APPENDIX B
Existing Drainage Infrastructure Diagram
APPENDIX C
Stormceptor STC-300
Typical Specification
APPENDIX A

Master Drainage Plan
A Report
To:

Fraser River Port Authority

For:

Surrey Dock Lands
Master Drainage Plan

AUGUST 2004
EB3612
# Table of Contents

1. **Purpose** ..................................................................................................................................... 1

2. **Background** .................................................................................................................................. 2
   - 2.1 FRPA Surrey Lands ................................................................................................................ 2
   - 2.2 Regulatory Framework ............................................................................................................ 2
   - 2.3 Time Frame ............................................................................................................................. 3

3. **Existing Drainage Patterns** ....................................................................................................... 4
   - 3.1 Drainage Patterns .................................................................................................................. 4
   - 3.2 Drainage Issues ...................................................................................................................... 5
   - 3.3 Design Criteria ....................................................................................................................... 5
   - 3.4 Fraser River Flood Risk ......................................................................................................... 6
   - 3.5 General Site Characteristics ................................................................................................. 7
   - 3.6 Drainage Area Assessments ................................................................................................. 7

4. **Conclusions** .............................................................................................................................. 15
   - 4.1 General .................................................................................................................................... 15
   - 4.2 Fraser River Flood Risk ......................................................................................................... 15
   - 4.3 Creek Systems ....................................................................................................................... 15
   - 4.4 Ponding and Localized Drainage ......................................................................................... 16

5. **Recommendations** .................................................................................................................... 17
   - 5.1 General .................................................................................................................................... 17
   - 5.2 Fraser River Flood Protection ............................................................................................... 17
   - 5.3 City of Surrey and Off-Site Upland Development ................................................................ 18
   - 5.4 Proposed Site Improvements ............................................................................................... 18

**Appendices**

- **Appendix 1** Photos
- **Appendix 2** IDC & Lot East of Shed 6 – Preliminary Design
- **Appendix 3** Timberland Road – Conceptual Cross-section
1. **PURPOSE**

This Master Drainage Plan (MDP) was prepared for the Fraser River Port Authority (FRPA) for their lands in and adjacent to the Fraser Surrey Docks. The purpose was to consolidate the known information about the existing site drainage, assess the drainage and flood protection on the lands, assess the potential impact of on-site and off-site development or other changes to the site drainage, and plan the necessary improvements. The plan includes:

- Background information that summarizes the geographic, historical, and regulatory framework for the site;
- A summary of the existing drainage patterns on the FRPA lands and adjacent lands;
- A list of drainage issues that may impact flood protection at the FRPA lands, including on-site issues and external drainage issues;
- Conclusions;
- Recommended improvements or other actions to reduce flood risk and accommodate planned development.

The FRPA lands are intended to be used as industrial port lands characterized by extensive impervious surfaces right up to the edge of the Fraser River. This MDP focuses on site drainage and flood protection in this industrial context, and does not address fish habitat and other social values attributed to watercourses. Nevertheless, we understand that it is the FRPA’s practice to install oil/silt separators wherever practical in new installations.
2. **BACKGROUND**

2.1 **FRPA Surrey Lands**

The location of the FRPA Surrey lands is shown in *Figure 1*, Location Plan. The lands run in a south-west to north-east direction. For simplicity, this report will refer to the Fraser River as north of the site, instead of north-west.

The lands include approximately 140 ha of federal industrial lands managed by the FRPA who in turn lease out portions of the lands to a variety of leaseholders and land management firms. A large portion of the lands is occupied by Fraser Surrey Docks (FSD), a break-bulk and container terminal.

The majority of the lands are contiguous and are bounded by the Fraser River to the north, the Surrey/Delta border to the west, the Manson Canal to the east, and the CN and BN rail lines, South Fraser Way, and River Road to the south. A smaller group of lots is located east of Manson Canal and is within an area bounded by the Fraser River to the north, Manson Canal to the west, the CN & BNR rail lines to the south, and Old Yale Road to the east. This report will refer to these lands as the Tannery Road Lands.

A breakwater separates the shipping berths and port waterfront from the main channel of the Fraser River from and Tannery Road to Berth 7 as shown on *Figure 2*.

2.2 **Regulatory Framework**

The FRPA Surrey lands lie within the City of Surrey (City) in the Province of British Columbia. As federal lands, they are subject to federal laws and are not legally subject to the same city by-laws and provincial regulations as adjacent non-federal land. However, some FRPA lands are part of larger City drainage catchments and the FRPA generally cooperates with the City in the planning and design of shared drainage infrastructure. The objective of this MDP is to cooperatively plan and design such facilities and generally conform to local municipal and provincial practices.

Under the authority of the Dike Maintenance Act, the Ministry of Water, Land and Air Protection regulates the operation and maintenance of flood protection structures by Diking Authorities through the Deputy Inspectors of Dikes Offices. Under common law and in accordance with pertinent legislation and/or agreements, responsibility for operation and maintenance (including inspection and emergency response) is vested with the City of Surrey.
2.3  **Time Frame**

The draft of this Master Drainage Plan was submitted in September, 2003. The significant increase in the FSD container traffic has resulted in a rapid succession of improvement construction and drainage changes between the dates of the draft Plan and this final report. The most pressing issue that precipitated this study was the pending development of the IDC lands and associated road and gate improvements. The final MDP reflects the conditions that existed up to September 2003 to remain consistent with the original intent.
3. **EXISTING DRAINAGE PATTERNS**

FRPA, City, and related as-built records were reviewed to determine the configuration of the existing drainage facilities and features on and adjacent to the lands. Multiple field inspections were performed to verify, clarify and correct records. Elevations were also collected from a number of recent surveys performed on site; however, they did not cover all areas of interest.

3.1 **Drainage Patterns**

The existing drainage patterns are presented in *Figure 2*, Existing Drainage. This figure presents the known drainage infrastructure overlain onto a site orthophoto. The drainage boundaries for each storm outlet are shown in their approximate locations with arrows indicating typical flow patterns.

In general, most of the land is fairly flat with portions lying below the 200 year flood level. Due to the flat grading, many portions of the site are subject to some steady and some periodic ponding, and some low lying areas and ditches are subject to continuous ponding. Most of the upland City drainage is channelled away from the site, although Delta Creek may overflow into the site. *Figure 1* and *Figure 2* show a number of creeks and a canal that is channelled either east or west around the lands.

To assist discussion about each area, the individual drainage areas are listed below and assigned names corresponding to the primary feature within them.

**Table 1**: Drainage Areas.

<table>
<thead>
<tr>
<th>No.</th>
<th>Area Name</th>
<th>Area Within FRPA (ha)</th>
<th>Land Use</th>
<th>Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Berth 1</td>
<td>10.5</td>
<td>Lumber yard, 70% impervious (imp.)</td>
<td>Open outfall</td>
</tr>
<tr>
<td>2</td>
<td>Berth 2</td>
<td>4.0</td>
<td>Storage yard &amp; berth, 100% imp.</td>
<td>Open outfall</td>
</tr>
<tr>
<td>3</td>
<td>Berth 3</td>
<td>4.3</td>
<td>Storage yard, shed &amp; berth, 100% imp.</td>
<td>Open outfall</td>
</tr>
<tr>
<td>4</td>
<td>Titan</td>
<td>18</td>
<td>Sheds &amp; storage yards, 60% imp.</td>
<td>Outfall w/ flap</td>
</tr>
<tr>
<td>5</td>
<td>Berth 5</td>
<td>3.4</td>
<td>Storage yard &amp; berths, 100% imp.</td>
<td>Open outfall</td>
</tr>
<tr>
<td>6</td>
<td>Berth 6</td>
<td>14</td>
<td>Storage yard, sheds &amp; berth, 100% imp.</td>
<td>Open outfall</td>
</tr>
<tr>
<td>7</td>
<td>Berth 7</td>
<td>0.8</td>
<td>Storage yard &amp; berth</td>
<td>3 open outfalls</td>
</tr>
<tr>
<td>8</td>
<td>Berth 8</td>
<td>1.0</td>
<td>Storage yard &amp; berth</td>
<td>4 open outfalls</td>
</tr>
</tbody>
</table>
### 3.2 Drainage Issues

The record and field review clarified our understanding of most of the drainage system. It also identified missing information and areas of concern. The understanding for each area and the related issues are described below. General issues that apply to all areas are described first.

### 3.3 Design Criteria

As a reference, the following design criteria are proposed. It is consistent with the criteria listed in the City of Surrey’s Master Servicing Plan (February 2003).

- The subsurface conveyance system (minor) shall be sized and configured to maintain the peak 1:5 year event below ground surface.
- Sufficient subsurface or surface flow paths must be provided for the 1:100 year (major) design flows without causing risk to public health or private property.
- All buildings shall be flood proofed in accordance with the Ministry of Water, Land and Air Protection requirements of ensuring that minimum building elevations are higher than the 200 year flood level plus 0.6 m freeboard. The 200 year flood level is 3.8 m and the minimum flood proof elevation for the lands, inclusive of the 0.6 m freeboard, is 4.4 m. Similarly, dykes and similar structures at the River’s edge should be constructed to 4.4 m.

For historical reference, the record extreme high water level was 4.5 m set in June 1948, prior to regular deep dredging of the river.
The level of responsibility the FRPA plans to take in the design of drainage infrastructure varies with the leasing arrangement, similar to the difference between managing private and public lands. Long-term commercial lease holders are treated in a manner similar to a City treating private property. Facilities constructed by long-term lease holders must meet acceptable design criteria, and are designed, constructed and maintained by the lease holders. For these tenants, the FRPA takes responsibility for the drainage after it crosses the lease area boundary.

Other lands, such as the shared roadway, short term lease lands, and the FSD lands are managed more actively by the FRPA. Facilities in these lands are typically designed and constructed by the FRPA, with maintenance responsibilities depending on the lease agreement.

3.4 Fraser River Flood Risk

The Surrey lands lie within the low lying flood plain of the Fraser River. The lands are partially protected by a dyke network and pump station, but most drain by gravity to the River. Portions of the lands are below the 200 year flood level with open outfalls to the Fraser River. Figure 2 shows the known areas below 3.8 m and buildings below 4.4 m. The low rail elevations account for a large portion of the low lying lands. Most of the tracks remain under 3.8 m and therefore form low lying interconnecting flow paths if flooding should occur. Some of the CN and BNR main tracks are even under 3.0 m.

Figure 2 also shows some of the elevations along the berth faces. In general, the berth face elevations start at 4.1 m at the east end of Berth 9, drop to about 3.8 m elevation at Berth 5, and continue to drop to about 3.5 m at the west side at Berth 2. East of Berth 9, an unimproved dyke right of way exists with variable elevations. West of Berth 2, the ground elevations at the River’s edge are also highly variable.

High river levels could overtop the berth faces in some locations. In other locations, they could backflow into the open storm sewers, flooding the low areas connected by the low-lying rails.

A breakwater separates the shipping berths and port waterfront from the main channel of the Fraser River between Berth 7 and Tannery Road (see Photo 15, Appendix 1). This breakwater protects the berths from the high velocities in the main channel. The elevation and design of this breakwater was not assessed to determine if it is sufficient to protect the area from bank erosion during a 200 year flood.
3.5 General Site Characteristics

The site is fairly level, with elevations between 3 m and 5 m. Ponding is common, especially along the CN and BN tracks to the south, at the south-west corner of the proposed IDC site, on the unpaved road surfaces, and in the undeveloped fields. Photos 16, 18, 19, 20, 23, 24, and 29 show many of these areas. A mix of open ditches and storm sewers collect and channel stormwater to outfalls along the Fraser River. Some areas are graded to directly drain to the river over the ground surface.

The water table was observed at approximately 2.4 m at the proposed IDC site following an extensive dry period.

3.6 Drainage Area Assessments

- **Area 1: Berth 1** (see Photo 1, Appendix 1)

  This 10.5 ha area is used for an Interfor lumber storage yard and Rivtow tug and barge facilities, and includes Berth One. The surface is around 50% impervious. The drainage boundaries are bounded by the limits of these activities. As a long term lease area with its own self-contained drainage system including an outfall to the river, drainage responsibility is appropriately assigned to the lease holders. The known elevations for this area were below the 200 year flood elevation of 3.8 m. The remainder of the area appears to be consistently below 3.8 m. Therefore, this area is susceptible to flooding during an extreme freshet event (200 year flood).

  No changes are expected in the near term. If a change of tenant or other facility improvements are planned, a more detailed review and redesign to current standards would be appropriate.

- **Area 2: Berth 2** (see Photo 2, Appendix 1)

  This 4.0 ha area is used for steel and other storage, and includes Berth Two. The surface is almost 100% impervious. The area is one portion of the larger FSD site and includes catch basins (CB’s), storm sewers, and an open outfall to the river. **Figure 2** shows that approximately one third of area is known to be below the 200 year flood elevation of 3.8 m, including a few administration trailers. The berth face is approximately 3.5 m in elevation. Therefore, this area and the buildings are susceptible to flooding during an extreme freshet event.
No changes are expected in the near term. If facility improvements are planned, a more detailed review and redesign to current standards would be appropriate. To reduce this risk of flooding, the most reliable approach is to raise the lands above 3.8 m, raise the berth face to 4.4 m, and raise the building grades to 4.4 m. Alternatively, the dyke or berth face could be raised to 4.4 m, flap gates added to the storm outfalls, and emergency pumps installed.

**Area 3: Berth 3**

This 4.3 ha area is used for uncovered storage, Shed 1, and Berth 3. The surface is almost 100% impervious. The area is one portion of the larger FSD site and includes CB’s, storm sewers, and an open outfall to the river. *Figure 2* shows that a strip of land along the rail line south of Shed One is below the 200 year flood elevation of 3.8 m, and the berth face is around 3.5 m elevation. This area is susceptible to flooding during an extreme freshet event.

No changes are expected in the near term. If facility improvements are planned, a more detailed review and redesign to current standards would be appropriate. To reduce this risk of flooding, improvements would include raising the rail and lands above 3.8 m and the berth face to 4.4 m.

**Area 4: Titan** (see Photos 3 and 4, *Appendix 1*)

This 17.5 ha area consists of:

- Titan Steel sheds, storage, parking, and administration building;
- FSD parking, storage yards, and Shed Four;
- BC Cleanwood buildings, storage, and parking; and
- Undeveloped land.

The surface is around 60% impervious and includes storm sewers, large open ditches, and an outfall with a flap gate to Gunderson Slough. *Figure 2* shows that a large portion of this area near Gunderson Slough lies below the 200 year flood elevation of 3.8 m. Much of the remaining area is suspected of lying below the 3.8 m elevation, but was not confirmed by survey. Shed four is included in this low lying land and is well below the building flood design elevation of 4.4 m. The adjacent berth faces at Berths 3, 4, and 5 are at 3.5 m. These low lying areas and buildings are susceptible to flooding during an extreme freshet event.

Robson Road may undergo changes with the expected closure of the connection to Timberland Road, and the empty field is available for development. New facilities should be designed to current standards. To reduce this risk of flooding, the most reliable approach is to raise the lands above 3.8 m and the building slab elevations above 4.4 m.
Steady flow from the main Titan Steel shed into a fenced pond and ditch was observed during very dry periods. This may be due to groundwater pumping or process water, and may have water quality impacts on Gunderson Slough.

Armstrong Creek connects to Kendale Creek which flows into Gunderson Slough. The connections were not successfully confirmed by field observations due to thick overgrowth that could also impair drainage. Any diversion or overflow to the Titan drainage area could result in increase flood risk to FRPA lands in Area 4. Upgrades to Armstrong Creek culverts were identified in the City of Surrey South Westminster Master Servicing Plan.

Area 5: Berth 5 (see Photo 5, Appendix 1)

This 3.4 ha area is used for steel and other storage, and includes Berth 4 and Berth 5. The surface is almost 100% impervious. The area is one portion of the larger FSD site and includes CB’s, storm sewers, and an open outfall to the river. Figure 2 shows that most of this area is known to be below the 200 year flood elevation of 3.8 m, including the berth face at 3.47 m. These low lying areas are susceptible to flooding during an extreme freshet event.

No changes are expected in the near term. If facility improvements are planned, a more detailed review and redesign to current standards would be appropriate. To reduce this risk of flooding the most reliable approach is to raise the lands above 3.8 m and the berth face above 4.4 m.

Area 6: Berth 6 (see Photo 6, Appendix 1)

This 3.4 ha area is used for a variety of purposes including storage, Shed 2, Shed 5, the Dip Tank Shed, and a garage. It also includes Berth 6. The surface is around 100% impervious. The area is one portion of the larger FSD site and includes CB’s, storm sewers, and an open outfall to the river. Figure 2 shows that areas of land adjacent to the rails are known to be below the 200 year flood elevation of 3.8 m, the cafeteria building is below the flood design elevation of 4.4 m, and the berth face is at 4.05 m. These low lying areas and buildings are susceptible to flooding during an extreme freshet event. A major overflow from Delta Creek could also flood the low-lying portions of this area via the low rail lines unless City improvements to Colliers canal are made.

Rail and facility relocations are proposed for the near future. If facility improvements are planned, a more detailed review and redesign to current standards would be appropriate. To reduce this risk of flooding the most reliable approach is to raise the lands above 3.8 m and the building slab elevation above 4.4 m.
Areas 7 and 8: Berths 7 and 8 (see Photo 7, Appendix 1)

Area 7 includes 0.8 ha of storage area behind Berth 7. It includes three separate minor drainage areas with separate CB’s and open outlets through the Berth 7 retaining structure. Berth 8 is similar with four drainage areas with a combined area of 1.0 ha. Areas 7 and 8 were assigned separate names only to keep the naming consistent with the adjacent berths. Figure 2 shows that areas of land adjacent to the rails are known to be below the 200 year flood elevation of 3.8 m and the berth face is approximately 4.05 m. These low lying areas are susceptible to flooding during an extreme freshet event.

No changes are expected in the near term. If facility improvements are planned, the dyke or berth face should be raised to 4.4 m and the lands behind the berth face raised above 3.8 m.

Area 9: Berth 9 (see photos 9, 16, 17, 18, 19, and 20, Appendix 1)

Area 9 includes approximately 36 ha of FRPA land plus about 4 ha of City lands. The FRPA lands include Shed 3, half of Shed 6, the Main Trucking Gate, container and other storage, the proposed IDC site, the Chemetron site, parts of Timberland Road, the CTL site, the south west corner of the Westran site, and rail yards. The off-site lands include CNR lands, BNR lands, and portions of South Fraser Way, with possible overflow from the Delta Creek watershed. The drainage is collected and conveyed through CB’s, storm sewers, and a 1050mm diameter concrete storm sewer that runs from the proposed IDC site to an outfall with a flap gate in the retaining wall under Berth 9.

Figure 2 shows that portions of the area parallel to the existing tracks are below the 200 year flood elevation of 3.8 m, Shed 3 lies below the flood design elevation of 4.4 m, and the berth face is at 4.08 m. These low lying areas and building are susceptible to flooding during an extreme freshet event.

The 1050 mm storm sewer does not have adequate excess capacity to drain the proposed IDC site or overflow from the City’s Delta Creek. This system appears to receive steady drainage from portions of South Fraser Way. The culverts under the tracks are lower than the inlet to the 1050 mm pipe and the water table, resulting in steady ponding and periodic flooding around the tracks. The channel bed in Delta Creek where it meets Colliers Canal is approximately 1m below the overflow to this system. A significant runoff event in Delta Creek would likely result in overflows to the FRPA drainage system and a significant increased risk of flooding primarily in the CN and BNR rights of way, and partially into areas 4, 6, and 13. This flooding would likely drain along the CN and BNR tracks to the Manson canal before spreading beyond the areas noted.
The City of Surrey South Westminster Master Servicing Plan identified “reduced channel capacity from sedimentation” in Collier’s Canal due to City development and identified upgrades to help address the insufficient capacity. The plans did not, however, address the ponding and flooding along the tracks. Although most of the tracks are not on FRPA lands, many are and the operation of the CNR and BNR tracks impacts on the operations of the FSD. Additional City development without significant City drainage improvements will increase the flooding risk further.

A potential canal diversion through FRPA lands was also identified. This cannot be accommodated in existing FRPA facilities, but it could address the rail flooding problem if designed appropriately. Pumping would likely be required which suggests that improvements to conveyance to the Manson Pump Station may be more efficient.

To reduce this risk of flooding from the Fraser River, the most reliable approach is to raise the lands above 3.8 m and the building slab elevations above 4.4 m. Due to limitations in the existing storm sewer capacity, additional drainage should not be directed to the Area 9 storm sewers.

♦ **Area 10: Shed 6** (see Photos 10, 21, 22, 23, 24 and 29, *Appendix 1*)

This 8.2 ha area is used for half of Shed 6, parking, and a gravel storage yard. The surface is around 25% impervious. The area is one portion of the larger FSD site and includes an open ditch that flows into the river.

The surface elevations vary, with some areas below the flood levels as shown on *Figure 2*. Development of the gravel storage yard with a paved surface is expected in the near future. A storm water collection system with an outfall with a flap gate is desired. This outfall can be constructed to also accommodate the IDC development on the adjacent lands, a new Truck Entrance Gate and reconstruction of a portion of Timberland Road. To reduce the risk of flooding, the redevelopment of this area should also include raising the dyke level to 4.4 m. This outfall will also reduce the risk of flooding described in Area 9. An overflow connection to a future Timberland road storm sewer to Manson Canal would provide pumped backup drainage in the event of a major freshet event. Preliminary drawings for the proposed storm water system are provided in *Appendix 2*. A proposed cross-section for Timberland Road is provided in *Appendix 3*. 
**Area 11: Sylvan** (see Photo 11, Appendix 1)

This 14.9 ha area is used for the Sylvan site and the R16 Lease Area, including sheds, parking, and storage yards. The surface is around 85% impervious. The area is one portion of the larger FSD site and includes two open outfalls to the river. The Sylvan surface elevations and storm drainage system were recently constructed and appear to be designed to acceptable standards, but the remaining areas are lower and more prone to flooding. The Sylvan storm sewer and the R16 ditches flow to two outfalls that are only a short distance apart and are interconnected. As two or more long term lease areas with a shared contained drainage system, including the interconnected outfalls to the river, the responsibility for most of the drainage system can be left with the lease holders. However, the interconnected outfalls may be considered FRPA facilities. To eliminate this ambiguity, the interconnection could be eliminated and R16 could be drainage solely through its own existing outfall.

No changes are expected in the near term. If a change of tenant or other facility improvements are planned, a more detailed review and redesign to current standards would be appropriate.

**Area 12: Dock Road** (see Photos 12 and 25, Appendix 1)

This 10.6 ha area is used for the Agwood Station facilities, including sheds, parking, and storage yards, the relocated MS&G site, and a shared road between them. The surface is around 30% impervious. Due to the flatness of the road, the drainage direction is easily reversed. During a storm, flow was observed to split north and south near the rail crossing. The portion of the area next to the River was observed to drain directly to the River through an open outfall just west of the loading barge. The existing shared road is partially paved with extensive ponding. The poor condition of the road and drainage may be worsened with the increase in heavy truck traffic to the new MS&G site.

Survey information was not available along Dock Road, but nearby higher grades along Timberland Road were recorded lower than 3.8 m. Therefore, Dock Road, Timberland Road, the SRY lease area, and possibly the adjacent buildings are susceptible to flooding during an extreme freshet event. To reduce this risk of flooding the most reliable approach is to raise the lands above 3.8 m and the dyke/shoreline and building slab elevations above 4.4 m. During reconstruction of Dock Road and Timberland Road, a new outfall with a flap gate could be constructed to drain the new roads by gravity. The storm sewer could be connected to an overflow to Manson Canal to provide back-up drainage during a major freshet event.
Area 13: Manson (see Photos 13, 28 and 31, Appendix 1)

The Manson Pump Station drains a large area of City land along with three disconnected FRPA lands:

- The east portion of main FRPA lands, including the Timberland Road east of CTL and west of Manson Canal, the Westran site, and the south and east edge of the MS&G site.
- The Tannery Road lands west of Tannery Road and south of Timberland Road; and
- The Tannery Road lands east of Tannery Road and north of Timberland Road.

The Westran and Tannery Road areas can be considered long-term lease lots responsible for their own internal drainage out to the adjacent road and drainage systems.

The FRPA is responsible for drainage along Timberland Road up to the Manson Canal. Timberland Road is planned to be reconstructed incorporating curb & gutters and storm sewers in the near future. During reconstruction of Timberland Road and Dock Road, a new outfall with a flap gate could be constructed to drain Timberland Road by gravity out the foot of Dock Road. The storm sewer could be connected to an overflow to Manson Canal to provide back-up drainage during a major freshet event.

The FRPA as built records for the Tannery Road Lands include two similar but different pipeline configurations. Since the records were similar but underground, the correct layout could not be determined without a more time consuming survey and/or flow tests. This should be addressed by the lease holder and is therefore out of the scope of this report. At their perimeters, these lots are serviced by a network of City ditches and storm sewers that convey drainage to the Manson Canal.

 Portions of the Westran lease area, CTL lease area, Dock Road and Timberland Road are known to be below the 200 year flood level of 3.8 m. The full area is drained by the Manson Pump Station and is partially protected by a dyke. However, an extreme freshet event could still flood these areas through adjacent low areas like Dock Road, the SRY lease area, Timberland Road, the CTL lease area and rail lines. Manson Pump Station could be relied upon to drain all of Area 13 during a freshet if the 4.4 m dyke elevation were extended to Sylvan and the hydraulic links to other unprotected areas were severed by creating high points over 3.8 m in the connecting rails and roads.
**Area 14: Alaska Way** (see Photos 14 and 30, Appendix 1)

This 2.0 ha area is used for Alaska Way and a number of leased buildings with parking adjacent to small docks on Gunderson Slough. The surface is around 80% impervious with two outfalls on record. The majority of land is suspected to drain overland across the leased lots into Gunderson Slough. The leased lots are responsible for their own drainage and flood protection.

Alaska Way is a dedicated road within the Corporation of Delta’s borders. The existing surface drainage from Alaska Way onto the leased lots may not be satisfactory to the FRPA or the lease holders. The road drainage should be intercepted and drained to the slough without drainage across the surfaces of the adjacent lots.

The only known elevations for this area are below the 200 year flood elevation of 3.8 m, and the remainder of the area is believed to also be below 3.8 m. Therefore, this area is susceptible to flooding during an extreme freshet event. No changes are expected in the near term. If a change of tenant or other facility improvements are planned, a more detailed review and redesign to current standards would be appropriate.

**Area 15 Elevator Road** (see Photo 30, Appendix 1)

This 1.3 ha area is used for Elevator Road, Robson Road and Alaska Way, and is part of the much larger Kendale Creek watershed. The surface is around 50% impervious. The roads drain to Kendale Creek as it enters Gunderson Slough. Similar to Area 4, the Armstrong Creek connection to Kendale Creek is poorly defined. Area 15 is susceptible to flooding from Kendale Creek, and City upgrades are identified in the South Westminster Master Servicing Plan. All or portions of these roads may be the responsibility of the City of Surrey and Delta.

No changes are expected in the near term. If facility improvements are planned, a more detailed review and redesign to current standards would be appropriate.
4. Conclusions

The FRPA Surrey Lands are exposed to flood risks from external watercourses such as the Fraser River, and internal grading and drainage deficiencies. Conclusions about these risks and methods to address them are summarized below in categories, starting with the most general and large scale issues, and working down to the smaller localized issues.

4.1 General

The FRPA lands have been developed over time with various standards employed and various responsibilities assigned to leaseholders and the FRPA. Drainage improvements are best planned with a consistent set of approaches applied across the FRPA lands, including:

- Formal assignment of responsibility between lease holders and the FRPA to remove ambiguity; and
- Uniform design standards that are consistent with City drainage criteria and MWLAP flood protection criteria.

4.2 Fraser River Flood Risk

Flooding from the Fraser River during extreme freshet events remains a risk to the FRPA lands due to low site elevations and open drainage outfalls. The breakwater typically reduces scouring and erosion along the shoreline, but may not be high or large enough to provide this protection during a 1:200 year event. Options to reduce the risk of major flooding include:

- Raise site elevations over 3.8 m;
- Raise dykes, building grades and berth faces over 4.4 m;
- Add flap gates to storm sewer outfalls where the storm sewers connect to low lands (less than 3.8 m) behind a dyke;
- Increase the size of the breakwater;
- Armour the shoreline;
- Divert overflow drainage to the Manson pump station; and
- Add pump stations.

4.3 Creek Systems

Delta Creek can currently overflow into the FRPA lands. The existing system is not sufficient to convey this overflow to the river. Additional upland off-site development will potentially negatively impact on the FRPA land drainage unless offset by drainage improvements. City improvements to Colliers Canal may address the Delta Creek overflow issues if designed
appropriately. Diverting the IDC drainage to a new outfall will reduce the risk of flooding to both the Berth 9 area and the IDC site.

The Armstrong Creek flow path to the river is uncertain and is identified in the City of Surrey South Westminster Master Servicing Plan as an area of concern for planned City upgrades. Further investigation and coordination with the City may address the potential flood risk this creek poses to Drainage Areas 4 and 15.

4.4 Ponding and Localized Drainage

Localized ponding occurs at various locations around the lands, especially in poorly graded gravel surfaced areas and low areas. These can be addressed during site redevelopment and road reconstruction. Specific areas to address and projects planned in the near future include:

- Development of the IDC site;
- Timberland Road closure and reconstruction;
- Relocation of MS&G east of Dock Road;
- Dock Road reconstruction;
- Redevelopment of the lot east of Shed 6;
- Truck Gate relocation;
- Various rail removals and additions;
- Ponding in CN & BNR lands;
- Non-storm flow discharges from the Titan Steel shed; and
- Elevator Road drainage through lease areas.

Significant ponding occurs along the rail rights of way and may impact the operation of these lines. It is mainly a rail issue, but can impact port operations. The City of Surrey South Westminster Master Servicing Plan does not propose a solution to this. Potential solutions include raising the track and ground elevations, pumping, or deep canals to the Manson Pump Station. The potential Collieries Canal Diversion proposed in the City’s Plan could be designed to address this ponding as well as IDC and Shed 6 drainage. This option is worth discussing with the City, but will likely require CN’s or BNR’s involvement to resolve.
5. **RECOMMENDATIONS**

Proposed improvements and related recommendations are described below. *Figure 3* shows the proposed future drainage plan, with drainage boundary revisions and proposed improvements.

### 5.1 General

Adapt the design criteria noted in this report as design standards for use on FRPA lands in the absence of mandatory Municipal or Provincial regulations. Install oil/silt separators wherever vehicle storage or maintenance areas or similar areas with high oil concentrations are planned.

Establish a policy to deal with drainage on leased lands that establishes lease holder responsibility to design, construct, and maintain internal drainage facilities. Keep central records of the as-built drawings up to date. Lease holders and facility operators should be informed of the flood risks associated with the site so that they can take appropriate risk management measures such as insurance to protect themselves in case of an extreme event and to protect the FRPA from liability.

### 5.2 Fraser River Flood Protection

The following actions are recommended to provide flood protection from the Fraser River consistent with Provincial and City standards:

- Raise the dyke along the shoreline to 4.4 m as opportunities arise;
- Investigate the capacity of the breakwater to provide protection during a 1:200 year event. Alternatively, the scour protection along the full shoreline should be assessed and upgraded to prevent bank failure.
- During site redevelopment, adhere to the design criteria by raising site elevations, & armouring the shoreline.
- Install flap gates to protect low areas behind dykes and provide overflow drainage to the Manson Canal for areas 10, 11, and 12, where the Manson Pump Station can provide emergency drainage when the river rises above the flap gates and the low site elevations.
- Eliminate or raise rail lines to eliminate flow channels between the lands protected by the dyke and the pump station and the low lands directly exposed to the river.
- Request BNR and CN to raise their lines above 3.8 m for their own protection and to eliminate the flood path they create from the Fraser River.
5.3 City of Surrey and Off-Site Upland Development

Coordinate shared drainage infrastructure plans with the City of Surrey, including:

- City improvements to address the Delta Creek overflow and Manson Pump Station capacity improvements.
- Planned City upgrades to Armstrong Creek culverts to address the potential flood risk this creek poses to Drainage Areas 4 and 15.
- The lack of any plans to address ponding and flooding along the rail tracks. The potential Collieries Canal Diversion proposed in the City’s Plan could be designed to address this ponding. Since the lowest rail tracks are on CN and BNR lands, they should either lead or at least be involved in upgrading their site grading or drainage.

5.4 Proposed Site Improvements

Complete designs and construct the following improvements:

- Development of the IDC site: Direct the IDC drainage to a new outfall east of Shed Six. The preliminary design is included in Appendix 2.
- Development of the lot east of Shed 6: Design the previously described outfall to accommodate full paving of the lot east of Shed Six. Design the grading and drainage for this site.
- Dock Road reconstruction: Design and reconstruct the Dock Road between the relocated MS&G site and the R16 lease area. Direct the drainage to a reconstructed outfall directly to the River with a flap gate, and tie it into the storm sewer in Timberland Road with overflows to Manson Canal.
- Timberland Road closure and reconstruction: Design and construct drainage associated with the Timberland Road closure and reconstruction. A typical cross section is shown in Appendix 3 and the flow direction is indicated on Figure 3.
- Truck Gate relocation: Design and construct drainage facilities associated with the Truck Gate relocation as indicated on Figure 3.
- Various rail removals and additions: Ensure drainage is addressed in rail additions and removals. Raise the tracks above 3.8 m where possible.
- Non-storm flow discharges from the Titan Steel shed: Investigate the significant non-storm discharges from the Titan Steel shed further to ensure adherence to DFO and other regulations.
- Elevator Road drainage through lease areas: Design and construct storm sewers or ditches to intercept runoff from Elevator Road to prevent it from flowing into leased lots and buildings. Determine if this is a City of Surrey, Delta or FRPA responsibility.
Appendix 1

Photos
PHOTOGRAPHS OF EXISTING CONDITIONS

1. Drainage Area 1 - Berth 1 Outfall

2. Drainage Area 2 - Berth 2 Outfall
3. Drainage Area 4 - Titan Outfall & Drainage Area 15 - Elevator Road - Outfall 7 Creek

4. Drainage From Titan Steel Shed
5. Drainage Area 5 - Berth 5 Outfall

6. Drainage Area 6 - Berth 6 Outfall
7. Drainage Area 7 - Berth 7 Outfall (Similar for all 7 Berth 7 & 8 Outfalls)

8. Drainage Area 9 - Berth 9 Outfall with Flap Gate
9. Drainage Area 9 - Berth 9 Ponding Between Rail Lines

10. Drainage Area 10 - Shed 6 Ditch Outlet
PHOTOGRAPHS OF EXISTING CONDITIONS

11. Drainage Area 11 - Sylvan Outfall

12. Drainage Area 12 - Dock Road
13. Drainage Area 13 - Manson Pump Station

14. Drainage Area 14 - Alaska Way Outfall
15. Breakwater Protecting Berths From Main Fraser River Channel

16. Ponding at Culverts Connecting Surrey Drainage to Drainage Area 9 - Berth 9
17. Delta Creek - South Fraser Way Bridge

18. Ponding up to Rail Ballast
PHOTOGRAPHS OF EXISTING CONDITIONS

19. Bridge Culverts Connecting Surrey & Rail Lands to Drainage Area 9 - Berth 9

20. Ponding / Water Table at Proposed IDC Site
21. Proposed Storm Sewer Alignment For IDC, Shed 6 & Lot East of Shed 6

22. Timberland Road
23. Ponding Along Timberland Road, West of Sylvan (Area 10)

24. Ponding at Fraser Surrey Docks Parking South of Shed 6 (Area 10)
25. Dock Road Ditch Flowing South (Area 12)

26. Sylvan Outfall (Area 11)
27. Van Isle Barge Ditch, Culvert and Connection to Sylvan Outfall (Area 11)

28. Ditch North of Westran and CTL (Area 13)
29. South West Corner of Westran Drainage to CTL (Area 10)

30. Elevator Road
31. City Ditch and Culvert Network Along Faulkner Road and Tannery Road (Area 13)
Appendix 2
IDC & Lot East of Shed 6
Preliminary Design
Appendix 3
Timberland Road
Conceptual Cross-Section
LEGEND:

Existing Fraser Port Lands

FIGURE 1: LOCATION PLAN

Existing Manson Pump Station

Approximate extent of 200 Year Design Flood (Elevation 4.4m including 0.6m freeboard. From Urban Systems Servicing Study, November 2002)

FRASER RIVER PORT AUTHORITY
SURREY LAND MASTER DRAINAGE PLAN

AUGUST 2004
Proposed Ditch Improvements

Catchment Boundary
Future Catchment Boundary
Existing Fraser Port Lands Boundary
Existing Storm Sewer
Existing Ditch
Existing Culvert

LEGEND:

EB - 3612
CTL LEASE
FIGURE 3
Proposed Ditch Improvements

Catchment Boundary
Future Catchment Boundary
Existing Fraser Port Lands Boundary
Existing Storm Sewer
Existing Ditch
Existing Culvert

LEGEND:
EB - 3612
CTL LEASE

FIGURE 3
APPENDIX B
Existing Drainage Infrastructure Diagram
APPENDIX C
Stormceptor STC-300 Typical Specification
This map is not intended to be a "stand-alone" document, but is a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

This extent should be considered approximate only.

Sources
- Overly Imagery: Existing storm sewer and existing ditch information provided by FSD as a pdf
- Basemap: Ortho Imagery from City of Surrey

Production Date: May 4, 2018
Page: 1055 of 36 to 1127 of 50

35x18: Path: S:\Geomatics\Projects\989290\01\map\SPP\Fig4_989290_01_BHP_Drainage_180504.mx.d
Stormceptor STC-300
Inline and/or Catchbasin Design
www.langleyconcretegroup.com

Notes:
1. STC 300 supplied in components to suit site elevations.
2. Ø1200mm manhole section w/fiberglass disc to have inlet/outlet stubs/cores as required.
3. Base cast integral with lower section of manhole.
4. For designs where pipe invert is < 0.8m below surface, contact sales office.
5. Design requires inlet invert 75mm higher than outlet.
6. Inlet pipes can be oriented up to 90° from outlet, depending on pipe size/type.
7. Multiple inlet pipes can be utilized (depending on pipe size/type) up to 120° apart.
8. Lid supplied w/Ø635mm access designed to HS-25 live loading.
9. Ladder rungs supplied at 300mm spacing as shown.
10. Manhole manufactured to ASTM C478 specifications.
11. Lifting inserts supplied in manhole sections.
12. Approx. weight:
   Ø1200x910 manhole section with integral base: 1900kgs. [12,980 lbs.]
13. Type QU Cement; min. concrete strength: 27.5MPa.
15. All dimensions are in millimeters.

Capacities:
Sediment - 1411 litres
Hydrocarbons - 441 litres

The Langley Concrete Group of Companies
LANGLEY (604)533-1656     VICTORIA (250) 478-9581     CHILLIWACK 1-800-667-9600
APPENDIX D
Storm and Water Main Infrastructure Drawing
STORM WATER CALCULATIONS:

USE SURREY DESIGN CRAIN MANUAL AS-8: SECTION 5 STORM DRAINAGE SYSTEM

1. CATCHMENT AREA: AREA A-1 = 6.05 ha
2. CATCHMENT AREA: AREA A-2 = 5.80 ha
3. CATCHMENT AREA: AREA C-1 = 6.61 ha

AVERAGE SLOPE = 1.0%

RI: 1.5 min., L = 27 min.

R = 0.90 (16.19 ha)(27 mm/hr) / 360 = 1.09 cms x 1.17 = 1.28 cms

DESIGN VOLUME = 50% x 2 hour duration Q

27 mm/hr = 27 mm/hr

R = 0.90

27 mm/hr = 27 mm/hr

OUTFALL A 900mm Ø

OUTFALL B 1050mm Ø