

REPORT

Regional Municipality of Wood Buffalo

Flood Mitigation Options Review



May 2017

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1 Introduction

1.1 BACKGROUND

In response to the Regional Municipality of Wood Buffalo's (the Municipality) Request for Proposal (RFP), RFPQU3321, Associated Engineering (AE) submitted a proposal with a work plan that was awarded in February 2015. AE began working with the Municipality immediately with Mr. Oscar Gonzalez as the project manager of the Municipality. Due to further discussions required within the Municipality, the project was put on hold since April 2015. The project was then resumed and a start-up meeting was held on April 5, 2016, with Mr. Saleem Ahmed as the project manager. Under Mr. Ahmed leadership, a feasibility study was requested for an evaluation on demountable walls. This report was submitted in draft to the Municipality in August 2016. The project was put on hold due to the fire of 2016, and discussion on the feasibility of the demountable wall system was on-going.

In 2017, the project was resumed on February 9, 2017 with a start-up meeting with Ms. Maureen Nakonechny as the new project manager of the Municipality. Preliminary design is pending on the analysis and discussion on demountable wall system that the Municipality is currently undertaking. While the assessment on demountable wall system is underway, this report is submitted as final.

1.2 OBJECTIVES

Based on the discussion on April 6, 2016, the Municipality would like to review and evaluate other flood protection options other than the earth berm structures. Particularly, the Municipality would like to review the demountable wall systems that can provide the necessary protection, and can be removed when not in use. In addition to this review, the Municipality requests AE to review other options such as a permanent wall system, reducing earth berm footprint with use of geosynthetic products (eg. geogrids, MSE walls, geoweb), or a combination of different wall and berm systems. The main intent is to conduct a thorough evaluation of different flood protection wall systems, and provide the Municipality with sufficient information to make an informed decision.

In response to the Municipality's request, AE has prepared this report with the following objectives:

1. Define the design criteria.
2. Identify options that consists of the following flood wall systems:
 - a. Earth berm
 - b. Demountable wall
 - c. Permanent wall
 - d. Combination of earth berm and walls.
3. Compare the principles of Triple Bottom Line criteria: Social, Environmental, Economics for each option with the added criterion, Constructability.
4. Identify key issues and provide recommendations for next steps.

2 Engineering Design Criteria

As discussed with the Municipality at the onset of the project in 2015, and at the re-start meeting in 2016, the following engineering design criteria for Reach 2, 7, 8 and 9 are:

1. During the April 2016 discussion with the Municipality, the design flood level at elevation 248.5 m was to be approved by Council. Based on previous studies conducted by NHC, flood level of elevation 250 m is recommended to be the flood protection level. For the purpose of this report, the Municipality would like to limit the discussion to 250 m flood protection level with the understanding of 248.5 m as an interim discussion.
2. Based on Tetra Tech's analysis, the flood berm and/or flood protection walls should be located at least 30 m from the top of river bank to the outside toe of the berm or outside edge of the flood wall.
3. If the flood structure consists of earth berm, the initial side slopes should be 3:1 (horizontal:vertical) unless reinforcements such as geogrids and soil wrapped in geotextiles (eg. MSE walls) are used to reduce its footprint. The assumption is that slope stability analysis would be conducted to confirm the final slope grades as part of the detailed design.

Other design considerations would include, but not limited to:

- Erosion and sedimentation control on an earth berm.
- Seepage control for a flood wall foundation or an earth berm.
- Overturning forces under active river flows, or ice jam conditions on the flood wall.
- Soil compaction under wall foundation (spread footing) or in an earth berm.
- Native soil condition in which wall foundation may be founded in (piles) or on (spread footing).
- Drainage and surface runoff on the properties inside of the flood protection.
- As indicated in the RFP, the flood structure would include a trail with the understanding that the trail system and look-out details will be determined at design stage, using the Municipality's design specification: Engineering Servicing Standards (ESS). Note that Reach 1 was modified to have a 4 m trail. The trail width would need to be confirmed prior to detailed design.

2.1 BOUNDARY CONDITIONS

The physical boundary conditions of each Reach that would require further design consideration are discussed here.

Reach 2

At Reach 2, the connection to Borealis Park as a continuation to Reach 1 and Snye Point Park would need to be evaluated, as the new construction may only need to be tied into the future Prairie Loop Boulevard at Morrison Street. The final design of Prairie Loop Boulevard needs to be confirmed.

Reach 7

The alternate alignment (Figure 1) as described in Background, has no major physical boundary conditions, except that a 30 m setback is recommended. The natural slope stability will also need to be assessed to determine if the 30 m set back is sufficient due to the additional loading of the flood protection structure. Geotechnical site assessment is pending, and soil characteristics would need to be evaluated for foundation design.

Reach 8

The existing development (Long Boat Landing) and the Hangingstone River limits the space of which a flood protection structure can be located (Figure 2). The setback distance of 30 m further reduces the space availability. Furthermore, Tetra Tech has reported that the natural river bank slope has a Factor of Safety of less than 1.5 (Tetra Tech, 2015), which signifies that the natural river bank is susceptible to failure with future flood events. Armoring of the natural slope will need to be considered.

During the onset of the project in 2015, a discussion with Devonian Properties Inc., regarding the development of Long Boat Landing indicated that they would entertain the discussion of the flood berm located within their property; however, the trail system would need to be outside of their property line. This would be important to include in the design of the flood berm, if it is selected.

Reach 9

The alignment is also located adjacent to the Hangingstone River (Figure 3). Although space for a flood protection structure is limited, the ground elevation ranges between 247.5 to 249 m in some areas. Hence, the areas that required further height extension for flood protection is small and the footprint would be narrow in comparison.

Connection and accessibility to the existing infrastructure such as PLB/Clearwater Drive, new pedestrian bridge, and Tolen Drive would need to be considered.

3 Flood Protection Best Management Practices

In Alberta, there is a Dyke (dike) Certification for flood berms. The certification provides a special status which provides the municipal governments added flexibility in establishing appropriate flood proofing standards consistent with current provincial guidelines (Alberta Environmental Protection, 1996) on flood damage reduction. Areas protected may include flood walls or other physical barriers. The intent of the certification is a means of assuring that the potential for dike failure or unsatisfactory performance is minimized.

Where Alberta regulation and guidelines are lacking in best management practices for flood wall/berm protection, we reviewed British Columbia's regulations and guidelines for guidance and consideration for implementation on flood protection. In BC, the province has reference documents regarding dike design and best management practices provide guidelines in design, site investigation, site selection, set back distance, construction inspection, slope protection, surface and groundwater controls, seepage controls, and maintenance and inspections. These are listed in the Reference section for information.

Specific to the maintenance and inspection of flood berms, the Province of British Columbia government would require a qualified inspector to inspect all works each Fall, Spring, and during freshet. Recommendations for dike maintenance activities are:

1. Removal of trees and brush growth and mowing of grass.
2. Excavation and backfill of animal burrows.
3. Repair of dike slopes damaged by sloughing, erosion, seepage.
4. Restoration of dike crests elevation to grade.
5. Removal of debris and garbage from the dike surface.
6. Removal of drift wood and heavy debris.
7. Survey the dike elevations.

These maintenance activities have been considered in the cost estimates and comparison discussion in Section 5.0.

4 Types of Flood Protection and Control Systems

In 2014, Associated Engineering worked with NHC to reviewed different types of flood wall systems; however, the work scope did not include detail research or evaluation on specific types of flood walls as the discussion was at a conceptual level. Upon re-starting of this project in 2016, the Municipality would like to review several combinations of flood protection structures before proceeding with detailed design. The project team recognized that this is an important phase of the project to ensure that the all suggested options are considered and evaluated to optimize the design.

The Municipality would like to review flood wall systems, earth berms, and a combination of the two. In particular, the Municipality requested that a demountable wall system be reviewed for its applicability to this project. In addition to the demountable wall systems, Associated Engineering has also reviewed permanent flood wall as a potential option. The following provides a brief description of possible wall systems discussed with the Municipality.

4.1 DEMOUNTABLE WALL

This wall system is specifically designed for major river flood events and has the flexibility to be erected prior to flood events, and taken down after the event. The system is then stored indoors until next use.

The flood wall system is designed and manufactured in United States and in Europe. The following photos show examples of these demounted wall systems used in urban areas. The wall system also provides the option of raising its wall height.



Photo 1: Flood barrier by IBS.



Photo 2: Flood wall consisting of permanent wall, and demountable wall adjacent to a sidewalk/road.

The demountable wall system is also available in glass panels as a permanent flood wall; only the European company supplies glass units.



Photo 3: Examples of flood glass walls.

The demountable wall components consist of aluminum planks, stainless steel or galvanized grade nuts/bolts and reinforcement/anchor plates, stainless steel posts, and gaskets/water stoppers. We identified two manufacturers of the demountable wall designers and manufacturers in US and Europe. During our interviews with these companies, the following key points that were discussed regarding design and operations:

- The demountable walls are typically designed up to 2 m height (not including the base foundation walls). Walls that exceed 2 m height would require site specific design considerations, deep foundations depending on soil conditions, and water pressures behind the wall. The manufacturers indicated that the cost will escalate with non-standard design.
- Foundations will consist of either spread footing or piles depending on the wall height and anticipated hydrostatic pressure. Ice impact will need to be considered as part of the design. The pile spacing and depths are specific to site and soil conditions.
- Foundation wall can be above grade that forms as part of a decorative wall or permanent wall system that is low to the ground, as shown in Photo 4.



Photo 4: Low foundation wall with demountable flood wall.

4 - Types of Flood Protection and Control Systems

- Wall components, once removed, will need to be stored in pallets as shown on Photo 5: indoors protected from rain, sun, and below freezing temperatures. These wall components would ideally be installed in non-frozen conditions; therefore timing of installation would need to be carefully considered and planned to ensure the system would not be compromised by ice and snow during cold weather conditions.
- The wall is claimed to be more tolerant to differential settlement than the concrete foundation wall.
- The metal products were claimed to last over 50 years, and gasket at 20 years. Replacement of components due to vandalism, and other damage, can be done as needed after annual inspection.
- For installation, the manufacturer indicated that one person can put up walls between 10 to 30 m² of wall per hour depending on the skill level, weather, and equipment availability. The manufacturer estimated that a 10 men crew can erect the walls at Reach 7, 8 and 9 within 10 days.

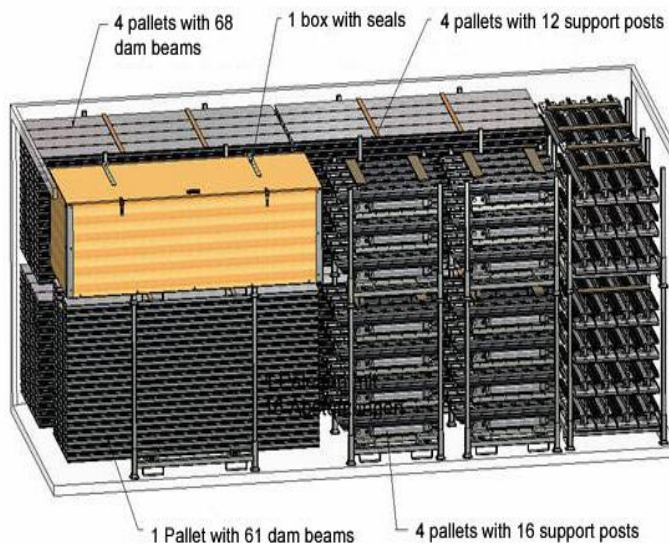


Photo 5: Storage Pallet

- The manufacturer advised that the local installation crew would be trained by a skilled/trained person; this person can be supplied by the manufacturer and designer. Staff turnover, labour availability, and training would need to be planned annually.
- The manufacturer recommended that 4m width of space to accommodate equipment when installing the walls. This will depend on the types of wall and wall height. Equipment required may include lifting arm (eg. Zoom Boom), flat back truck, scaffolding or ladder.



Photo 6: Flood wall installation.

- Delivery after shop drawing review is 4 to 6 months.

The maintenance and inspection of the flood wall would be conducted as part of the construction and deconstruction process annually. Specific items to review are dents, cracks, rusting of metal material, cracking and hardening of gaskets, as well as inspection on the above grade foundation wall. Any cracks in the foundation due to settlement would need to be mitigated. Survey of wall elevation will also be recommended as part of the annual inspection process.

Discussions through e-mail correspondence with the US and European companies are found in Appendix C.

4.2 PERMANENT WALL

The permanent wall system in this context is not removable and forms part of the park trail system. It is often decorative or esthetically acceptable to the public. As noted in Photo 7, this example was constructed in Grand Forks, North Dakota, US, as a flood wall and incorporated as part of the trail and park system.



Photo 7: Permanent flood wall installation.



Photo 8: Flood wall installation with demountable wall in some sections.

Similar to the demountable wall system, foundation considerations can be spread footing and/or deep foundations depending on the local soil conditions. The wall systems can be precast, cast-in-place, brick, stones, etc., which can be cast with the foundation.

One of the discouraging perceptions of a permanent wall is that it could be esthetical unpleasing and blocks the view to the rivers; however, depending on the design and height of the wall, it can be designed with different material and colours that would reflect the local character.



Photo 9: Example of permanent flood wall installation.

The maintenance and inspection of a permanent wall would be conducted annually during spring melt and in fall. Inspection would identify any ground settlement, cracks, gaps, and breach in the wall system that would cause a leak in the event of a flood, as well as wall elevation to be surveyed. Mitigation would be required annually to address the deficiencies.

4.3 EARTH BERM STRUCTURE

Earth berm structure is the basis of the initial discussion and the original RFP of this project. It consists of sloped sides with trail systems at the top, similar to that of Reach 1 along the west end of Snye Channel.

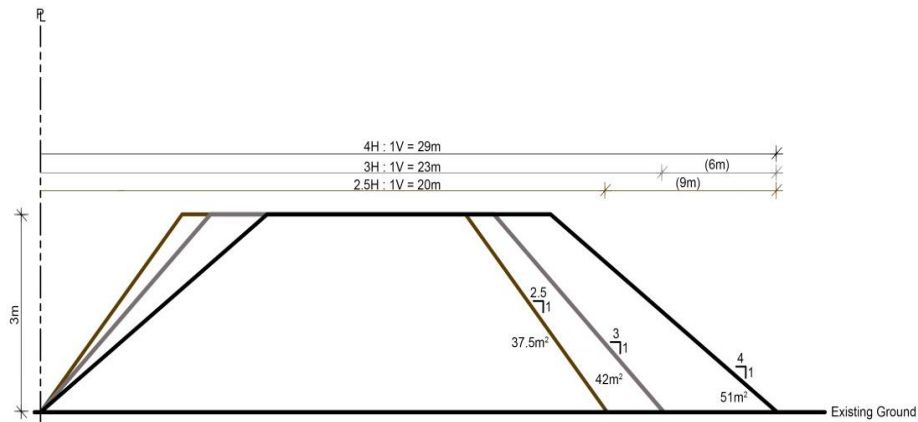


Figure 3-1- Effects of Side Slopes on Berm Foot Print

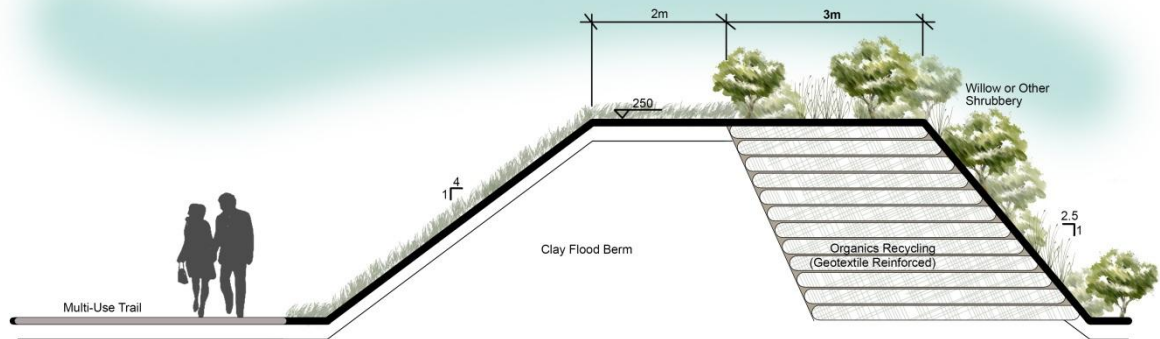


Figure 3-2 - Berm Construction with Composite Materials

Similar concepts are identified for Reach 2, 7, 8, and 9, with some considerations of geosynthetic projects such as that in MSE wall, and reinforced soil with geogrid, or geoweb/geocell, to reduce the footprint of the berm, as shown in figures above. The use of geogrid to reinforce soil, soil wrap using geotextile, and MSE walls tie backs are commonly used to reinforce slopes to allow reduction in slope angle and maintain its global stability.

Thurber Engineering, our geotechnical sub-consultant, evaluated geocell and indicated concerns with types of granular fill, and long term global stability, compared with other types of reinforcements and protection listed above. Geocells or geoweb are better applied in road foundations where the granular base or sub-base of the road structure is confined within the geocells/geoweb thus increasing the stability of the road structure. However, this application is not suitable for retaining walls where it is frequently exposed to floods and elevation change in water levels. Thurber's report found in Appendix A provides further details.

The maintenance and inspection duties are to be performed to the recommendation of the guidelines listed in Section 3.0.

4.4 COMBINED WALL AND BERM SYSTEMS

The purpose of discussing a combined wall and berm systems is that in areas where the original ground elevations is about 3 to 4 m lower than elevation 250m (flood protection), constructing a berm to raise the original ground could be more cost effective than constructing, say a 4 m tall wall. The construction of earth berm would reduce the required height of the flood wall. Reach 7 and parts of 8 have about 2.5 to 4 m elevation difference. Understanding the merits of a combined wall and berm systems is important in selection of flood mitigation option, as some flood protection system may be more suitable than others.

The discussion in the following section would include this option to provide cost, environmental and social comparison.

5 Flood Protection Systems Comparison

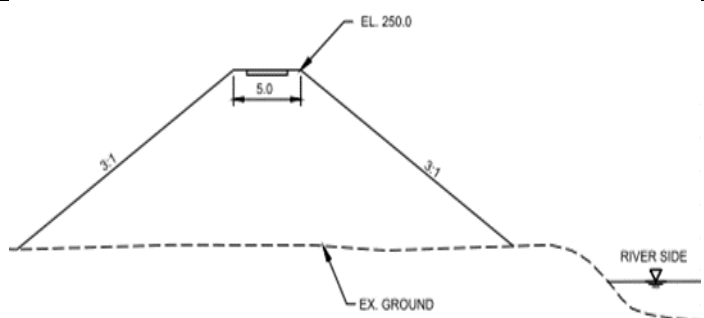
5.1 FLOOD PROTECTION OPTIONS

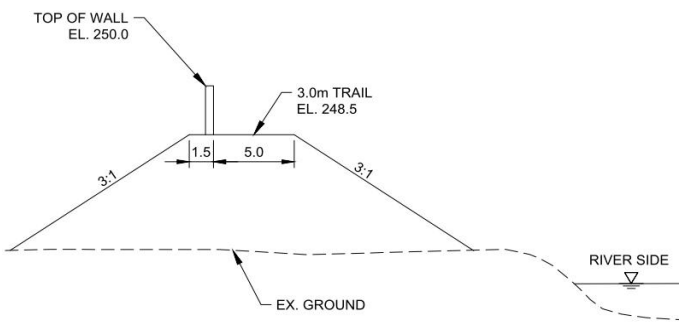
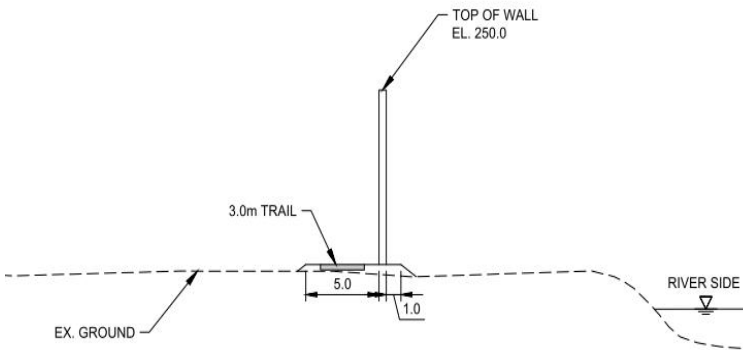
As discussed, during the April 2016 discussion with the Municipality, the design flood level at elevation 248.5 m was identified to be an interim level. Flood level of elevation 250 m is the ultimate protection level. For this report, the Municipality would like to limit the discussion to 250 m flood level protection.

The following flood protection options reviewed for this project are illustrated in [Table 5-1](#). For the purpose of this comparison, the illustrations are concepts and are indicative of baseline conditions that can be refined in detailed design. It is also assumed that a 30 m offset from the river bank has been applied.

The location of the flood walls, whether it is on the river side or away from the river, will be finalized based on social acceptance from adjacent residents (specifically Reach 8), and operational and maintenance requirement. For the current study, the flood walls are placed to illustrate potential location based on privacy and ease of maintenance and operations.

Table 5-1
Options Description

No.	Options	Basic Description
1		· Earth Berm only at 250m elevation. · Trail systems at the top.

No.	Options	Basic Description
2		• Earth Berm + Wall Extension • Berm at elevation 248.5m • Demountable wall or permanent wall extended to 250.0m. • Trail system at the top of the berm.
3		• Demountable Wall only at 250m elevation. • Trail system adjacent to the wall.

The proposed alignments, Reach 7, 8 and 9, discussed with the Municipality in 2015 are shown in [Figure 1, 2, and 3](#), respectively in the attached. Each figure shows the potential footprint depending on the option selected. As indicated, the largest footprint would be Option 1, and reduction thereafter. This is important as there are concerns with proximity to the Hangingstone River and Clearwater River due to scouring and potential erosion causing instability of the natural river bank. The setback distance would also be considered to provide additional protection to the adjacent properties.

5.2 METRICS

The options are evaluated based on the concepts of best management practice and sustainability: Environmental, Social, Economics. For this discussion, we have also added Constructability for consideration. To assist with the evaluation, we have used the basic principles of Envision™ Rating System for outlining the relevant metrics at this early stage of the project. Envision Rating System is originally developed for infrastructure project assessment as well as a guidance tool for sustainable



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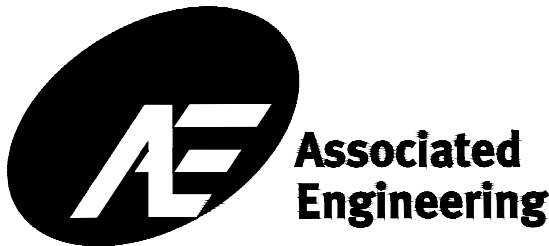
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REVISIONS



FORT McMURRAY
FLOOD PROTECTION

REACH 7 PLAN
BOTTOM OF BANK FOOTPRINTS

APPROVED BY: J. TANG	CHECKED BY:
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DESIGNED BY: C. BALITBIT	DRAWN BY: K. GRANDISH
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SCALE: 1:1000	DRAWING NO.
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DATE: 2016-08-04	FIGURE 1
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CONSULTANT NO. 2015-3349

MUNICIPAL DRAWING NUMBER:



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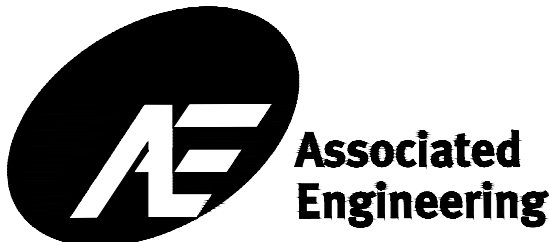
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REVISIONS



FORT McMURRAY
FLOOD PROTECTION

REACH 8 PLAN
BOTTOM OF BANK FOOTPRINTS

APPROVED BY: J. TANG	CHECKED BY:
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DESIGNED BY: C. BALITBIT	DRAWN BY: K. GRANDISH
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SCALE: 1:1000	DRAWING NO. FIGURE 2
DATE: 2016-08-04	
CONSULTANT NO. 2015-3349	

MUNICIPAL DRAWING NUMBER:



OPTION BERM HEIGHT TOE OF BERM
1 (FULL BUILD) 250.0m — — —



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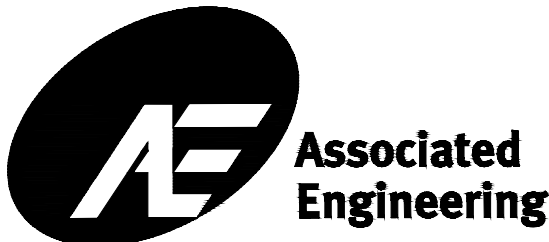
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REVISIONS



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FORT McMURRAY FLOOD PROTECTION

REACH 9 PLAN BOTTOM OF BANK FOOTPRINTS

APPROVED BY: J. TANG	CHECKED BY:
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DESIGNED BY: C. BALITBIT	DRAWN BY: K. GRANDISH
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SCALE: 1:1000	DRAWING NO. FIGURE 3
DATE: 2016-08-04	
CONSULTANT NO. 2015-3349	

MUNICIPAL DRAWING NUMBER:

infrastructure design. It provides a holistic framework for evaluating and rate projects against the needs and values of the community. It systematically organizes into five categories of sustainability objectives:

1. Quality of Life
2. Leadership
3. Resource Allocation
4. Natural World
5. Climate and Risk

Although it is premature to use the Rating System for this project at this time because we are in the process selecting an option, its basic principles of sustainability still apply. Envision provides a self assessment checklist to identify areas where sustainable performance can be identified, considered, and improved. The checklist is applicable for this project as it captures the Triple Bottom Line (TBL) metrics of Environmental, Social, Economics, and Constructability. The following a list and a description of each metric:

Environmental

- a) **Green Space**
 - Evaluates any gain or loss of green space to the pre-developed area. Preserve existing flood plains, if any.
- b) **Riparian Vegetation (Habitat Enhancement)**
 - Provides opportunity for habitat enhancement with vegetation planting.
- c) **Proximity to River Banks**
 - Maintain a setback distance of 30 m to avoid flood protection to be impacted by future flooding or wash out of river banks.
- d) **Carbon Footprint**
 - Anticipated CO₂ emission activities during construction phase.

Social

- a) **Trail System**
 - Provides opportunity for trail system development that would provide public access along the river banks.
- b) **Accessibility to River**
 - Provides opportunity for public to access the river safely.
- c) **View of River**
 - Provides public view of the river and its surrounding natural setting.
- d) **Maintenance and Inspection**
 - Performs duties that would maintain the flood system in good operation to ensure long term proper function.
- e) **Land Utilization**
 - Provides opportunity for future development and not cause unintended sterilization of land.
- f) **Public Safety**
 - Ensure public safety is addressed through proper lighting, signage, policing, vandalism prevention, etc.

g) **Preserving Local Character**

- Provides opportunity to preserve or restore historical or local character.

h) **Enhance Public Space**

- Provides opportunity to improve existing public space. The addition of the flood protection should not degrade the use of public space.

Economics

a) **Capital Cost**

- Cost of extending the flood protection structure to an elevation of 250.0m for Reach 7, 8, 9.

b) **Operations and Maintenance Cost**

- O&M cost for structures constructed to 250.0m.

c) **Land Acquisition Cost**

- Cost of purchasing land that currently is not owned by the Municipality.

A cost estimate of Class D (>50% uncertainty) showing items, estimated quantities, and assumptions for each options of Reach 7, 8, and 9 are summarized in table found in Appendix B. A contingency of 30% is applied for uncertainties. Further discussions on assumptions and constraints are in Section 5.3.

Constructability

a) **Material Availability**

- Material that is readily available for construction. Potential long travel distances.

b) **Supply Time**

- Time for the material to be manufactured and/or delivered to site. Identify potential late deliveries.

c) **Sequence of Construction**

- Considers the sequence of construction that is necessary of extending the wall from 248.5m to 250.0m.

d) **Available Space**

- Considers the amount of space for construction, and identify physical boundary that may require special equipment.

5.3 ASSUMPTIONS AND CONSTRAINTS

Majority of the discussion in this section will pertain to the cost estimate. At this stage of the project, there is a high level of uncertainties with the types of flood protection specifically with design parameters, soil conditions, foundation types, operational requirements; therefore, the cost estimate is based on Class D or greater than 50% uncertainties. Assumptions and constraints are discussed as follows:

a) **Environmental**

- 30 m setback distance as recommended by Tetra Tech will be assumed unless advised otherwise.
- Insufficient information to calculate carbon footprint at this stage, but it has been identified as a quantifiable metric. Further discussion with the Municipality is required.

b) Social

- Maintenance and inspection would follow the recommendations as discussed in Section 3.0.
- Any land that is proposed to be developed for flood protection is available for negotiation and purchase by the Municipality.
- The Municipality would need to address potential vandalism on the flood walls.
- The Municipality would need to address public concerns on esthetics, accessibility to the river, views to the river, and safety.

c) Economics

- The approximate lengths for each Reaches are:
 - Reach 7 is 930m
 - Reach 8 is 700m
 - Reach 9 is 450m
- All estimated unit rates are based on 2016 construction rates in northern Alberta.
- Land purchase is assumed to be \$79/m² (based on preliminary discussion with the Municipality). This would need to be confirmed with the Municipality.
- **Option 1 – Earth Berm**
 - *Capital Costs:*
 - Tie-ins or access ramps or stairs are not included.
 - Bench nodes are located based on Municipality ESS.
 - Lighting is provided only at the bench nodes and at the start of the trail.
 - Minor electrical work such as ducts, and light poles are included.
 - Vegetation planting is similar to Reach 1.
 - Soil is available within 40km of the project site.
 - *Operations and Maintenance Costs:*
 - Allowance has been made routine inspection and preventative maintenance for grass/vegetation maintenance, minor pavement repairs, cleaning and washing, component replacements (light bulbs, waste bins), survey, inspection.
 - No major repairs are included (berm restoration and reshaping, animal/vehicle damage).
- **Option 2 – Earth Berm + Demountable Wall or Permanent Wall**
 - *Capital Costs:*
 - Tie-ins or access ramps or stairs are not included.
 - Bench nodes are located based on Municipality ESS.
 - Lighting is provided only at the bench nodes and at the start of the trail.
 - Minor electrical work such as ducts, and light poles are included.
 - Vegetation planting is similar to Reach 1.
 - Spread footing is 5.5 m in total length with 1.2 m above ground.

- Shipping and freight cost of the demountable walls are not included.
- Soil is available within 40km of the project site.

Operations and Maintenance Costs:

- Allowance has been made routine inspection and preventative maintenance for grass/vegetation maintenance, minor pavement repairs, cleaning and washing, component replacements (light bulbs, waste bins), survey, inspection.
- No major repairs are included (berm restoration and reshaping, animal/vehicle damage).
- Annual allowance made for:
 - Rental space for storage of demountable wall.
 - Labour crew and equipment to construct and de-construct demountable wall.
 - Labour training.
 - Component replacements of the wall due to wear and tear and vandalism (1% of total wall area).
 - Cleaning/removal of graffiti, and repairs.

Option 3 – Demountable Wall (Glass or Panels)

Capital Costs:

- Tie-ins or access ramps or stairs are not included.
- Bench nodes are located based on Municipality ESS.
- Lighting is provided only at the bench nodes and at the start of the trail.
- Minor electrical work such as ducts, and light poles are included.
- Vegetation planting is similar to Reach 1.
- Wall is supported by piles and foundation wall/base. Piles are H-piles spaced at every 5 m, and depth of 8 m. Foundation wall/base for the demountable walls has total height of 2m, with 1.2 m above ground, and 0.6 m thick.
- Shipping and freight cost of the demountable walls are not included.
- Soil is available within 40km of the project site.

Operations and Maintenance Costs:

- Allowance has been made routine inspection and preventative maintenance for grass/vegetation maintenance, minor pavement repairs, cleaning and washing, component replacements (light bulbs, waste bins), survey, inspection.
- No major repairs are included (berm restoration and reshaping, animal/vehicle damage).
- Annual allowance made for:
 - rental space for storage of demountable wall.
 - labour crew and equipment to construct and de-construct demountable wall.

- labour training.
- component replacements of the wall due to wear and tear and vandalism (1% of total wall area).
- Cleaning/removal of graffiti.

For all demountable wall options, glass panels are available by the European manufacturer. The cost increment is at least 1.5 times higher than aluminum panels (\$3,000/m²).

5.4 COMPARISON DISCUSSION

We conducted a preliminary comparison of each option against the above metrics. Qualitative and quantitative observations of each option are tabulated on [Table 5-2](#) for Options 1 through 3. The quantitative comparison is only made for the Economics category and not for the other category, as there is insufficient information to conduct the calculation at this time.

The intent of this comparison is to provide the Municipality with an overview of each option and understand the potential effect (positively or adversely) on the community without providing unintentional biased opinion that could impact decision making. This comparison is to provide the foundation for a Triple Bottom Line assessment as part of the selection process.

Our initial key findings of the comparison in term of sustainability categories are:

i. Environmental

- Option 1, Earth berm structures, has the highest footprint of disturbance, but the disturbance on the green space can be restored. The footprint can be reduced with use of geogrid, and MSE wall. This would be explored as part of final design.
- It is anticipated that the combination of earth berm and wall systems (Option 2) would have high carbon footprint due a combination of berm construction and long distance travel for the walls.

ii. Social

- All options provide trail systems. Permanent wall system may have negative perception for obstructing view and limited accessibility to the river. Glass wall system could be considered, but may be susceptible to vandalism. As noted in the example of Grand Forks, the wall design would need to be considered for esthetic and public acceptance.
- The demountable wall system (Option 2, and 3) can provide access and views as it can be removed after use.
- Option 3 has the smallest impact on the physical footprint. This option may be suitable for Reach 8 and 9, where space is limited.

iii. Economics

- Option 3 (Demountable Glass Walls) has the highest capital and operations costs.
- Option1 (Earth Berm) has the least capital and operations cost.

- c. Land acquisition is the highest for Option 1 and lowest for Option 3.
- d. The reduction of berm footprint for Option 1 and 2 are possible with use of MSE wall system, geogrid, etc. Depending on the reduction of footprint required, the MSE wall would provide the most reduction. The unit rate cost for MSE wall is estimated to be \$1000/m² (supplied and installed), whereas the geogrid is approximately \$6/m² supplied and installed. These costs are not included in the cost estimate, and would be considered as an addition. Cost savings on reduction of land footprint can be determined in detailed design.
- e. A summary of capital costs per meter for each option with phasing consideration are:

Costs	Capital Costs	Capital Cost/Lineal Meter	Annual O&M Costs
Option 1 – Earth Berm	\$21,500,000	\$10,400/m	\$75,000
Option 2 – Berm + Demountable Wall; no glass	\$55,730,000	\$26,800/m	See below Item f
Option 2 – Berm + Demountable Glass Wall	\$65,802,000	\$30,900/m	See below Item f
Option 2 – Berm + Permanent Concrete Wall	\$55,300,000	\$26,600/m	\$95,000*
Option 3 – Demountable Wall; no glass	\$32,000,000	\$15,500/m	See below Item f
Option 3 – Demountable Glass Wall	\$51,300,000	\$26,400/m	

*The permanent concrete wall annual maintenance is mainly to address vandalism on the walls. Other maintenance requirement is berm maintenance.

- f. As requested, the following is a summary of the Operational costs further broken down into labour, equipment and storage of the demountable wall systems. We have considered indirect costs of annual salary, overhead costs, and benefits for RMWB staff who will be assigned to this task. The unit rate details are shown in Appendix B:

Cost Description	Cost Estimate	Comments
1. Labour	\$448,000	Includes assembling, disassembling, inspection of panels, base, spare parts, vandalism repair/cleaning. Assumed 10 men crew, 10

Cost Description	Cost Estimate	Comments
		days at 10 hours/day for assembling and disassembling. No allowance made here for engineering planning, budget review, operations, asset management, reporting, follow-up activities.
2. Labour Training	\$8,000	Annual training of new labourers. Initial training by vendor is only a one-time allocation and not included here.
3. Equipment	\$195,000	Includes assembling and disassembling walls. Equipment including forklift/zoom-boom, flat bed truck, scaffolding. Operator included in Item 1, Labour. Includes vandalism cleaning and repair.
4. Material/ Storage	\$533,000	Includes rental of in-door storage of material, spare parts replacements. Rental includes utilities and insurance. No man/security is included.
TOTAL	\$1,539,000	With 30% contingency

iv. Constructability

- a. The demountable wall options (Option 2, 3) would require consideration for longer delivery time. Availability of material is not as convenient as it comes from either US or Europe.
- b. There is ample room for construction at Reach 7 and 9, but relatively less for Reach 8. Option 1 less favourable than Option 2 and 3 for constricted areas.

Environmental approval is another component to be considered as part of the project schedule, but it is not part of the evaluation metric, as it is assumed to be equally important for all options. Once the flood protection option is selected and alignment is confirmed, we will initiate the environmental regulatory approvals process, where necessary.

Table 5-2: Options Comparison

August 2016

OPTIONS	1A – Earth Berm	2 – Berm + Demountable Wall or Permanent Wall	3: Demountable Wall
METRICS			
ENVIRONMENTAL			
1. Green space	Provides green space. Berms are topsoil and vegetated to protect against erosion and river scouring during floods.	Similar to 1.	Limited vegetation required. landscaping can be considered for esthetics.
2. Riparian Vegetation Habitat enhancement	Riparian vegetation (shall roots) can be placed on the river side to protect against erosion.	Similar to 1.	No riparian vegetation required.
3. Proximity to river banks	Toe of slope set back 30 m from the top of river bank per Tetra Tech report.	Similar to 1.	Similar to 1.
4. Carbon footprint	Carbon footprint can be calculated for berm construction, delivery of construction material. Soil is assumed to be available within 40km of site. Equipment could be available from within the province.	Similar to 1. High carbon footprint is associated with transporting of wall components from Europe and/or USA.	High carbon footprint is associated with transporting of wall components from Europe and/or USA.

Table 5-2: Options Comparison

August 2016

OPTIONS	1A – Earth Berm	2 – Berm + Demountable Wall or Permanent Wall	3: Demountable Wall
METRICS			
SOCIAL			
1. Trail System	Trail system is incorporated as per Parks design and requirements for public space. Look out nodes with benches can be included.	Similar to 1.	Similar to 1.
2. Accessibility to River	Accessible by foot. Driveways or path would need to be included for vehicular or wheelchair access. Specific vehicular access to the river system such as a boat launch, picnic areas will be designated at specific area so that the berm is not interrupted. Safety will be considered carefully and shall not be compromised by allowing vehicle to travel on the berms.	Similar to 1. Access to the river can be carefully planned along the alignment. At these locations that are designated for access, they can be designed with flood gates system.	Similar to 1. Access to the river can be carefully planned along the alignment. At these locations that are designated for access, they can be designed with flood gates system.
3. View of river	Elevated trail providing view to the river. View from behind the berm at lower elevations may be obstructing.	Elevated trail providing view to the river. The demountable wall can be removed and provide less obstruction during non-flooding periods. The permanent wall would consider to be obstructive. Public art could be incorporated into the wall for visual interest and enhance public space.	Trail is not elevated. The demountable wall can be removed to provide less obstruction during non-flooding periods.
4. Maintenance and Inspection	Inspections of the berm recommendation are referenced in Reference Section of this memorandum. Depending on the severity of damage by animals, sinkholes, erosion, cracking and slope instability, settlement, earthworks equipment and soil are necessary to conduct repairs. Other maintenance will include cleaning, vegetation maintenance, and other trail maintenance duties. Trail maintenance including waste disposal, washing, grass mowing, and trail asphalt replacement. Addressing vandalism and component replacement will be required when necessary.	For earth berm, similar to 1. The demountable walls or glass panels would need to be installed prior river breaks and removed after spring melt – assumed that river levels are monitored to determine the period of which the walls will be erected. The walls or glass panels would need to be stored as per manufacturer's recommendation. The foundation base and bolts at each anchor posts would need to be inspected for damage, cracks, differential settlements, etc. Ice and snow would need to be removed prior to installation. Any scratches or damaged surfaces can be locally repaired. If the aluminium planks are damaged, they will need to be	The demountable walls would need to be removed for winter periods and place in storage. The foundation base and bolts at each anchor posts would need to be inspected for damage, cracks, differential settlements, etc. Ice and snow would need to be removed prior to installation. Any scratches or damaged surfaces can be locally repaired. If the aluminium planks are damaged, they will need to be replaced. Inspection on the wall panels, posts, foundation wall and anchor points shall be conducted before, during and after inspection. Similarly, to glass walls, any breakage or damage would need to be repaired and inspected prior to installation.

Table 5-2: Options Comparison

August 2016

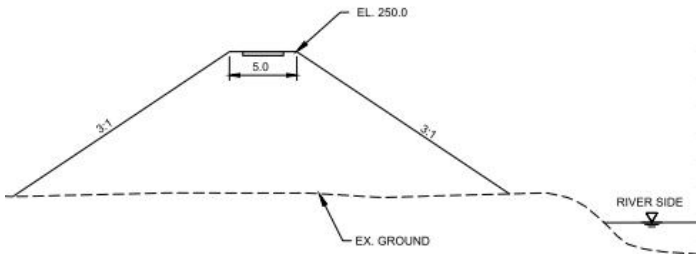
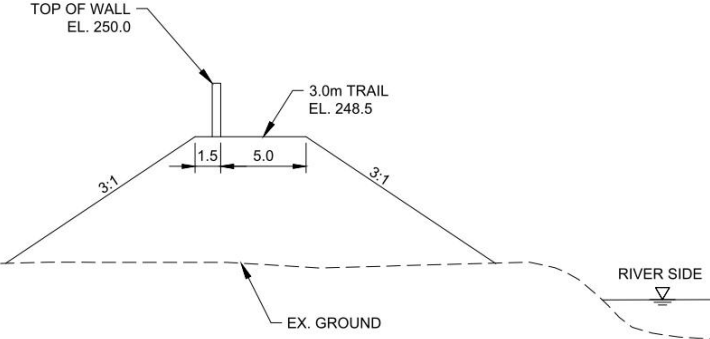
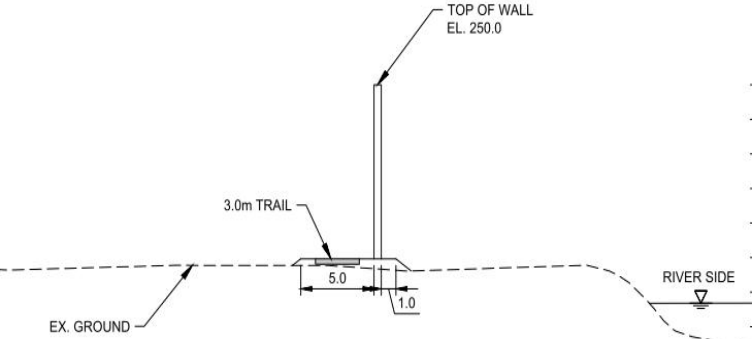
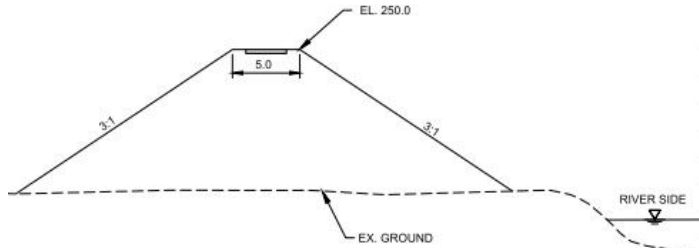
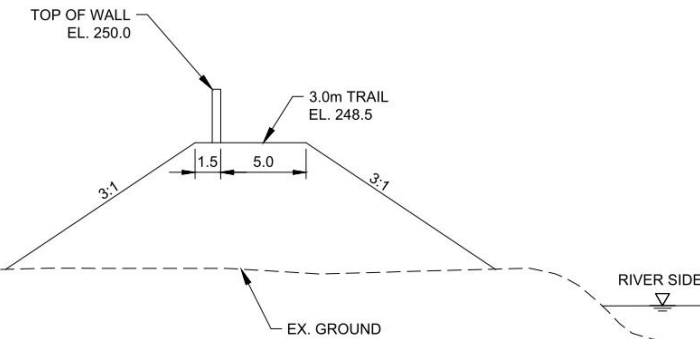
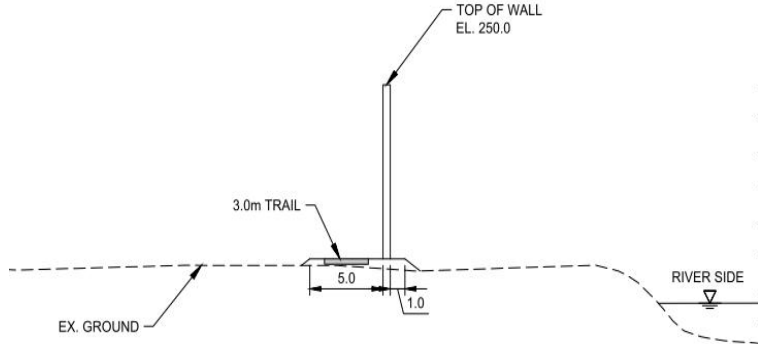
		replaced. Inspection on the wall panels, posts, foundation wall and anchor points shall be conducted before, during and after inspection. Similarly, to glass walls, any breakage or damage would need to be repaired and inspected prior to installation. Permanent wall system would require inspection twice a year for gaps due to cracking, differential settlements, etc.	
OPTIONS	1 – Earth Berm	2 – Berm + Demountable Wall or Permanent Wall	3 – Demountable Wall
			
5. Land utilization	Wide footprint from the flood berm. Land purchasing or swapping will need to be considered as the Municipality does not own the land of the current proposed alignment.	Lower berm height will result in smaller footprint. However, similar to 1, remaining of the land would need to be purchased or swapped.	Only limited low berms are constructed. Some fill will be required for asphalt and trail construction.
6. Public Safety – Way-finding, Vandalism/Illegal Dumping	The berm is elevated and open. Frequent checks are required to address any issues of vandalism or dumping. Crime Prevention Through Environmental Design principals will be part of the design process.	Similar to 1. The walls may be vandalized with graffiti. Obstruction of the wall provides less visibility to the public and may lead to illegal dumping or activities. Glass walls may encourage vandalism. Increased policing may be required.	The walls may be vandalized with graffiti. Obstruction of the wall provides less visibility to the public and may lead to illegal dumping or activities. Glass walls may encourage vandalism. Increased policing may be required.
7. Preserve local character and enhance public space	Reach 1 is a berm structure and was designed to be non-obstructive and ties-into the existing trail system with vegetation. It provides an elevated view for public enjoyment. This is an important feature would require public engagement and feedback to confirm berm configuration.	Similar to 1. Although the demountable walls and glass panels can be removed, the berm and wall system combination would need to be communicated with the public and demonstrate that the use is appropriate for the community. This is an important feature would require public engagement and feedback to confirm berm configuration.	This feature could be perceived as obstructive when erected. Considering that the demountable wall system will only be used for a short period of time, public can enjoy the river after the wall is removed. Similar, this will require public engagement and feedback prior to final design.

Table 5-2: Options Comparison

August 2016

OPTIONS	1 – Earth Berm	2 – Berm + Demountable Wall or Permanent Wall	3 – Demountable Wall
METRICS			
ECONOMICS			
1. Capital Cost for Reach 7, 8, 9	\$21,500,000	\$55,730,000 (Demountable Wall; no glass) \$66,900,000 (Demountable Glass Wall) \$55,300,000 (Permanent Concrete Wall)	\$32,000,000 (Demountable Wall; no glass) \$62,300,000 (Demountable Glass Wall)
2. Operations and Maintenance Cost for Reach 7, 8, 9	Annual Cost estimate is \$75,000	Annual Cost estimate is \$709,000 (Including the berm and the Demountable Walls)	Annual Cost estimate is \$2,040,000
3. Land Acquisition Cost (at \$79/m²)	Potential additional \$2,600,000	Potential additional \$1,700,000	Potential additional \$415,000
CONSTRUCTABILITY			
1. Material availability	Borrow source has not been confirmed or secured. Assumed material will be available within 40 km of the site.	Similar to 1. The demountable wall is available; however, the distance of travel greatly differs between Europe and US supplier.	The demountable wall is available; however, the distance of travel greatly differs between Europe and US supplier.
2. Supply time	Once borrow source is confirmed, no issue with supply time.	Advance notice is required for demountable wall. US product indicated 4 to 6 months after shop drawing review. European product would take the same time, but freight would need additional coordination time of at least 1 month. Material supply for the Permanent Wall will depend on local supplier. This may require pre-planning of 2 months.	Advance notice is required for demountable wall. US product indicated 4 to 6 months after shop drawing review. European product would take the same time, but freight would need additional coordination time of at least 1 month.
3. Sequence of construction	No main concerns or issues. Connectivity to the other Reaches would need to be coordinated. Trails would need to be re-established and landscaping would need to be redone.	Similar to 1.	No main concerns or issues.
4. Available space	Due to its footprint, the berm could impede or have adverse impact on adjacent properties, structures, infrastructures. Care would need to be taken to avoid damages or impacts.	Similar to 1.	No main concerns or issues.

6 Recommendations

We conducted a review of three potential options:

- Option 1 – Earth berm structure
- Option 2 – Earth berm structure with 1.5 m of wall systems. The wall can be either demountable wall (panels or glass) or permanent concrete wall.
- Option 3 – Demountable wall system (panels or glass)

We conducted a preliminary Triple Bottom Line discussion and comparison for each option. The intent of this comparison is to provide the Municipality an overview of each option and understand the potential effect (positively or adversely) on the community. Based on the preliminary assessment, Option 1 – Earth Berm is the most viable option for Reach 7 and 9, Option 2 with combination of wall and berm would be viable for Reach 8 due to limited space adjacent to Long Boat Landing and the Hanginstone River.

In determining the most suitable options, it is equally important that the flood protection would provide positive social and economical outcome. The following discusses the next steps to assist the Municipality in the decision-making process:

1. In the proposal, Associated Engineering included a Value Engineering session to discuss berm design. We recommend that this session be used for Triple Bottom Line discussion using Decision Support System (DSS) process to evaluate the options. DSS is an evaluation framework that enables the objective scoring of flood protection structures to determine the most favorable alternative to take forward into the next phase of design. The evaluation framework is based on a weighted multi-criteria approach using the Triple Bottom Line criteria with the metrics used in this report. Cost will be taken into account in the decision-making process through the use of cost-benefit calculation using a net present cost and scored benefit for each option.

In preparation for this session, the Municipality can determine which metrics would be important and relevant to the project, and which metric are quantifiable. A life-cycle cost analysis that considers for a period of 30 years or more would need to be conducted for each option for the cost evaluation.

The process of the DSS involves the following steps:

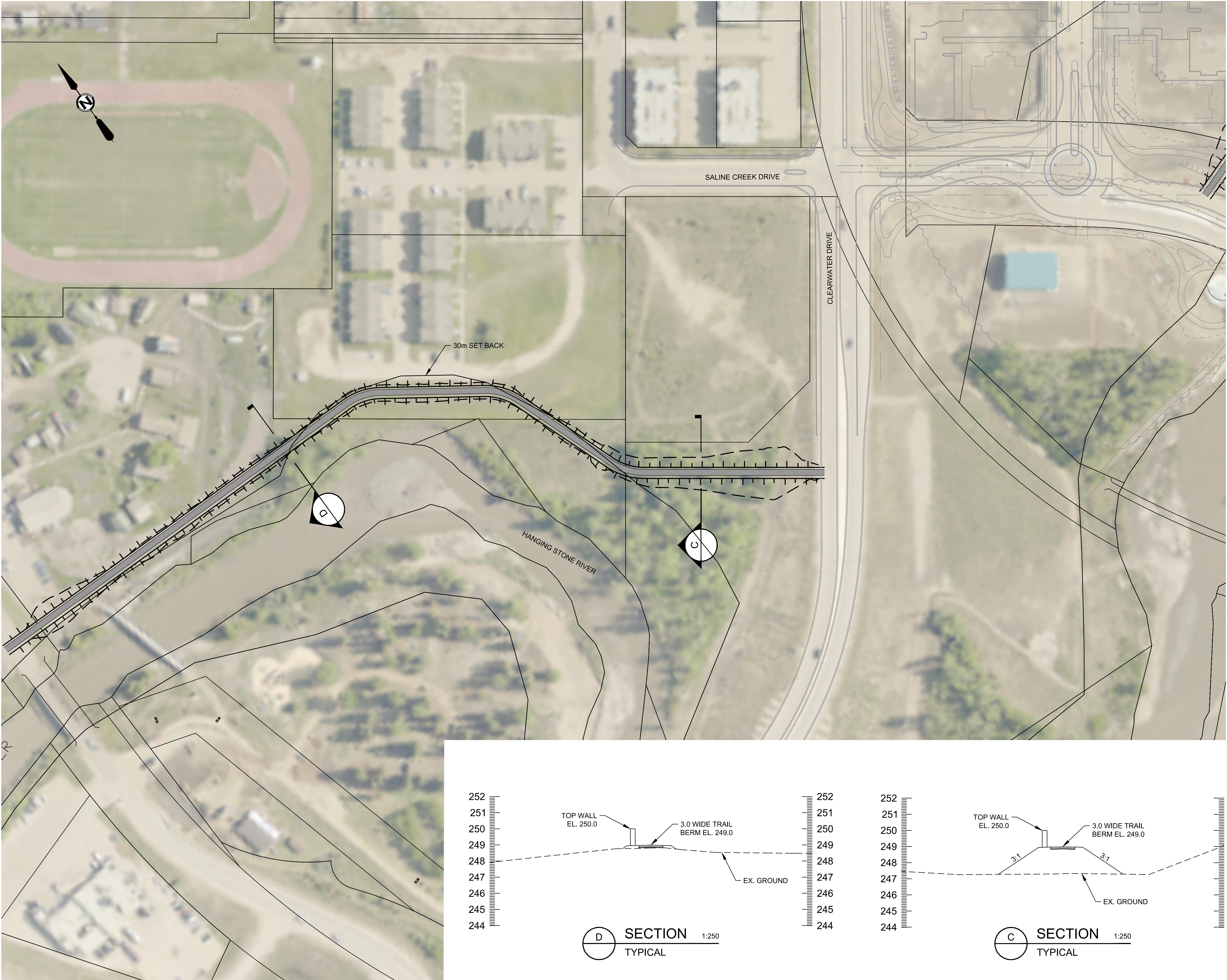
- Review the DSS approach and process with the Municipality;
- Identify the issues requirement assessment;
- Conduct DSS workshop with the Municipality and internal stakeholders to frame the assessment overall;
- Conduct metrics and risk analysis;
- Conduct modelling and sensitivity analysis, and
- Present the results to the Municipality and incorporating feedback.

2. The Municipality would like to consider conducting a pilot test on the demountable wall systems. We understand the intent is not to test its flood protection capabilities, but to provide an understanding of how it is installed, what it looks like, and collect feedback. The details of the pilot testing have not been defined, and a budget has not been approved; however, for consideration at this stage, areas of Reach 9 would provide a suitable test site for the reason that:

- Adjacent development is mainly non-residential; and
- Existing elevation is near 248.5m and in some places, it exceeds elevation 248.5m; therefore would not require extension berm construction, thus lower cost.

The attached [Figure 4](#) shows a preliminary alignment of Reach 9. This figure shows two cross-sections: Section D, minor earth berm, and Section C, 2 m high earth berm. The pilot project could be conducted at Section D that does not require extensive berm construction. The flood wall is approximately 1 m tall; this can be an aluminum panels or glass.

A detailed design would need to be conducted for the pilot project including foundation, wall supports, wall restrains, and finalizing geotechnical conditions. This will help in estimating a budget for the pilot project.



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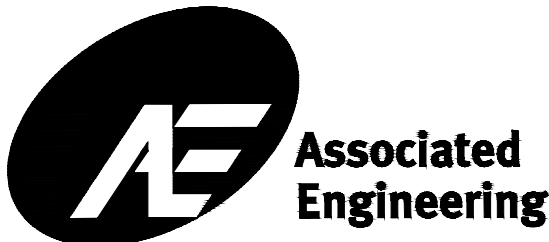
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REVISIONS



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FORT McMURRAY FLOOD PROTECTION

REACH 9 PLAN OPTION 3

APPROVED BY: J. TANG	CHECKED BY:
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DESIGNED BY: C. BALITBIT	DRAWN BY: .M. TREMBLAY
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SCALE: 1:1000	DRAWING NO. FIGURE 4
DATE: 2016-04-12	
CONSULTANT NO. 2015-3349	

MUNICIPAL DRAWING NUMBER:

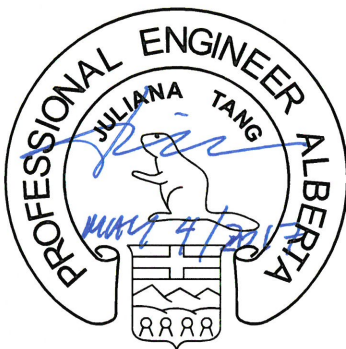
REPORT

Closure

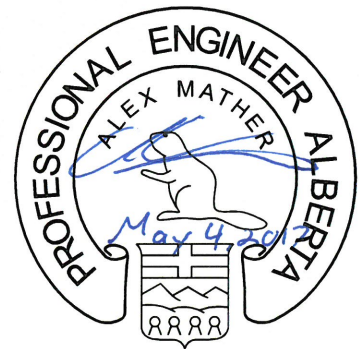
This report was prepared for the Regional Municipality of Wood Buffalo to conduct a feasibility study of various flood wall and berm systems for Reach 7, 8, and 9.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.



Juliana Tang, M.Sc., P.Eng., LEED AP, ENV SP.
Project Manager



Alex Mather, P.Eng.
Project Engineer

ASSOCIATED ENGINEERING QUALITY MANAGEMENT SIGN-OFF	
Signature:	
Date:	<u>May 4, 2017</u>
APEGA Permit to Practice P 3979	

PERMIT STAMP

References

Tetra Tech, February 2015. Geotechnical Evaluation, City Centre – Waterfront Development, Site F+: Hangingstone River (Long Boat Landing to Prairie Loop Boulevard), Fort McMurray, Alberta.

Ministry of Environment, Lands and Parks, Province of British Columbia, March 2000. Flood Protection Works, Inspection Guide.

Alberta Environment Protection, May 1996. Dyke Certification Guidelines.

Golder Associates Ltd., and Associated Engineering (BC) Ltd., July 2003. Dike Design and Construction Guide. Best Management Practices for British Columbia.

Bekevich Engineering Ltd., July 1997. Peace River Dyke Assessment, Report No.2.

Appendix A - Thurber Engineering Memorandum



THURBER ENGINEERING LTD.

MEMORANDUM

To: Juliana Tang, P.Eng.

Date: April 15, 2016

From: John Rybak, P.Eng.
(Reviewed by Don Proudfoot, P.Eng.)

File: 12689

FLOOD PROTECTION BERMS – REACHES 7, 8 AND 9 GEOTECHNICAL COMMENTS ON FLOOD PROTECTION OPTIONS

As requested, the following memorandum presents the geotechnical comments that Thurber Engineering Ltd. (Thurber) has on the berm and concrete wall and Geocell berm options for flood protection along Reaches 7, 8, and 9. It is understood that these comments will be used by Associated Engineering Alberta Limited (AEAL) to determine the relative costs and advantages/disadvantages for each of the options to present the Regional Municipality of Wood Buffalo (Municipality) for them to select their preferred flood protection option.

It is a condition of this memorandum that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Option 1: Earth Berm with Concrete Wall

As shown on Associated Engineering Alberta Limited's (AEAL's) Drawings 3349-00-SK201 through SK203, this option involves the construction of an earth berm with 3H:1V sideslopes to elevation 248 m with a concrete wall constructed up to elevation 250 m. Thurber has the following comments on this option:

- The proposed slope angles are reasonable for the expected subsurface conditions, provided that a medium plastic clay is used to construct the berm. If high plastic clay is used, then flatter slope angles (4H:1V or flatter) will be required.
- The base of the concrete wall will need to be supported on some sort of foundation. Feasible foundations are either a strip footing founded a minimum of 2.8 m below the top of berm (to help protect against movement due to frost heave), or at a shallower depth if supported by piles. The piles may consist of either driven steel piles or continuous flight augur (CFA) concrete piles and should extend a minimum of 8 m below the top of berm to resist uplift forces due to frost. The foundation system will need to be designed to handle the lateral forces imposed by the impounded water and any ice impact forces.
- The wall should be embedded a minimum depth into the berm to act as a cutoff to prevent seepage from going under the wall. This depth can be determined by performing a seepage analysis during detailed design if this option is chosen.
- Seepage under the berm should also be analyzed to determine if there is a need to install some sort of seepage cutoff system (such as a clay filled trench) under the berm.
- The berm should be overbuilt to allow for some settlement over time, and so that once the settlement is finished that the top of the berm is not below 248 m. Well compacted clay fill will tend to settle 1 percent to 2 percent of the fill height, in addition to the consolidation of



the underlying clay materials. Settlement analysis should be conducted during detailed design to calculate a more accurate estimate of the total amount settlement that can be expected.

Option 2: Geocell Faced Berm

This option is being considered at the request of the Municipality. Thurber has the following comments on this option:

- If this option is only being considered to narrow the berm footprint, then it is likely that the narrowing can be achieved in a more cost effective way by using geogrid reinforced fill rather than using the Geocell system.
- If it is used to replace rip-rap, the cost might be cheaper as the cost for the smaller free draining aggregate to fill the cells might be cheaper than the cost of the rip-rap to cover an equivalent surface area. However, a qualified hydraulic engineer should determine whether the gravel filled Geocell will handle the erosive wave action imposed by the flood water.
- At the time of this memorandum we could not find a much long term data on the performance of this system in this application. The sample cited by the Municipality was only constructed in 2012.
- It is unknown how durable this product is and what its resistance is to ice and debris (eg. Logs floating in flood water) impacts.
- The system is also susceptible to vandalism (i.e. deliberate cutting or burning of the outside cell wall) which is difficult to repair.
- The cells must be filled with either a free draining sand or gravel fill which is typically more expensive than clay.
- The cell fill materials must be filled and compacted by hand or using light equipment (i.e. skid steers and plate tampers), no large compaction equipment can be used on top of the cells. In addition, the manufacturer also recommends that heavy compaction equipment be kept back a minimum distance of 1 m from the cells and that the cell faces should be monitored during construction to make sure that the compaction equipment does not alter the alignment of the cell faces.
- The system does not eliminate the need for additional fill material behind the cells.
- The system is flexible and can incorporate curved or other aesthetic landscaping features. The cell backfill materials can also be selected to promote vegetation growth while still maintaining erosion protection capabilities.

Closure

We trust this memorandum meets your needs at this time. If you have any other questions, please feel free to contact us.

Appendix B - Cost Estimate Tables

Table B-1: Reach 7, 8 and 9 Flood Protection Options Cost Estimates

5/4/2017

Option 1 - Earth Berm	Quantities					Costs			Assumptions
Capital Cost Items	Reach 7	Reach 8	Reach 9	Unit Rate	Unit	Reach 7	Reach 8	Reach 9	
Clay	99,000	65,650	54,250	\$ 51	m3	\$ 5,049,000	\$ 3,348,150	\$ 2,766,750	From model
Topsoil	32,240	25,941	24,466	\$ 7	m2	\$ 225,680	\$ 181,587	\$ 171,262	From model
Seeding	32,240	25,941	24,466	\$ 4	m2	\$ 112,840	\$ 90,794	\$ 85,631	From model
Asphalt Trail	2,760	2,100	1,350	\$ 51	m2	\$ 140,760	\$ 107,100	\$ 68,850	From model, does not include tie-ins or access ramps/stairs
Granular base	2,760	2,100	1,350	\$ 18	m2	\$ 49,680	\$ 37,800	\$ 24,300	From model, does not include tie-ins or access ramps/stairs
Clearing and Grubbing	3.4	2.6	2.7	\$ 17,500	ha	\$ 58,625	\$ 45,938	\$ 46,988	From model
Topsoil stripping	33,500	26,250	26,850	\$ 19	m2	\$ 636,500	\$ 498,750	\$ 510,150	From model
Bench Nodes	10	7	5	\$ 50,000	ea	\$ 500,000	\$ 350,000	\$ 250,000	Bench node includes 1 rest node and 1 refuse node every 100m
Lighting	\$ 210,000	\$ 159,000	\$ 109,500	1	LS	\$ 210,000	\$ 159,000	\$ 109,500	Assuming lighting at start/end of trail and at each bench node. \$3K for lights,\$3K for bases and \$150/m for ducts
Vegetation/Landscape	\$ 303,600	\$ 231,000	\$ 148,500	1	LS	\$ 303,600	\$ 231,000	\$ 148,500	Similar plantings per length as Reach 1
Total Estimated Cost						\$ 7,287,000	\$ 5,051,000	\$ 4,182,000	
30% Contingency						\$ 2,187,000	\$ 1,516,000	\$ 1,255,000	
Total Estimate Capital Cost						\$ 9,474,000	\$ 6,567,000	\$ 5,437,000	
Estimate Capital Cost (\$/m)						\$ 10,400			

Operational Cost - Option 1 - Earth Berm	Quantities				Costs		Assumptions
Grass/vegetation maintenance	1		\$5,000	LS	\$5,000		Annual minor maintenance including mowing, tree maintenance.
Pavement Repairs	1		\$10,000	LS	\$10,000		Annual allowance
Cleaning/washing	1		\$5,000	LS	\$5,000		Annual allowance
Components replacements	1		\$5,000	LS	\$5,000		Annual allowance
Elevation Survey	1		\$5,000	LS	\$5,000		Annual allowance
Inspection for signs of erosion, riprap failure, river migration, animal burrowing	1		\$5,000	LS	\$5,000		Annual allowance
Vandalism Cleaning	1		\$15,000	LS	\$15,000		Annual allowance
Total Estimated Cost					\$50,000		
50% Contingency					\$25,000		
Estimate Annual Operational Cost					\$75,000		

Table B-1: Reach 7, 8 and 9 Flood Protection Options Cost Estimates

5/4/2017

Option 2 - Earth Berm + Demountable Wall	Quantities					Costs			Assumptions
Capital Cost Items	Reach 7	Reach 8	Reach 9	Unit Rate	Unit	Reach 2	Reach 7	Reach 8	Reach 9
Clay	45,500	29,000	3,000	\$51	m3	\$ 2,320,500	\$ 1,479,000	\$ 153,000	From model
Topsoil	21,210	13,900	3,650	\$7	m2	\$ 148,470	\$ 97,300	\$ 25,550	From model
Seeding	21,210	13,900	3,650	\$4	m2	\$ 74,235	\$ 48,650	\$ 12,775	From model
Asphalt Trail	2,790	2,100	1,350	\$51	m2	\$ 142,290	\$ 107,100	\$ 68,850	From model, does not include tie-ins or access ramps/stairs
Granular base	2,790	2,100	1,350	\$18	m2	\$ 50,220	\$ 37,800	\$ 24,300	From model, does not include tie-ins or access ramps/stairs
Clearing and Grubbing	2.3	1.6	0.5	\$17,500	ha	\$ 40,250	\$ 27,125	\$ 7,875	From model
Topsoil stripping	23,000	15,500	4,500	\$19	m2	\$ 437,000	\$ 294,500	\$ 85,500	From model
Bench Nodes	10	7	5	\$50,000	ea	\$ 500,000	\$ 350,000	\$ 250,000	Bench node includes 1 rest node and 1 refuse node every 100m
Lighting	\$210,000	\$159,000	\$109,500	1	LS	\$ 210,000	\$ 159,000	\$ 109,500	Assuming lighting at start/end of trail and at each bench node. \$3K for lights,\$3K for bases and \$150/m for ducts
Vegetation/Landscape	\$303,600	\$231,000	\$148,500	1	LS	\$ 303,600	\$ 231,000	\$ 148,500	Similar plantings per length as Reach 1
Wall posts and panels	1,395	1,050	675	1400	m2	\$1,953,000	\$1,470,000	\$945,000	Price from IBI.
Recommend Spares (5%)	70	53	34	1400	m2	\$97,650	\$73,500	\$47,250	Supplier recommendation.
Foundation Wall and Spread Footing	4,520	3,400	2,190	3,000	m3	\$13,560,000	\$10,200,000	\$6,570,000	Height: 5.5m, footing H=0.65. 1.2m above ground.
Glass Panels (Optional)	1,465	1,103	709	3000	m2	\$4,394,250	\$3,307,500	\$2,126,250	Price includes 5% spares.
Total Estimated Cost						\$19,838,000	\$14,575,000	\$8,449,000	with glass no glass
30% Contingency						\$ 5,952,000	\$ 4,373,000	\$ 2,535,000	
Total Estimate Capital Cost (no glass)						\$ 25,790,000	\$ 18,948,000	\$ 10,984,000	
Total Estimate Capital Cost (with glass)						\$ 29,547,905	\$ 21,777,218	\$ 12,801,655	
Estimate Capital Cost (\$/m)						\$ 30,900			
Estimate Capital Cost (\$/m)						\$ 26,800			

Option 2 - Earth Berm + Permanent Wall	Quantities					Costs			Assumptions
Capital Cost Items	Reach 7	Reach 8	Reach 9	Unit Rate	Unit	Reach 2	Reach 7	Reach 8	Reach 9
Clay	45,500	29,000	3,000	\$51	m3	\$ 2,320,500	\$ 1,479,000	\$ 153,000	From model
Topsoil	21,210	13,900	3,650	\$7	m2	\$ 148,470	\$ 97,300	\$ 25,550	From model
Seeding	21,210	13,900	3,650	\$4	m2	\$ 74,235	\$ 48,650	\$ 12,775	From model
Asphalt Trail	2,790	2,100	1,350	\$51	m2	\$ 142,290	\$ 107,100	\$ 68,850	From model, does not include tie-ins or access ramps/stairs
Granular base	2,790	2,100	1,350	\$18	m2	\$ 50,220	\$ 37,800	\$ 24,300	From model, does not include tie-ins or access ramps/stairs
Clearing and Grubbing	2.3	1.6	0.5	\$17,500	ha	\$ 40,250	\$ 27,125	\$ 7,875	From model
Topsoil stripping	23,000	15,500	4,500	\$19	m2	\$ 437,000	\$ 294,500	\$ 85,500	From model
Bench Nodes	10	7	5	\$50,000	ea	\$ 500,000	\$ 350,000	\$ 250,000	Bench node includes 1 rest node and 1 refuse node every 100m
Lighting	\$210,000	\$159,000	\$109,500	1	LS	\$ 210,000	\$ 159,000	\$ 109,500	Assuming lighting at start/end of trail and at each bench node. \$3K for lights,\$3K for bases and \$150/m for ducts
Vegetation/Landscape	\$303,600	\$231,000	\$148,500	1	LS	\$ 303,600	\$ 231,000	\$ 148,500	Similar plantings per length as Reach 1
Foundation Wall and Spread Footing	4,520	3,400	2,190	3,000	m3	\$13,560,000	\$10,200,000	\$6,570,000	Height: 5.5m, footing H=0.65. 1.2m above ground.
Wall	628	473	304	3,000	m3	\$1,883,250	\$1,417,500	\$911,250	Additional 1.5m height, excludes tying into existing wall, thickness is 0.45m
			Total Estimated Cost			\$19,670,000	\$14,449,000	\$8,368,000	
			30% Contingency			\$ 5,901,000	\$ 4,335,000	\$ 2,511,000	
			Total Estimate Capital Cost			\$ 25,571,000	\$ 18,784,000	\$10,879,000	
			Estimate Capital Cost (\$/m)			\$ 26,600			

Table B-1: Reach 7, 8 and 9 Flood Protection Options Cost Estimates

5/4/2017

Option 3 - Demountable Wall	Quantities					Costs			Assumptions
Capital Cost Items	Reach 7	Reach 8	Reach 9	Unit Rate	Unit	Reach 7	Reach 8	Reach 9	
Clay	2,000	4,500	3,000	\$35	m3	\$70,000	\$157,500	\$105,000	From model
Topsoil	5,150	5,400	3,650	\$3	m2	\$15,450	\$16,200	\$10,950	From model
Seeding	5,150	5,400	3,650	\$6	m2	\$30,900	\$32,400	\$21,900	From model
Asphalt Trail	2,850	2,100	1,350	\$22	m2	\$62,700	\$46,200	\$29,700	From model, does not include tie-ins or access ramps/stairs
Granular base	2,850	2,100	1,350	\$15	m2	\$42,750	\$31,500	\$20,250	From model, does not include tie-ins or access ramps/stairs
Clearing and Grubbing	0.8	0.7	0	\$17,500	ha	\$14,000	\$12,250	\$7,875	From model
Topsoil stripping	8,000	7,000	4,500	\$4	m2	\$32,000	\$28,000	\$18,000	From model
Bench Nodes	10	7	5	\$50,000	ea	\$500,000	\$350,000	\$250,000	Bench node includes 1 rest node and 1 refuse node every 100m
Lighting	\$210,000	\$159,000	\$109,500	1	LS	\$210,000	\$159,000	\$109,500	Assuming lighting at start/end of trail and at each bench node. \$3K for lights,\$3K for bases and \$150/m for ducts
Vegetation/Landscape	\$303,600	\$231,000	\$148,500	1	LS	\$303,600	\$231,000	\$148,500	Similar plantings per length as Reach 1
Foundation Piles	186	140	0	\$10,000	ea	\$1,860,000	\$1,400,000	\$0	H-piles, spaced at 5m c/c, H=8m
Foundation wall/base	1,116	840	0	\$3,000	m3	\$3,348,000	\$2,520,000	\$0	Above 1.2m above ground, total height 2m. 0.6m thick
Wall posts and panels	4,720	3,070	675	\$1,400	m2	\$6,608,000	\$4,298,000	\$945,000	From model
Recommend Spares (5%)	236	154	34	\$1,400	m2	\$330,400	\$215,600	\$47,600	Supplier recommendation.
Glass Panels (Optional)	4,956	3,224	709	3000	m2	\$14,868,000	\$9,672,000	\$2,127,000	Price includes 5% spares.
Total Estimated Cost						\$13,428,000	\$9,498,000	\$1,715,000	with glass no glass
30% Contingency						\$ 4,029,000	\$ 2,850,000	\$ 515,000	
Total Estimate Capital Cost (no glass)						\$ 17,457,000	\$ 12,348,000	\$ 2,230,000	
Total Estimate Capital Cost (with glass)						\$30,176,540	\$20,622,545	\$4,048,658	
Estimate Capital Cost (\$/m)						\$		26,400	
Estimate Capital Cost (\$/m)						\$		15,500	

Table B-1: Reach 7, 8 and 9 Flood Protection Options Cost Estimates

5/4/2017

Operational Cost Items - Option 3		Quantities		Costs	Assumptions
Labour Operational Costs - Demountable Wall					
Assemble wall	1	\$100,000	ea	\$100,000	Annual allowance - Assume 1000 man hours at \$100/hr total cost of RM staff including pay and benefits. (10 men crew; 10 days at 10 hours/day)
Disassemble wall	1	\$100,000	ea	\$100,000	Annual allowance - Assume 1000 man hours at \$100/hr total cost of RM staff including pay and benefits. (10 men crew; 10 days at 10 hours/day)
Annual Inspection of Panels in Warehouse	1	\$20,000	ea	\$20,000	Annual allowance - Assume 200 man hours at \$100/hr total cost of RM staff including pay and benefits.
Annual Inspection of Wall Base Integrity prior to Assembly	1	\$20,000	ea	\$20,000	Annual allowance - Assume 200 man hours at \$100/hr total cost of RM staff including pay and benefits
Vandalism Cleaning/Repair	2080	\$100	m	\$208,000	Assume 10hr/200m, \$100/hr per personnel; 2 personnel allocated; 10 days of repair.
Training	1	\$8,000	LS	\$8,000	80 man hour training @\$100/hr for new labour. Training by vendor is only one time in first year and not included here.
Equipment Operational Costs - Demountable Wall					
Assemble wall	1	\$75,000	ea	\$75,000	Annual allowance - Assume total of 500 rental hours (10 days) for all equipment and assembly. \$150/hr per equipment and material rental - includes fork lift, flat bed, man lifter, scaffolding.
Disassemble wall	1	\$75,000	ea	\$75,000	Annual allowance - Assume total of 500 rental hours (10hrs; 10 days) for all equipment and assembly. \$150/hr per equipment and material rental - includes fork lift, flat bed, man lifter, scaffolding.
Vandalism Cleaning/Repair	1	\$45,000	ea	\$45,000	Annual allowance - Assume total of 110 rental hours (10 days) for all equipment and assembly. \$150/hr per equipment and material rental - includes flat bed, fork lift, water truck/pressure wash/chemicals.
Material Operational Costs - Demountable Wall					
Components replacements	1	\$121,000	ea	\$121,000	Assumed 1% of the area due to vandalism and wear
Rental Storage Warehouse	4,113	\$100	m2	\$411,290	Rental space for 275 pallets (15m ² warehouse space per pallet) including circulation. Includes utilities and insurance. Does not include equipment/personnel for warehouse management.
		Total Estimated Cost		\$1,183,290	Estiamted Cost excludes glass panels and assumes all panels will be aluminum. Costs will increase if glass panels used.
		30% Contingency		\$354,987	
		Estimate Annual Operational Cost		\$1,538,277	

Appendix C - E-mail Correspondence

Juliana Tang

From: Patrick Gilg <gilg@ibs-technics.de>
Sent: Wednesday, April 27, 2016 9:00 AM
To: Juliana Tang
Cc: Berthold Reiter
Subject: AW: [Spam-Wahrscheinlichkeit=61]RE: Proposed Alignment - Attachment No. 2 - 20153349.00.E.05.00

Categories: AE FILED EMAIL

Hi Juliane,

I hope you're doing fine and get along with the information I sent you last week.

Juliana, regarding the prices for our system:
For projects with such dimensions we calculate with following prices:

- Demountable system: 750,--€/m²
- Glass wall: 1850,-- €/m²

These prices include the components incl. **delivery**.
Concrete and foundation works have to be provided/done by others

I hope I could help you a little bit with this information.

Just for our information: This project sounds very, very interesting. A project we would like to handle with you.
Can you give me some more information about actual status of the project? Also interesting for us: Sizes, time range, ...

I'm looking forward to your reply

Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager



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E-Mail: gilg@ibs-technics.de

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Geschäftsführer: Dipl.Ing. Xaver Storr, Dipl. Wirtsch.-Ing. Sebastian Schauback
Eintrag: Amtsgericht Augsburg, HRB 13846
USt-ID: DE164481231

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Von: Juliana Tang [mailto:tangj@ae.ca]
Gesendet: Montag, 25. April 2016 19:21
An: Patrick Gilg
Cc: Berthold Reiter; Alex Mather
Betreff: [Spam-Wahrscheinlichkeit=61]RE: Proposed Alignment - Attachement No. 2

Hi Patrick,

Thanks for the information. Please provide us with approximate unit rate for supply of material including posts and aluminum panels. Please separate the cost between glass and aluminum. Thank you.

Juliana Tang, M.Sc., P.Eng. LEED A.P.
Geo-environmental Engineer, Sustainable Design
Associated Engineering Alberta Ltd.
500, 9888 Jasper Avenue, Edmonton, AB T5J 5C6

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From: Patrick Gilg [mailto:gilg@ibs-technics.de]
Sent: Friday, April 22, 2016 6:29 AM
To: Juliana Tang
Cc: Berthold Reiter
Subject: RE: Proposed Alignment - Attachement No. 2

Dear Juliana,

please excuse my late response, but today is my first day back in office after my business trip to UK.

Juliana, you'll find my answers to your questions below in "red".

Also you'll find different attachment. You'll find information about these documents and photos in my answers.

If you have any further questions, do not hesitate to contact me.

I'm looking forward to your reply

Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager



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Von: Juliana Tang [<mailto:tangj@ae.ca>]
Gesendet: Montag, 18. April 2016 17:17
An: Patrick Gilg
Cc: Berthold Reiter; Xaver Storr
Betreff: [Spam-Wahrscheinlichkeit=46]RE: Proposed Alignment - Attachment No. 2

Hi Patrick,

Thank you for your response. Please see below within your e-mail for my comments and responses in "green". In addition, we have questions on maintenance and operations:

1. What is the storage requirements of the panels and posts when demounted? Does it need to be indoor, or can it be indoor/outdoor? Is there a typical storage area requirement they can provide? -> **Juliana, please find attached documents 01-03: Our standard pallets for center-posts (for flood height of 2 meters), dam beams and dam beams with ground seal.**

LT-PO2-DBAL 2100: On our standard log pallet you can stack 68 beams -> according to an axis distance of 3 meters, these logs would cover 40,8 m² wall.

LT-PO2-DBAL+BD 2100: logs including ground seal you can stack on 51 dam beams on it -> 30,6 m²

LT-PO2-MS100K-T03-2325: On one pallet you can stack on 8 Center Posts

For our standard system we're using long life materials like Aluminium, stainless steel or EPDM. Materials are tested for the outside usage. But: for durability of the similar components it is in advantage to store the system indoor (temperature over freezing point, dry and sun-protected). Outdoor storage could shorten this life-time. That's why we're recommending indoor storage. (Please find attached two photos of a storage depot in Grein as one good example of storing our components)

2. What is the preventative maintenance requirements for the wall, posts, panels and bolts? -> We're using long life materials -> so you need no special maintenance for materials itself. It's useful for the operator to organize an annually partly test set-up (for teaching crew, test logistics system,...)
3. What is the life cycle of the various components in terms of years or uses? -> Our long-life materials have no defined life-time -> life cycle of several decades
4. Where is the closest supplier? Do you have a supplier in US? -> We have contacts available in order to execute single projects steps in the concerning region. IBS is actually thinking to develop the appearance and its set up in Canada. We have completed several projects in USA as well.
5. What is the crew requirements to deploy the wall in terms of manpower, time and equipment? -> For guideline: One person can build approx.. 10-15 m² wall per hour. This guideline includes set up only – time expenses for alarm, transport and unloading the components is not included. Equipment Example see attachment 09
6. What training and skill level is required to install the wall? Can there be one person trained, directing the rest of untrained personnel? -> Yes, one person per team can be trained to lead the set up. There are no special skills required. The set up consists of a number of repeating steps.
7. How long would it take to install the walls assuming an experienced and inexperienced crew? -> see question 5
8. How much room is required for equipment access to install the walls? How far should obstructions (light posts, bench nodes) be located from the wall? -> That depends on axis distance and length of the pallets (Documents 11 & 12). You need enough space to handle these pallets and work along the line. Regarding your question about obstructions: There are different possibilities – e.g integrating bench nodes in the mobile system or provide mobile benches,... (You find some examples on documents 13 & 14)
9. Can drainage pipes be designed to pass through the foundation? Yes, sealed connection through the foundation can be provided. This connection should be closable of in case of flood in order to prevent from water back flow.
10. Is there a recommended percentage for spare wall panels and posts? Usually 5% of the mobile components (Center-posts, dam beams, pressing tools, at least 1pc of special each component such as corner posts...). However, this percentage depends on the size of the project.

If I did not provide sufficient information, please let me know and I will try my best to clarify and provide more information.

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From: Patrick Gilg [<mailto:gilg@ibs-technics.de>]
Sent: Monday, April 18, 2016 7:12 AM
To: Juliana Tang
Cc: Berthold Reiter; Xaver Storr
Subject: AW: Proposed Alignment - Attachement No. 2

Hi Juliana,

thank you very much for Drawings regarding the project in Fort McMurray.

Juliana, for calculating respectively cost estimating this project we need more detailed measurements:

Length, Flood Height, number of Flood Height Transitions and number of Corners (over 174°). By the way, the drawings are drawn to scale, you can print them to ANSI Series A1, 594 mm x 841 mm or half size. Don't print to "fit page", as this will not print to scale.

Lengths are:

Reach 7: 930 m

Reach 8: 700 m

Reach 9: 450 m

Flood Height is elevation 250m above sea level. The top of wall will be a continuous elevation of 250 m elevation with a factor of safety up to 251 m. The combination of earth berm and your wall system is so that the earth berm will also act as a dam. Your wall system (Option 1) will only be 2m tall to resist hydrostatic force. The wall will continuously be 2 m height, which could include the concrete base for the post supports. For example, if the concrete base is 1.2 m and then the wall height would be 0.8 m (elevation 250m) to 1 .8 (elevation 251 m). Or if the base is 0.6 m high, than the remaining height will be the wall system.

Number of corners would be mostly on Reach 7 and 9 Plan, but don't think they are great than 174°, but they do come close. (please see document 10 for corners over 174°)

We understand that you cannot deliver this information at this stage, so we need to approach the project step by step

We try to support you as good as we can come from rough estimations from former projects to more detailed information.

We can support you with

- technical sketches of our components
- a planning guide
- our experience based on more than 20 years of mobile flood protection

At this stage of the design, it is highly conceptual, therefore, concept drawings with typical sketches would be sufficient.

-> Please find attached (documents 04-07) sketches of the used components (-regarding a flood height of 2m and an axis distance of 3m with hydrostatic water pressure)

Juliana, on your Drawings you sent us two options for a mobile flood wall:

Option 1: Flood Height up to 2,5 meter freestanding posts

For this flood height we can offer our standard 100K system. The components for this system you'll find on our homepage:

http://www.ibs-technics.com/fileadmin/documents/Produktkatalog_100K_System_-_Englisch.pdf

Yes, this is what we have in mind for the 2m tall wall. The concrete base would provide permanent structure but not tall enough to obstruct the view. The client is also interested in glass as an option, as well as opaque wall (demountable) as another option. Can the glass be removed like the demountable walls? -> Theoretically the glass system can be removed. The bolts are placed inside the aluminium profile in order to deliver a well looking optical appearance and protect the system from uncontrolled Vandalism. In fact, the glass system is normally used as a permanent system due to its transparency (you find some information about our glass wall systems in document 15).

In such a project we try to use our standard dam beam (you'll find some information about it attached – page 18 & 19). For a flood height of 2,5 Meter, we can work with an axis distance up to 3 Meter. That means: every 3 meter will on center post be placed.

One big advantage of our system: All center posts will be built freestanding, without back support. This is great. A single post anchored in the floor. So you'll need lower logistics equipment, less weight to move and less expenses in set up. Questions:

1. What type of foundation system is typically used to support the wall posts? How large would the concrete base be? -> our system has to transfer a shear force and a momentum into the foundation. These numbers can be provided by IBS. Foundation itself and reinforcement dimensions should be provided by others. IBS can provide size of Anchor Plates. Anchor Plate depends on flood height and axis distance → Foundation is also depending on flood height and axis distance
2. If piles is required what are the typical diameters? -> deep foundations requirement depends on soil and its load capability and should be provided by others
3. How does the wall perform in freeze/thaw cycles over winter and spring season -> We're using long life and testified materials. According to its characteristics tolerances from temperatures are included in the system
4. What is the tolerance in the base seal to cold temperatures? How often would it need to be replaced? -> It is a long life proved material. No scheduled replacement is required – independent to the temperature. The ground seal will be pressed during setup and stored dry and over freezing point after a flood event.
5. How does the wall take impacts from ice flows? -> Definition of structural load criteria has to be done at design stage. IBS is ready to consult in calculating load criteria due to our long, world wide experience in building such systems we'd like to consult you in this point as well.

Option 2: Flood Height up to 5 meter

We can offer such a system. But, this wouldn't be a standard system. Five meter is very high for a mobile flood protection system. IBS recommend a flood height from 3,5 to 4 meters. Everything higher is very sophisticated engineered work. Sophisticated engineered we – of course - can do. But for this we have to calculate a lot of variables.

- Axis distance
- Load criteria (hydrostatic, impact, wave,...)
- Width and Thickness of the foundation

We understand that 5 m high is not standard system, and I don't anticipate the client to choose this option, but it is part of our evaluation due diligence. Therefore, don't feel like you have to provide precise cost; a high level approximation with assumptions clearly stated would be sufficient. For example, if your wall system can only be 5 m at the highest, please state it, and we will supplement the remaining height with earth berms or concrete walls. As part of the exercise is to provide costs for this system, we will also need to know what type of foundation system is required:

1. What type of foundation system is typically used to support the wall posts? How large would the concrete base be? Please see answer 1
2. If piles is required what are the typical diameters? –Please find answer up to point 2

Juliana, please find attached a sketch of our Anchor Plate AP100S-T41 (Document 08) -> we would use this Anchor Plate for a flood height of 5 Meter with hydrostatic water-pressure, this solution works up to 4m free standing, after rising water the back support has to be attached.

Juliana, I'm really looking forward to your reply. If you need any support for planning this project, please let me know. We're world market leader in mobile flood protection walls made of dam beam. There is no other company that has these experiences than IBS.

Have a great day and a good start in this new week

Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager



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IBS Technics GmbH
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Geschäftsführer: Dipl.Ing. Xaver Storr, Dipl. Wirtsch.-Ing. Sebastian Schauback
Eintrag: Amtsgericht Augsburg, HRB 13846
USt-ID: DE164481231

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Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager





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Hinweis auf elektronischen Datenschutz

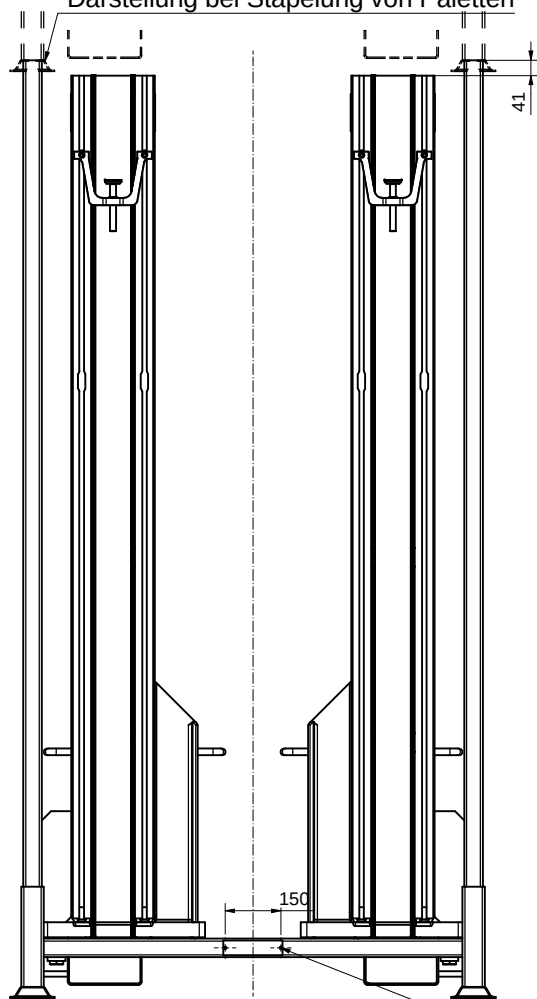
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Darstellung bei Stapelung von Paletten

Item 01



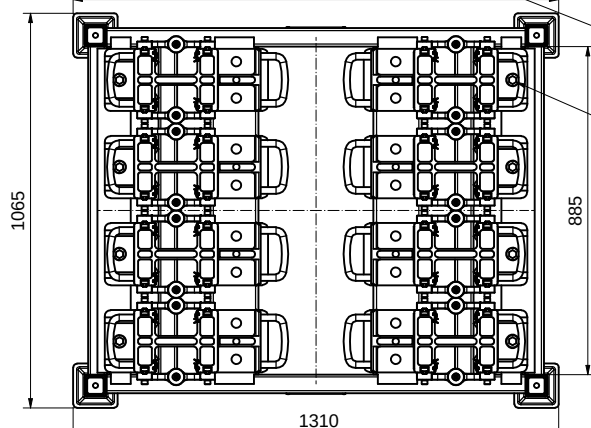
Systemhöhe 2325

Rungenhöhe 2500

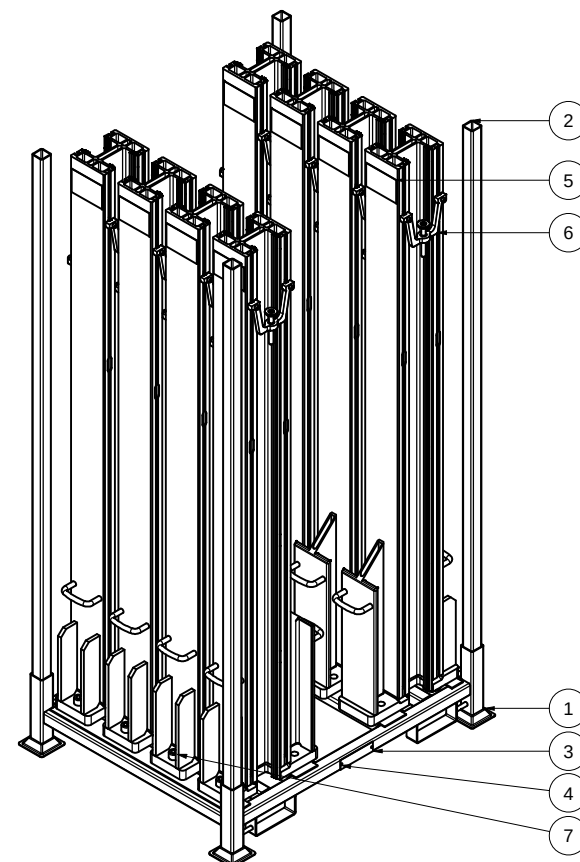
2530

Aufkleber nach Bestellung
Nieten Ø4, Bohrung Ø4,1

MS mit 1x M24x110
außen verschraubt!



Schutzvermerk DIN 34: Weitergabe sowie Vervielfältigung dieses Dokuments, Verwertung und Mitteilung seines Inhalts sind verboten, soweit nicht ausdrücklich gestattet. Zuwiderhandlungen verpflichten zu Schadenersatz. Alle Rechte vorbehalten.



Hinweis: Schrauben vor dem eindrehen
mit Anti Seez E-COLL einsprühen!

7	8	18006651	Zylinderschraube	DIN 912 M24 x 110	8.8 g.v.
6	16	20004424	Verspannschlitten	VS100K	
5	8	20006185	MS100K	T03-13-00_AW6005	
4	4	17000189	Blindniet - Flachrundkopf	W-0935 4 10 - 4,5-6,5	
3	2	20015359	Blech	LT-Beschriftung	EN AW-5083 H112
2	4	20017369	Vierkantrrohr	DIN EN 10305 50 x 50 x 3	S235
1	1	20017355	LT-P02	MS100K-T01-03-V S235	
Pos.	Anz.	Ident-Nr.	Titel		Material
			Bezeichnung		

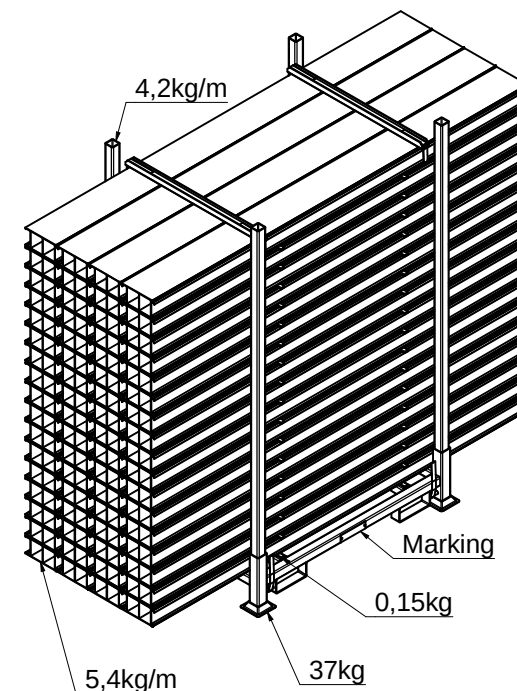
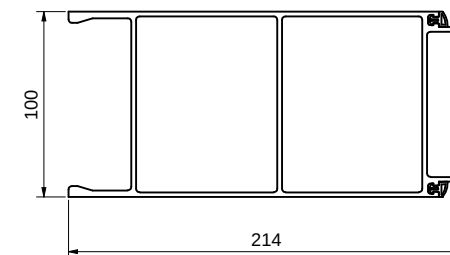
Allgemeintoleranzen für Schweißkonstruktionen nach DIN EN ISO 13920-BE
Allgemeintoleranzen für Längen, Winkel, Form und Lage nach DIN ISO 2768 mittel
Werkstückkanten nach DIN 6784
Oberflächen nach DIN ISO 1302
Ra in µm

- Freigegeben zur Herstellung 04.09.2013 Test

IBS
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D-86672 Thierhaupten
Tel: +49-8271/8176-0 Fax: -76
E-Mail: info@ibs-technik.de
Scale: 1:10 Weight: 704,342 kg
Title / Description
LT-P02
MS100K-T03-2325-V_S235
L= 1130,000 mm
W= 885,000 mm
H= 2500,000 mm

Created by	Date	Name	Ident-No.	Drawing No.	Material:	Sheet
04.08.2013	Wagner	20017512	20017513	1/1	A2	
PSP-Nr.				Status: Freigegeben		

DBAL100x200-2,5 (1 : 2)

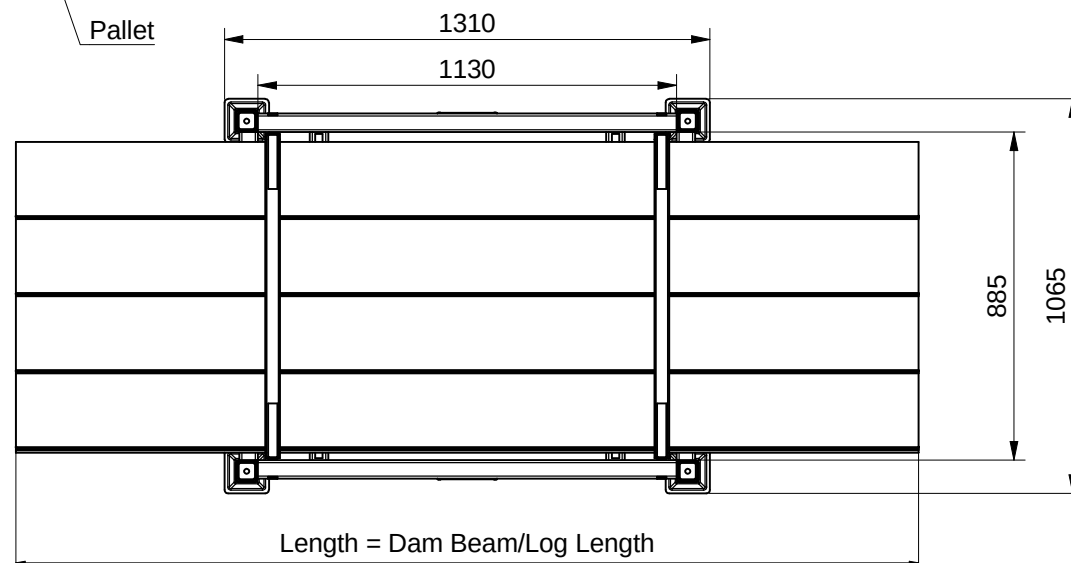
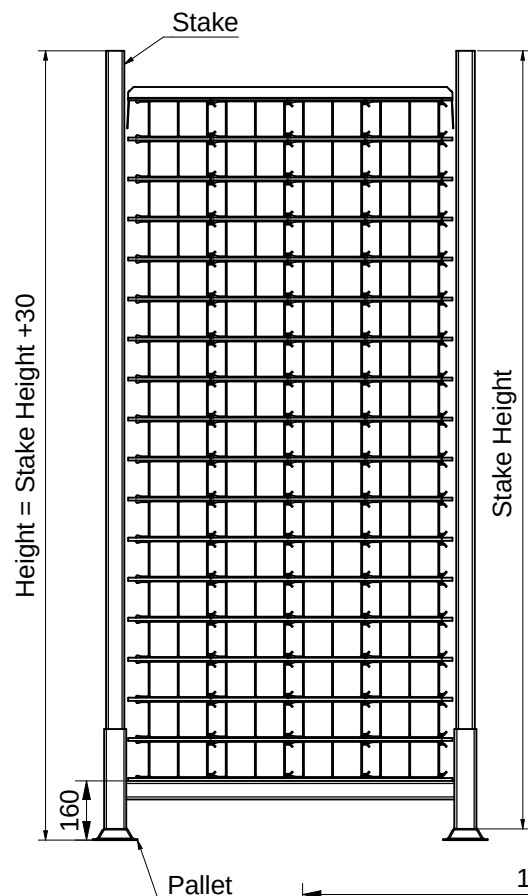


Compilation				Contents			
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	2	500	20022408				
	3	600	20022409				
	4	700	20022412				
	5	800	20015743				
	6	900	20022253				
	7	1000	20022414				
	8	1100	20022416				
	9	1200	20022074				
	10	1300	20022257				
	11	1400	20015745				
	12	1500	20019683				
	13	1700	20022420				
	14	1800	20022075				
	15	1900	20022422				
	16	2000	20022424				
	17	2100	20015731				

No. Pallets:	
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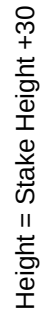
Sticker: ☐

Label:



Weight:			
 IBS GmbH Gemeindewald 4-6 D-86672 Thierhaupten Tel: +49-8271/8176-0 Fax: -76 E-Mail: info@ibs-technik.de		Scale: 1:10	
		Title / Description principle drawing LT-P02 DBAL100x200-2,5	
		L=	
		W=	H=
	Date	Name	Ident.No.
Created by	27.11.2013	Wagner	P0000993
PSP-Abz.			
		Drawing No.	Material:
		P0000994	
		Status: In Bearbeitung	
			Sheet 2 / 2 A2

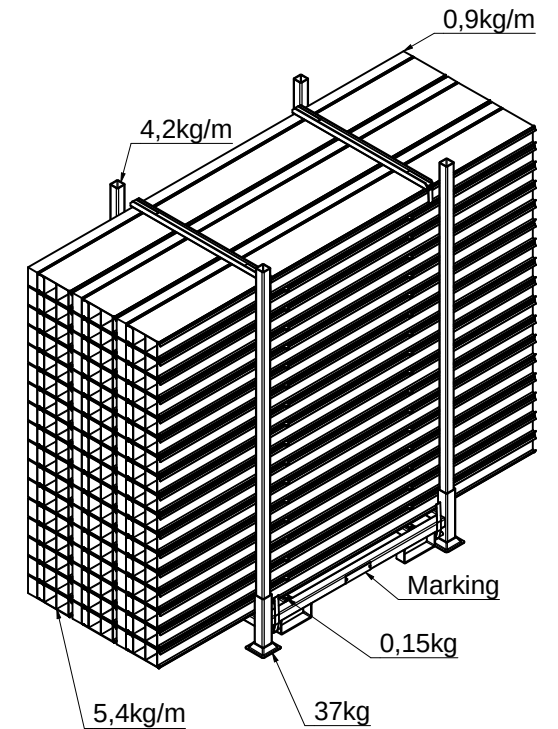
DBAL100x200-2,5 (1 : 2)



No. Pallets:

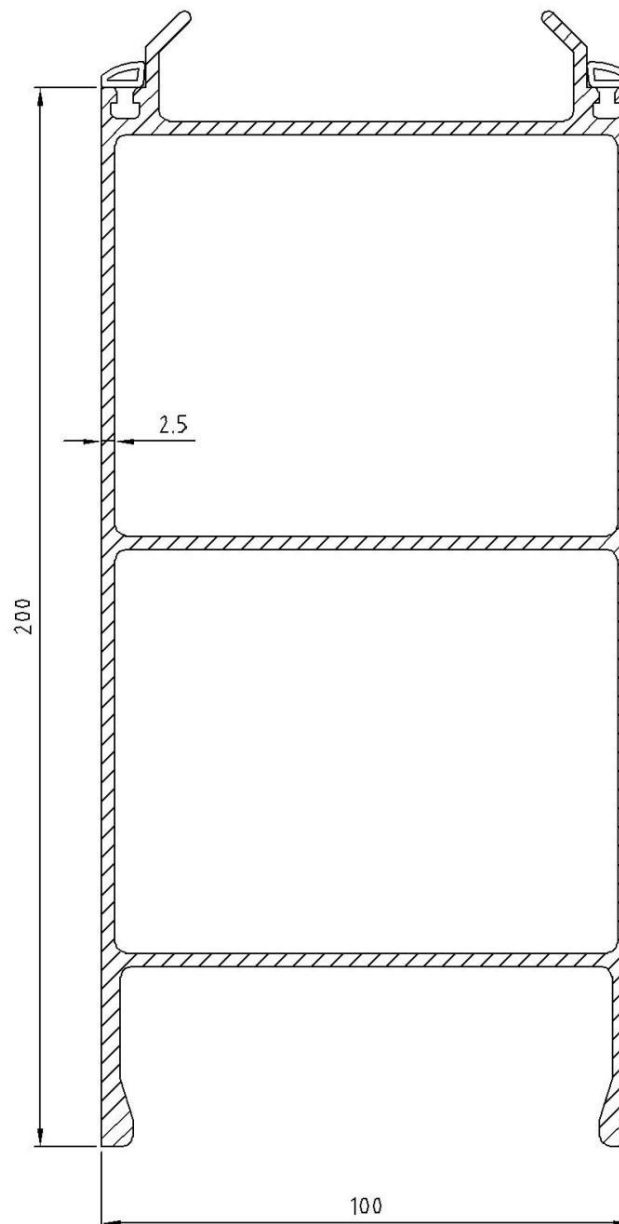
Sticker: ☐

Contents			
Piece	DB	DB+BD	Length



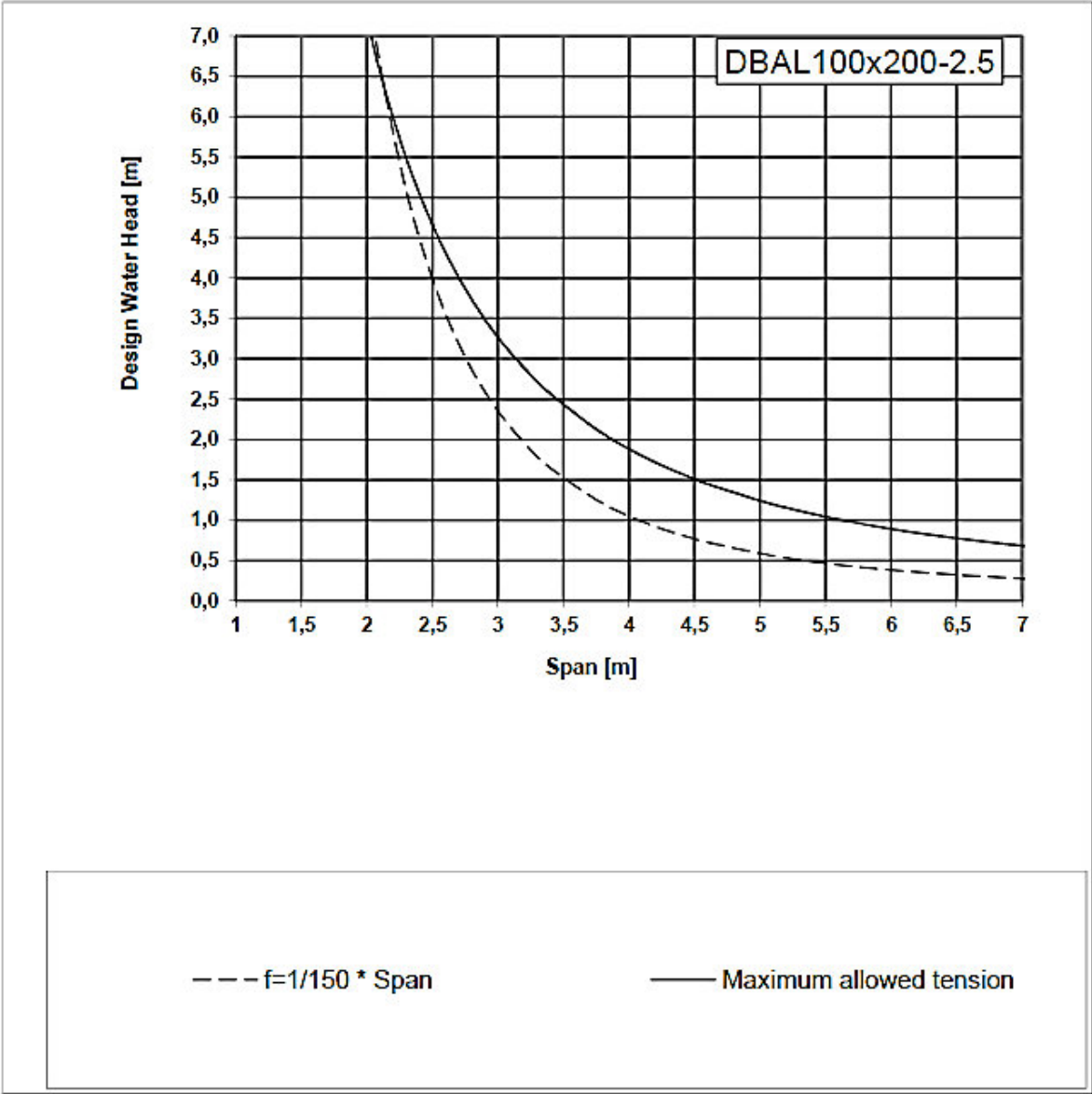
Weight:				Scale: 1:10				
 IBS GmbH Gemeindewald 4-6 D-86672 Thierhaupten Tel: +49-8271/8176-0 Fax: -76 E-Mail: info@ibs-technik.de		Title / Description principle drawing LT-P02 DBAL100x200-2,5+BD-100-PE-PU						
		L= W=						
		H=						
Date	Name	Ident.No.	Drawing No.		Material:		Sheet	
28.11.2013	Wagner	P0001001	P0001002				2 / 2	
PSP-Nr.			Status: In Bearbeitung					A2

2.3.3 DBAL100x200-2.5



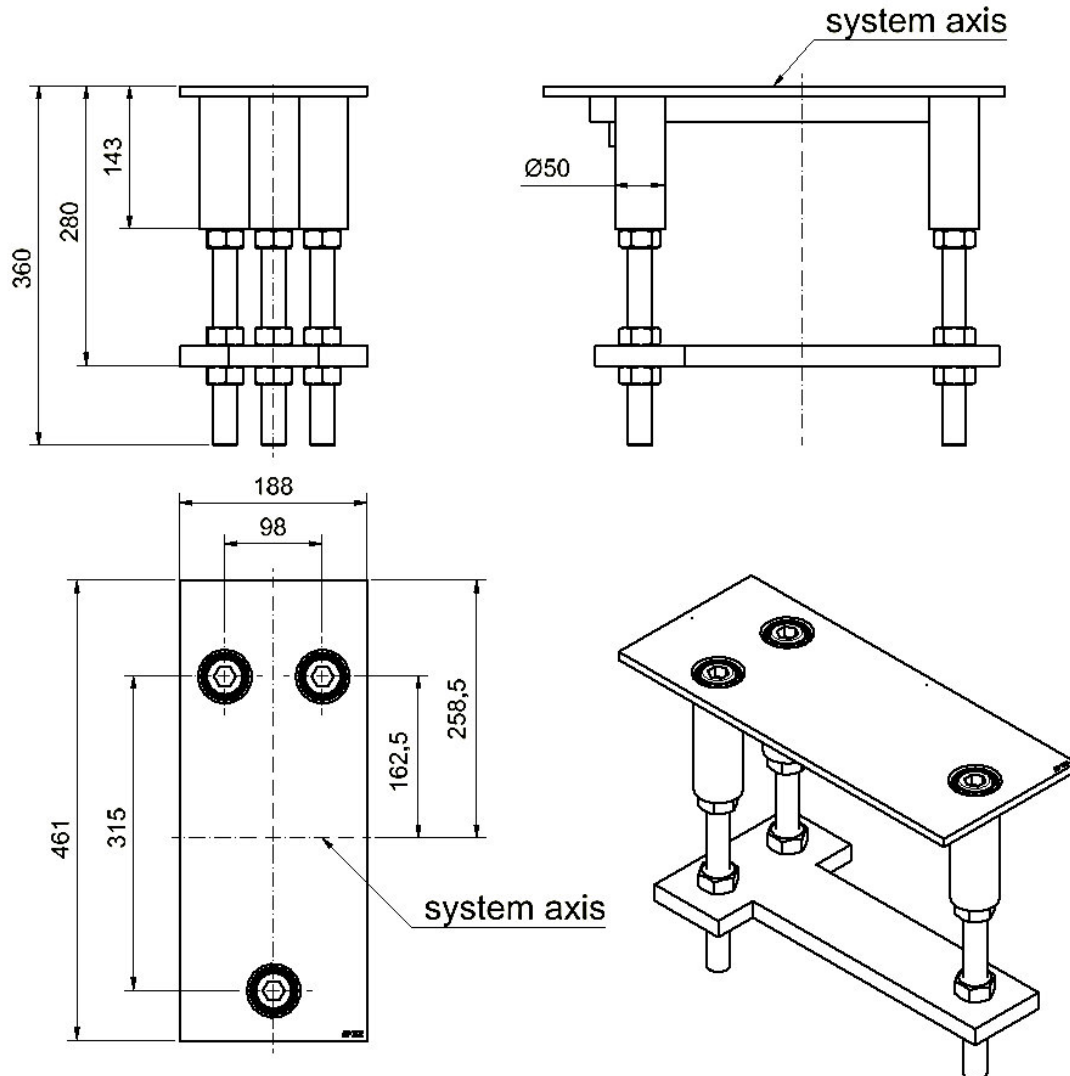
PROFILE CHARACTERISTICS		
Height	mm	200
Width	mm	100
Thickness	mm	2,5
Cross-sectional area	cm ²	19,7
Weight per linear m	kg/m	5,3
Material	-	EN AW-6063-T66
Moment of inertia	cm ⁴	339,5
Modulus of elasticity E	N/mm ²	70.000

Deflection Graph DBAL100x200-2.5



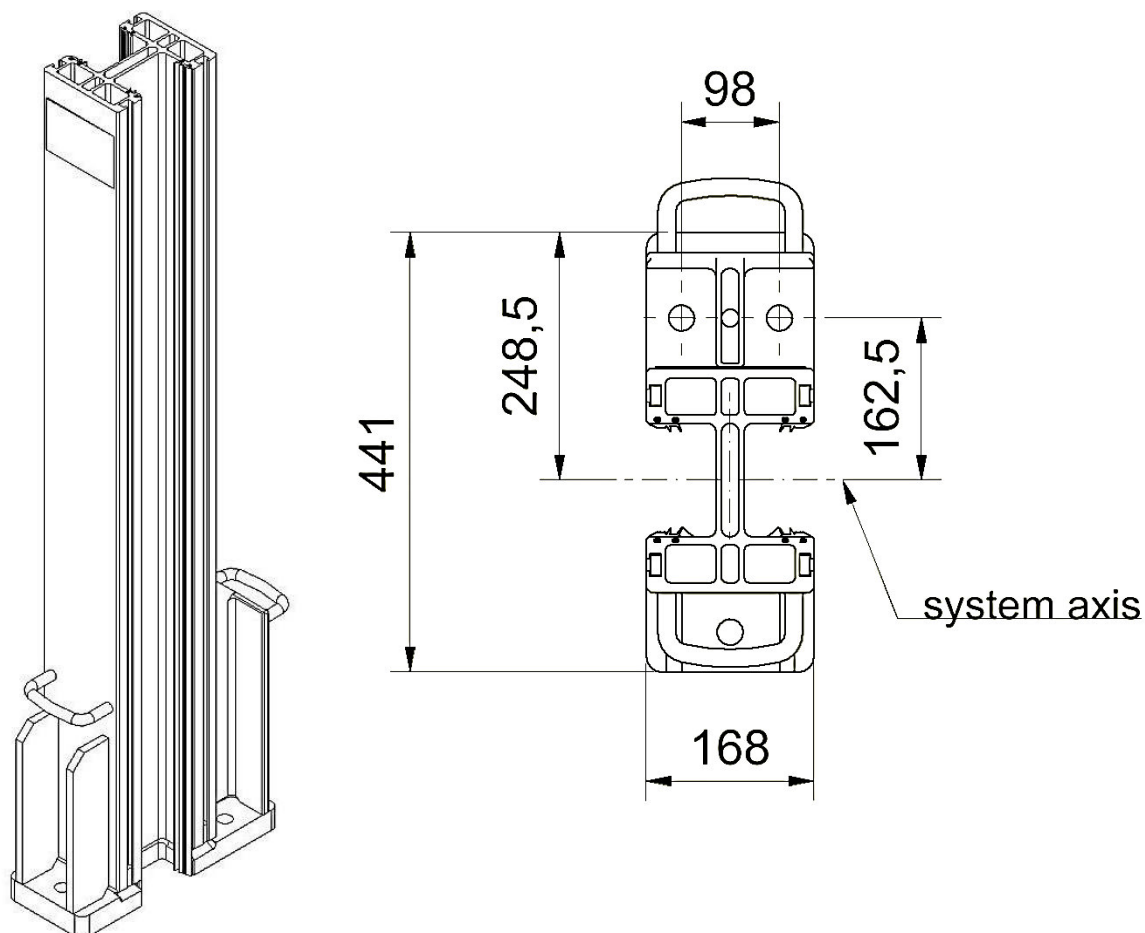
2.6 Anchor Plate

2.6.1 AP100K-T03



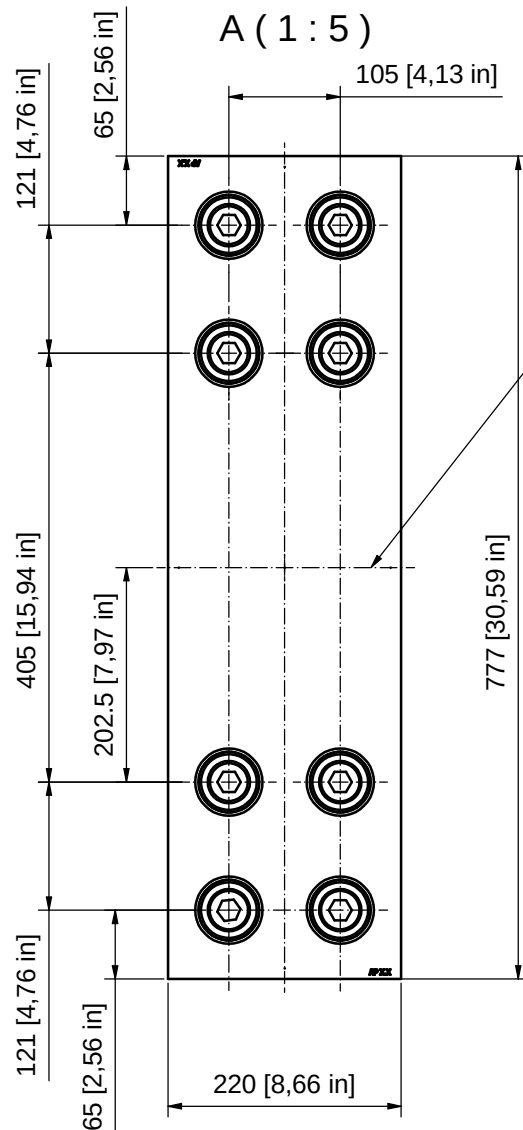
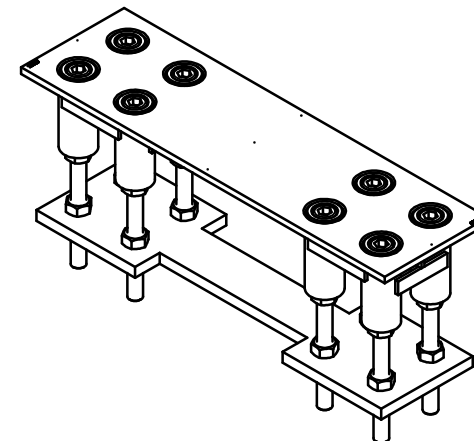
Coverplate	Stainless Steel, Grade.: SS 304
Bushes	Stainless Steel, Grade.: SS 304
Reinforcement Spindles	Mild Steel, Grade: S235; 8.8 blanc
Reinforcement Plate	Mild Steel, Grade: S235
Nuts	Mild Steel, Grade: S235; 8.8
Dummy Bolt (cylinder head bolt)	DIN912 M24x40 A4-70

2.7.2 MS100K-T03



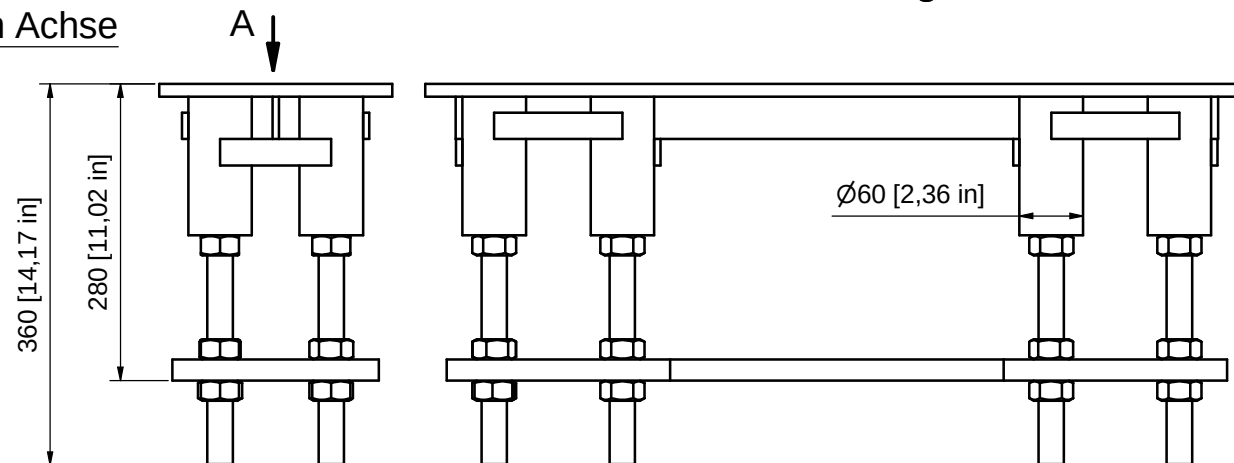
LEGEND				
Description	Flood Height [mm]	Max. Axis Distance/Span a [mm]	Weight [kg]	Material
MS100K-T03-1405	1350	6000	47,8	EN AW 6005-T6
MS100K-T03-1450	1400	6000	49,7	
MS100K-T03-1560	1500	6000	52,6	
MS100K-T03-1655	1600	6000	55,1	
MS100K-T03-1715	1650	6000	58,3	
MS100K-T03-1800	1750	6000	61,2	
MS100K-T03-1865	1800	4900	63,4	
MS100K-T03-2020	1950	4200	68,7	
MS100K-T03-2060	2000	4000	70,0	
MS100K-T03-2170	2100	3600	73,8	
MS100K-T03-2265	2200	3300	77,0	
MS100K-T03-2325	2250	3150	79,1	
MS100K-T03-2480	2400	2750	84,3	

Item 08



waterside
Wasserseite

system axis
System Achse



Weight: 145,298 lb

Weight: 65,906 kg

Scale: 1:2

Title / Description

AP100S

T41-00	1.4301
--------	--------

 $L =$
$$W =$$
 $H =$

Materials

Sheet
3 / 4
A3

Drawing No.	
-------------	--

Material:

20015372

Status: Freigegeben

IBS

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Gemeindewald 4-6
D-86672 Thierhaupten

Tel: +49-8271/8176-0 Fax: -76
E-Mail: info@ibs-technik.de

	Date
--	------

Date	
29.03.2011	

Nome

Name	
Wagner	

Ident. No.	
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Ident-No. **20015370**

PSP-Nr.	052028
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Drawing No.	
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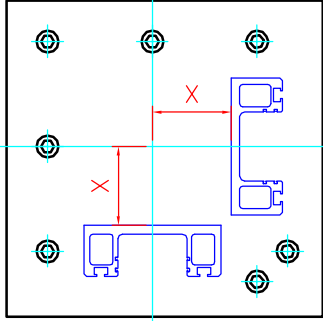
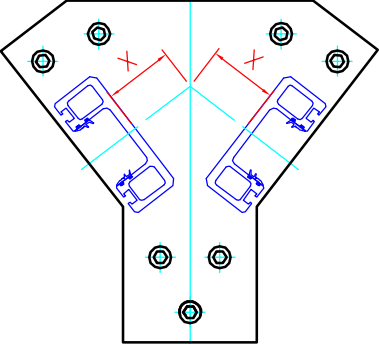
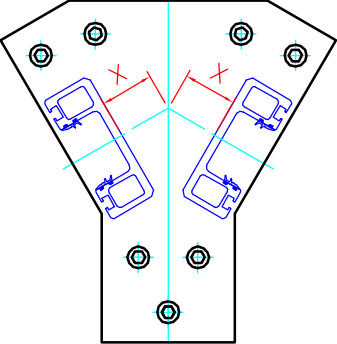
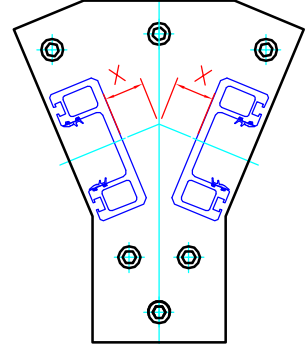
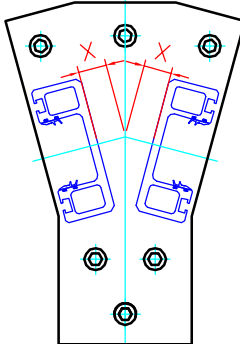
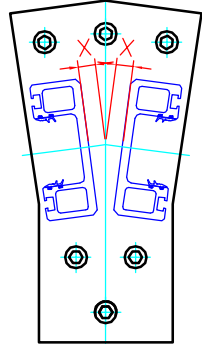
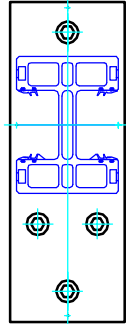
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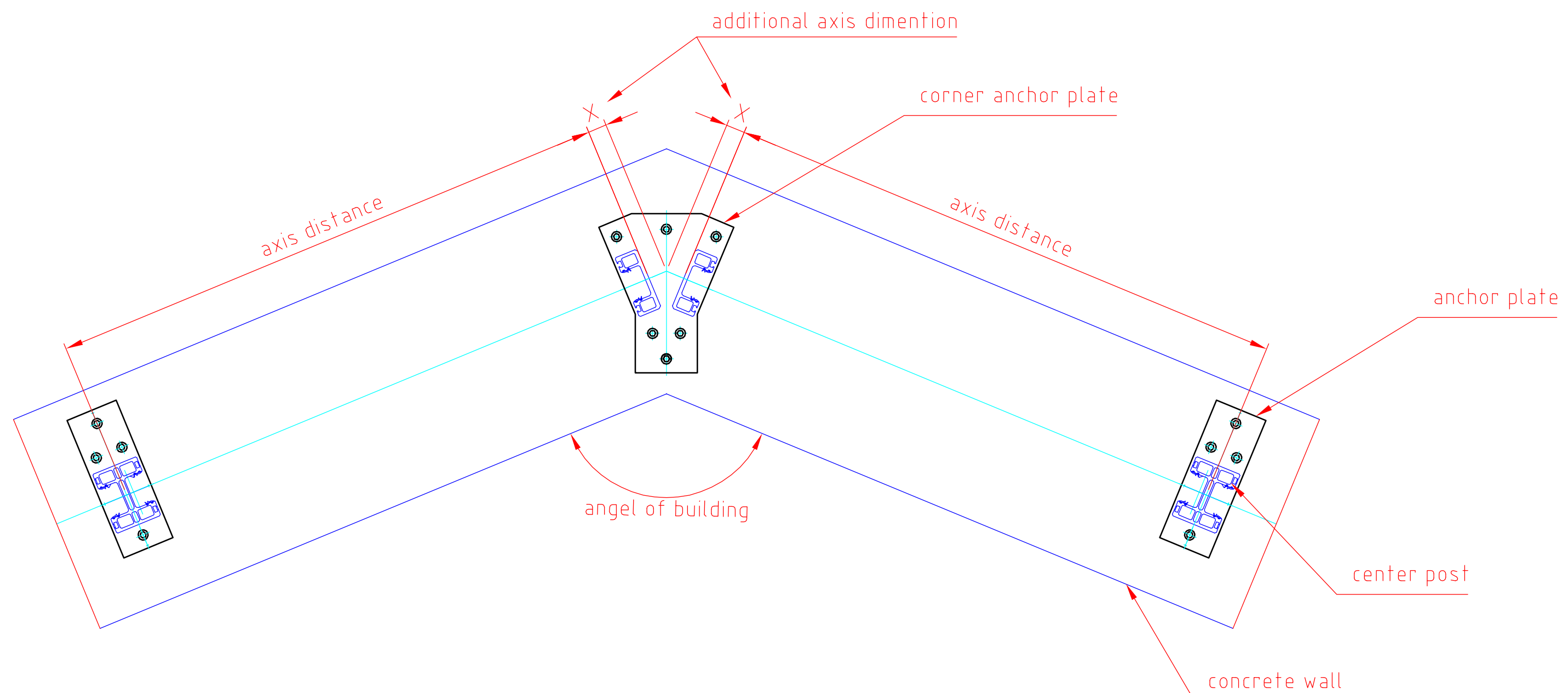
20015372

Status: Freigegeben

Item 09



angel of anchor plate	90°	105°	120°	135°	150°	165°	180°
angel of building	82,5° - 97,49°	97,5° - 112,49°	112,5° - 127,49°	127,5° - 142,49°	142,5° - 157,49	157,5° - 171,99°	172° - 188°
additional axis dimention "X"	130 mm	114 mm	88 mm	66 mm	46 mm	28 mm	0 mm
							



IBS GmbH Gemeindewald 4 D-86672 Thierhaupten TEL. +49 (0)8271/8176-0 FAX. +49 (0)8271/8176-76				IBS		Oberfläche		Maßstab 1:10		Position		Menge							
								AP100K -additional axis dimention											
				Datum		Name													
				Bearb.		28.01.10								Sedlmair					
				Gepr.															
				Norm															
								038580											
																		Blatt	
																		Bl	
Zust.		Änderungen		Datum		Name		Dateiname 038580											

Item 11



Item 12



Item 13



Item 14





IBS GROUP

Our Production Facilities

- › IBS Technics GmbH Thierhaupten
- › IBS Technics Rotava (s.r.o.)
- › IBS Engineered Products Ltd, Doncaster, UK

About Us

- › International Engineering Company
- › 150 employees
- › 11,000 m² manufacturing facilities
- › global leader for mobile flood water protection
- › more than 4000 successfully completed projects

Our Performance

- › Global distribution
- › Development, design and construction
- › State of the art production
- › Modern machinery
- › International service structure

Our Markets

- › Europe
- › Middle East
- › North America
- › Australia
- › Asia

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WWW.IBS-TECHNICS.DE

IBS Technics GmbH

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Mail: info@ibs-technics.de · Web: www.ibs-technics.de

IBS GROUP
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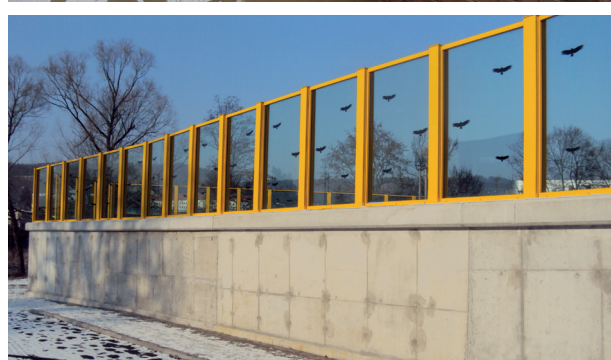
Unit 7 · Brunel Park · Off Blyth Road · Harworth
Doncaster · South Yorkshire · DN11 8NE
Phone: +44 1226 6300-15 · Fax-Nr.: +44 1302 6300-14
Mail: info@ibsengeeredproducts.com · www.ibsengeeredproducts.co.uk

IBS Flood Protection Glass Walls



- › Time-tested
- › Standardised solutions
- › International distribution structure
- › Economic serial Production
- › Complete portfolio of solutions

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Glass Walls made by IBS

Our experience – Your advantage

- Capable
- Tested
- International
- Qualified
- Flexible
- Resilient

Quality Standards

- DIN German Industrial Standard
- EN 1090
- Industrial Production
- Certified Welding Specialists

Sizes

- Unlimited length, standard individual field sizes up to 2500mm
- Heights up to 1200mm
- Special design and sizes on request

Area of Application

- Riverside areas
- Seaside promenades
- Public spaces
- Private properties

Advantages

- Permanent flood protection
- Maintenance friendly
- Advanced, high performance system
- Adaption to project specific requirements

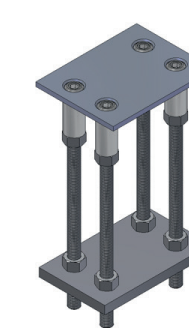


Components

- Endposts
- Center Posts
- Anchor Plates
- Frames
- Laminated Safety Glass
- Ground Seals

References

- Northwich (UK)
Length: 330 m; max. Height: 1,4 m; Area: 358 m²
- Leeds (UK)
Length 103 m; max. Height: 1,3 m; Area: 86m²
- Bad Neustadt/Brend (D)
Length: 340 m; max. Height 0,60 m; Area 204m²
- Paul Glass Wall, Hull (UK)
Length: 526 m; max. Height: 1,1 m, Area: 550 m²
- Upton upon Severn (UK)
Length: 143 m; max. Height: 0,5 m; Area: 87m²
- Keswick (UK)
Length: 120 m; max. Height 0,8m; Area: 96 m²
- Littlehampton (UK)
Length: 82m; max. Height: 0,8m, Area: 66m²
- Penig (D)
Length: 210 m; max. Height: 0,7 m; Area: 147 m²
- Timmendorfer Strand (D)
Length: 126; max. Height: 1,0 m; Area: 88m²
- Plauen (D)
Length 200 m; max. Height: 1,0 m; Area: 200 m²
- Decin (CZ)
Length: 160 m; max. Height: 2,1 m; Area: 330 m²
- Köln-Westhoven (D)
Length: 310 m; max. Height: 0,4 m; Area: 125 m²



Juliana Tang

From: George Fryklund <georgefryklund@comcast.net>
Sent: Thursday, April 21, 2016 9:44 AM
To: Juliana Tang
Subject: RE: Replacement Costs and Lengths - 20153349.00.E.05.00

Categories: AE FILED EMAIL

Juliana

At today prices planks - approx. US\$300 per each
Lengths – customer choice – FCA reco 20'

From: Juliana Tang [mailto:tangj@ae.ca]
Sent: Thursday, April 21, 2016 10:09 AM
To: George Fryklund <georgefryklund@comcast.net>
Subject: Replacement Costs and Lengths

Thanks George. A couple more questions:

1. How much would components replacements cost per for the aluminum planks if there are damage due to vandalism?
2. What are the ranges of length of aluminum planks between post that your product offer?

Thanks.

Juliana

From: George Fryklund [mailto:georgefryklund@comcast.net]
Sent: Thursday, April 21, 2016 7:54 AM
To: Juliana Tang
Subject: RE: RMWB Flood Wall - Attachment No.2

Juliana

Depends on backlog at time of order, but 4 to 6 months, after shop drawing approval.

Thanks,

George Fryklund
Flood Control America
O: 978-440-8902
C: 617-283-6236

From: Juliana Tang [mailto:tangj@ae.ca]
Sent: Tuesday, April 19, 2016 6:24 PM
To: george@floodcontrolam.com
Subject: RE: RMWB Flood Wall - Attachment No.2

George,

What is the supply time to Alberta?

Juliana Tang, M.Sc., P.Eng. LEED A.P.
Geo-environmental Engineer, Sustainable Design
Associated Engineering Alberta Ltd.
500, 9888 Jasper Avenue, Edmonton, AB T5J 5C6

Tel: 780.451.7666 | Cel: 780.718.8420 | Dir: 587.772.0684



You may [unsubscribe from Associated Engineering electronic communications](#) at any time.

From: Juliana Tang
Sent: Tuesday, April 19, 2016 3:27 PM
To: george@floodcontrolam.com
Subject: RE: RMWB Flood Wall - Attachment No.2

Thanks George for the discussion. Please see below the notes I have taken during our phone conversation. You have also provided a ball park cost of US\$110/ft² for supply of wall systems including posts, bolts, planks, and all incidental material that forms part of the wall. This does not include freight or installation, foundation installation.

Flood Wall America also does not provide glass panels.

If there is anything missed, please feel free to add to it. Thank you.

Juliana

From: Juliana Tang
Sent: Monday, April 18, 2016 9:32 AM
To: 'George Fryklund'
Subject: RE: RMWB Flood Wall - Attachment No.2

Thanks George. The drawings are drawn to scale, ANSI A1 size. You can print to 11x17 for half size. Some additional information:

Lengths are:

Reach 7: 930 m

Reach 8: 700 m

Reach 9: 450 m

Flood Height is elevation 250m above sea level. The top of wall will be a continuous elevation of 250 m elevation with a factor of safety up to 251 m. The combination of earth berm and your wall system is so that the earth berm will also act as a dam. Your wall system in Sketches 201, 202, 203 will only be 2m tall to resist hydrostatic force. Sketch 203 does not need such a high wall as you will see the ground is already relatively high. Therefore the wall may be only 1m high. For other Reaches, the wall will continuously be 2 m height, which could include the concrete base for the post

supports. For example, if the concrete base is 1.2 m and then the wall height would be 0.8 m (elevation 250m) to 1 .8 (elevation 251 m). Or if the base is 0.6 m high, than the remaining height will be the wall system.

Also, here are our questions:

No glass panels.

Design

1. What type of foundation system is typically used to support the wall posts? **Spread footing.** How large would the concrete base be? **Forms as part spread below ground. Base is 2x the height of the wall.**
2. If piles is required what are the typical diameters? **Generally not required for shorter walls.**
3. How does the wall perform in freeze/thaw cycles over winter and spring season **Don't leave it up. Remove it over winter.**
4. What is the tolerance in the base seal to cold temperatures? **Gaskets travel with the aluminum panels, and will need to be stored indoor.** How often would it need to be replaced? **More than 20 years. Not out in weathering effects.**
5. How does the wall take impacts from ice flows?

Settlement issues – tolerant to settlement if all settled at once. Differential settlement – concrete is less tolerant.

Maintenance and Operations

1. What is the storage requirements of the panels and posts when demounted? Does it need to be indoor, or can it be indoor/outdoor? Is there a typical storage area requirement they can provide? **Indoor storage.**
2. What is the preventative maintenance requirements for the wall, posts, panels and bolts? **Galvanized. Spray to coating, if needed.**
3. What is the life cycle of the various components in terms of years or uses? **50 plus years.**
4. Where is the closest supplier? Do you have a supplier in US?
5. What is the crew requirements to deploy the wall in terms of manpower, time and equipment? **Wall does not need specific skills to install.**
6. What training and skill level is required to install the wall? Can there be one person trained, directing the rest of untrained personnel? **Need one trained person and labour.**
7. How long would it take to install the walls assuming an experienced and inexperienced crew? **A crew of ten men for 1 week.**
8. How much room is required for equipment access to install the walls? How far should obstructions (light posts, bench nodes) be located from the wall? **On site- from back of the truck – more than 7 to 8 ft high, need equipment. 10 ft room to installation.**
9. Can drainage pipes be designed to pass through the foundation? **Not recommended.**
10. Is there a recommended percentage for spare wall panels and posts? **No specific requirement. Only as needed.**

As this is still in conceptual stage, we are expecting detailed information for pricing, as long as you state your assumptions clearly.

Juliana Tang, M.Sc., P.Eng. LEED A.P.
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From: George Fryklund [<mailto:georgefryklund@comcast.net>]
Sent: Friday, April 15, 2016 10:21 AM
To: Juliana Tang
Subject: RE: RMWB Flood Wall - Attachment No.2

Hi again

The attachments do open on my home computer, so I need a little time to get to them, but I will and get back to you.

George Fryklund
Flood Control America
O: 978-440-8902
C: 617-283-6236

From: Juliana Tang [<mailto:tangj@ae.ca>]
Sent: Tuesday, April 12, 2016 7:05 PM
To: george@floodcontrolam.com
Subject: RMWB Flood Wall - Attachment No.2

George,

As discussed in the first e-mail. Thanks.

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Juliana Tang

From: Patrick Gilg <gilg@ibs-technics.de>
Sent: Wednesday, January 25, 2017 7:28 AM
To: Juliana Tang
Cc: Berthold Reiter
Subject: AW: Proposed Alignment - Attachement No. 2

Dera Juliana,

very nice to hear from you. First of all: Best wishes for good, successful and healthy new year 2017.
I hope you had a good start in this new year.

Juliana, please find my answers below in orange.

I hope this answers help you.
If you need any further information do not hesitate to contact me.
I'm looking forward to hear from you.

Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager



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Von: Juliana Tang [<mailto:tangj@ae.ca>]
Gesendet: Freitag, 20. Januar 2017 18:36
An: Patrick Gilg

Cc: Berthold Reiter
Betreff: RE: Proposed Alignment - Attachement No. 2

Hi Patrick,

Just want to follow up with our questions in green below. Your help would be much appreciated. Thank you.

Juliana Tang, M.Sc., P.Eng., LEED A.P., ENV SP
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From: Juliana Tang
Sent: Thursday, September 29, 2016 12:21 PM
To: 'Patrick Gilg' <gilg@ibs-technics.de>
Cc: Berthold Reiter <reiter@ibs-technics.de>
Subject: RE: Proposed Alignment - Attachement No. 2

Hi Patrick,

Long time no chat. Sorry, the project was on hold due to local political discussions, and now it is back on track again. I have a couple more questions to clarify and if you can help me. Below is what we discussed previously, my new questions are in green:

1. What is the crew requirements to deploy the wall in terms of manpower, time and equipment? -> For guideline: One person can build approx. 10-15 m² wall per hour. This guideline includes set up only – time expenses for alarm, transport and unloading the components is not included. If the wall is 3m to 5m high, what is the rate of building these walls? Would the rate change? -> Time for set up won't change. But Attention: From flood heights over 2 Meters some scaffolding has to be provided.
2. Because of the winter conditions here in northern Alberta, Canada, what kind of maintenance or cleaning needs to be done before installing the walls? For example, ice and snow removal, etc? -> In this point you have different types of maintenance.
 - Annual maintenance: this is an extract of the annually works you have to do: check completeness and readiness of operation, check seals are not damaged,... It's advisable to set up a few fields every year for testing purposes.
 - Before installing: operator has to ensure availability and readiness for setup including all necessary steps according to local weather conditions. System is working at complicated conditions like temperatures below zero as well as at night

Thank you.

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From: Patrick Gilg [<mailto:gilg@ibs-technics.de>]
Sent: Friday, April 22, 2016 6:29 AM
To: Juliana Tang <tangj@ae.ca>
Cc: Berthold Reiter <reiter@ibs-technics.de>
Subject: RE: Proposed Alignment - Attachement No. 2

Dear Juliana,

please excuse my late response, but today is my first day back in office after my business trip to UK.

Juliana, you'll find my answers to your questions below in "red".
Also you'll find different attachment. You'll find information about these documents and photos in my answers.

If you have any further questions, do not hesitate to contact me.

I'm looking forward to your reply

Mit freundlichen Grüßen/Best regards

Patrick Gilg
PR- Marketing- and Sales-Manager



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