.25	58*		Lock 1 to Federal Dam	9,023	9,023	0	0			0	No			
Phase 2 (Year 6)	237,860	2,650,000	24	W	RM 165.75 - 166.75	49*	3	Lock 4 / Stillwater Dam to Lock 3	9,023	9,023	0	1	0	63	0	No			
						50			144,966	50,648	94,317	1			31	Yes	3,432	3,711	0
			27	W	RM 163.25 - 164.25	53*		Lock 3 to Lock 2	9,023	9,023	0	0			0	No			
						54			74,848	31,261	43,588	2			16	Yes	1,035	1,458	0
						55						4			16	Yes	2,663	864	0

(1)Of the volume dredged by alternative equipment, 93,300 cy are dredged by a production dredge or other dredge operating at a production rate of 82 c

Note: Represents areas where no containment will be needed; area either in channel (navigational dredging) or behind rock outcrop

* Volume for this DMC is assumed to be 1/13th of Total Navigational Dredging Volume in River Section 3

Table E-1
Productivity Schedule Backup Table

Dredging Year	Seasonal Volume Dredged (CY)	Cumulative Volume Dredged (CY)	Site Location: Dredge Site Number	Site Location: Site Location E=East, W=West, NAV=Nav. Channel	Site Location: Location by River Mile	Site Location: Dredge Management Cell (DMC)	Site Location: River Section	Site Location: Pool Location Description	Site Preparation: Install Steel Sheet Piling (LF)	Site Preparation: Install HDPE Silt Barriers (LF)	Site Preparation: Additional Schedule Duration Due to Obstructions (Days on Critical Path)	Number of Obstructions by Obstruction Type: Bridges	Docks	WWTP Outlet	Boat Launch	Power Lines	Lock Wall	Lock Ballards	Shoreline Characteristics (LF): Trees	Rip Rap / Large Rocks	Residential / Man Made	Natural Shore / Small rocks	Concrete Structures	Stream Inlet
Phase 1 (Year 1)	268,977	268,977	1	E & W	Around Rogers Island (RM 193.75 - 194.5)	1	1	Thompson Island Pool	111	416	1	2							710			710		
						1a			513	0	0								350			350		
						2			207	0	2		1	1					2,549			1,663	20	200
			2	W	RM 193.5 - 193.75	3			409	687	1				1				426			426	20	
			3	W	RM 192.5 - 193.5 W	4a			546	1,679	1		1			1			304			304		
						5										1								
			5	W	RM 191.5 - 192.5 W	9			167	301	0								46			414		
						10			520	905	1		1						382			574		
						11			335	1,315	1		1						365	731		365		
Phase 2 (Year 2)	529,440	798,417	5	W	RM 192.5 - 193.5 W	4b	1	Thompson Island Pool	189	2,853	0								1,261			1,261		
			8	W	RM 190.5 - 191.5 W	15			449	1,103	0								519	100		519		
						16			358	1,667	0								467			1,400		
						17			397	1,130	0								987			284		150
						18																		
			10 [1]	W	RM 189.5 - 190.5 W	17a			509	2,539	0					1			6,565	100		6,565		200
			12	W	RM 188.5 - 189.5 W	17b			261	2,358	0								713			1,663		
						29			215	803	0								215	400		239		30
						30																		
						31			100	507	0								122	100				
Phase 2 (Year 3)	601,810	1,400,227	4	E	RM 192.5 - 193.5 E	6	1	Thompson Island Pool	136	3,493	1		1			1			1,198	1,198		1,027		
			6	E	RM 191.5 - 192.5 E	7			1,018	5,057	7		7						7,832			2,727		350
						8																		
			7	E	RM 190.5 - 191.5 E	12			362	2,352	0								1,772	400		241		
						13																		
						14			360	831	0								660	100		190		
			13	W	RM 187.5 - 188.5	32	2	TI Dam to Fort Miller Dam / Lock 6	418	835	0								1,109			277		
			14	W	RM 186.5 - 187.5	33			333	1,454	1		1						1,022			255		
						34			363	1,489	0								1,486			176		100
			18	W	RM 183.25 - 184.25 W	40		Fort Miller Dam / Lock 6 to Northumberland Dam			1		1						200	850		511		
						41			383	1,320	3		3						101		101	1,824		
Phase 2 (Year 4)	564,533	1,964,760	9	E	RM 189.5 - 190.5 E	19	1	Thompson Island Pool	413	517	0								177			390		
						20													407					
						21			449	2,211	0		2						421	800	100	1,262		
						22			0	1,010	0		1						202		200	608		
			11	E	RM 188.5 - 189.5 E	22a			475	858	0		1						685	50		245		
						23													145			145		
						24			604	1,133	0								1,265			141		
						25			775	616	1						1		274			30	600	
						26													696					
						27			100	459	0								207	200		207		
						28																		
			15	E	RM 185.25 - 186.25	35	2	Fort Miller Dam / Lock 6 to Northumberland Dam	506	2,052	6		5				2		301	300		2,255	800	150
						36																		
Phase 2 (Year 5)	447,387	2,412,147	16	E	RM 184.25 - 185.25	37	2	Fort Miller Dam / Lock 6 to Northumberland Dam	331	2,128	0								1,468	100		672		
			17	E	RM 183.25 - 184.25 E	38			957	1,364	0								1,291			553		
						39			170	1,195	0								140	1,200		57		
			19	NAV	RM 176.75 - 177.25	42*	3	Lock 5 to Lock 4 / Stillwater Dam																
			20	NAV	RM 175.0 - 175.25	43*																		
			21	NAV	RM 171.5 - 172.0	44*																		
			22	E	RM 169.25 - 170.25	45*																		
						46*																		
						47			588	4,348	1		1						2,220	200		2,220		
			23	NAV	RM 167.0 - 167.5	48*		Lock 4 / Stillwater Dam to Lock 3																
			25	NAV	RM 164.25- 165.0	51*																		
			26	NAV	RM 164.0 - 164.25	52*		Lock 3 to Lock 2																
			28	NAV	RM 162.25 - 162.75	56*		Lock 2 to Lock 1																
			29	NAV	RM 159.25 - 159.75	57*																		
			30	NAV	RM 158.5 - 159.25	58*		Lock 1 to Federal Dam																
Phase 2 (Year 6)	237,860	2,650,000	24	W	RM 165.75 - 166.75	49*	3	Lock 4 / Stillwater Dam to Lock 3			1				1								20	
						50			619	3,092	1						2			600		1,932	900	
			27	W	RM 163.25 - 164.25	53*		Lock 3 to Lock 2																
						54			576	882	2							3	778			207		50
						55			864	0	4						1	7	133	1,864		666		400

(1)Of the volume dredged by alternative equipment, 93,300 cy are dredged by a production dredge or other dredge operating at a production rate of 82 c

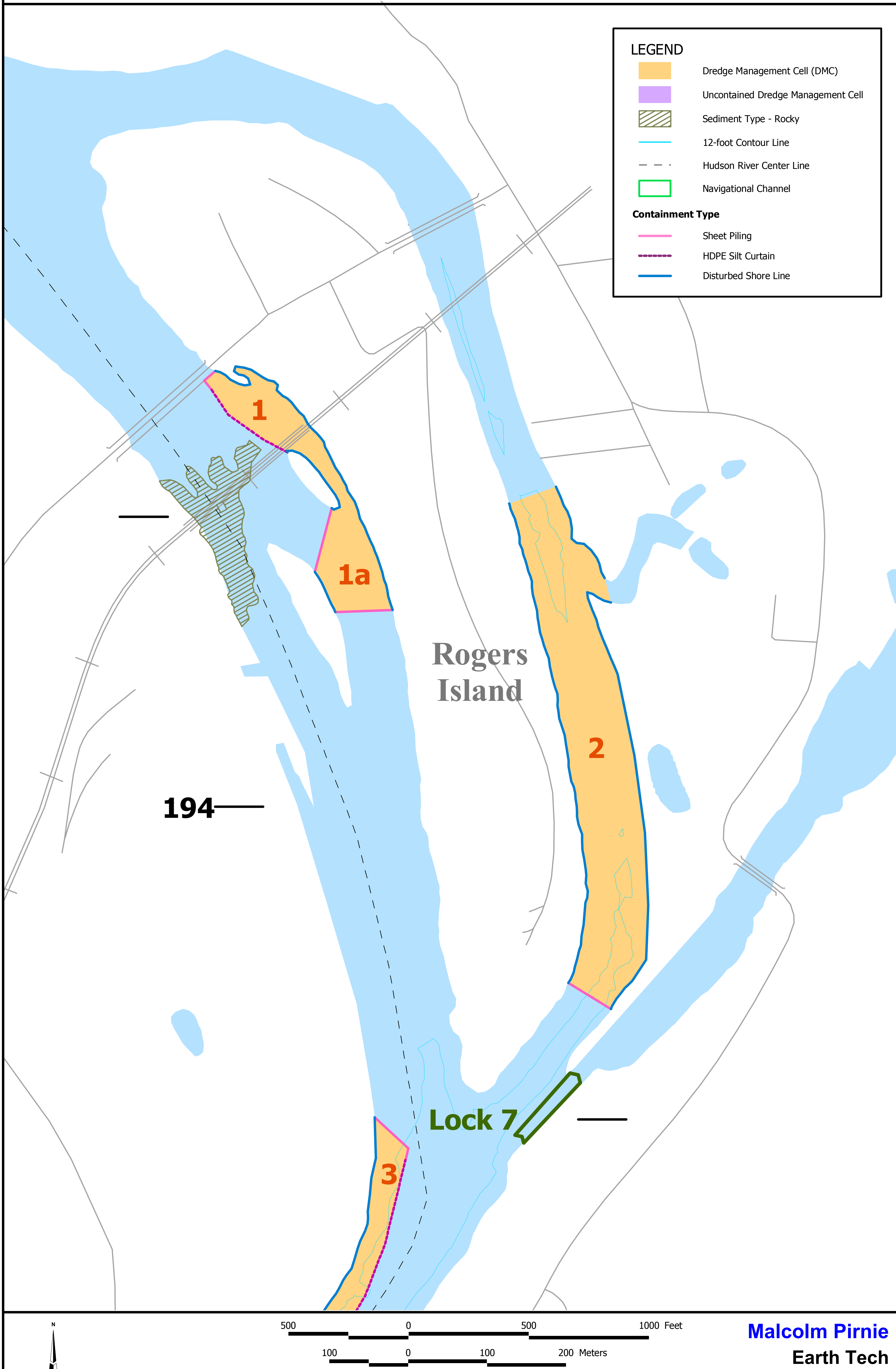
Note: Represents areas where no containment will be needed; area either in channel (navigational dredging) or behind rock outcrop

* Volume for this DMC is assumed to be 1/13th of Total Navigational Dredging Volume in River Section 3

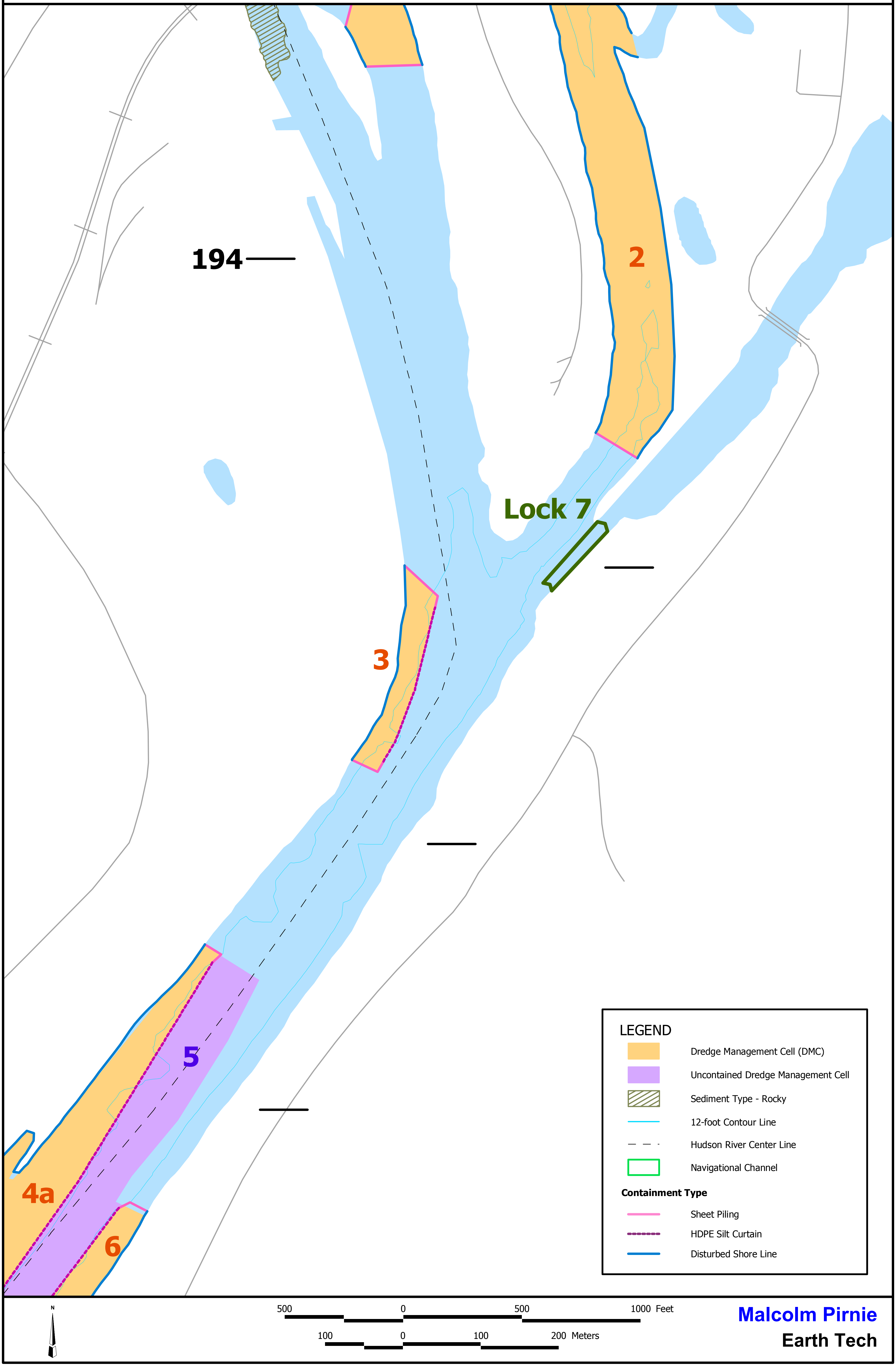
Figure E-1

Containment Types

Containment Types - RM 193.75 - 194.5

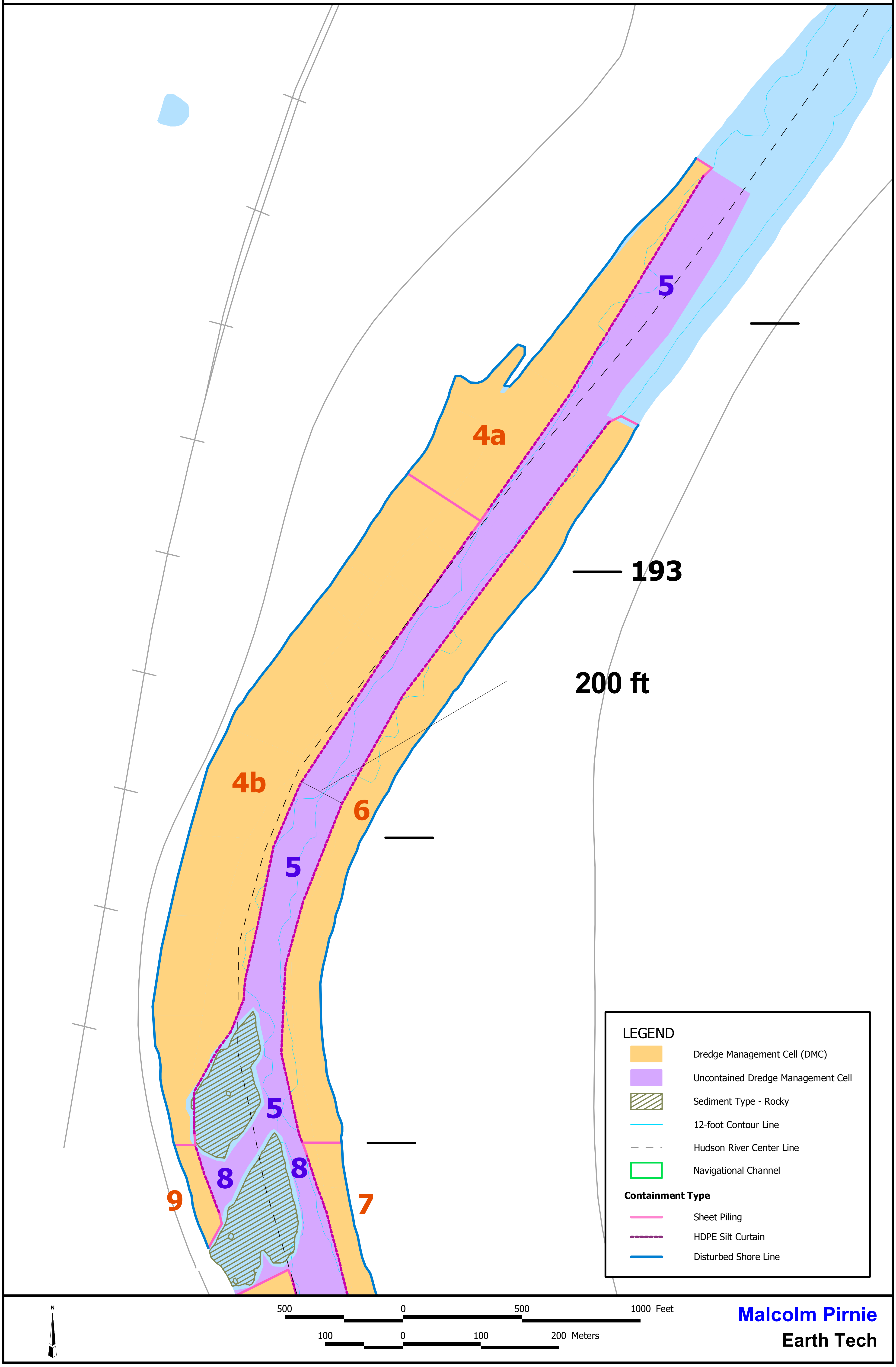


Containment Types - RM 193.5 - 193.75



Malcolm Pirnie
Earth Tech

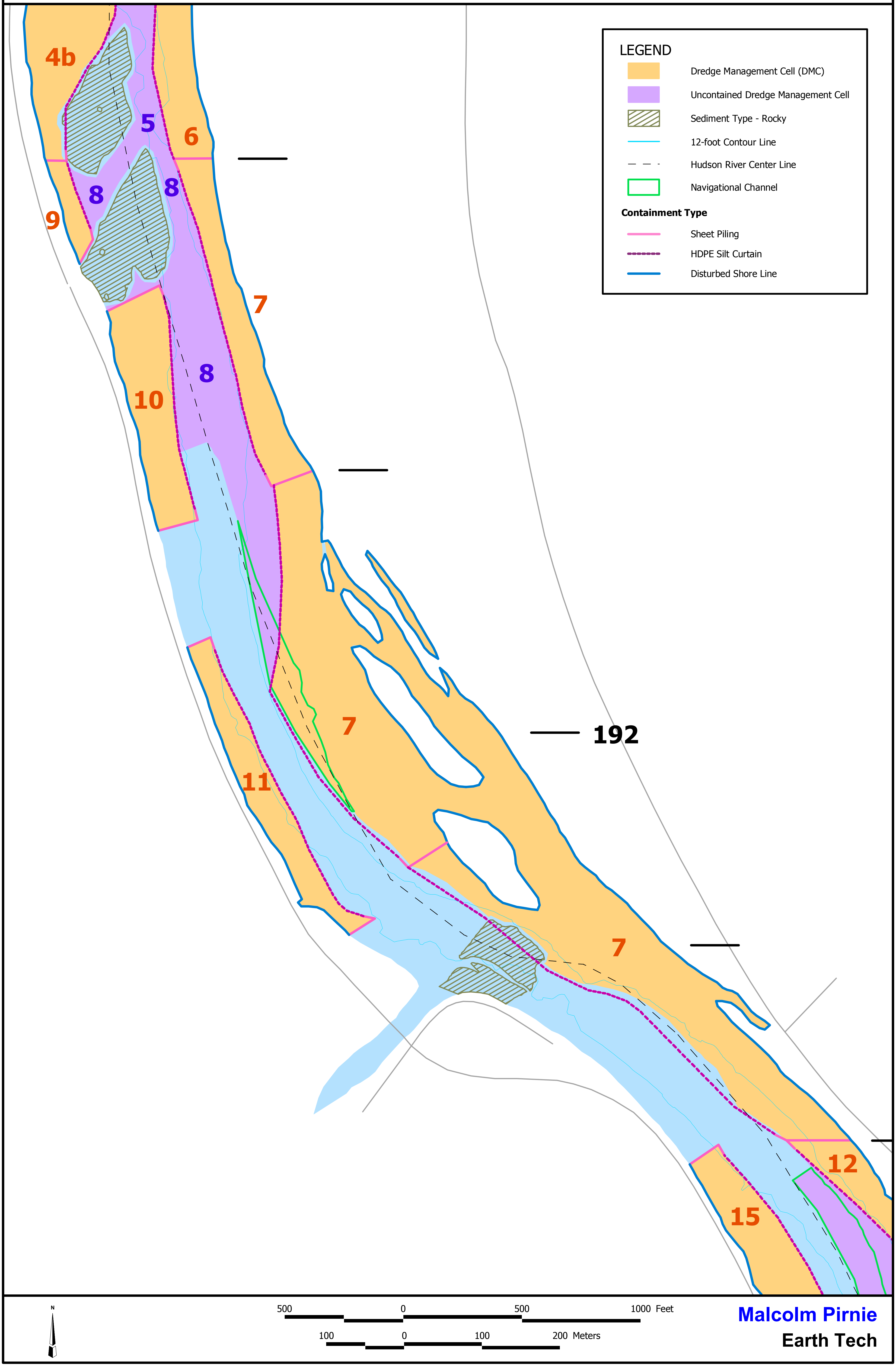
Containment Types - RM 192.5 - 193.5



Malcolm Pirnie

Earth Tech

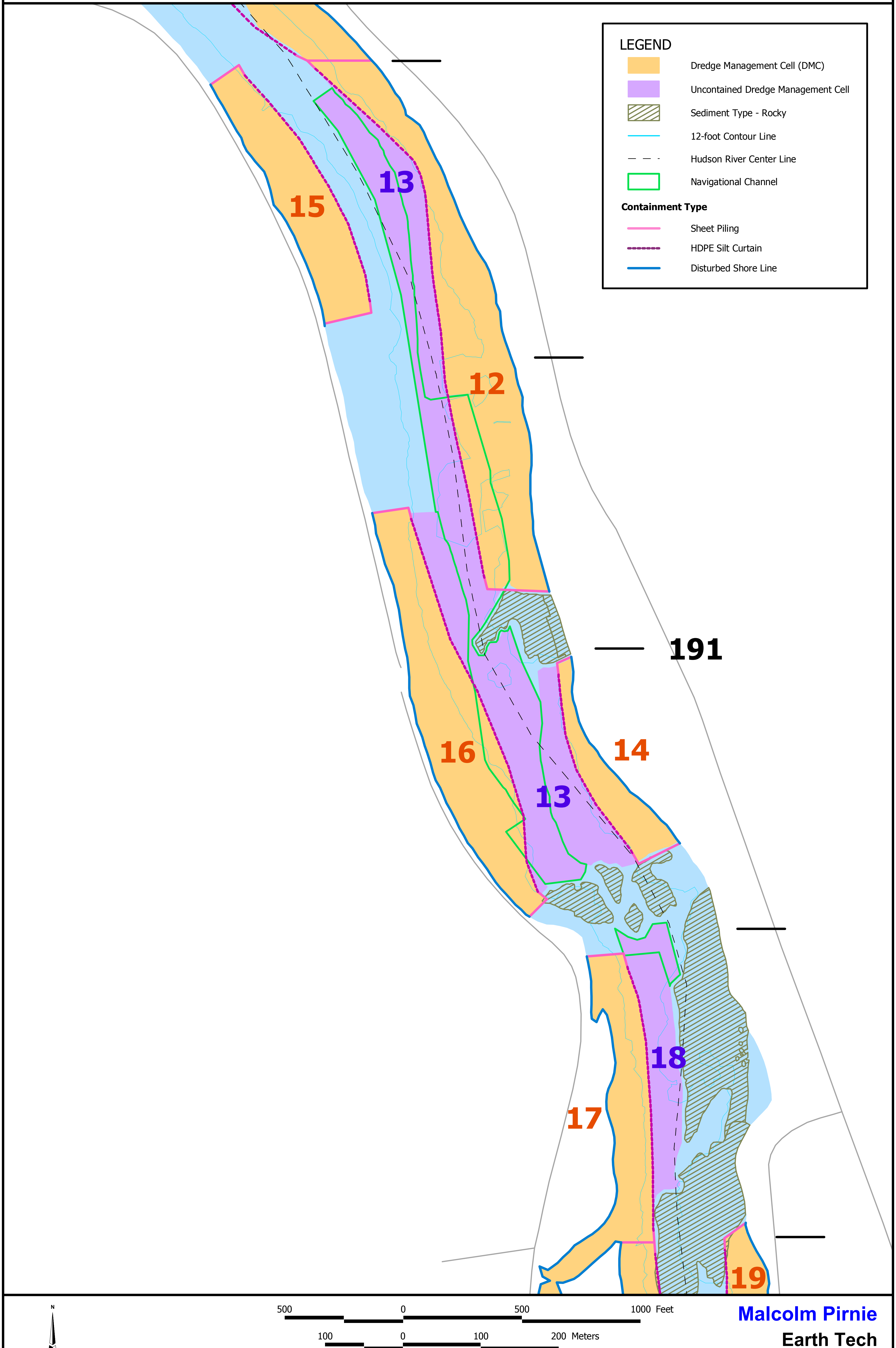
Containment Types - RM 191.5 - 192.5



Malcolm Pirnie

Earth Tech

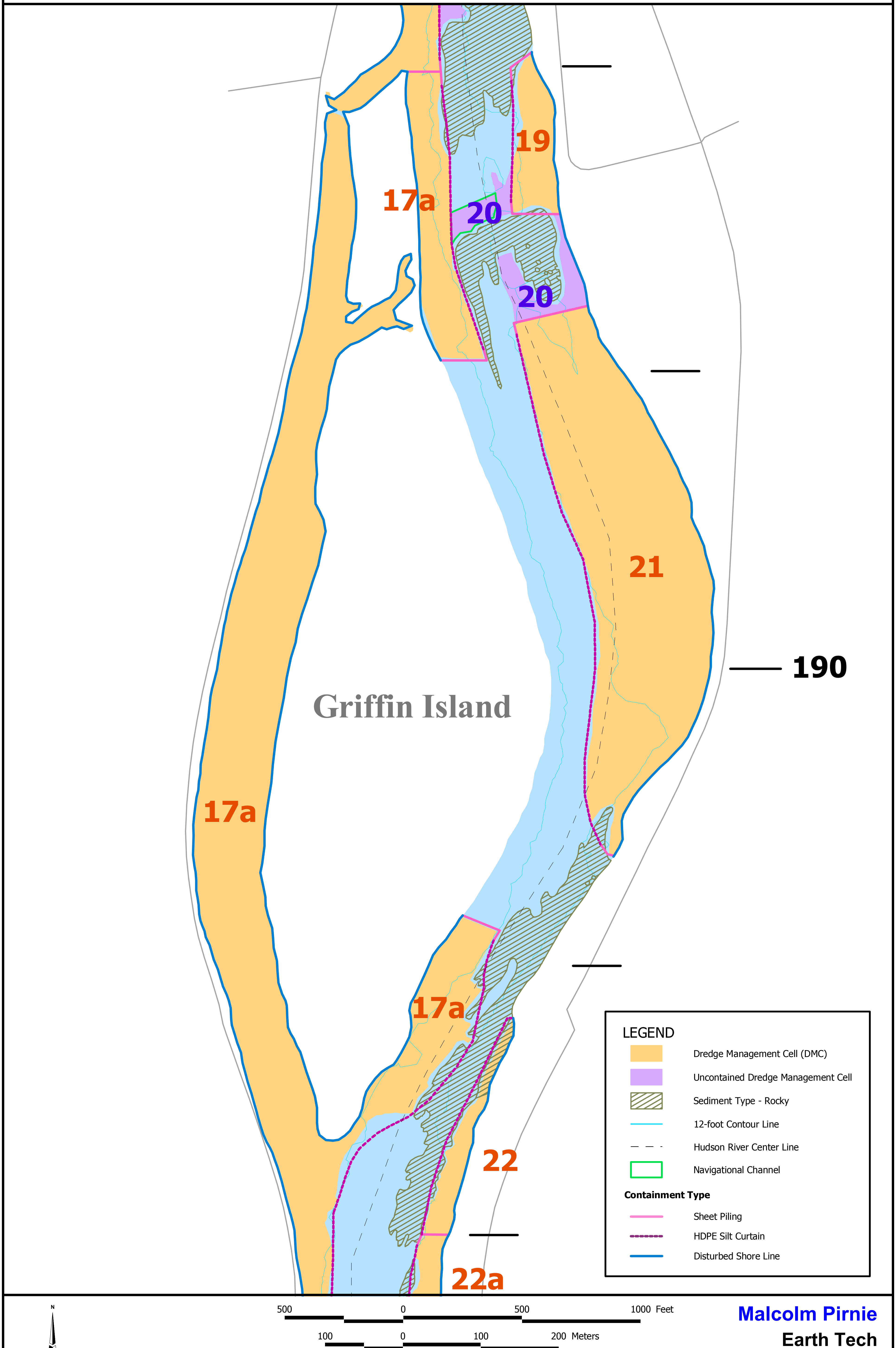
Containment Types - RM 190.5 - 191.5



Malcolm Pirnie

Earth Tech

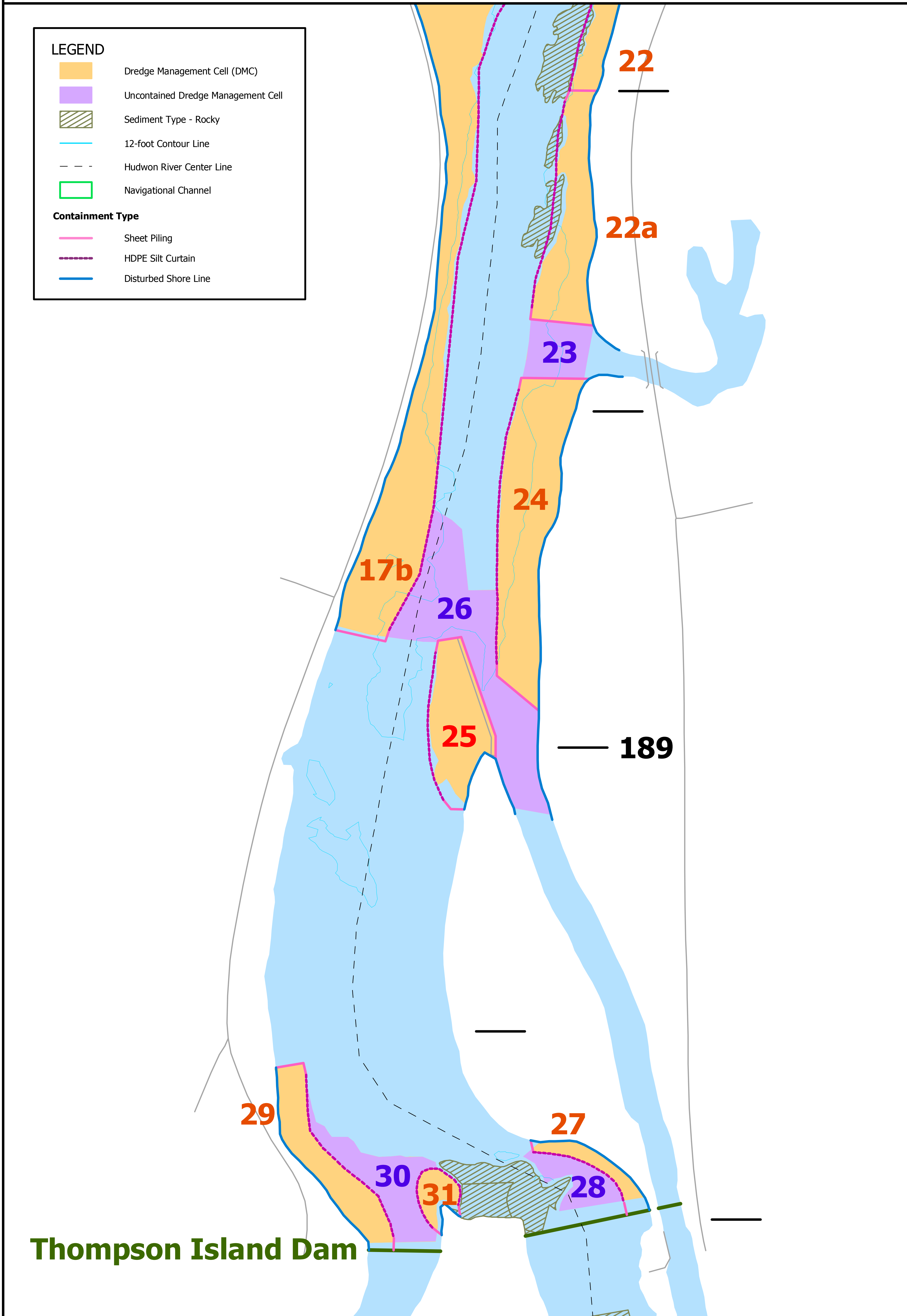
Containment Types - RM 189.5 - 190.5



Malcolm Pirnie

Earth Tech

Containment Types - RM 188.5 - 189.5



N

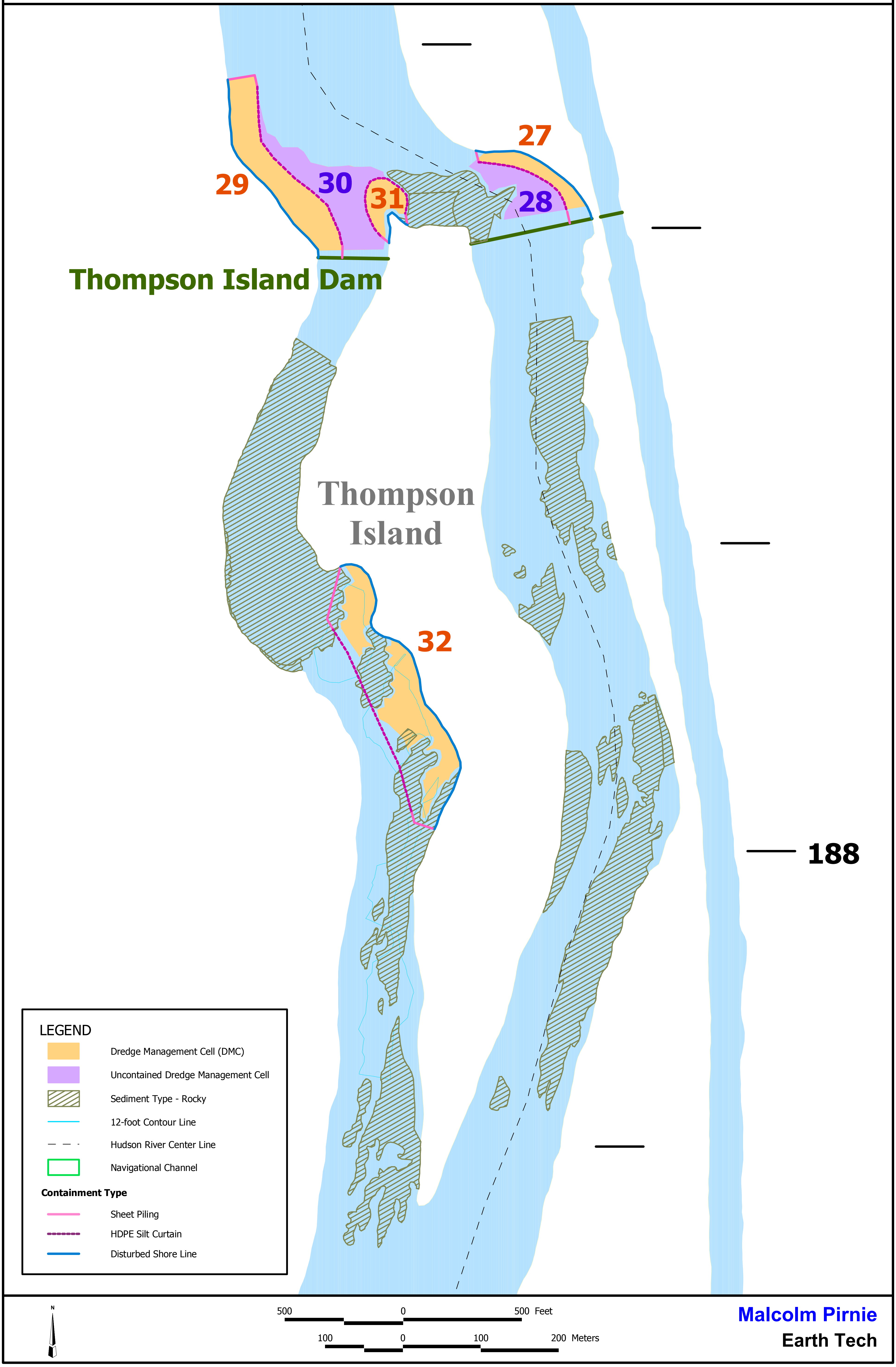
500 0 500 1000 Feet

100 0 100 200 Meters

Malcolm Pirnie

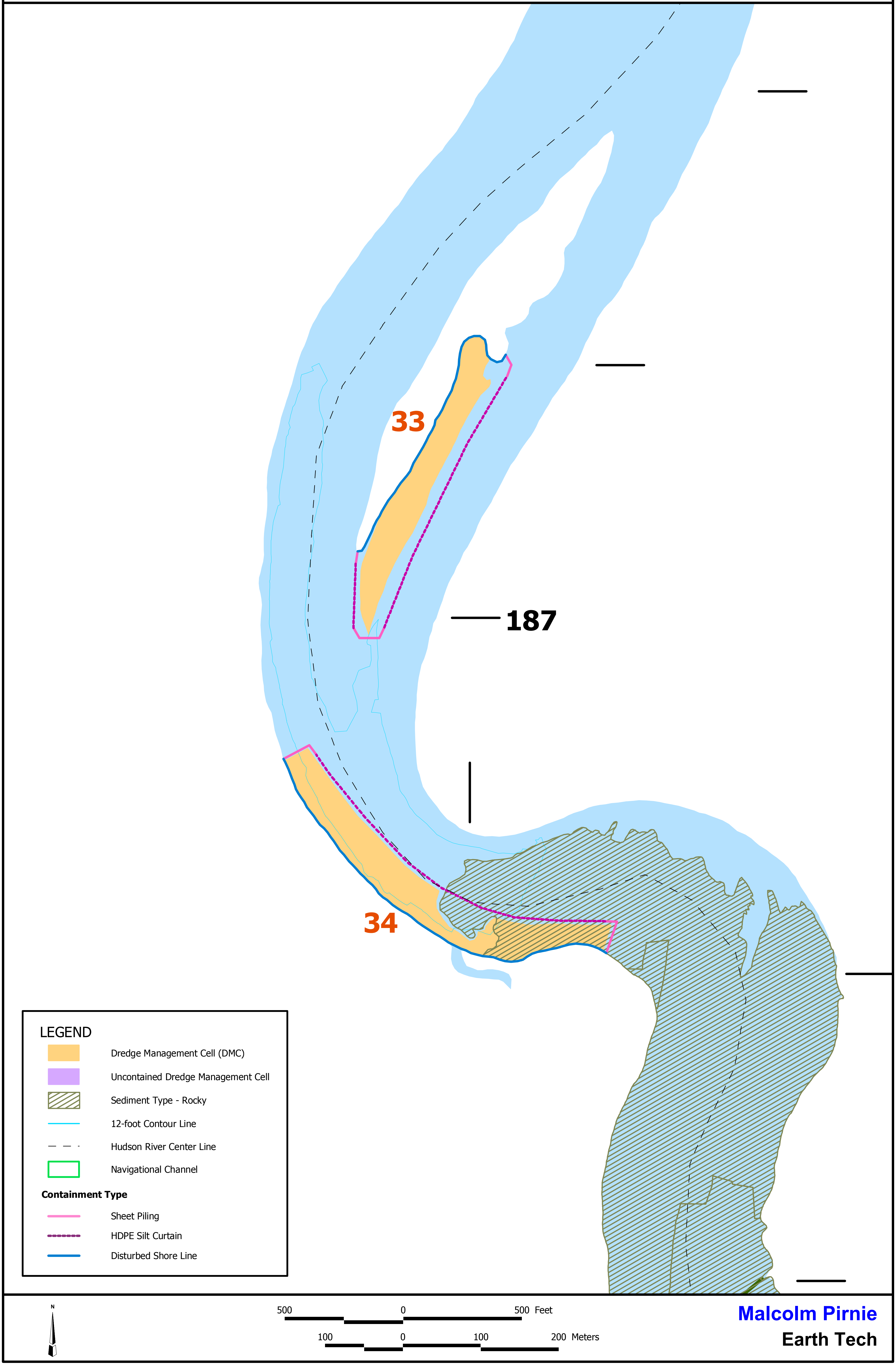
Earth Tech

Containment Types - RM 187.5 - 188.5



Malcolm Pirnie
Earth Tech

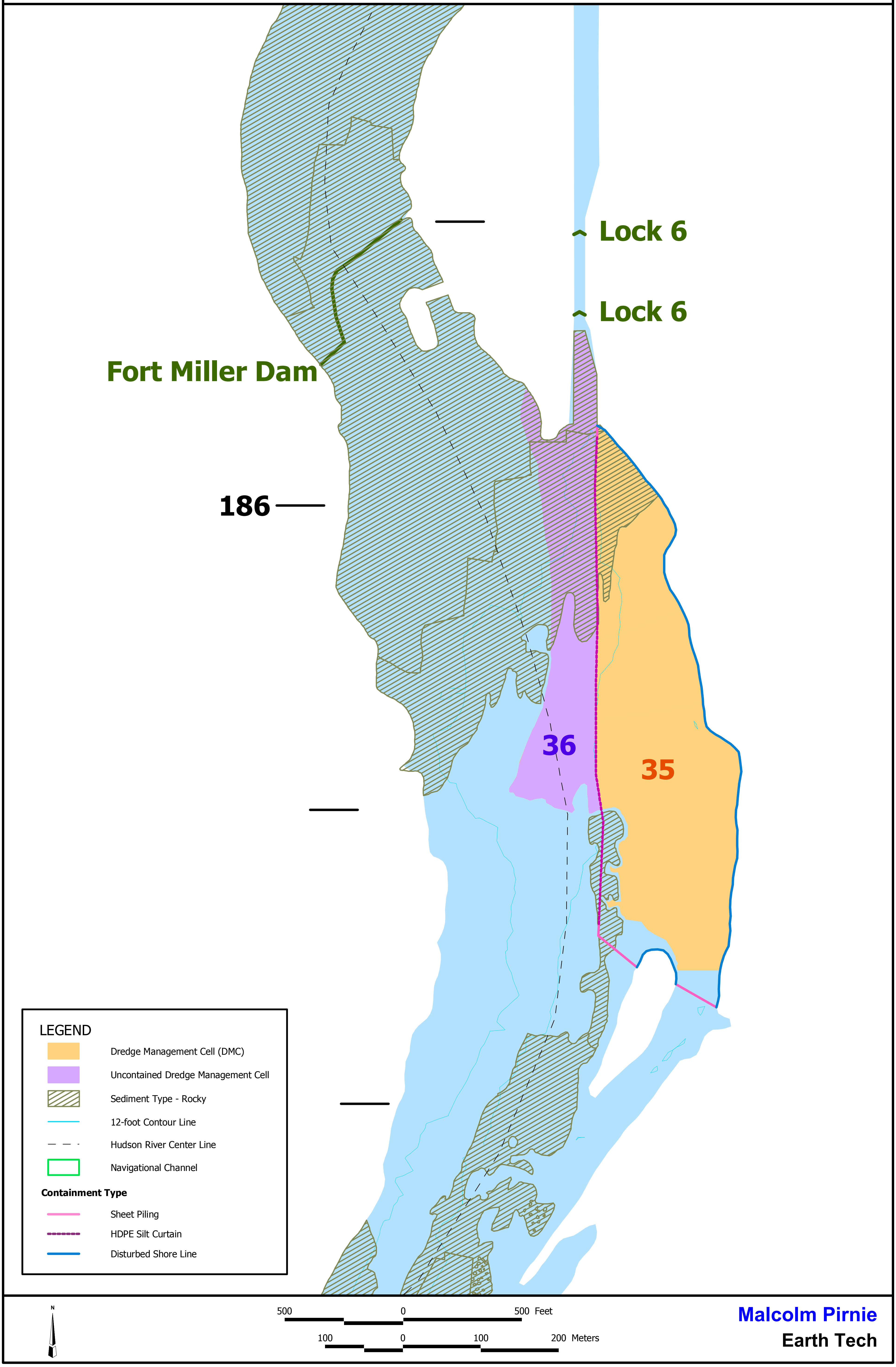
Containment Types - RM 186.5 - 187.5



Malcolm Pirnie

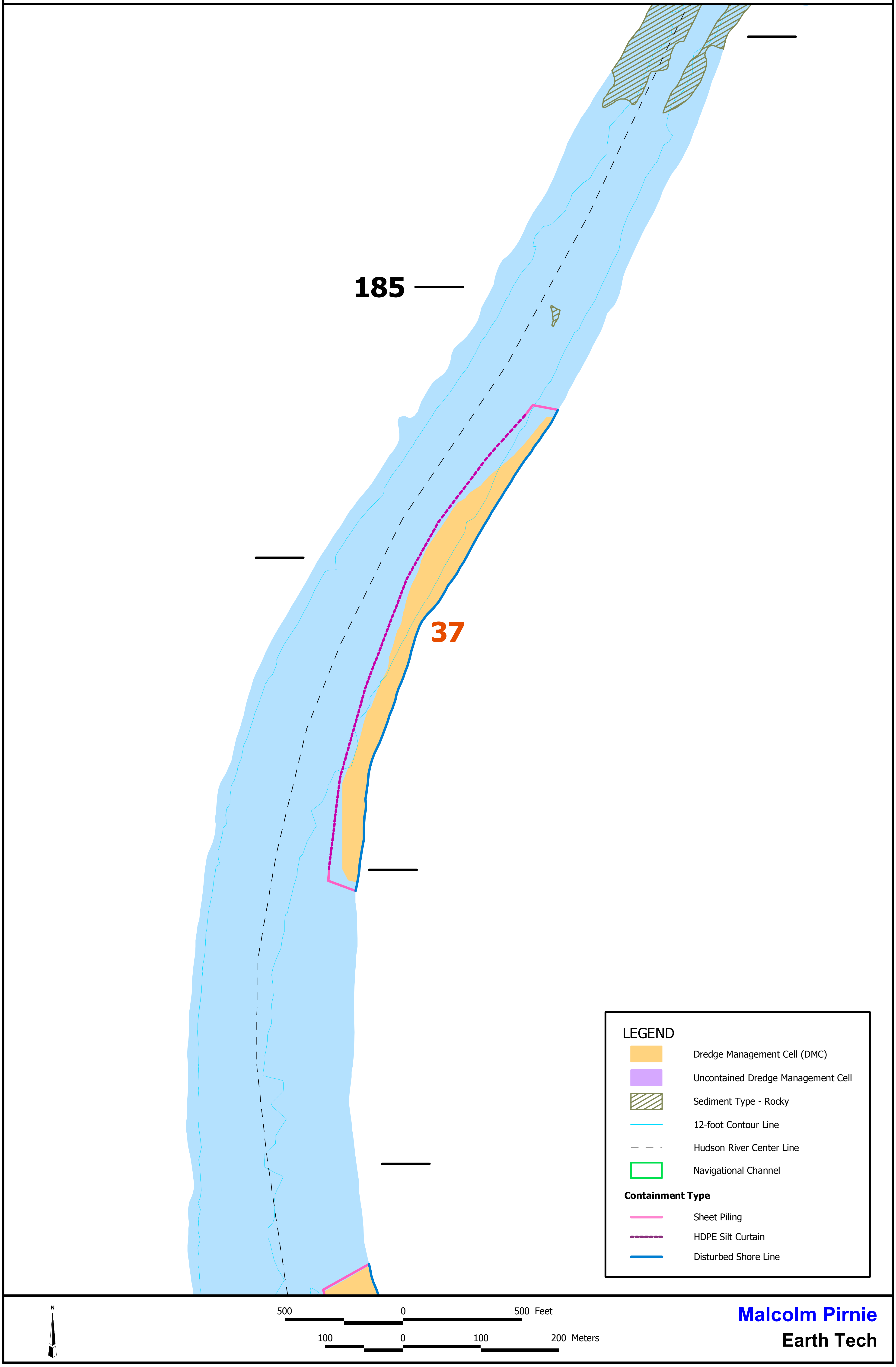
Earth Tech

Containment Types - RM 185.25 - 186.25



Malcolm Pirnie
Earth Tech

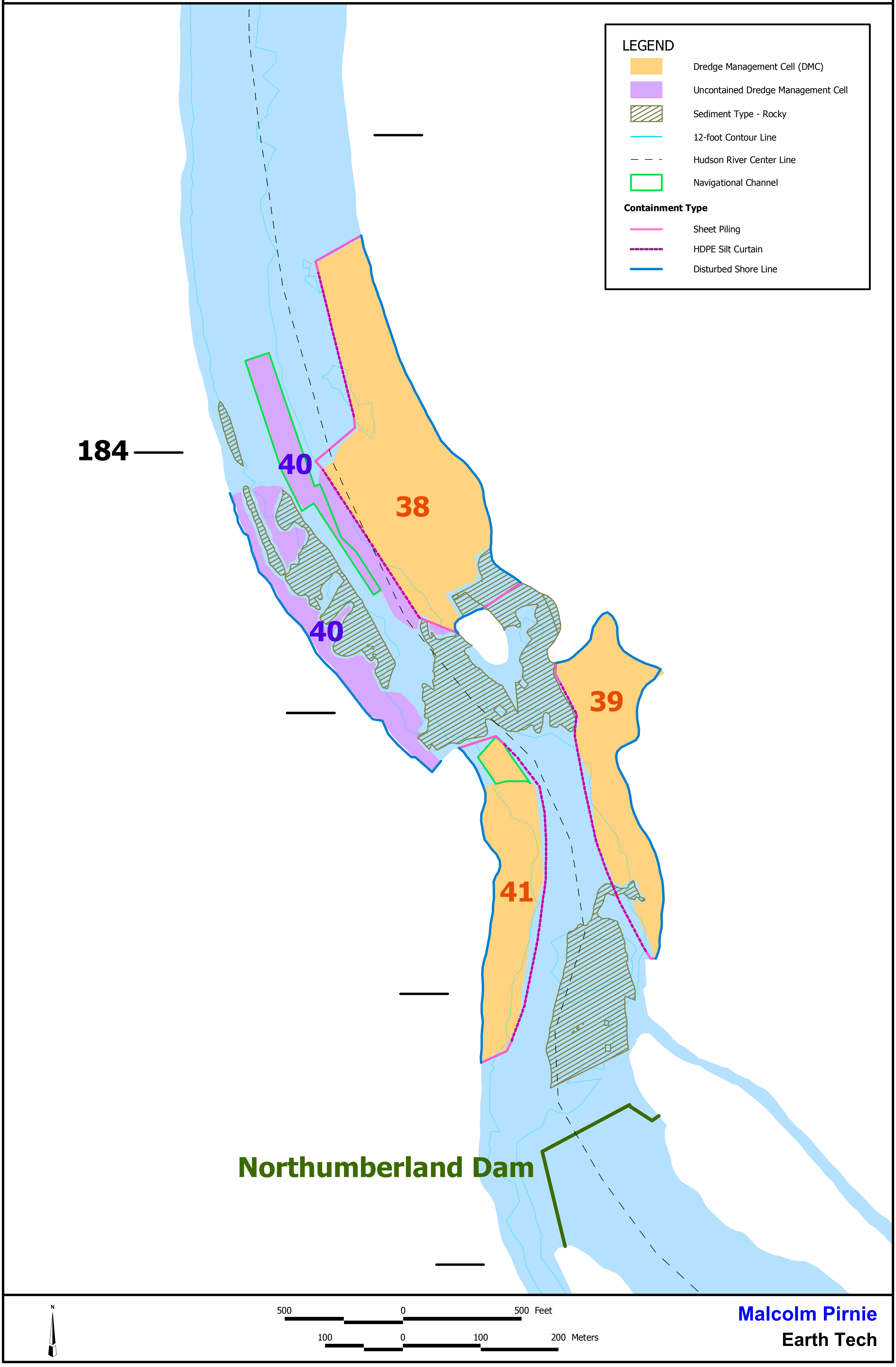
Containment Types - RM 184.25 - 185.25



Malcolm Pirnie

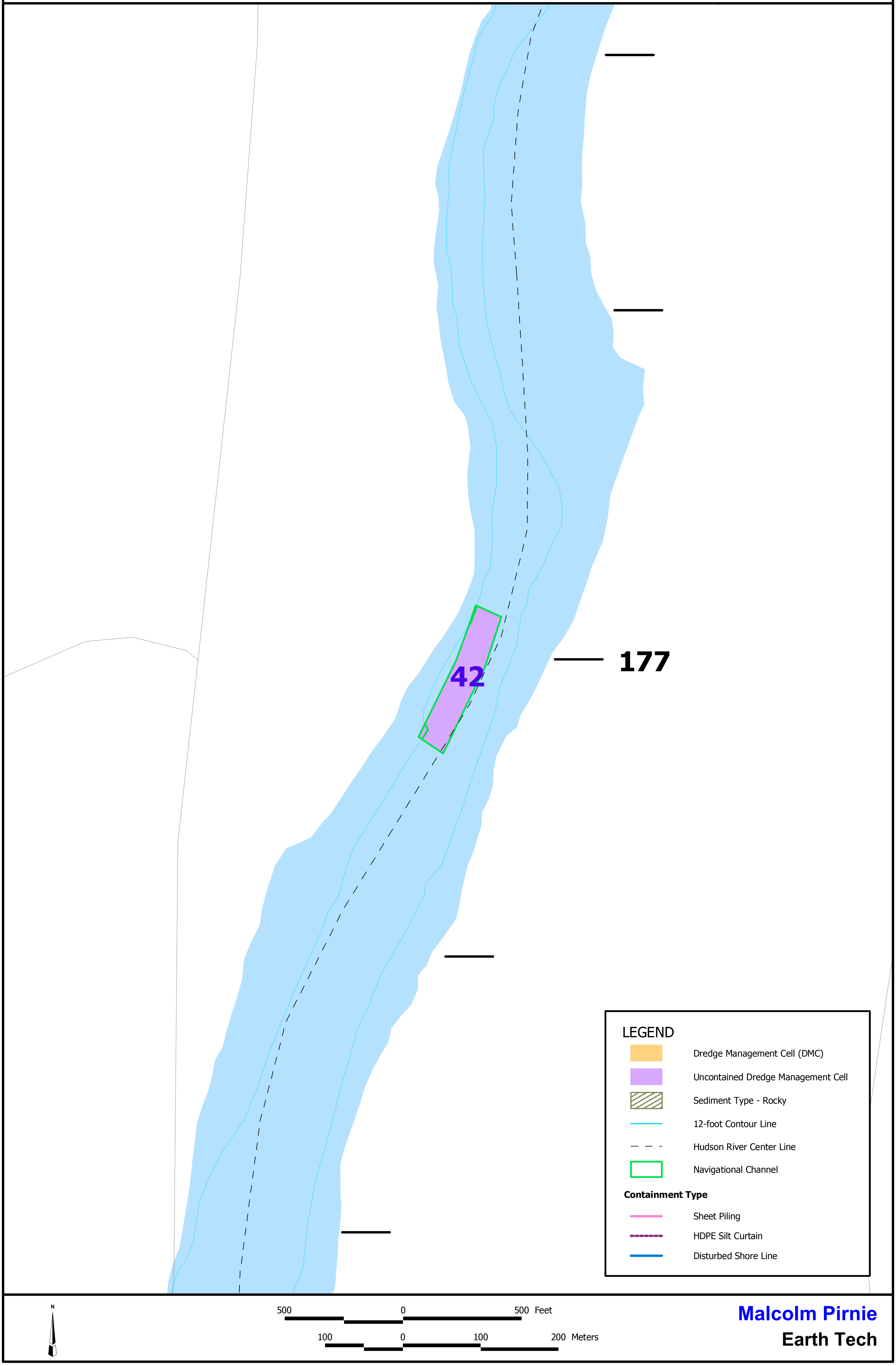
Earth Tech

Containment Types - RM 183.25 - 184.25



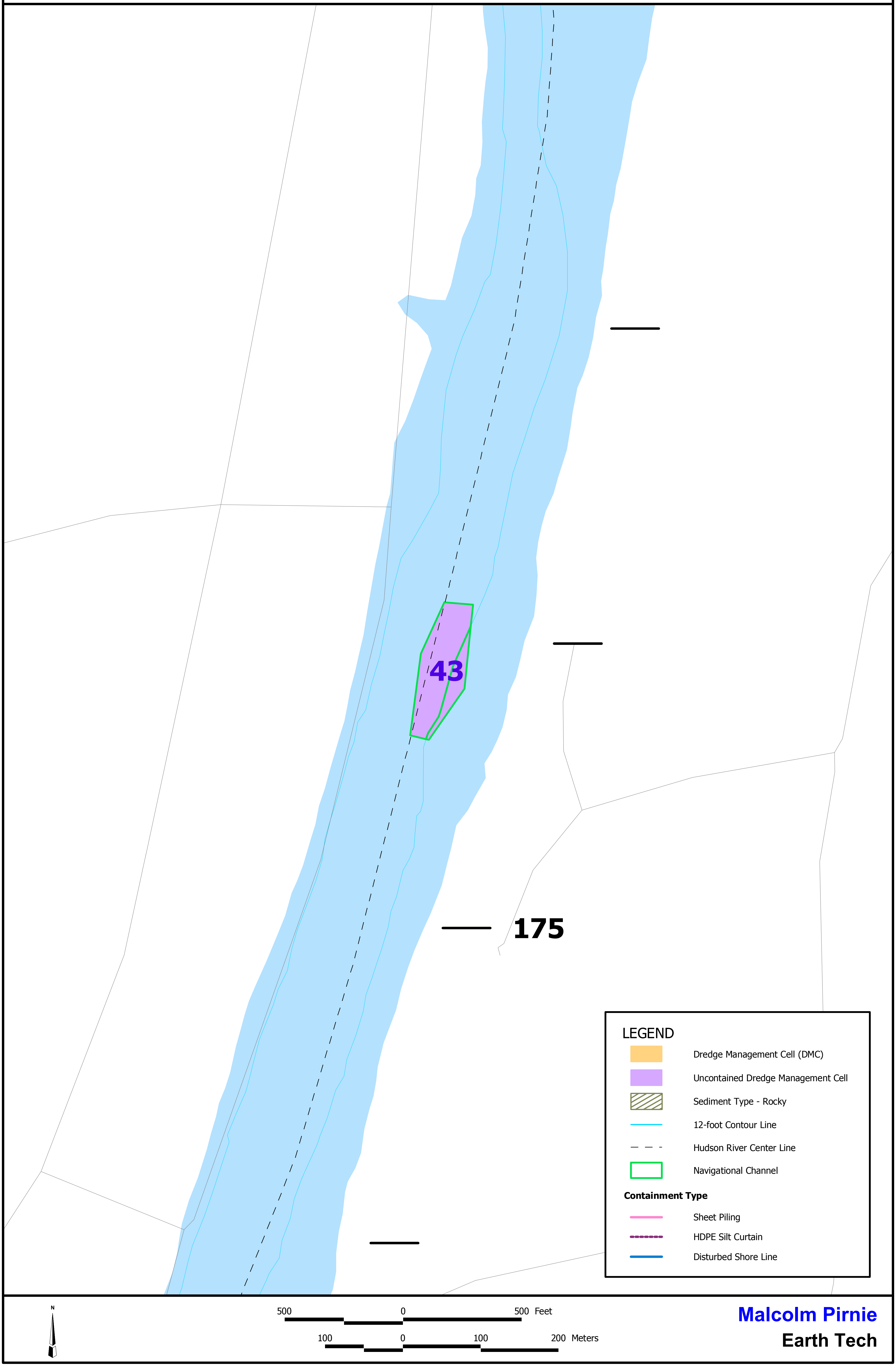
Malcolm Pirnie
Earth Tech

Containment Types - RM 176.5 - 177.5



Malcolm Pirnie
Earth Tech

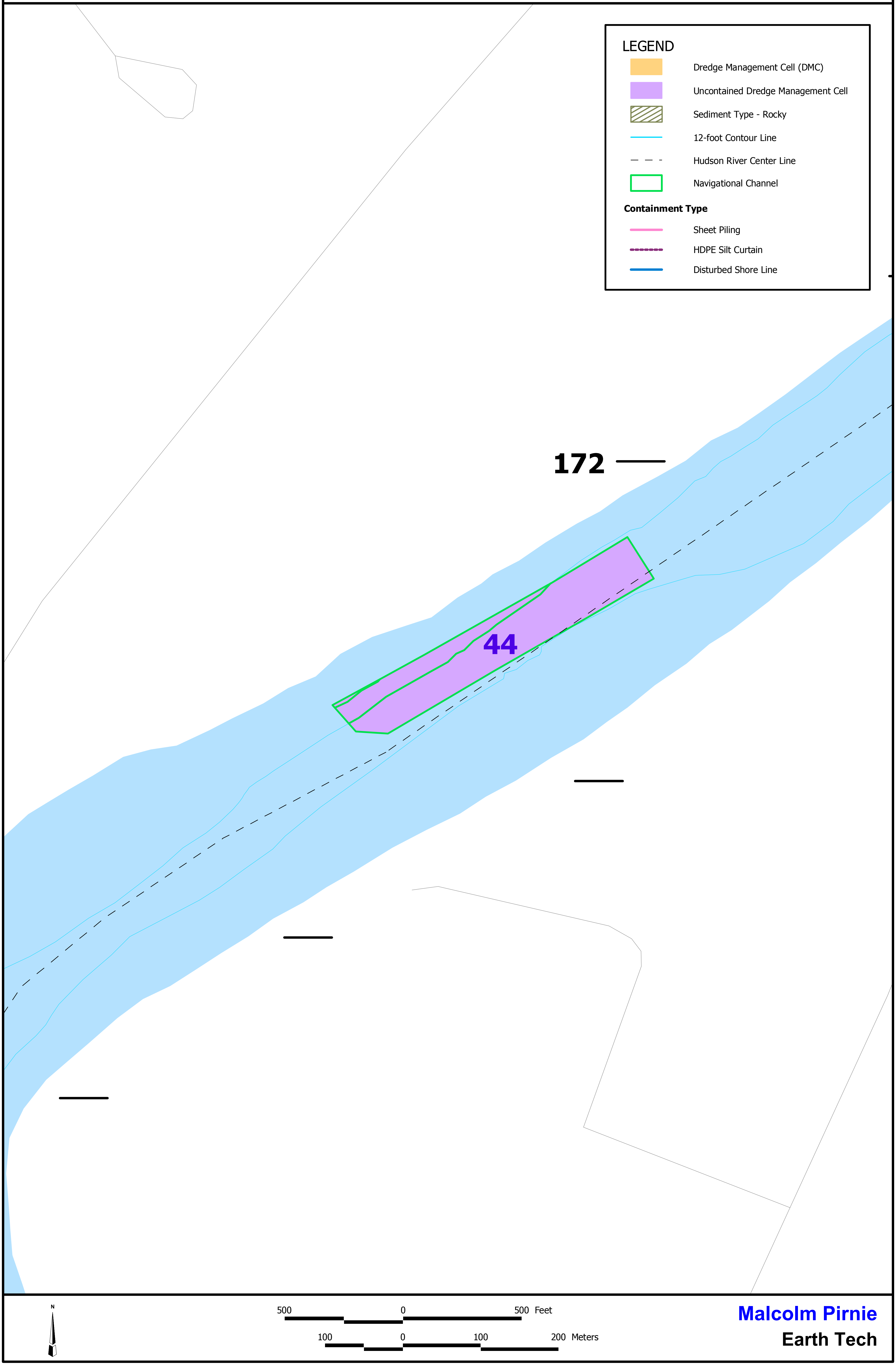
Containment Types - RM 174.75 - 175.75



Malcolm Pirnie

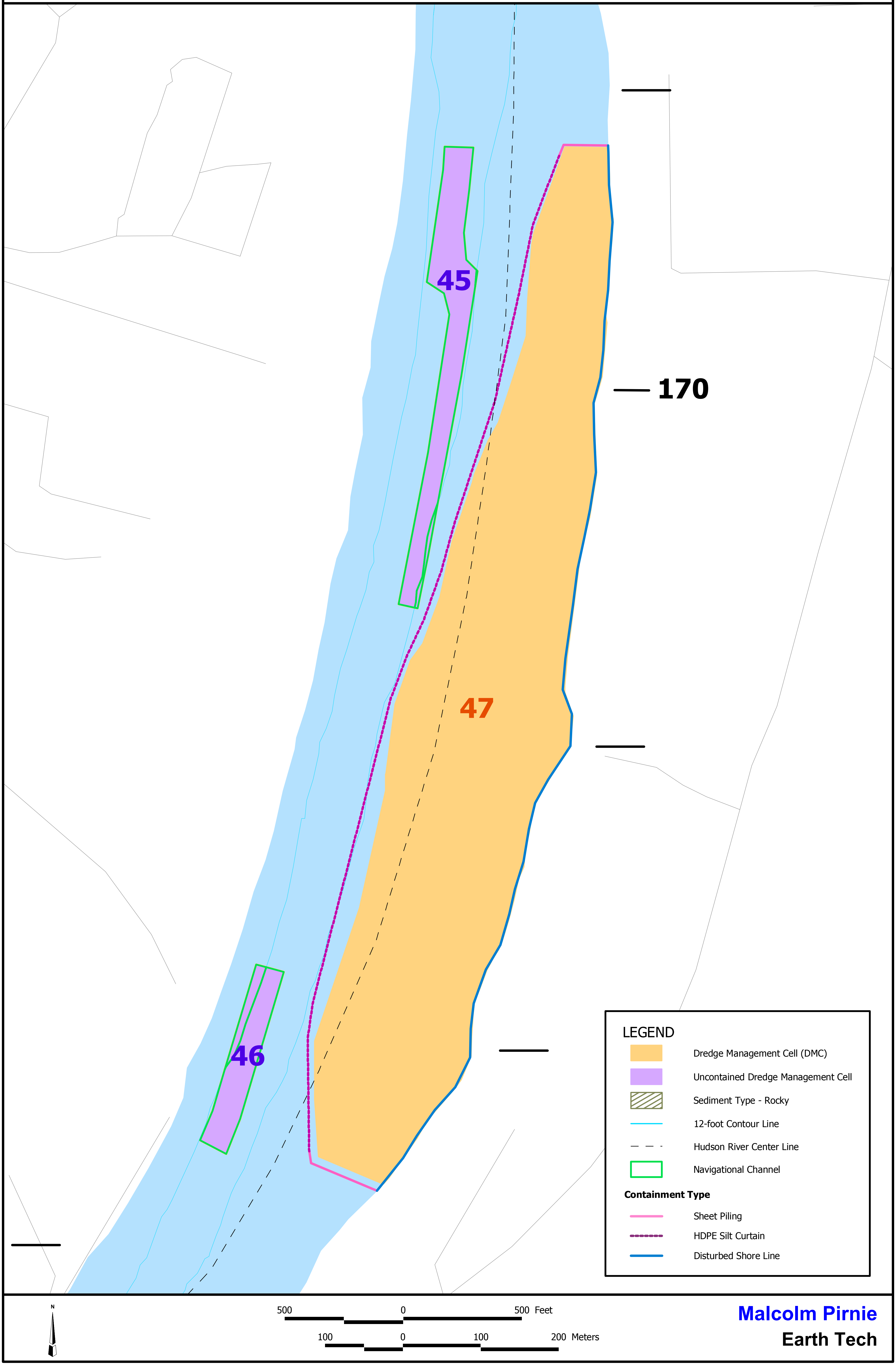
Earth Tech

Containment Types - RM 171.25 - 172.25



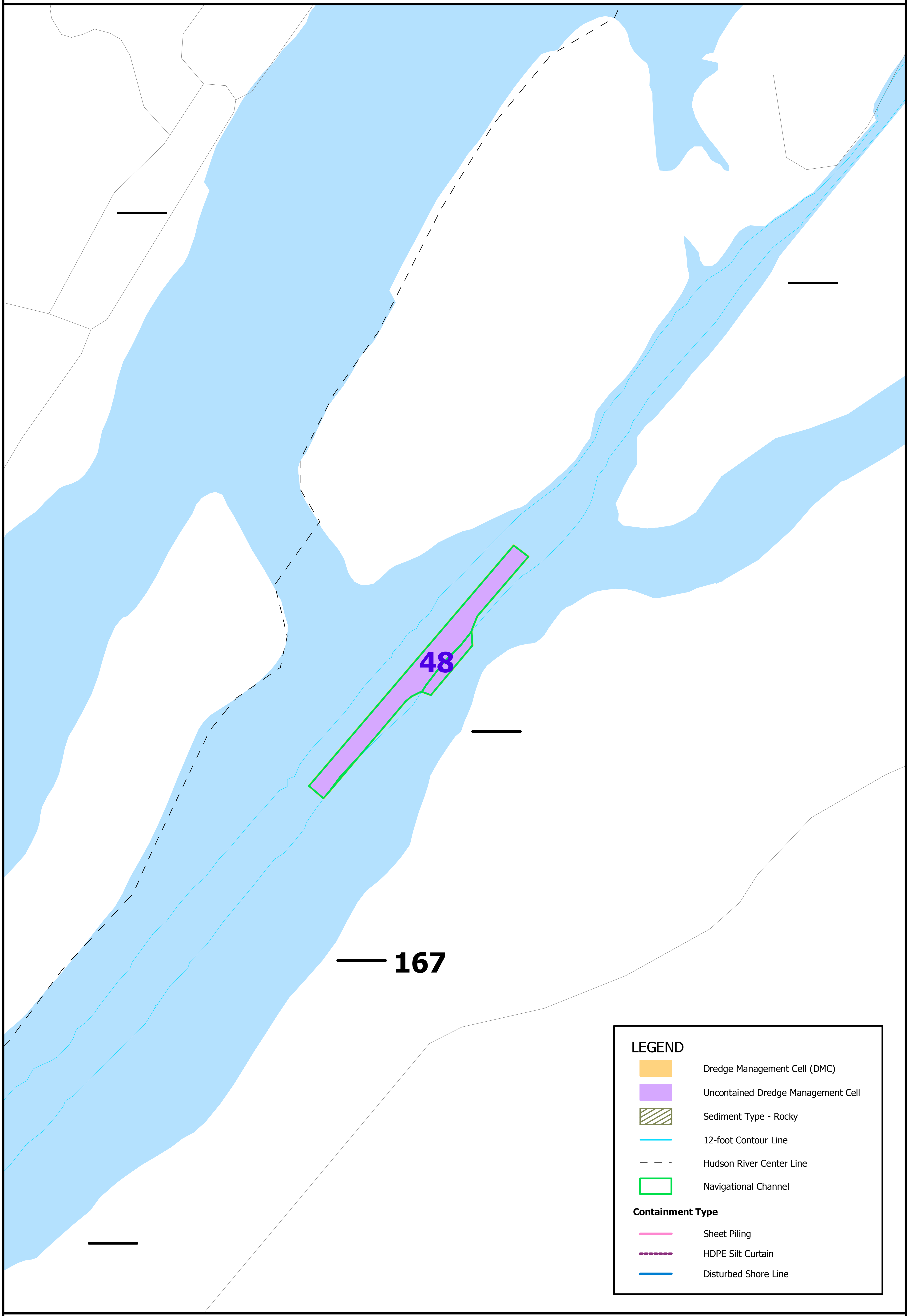
Malcolm Pirnie
Earth Tech

Containment Types - RM 169.25 - 170.25



Malcolm Pirnie
Earth Tech

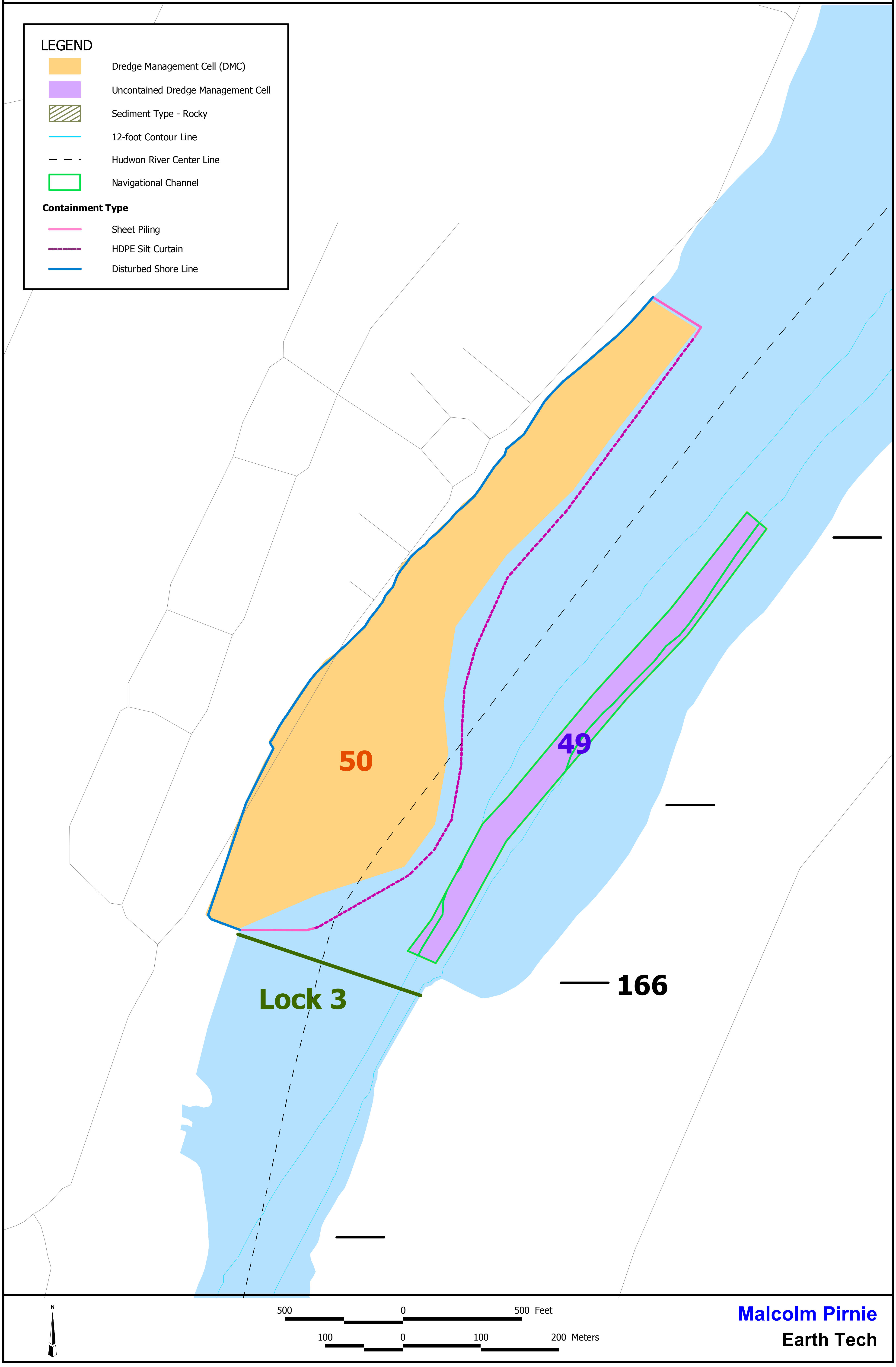
Containment Types - RM 166.75 - 167.75



Malcolm Pirnie

Earth Tech

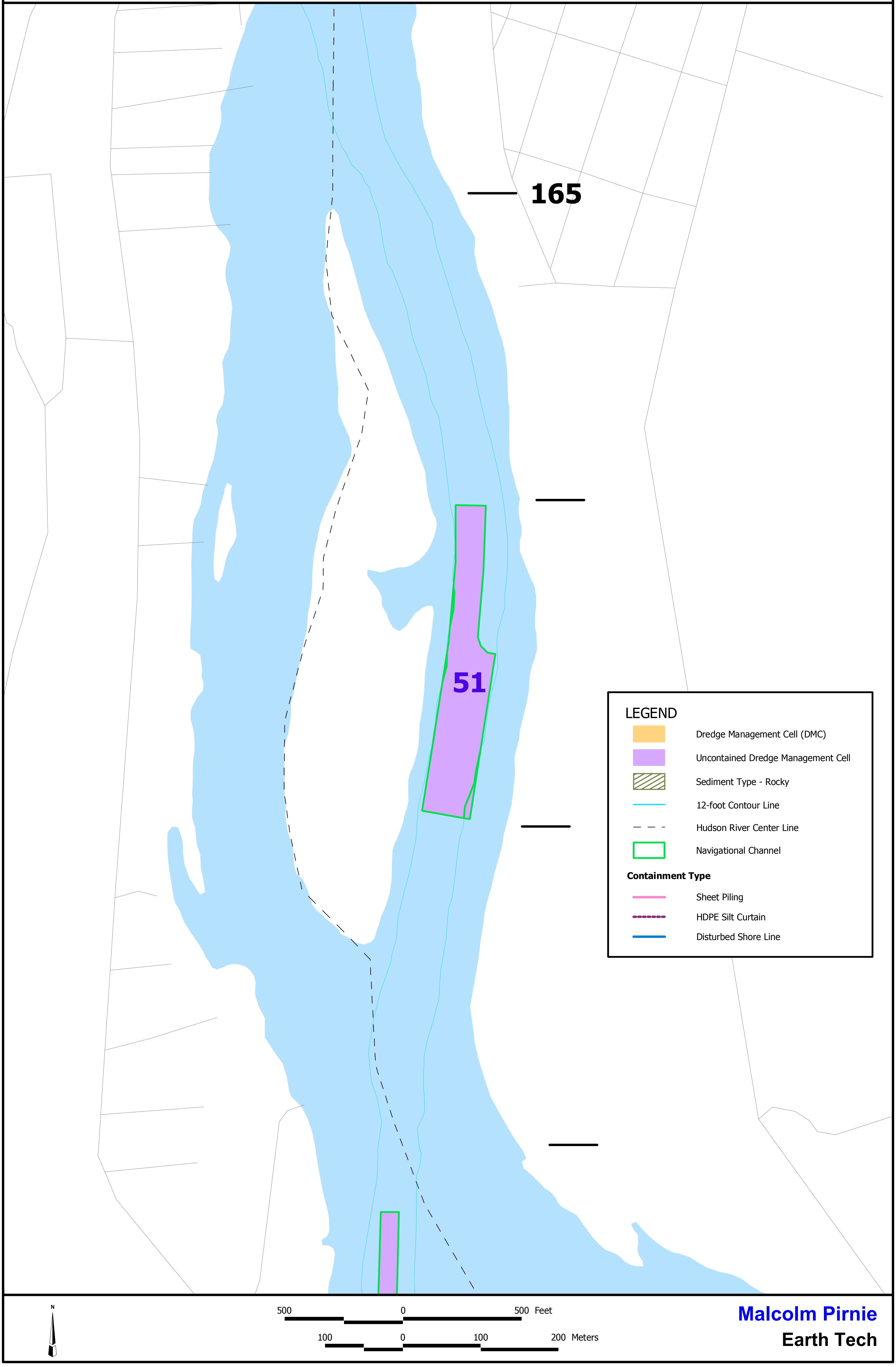
Containment Types - RM 165.75 - 166.75



Malcolm Pirnie

Earth Tech

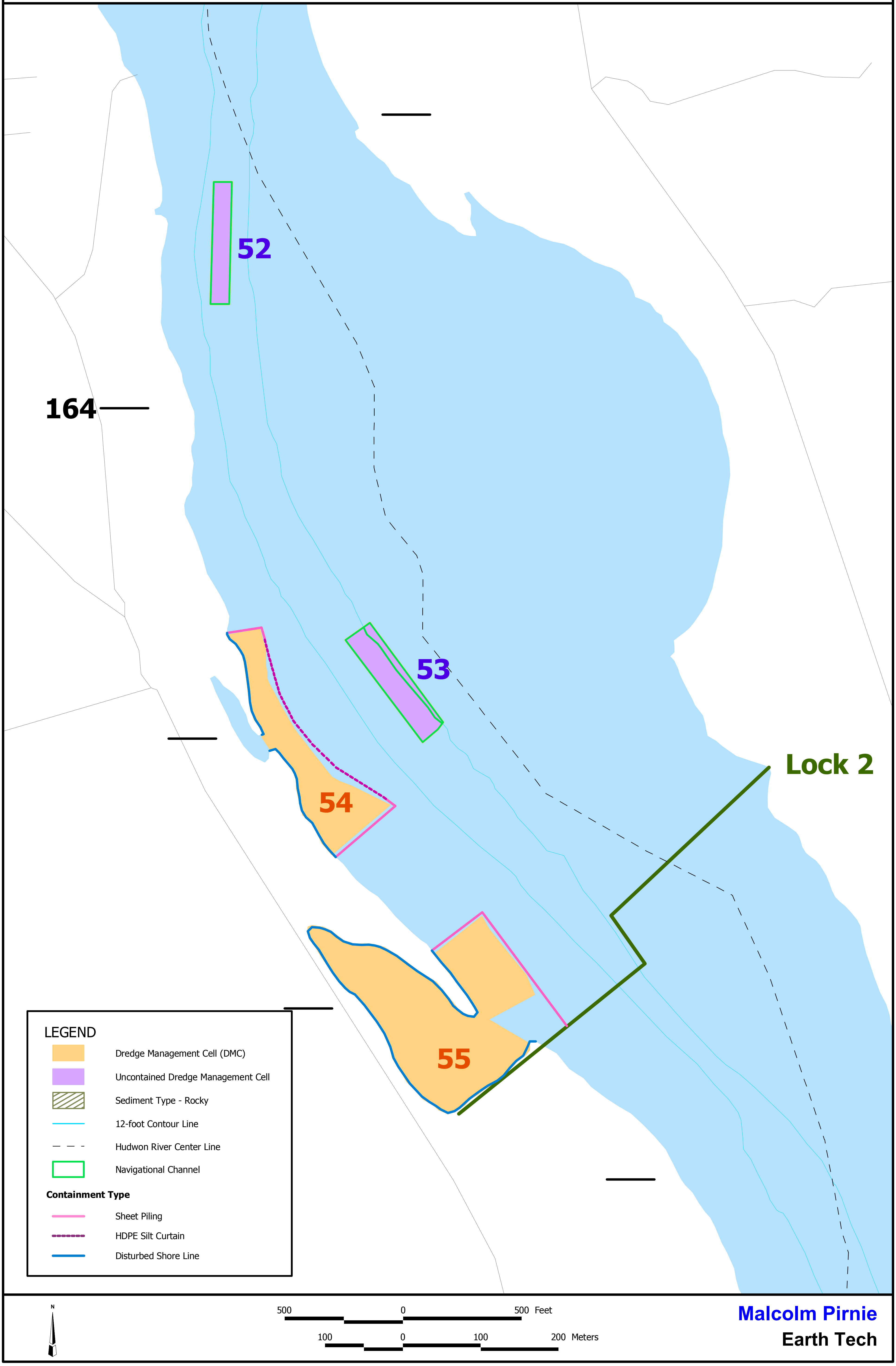
Containment Types - RM 164.25 - 165.25



Malcolm Pirnie

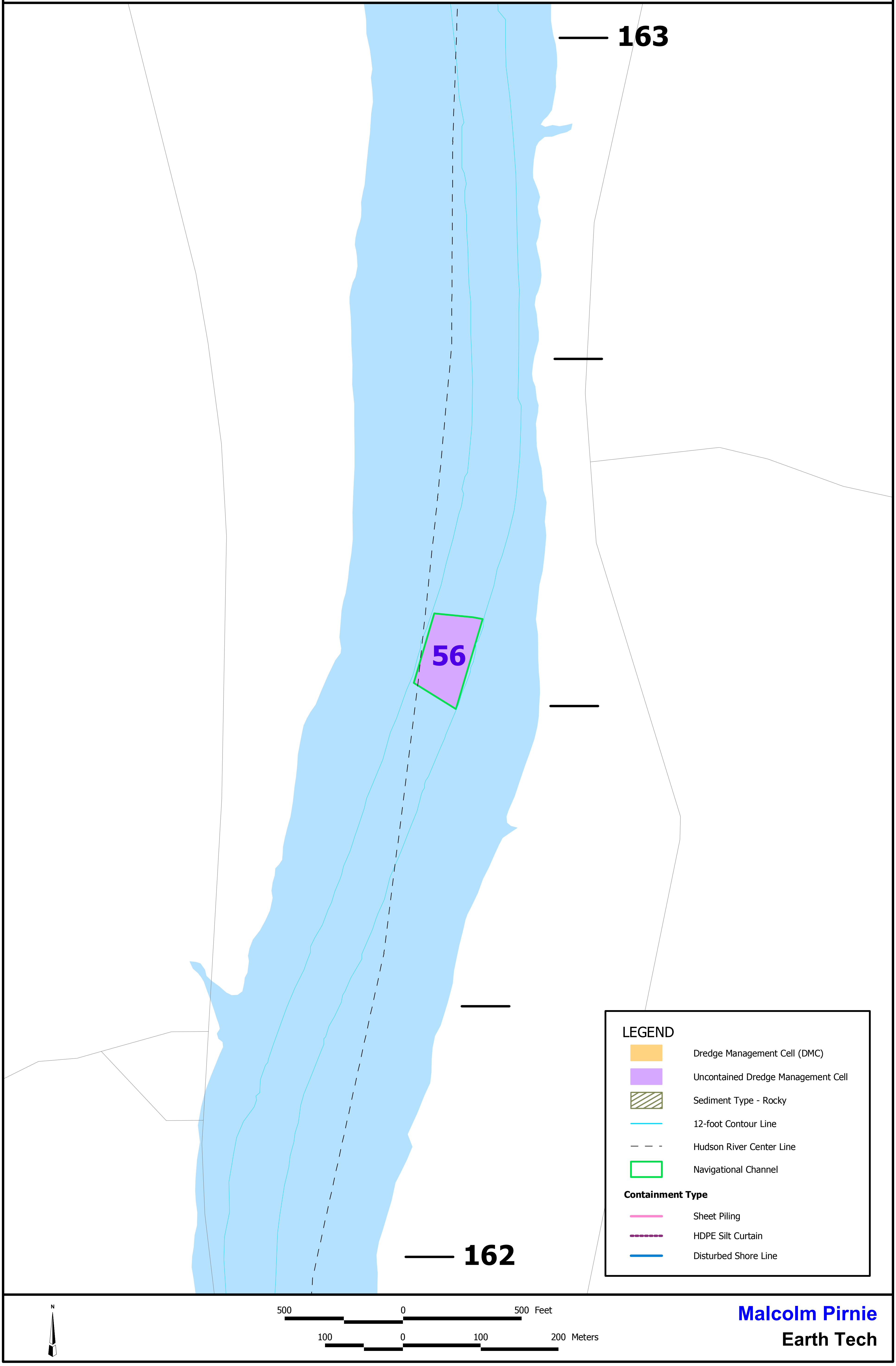
Earth Tech

Containment Types - RM 163.25 - 164.25



Malcolm Pirnie
Earth Tech

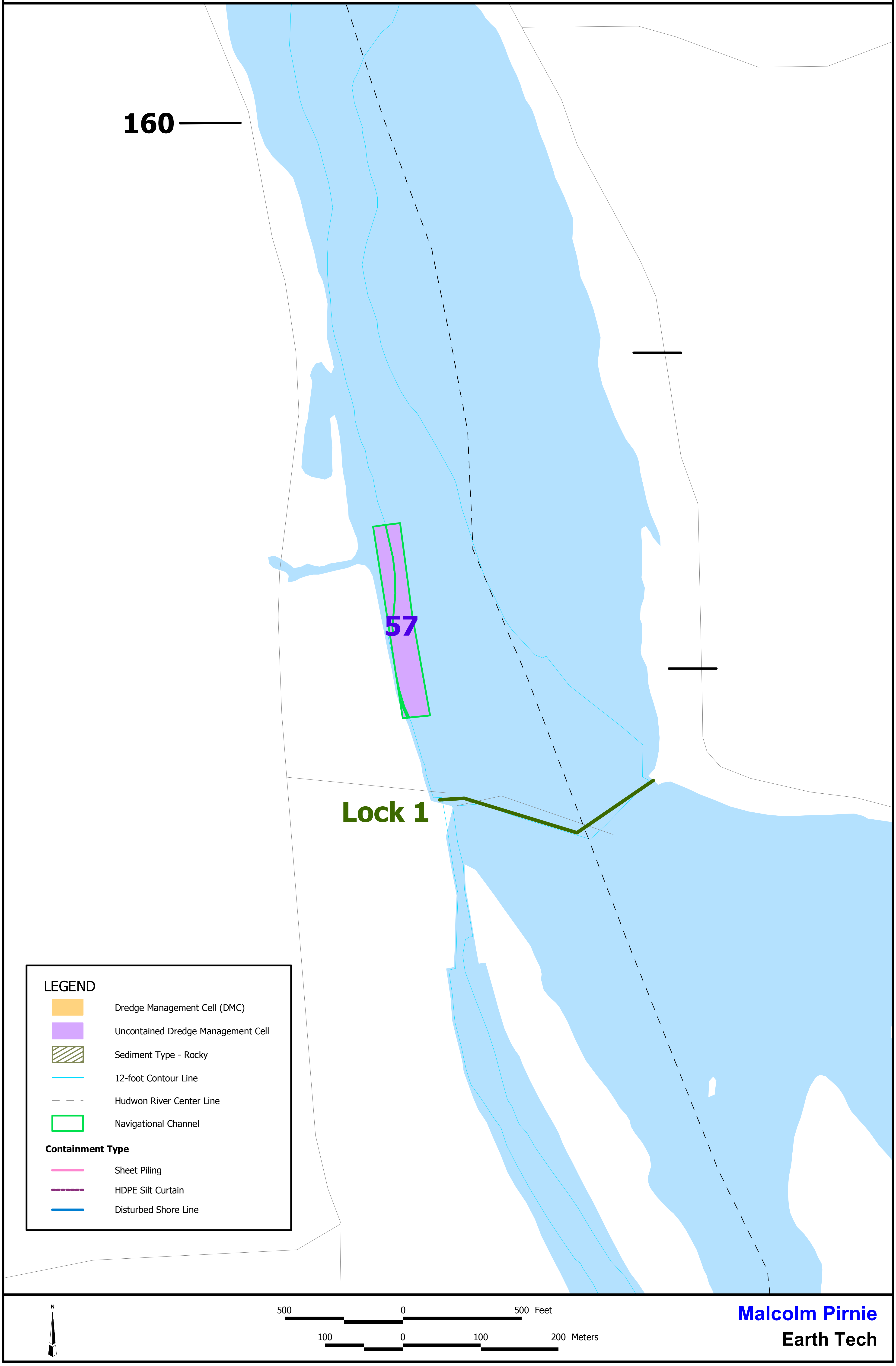
Containment Types - RM 162 - 163



Malcolm Pirnie

Earth Tech

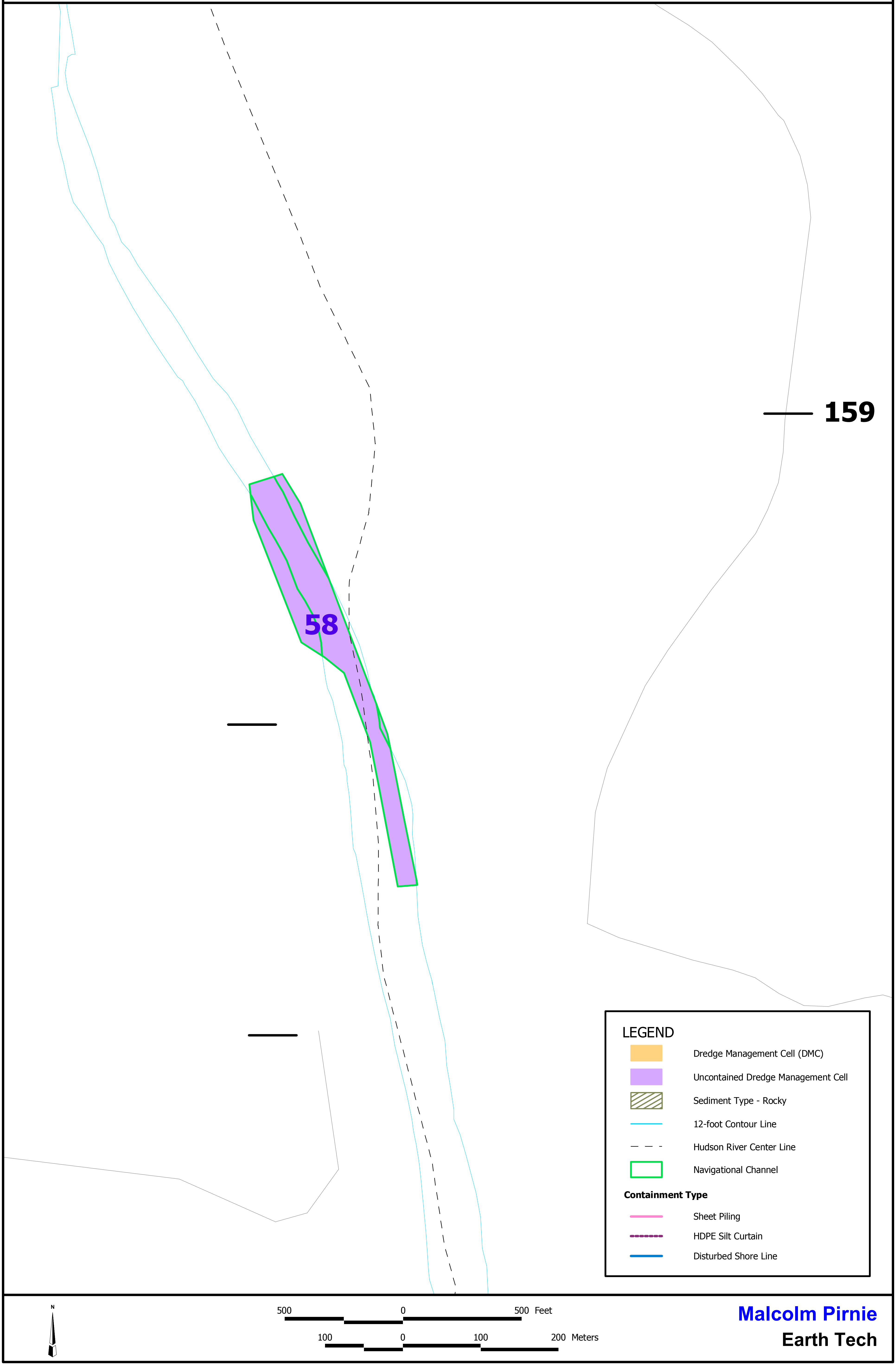
Containment Types - RM 159 - 160



Malcolm Pirnie

Earth Tech

Containment Types - RM 158.25 - 159.25



Malcolm Pirnie

Earth Tech

Attachment F
Evaluation of Applicable Dredge Equipment for the Upper Hudson River

1.0 Introduction

For the development of production standards, each target area to be dredged throughout the three river sections of the Hudson River was evaluated with regard to water depth, depth of cut, sediment texture (cohesive, non-cohesive, rocky), and need for shoreline dredging. Sediment characteristic quantities were then computed per one-mile river segments and were further divided based on their location with respect to the Hudson River centerline (east or west). Based on this evaluation, relevant dredging equipment was selected and evaluated. The analysis was conducted for two scenarios: one wherein it was assumed that mechanical dredging equipment would primarily be utilized and the second wherein it was assumed that hydraulic dredging equipment would be the principal technology utilized.

For each of the scenarios, it was determined that specialty equipment would be required to remove contaminated sediment in areas such as wetlands, backwaters, near rocks, and around islands because the principal technology could not access these areas. Work accomplished by specialty equipment including small, cleanup dredges, amphibious excavators, and similar equipment is expected to be at lower production rates than that accomplished by the primary dredging equipment. In order to accurately estimate removal times for the specialty equipment, an analysis was conducted to identify areas where such equipment would operate and the associated volume of contaminated sediment that would be removed.

Within each river section, the targeted areas were divided into one-mile segments. For each one-mile segment, the total volume of sediment and the volume per sediment characteristic were computed (volume cohesive and volume non-cohesive). In addition, the volume of sediment requiring removal to depths less than three feet and to depths greater than three and half feet were quantified. Figure F-1 illustrates the targeted areas in terms of characteristics important to dredging operations. Tables F-1A and F-1B present this information per one-mile segment.

2.0 Equipment and Analysis

2.1 Mechanical Equipment

For mechanical dredging equipment, it was assumed that a hydraulic excavator mounted on a floating platform would be capable of working from the channel shoreward to the 6-ft post-dredge bathymetric contour plus 30 ft, which represents the working reach of the mechanical dredge in shallow water. The 6-ft post-dredge contour was selected as the physical limit of removal for the mechanical dredge due to draft requirements of the associated hopper barges. The draft of barges loaded with 1,000 tons of material is approximately 6 feet.

Based on these parameters, the 6-foot post-dredge bathymetric contour was identified. This line was then off set 30 feet in the direction of the shoreline. Shoreward of this line, alternative dredges or specialty excavating equipment would be needed to complete the work. If the 6-foot post-dredge bathymetric contour plus 30 feet fell beyond the Upper Hudson River shoreline, it was concluded that dredging could be completed with the principal mechanical dredge. Following identification of the working limits of the specialty equipment, associated volumes and areas were computed using Arc View GIS. Figure F-2 presents these areas and Table F-2 presents the associated quantities.

2.2 Hydraulic Dredge Equipment and Analysis

For the second scenario wherein hydraulic dredging equipment will be used as the main type of dredge, it was assumed that the draft of the selected cutter head dredge would be three feet. The analysis was carried out assuming that the dredge could operate from the channel shoreward to the 3-ft post-dredge contour. This boundary condition was established for each target area. Specialty areas were then identified as areas where the main hydraulic dredge is not expected to function. After identification of the boundaries of work for the specialty equipment, the associated volumes and areas were computed using Arc View GIS. Figure F-3 presents these areas and Table F-3 presents the associated quantities.

3.0 Evaluation

For the two scenarios presented above, it was possible to compute the time to dredge sediment contained within each river mile section. Using the production rates developed for the principal mechanical and hydraulic dredges, as well as the specialty equipment, it was possible to initiate the process of estimating overall removal time.

Table F-1A
Existing Sediment Characteristics per Water Depth

River Section by One Mile Increments	Location [1]	Total Volume	Water Depth								
			Less than 3ft water			3ft - 6ft Water			>6ft water		
			%NC	%C	Total (cy)	%NC	%C	Total (cy)	%NC	%C	Total (cy)
River Section 1- Thompson Island Pool [2]											
193.75-194.5	Rogers Island (both east and west dredge areas)	83,724.52	100%	0%	12,022.33	100%	0%	7,338.74	89%	11%	64,363.44
193.5-194	West	228,797.00	83%	83%	114,457.19	43%	57%	48,943.70	6%	94%	65,396.11
192.5-193.5	West	59,432.22	74%	26%	38,830.26	65%	35%	9,136.37	92%	8%	11,465.59
192.5-193.5	East	225,035.41	44%	56%	101,971.44	95%	5%	36,470.78	86%	14%	86,593.19
191.5-192.5	West	137,154.11	49%	51%	92,347.81	45%	55%	16,418.81	85%	15%	28,387.48
191.5-192.5	East	142,861.15	29%	71%	15,357.30	45%	55%	8,845.15	76%	24%	118,658.70
190.5-191.5	West	196,162.00	77%	23%	27,832.19	53%	47%	4,940.00	3%	97%	163,389.81
190.5-191.5	East	164,418.22	5%	95%	19,815.15	4%	96%	11,421.30	26%	74%	133,181.78
189.5-190.5	West	69,317.15	82%	18%	19,352.44	83%	17%	11,589.30	97%	3%	38,375.41
189.5-190.5	East	139,039.37	19%	81%	47,228.26	38%	62%	21,314.37	36%	64%	70,496.74
188.5-189.5	East	139,039.37	19%	81%	47,228.26	38%	62%	21,314.37	36%	64%	70,496.74
188.5-189.5	West	69,317.15	82%	18%	19,352.44	83%	17%	11,589.30	97%	3%	38,375.41

Table F-1A
Existing Sediment Characteristics per Water Depth

River Section by One Mile Increments	Location [1]	Total Volume	Water Depth								
			Less than 3ft water			3ft - 6ft Water			>6ft water		
			%NC	%C	Total (cy)	%NC	%C	Total (cy)	%NC	%C	Total (cy)
River Section 2- Thompson Island Dam to Lock 5 [2]											
188.25-187.25	Land Locked Section: One Dredge Areas (on west side Thompson Island HS 22)	12,550.22	3%	97%	2,164.44	0%	100%	1,177.00	0%	100%	9,208.78
187.25-186.25	Land Locked Section: Two dredge areas (HS 25 and HS 26) [1]	41,544.67	32%	68%	12,321.67	11%	89%	11,106.00	9%	91%	18,117.00
186.25-185.25	East (HS 28) [2]	228,252.26	13%	87%	70,909.63	10%	90%	53,562.07	25%	75%	103,780.56
185.25-184.25	East (HS 31)	29,875.26	0%	100%	8,087.11	0%	100%	5,354.81	0%	100%	16,433.33
184.25-183.25	West (HS 34)	72,249.56	4%	96%	21,585.74	19%	81%	12,129.96	21%	79%	38,533.85
184.25-183.25	East (HS 33 and HS 35)	107,500.90	0%	100%	26,466.37	79%	21%	71,558.67	80%	20%	9,475.87

Table F-1A
Existing Sediment Characteristics per Water Depth

River Section by One Mile Increments	Location (1)	Total Volume	Water Depth								
			Less than 3ft water			3ft - 6ft Water			>6ft water		
			%NC	%C	Total (cy)	%NC	%C	Total (cy)	%NC	%C	Total (cy)

River Section 3- Lock 5 to the Federal Dam at Troy, NY (2)

River Section by One Mile Increments	Location	Total Volume	Water Depth (3)					
			Less Than 6ft Water			Greater Than 6ft water		
			%NC	%C	Total (cy)	%NC	%C	Total (cy)
170.25-169.25	East (HS 36)	128,536.6	1%	99%	125,778.78	98%	2%	2,757.85
166.75-165.75	West (HS 37)	120,868.6	46%	54%	65,584.56	0%	0%	0.00
164.25-163.25	West (HS 39 and at Lock 2)	65,019.37	96%	4%	65,019.37	0%	0%	0.00

HS = Hot Spot
%NC = % non-cohesive
%C = % cohesive

Notes:
(1) The Location (East and West) is relative to the Hudson River Centerline
(2) These volumes do not include the estimated total 198,800 cy of required navigational dredging
(3) Only the 6 foot and 12 foot bathymetry data exist for River Section 3 currently

Table F-1B
Existing Sediment Characteristics per Targeted Sediment Removal Depth

River Section by One Mile Increments	Location (1)	Total Volume	Sediment Removal Depth: 3 ft and Less %NC	%C	Total (cy)	3.5 ft and Greater %NC	%C	Total (cy)
River Section 1- Thompson Island Pool (2)								
193.75-194.5	Rogers Island (both east and west)	76,768.41	100%	0%	69,078.96	100%	0%	7,689.44
193.5-194	West	13,002.74	100%	0%	1.89	100%	0%	13,000.85
192.5-193.5	West	228,796.96	73%	27%	145,688.30	16%	84%	83,108.67
192.5-193.5	East	83,724.48	92%	8%	83,724.48	0%	0%	0
191.5-192.5	West	59,432.19	68%	32%	43,745.15	100%	0%	15,687.04
191.5-192.5	East	225,035.33	68%	32%	112,499.85	69%	31%	112,535.48
190.5-191.5	West	137,154.11	81%	19%	38,794.81	46%	54%	98,359.30
190.5-191.5	East	142,861.11	81%	19%	106,062.59	34%	66%	36,798.52
189.5-190.5	West	196,161.96	21%	79%	128,573.11	2%	98%	67,588.85
189.5-190.5	East	164,418.22	41%	59%	56,055.70	12%	88%	108,362.52
188.5-189.5	East	139,039.33	40%	60%	27,858.37	29%	71%	111,180.96
188.5-189.5	West	69,317.11	100%	0%	43,003.11	75%	25%	26,314.00

Table F-1B
Existing Sediment Characteristics per Targeted Sediment Removal Depth

River Section by One Mile Increments	Location [1]	Total Volume	Sediment Removal Depth: 3 ft and Less %NC	3 ft and Less %C	3 ft and Less Total (cy)	3.5 ft and Greater %NC	3.5 ft and Greater %C	3.5 ft and Greater Total (cy)
River Section 2: Thompson Island Dam to Lock 5 [2]								
188.25-187.25	Land Locked Section: One Dredge Areas (on west side Thompson Island)	12,550.22	0%	100%	12,550.22	0	0	0.00
187.25-186.25	Land Locked Section: Two dredge areas (HS 25 and HS 26) [1]	41,544.67	17%	83%	41,544.67	0	0	0.00
186.25-185.25	East (HS 28) [2]	228,252.26	68%	32%	45,072.78	5%	95%	183,178.33
185.25-184.25	East (HS 31)	29,875.26	0%	0%	0.00	0%	100%	29,875.26
184.25-183.25	West (HS 34)	72,249.56	0%	100%	10,249.00	18%	82%	62,000.52
184.25-183.25	East (HS 33 and HS 35)	107,500.90	42%	58%	136,043.63	38%	62%	18,832.74
River Section 3: Lock 5 to the Federal Dam at Troy, NY [2]								
170.25-169.25	East (HS 36)	128,536.63	1%	99%	125,778.78	0	0	0.00
166.75-165.75	West (HS 37)	120,868.67	46%	54%	120,868.67	0	0	0.00
164.25-163.25	West (HS 39 and at Lock 2)	65,019.37	67%	33%	48,483.37	100%	0%	16,536.00

HS = Hot Spot
%NC = % non-cohesive
%C = % cohesive

Notes:
(1) The Location (East and West) is relative to the Hudson River Centerline
(2) These volumes do not include the estimated total 198,800 cy of required navigational dredging

Table F-2
Mechanical Dredging Scenario:
Equipment-Specific Removal Volumes and Areas

River Section 1: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume Removed for Location (cy)
Around Rogers Island	64,517.44	13.53	12,743.09	2.97	77,260.53
RM 193.5 - 193.75	13,192.98	1.82	0.00	0.00	13,192.98
RM 192.5 - 193.5 E	121,403.00	28.07	1,580.95	0.35	122,983.95
RM 192.5 - 193.5 W	172,856.10	30.21	26,380.83	4.67	199,236.93
RM 191.5 - 192.5 E	164,834.90	27.81	65,057.10	11.86	229,892.00
RM 191.5 - 192.5 W	59,965.87	11.21	3,132.49	0.61	63,098.36
RM 190.5 - 191.5 E	107,927.00	21.44	2,206.59	0.45	110,133.59
RM 190.5 - 191.5 W	168,941.80	30.28	3,600.13	0.58	172,541.93
RM 189.5 - 190.5 E	144,987.70	22.33	4,143.31	0.86	149,131.01
RM 189.5 - 190.5 W	58,936.41	12.80	154,743.00	26.85	213,679.41
RM 188.5 - 189.5 E	127,949.90	17.22	13,046.96	2.70	140,996.86
RM 188.5 - 189.5 W	63,010.23	11.93	7,079.06	1.47	70,089.29
Total Volume (cy)	1,268,523.33		293,713.51		1,562,236.84
Total Area (Acres)		228.64		53.35	281.99

River Section 2: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume Removed for Location (cy)
RM 183.25 - 184.25	172,709.00	27.13	15,693.08	3.23	188,402.08
RM 184.25 - 185.25	30,167.99	4.68	0.00	0.00	30,167.99
RM 185.25 - 186.25	223,977.30	28.49	5,927.93	1.23	229,905.23
RM 186.5 - 187.5	34,682.30	7.17	5,778.96	1.19	40,461.26
RM 187.5 - 188.5	12,936.08	2.67	90.14	0.02	13,026.22
Total Area (Acres)		70.14		5.67	
Total Volume (cy)			27,490.12		501,962.79

River Section 3: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume Removed for Location (cy)
RM 163.25 - 164.25	31,260.51	4.00	43,587.73	7.72	74,848.24
RM 165.75 - 166.75	50,648.43	10.24	94,317.22	19.18	144,965.65
RM 169.25 - 170.25	166,434.20	37.89	58,372.12	13.55	224,806.32
Total Area (Acres)		52.13		40.44	
Total Volume (cy)	248,343.14		196,277.07		
Navigational Channel (cy) and (Acres)	117,292.20	43.00			117,292.20
Total Removal for River Section 3 (cy)					561,912.41

Table F-3
Hydraulic Dredging Scenario:
Equipment-Specific Removal Volumes and Areas

River Section 1: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume for Location (cy)
Around Rogers Island	67,150.95	13.99	10,115.93	2.51	77,266.88
RM 193.5 - 193.75	13,192.98	1.82	0.00	0.00	13,192.98
RM 192.5 - 193.5 E	118,310.20	27.41	4,679.22	1.01	122,989.42
RM 192.5 - 193.5 W	193,510.90	33.70	5,730.93	1.18	199,241.83
RM 191.5 - 192.5 E	189,601.90	31.29	40,294.38	8.39	229,896.28
RM 191.5 - 192.5 W	60,895.43	11.33	2,203.45	0.50	63,098.88
RM 190.5 - 191.5 E	106,338.10	21.10	3,800.18	0.80	110,138.28
RM 190.5 - 191.5 W	170,323.00	30.31	2,236.49	0.55	172,559.49
RM 189.5 - 190.5 E	144,552.10	22.22	4,581.78	0.96	149,133.88
RM 189.5 - 190.5 W	126,704.00	21.60	86,957.64	18.05	213,661.64
RM 188.5 - 189.5 E	131,246.50	17.35	9,759.28	2.57	141,005.78
RM 188.5 - 189.5 W	66,252.33	12.57	3,837.05	0.83	70,089.38
Total Volume (cy)	1,388,078.39		174,196.32		
Total Area (Acres)		244.68		37.35	1,562,274.71

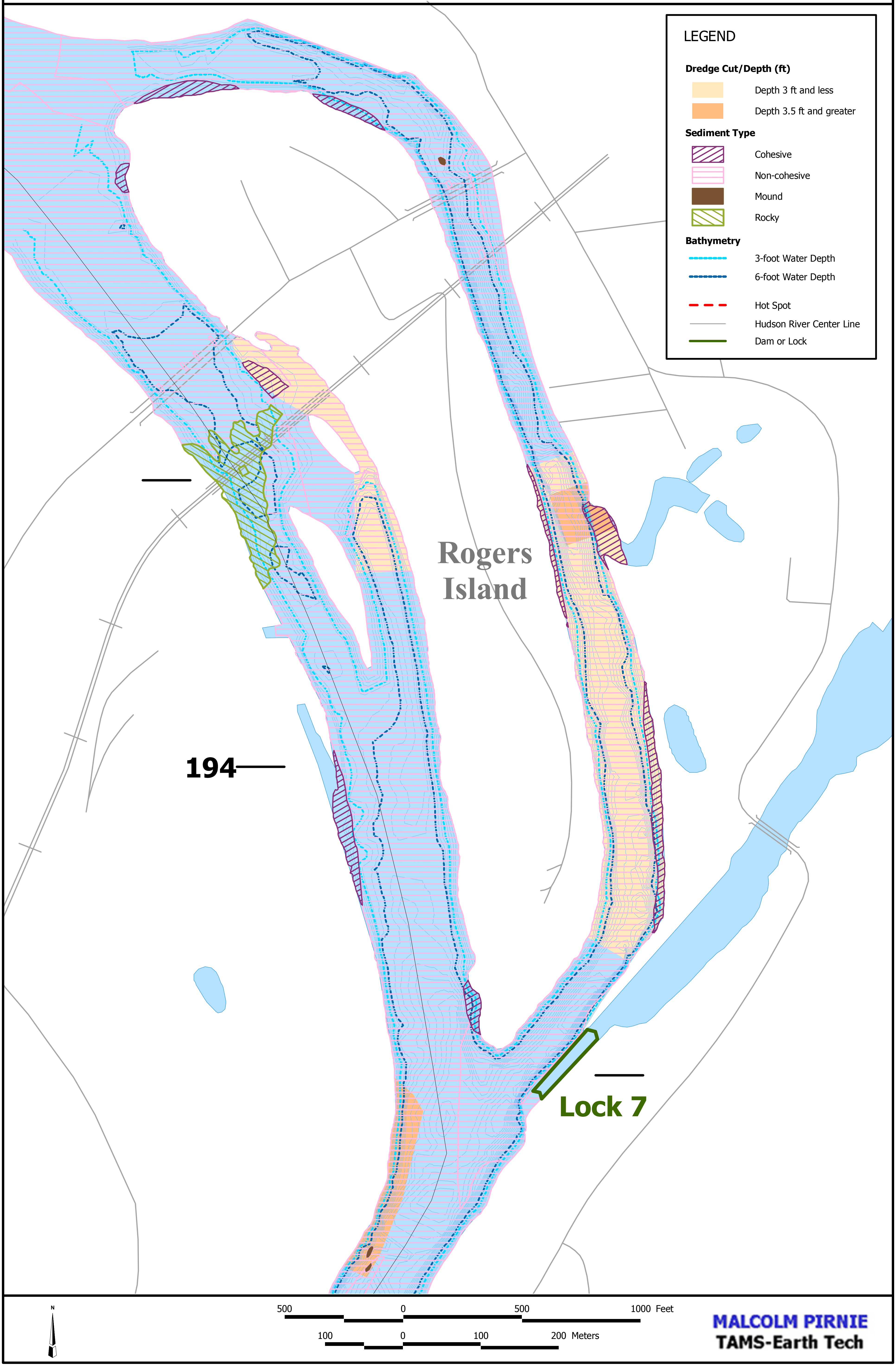
River Section 2: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume for Location (cy)
RM 183.25 - 184.25	178,410.00	28.30	9,994.13	2.06	188,404.13
RM 184.25 - 185.25	30,167.99	4.68	0.00	0.00	30,167.99
RM 185.25 - 186.25	223,341.20	28.36	6,563.33	1.36	229,904.53
RM 186.5 - 187.5	35,999.58	7.44	4,462.01	0.92	40,461.59
RM 187.5 - 188.5	12,122.95	2.50	904.06	0.19	13,027.01
Total Area (Acres)		71.28		4.53	
Total Volume (cy)	480,041.72		21,923.53		501,965.25

River Section 3: Location	Volume By Production Equipment (cy)	Area By Production Equipment (Acres)	Volume By Alternative Equipment (cy)	Area By Alternative Equipment (Acres)	Total Volume for Location (cy)
RM 163.25 - 164.25	74,850.63	11.73	0.00	0.00	74,850.63
RM 165.75 - 166.75	144,965.50	29.42	0.00	0.00	144,965.50
RM 169.25 - 170.25	224,806.20	51.44	0.00	0.00	224,806.20
Total Area (Acres)		92.59		0.00	
Total Volume (cy)	444,622.33		0.00		444,622.33
Navigational Channel (cy) and (acres)	117,292.20	43.00			117,292.20
Total Removal for River Section 3 (cy)					561,914.53

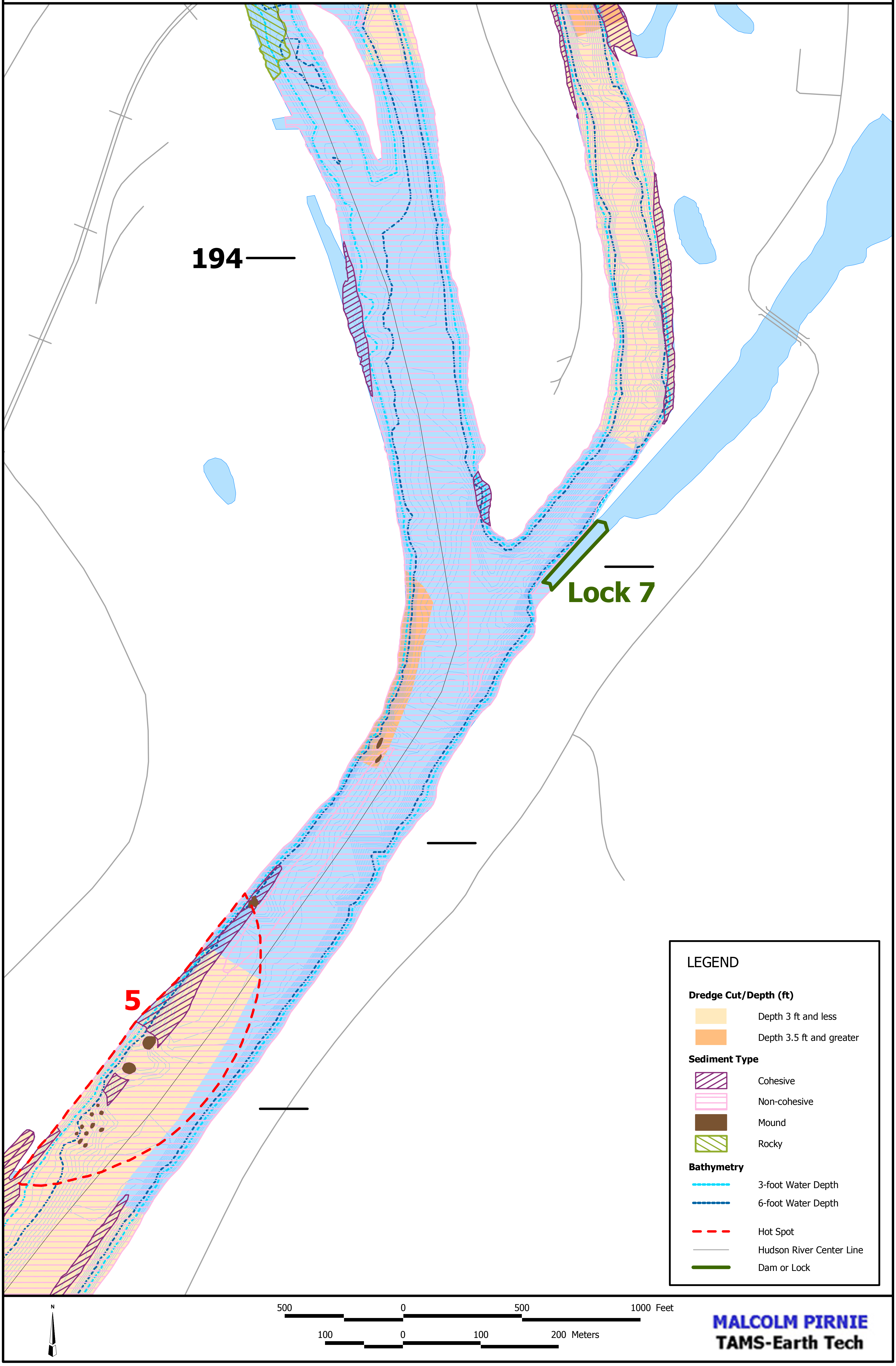
Figure F-1

Sediment Characteristics

Sediment Characteristics - RM 193.75 - 194.5



Sediment Characteristics - RM 193.5 - 193.75



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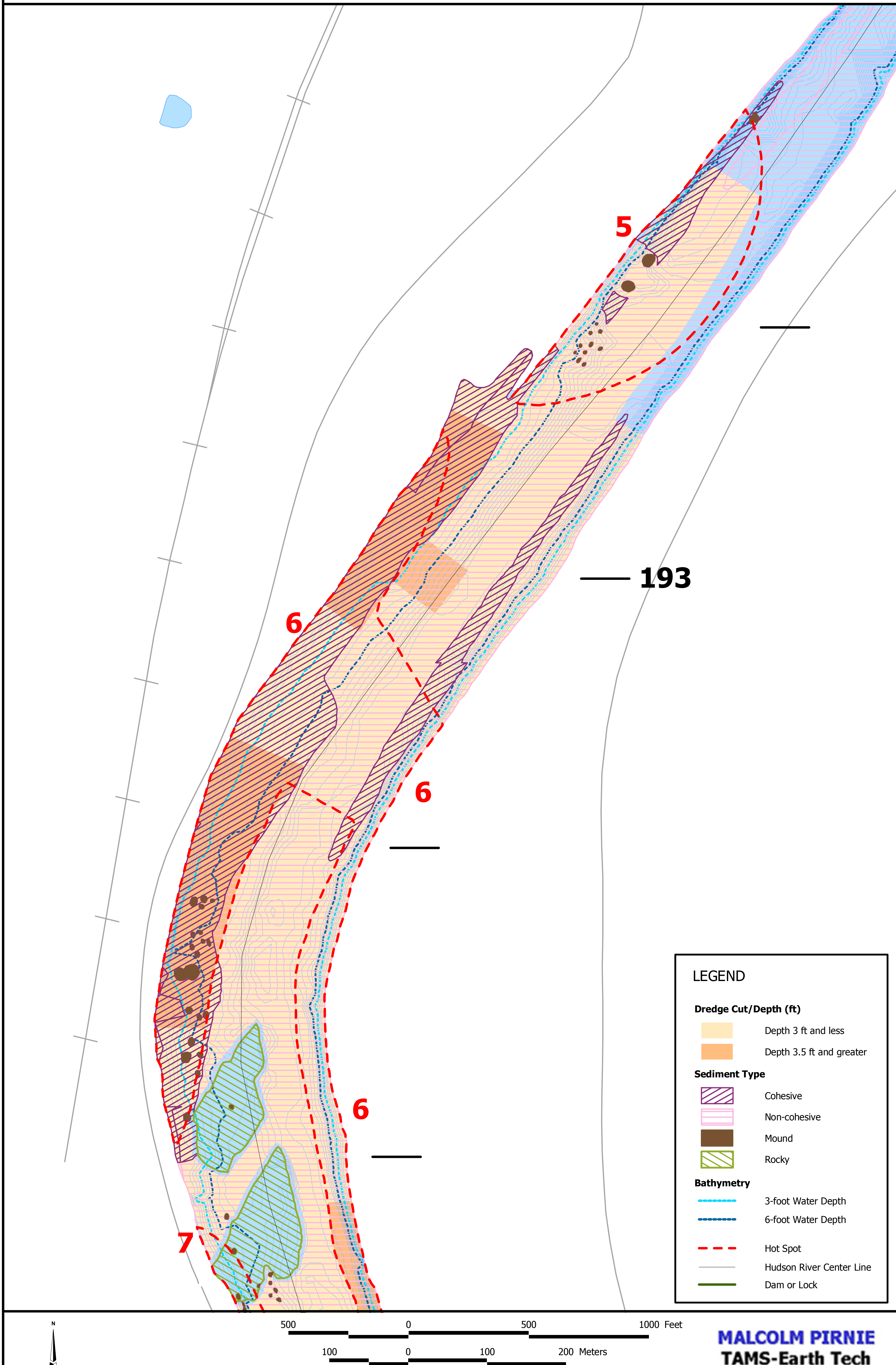

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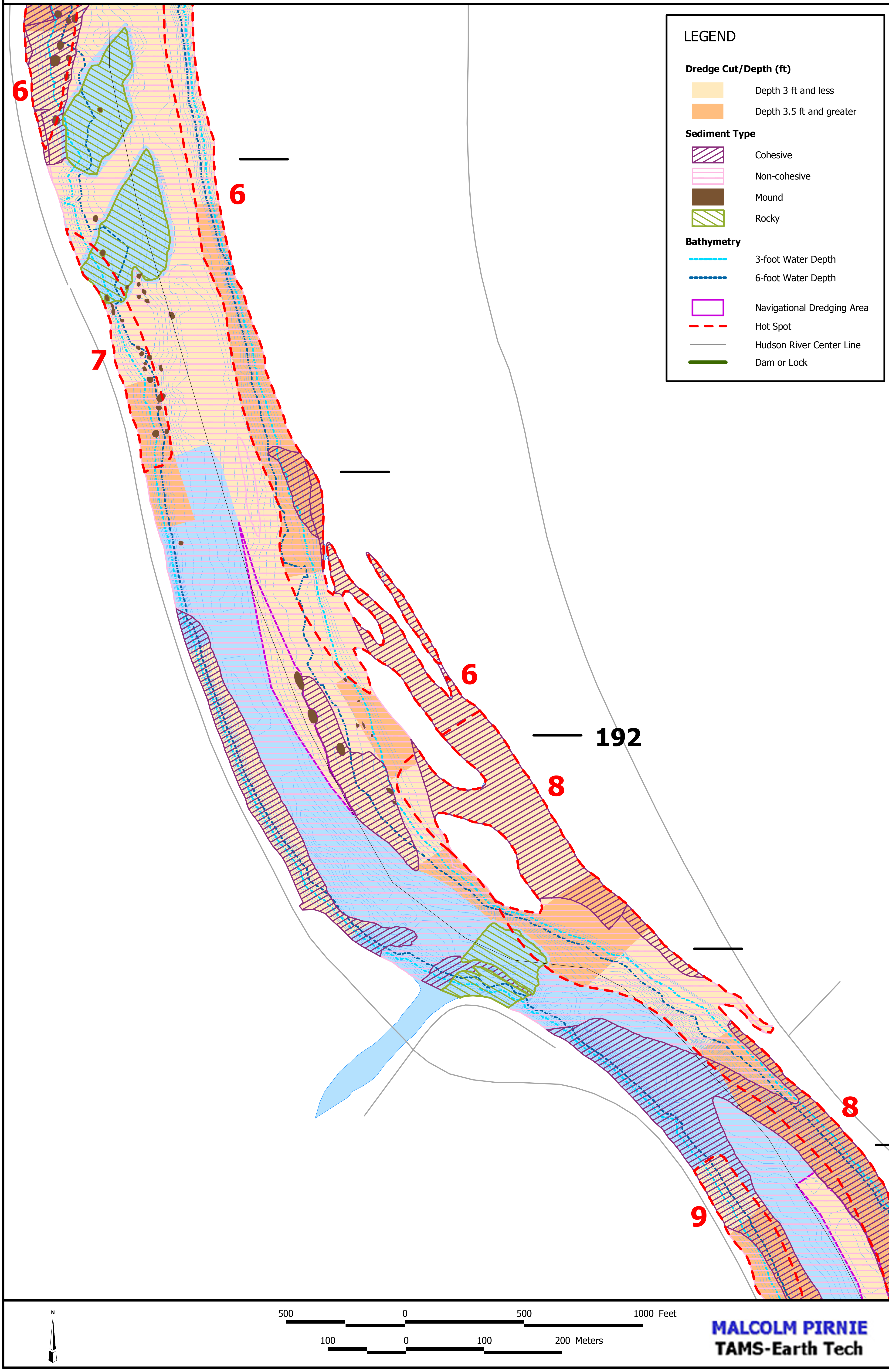
Sediment Characteristics - RM 191.5 - 192.5



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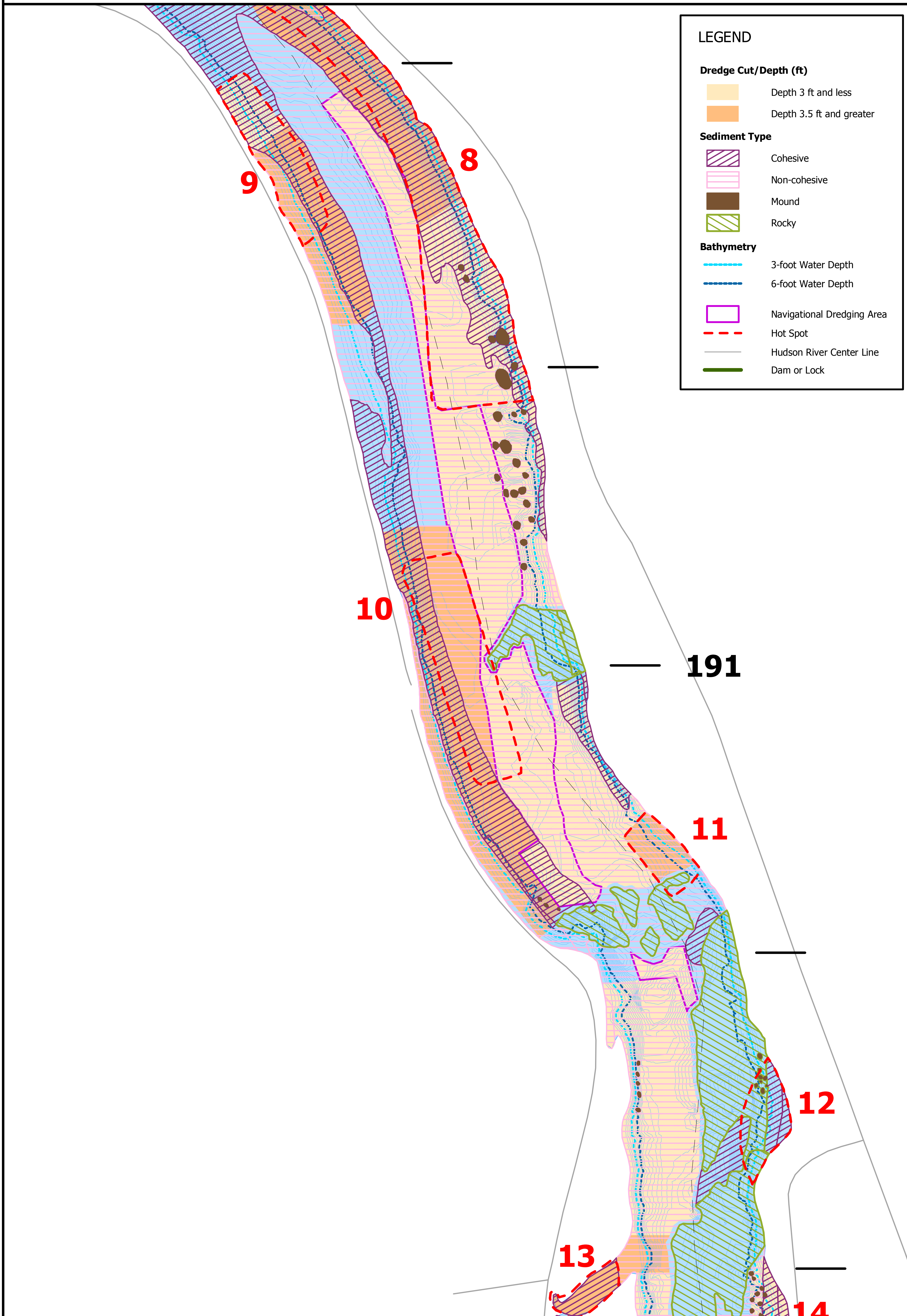

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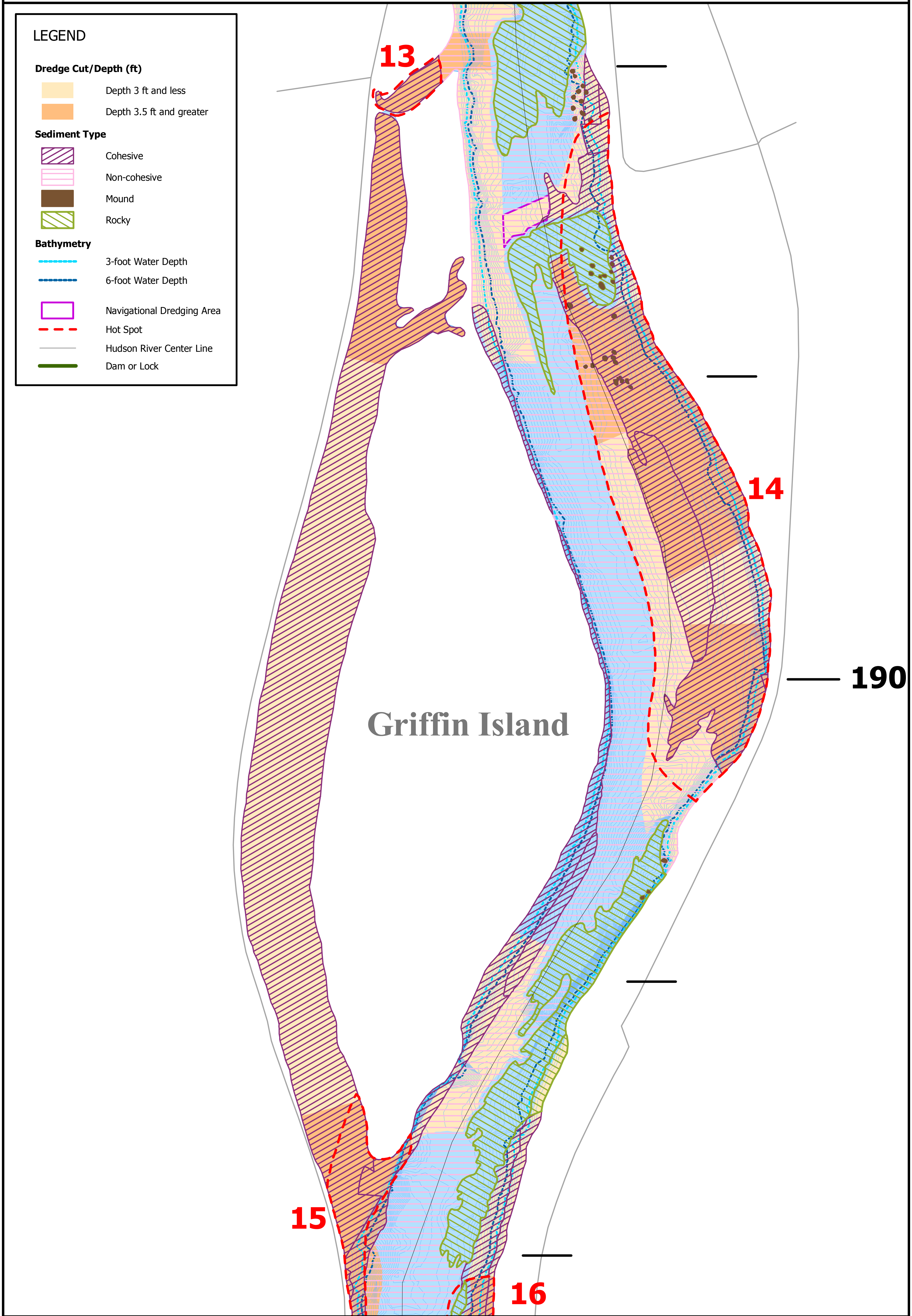

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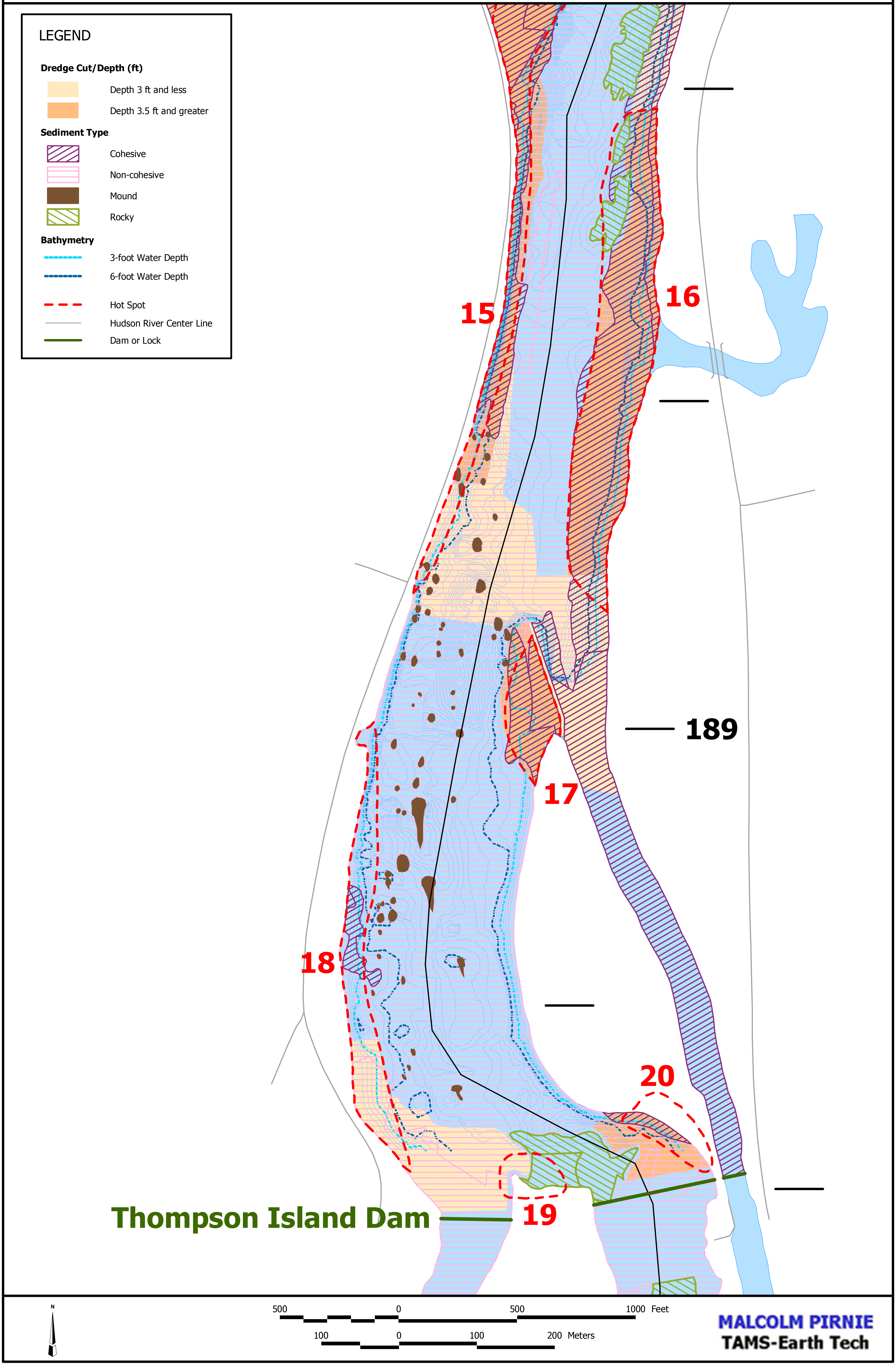

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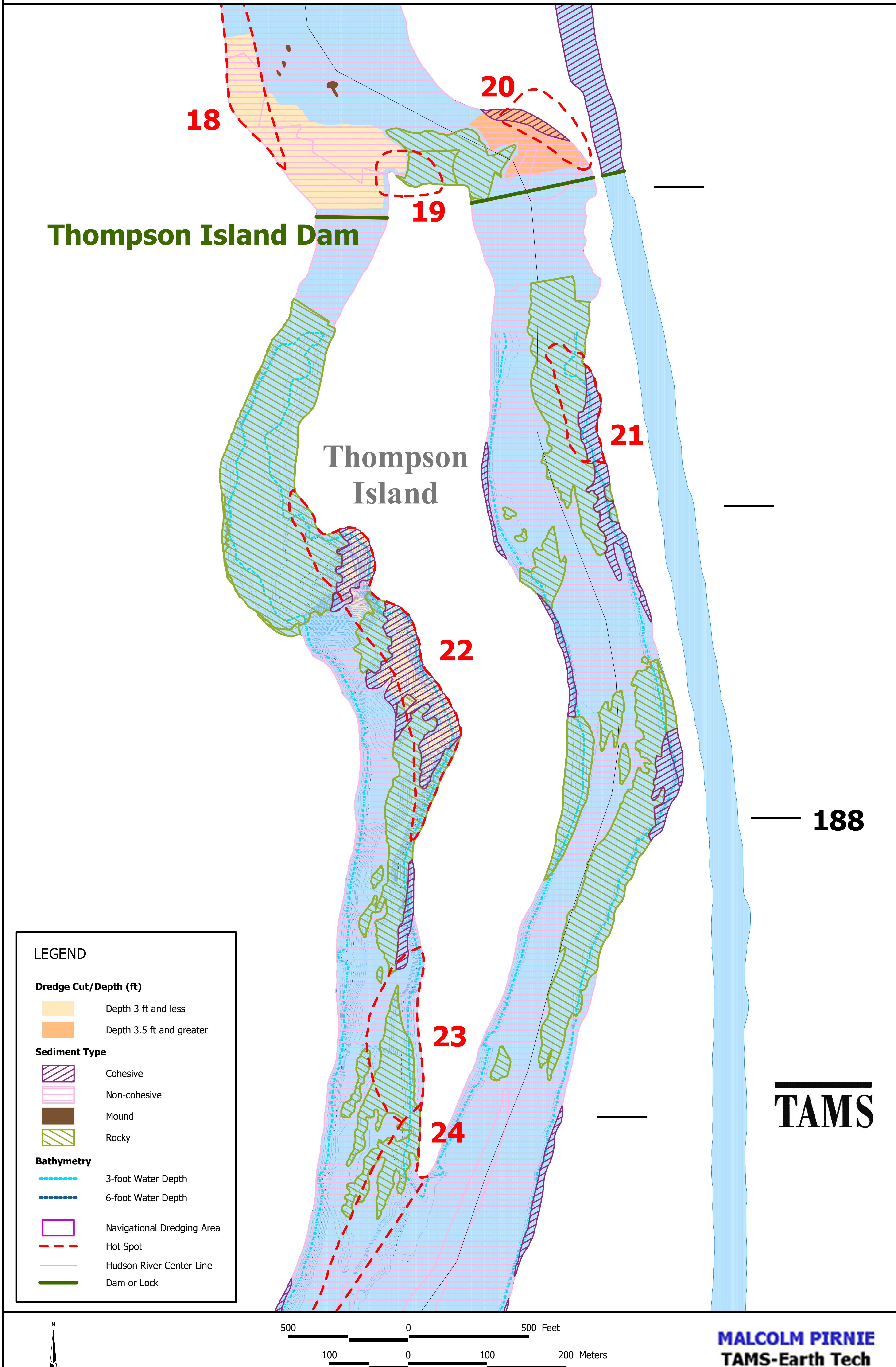
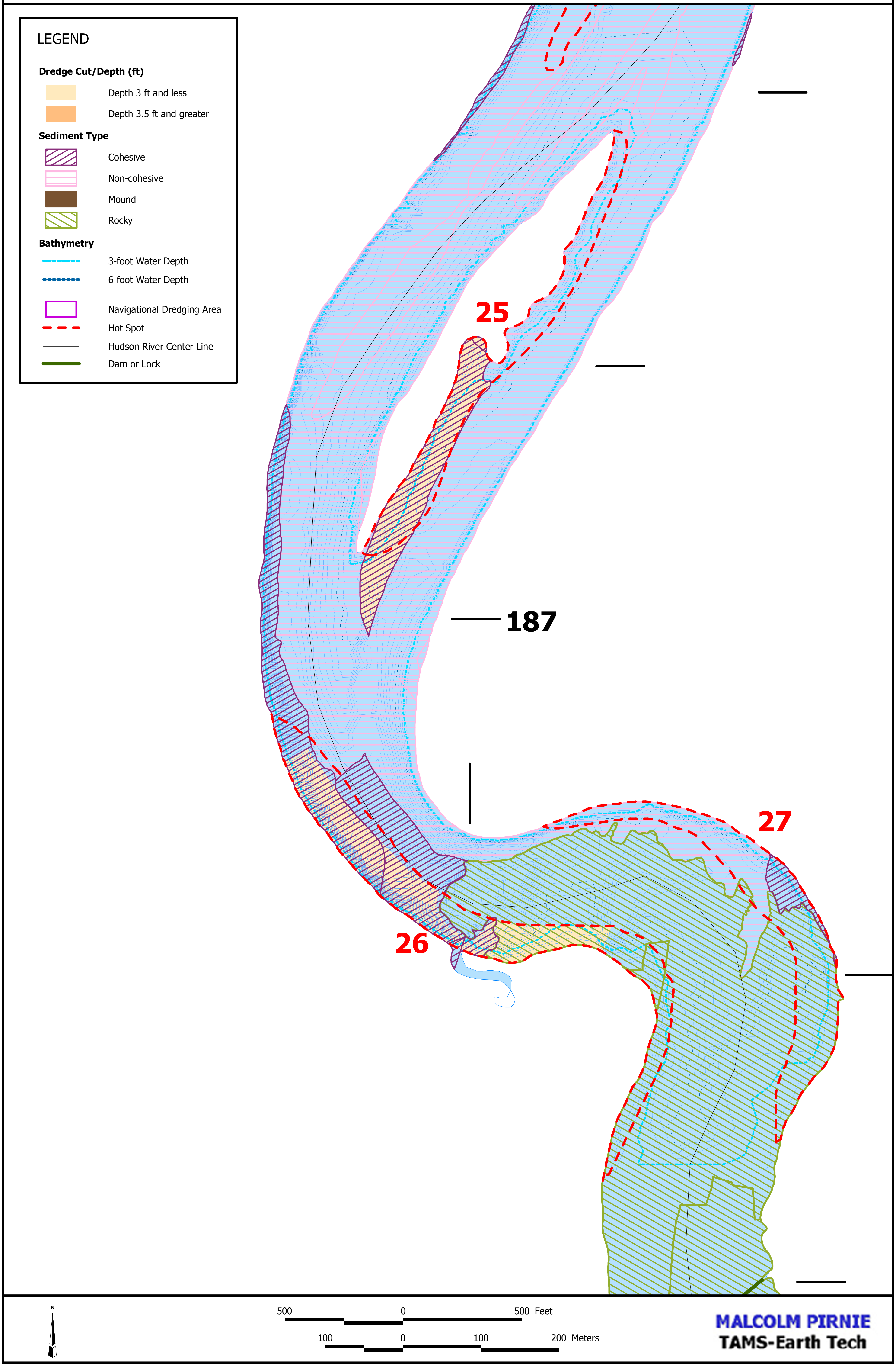
Sediment Characteristics - RM 187.5 - 188.5



Sediment Characteristics - RM 186.5 - 187.5



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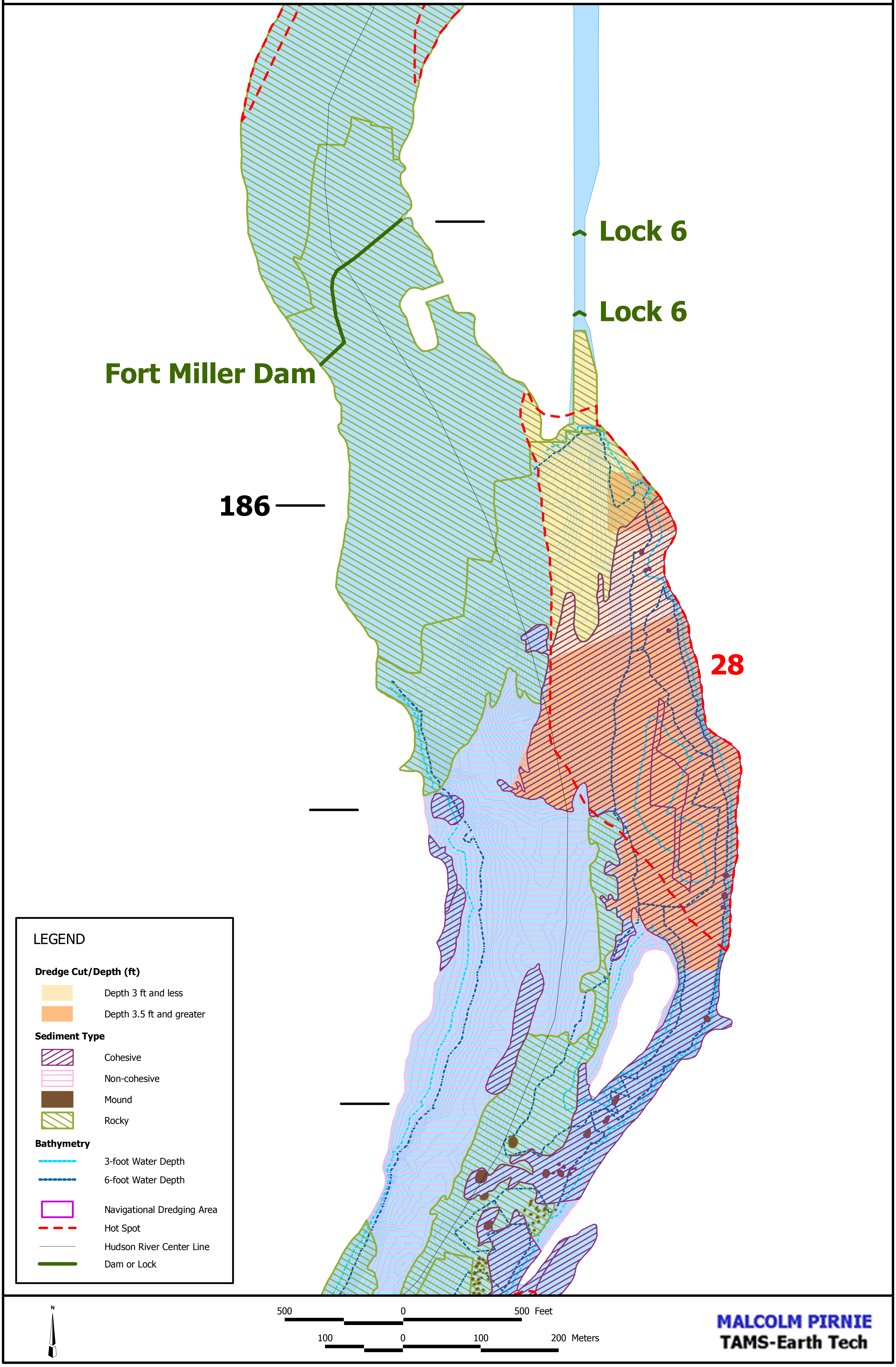
Sediment Characteristics - RM 185.25 - 186.25



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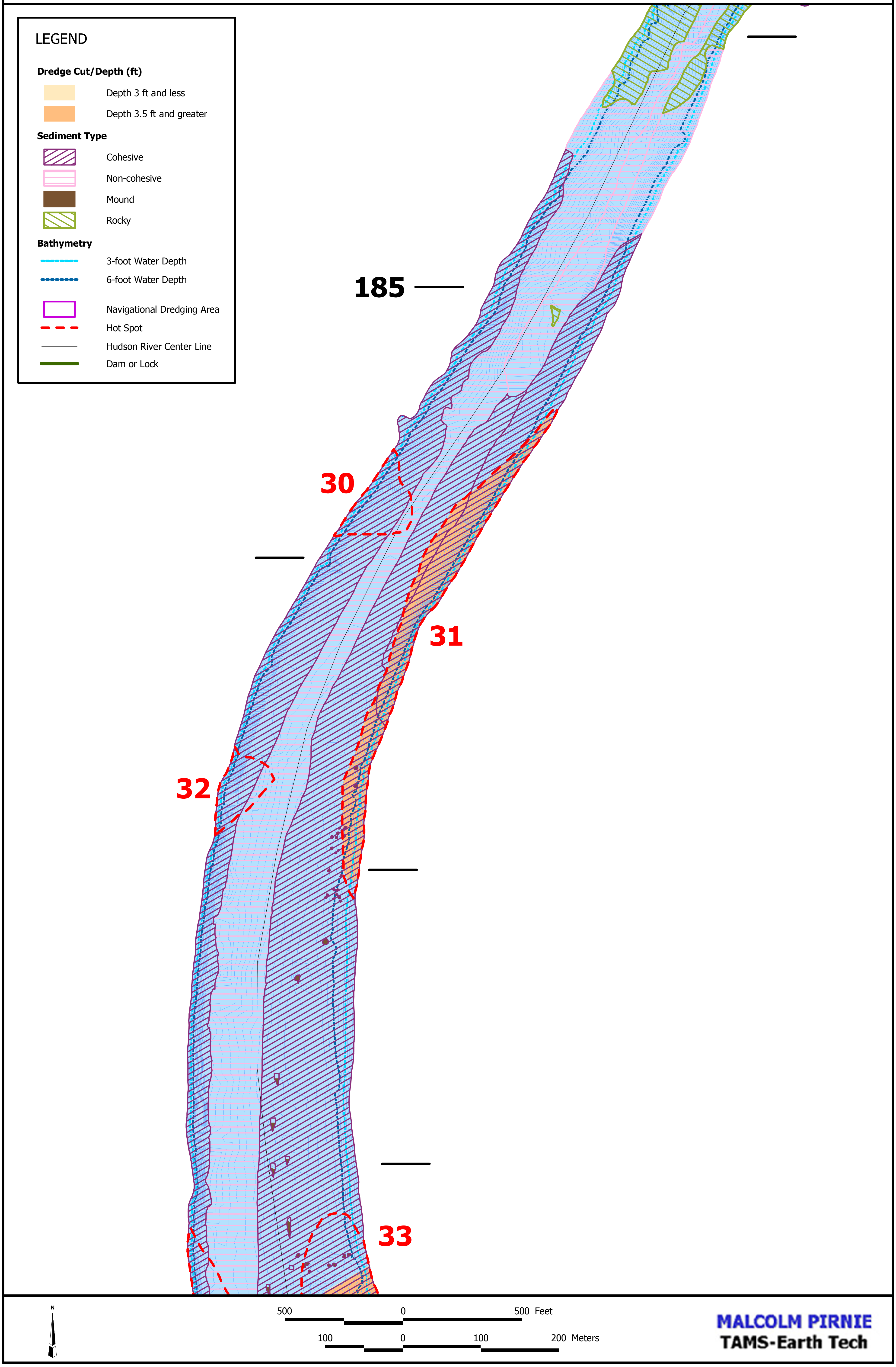

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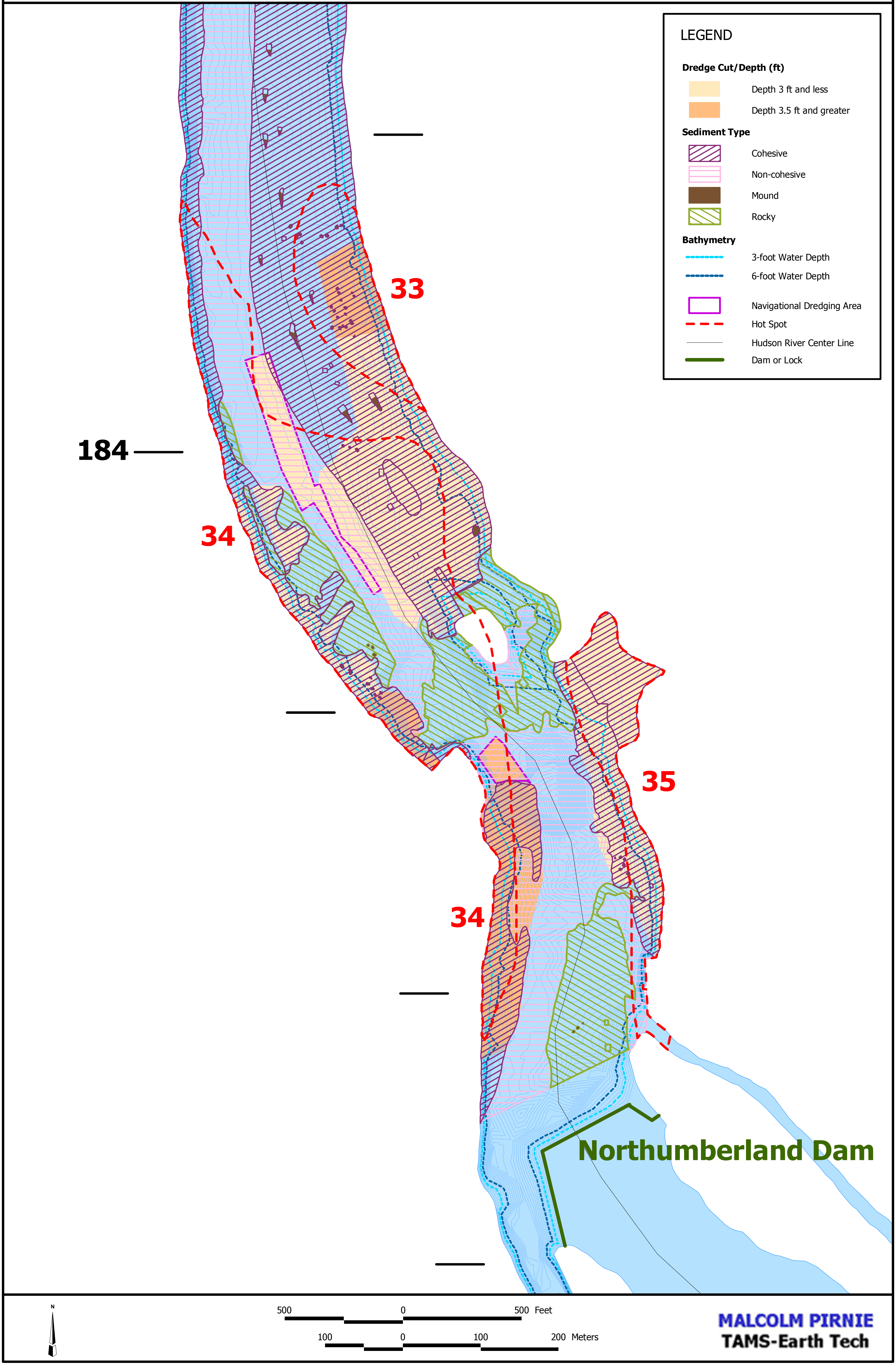
Sediment Characteristics - RM 183.25 - 184.25



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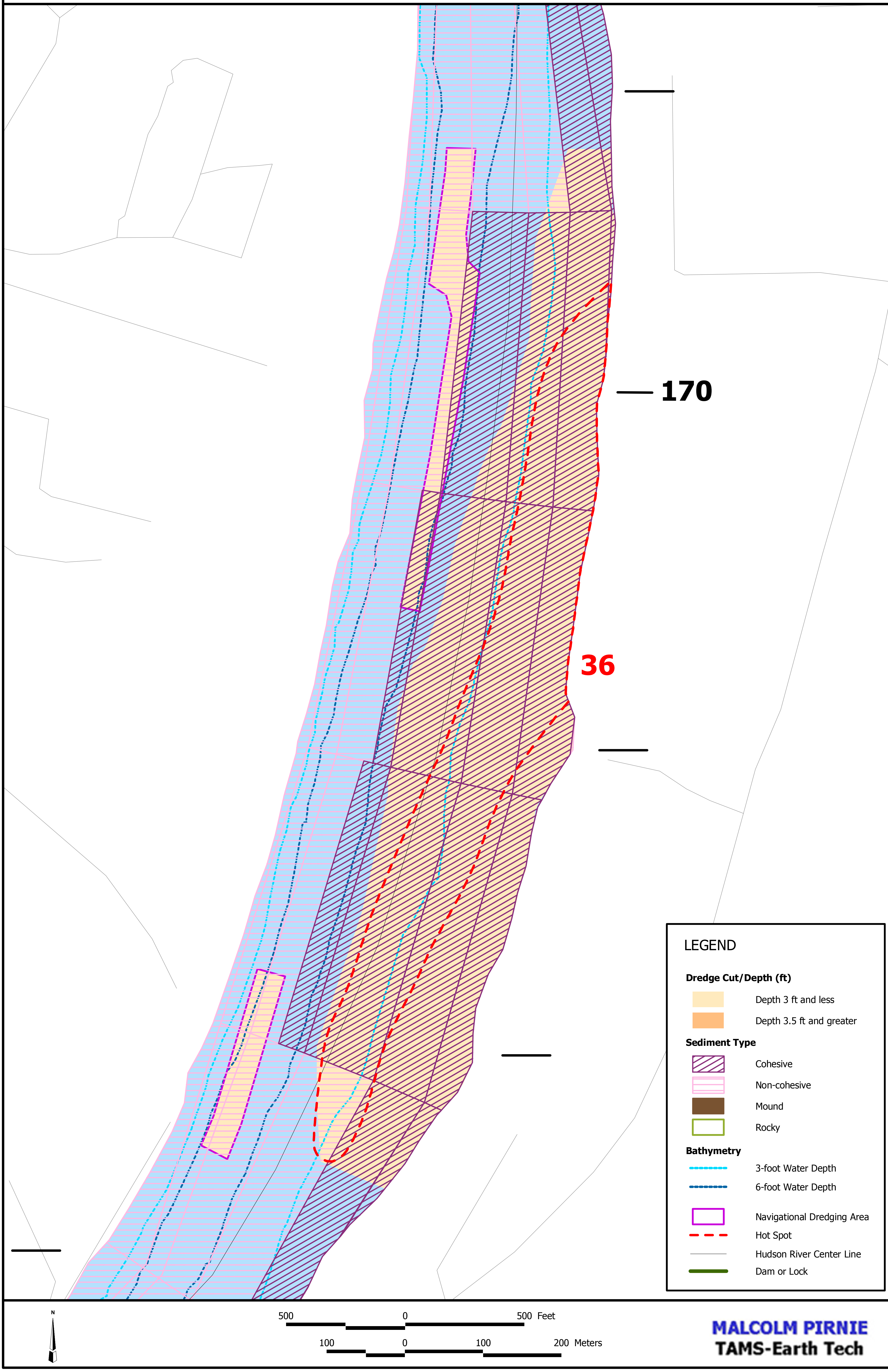
Sediment Characteristics - RM 169.25 - 170.25



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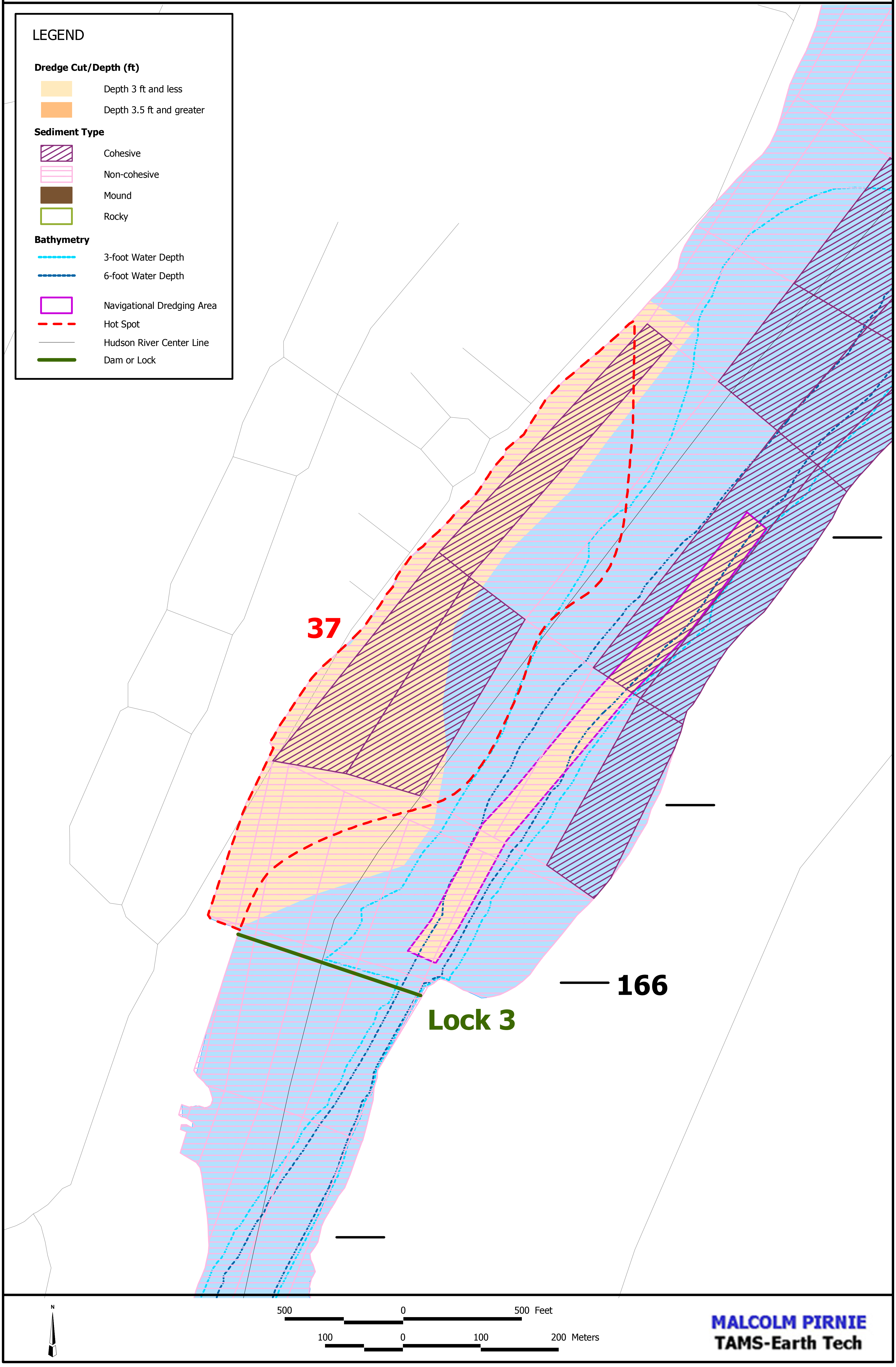
Sediment Characteristics - RM 165.75 - 166.75



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Sediment Characteristics - RM 163.25 - 164.25

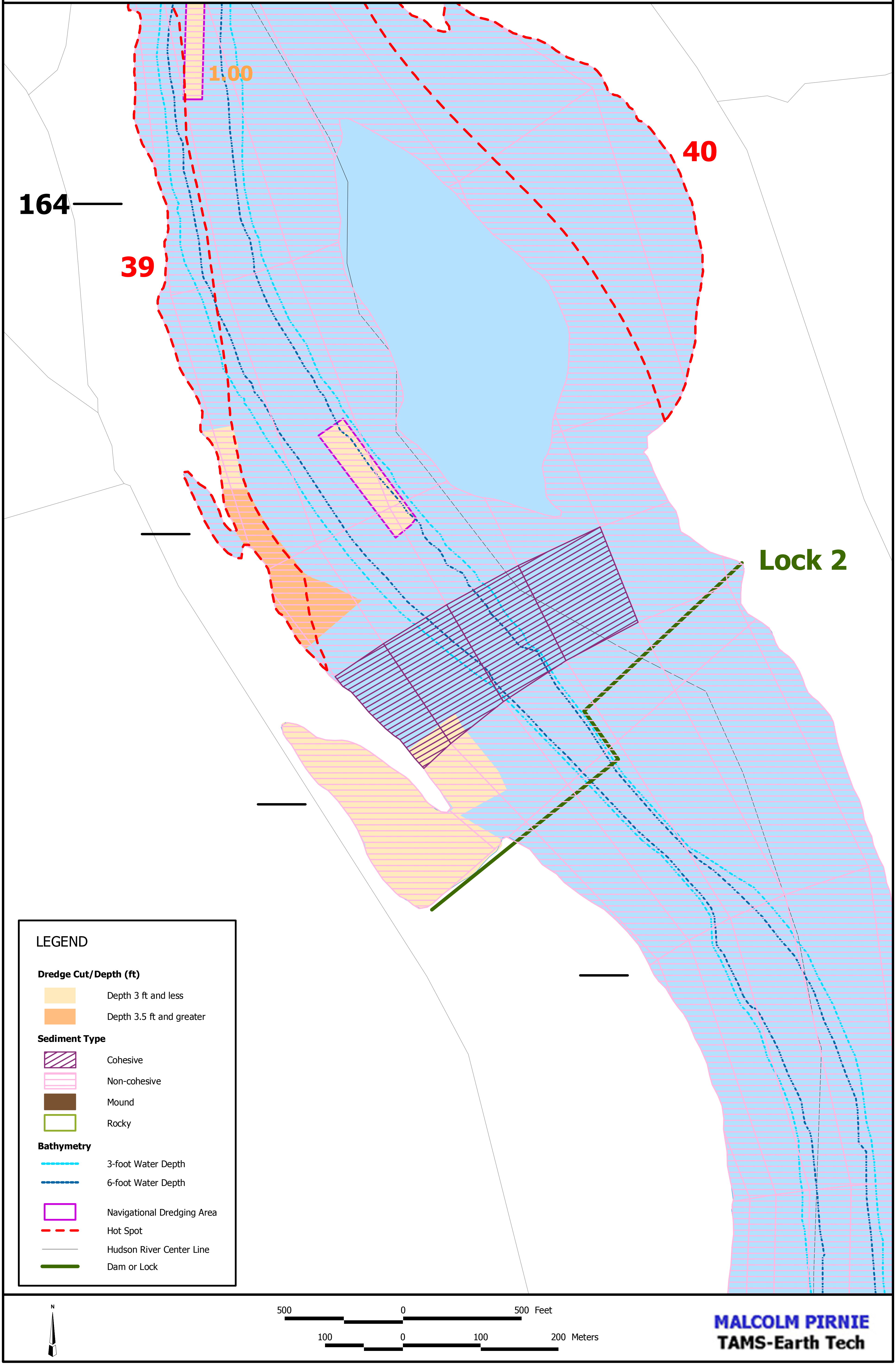

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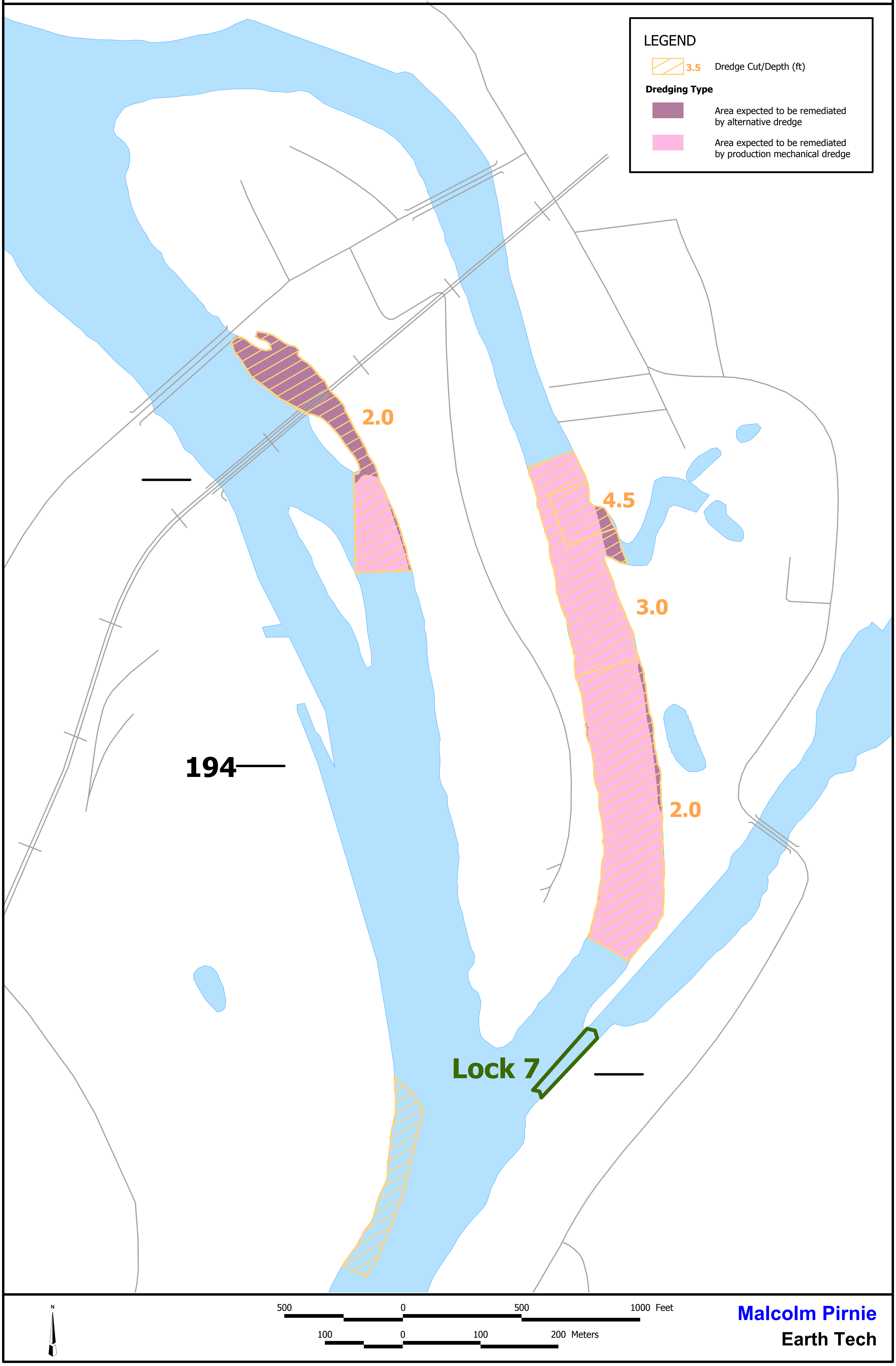
Figure F-2

Mechanical Dredging Equipment Analysis

Mechanical Dredging Equipment Analysis - RM 193.75 - 194.5



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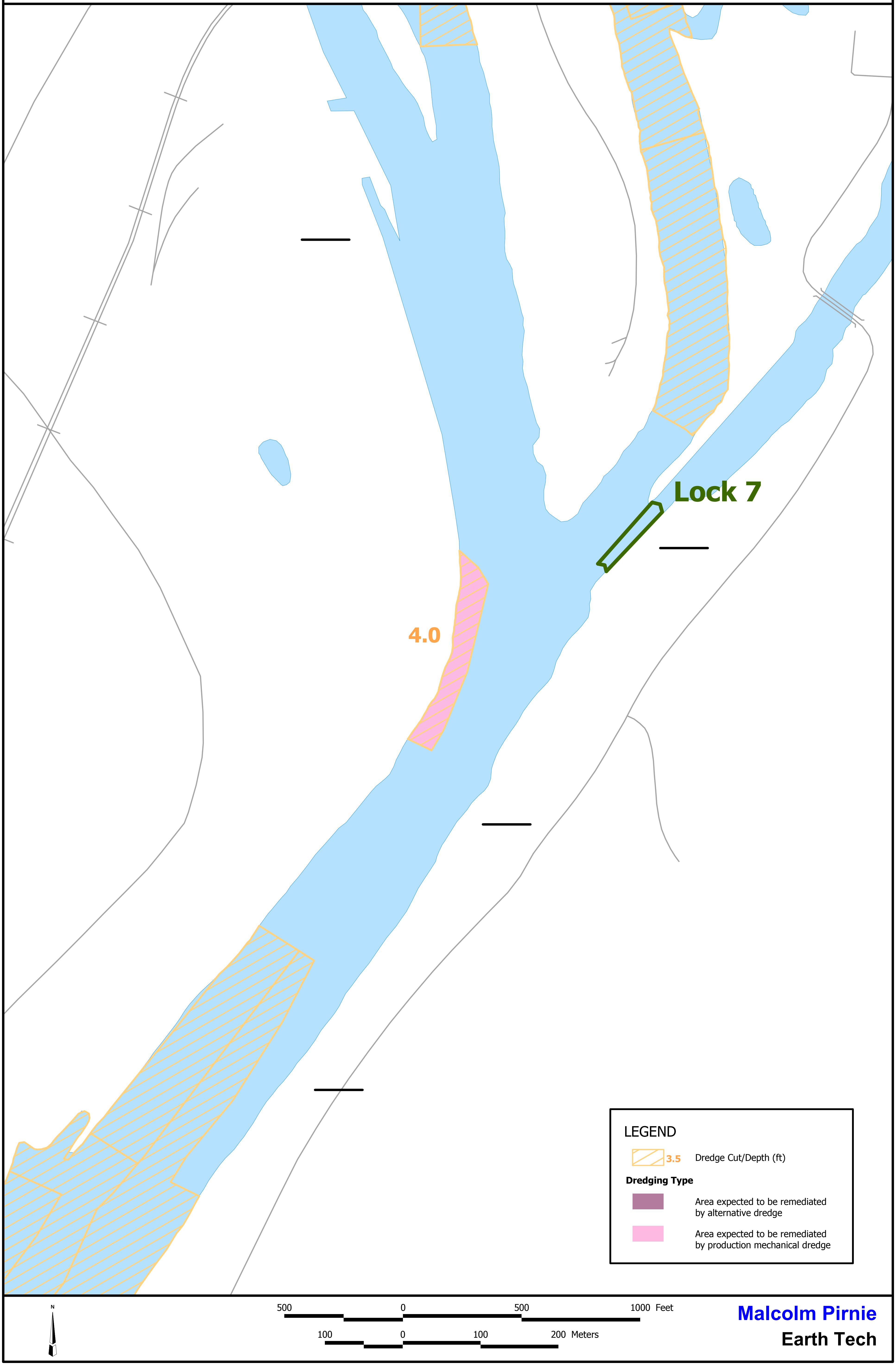
Mechanical Dredging Equipment Analysis - RM 193.5 - 193.75



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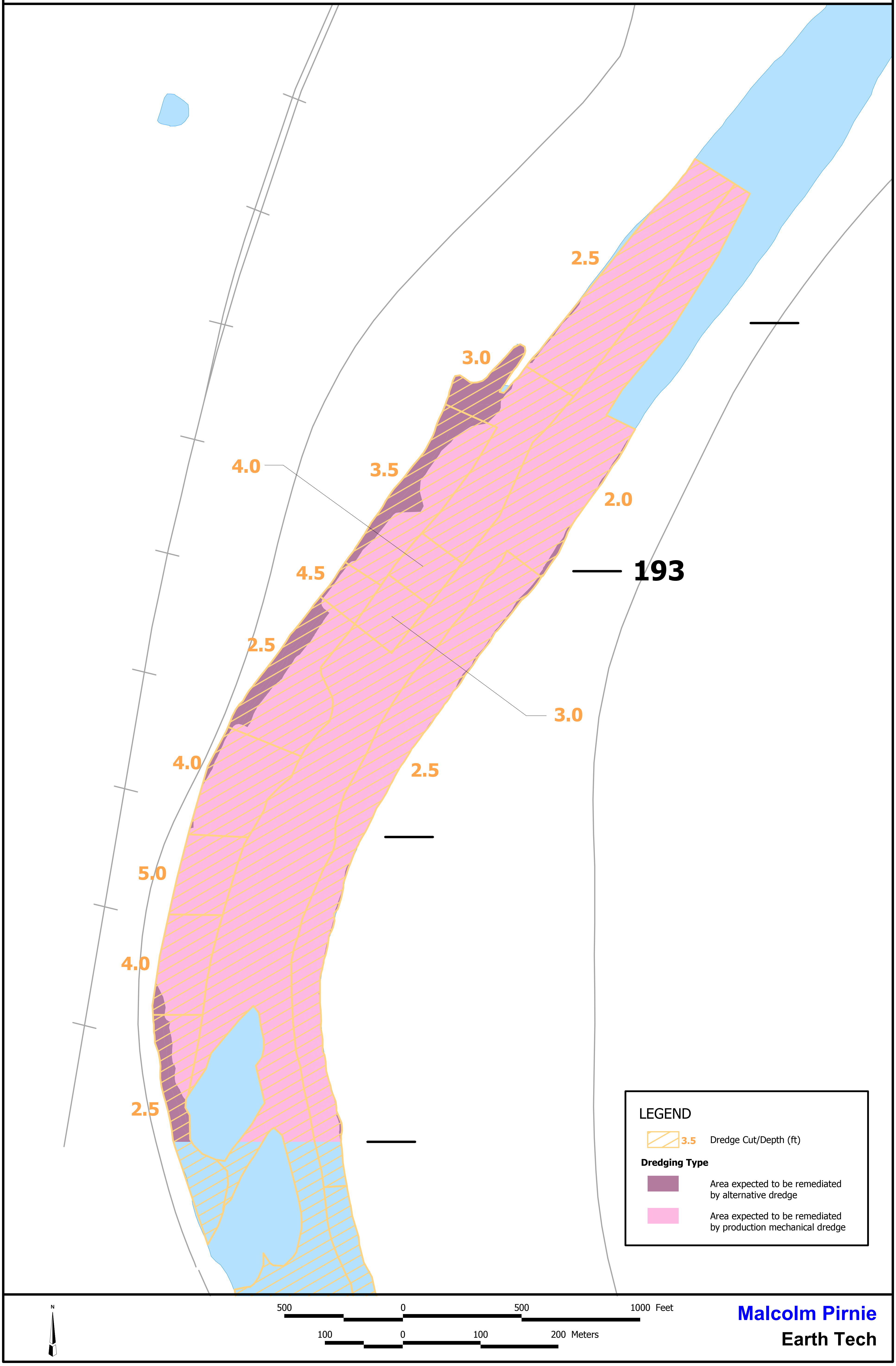
Mechanical Dredging Equipment Analysis - RM 192.5 - 193.5



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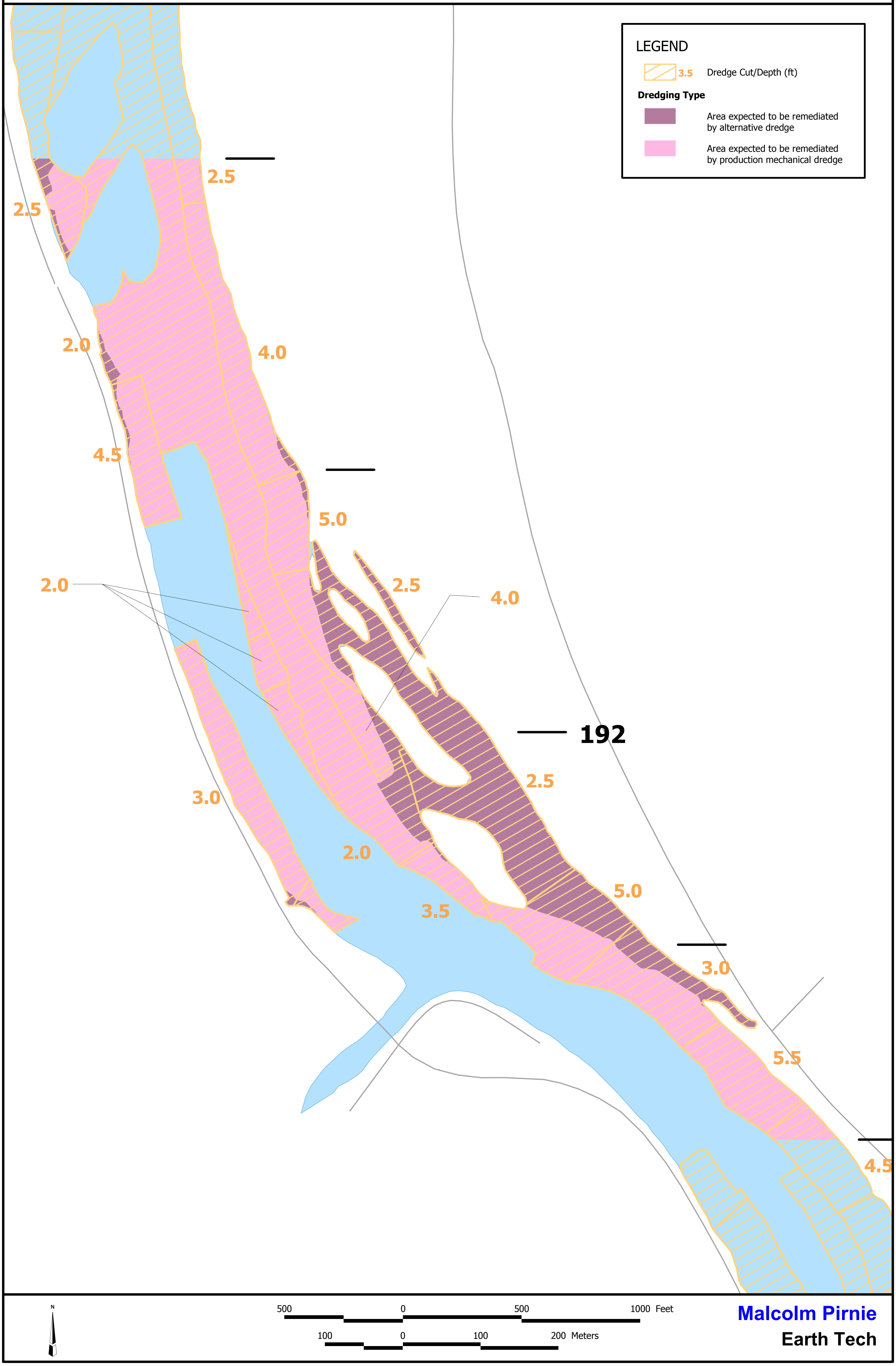
Mechanical Dredging Equipment Analysis - RM 191.5 - 192.5



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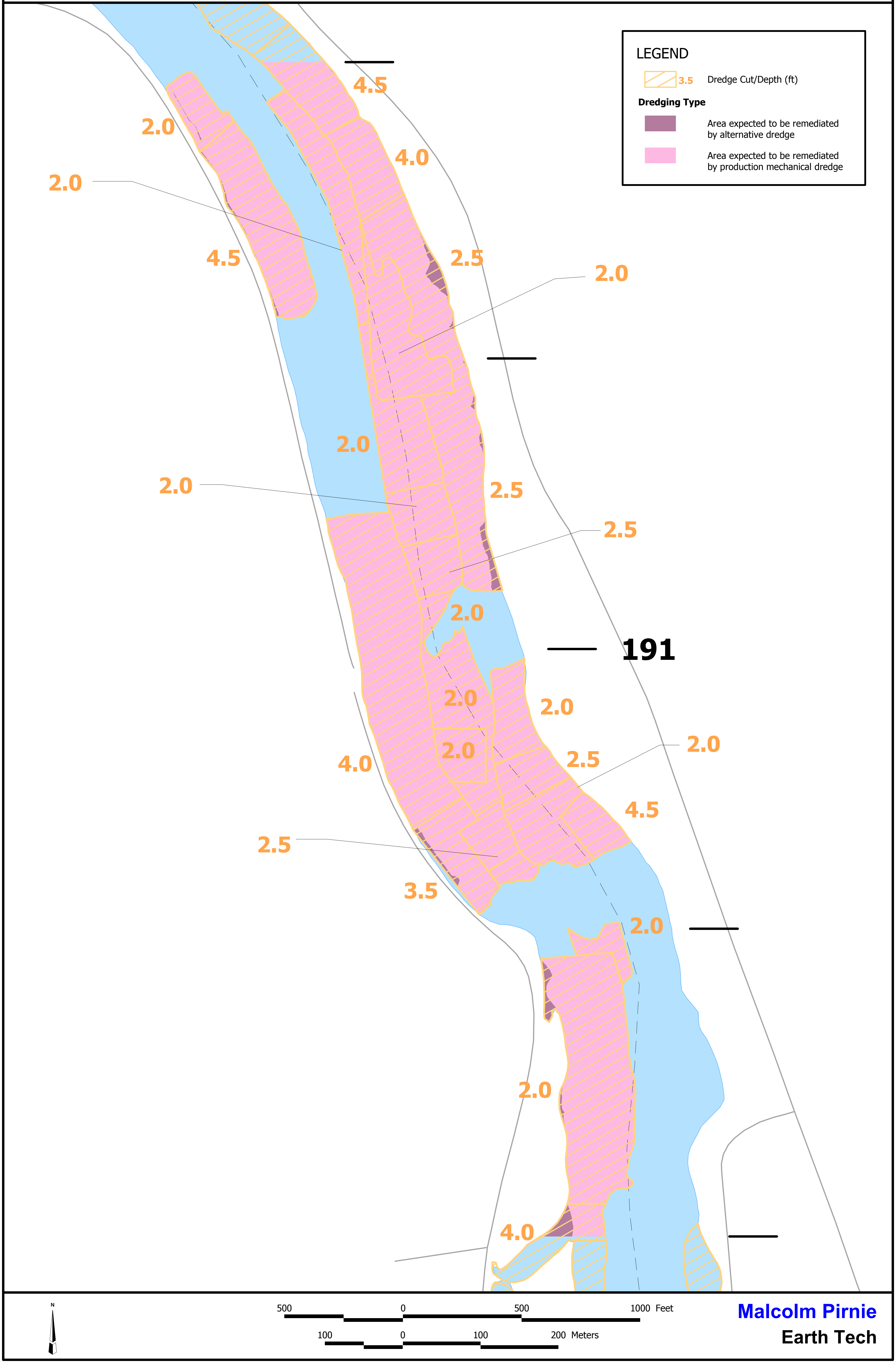
Mechanical Dredging Equipment Analysis - RM 190.5 - 191.5



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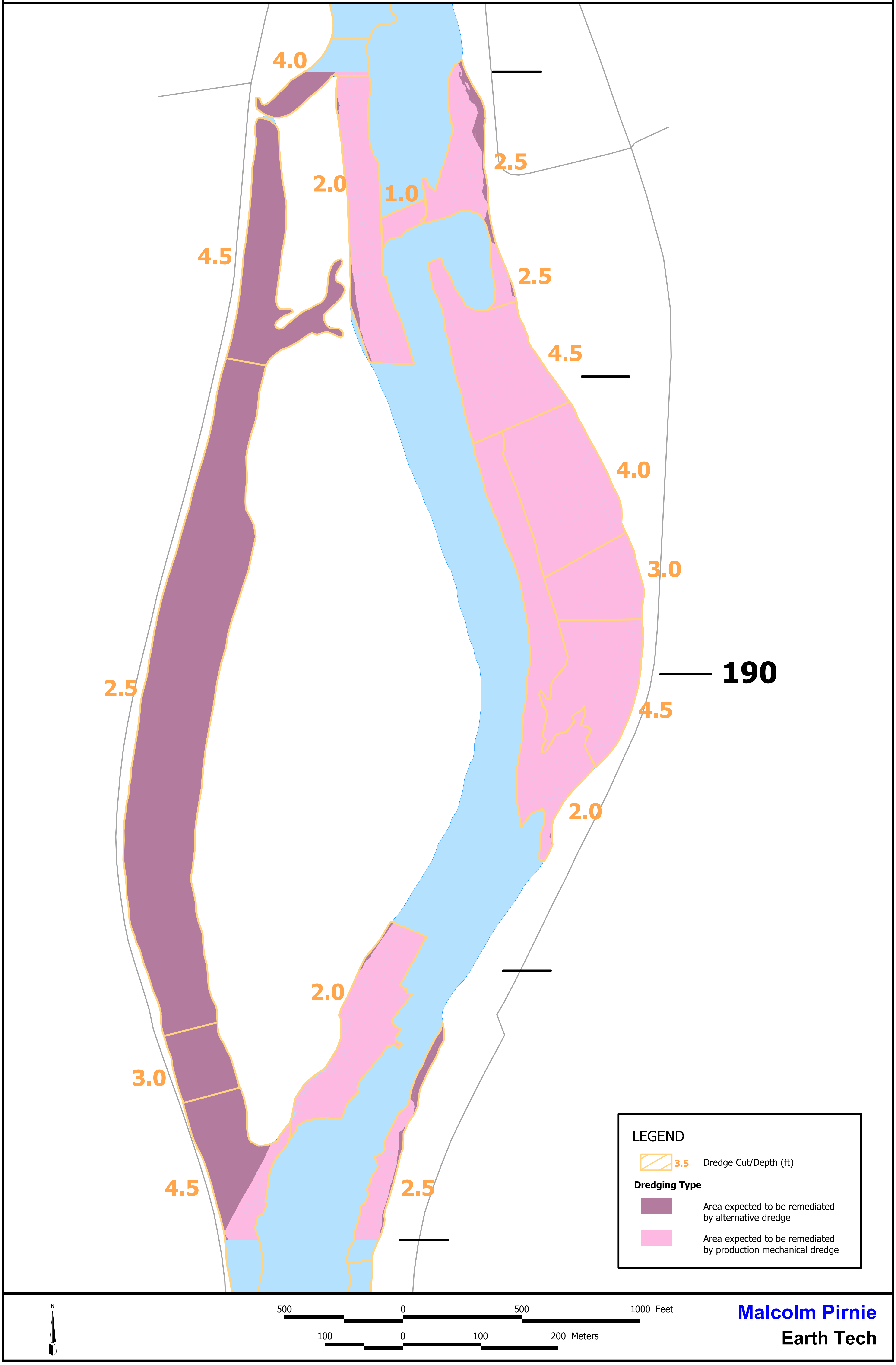
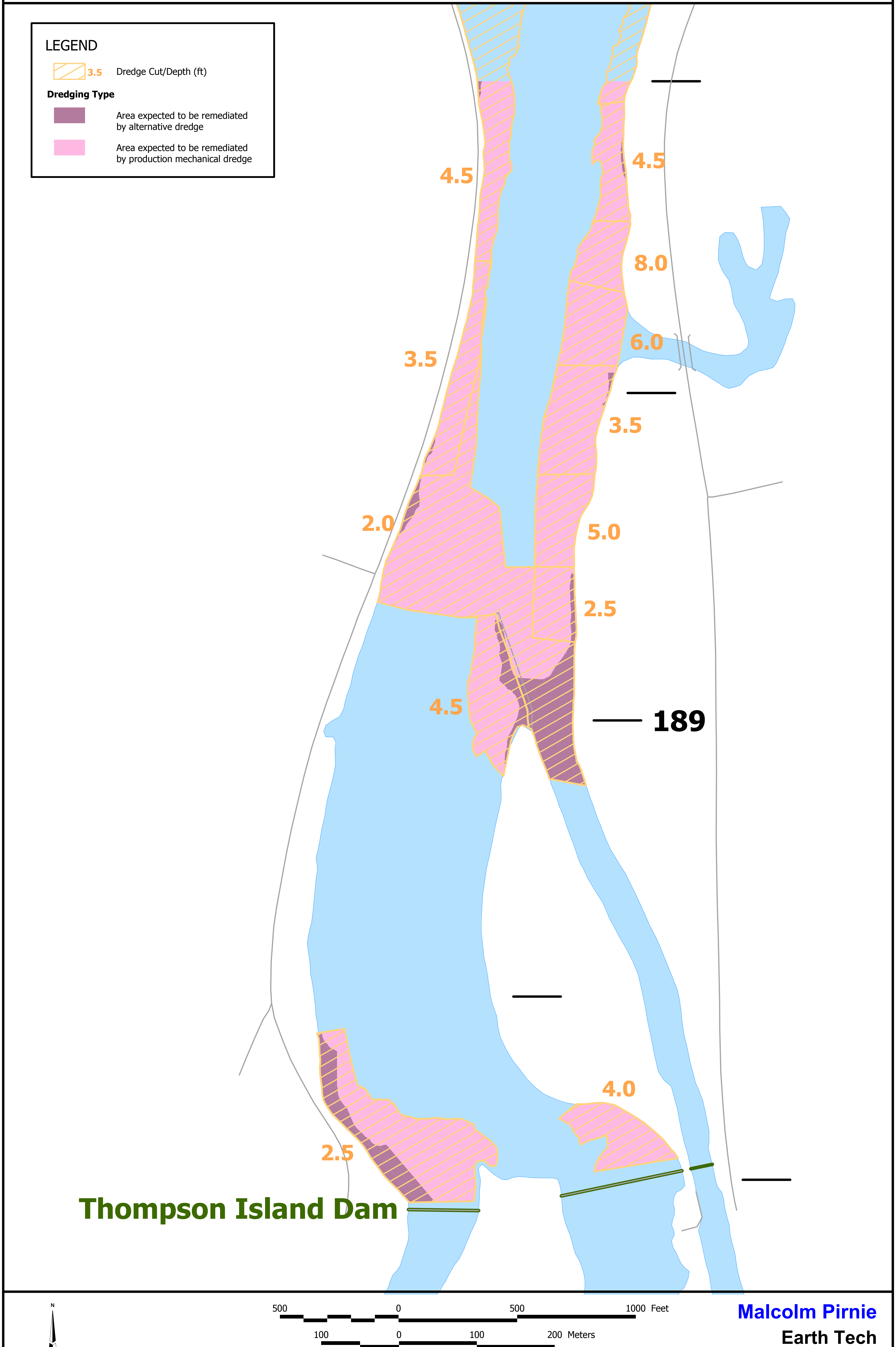
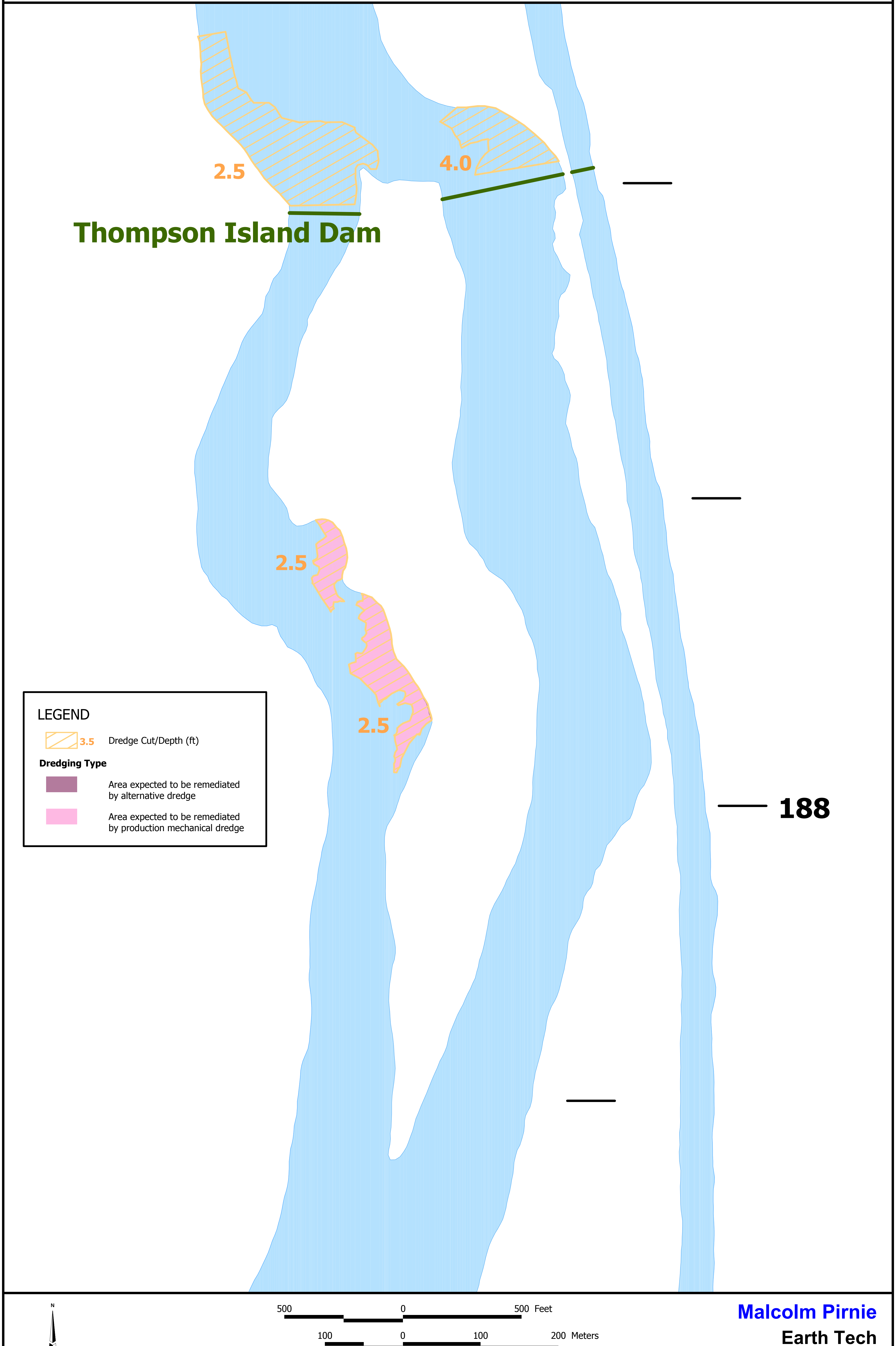
Mechanical Dredging Equipment Analysis - RM 189.5 - 190.5



Mechanical Dredging Equipment Analysis - RM 188.5 - 189.5



Mechanical Dredging Equipment Analysis - RM 187.5 - 188.5



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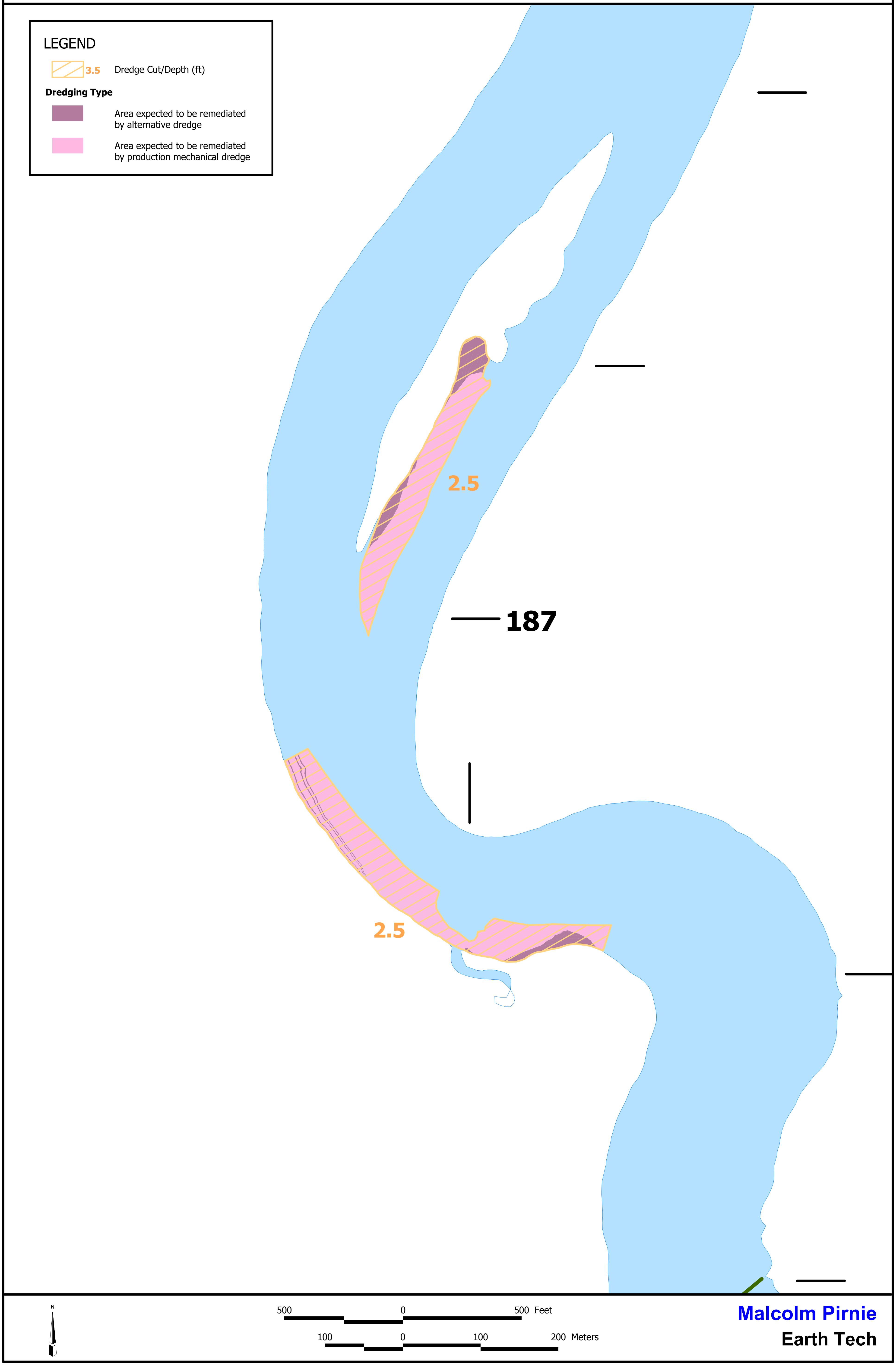
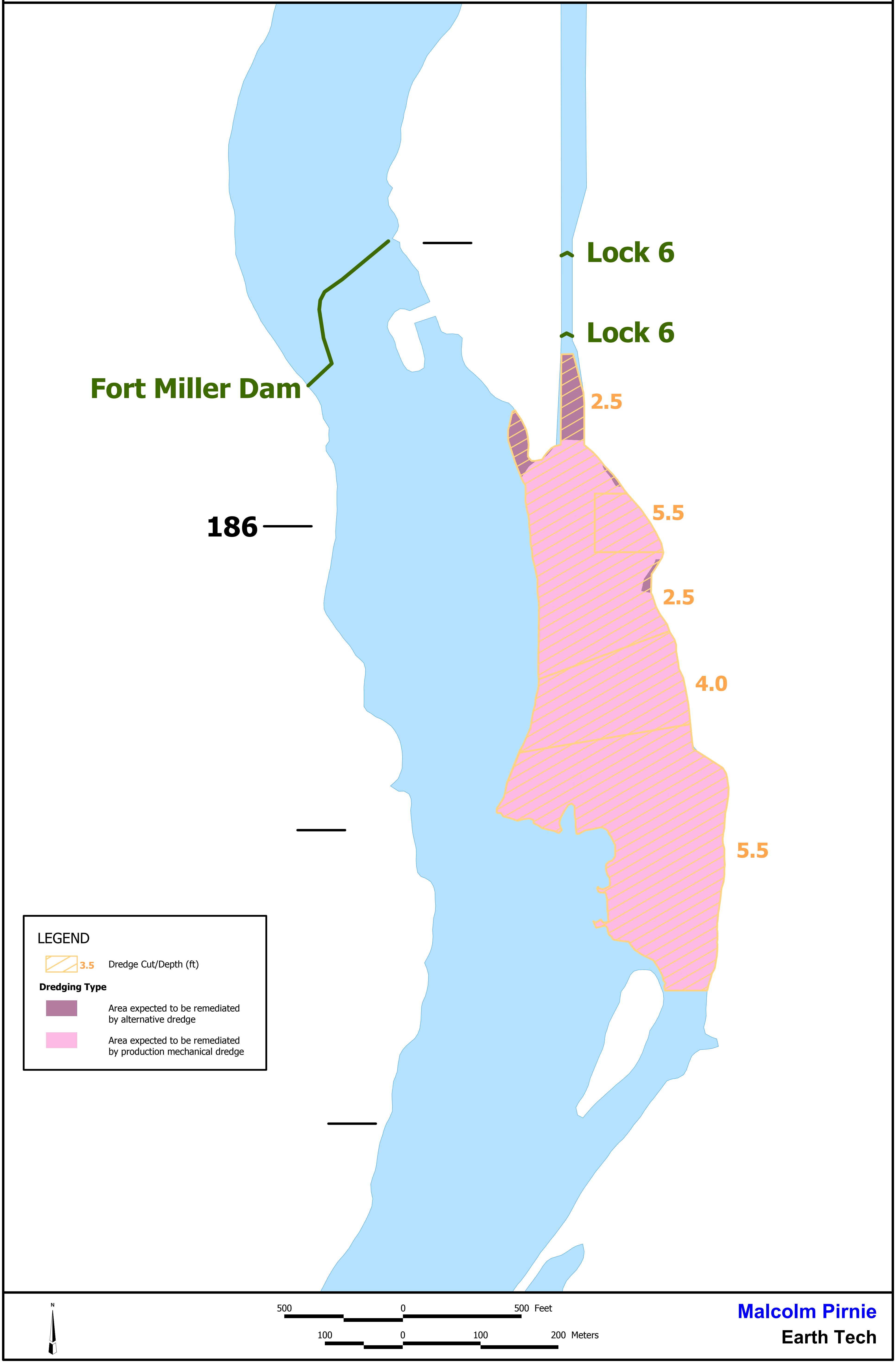
Mechanical Dredging Equipment Analysis - RM 186.5 - 187.5



Mechanical Dredging Equipment Analysis - RM 185.25 - 186.25



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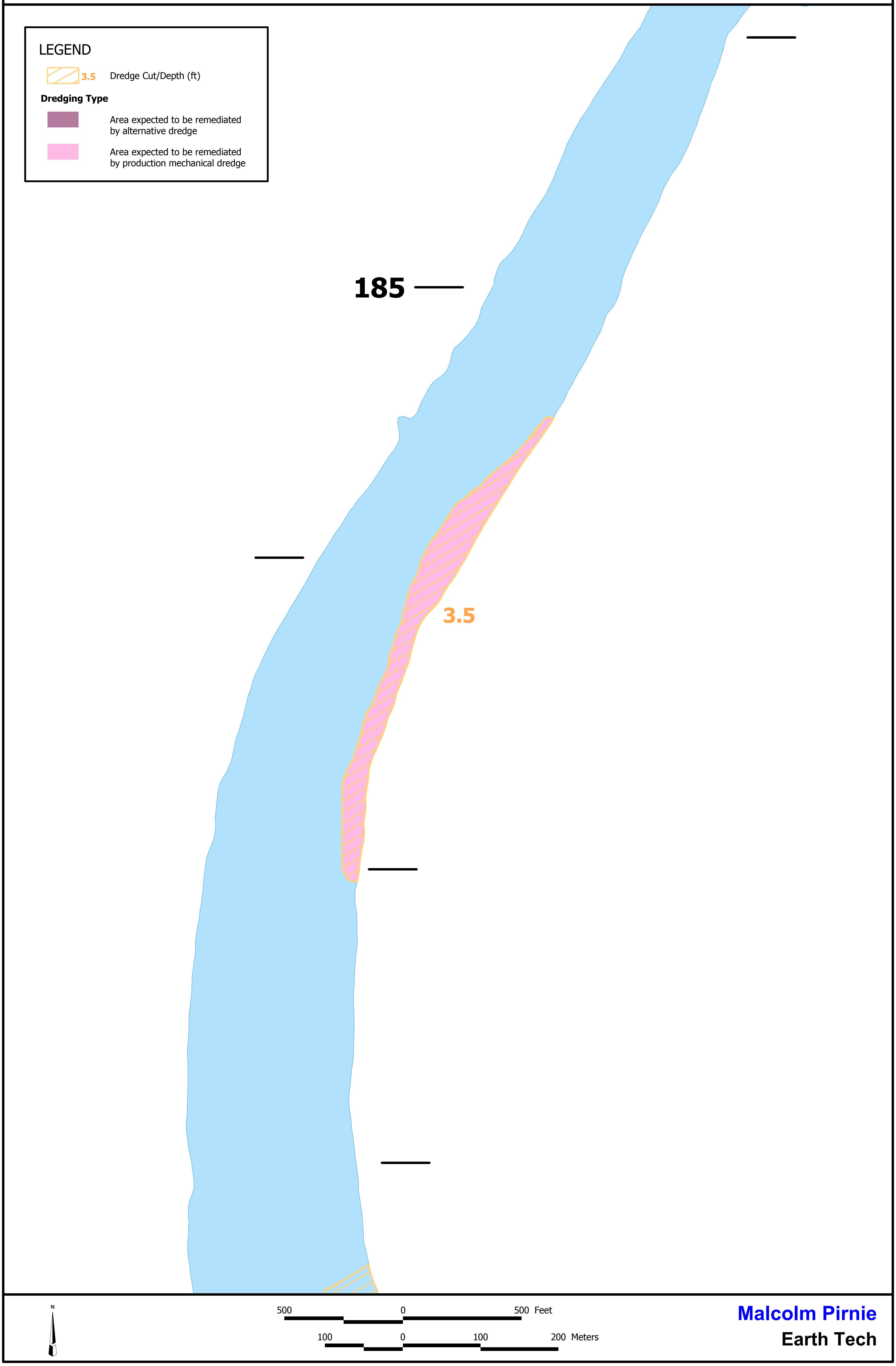
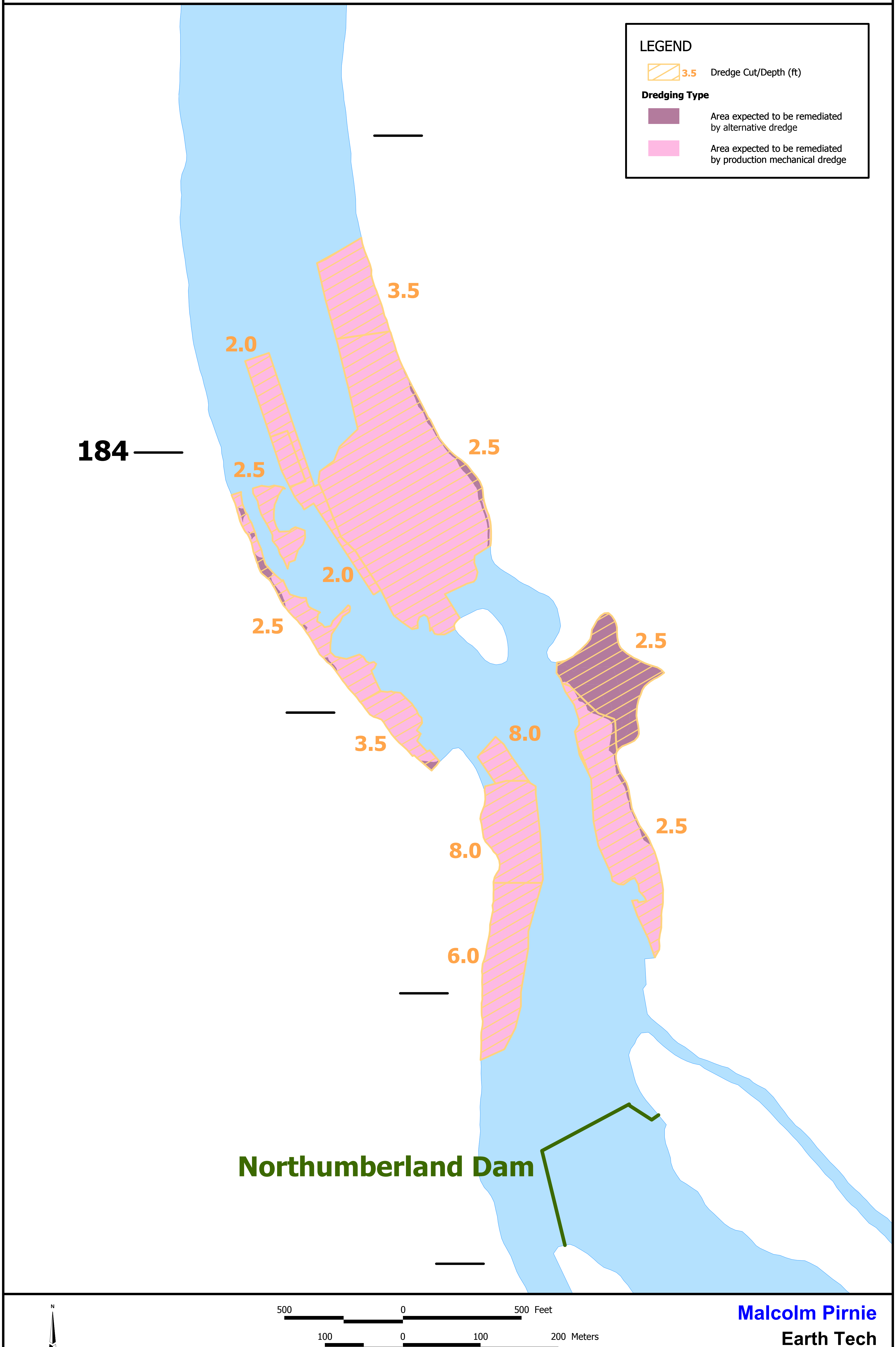
Mechanical Dredging Equipment Analysis - RM 184.25 - 185.25



Mechanical Dredging Equipment Analysis - RM 183.25 - 184.25



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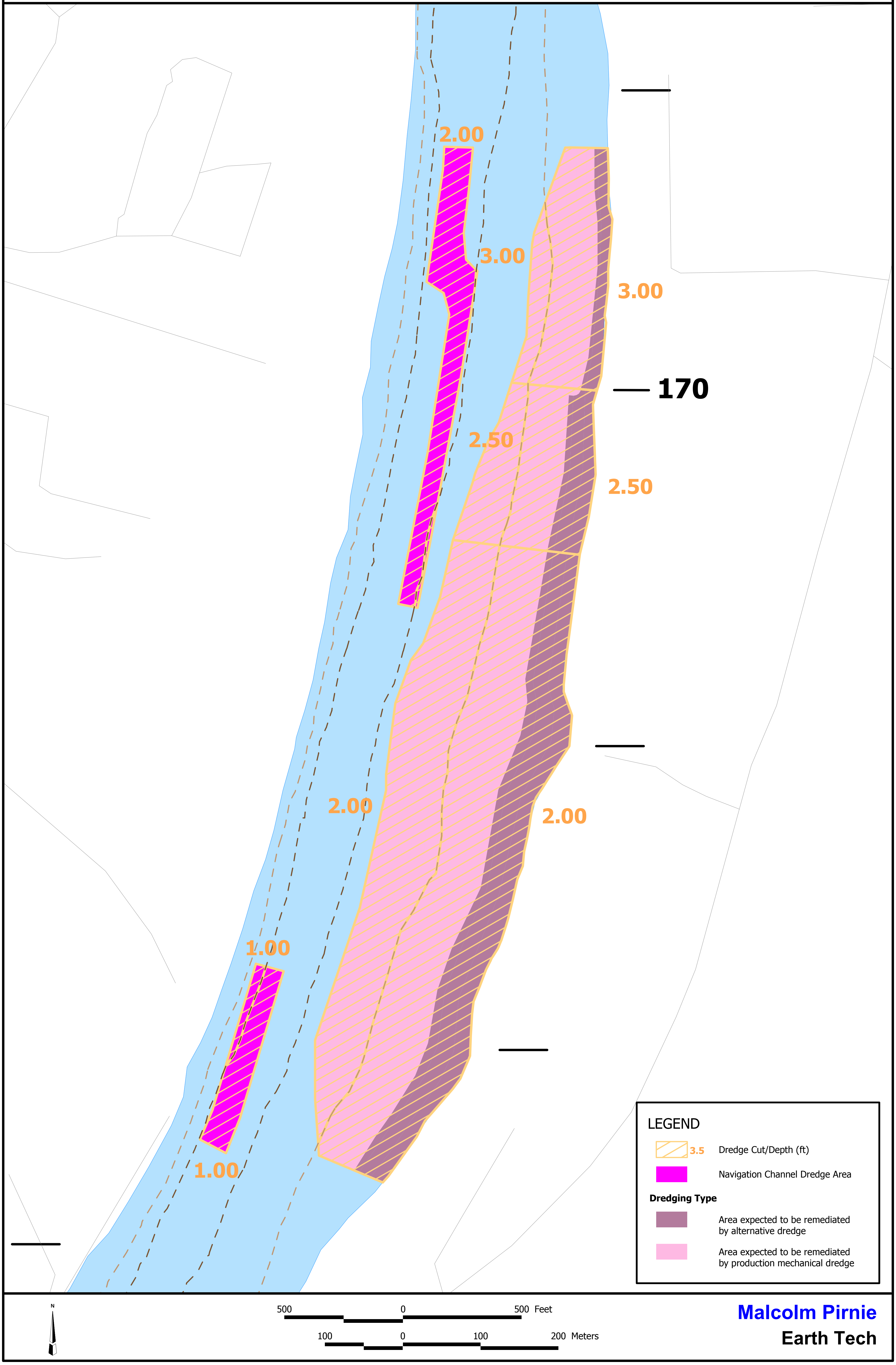
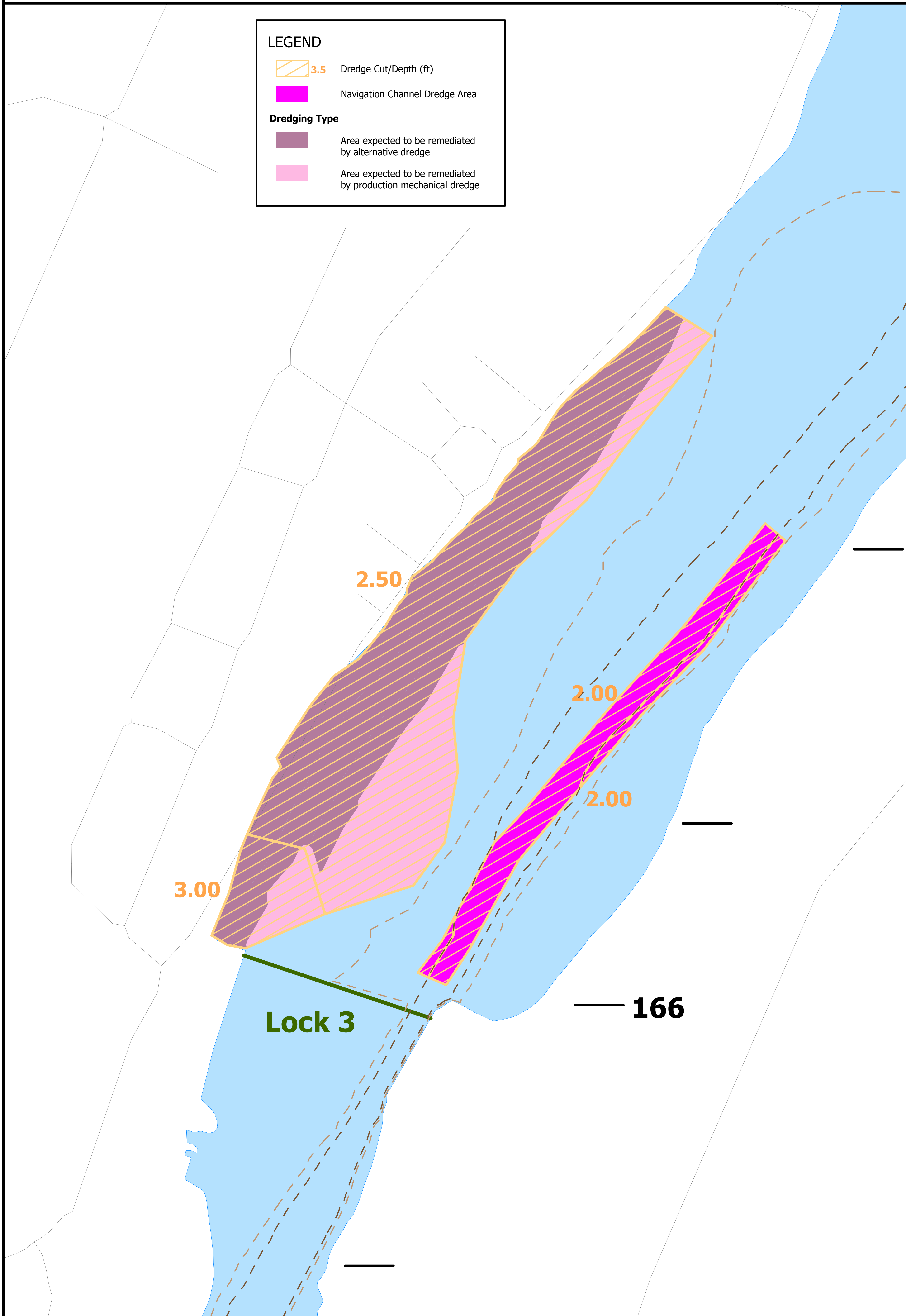
Mechanical Dredging Equipment Analysis - RM 169.25 - 170.25



Mechanical Dredging Equipment Analysis - RM 165.75 - 166.75



500 0 500 Feet

100 0 100 200 Meters

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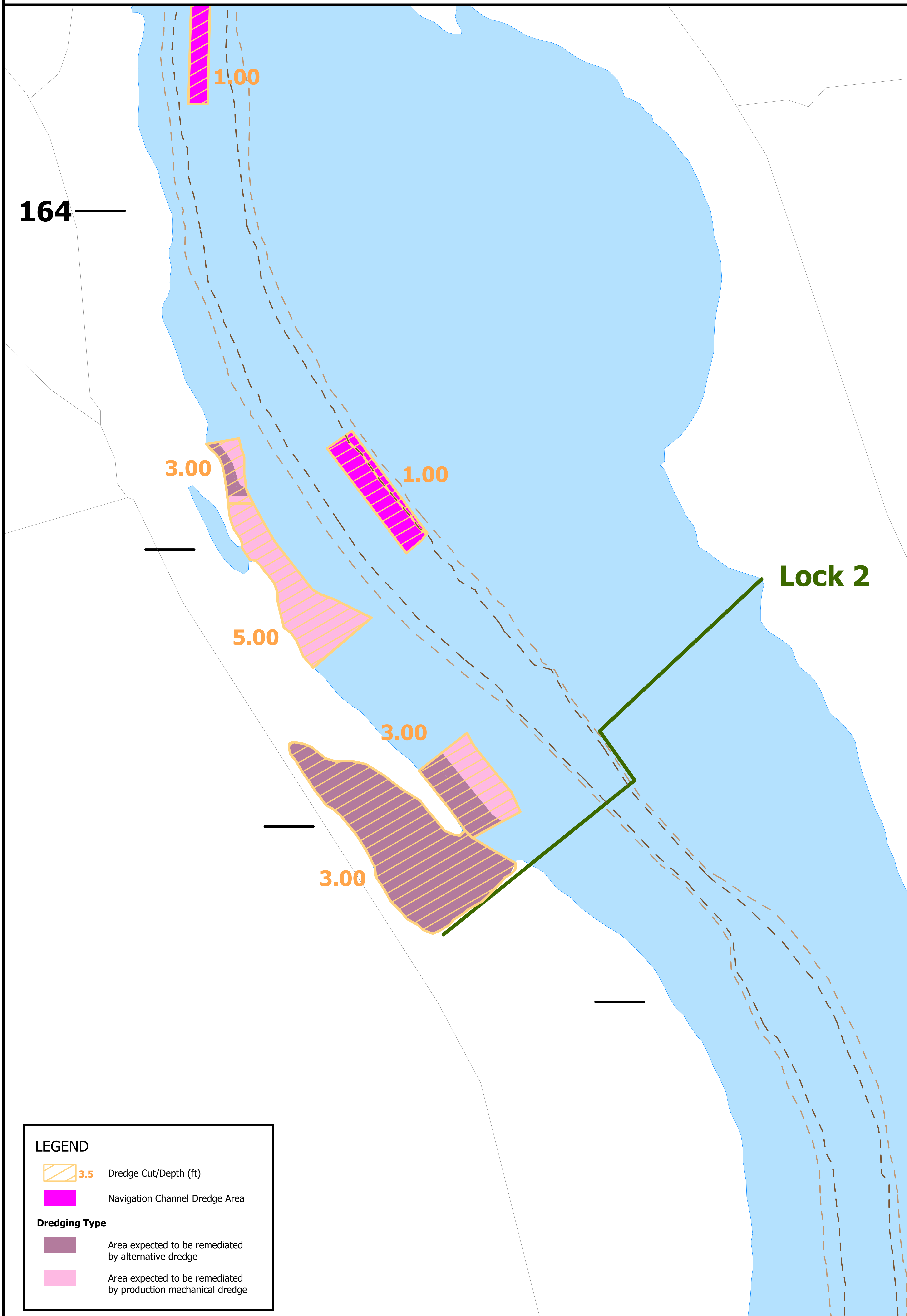
Mechanical Dredging Equipment Analysis - RM 163.25 - 164.25



N

500 0 500 Feet

100 0 100 200 Meters

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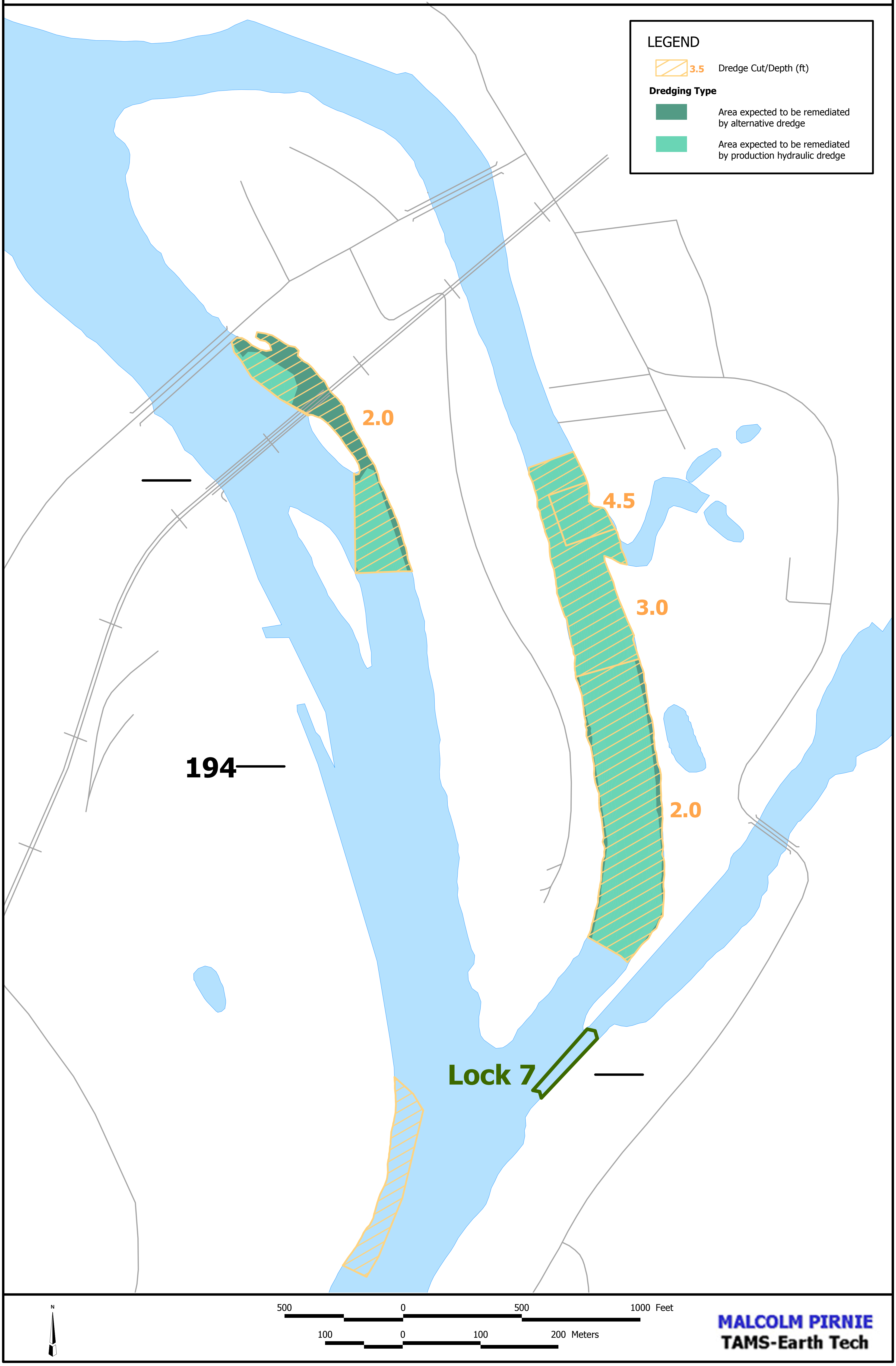
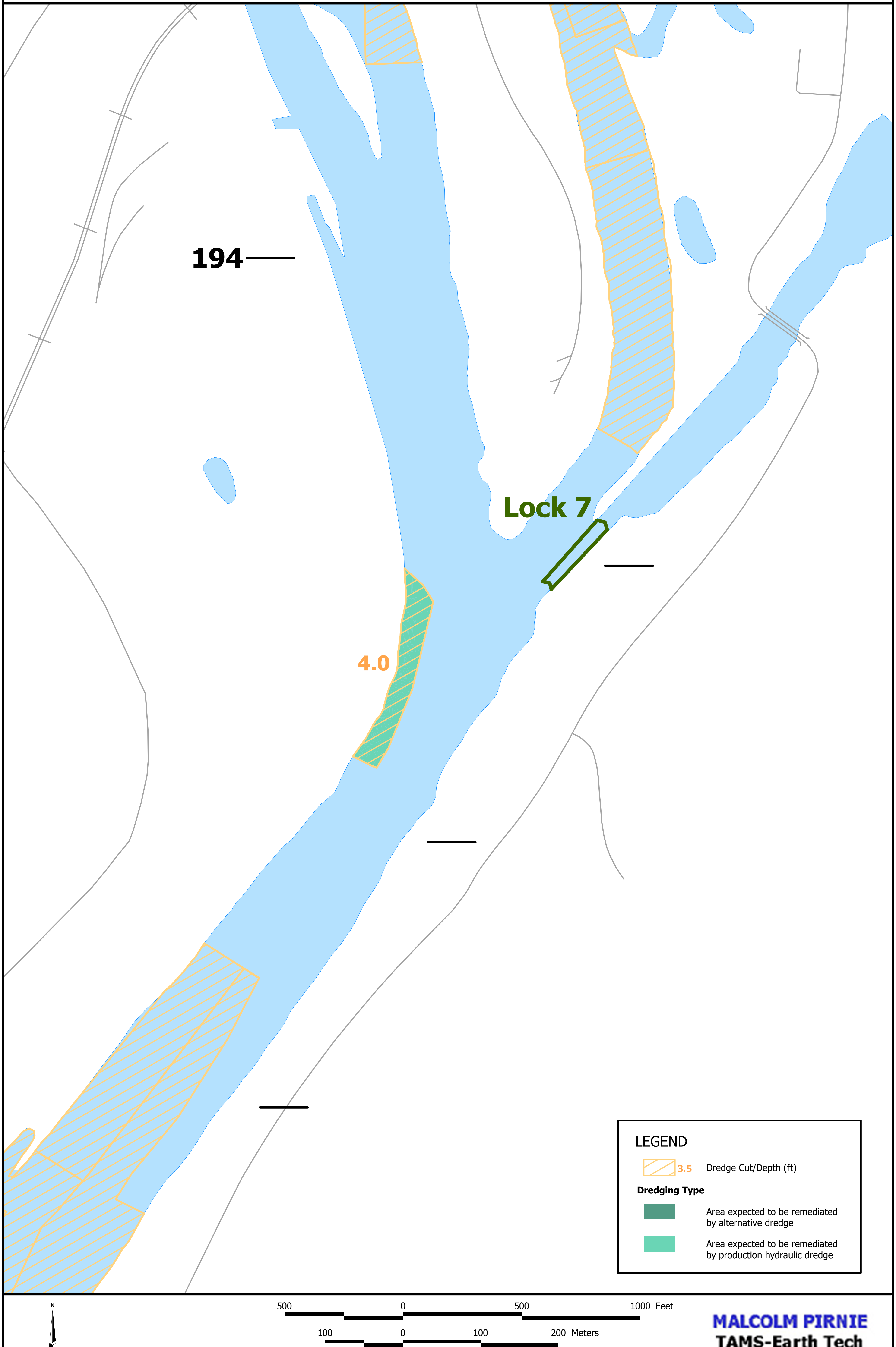
Figure F-3

Hydraulic Dredging Equipment Analysis

Hydraulic Dredging Equipment Analysis - RM 193.75 - 194.5



Hydraulic Dredging Equipment Analysis - RM 193.5 - 193.75



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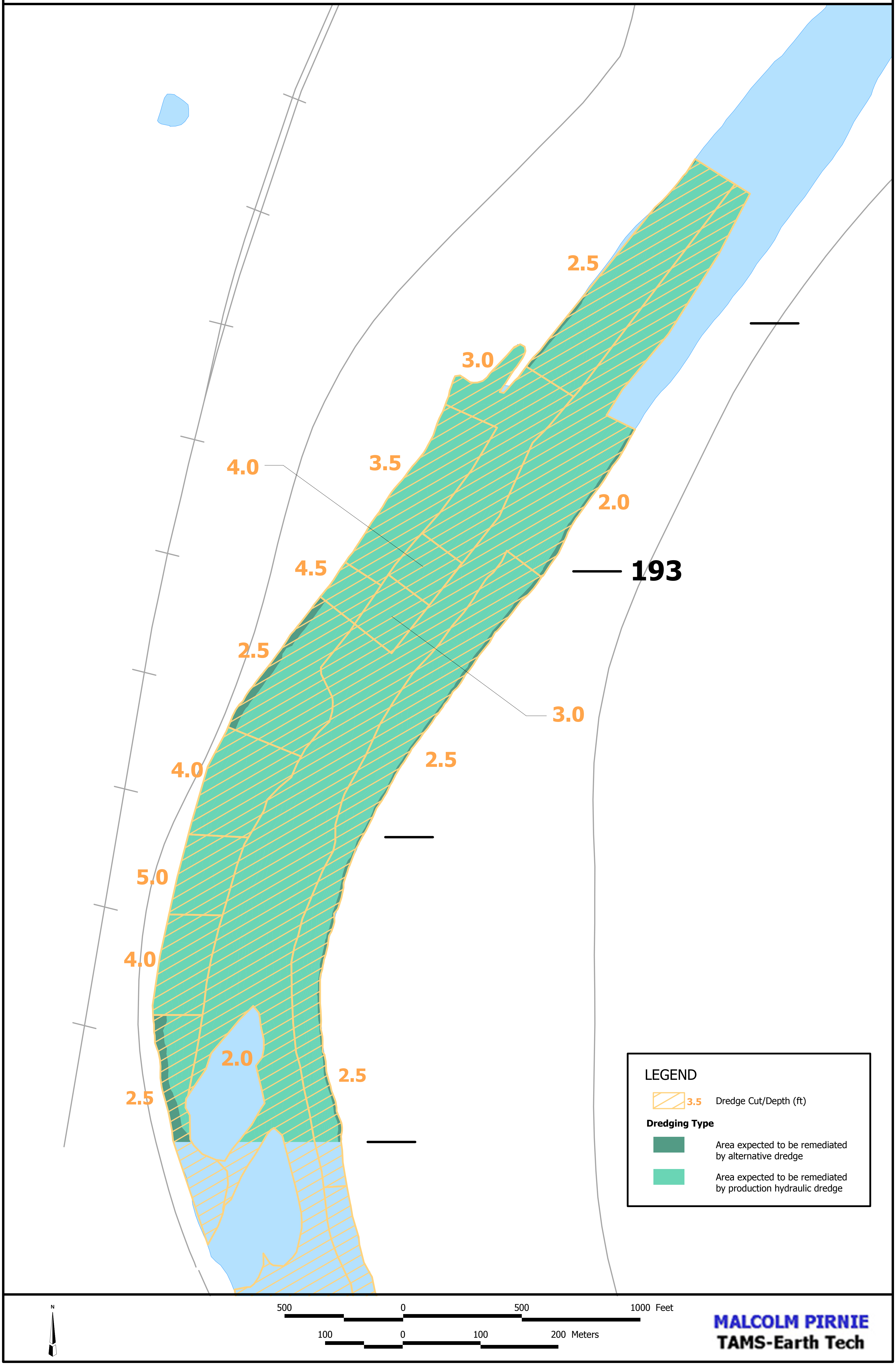
Hydraulic Dredging Equipment Analysis - RM 192.5 - 193.5



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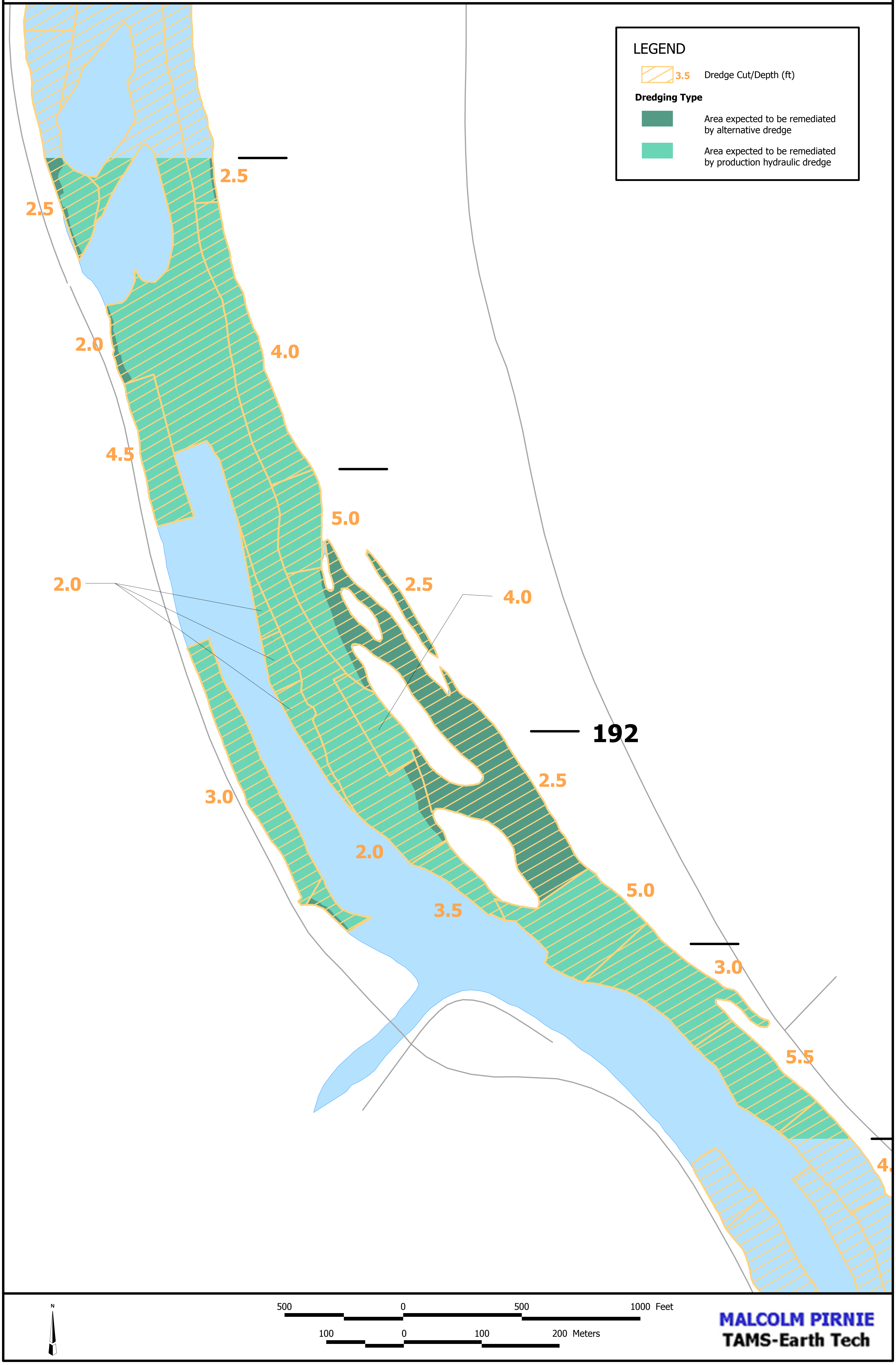
Hydraulic Dredging Equipment Analysis - RM 191.5 - 192.5



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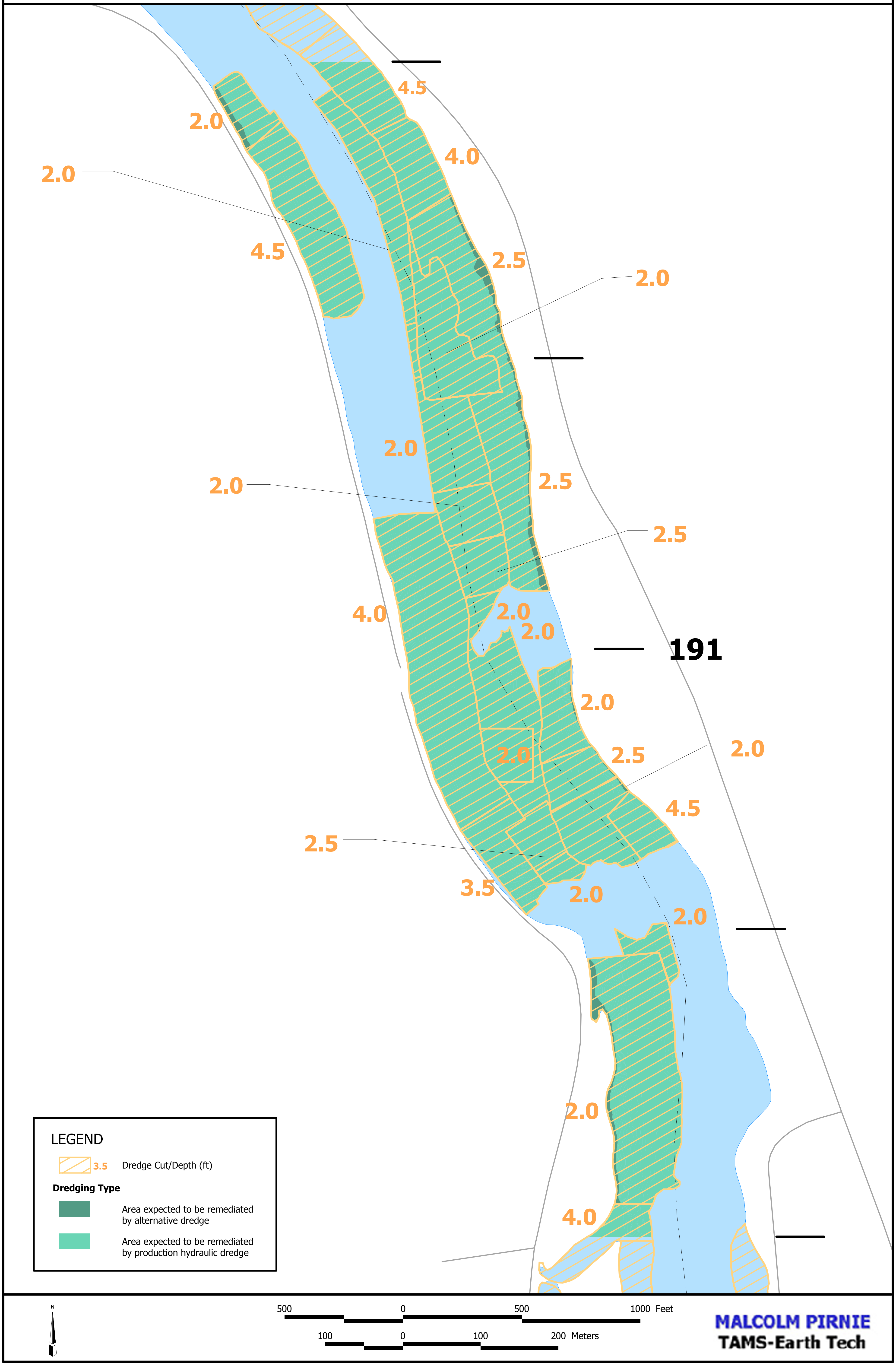
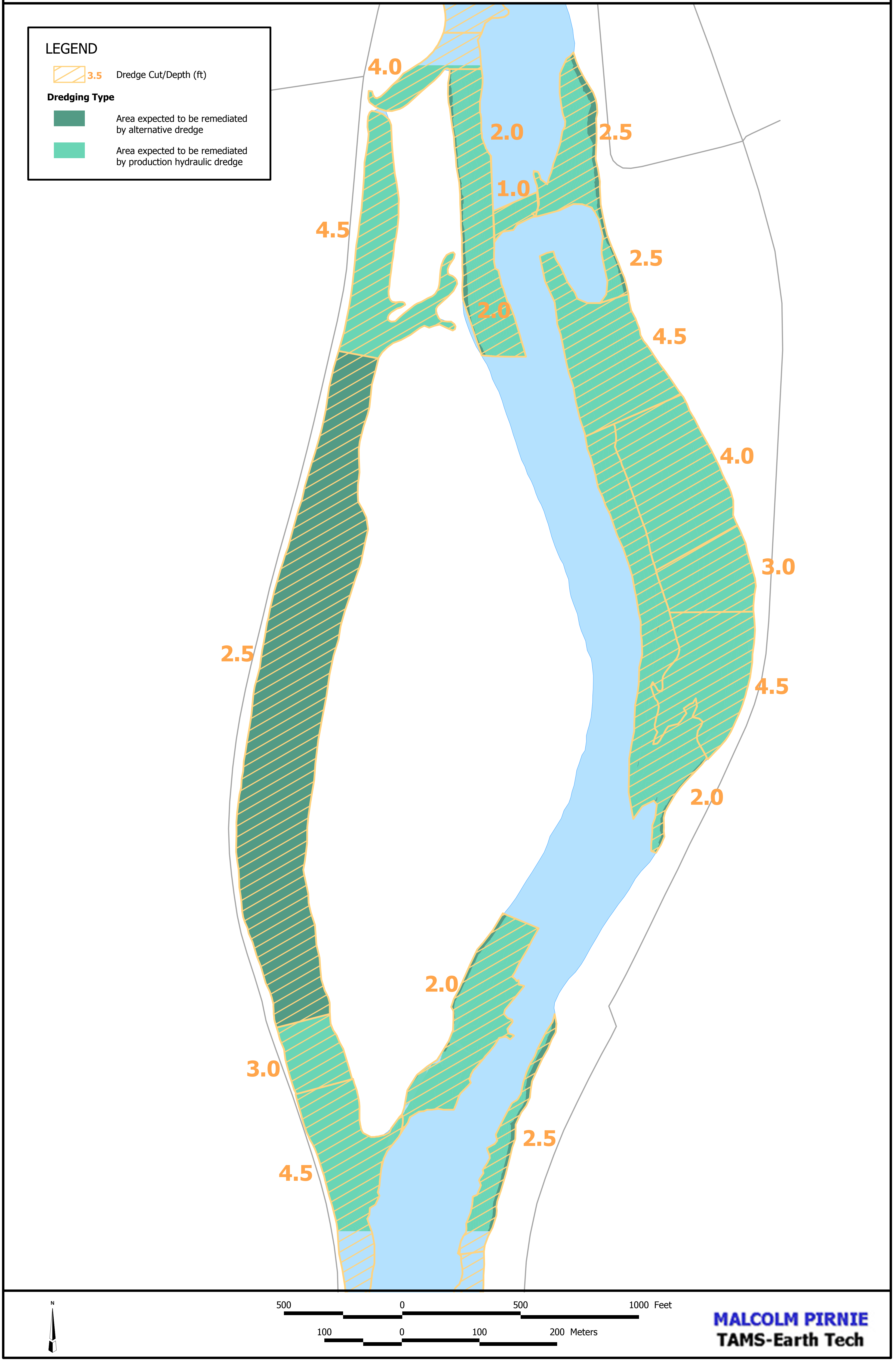
Hydraulic Dredging Equipment Analysis - RM 190.5 - 191.5



Hydraulic Dredging Equipment Analysis - RM 189.5 - 190.5



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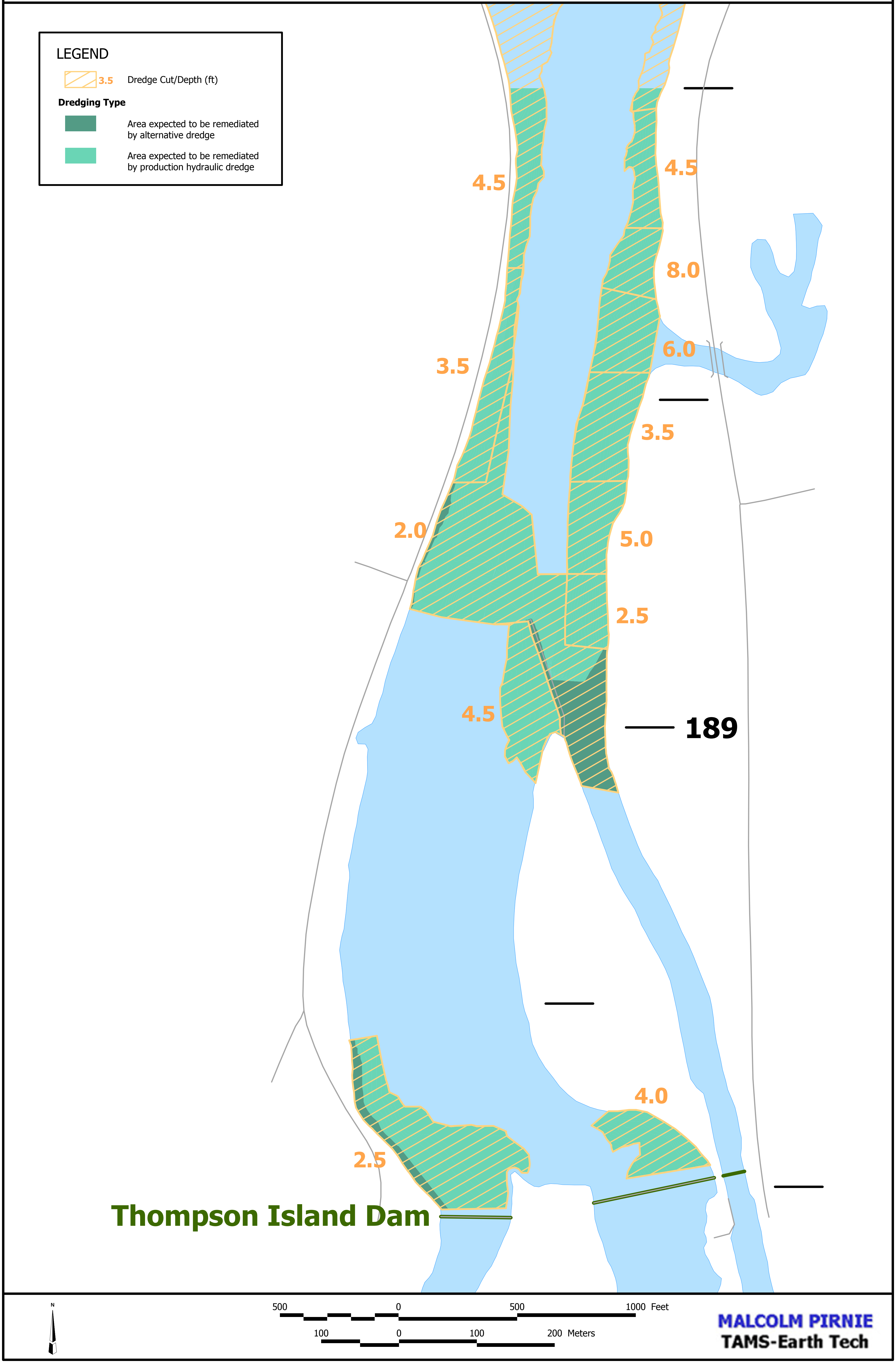
Hydraulic Dredging Equipment Analysis - RM 188.5 - 189.5



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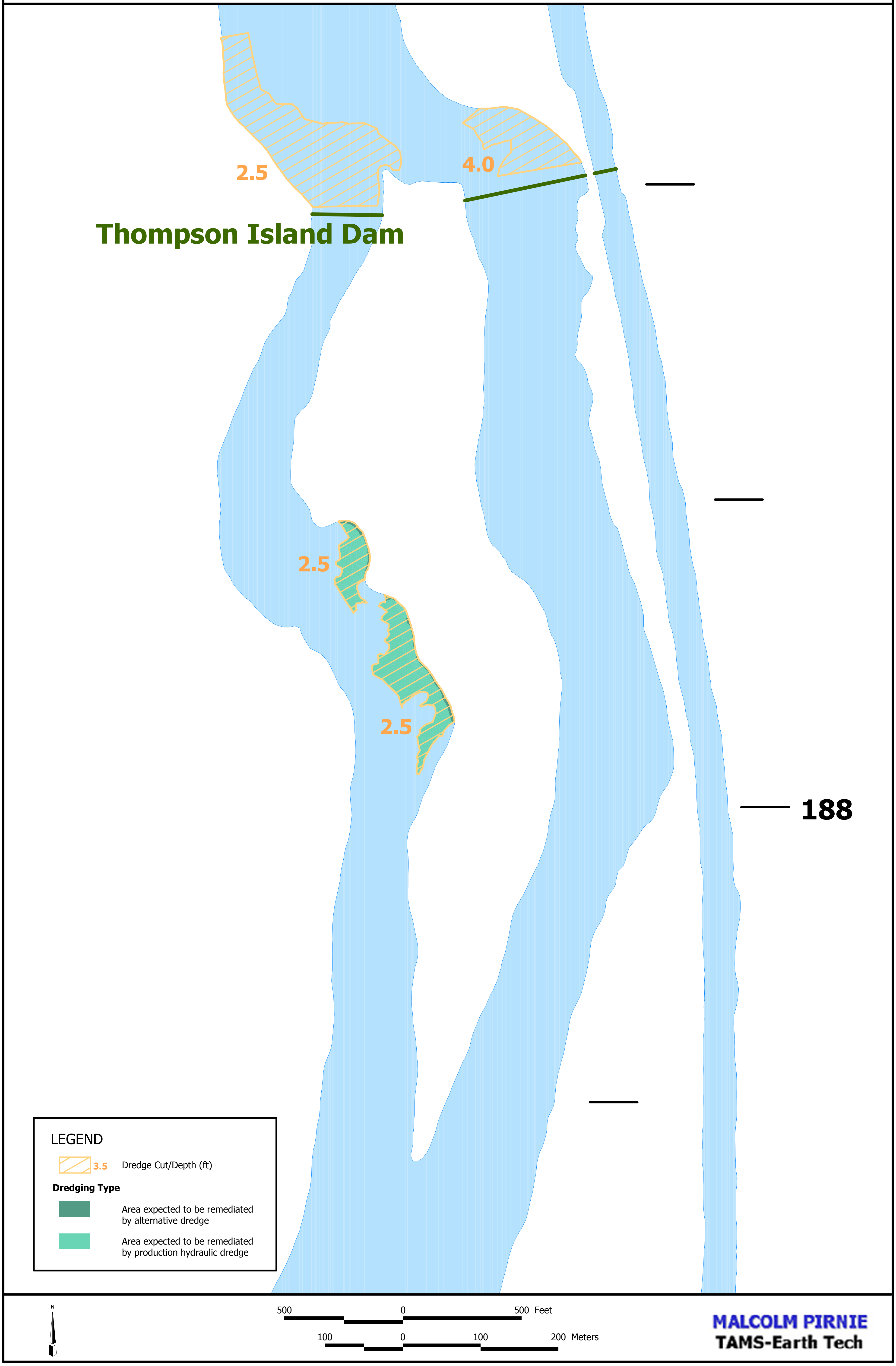
Hydraulic Dredging Equipment Analysis - RM 187.5 - 188.5



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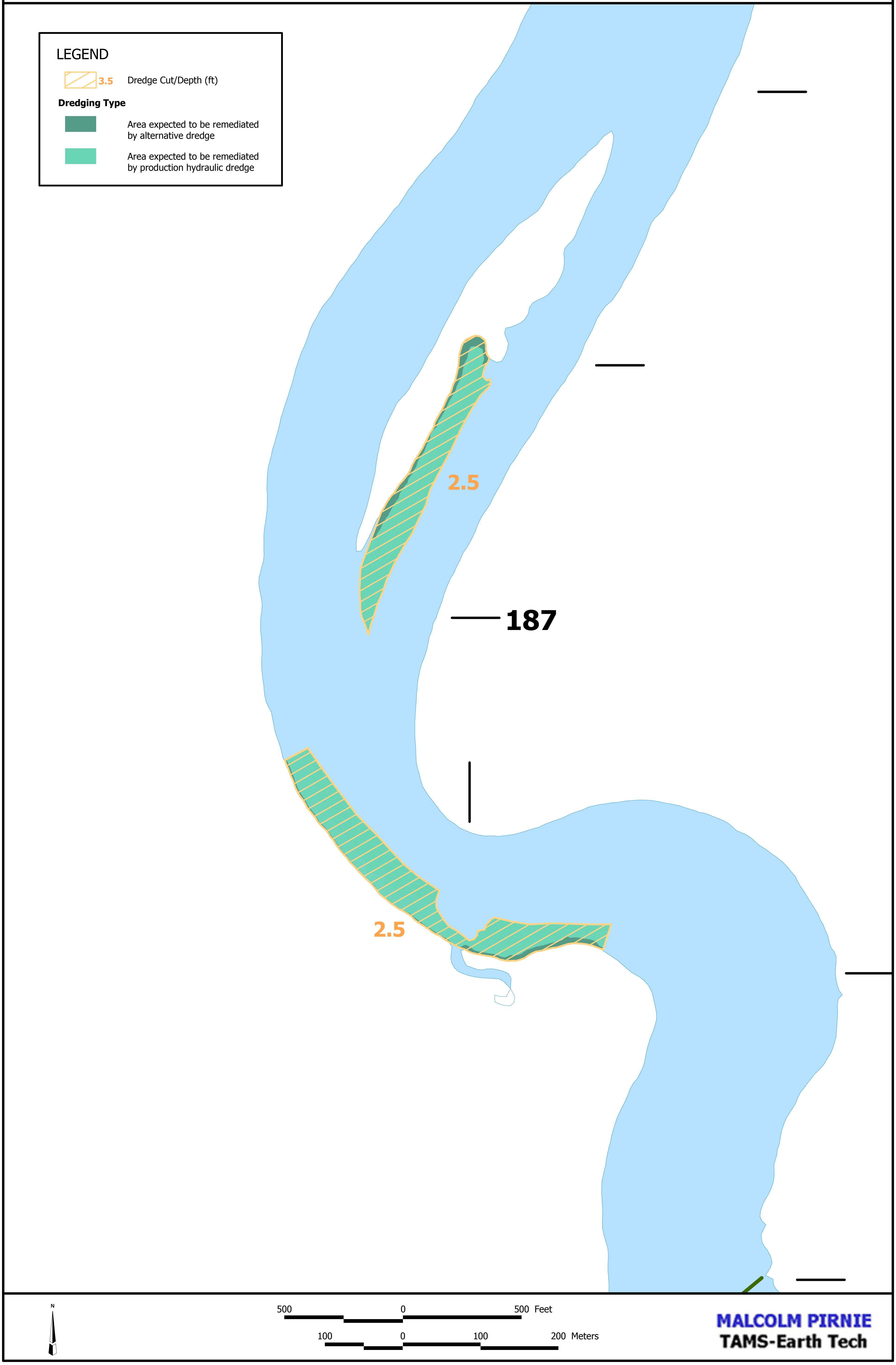
Hydraulic Dredging Equipment Analysis - RM 186.5 - 187.5



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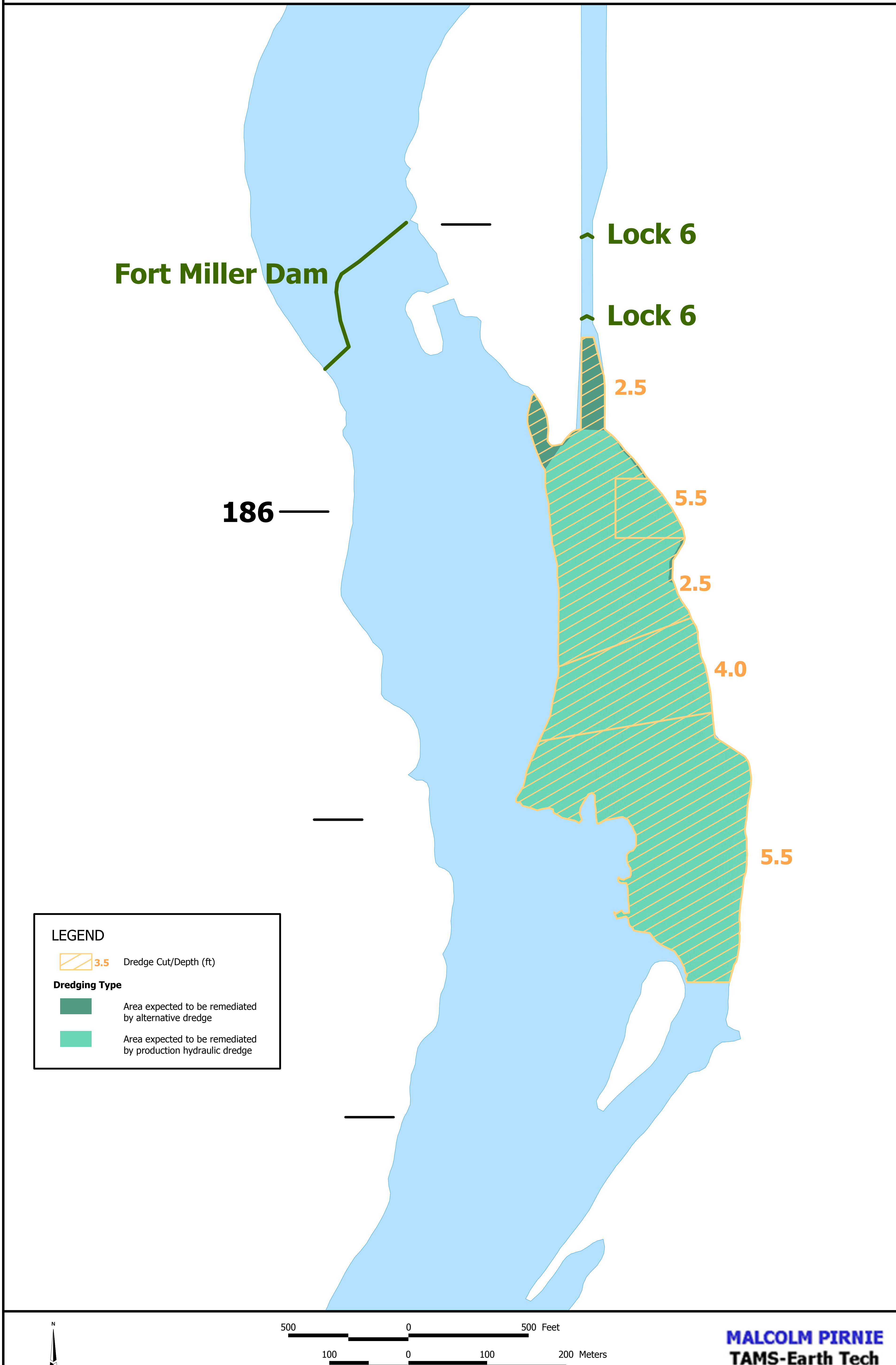
Hydraulic Dredging Equipment Analysis - RM 185.25 - 186.25



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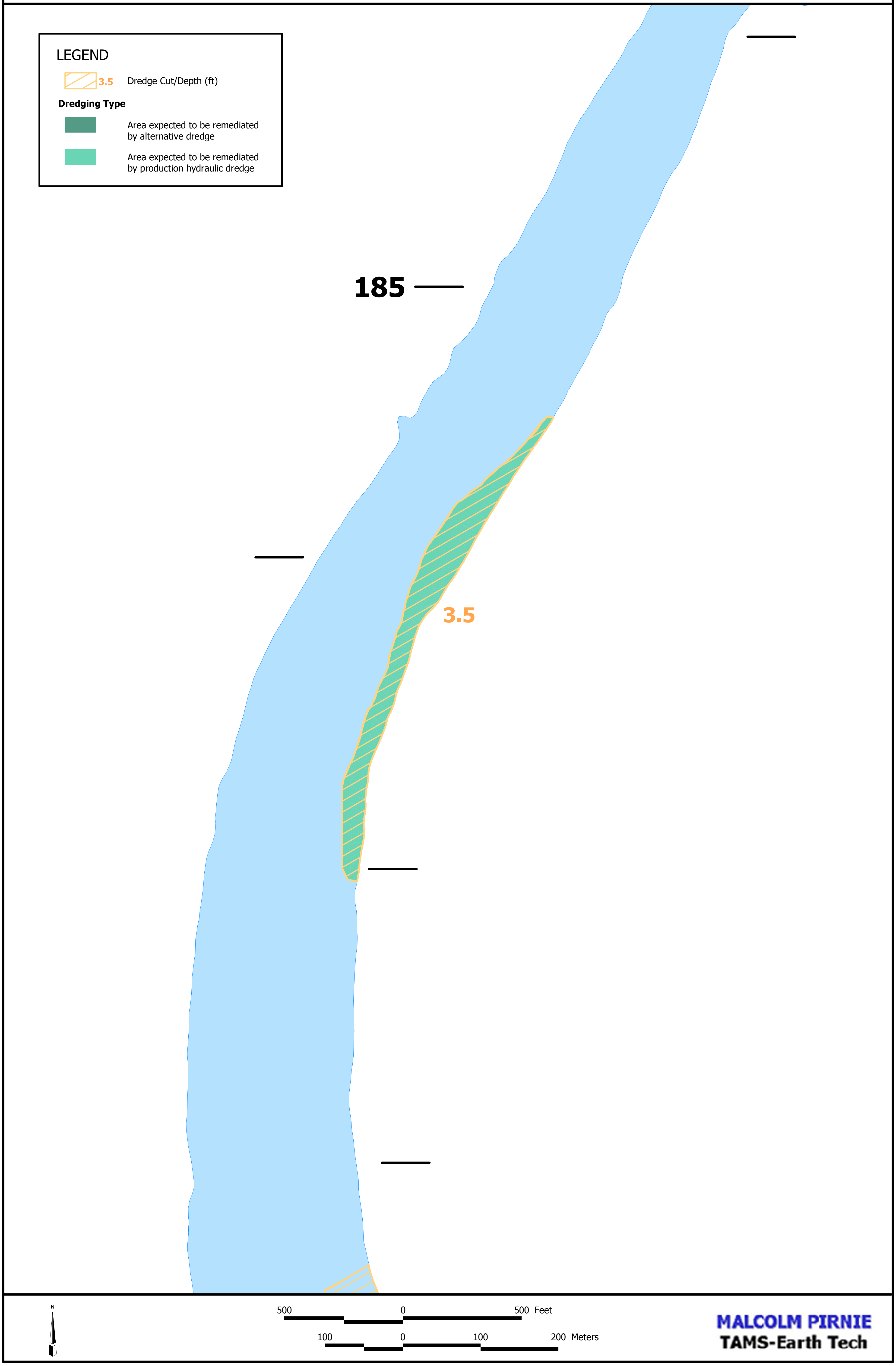
Hydraulic Dredging Equipment Analysis - RM 184.25 - 185.25



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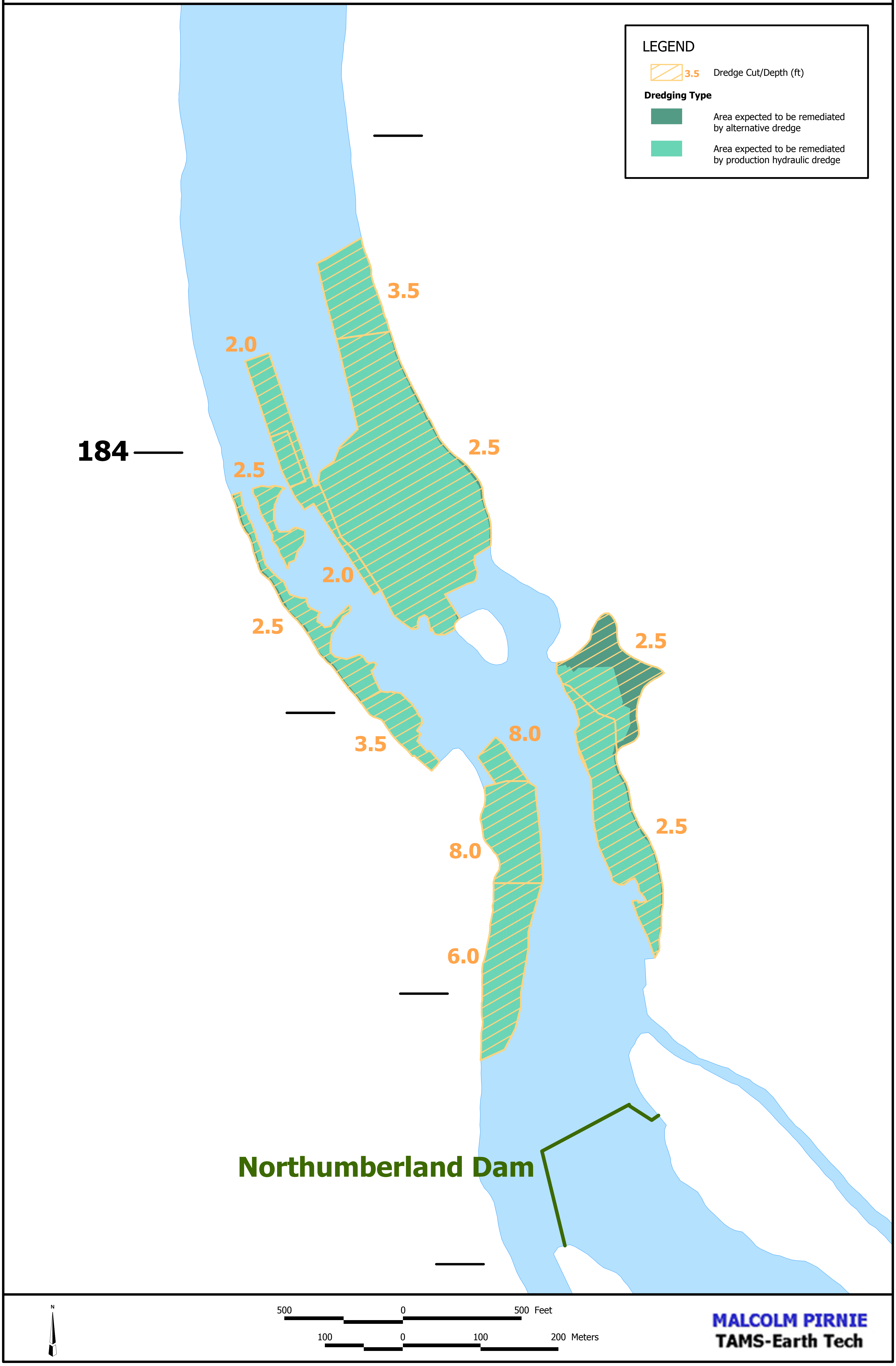
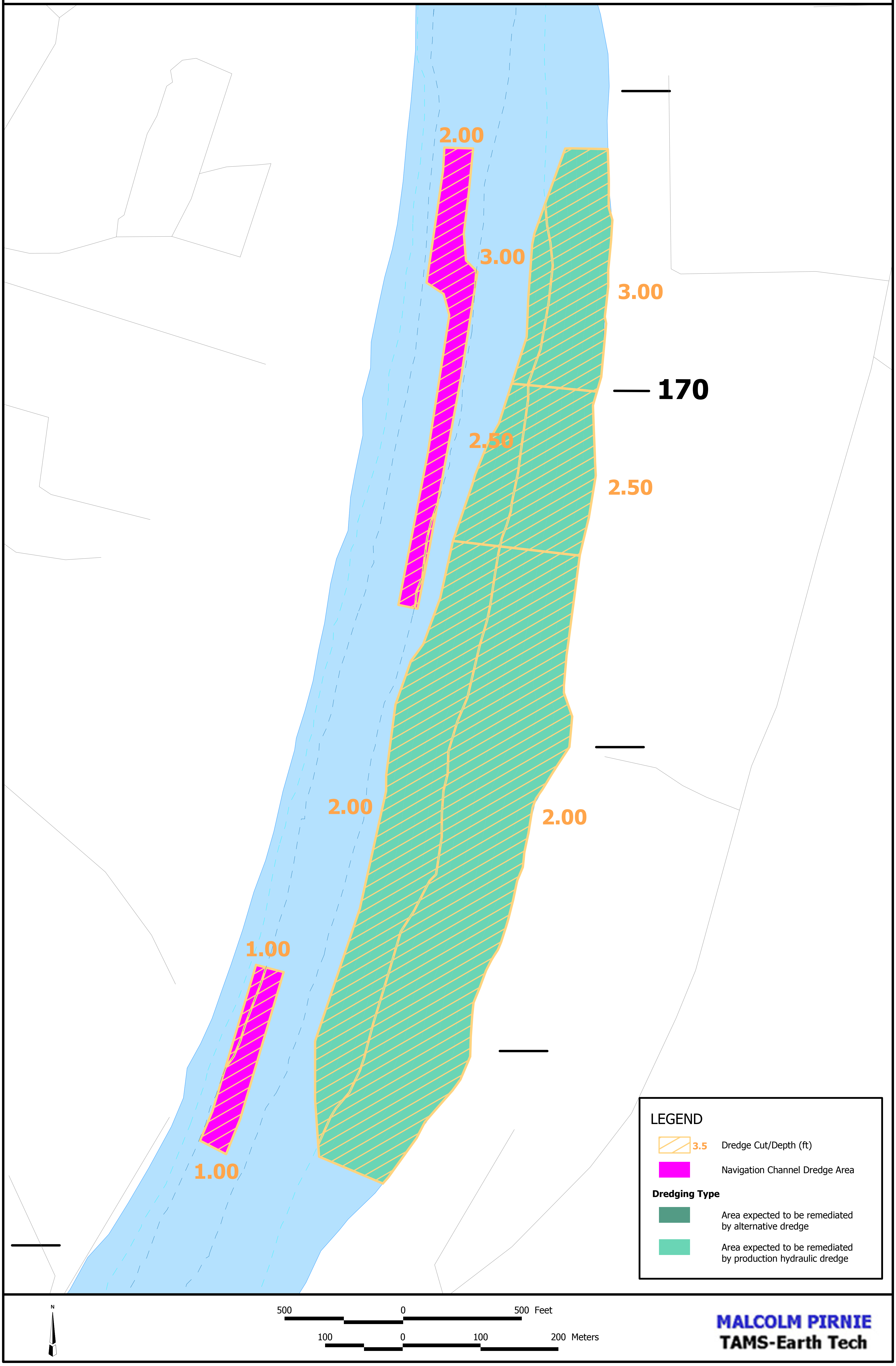
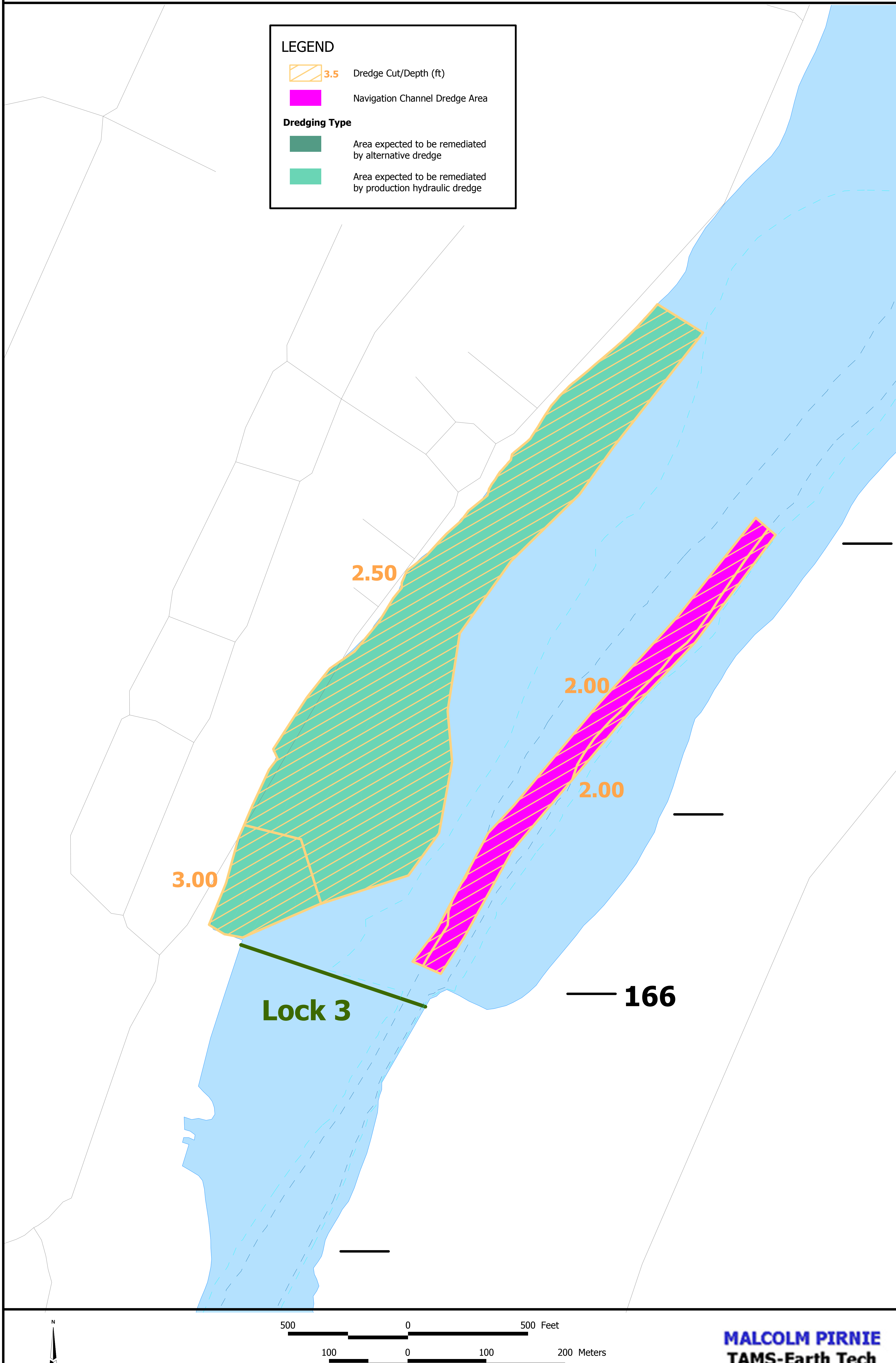
Hydraulic Dredging Equipment Analysis - RM 183.25 - 184.25



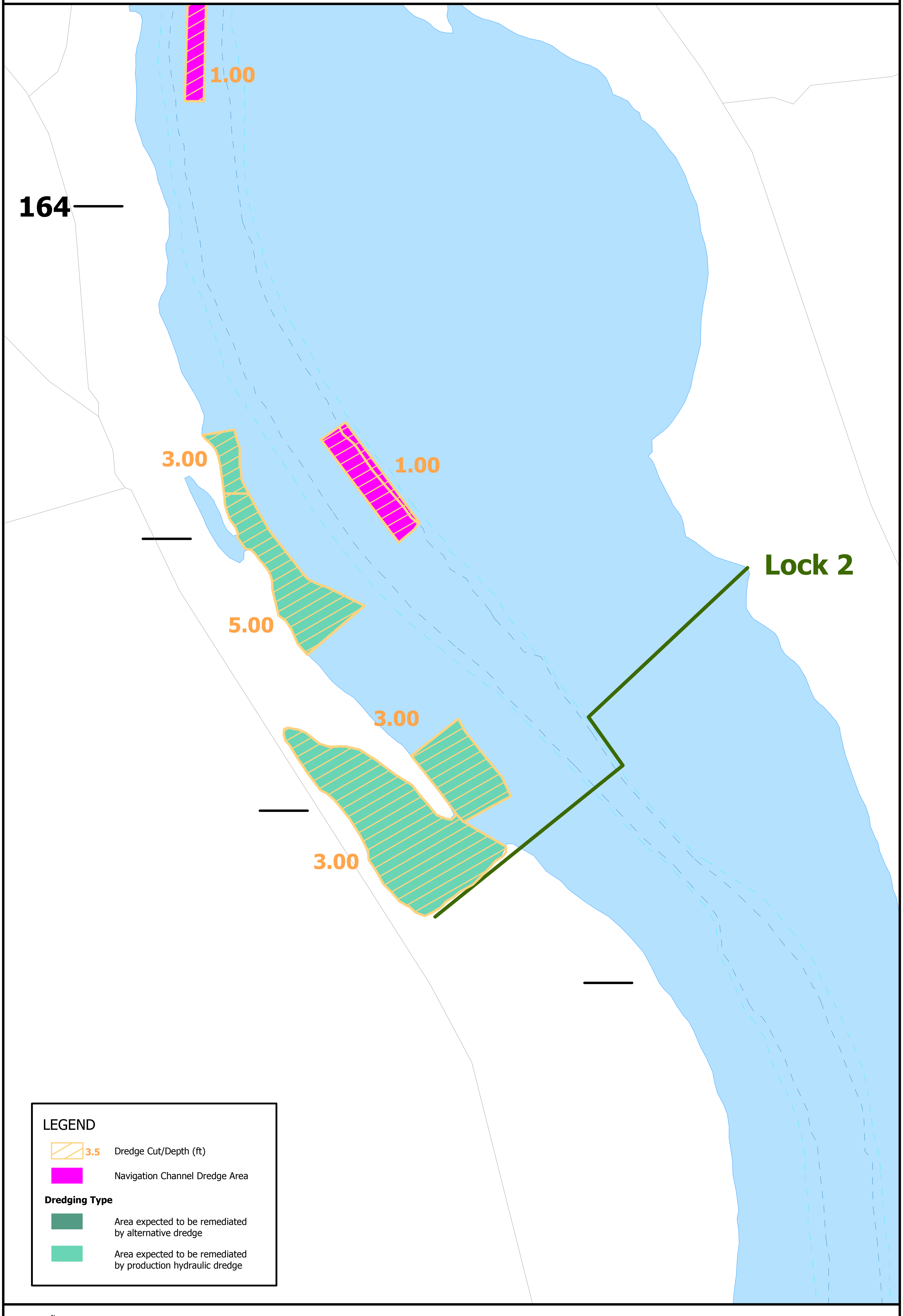
Hydraulic Dredging Equipment Analysis - RM 169.25 - 170.25



Hydraulic Dredging Equipment Analysis - RM 165.75 - 166.75



Hydraulic Dredging Equipment Analysis - RM 163.25 - 164.25



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