

# **SPECIFICATIONS**

**for**

**Fisheries and Oceans Canada**

**Inch Creek Hatchery – Well #5 Water Supply and Drainage Upgrades**

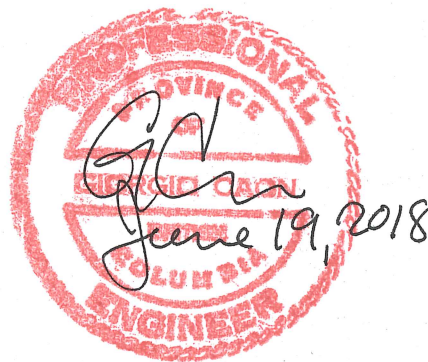
May 2018

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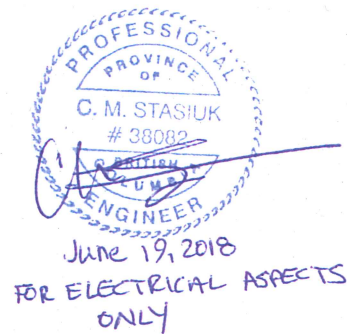
**Fisheries and Oceans Canada**  
**Inch Creek Hatchery – Well #5 Water Supply and Drainage Upgrades**

May 2018

**Specifications Prepared By:**



David Nairne + Associates Ltd. (Civil/Mechanical)



Ready Engineering (Electrical)

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## Construction Drawings

### Civil

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11-31-472	Site Single Line Diagram
11-31-473	PH2 Layout & System Block Diagram
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## Reference Drawings

### Inch Creek Hatchery - Record Drawings

11-31-410	Site Plan
11-31-221	Groundwater Supply Mains Plan, Profile and Details
11-31-240	Keeper Channels & Interm. Rearing Troughs Conc. Outline
11-31-240A	Intermediate Rearing Troughs Supporting Slabs
11-31-244	Ground Water Distribution Water Supply Piping
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11-31-271	Site Layout & Grading Plan General Arrangement & Details
11-31-M12	Rearing Tubs Layout Plan and Piping Details
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# **Division 01 - General Requirements**

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- |    |                                 |    |  |
|----|---------------------------------|----|--|
| 1. | <b>General</b>                  | .1 | Not used   |
| 2. | <b>Documents Required</b>       | .1 | Refer to Section 01 11 00 – 1.6 for Documents Required.  |
| 3. | <b>Definition of Roles</b>      | .1 | The “Owner” of this project is the Department of Fisheries and Oceans (DFO).   |
|    |                                 | .2 | The “Contractor” for this project will be selected after the tender process and the “Contractor’s” designated representative will be identified to the “Owner” in writing.   |
|    |                                 | .3 | The “Departmental Representative” and the “Contract Administrator” are synonymous terms and represent the designated representative of the “Owner.” This person or persons will be identified by the “Owner” in writing to the “Contractor.”   |
|    |                                 | .4 | The “Engineer” and “Consultant” are synonymous terms and represent the “Owner’s” outside consultants. Communication between the “Contractor” and “Engineer” will be directed through the “Departmental Representative” and not communicated directly unless authorized by the “Departmental Representative.” |
| 4. | <b>Work Schedule</b>            | .1 | Submit a construction schedule to the Departmental Representative, showing anticipated progress stages and final completion of work within time period required by Contract Documents. The schedule is to be updated monthly or as required by the Departmental Representative.                              |
|    |                                 | .2 | Contractor will be permitted to work during normal hatchery operation hours (Monday to Friday, 8:00 to 16:00). Work outside of normal hatchery operation hours will need to be co-ordinated and approved by hatchery staff.  |
|    |                                 | .3 | All work as specified in the contract drawings and specifications is to be completed by <b>October 19<sup>th</sup>, 2018</b> .   |
| 5. | <b>Contractor's Use of Site</b> | .1 | Do not unreasonably encumber site with materials or equipment.   |
|    |                                 | .2 | Move stored products or equipment which interfere with operations of Departmental Representative or other contractors.   |
|    |                                 | .3 | Obtain and pay for use of additional storage or work areas needed for operations.  |

- 
- .4 Maintain reasonable access.
  - .5 Maintain a reasonably clean and safe site.
- 6. Codes and Standards**
- .1 Perform work in accordance with National Building Code of Canada, latest edition, and any other code of provincial or local application provided that in any case of conflict or discrepancy, the more stringent requirements shall apply.
  - .2 Observe and enforce construction safety measures required by Canadian Construction Safety Code, Provincial Government, WorkSafeBC, Workplace Hazardous Materials Information System Requirements, including training of all workers on the job site, and municipal status and authorities.
  - .3 Meet or exceed requirements of specified standards, codes and referenced documents.
  - .4 Where work is situated on land managed by different legislative bodies the contractor will meet the requirements set out by the authorities responsible. In any case of conflict between the requirements set out by the authorized body and these contract documents, the more stringent requirements shall apply.
- 7. Project Meetings**
- .1 Departmental Representative will arrange project meetings and assume responsibility for setting times and recording and distributing minutes.
- 8. Existing Conditions**
- .1 Inspect surfaces and conditions before commencing work and report defects to the DFO representative. No work to commence until conditions are acceptable. Commencement of work will indicate acceptance of surfaces and conditions.
- 9. Setting out of Work**
- .1 **Construction Drawing elevations use Hatchery Datum. Hatchery Datum relates to Aeration Tower Slab at 27.95m in Reference Drawing Package: Inch Creek Hatchery Record Drawing #11-31-349. Hatchery Datum is equal to Geodetic Datum plus 17.80m**
  - .2 Geodetic Datum is related to BM296-J situated 400m east of Hatchery at CP Railway Bridge over Norish Creek marked by Table set in vertical face of western concrete abutment, 0.3m below bridge seat, elevation 10.308 m. Horizontal coordinates are UTM NAD83 Zone 10.

- .3 Locate and preserve general reference points.
  - .4 Employ qualified person to lay out work in accordance with control lines and grades provided by Departmental Representative.
  - .5 Supply stakes and other survey markers required for this work.
  - .6 The detailed layout is the responsibility of the Contractor. Detailed layout will be performed at the Contractor's expense.
- 10. Location of Equipment and Fixtures**
- .1 Location of equipment, fixtures and outlets indicated or specified is to be considered as approximate. The contractor is responsible for verifying those locations in the field prior to commencing the work.
- 11. Additional Drawings**
- .1 Departmental Representative may furnish additional drawings to assist proper execution of work. These drawings will be issued for clarification only. Such drawings shall have same meaning and intent as the drawings included within the Table of Contents.
- 12. Relics and Antiquities**
- .1 Relics and antiquities such as cornerstones and similar objects found on site or in buildings to be demolished, shall remain property of the Owner. Protect such articles and request directives from Departmental Representative.
  - .2 Give immediate notice to Departmental Representative if evidence of archaeological finds are encountered during construction, and await his written instructions before proceeding with work in that area.
- 13. Site Maintenance and Clean-up**
- .1 Maintain the working area in an orderly manner and not encumbered with equipment, materials, or debris.
  - .2 Clean-up to be a continuing process from the start of the work to final acceptance of the project. At all times, and without further order, keep property on which work is in progress free from accumulations of waste materials or rubbish caused by employees or by the work. Accumulations of waste materials which might constitute a fire hazard will not be permitted. Spillage from the Contractor's hauling vehicles on traveled public or private

roads to be promptly cleaned up. On completion of construction, remove all temporary structures, rubbish, and waste materials resulting from construction operations and dispose of offsite at Contractor's expense.

**14. Ambiguities**

- .1 In the event of discrepancies and ambiguity in the contract document, manufacturers guidelines and relevant provincial and federal regulations the Contractor shall notify the Departmental Representative for clarification. The more stringent requirement shall apply unless otherwise instructed in writing by the Departmental Representative.

END OF SECTION

**Part 1 General****1.1 Work Covered by Contract Documents**

- .1 Work of this Contract comprises and shall be further identified as “the Work” and shall include the following:
  - .1 Install one new submersible well pump in an existing 400mm diameter steel casing. Well work to include installation of 400mm pitless well unit, stainless steel pitless adapter, 250mm stainless steel connection and transition coupling to 300mm PVC main and all other work as indicated on the drawings.
  - .2 Install 150m of 300mm diameter PVC C900 ground water supply pipe as indicated on the proposed water supply line. The new pipe is to be connected to the existing 300mm diameter supply line and extended to the cap and blow off assembly. Water supply work to include air release valve, flush out assembly, gate valves and various tees and bends as indicated on the drawings.
  - .3 Remove 55m of 200mm diameter PVC drain pipe and replace with 55m of 250mm diameter PVC SDR 35 drain pipe and two new 1050mm concrete manholes. Rearing trough and tub drains to be reconnected to the new 250mm PVC drain pipe. Drain pipe to be installed in close proximity to the existing concrete rearing troughs and the contractor is responsible for the integrity and any remediation work of the existing concrete.
  - .4 All electrical and controls work as indicated on the electrical drawing package.
  - .5 All site restoration work as needed to restore the site to original or better conditions including asphalt restoration, reinstallation of chain link fencing and regrading of landscaped areas.
  - .6 Temporary construction fencing as indicated on the drawings.
  - .7 All other work as indicated in the contract drawings and specifications.

**1.1 Work Sequence**

- .1 Construct Work in a single stage to accommodate Hatchery Staff’s continued use of premises during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Hatchery Staff during construction.
- .3 Maintain fire access/control.

**1.2 Contractor Use of Premises**

- .1 Coordinated use of site until Substantial Performance.
- .2 Co-ordinate use of premises under direction of the Departmental Representative and Hatchery Staff.
- .3 Water and Electricity will be provided on an as is and where is basis.

- .4 Parking, Staging and Storage locations will be at the discretion of the Hatchery Staff and Departmental Representative.
- .5 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .6 Contractor will be permitted to work during normal hatchery operation hours (Monday to Friday, 8:00 to 16:00). Work outside of normal hatchery operation hours will need to be coordinated and approved by hatchery staff.

### **1.3 Hatchery Staff Occupancy**

- .1 Hatchery Staff will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Hatchery Staff in scheduling operations to minimize conflict and to facilitate normal Hatchery usage.

### **1.4 Existing Services**

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 72 hours' notice for necessary interruption of Mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to vehicular traffic and tenant operations.
- .3 Provide alternative routes for personnel and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.
- .5 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant systems.
- .7 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .8 Protect, relocate or Departmental Representative maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .9 Record locations of maintained, re-routed and abandoned service lines.
- .10 Construct hoarding (fencing) in accordance with Section 01 53 01 – 1.10.



**1.6 Documents Required**

- .1 Maintain at job site, one (1) copy of each document as follows:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Reviewed Shop Drawings.
  - .5 List of Outstanding Shop Drawings.
  - .6 Change Orders.
  - .7 Other Modifications to Contract.
  - .8 Field Test Reports.
  - .9 Copy of Approved Work Schedule.
  - .10 Health and Safety Plan and Other Safety Related Documents.
  - .11 Other documents as specified.
- .2 Maintain documents in clean, dry, legible condition.
- .3 Make documents available at all times for inspection by Departmental Representative.

**Part 2 Products****2.1 NOT USED**

- .1 Not used.

**Part 3 Execution****3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1      General****1.1      Administrative**

- .1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved Departmental Representative review.
- .10 Keep one reviewed copy of each submission on site.

**1.2      Shop Drawings and Product Data**

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia of Canada.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Allow 15 days for Departmental Representative review of each submission.
- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state

such in writing to Departmental Representative prior to proceeding with Work.

- .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 Accompany submissions with transmittal letter, containing:
  - .1 Date.
  - .2 Project title and number.
  - .3 Contractor's name and address.
  - .4 Identification and quantity of each shop drawing, product data and sample.
  - .5 Other pertinent data.
- .8 Submissions include:
  - .1 Date and revision dates.
  - .2 Project title and number.
  - .3 Name and address of:
    - .1 Subcontractor.
    - .2 Supplier.
    - .3 Manufacturer.
  - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
  - .5 Details of appropriate portions of Work as applicable:
    - .1 Fabrication.
    - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
    - .3 Setting or erection details.
    - .4 Capacities.
    - .5 Performance characteristics.
    - .6 Standards.
    - .7 Operating weight.
    - .8 Wiring diagrams.
    - .9 Single line and schematic diagrams.
    - .10 Relationship to adjacent work.
- .9 After Departmental Representative review, distribute copies.
- .10 Submit electronic copy and 6 prints of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

- .11 Submit 6 electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit 6 copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
  - .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit 6 copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
  - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit 6 copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit 6 copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit 3 copies and electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

**1.3 Photographic Documentation**

- .1 Submit electronic copy of colour digital photography in jpg format, standard resolution monthly with progress statement as directed by Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.

**1.4 Certificates and Transcripts**

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
- .2 Submit transcription of insurance immediately after award of Contract.

**1.5 Inspection and Testing**

- .1 The requirements for Inspection and Testing required under this contract are detailed throughout the contract documents.
- .2 All Inspection and Testing required by the contract document and/or relevant provincial and federal regulations shall be completed by the Contractor at his cost. All inspections and testing shall be carried out by an independent certified testing agency.
- .3 Supply certifications for all independent testing agencies to the Departmental Representative prior to commencement of work.
- .4 The Contractor shall promptly provide copies of all inspection and tests to the Departmental Representative.
- .5 The Contractor shall notify the Departmental Representative at least 48 hours in advance of all testing, for an opportunity to be present.
- .6 All subsequent work and testing required due to unsatisfactory work shall be completed by the Contractor at his cost.
- .7 The contractor shall provide access and assistance when additional sampling / testing is required by the Departmental Representative.
- .8 Prior to road paving, the Contractor shall arrange for the subgrade and road bases to be tested and inspected by a geotechnical engineer. The geotechnical engineer shall also test and inspect all pavement. The tests and inspections should be performed at the Contractor's expense and submitted to the Departmental Representative for review.
- .9 All pipe bedding, pipe cushion and granular backfill shall be import granular material. All trench subgrade, pipe bedding and base gravels to be reviewed and approved by a geotechnical engineer. The tests and inspections should be performed at the Contractor's expense and submitted to the Departmental Representative for review.

**Part 2        Products**

**2.1        NOT USED**

.1        Not Used.

**Part 3        Execution**

**3.1        NOT USED**

.1        Not Used.

END OF SECTION

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**PART 1 - GENERAL**

- 1.1 General** .1 Not used
- 1.2 Documents Required** .1 Refer to Section 01 11 00 – 1.6 for Documents Required.
- 1.3 Workmanship Standards** .1 Make available on site one (1) copy of each workmanship standard called for under "Reference Standards" in project Specifications.
- 1.4 Record Drawings** .1 Departmental Representative will provide two (2) sets of white prints for record drawing purposes.
- .2 Maintain project "as-built" record drawings and record accurately significant deviations from Contract Documents caused by site conditions and changes ordered by Departmental Representative.
- .3 Mark "as-built" changes in red.
- .4 Record following information:
- .1 Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvement.
  - .2 Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
  - .3 Field changes of dimension and detail.
  - .4 Changes made by Change Order or Field Order.
  - .5 At completion of project and prior to final inspection, neatly transfer "as-built" notations to second set and submit both sets to Departmental Representative.

END OF SECTION

**Part 1 General****1.1 Related Requirements**

- .1 Section 01 33 00 – SUBMITTAL PROCEDURES.

**1.2 Reference Standards**

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Province of British Columbia
  - .1 Workers Compensation Act, RSBC 1996 - Updated 2012.

**1.3 Action and Informational Submittals**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
  - .1 Results of site specific safety hazard assessment.
  - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit 1 weekly submittal to Departmental Representative.
- .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS MSDS - Material Safety Data Sheets.
- .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 3 days.
- .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.
- .10 SPEC NOTE: If there are specific emergency response procedures for the Building, Facility or Site, then the Departmental Representative/DCC Representative or Consultant must provide the Contractor with the details for consideration of incorporation into the Contractor's on-site Contingency and Emergency Plan as a component of the site specific health and safety plan.
- .11 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.



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**1.4 Filing of Notice**

- .1 File Notice of Project with WorkSafeBC authorities prior to beginning of Work.
- .2 Contractor shall be responsible and assume the Principal Contractor role for the work zone. Contractor shall provide a written acknowledgement of this responsibility within 3 weeks of contract award. Contractor to submit written acknowledgement to Departmental Representative.
- .3 Work zone locations include:
  - .1 Chehalis Hatchery – 16250 Morris Valley Rd, Agassiz, BC V0M 1A1
- .4 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

**1.5 Safety Assessment**

- .1 Perform site specific safety hazard assessment related to project.

**1.6 Meetings**

- .1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

**1.7 Regulatory Requirements**

- .1 Not used.

**1.8 Project Site Conditions**

- .1 Work at site will involve contact with:
  - .1 Departmental Representative.

**1.9 General Requirements**

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

**1.10 Responsibility**

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 SPEC NOTE: Use the following paragraph for Construction Projects in the Province of Ontario: N/A

.3 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

#### **1.11 Compliance Requirements**

- .1 Comply with Workers Compensation Act, B.C.
- .2 Comply with R.S.Q., c. S-2.1, an Act respecting Health and Safety, and c. S-2.1, r.4 Safety Code for the Construction Industry.
- .3 Comply with Occupational Health and Safety Regulations, 1996.
- .4 Comply with Occupational Health and Safety Act, General Safety Regulations, O.I.C.
- .5 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

#### **1.12 Unforeseen Hazards**

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of BC having jurisdiction and advise the Departmental Representative verbally and in writing.
- .2 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise WorkSafeBC and follow procedures in accordance with Acts and Regulations of BC having jurisdiction and advise Departmental Representative verbally and in writing.

#### **1.13 Health and Safety Co-Ordinator**

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
  - .1 Have site-related working experience specific to activities associated with the site.
  - .2 Have working knowledge of occupational safety and health regulations.
  - .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
  - .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
  - .5 Be on site during execution of Work and report directly to Departmental Representative and be under direction of the site supervisor.

**1.14 Posting of Documents**

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of BC having jurisdiction, and in consultation with Departmental Representative.

**1.15 Correction of Non Compliance**

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

**1.16 Blasting**

- .1 Not used.

**1.17 Powder Actuated Device**

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

**1.18 Work Stoppage**

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

**Part 2 Products****2.1 NOT USED**

- .1 Not used.

**Part 3 Execution****3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**PART 1 - GENERAL**

- |             |  |    |  |
|-------------|--|----|--|
| <b>1.1</b>  | <b>General</b>                                   | .1 | Not used   |
| <b>1.2</b>  | <b>Access</b>                                    | .1 | Provide and maintain adequate access to project site.  |
|             |  | .2 | If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractor's use of roads.  |
| <b>1.3</b>  | <b>Departmental Representative's Site Office</b> | .1 | Not Required.  |
| <b>1.4</b>  | <b>Storage Sheds</b>                             | .1 | Provide adequate weather tight sheds with raised floors, for storage of materials, tools, and equipment which are subject to damage by weather.  |
| <b>1.5</b>  | <b>Sanitary Facilities</b>                       | .1 | Provide sanitary facilities for work force in accordance with governing regulations and ordinances.  |
|             |  | .2 | Post notices and take such precautions as required by local health authorities. Keep areas and premises in sanitary condition.   |
| <b>1.6</b>  | <b>Power</b>                                     | .1 | Arrange, pay for and maintain temporary electrical power supply in accordance with governing regulations and ordinances.   |
| <b>1.7</b>  | <b>Water Supply</b>                              | .1 | Arrange, pay for and maintain temporary water supply in accordance with governing regulations and ordinances.  |
| <b>1.8</b>  | <b>Heating and Ventilating</b>                   | .1 | Maintain minimum temperature of 10°C or higher where specified as soon as finishing work is commenced and maintained until acceptance of structure by Departmental Representative.   |
|             |  | .2 | Maintain ambient temperature and humidity levels as required for comfort of office personnel.  |
| <b>1.9</b>  | <b>Drainage</b>                                  | .1 | Refer to Section 01 57 01 for site drainage and pumping requirements.  |
| <b>1.10</b> | <b>Hoarding</b>                                  | .1 | Provide hoarding (fencing) as needed to protect public and private property from injury or damage. Provide lockable gates within hoarding for access to site by workers and vehicles. Make site accessible to Departmental Representative for inspection upon request. |

END OF SECTION

**PART 1 - GENERAL**

- 1.1 General** .1 Not used
- 1.2 Traffic Management** .1 Traffic management shall comply with the requirements of British Columbia's Ministry of Transport and Infrastructure over the entire contract period, specifically the latest edition of "Traffic Control Manual for Work on Roadway".
- .2 The Contractor shall be responsible for acquiring and complying with all required permitting required by British Columbia's Ministry of Transport and Infrastructure.
- .3 During progress of the Works, make adequate provision to accommodate normal traffic along streets and highways immediately adjacent to or crossing the Works so as to minimize inconvenience to the general public.
- .4 Inform all owners or occupants of properties where access is affected in advance of proposed works.
- .5 When working on travelled ways:
1. Place equipment in such position as to present a minimum of interference and hazard to the travelling public.
  2. Keep equipment units as close together as working conditions will permit and preferably on same side of travelled way.
  3. Do not leave equipment on travel led way overnight.
  4. Do not close any lanes of road or highway without prior approval of the Departmental Representative. Before re-routing traffic erect suitable signs and devices as approved by the Departmental Representative.
  5. Provide and maintain reasonable road access and egress to property fronting along or in vicinity of work under contract unless approved otherwise by the Departmental Representative.

\*\*\*\* END of SECTION \*\*\*\*

**PART 1 - GENERAL**

- |            |   |    |  |
|------------|---|----|--|
| <b>1.1</b> | <b>General</b>                            | .1 | Not used   |
| <b>1.2</b> | <b>Disposal of Wastes</b>                 | .1 | All waste and rubbish materials shall be disposed to an approved landfill. Disposal of waste or rubbish material to land or burning will NOT be accepted.  |
|            |   | .2 | Discharge of water containing chlorine or other chemical compounds into waterways is prohibited.   |
| <b>1.3</b> | <b>Drainage</b>                           | .1 | Provide temporary drainage and pumping as necessary to keep excavations and site free from surface water and groundwater.  |
|            |   | .2 | Pumping of water containing silt in suspension into waterways, sewer or drainage systems prohibited.   |
|            |   | .3 | The Contractor shall control disposal or runoff of water containing suspended materials or harmful substances in accordance with this contract document and applicable Federal and Provincial standards. |
| <b>1.4</b> | <b>Site Clearing and Plant Protection</b> | .1 | Protect trees and plants on site and adjacent properties where indicated.  |
|            |   | .2 | Minimize stripping of topsoil and vegetation.  |
|            |   | .3 | Restrict tree removal to those areas designated by Departmental Representative.  |
| <b>1.5</b> | <b>Work Adjacent to Waterways</b>         | .1 | Prohibit operation of construction equipment in waterways without Departmental Representative's approval and approval of Fisheries authorities.  |
|            |   | .2 | Do not use waterway beds for borrow material.  |
|            |   | .3 | Do not dump excavated fill, waste material or debris in waterways.   |
|            |   | .4 | Design and construct temporary crossings so that minimum erosion is caused to waterways.   |
|            |   | .5 | Do not skid logs or construction materials across waterways.   |

- .6 Avoid indicated spawning beds when constructing temporary crossings of waterways.
- .7 Blasting under water or within 100 m of indicated spawning beds not permitted.

**1.6 Erosion and Sedimentation Control**

- .1 The Contractor must prepare Erosion and Sedimentation Control Plan and implement siltation control measures for all excavation to minimise siltation of ditches, watercourses and storm water systems.
- .2 Siltation control shall include but not be limited to installation of silt fences and construction of sedimentation ponds as shown in the contract documents. Siltation control shall meet the standards described in Land Development Guidelines for the Protection of Aquatic Habitat published jointly by the BC Ministry of Environment and Department of Fisheries and Oceans. Siltation control measures shall remain in place until completion of construction. Contractor shall implement erosion and sedimentation control measures during the construction process.
- .3 Contractor shall ensure that all works is performed to prevent release of sediment laden or hydrocarbon contaminated (e.g. oil, grease, hydraulic fluid, or fuel) water from the site boundary. This includes ensuring no water flows are pumped or channeled to bypass the sediment control facilities.
- .4 Erosion and sedimentation control measures shall include but not be limited to retention of existing vegetation, installation of silt fences, and construction of settlement ponds. Sedimentation control measures shall remain in place until completion of construction.
- .5 Contractor shall ensure that sediment and hydrocarbon control facilities are frequently visually inspected and repaired as necessary.

**1.7 Hazardous Materials Handling and Storage**

- .1 Hazardous materials including, but not limited to, fuels, bitumens, cement, paints, solvents, cleaners, dust suppressants, used fuel and oil filters, and other construction materials shall be stored and handled to minimize lose and to allow containment and recovery in the event of a spill.
- .2 The Contractor shall designate area(s) for the transfer and temporary storage of hazardous materials and wastes. The designated area(s) shall be used by the Contractor as a transfer and temporary storage area for potentially hazardous materials and wastes. The area(s) shall be clearly labeled and appropriately controlled.

- .3 The Contractor shall maintain proper Workplace Hazardous Material Information Systems (WHMIS) labels and Material Safety Data Sheets (MSDS) for all hazardous materials used and stored on site.
- .4 Discharge of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers is prohibited.
- .5 Discharge of water containing chlorine or other chemical compounds into waterways is prohibited.

**1.8 Special and General  
Waste, Rubbish and  
Garbage**

- .1 Special Waste generated in the course of the construction activities shall be handled and disposed of in compliance with the British Columbia Special Waste Regulation. As defined by these regulations, Special Wastes include, but are not limited to, such things as waste asbestos, oils, greases, lubricants, solvents, batteries, polychlorinated biphenyls (PCBs), paints and used spill cleanup materials.
- .2 When handling, storing, and removing Special Wastes, the Contractor shall maintain the following records: Inventories of types and quantities of Special Wastes generated, stored, or removed; manifests identifying Special Waste haulers and disposal destinations; MSDS and disposal certification documents.
- .3 Non-hazardous solid wastes, such as but not limited to, waste wood, asphalt, concrete, and metals shall be disposed of at an approved and licensed disposal facility in compliance with the British Columbia Waste Management Act.
- .4 The Contractor shall establish regular clean up and disposal programs so as to prevent the unnecessary accumulation of excessive solid waste and contain all garbage related to the project.

**1.9 Equipment Operation**

- .1 Contractor shall maintain construction equipment in good condition and free of excess oil and grease.
- .2 Waste oils and other materials related to equipment shall be removed from site upon completion of project.
- .3 Maintenance of equipment shall be confined to specific areas such that spills can be contained and collected before contaminants reach ditches, watercourses, and storm water systems.
- .4 There shall be no discharge of wash water to ditches, watercourses or storm water systems from trucks and equipment related to concrete supply, pumping, or placing equipment.
- .5 Equipment operation shall be limited to hours acceptable to the community.
- .6 Any fuel spills shall be absorbed immediately.



**1.10 Work Adjacent  
to Drainage Courses and  
Waterways**

- .7 Contractor shall have fuel absorbents on site and shall deal with any spills which should occur immediately.
- .1 Contractor shall implement siltation control measures for all excavation. Siltation shall include but not be limited to installation of silt fences and construction of sedimentation ponds. Siltation control measures shall remain in place until completion of construction.
- .2 The Contractor must develop and implement an Erosion and Sediment Control Plan and have this plan reviewed by the Departmental Representative prior to site preparation and construction of works involving excavation and fill placement. These facilities must be maintained by the Contractor and be working effectively to control discharges from the site.
- .3 Prohibit operation of construction equipment in waterways without Departmental Representative's approval and approval of Fisheries authorities.
- .4 Do not use waterway beds for borrow material.
- .5 Do not dump excavated fill, waste material or debris in waterways.
- .6 Design and construct temporary crossings so that minimum erosion is caused to waterways.
- .7 Construction and excavation wastes, overburden, soil, or other substances deleterious to aquatic life must be disposed of or placed in such a manner so as to prevent their entry into any ditch, watercourse, or storm water system.
- .8 All excavated material is to be side-cast as far as possible from ditches, trenches, or storm water systems to prevent its re-entry into the watercourse. Spoil must be removed offsite or spread out, levelled and seeded to promote re-vegetation and reduce surface erosion.
- .9 Do not skid logs or construction materials across waterways.
- .10 Avoid indicated spawning beds when constructing temporary crossings of waterways.
- .11 Blasting under water or within 100 m of indicated spawning beds not permitted.
- .12 Contractor shall remove any equipment from near watercourse area if not required, or broken down.

**1.11 Revegetation and  
Site Restoration**

- .1 Disturbed areas adjacent to ditches, watercourses and storm water systems shall be re-seeded to prevent surface erosion and/or downstream water quality impacts.
- .2 Ditches and newly constructed diversion channels shall be seeded and planted with grasses and/or native vegetation, to reduce surface erosion.

**1.12 Spill Prevention and  
Emergency Response**

- .1 The Contractor shall develop a Spill Prevention and Emergency Response Plan and distribute it to the Departmental Representative and Owners of the project prior to commencing any work.
- .2 The Contractor shall complete a daily visual inspection of all hazardous material and equipment for signs of leakage. Daily visual inspection will include, among other things ensuring that all personal protective equipment and other emergency response equipment is in its place.
- .3 The Contractor shall maintain a readily available supply of spill emergency response material and equipment on site at all times in effective working condition appropriate to the scale of the project.
- .4 The Contractor shall deal with any spills which occur immediately.
- .5 The Contractor shall report any environmental incident or spill/release of a substance to the Departmental Representative and to the Provincial Emergency Program of the Ministry of Attorney General in accordance with the Spill Reporting Regulations of the Waste Management Act.

END OF SECTION

**PART 1 - GENERAL**

- |  |    |  |
|--|----|--|
| <b>1.1 General</b>                     | .1 | Use new material and equipment unless otherwise specified.   |
|  | .2 | Provide material and equipment of specified design and quality, performing to published ratings and for which replacement parts are readily available.   |
|  | .3 | Use products of one manufacturer for equipment or material of some type or classification unless otherwise specified.  |
| <b>1.2 Manufacturers' Instructions</b> | .1 | Unless otherwise specified, comply with manufacturers' latest printed instructions for materials and installation methods.   |
|  | .2 | Notify Departmental Representative in writing of any conflict between these Specifications and manufacturers' instructions. Departmental Representative will designate which document is to be followed.   |
| <b>1.3 Delivery and Storage</b>        | .1 | Deliver, store, and maintain package material and equipment with manufacturers' seals and labels intact.   |
|  | .2 | Prevent damage, adulteration and soiling of material and equipment during delivery, handling and storage. Immediately remove rejected material and equipment from site.  |
|  | .3 | Store material and equipment in accordance with supplier's instructions.   |
|  | .4 | Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use primer or enamel to match original. Do not paint over name plates.   |
| <b>1.4 Conformance</b>                 | .1 | When material or equipment is specified by standard or performance specifications, upon request of Departmental Representative, obtain from manufacturer an independent testing laboratory report, stating that material or equipment meets or exceeds specified requirements. |
| <b>1.5 Substitution</b>                | .1 | Proposals for substitution may be submitted only after award of Contract. Such requests must include statements of respective costs of items originally specified and proposed substitutions.  |

- .2 Proposals will be considered by Departmental Representative if:
  - .1 Products selected by Tenderer from those specified are not available; or
  - .2 Delivery date of products selected from those specified would unduly delay completion of Contract; or
  - .3 Alternative products to those specified, which are brought to attention of, and considered by, Departmental Representative as equivalent to those specified and will result in credit of Contract amount.
- .3 Should proposed substitution be accepted either in part or in whole, assume full responsibility and costs when substitution affects other work on project. Pay for drawing changes required as result of substitution.
- .4 All credits arising from approval of substitutions will be credited to Contract in such amounts as may be determined by Departmental Representative and Contract price will be adjusted accordingly. No substitutions will be permitted without prior written approval of Departmental Representative.

END OF SECTION

**PART 1 - GENERAL**

- |            |   |    |   |
|------------|---|----|---|
| <b>1.1</b> | <b>General</b>                          | .1 | Not used  |
| <b>1.2</b> | <b>Description</b>                      | .1 | Commissioning includes the start-up of individual systems and equipment, the start-up of the entire system as a cohesive unit, and the training of operators and turnover of the operating water treatment plant. |
|            |   | .2 | Commissioning shall include the General Contractor and all necessary Sub-contractors and/or Suppliers involved in equipment or systems installation.  |
| <b>1.3</b> | <b>Related Work Specified Elsewhere</b> | .1 | Operations and Maintenance – Section 01 91 13.13  |
| <b>1.4</b> | <b>Hatchery Staff</b>                   | .1 | The Contractor shall have the Hatchery Staff in attendance at all system start-ups. Contractor to inform Departmental Representative prior to system start-ups with date and time.                                |
|            |   | .2 | The Contractor is to facilitate the training of Hatchery Staff in accordance with Section 3.5 System Operation.   |

**PART 2 - PRODUCTS**

- |            |                |    |  |
|------------|----------------|----|--|
| <b>1.1</b> | <b>General</b> | .1 | Contractor to supply all required equipment and material for startup, commissioning and hand over period of the water supply infrastructure. |
|------------|----------------|----|--|

**PART 3 – EXECUTION**

- |            |                                |    |  |
|------------|--------------------------------|----|--|
| <b>3.1</b> | <b>Power Supply</b>            | .1 | Where modifications and/or additions to existing electrical equipment or apparatus are required, ensure that all changes are made in accordance to CSA 22.2. Obtain CSA re-certification of the modified electrical equipment. |
| <b>3.2</b> | <b>Treatment System</b>        | .1 | Retain and pay for the services of the authorized manufacturers' representatives to be on-site for the startup of both mechanical and electrical/control systems and operator training.  |
| <b>3.3</b> | <b>Supply and distribution</b> | .1 | After sterilization of the supply pipe open valve on new supply line to fill storage tank.   |
|            |                                | .2 | Take records of operation of storage tank sensors at low and high water level.   |

- .3 Take records of booster pump, pressure tank and water treatment equipment functioning.
  - .4 Take records of pressure in system before and after treatment.
  - .5 Departmental Representative to be informed if any component is not working as intended.
- 3.4 Maintenance Manual** .1 Refer to Section 01 91 13.16. These manuals to be prepared, reviewed, approved and distributed to the Owner, prior to turn-over.
- 3.5 System Operation** .1 The System shall be handed over during a minimum two week period in which the contractor is to facilitate the authorized training of the proposed Hatchery Staff Operator(s) and oversee the initial operation of the system. Ensuring that the system is operating as designed.
- .2 Substantial Completion under the terms of the contract may be granted after, but not before, the two week hand over period with the Hatchery Staff.

\*\*\*\*\* END OF SECTION \*\*\*\*\*

**PART 1 - GENERAL**

- |            |                           |    |  |
|------------|---------------------------|----|--|
| <b>1.1</b> | <b>General</b>            | .1 | Not used   |
| <b>1.2</b> | <b>Maintenance Manual</b> | .1 | <p>On completion of project, submit to Departmental Representative four (4) copies of Operations Data and Maintenance Manual in English made up as follows:</p> <ul style="list-style-type: none"> <li>.1 Bind data in vinyl hard covered, 3-ring loose leaf binder for 215 x 280 mm size paper.</li> <li>.2 Enclose title sheet, labeled "Operation Data and Maintenance Manual", project name, date, and list of contents.</li> <li>.3 Organize contents into applicable Sections of work to parallel project specification break-down. Mark each Section by labeled tabs protected with celluloid covers fastened to hard paper dividing sheets.</li> </ul> <p>.2 Include following information plus data specified.</p> <ul style="list-style-type: none"> <li>.1 Maintenance instruction for finished surface and materials.</li> <li>.2 Copy of hardware and paint schedules.</li> <li>.3 Description, operation and maintenance instructions for equipment and systems, including complete list of equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.</li> <li>.4 Names, addresses and phone numbers of sub-contractors and suppliers.</li> <li>.5 Guarantees, warranties and bonds showing: <ul style="list-style-type: none"> <li>.1 Name and address of projects.</li> <li>.2 Guarantee commencement date of Final Certificate of Completion.</li> <li>.3 Duration of guarantee.</li> <li>.4 Clear indication of what is being guaranteed and what remedial action will be taken under guarantee.</li> <li>.5 Signature and seal of Contractor.</li> <li>.6 Additional material used in project listed under various Sections showing name of manufacturer and source of supply.</li> </ul> </li> </ul> <p>.3 Neatly type lists and notes. Use clear Drawings, diagrams or manufacturers' literature.</p> <p>.4 Include one complete set of final shop Drawings bound separately indicating corrections and changes made during fabrication and installation.</p> |

**1.3 Maintenance  
Materials**

- .1 Where supply of maintenance materials is specified, deliver to Departmental Representative as follows:
  - .1 Materials in unbroken cartons, or if not supplied in cartons, they shall be strongly packaged.
  - .2 Clearly mark as to content.
  - .3 If applicable give colour, room number or area where material used.

END OF SECTION



## **Division 03 – Concrete**

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**PART 1 - GENERAL**

- 1.1 **General** .1 Not Used
- 1.2 **Description** .1 This section specifies requirements for all plain and reinforced cast-in-place concrete as described herein and as shown on the Drawings, or reasonably implied to provide a complete structure.
- 1.3 **Reference Standards** .1 Do cast-in-place concrete work in accordance with the latest issues of:
  - .1 CSA CAN3-A23.1-M - Concrete Materials and Methods of Concrete Construction.
  - .2 CSA CAN3-A23.2-M - Methods of Test for Concrete.
  - .3 CSA CAN3-A23.3-M - Code for the Design of Concrete Structures for Buildings.

.2 Keep a copy of the above CSA Standards on site for the duration of the work. "Standard" referred to later in this Specification means these CSA Standards.
- 1.4 **Related Work Specified Elsewhere** .1 Not Applicable
- 1.5 **Mix Design** .1 Submit certified copy of mix design showing concrete mix design conforming to specified requirements.

**PART 2 - PRODUCTS**

- 2.1 **Materials**
  - .1 Cement: to CSA CAN3-A5-M, normal Type 10 unless otherwise specified.
  - .2 Water, fine aggregates, normal weight coarse aggregates: to CSA CAN3-A23.1-M, Group 1, unless otherwise specified.
  - .3 Form work lumber: plywood and wood form work materials to CSA CAN3-A23.1-M.
  - .4 Form ties: removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
  - .5 Reinforcing bars: billet steel, grade 400 deformed bars to CSA G30.12-M unless indicated otherwise. Provide with identifying marks.
  - .6 Welded steel wire fabric: to CSA G30.5; provide in flat sheets only.

- .7 Air-entraining admixtures: to CSA CAN3-A266.1-M.
- .8 Non-shrink grout: premixed compound consisting of metallic aggregate, cement, water reducing and plasticizing agents, of pouring consistency, capable of developing compressive strength of 50 MPa at 28 days.
- .9 Dry pack: premixed or non-premixed composition of non-metallic aggregate, cement and sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 50 MPa at 28 days.

## 2.2 Concrete Mix

- .1 Except where indicated or specified otherwise, use concrete designed to meet all of the following:
  - .1 Compressive cylinder strength at 28 days of 28 MPa.
  - .2 Maximum coarse aggregate size of 20 mm.
  - .3 Water/cement ratio maximum of .55.
  - .4 Slump between 50 mm and 80 mm at time and point of deposit.
  - .5 Air content of 5%, plus or minus 1%, except in slabs requiring hard trowelling where it is not to exceed 3%.
- .2 Admixtures: obtain written approval of Departmental Representative before using admixtures other than air entraining agents or water reducing agents. When permitted, use only in accordance with Standard.
- .3 Mass density: supply only concrete with air dry unit mass between 2,150 and 2,500 kg/m<sup>3</sup> unless otherwise specified.
- .4 Prior to execution of the work, provide a statement certifying that the materials, including admixtures, are in accordance with this Specification and evidence that the mix proportions selected will produce concrete of the specified quality and strength.

## PART 3 - EXECUTION

### 3.1 Workmanship

- .1 Notify Departmental Representative 24 hours prior to the anticipated time of any concrete pour.

- .2 Obtain the inspection and approval by the Departmental Representative of the preparation for all pours before placing concrete.
- .3 Ensure pipework are not disturbed during concrete placement.
- 3.2 Waterpipe**
  - .1 Correctly position all pipes, sleeves, bolts, hangers and other inserts in the concrete as required by other trades or as shown on the Drawings.
  - .2 Obtain approval by the Departmental Representative of all sleeves, ducts, pipes or other openings (except openings less than 100 x 100 mm in floors and walls) which are not shown on the Structural Drawings before placing concrete.
- 3.3 Inspection and Testing**
  - .1 Where required, the Owner will employ an independent testing firm to make the required field and laboratory tests in accordance with the Standard for field control of concrete quality during construction. Make available materials, space and equipment as are necessary for the tests.
- 3.4 Curing**
  - .1 Cure concrete in accordance with the Standard. Obtain approval of the Departmental Representative for each method used.
- 3.5 Ready-Mix Concrete**
  - .1 Obtain approval by the Departmental Representative of the ready-mix manufacturers before ordering.
- 3.6 Failure to Meet Requirements**
  - .1 When any concrete is not in accordance with these Specifications or the applicable standards, obtain Departmental Representative's ruling on whether to remove and replace it or apply the remedies provided in the applicable Standards to the Departmental Representative's approval.

END OF SECTION



**PART 3 - EXECUTION**

**3.1 Execution**

- .1 Place concrete on moistened granular cushion.
- .2 Rigidly support forms to produce a finished profile within the following limits: Vertical alignment + 15 mm from designed grade, horizontal alignment + 30 mm.
- .3 Place concrete continuously between transverse joints without the use of intermediate bulkheads. Do not spread concrete with rakes. Thoroughly consolidate concrete, but do not operate vibrators longer than 20 seconds in any one location.
- .4 Do not add water to the surface of the concrete unless it is by approved fog spray equipment.
- .5 Finish edges with a curved edger prior to initial set.
- .6 Provide exposed aggregate surface with consistent even appearance to approval of Departmental Representative. Provide 300 mm square sample panel for approval by Departmental Representative prior to construction.
- .7 Protect concrete against loss of moisture, rapid temperature change and mechanical injury for at least three (3) days after placement. Protect edges of slab with continuous curing treatment equal to the method selected for curing the slab surface.
- .8 Control joints: Construct weakened plane control joints longitudinally for the full width of the pavement as required, and transversely at intervals not exceeding 4 m for the fire lane and the parking lot, and 1.5 m for sidewalk. Longitudinal joints to not exceed 4 m in width in parking lot. All joints to terminate at right angles to the edge of the pavement. Use sawed joints or plastic strips.
- .9 Sawing of joints to begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. Sawing to be completed before shrinkage cracking occurs.
- .10 Place transverse construction joints of the type shown on the plans whenever the placing of concrete is suspended for more than 30 minutes.
- .11 Isolation joints: Finished joints to not deviate in horizontal alignment more than 7 mm from a straight line. Joints required around all fixed objectives such as manholes,

existing pavements, etc. No plugs of concrete are permitted anywhere within the expansion space.

- .12 Finished surface to be true to required profile and cross-section with a maximum tolerance of 12 mm and a maximum deviation of 6 mm under a 3 m straightedge.

### 3.2 Testing

- .1 Do testing in accordance with CSA-A23.2.
- .2 Retain services of approved testing agency to do the following:
  - .1 Approve mix design.
  - .2 Make and cure test cylinders and flexural test specimens.
  - .3 Make slump tests and air content tests for each concrete test.
- .3 Make three (3) test cylinders and at least one flexural test specimen for each 100 cubic meters, or fraction thereof, for each class of concrete placed in any one day, except that in no case shall a class of concrete be represented by less than three (3) tests.
- .4 Do compression tests of one cylinder of each set at 7 days and at 28 days for the remaining cylinders. Strength level of concrete shall be considered satisfactory if the averages of compressive tests equal or exceed the specified strength and no individual test is more than 3.45 MPa below the specified strength.
- .5 Do flexural specimen test at 28 days. The daily average flexural strength to be not less than specified. Not more than 10% of test specimens shall be below strength specified, no flexural test below 93% of the strength specified, and the average of any three consecutive tests must be equal to or greater than the specified strength.

END OF SECTION



# **Division 15 - Mechanical**

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**PART 1 - GENERAL**

- 1.1 General** .1 Not Used
- 1.2 Scope** .1 This section includes general requirements for mechanical work.
- 1.3 Shop Drawings** .1 The Contract Drawings show the locations of major components and the piping configuration in schematic form with only major components identified.
- .2 Prior to fabrication, submit four complete sets of Shop Drawings and data sheets covering all details of equipment, materials and fabrication intended for installation under this Contract, and in accordance with the Contract Documents.
- .3 All Shop Drawings submitted for approval shall be certified by the manufacturer and carefully checked by the Contractor, noting all changes required and shall bear the Contractor's approval stamp and signature prior to submitting to the Departmental Representative for approval; drawings will not be considered if not previously checked by the Contractor.
- 1.4 Equipment Requirements and Installation**
- .1 Permit equipment maintenance and disassembly by use of unions or flanges to minimize disturbance to connecting piping and duct systems and without interference from the building structure or equipment.
- .2 Provide accessible means for lubricating equipment including permanent lubricated "lifetime" bearings.
- .3 Base mounted equipment to be mounted on chamfered edge housekeeping pads a minimum of 50 mm high and 50 mm larger than equipment dimensions all around.
- .4 Pipe drain lines to drains. Provide piped drains from pump packing glands to building drain.
- .5 Equipment, floor plates and ceiling plates shall line up with building walls wherever possible.
- .6 Provide all structural work required for foundation and support of the units, foundation bolts, sleeves, washers, nuts, shims, and templates to locate position of bolts.
- .7 Install pumps, motors and other equipment as shown on the drawings, in accordance with the manufacturer's

instructions and as directed by the Departmental Representative.

- .8 Motors shall be aligned, shimmed, and coupled to fit driven shaft to satisfy the tolerance given by the equipment manufacturer.
- .9 For anchorage, embed anchor bolts sufficiently to prevent pull-out. Provide minimum of 25 mm of grout between bedplate and foundation; fill void; finish to approval; do not remove wedges before grout is set.
- .10 Align piping to avoid excessive forces on fixed equipment when piping connections are tightened.
- .11 Pipes shall not be bolted to equipment until grouting and alignment are completed. Bolting shall be done so that no stresses are set up in the flanges.

## 1.5 Pipe Hangers and Supports

- .1 Fabricate hangers, supports and sway braces in accordance with ANST B31.1 and requirements of ULC C203.
- .2 Suspend hangers from steel channels or angles. Submit anchorage system for review. Acceptable products Grinnell Fig. 202, 194, 213, 195.
- .3 Use split adjustable steel ring hanger on piping less than 38 mm diameter. Use clevis type for 38 mm diameter and above. Acceptable products Grinnell Fig. 104, 160, 65.
- .4 For copper pipe, use copper finish tubing hangers Grinnell Fig. CT-109, CT-65 tube strap.
- .5 For pipes supported from floor, use adjustable pipe support saddle welded to pipe support and fabricated base to suit, bolted to floor. Grinnell Fig. 264.
- .6 Pipe 38 mm diameter and smaller may rest on cast wall bracket and held by U-bolt, Grinnell Fig. 213, 137; or may be strapped to wall using Fig. 126, 231, 262.
- .7 Use rod diameters and spacing for pipe supports as shown in table with the following exceptions.
  - .1 Support plumbing piping in accordance with more stringent requirements of authorities having jurisdiction.
  - .2 Support plastic piping in accordance with manufacturer's recommendations.

Pipe Size	Rod Diameter	Maximum Steel	Spacing Copper
NPS 1/2	-	-	1.5m
NPS 1, 3/4	10 mm	2.1m	1.8m
NPS 1 1/2	10 mm	2.7m	2.4m
NPS 2	10 mm	3.0m	2.7m
NPS 2 1/2-3	10 mm	3.6m	3.0m
NPS 4	16 mm	4.2m	3.6m

- .8 Submit arrangement and type of hangers and wall hooks for review.
  - .1 Place support within 300 mm of each horizontal elbow.
  - .2 Hangers shall be three piece minimum standard, consisting of hanger, rod and pipe attachment.
  - .3 Med steel wall hooks may be used to support non-expanding piping.
  - .4 Isolate copper piping from ferrous hanger.

**1.6 Escutcheons and Plates**

- .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
- .2 Use chrome or nickel plated brass with set screws for ceiling or wall mounting.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.

**1.7 Tests**

- .1 Give 24 hours notice of date when tests will be made.
- .2 Conduct tests in presence of Departmental Representative.
- .3 Leave work exposed until tested and approved.
- .4 Bear costs including re-testing and making good.
- .5 Hydraulically test water supply systems at 860 kPa and maintain test pressure without loss for 4 hours.
- .6 Test fuel oil systems to CSA B139.
- .7 Test drainage, waste and vent piping to code.

**1.8 Dielectric Couplings**

- .1 Provide wherever pipes of dissimilar metals are joined.
- .2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.

- 
- .3 Provide felt or rubber gaskets to prevent dissimilar metals contact.
- 1.9 Instruction of Operating Staff**
- .1 Provide nameplates for all valves and pieces of equipment, supplied by either the Contractor or others, as directed by the Departmental Representative.
- .2 Nameplates to be laminated plastic with black face and white centre of minimum size 90 x 40 x 2.5 mm nominal thickness, engraved with 6 mm high lettering. Use 25 mm lettering for major equipment, as directed by Departmental Representative.
- .3 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on a cool surface, provide standoffs or hang from chain.
- .4 Identify equipment type and number of service zone, as applicable. eg. shut-off valve, pressure relief valve, etc.
- .5 Submit list of equipment nameplates for review prior to engraving.
- 1.10 Identification of Piping**
- .1 Identify all piping with markers showing identification of pipe and directional flow arrows.
- .2 Use block capital letters 50 mm high for pipes of 75 mm nominal and larger diameter, and not less than 20 mm high for smaller diameters.
- .3 Use direction arrows 150 mm long by 50 mm wide for piping of 75 mm nominal or larger diameter and 100 mm long by 20 mm wide for smaller diameters.
- .4 Use waterproof plastic marker tapes for pipes and tubing of 19 mm and smaller diameter.
- .5 Acceptable Product: WH Brady identification tapes and bands and Seton Name Plate Corporation Setmark pipe markers.
- .6 Locate identification as follows:
- .1 Identify piping runs at least once in each room.
- .2 Do not exceed 5 m between identifications in open areas.
- .3 Identify both sides where piping passes through walls, partitions and floors.

- .4 Where piping is concealed in pipe chase or other confined space, identify at point of entry and leaving, and at each access opening.
- .5 Identify piping at starting and ending points of runs and at each piece of equipment.
- .6 Identify piping at major manual and automatic valves immediately upstream of valves. Where this is not possible, place identification as close to valve as possible.
- .7 Identify branch, equipment or building served after such valve.

**1.11 Temporary and  
Trial Usage**

- .1 Temporary or trial usage by the Owner of any mechanical machinery, apparatus, equipment, or any other work or materials supplied under the contract before final written acceptance by the Departmental Representative, is not to be construed as an evidence of the acceptance of same by the Owner. The Owner shall have the privilege of such temporary and trial usage as soon as the Contractor shall claim that said work is completed. Any damage caused by defective material or workmanship through temporary or trial usage by the Owner shall be the responsibility of the Contractor.

END OF SECTION

**PART 1 - GENERAL**

- 1.1 General** .1 Not Used
- 1.1 Scope** .1 The work and materials covered by this section include the furnishing and installation of the pump and associated mechanical equipment.
- 1.3 Related Work Specified Elsewhere** .1 Mechanical General Provisions Section 15 01 00
- 1.4 Standard** .1 Cast Iron Pipe: AWWA C151  
Cast Iron Flanges: ASA B16.1  
Galvanized Iron Pipe: ASTM A120  
Malleable Iron Pipe Fittings: ASTM A107
- .2 Install piping in accordance with the requirements of the latest edition of the British Columbia Plumbing Code.
- 1.5 Certificates** .1 Provide written certificate that components are compatible, and where applicable, certified for intended use by nationally recognized testing agency.

**PART 2 – PRODUCTS**

- .1 Refer to Construction Drawings

**PART 3 - EXECUTION**

- 3.1 General** .1 Install all pipework, fittings, equipment and fixtures to the satisfaction and approval of the Departmental Representative.
- .2 Run exposed pipework parallel to walls and ceilings neatly grouped in parallel lines.
- .3 Temporarily plug ends of pipework to keep foreign matter out before final connections are made.
- 3.2 Tolerances** .1 All horizontal drain leaders above ground shall be graded to one percent slope, unless otherwise shown on the Drawings.
- .2 All drain lines and horizontal lines of soil and waste piping shall be graded two percent minimum unless otherwise shown on the Drawings.
- .3 Horizontal branches of all pipework shall be graded downwards so that they may be completely drained through risers, fixtures or drain cocks. Minimum slope one-half of one percent.



**3.3 Installation  
of Pipework**

- .1 Do no cutting that may impair the strength of the building. Drill no holes, except for expansion bolts and small screws in the structure without obtaining prior approval from the Departmental Representativeing.
- .2 Pipes passing through roofs, floors or other areas requiring waterproofing shall be flashed by the Contractor. Seal pipe passing through walls and floors inside the building with flexible caulking applied into space between pipe and sleeve or as detailed.
- .3 Run all piping parallel to building lines. Fasten supports to inserts in concrete. Do not use perforated band iron for hangers. All hanger rods are to have machine threads capable of vertical adjustment after pipe is erected.
- .4 Piping, ducts, and equipment shall be thoroughly cleaned of dirt, cuttings and other foreign substances. Should any pipe, duct or other part of systems be obstructed by any foreign matter, disconnect, clean and re-connect whenever necessary for purpose of locating and removing obstructions. Repair work damaged in the course of removing obstructions.
- .5 Provide temporary bracing and supports to adequately support the pipe during installation.
- .6 Take care to prevent damage to the pipe, pipe coatings and the adjacent structure during erection. Make good all damage. Completely repaint all ferrous pipework and fittings after installation is completed.
- .7 Where the required piping is not shown on the plans or shown only diagrammatically, install pipes in such a way as to conserve head room and interfere as little as possible with free use of the space through which they pass.
- .8 Install all valves so as to facilitate servicing or re-packing.
- .9 Erect and support all piping in a manner that will not put undue strain on pumps, tanks, equipment or adjacent piping.
- .10 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- .11 Where pipe sizes differ from connections to equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

- 
- .12 Use non-corrosive lubricant or teflon tape applied to male threads.
- .13 Install flanges or unions to permit removal of equipment without disturbing piping systems.
- 3.4 Welding of Steel Pipe**
- .1 Do pipe welding in accordance with the current AWWA Specification C-206-62. The welding operators and supervisors employed and the welding procedure shall be qualified in accordance with the current CSA Standard W-47 Welding Specification Code. Each operator's certificate of qualification and experience record shall be on file at the site, and shall be made available to the Departmental Representative on request. Each operator shall be currently qualified for the P number covering the material on which he will be engaged as prescribed in the Welding Qualification Code, latest revision.
- .2 The Departmental Representative reserves the right to specifically test, at no cost to the Owner, the qualification of individual welders employed by the Contractor. Any welder who does not perform satisfactorily in the Departmental Representative's test shall be removed from the job at no cost to the Owner.
- .3 All welding shall be shielded metal-arc welding process. Welded pipe joints shall be single-V butt joints, using a root gap of 1.6 mm. Welds shall be full penetrating welds. Care shall be exercised to keep the interior pipe lining free from damage during welding. Longitudinal weld seams shall be on opposite sides of the pipe at the joint. Welding shall not be carried on when weather conditions, in the opinion of the Departmental Representative, are unsatisfactory and would impair the quality of the welds.
- .4 The minimum distance between the edges to adjacent circumferential welds shall be 50 mm. If this requirement cannot be satisfied, stress-relieving of the welds must be undertaken.
- 3.5 Valve, Equipment and Appurtenance**
- .1 Install all valves, equipment and appurtenances to manufacturer's instructions and these Specifications.
- 3.6 Final Inspection and Start-up**
- .1 Subject to systems and equipment to operational test.

- .2 During tests, stop any leaks and remove and repair any defective part. Perform test over again until satisfactory results are obtained.
- .3 Provide pump, temporary connections and labour required for tests.
- .4 Carry out the following before final inspection:
  - .1 complete construction and site restoration
  - .2 complete all painting and finishing
  - .3 align and adjust all equipment
  - .4 where applicable, mail equipment warranty form to manufacturer. Provide the Owner with a copy of the original warranty for any equipment which has a warranty period longer than one year.
- .5 Notify Departmental Representative at least 48 hours prior to start-up.

END OF SECTION

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# **Division 26 - Electrical**

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**DIVISION 26 – ELECTRICAL**

**SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL**

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**PART 1    GENERAL**

**1.01    Work Included**

- .1    Provide all labour, materials, equipment, services and supervision required to provide a complete electrical system as listed herein and shown on the drawings.
- .2    This shall generally include work in the following areas:
  - a)    The Inch Creek Hatchery general site
  - b)    Hatchery Building with feeder originating in the electrical room
  - c)    Trenching for feeders between the Hatchery and Pump House No. 2
  - d)    Pump House No. 2 for new VFD for Well #5 and existing remote I/O for controls
  - e)    Trenching and ducts, including spares between Pump House No. 2 and new Well #5's H-frame mounted junction box.
  - f)    Well #5
  - g)    Spare ducts stubbed out of Well #5's junction box in the direction of the test well for future development of the well.
- .3    This includes, but is not limited by the generality of the following:
  - a)    Removal of a spare breaker in Panel 6A-2 in the Hatchery and replacement with a new breaker
  - b)    Secondary Feeders and Ducts
  - c)    Motor Control
  - d)    Provide wiring to the Remote I/O Panel in Pump House No. 2 for connection by DFO.
  - e)    Control Panel as part of the VFD (Variable Frequency Drive) for Well #5
  - f)    Instrumentation
  - g)    Termination panel adjacent the wellhead
  - h)    Testing and Commissioning
  - i)    Spare ducts complete with nylon pull string as noted on the drawings.

**1.02    Work Not Included**

- .1    The following work will be done by others. The contractor shall co-ordinate his work with the following and co-operate where required.
  - a)    Final connections to the Remote I/O panel (Scada) by DFO
  - b)    24vdc for well level element will be by DFO in the Remote I/O panel

**1.03    Owner Supplied Equipment and Materials**

- .1    The contractor shall accept all Owner supplied equipment and materials within 48 hours of a request to do so by the Owner. The contractor shall inspect same prior to acceptance and any loss or damage after acceptance shall be made good at no cost to the Owner.
- .2    The Owner will supply the following equipment:
  - a)    None on this project



**1.04 Contract Drawings**

- .1 The electrical drawings do not show structural details.
- .2 Accurate dimensions shall be taken from structural or architectural drawings or by measurement of the buildings. The electrical drawings show approximate location of apparatus, equipment and wiring. The arrangement is diagrammatic in some areas. The exact location of apparatus, equipment and wiring shall be determined in the field in accordance with good practice and shall be to the approval of the Engineer prior to installation.
- .3 Check the location of all items fed by conduit embedded in or below the floor slab. Ensure that the conduit is located correctly.
- .4 Ensure adequate clearance in front of all electrical panels and equipment.
- .5 Check all electrical equipment and motor nameplates to ensure that the breakers, fuses, overload heaters and conductor is sized in accordance with Canadian Electrical Code requirements. Place a copy of the submersible pump's nameplate in the VFD cabinet.
- .6 Check all equipment against the Single Line Diagram to ensure that the voltage and frequency are correct.
- .7 The drawings show sufficient detail to indicate the scope of work. Minor changes may be made after award of contract, and after receipt of shop drawings. Changes made as a result of receiving the Contractor's shop drawings shall not be considered extra work.
- .8 The Engineer reserves the right to change the location of equipment, switches, outlets, etc., to within 3000mm of points indicated on the drawings without involving an extra, providing the electrical trade is advised of the change in time to avoid removal of material already installed.
- .9 Obtain ruling, prior to tender closing, from Engineer, on any discrepancy between specification and drawings. If this is not done, the expensive alternative will be assumed.
- .10 Arrange wiring and apparatus to conform to architectural and structural details, in an approved manner.

**1.05 Shop Drawings**

- .1 Submit an electronic copy as PDFs of shop drawings to the Engineer for review.
- .2 Shop drawings shall include catalogue sheets, manufacturer's bulletins, wiring diagrams, dimensional data and operating descriptions of all items listed under Part 2 Products, in each section of the Specification.
- .3 Shop drawings shall include an interconnection diagram showing terminal numbers, number of conductors between components and requirements of interwiring conductors. This shall include requirements for shielding, twisting of pairs, minimum and maximum resistance, capacitance, reactance, etc.
- .4 Submit breaker trip curves and fuse curves for all breakers or fuses of more than 50 ampere rating.
- .5 The Engineer will review shop drawings. Engineer's review of shop drawings does

not relieve the Contractor from the requirement to provide equipment and systems in accordance with this specification and the contract drawings.

- .6 The Contractor shall also check manufacturer's shop drawings. He shall ensure that the shop drawings and equipment meet the requirements of the contract drawings and specifications.

#### **1.06 As-Built Drawings**

- .1 Maintain one set of white prints on jobsite for recording of field changes to conduit runs, equipment locations, etc. As-built markups shall be done daily. Deliver set to Engineer at job completion.
- .2 As-built markups shall be to the same standard and detail as the contract drawings. Markups shall be to scale, or dimensions shall be noted. They shall show all changes made by the Engineer, Owner and Contractor.
- .3 The Contractor shall submit as-built drawings to the Engineer for inspection, when the Engineer is on site to inspect the Contractor's work.
- .4 If the Engineer finds that the final as-built drawings do not accurately reflect the work done, he shall return them to the Contractor for revision. If the Contractor does not resubmit adequate and correct drawings within 7 days, the Engineer will mark up as-built prints to final and correct state. The Engineer's cost for this work will be deducted from the Contractor's final payment.

#### **1.07 Operating and Maintenance Manuals and Spare Parts Lists**

- .1 Four copies of the manufacturer's maintenance instructions, operating manuals and spare parts lists shall be supplied by the Contractor to the Engineer on job completion showing each major piece of electrical equipment and/or equipment as designated by the Engineer. PDF copies shall be acceptable. Instructions shall be complete with installation, operating and maintenance drawings and shall include one corrected copy of all shop drawings. Catalog details of all equipment actually installed, including schematic drawings, layouts and maintenance data as applicable shall be included in the maintenance instructions.
- .2 All four copies of maintenance instructions and operating manuals shall be bound in separate hard back cover folders, complete with index and tabs.

#### **1.08 Guarantee**

- .1 The Contractor shall guarantee his work, equipment and materials supplied for a period of one year after final completion. He shall repair, replace or otherwise make good the electrical installation should failure, malfunction or deficiency become known during the guarantee period. This work shall be done at no cost to the Owner.

## **PART 2 PRODUCTS**

### **2.01 Materials and Equipment**

- .1 Provide new and CSA approved equipment, free of defects. Factory seconds will

not be accepted. Equipment shall carry an approval label.

- .2 Other agencies, acceptable to the BC Safety Authority, will be considered as equal to CSA. They include:
  - a) CGA - Canadian Gas Association
  - b) ULC - Underwriter Laboratories of Canada
  - c) ITS - Intertek Testing Services NA Ltd., (ITS - Canadian Divisions) formerly Warnock Hersey Professional Services Ltd. (label is still a stylized WH)
  - d) ETL - Intertek Testing Services NA Inc., (ITS - US Division) formerly ETL Testing Laboratories (label is still ETL)
  - e) cUL - Underwriters Laboratories Inc.
  - f) cMET -MET Laboratories Inc.

The above labels should be affixed to the various components within a control panel, and the control panel itself should have an approval label.

If approval labels are missing the Contractor shall arrange for the BC Safety Authority to inspect and approve (usually at the job site) the equipment, under the SPECIAL INSPECTION PROGRAM. All costs shall be borne by the Contractor.

- .3 Install all materials and equipment in accordance with the manufacturer's recommendations.
- .4 All equipment and systems shall meet WorkSafe BC (WSBC) requirements.
- .5 Provide WHMIS data sheets on all equipment and material, where required by WCB.

## **2.02 Equals and Substitutions**

- .1 Where equipment and materials is specified by manufacturer, "or approved equal" is implied unless specifically noted otherwise. Submit full technical data with request for approval of equals, a minimum of 5 days prior to tender closing.
- .2 Contractors who supply approved equals shall furnish revised wiring and mounting details where required. The Contractor shall pay for all additional Engineering costs related to installation of substituted equipment.
- .3 As-built drawings shall show complete installation information, including all wiring and mounting details.

## **2.03 Names of Suppliers, Manufacturers & Distributors**

- .1 The Contractor shall provide, with his tender, a list of all manufacturers and their distributors or suppliers, who will supply equipment listed in the "Part 2 - Products," sections of this specification.
- .2 This list shall be detailed, item by item, or summarized in categories as follows:
  - a) Variable Frequency Drive (VFD)
  - b) Instrumentation Equipment
  - c) Control Panels
  - d) Specialty Items (list)

- .3 Where items are omitted from this list and the material has not been given "accepted" status, the Engineer or Owner may request that this material be changed, at any stage during construction, at no expense to the Owner.
- .4 Contractors shall not change listed suppliers following tender close without written permission from the Engineer.

### **PART 3     PART 3     EXECUTION**

#### **3.01     Site Inspection**

- .1 The Contractor may examine the construction site prior to submitting tender and ascertain all conditions affecting work. Base tender on site conditions. Advise Engineer of any potential problems observed during the site visit, within 24 hours of visit.

#### **3.02     Permits, Licenses and Fees**

- .1 Submit drawings to the appropriate inspection authorities for approval.
- .2 Apply and pay for all required permits, licenses and fees. Supply inspection certificates to the Owner at the end of the job. Provide one additional copy in each O&M Manual. Work shall not be considered complete until these certificates are submitted to the Owner.

#### **3.03     Codes**

- .1 Perform work in accordance with Canadian Electrical Code, current edition, and local and regional authorities having jurisdiction.
- .2 Perform work in accordance with WorkSafeBC requirements.

#### **3.04     Safety**

- .1 Contractor shall be responsible for the safety of all personnel affected by his work.
- .2 Contractor shall establish lock-out procedures and enforce these procedures.
- .3 Contractor shall provide training and instruction as required for all his personnel, and others working on the electrical equipment.
- .4 Contractor shall obtain assistance from outside agencies or specialists, where required, to insure a safe operating workplace.
- .5 The workplace shall be kept neat and tidy during construction. Tools shall not be left exposed while not in use, and material shall not be allowed to accumulate in the work area.

#### **3.05     Excavation, Backfill, Cutting and Patching**

- .1 All excavation, backfill, cutting and patching required for electrical installation, will be by the General Contractor.

**3.06 Equipment Identification**

- .1 All field components shall be clearly labeled with lamicoid labels. Labels shall have minimum 3mm white letters on black background. Dymo tape labels are not acceptable. Submit list for approval with shop drawings.

**3.07 Conduit and Cable Identification**

- .1 All conduits and cables for power and control, shall be clearly identified with cable numbers as shown on the drawings, at the starters, MCC or Control Panel(s) and at point of termination. Provide Electrovert "strap-on S markers" or T & B Tyrap or Raychem TM3 identification cable ties with indelible marking.
- .2 Conduits shall be labeled at least once on every building floor.

**3.08 Testing**

- .1 All electrical power, control and alarm systems shall be tested and calibrated by the Contractor to ensure that they are operating in accordance with the intent of the drawings and specifications. If the Contractor is in doubt as to the intent he shall obtain clarification prior to tender closing.
- .2 The Contractor shall supply all necessary instruments, meters, equipment and qualified personnel to make tests on electrical equipment and wiring during construction or after installation when requested by the Engineer.

The tests shall include:

- a) Insulation resistance tests in accordance with the Canadian Electrical Code before energization of any circuits or equipment.
- b) All tests as recommended in manufacturer's instructions.
- c) Phase rotation tests on circuits, motors, etc.
- d) Tests of adequacy of grounding system and connections.

Where tests are optional, it shall be presumed to be included unless this is highlighted in the tender, and approval to delete the test in question has been given.

- .3 The Contractor shall troubleshoot and replace all defective equipment, systems and wiring discovered during his testing program. He shall retain such competent personnel, suppliers, representatives or subcontractors as necessary to complete this work. He shall retest all systems where remedial action was necessary. After he is completely satisfied that everything is completely operational he shall inform the Engineer that he is ready for startup. He shall submit the test report at this time.

**3.09 Test Report**

- .1 The test report shall include all calibration calculations and shall show all setpoints as left. It shall include the following data on motors:
  - a) Nameplate full load current
  - b) Measured current at maximum load
  - c) Cat. No. and current range of installed O/L heater
  - d) Settings of circuit breakers
  - e) Settings of all protective relays

- .2 The test report shall include confirmation of manufacturer's and supplier's recommended procedures. It shall also include all requested manufacturer's certificates of inspection. It shall include the following data on all instrumentation:
- a) All VFD settings and parameters

### **3.10 Startup**

- .1 The contractor shall completely test and demonstrate the system to the satisfaction of the engineer. This test shall include but not be limited by the generality of the following:
- a) Motor Control
    - i. All alarm points
    - ii. All interlocks
    - iii. All shutdowns
    - iv. All meters
    - v. All protective relay settings
    - vi. All control pushbuttons and switches
    - vii. All pilot lights
    - viii. Ampere readings on all motors
  - b) Instrumentation
    - i. All level measurements
  - c) Alarm Systems
    - i. Each actuating device
    - ii. Each signaling device
    - iii. Interlocks

### **3.11 Startup Co-ordination**

- .1 The contractor shall co-ordinate the startup of the facilities in co-operation with the Owner, Engineer, other contractors on site and the various vendor representatives.

### **3.12 Special Areas**

- .1 The Contractor shall follow accepted practices and code regulations in hazardous locations, areas requiring weatherproof construction, and areas subject to extreme temperatures or vibrations.

### **3.13 Making Good**

- .1 The Contractor shall make good all damage, physical and financial caused by him, to the Owner, the premises and other trades on this project.

### **3.14 Protection of Work**

- .1 The Contractor shall properly cover and protect from damage and weather, all equipment and material related to his work.

**3.15 Clean-Up**

- .1 Upon completion of the work, the Contractor shall remove all tools, debris, and surplus material, and shall leave the area neat and clean to the Engineer's satisfaction.

**3.16 Co-ordination**

- .1 The Contractor shall co-ordinate the supply of information between all suppliers and manufacturers of electrical equipment to insure that electricians in the field have correct and adequate information to install all equipment.

**3.17 Workmanship**

- .1 Work shall be done in accordance with good practice and by tradesmen accredited and skilled in the performance of electrical work.
- .2 The Engineer shall determine whether workmanship is acceptable. Work approved by the Electrical Inspector or other authorities may still be rejected by the Engineer.
- .3 Grounds for rejection shall be any one of, but not limited by the following:
  - a) Poor appearance
  - b) Poor quality materials
  - c) Conduit or wiring connections incompatible with standard of enclosures used
  - d) Insufficient support or fastenings
  - e) Materials installed in a manner or location that will impede other trades or make future maintenance awkward, costly or impossible.

**3.18 Supplier Responsibilities**

- .1 The Contractor shall be responsible for insuring that all his suppliers of equipment and material have sufficient information to determine whether their equipment and material is suitable for the intended use shown in these documents.
- .2 The Contractor shall notify his suppliers as follows:
  - a) All suppliers shall insure their equipment and material is suitable for the installation intended. If his equipment is found to be deficient, it shall be removed and replaced with suitable equipment, all at no cost to the Owner.
  - b) The supplier shall insure, when applying for "equal" status to specified equipment, that his equipment is truly equal. If his equipment is discovered to be deficient in this respect, it shall be removed and the specified equipment provided, all at no cost to the Owner or Engineer.

**3.19 Earthquake Restraint**

- .1 The Contractor shall provide restraint for all wall mounted equipment. Wall mounted equipment shall be firmly bolted to wall brackets. Supports, anchors and bracing shall prevent horizontal movement or tipping of wall mounted equipment during and after earthquakes.

**3.20 Inspection of Work**

- .1 On this project the Electrical Engineer, Owner and BC Safety Authority will be inspecting electrical work at various stages of construction.
- .2 The electrical contractor and/or general contractor shall notify the Electrical Engineer a minimum of two weeks prior to rough-in completion and wall boarding in order to schedule rough-in inspection. Failure to request rough-in inspection may result in the stopping of work on site by the local building inspector. This is due to the current BC Building Code requirement for field review by the Electrical Engineer.
- .3 Provide a minimum of two weeks advance notice to the Engineer of request for substantial completion and final inspection.

**3.21 Alternatives**

- .1 Bidders are encouraged to make alternative proposals where they feel that an alternative would be of advantage to the Owner.



**DIVISION 26 – ELECTRICAL**

**SECTION 26 05 20 – WIRE AND BOX CONNECTORS**

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**PART 1**    **GENERAL****1.01**    **Wiring Method**

- .1    Wiring method shall be surface run conduit and wire, except where specifically noted otherwise herein or on the drawings.
- .2    Wiring method shall be concealed teck cable where permitted by code, wire in conduit elsewhere. Teck cable shall be used in the Hatchery Building.
- .3    Wiring shall be concealed in all areas except in electrical rooms and mechanical rooms, where it shall be surface run.
- .4    All conduit and wiring is not shown on the drawings. The Contractor shall provide conduit and wiring as per circuit numbers shown. He shall install this in accordance with good practice with no conflicts with other trades.
- .5    Interior control panel wiring shall be "TY-RAP'ed" bundles, secured to rear mounting panel, or installed in "Panduit" type wiring trough.

**1.02**    **Ground Conductor**

- .1    Provide separate ground conductor in all non-metallic conduit and duct.

**PART 2**    **PRODUCTS****2.01**    **Conduit**

- .1    Provide galvanized steel electrometallic tubing in all areas, except where direct buried or exposed to mechanical damage.
- .2    Provide rigid PVC duct (DB2) CSA 22.2 No. 211.1 – latest edition where direct buried or encased in concrete. Use approved jointing cement. Run ground conductor.
- .3    Provide rigid PVC conduit CSA 22.2 No. 211.2 – latest edition where rigid PVC is surface run. Use approved jointing cement. Run ground conductor.
- .4    Provide rigid hot dipped galvanized steel in areas where exposed to mechanical damage.
- .5    Areas where conduit is exposed to mechanical damage are as follows:
  - a)    Surface mounted outdoors, from 600mm below ground to at least 300mm above ground.
  - b)    Stubbed up through floor to motors and control pilot devices.
  - c)    Where noted on drawings.
- .6    Provide electrical non-metallic tubing (ENT) for concealed work and concrete encasement.
- .7    All conduit shown is 21mm diameter unless otherwise noted, or where the code calls for a larger size because of conduit fill.
- .8    Provide flexible conduit for last 500mm of connection to motors, solenoid valves, pressure switches and similar devices.

**2.02**    **Flexible Conduit**

- .1 Provide flexible water tight conduit for connections to pump bases.
- .2 Flexible conduit shall be Hydrotite or Sealtight with extruded PVC Jacket.
- .3 Non-metallic flexible conduit is acceptable.

**2.03 Secondary Distribution Duct**

- .1 Provide 78mm PVC where direct buried or encased in concrete.
- .2 Adapt to rigid galvanized steel where exposed to mechanical damage.

**2.04 Wire**

- .1 Provide stranded copper conductor unless otherwise noted.
- .2 Provide extra flexible switchboard wire #16 AWG for all control panel wiring.
- .3 Provide minimum #12 AWG for lighting, heating and receptacle circuits.
- .4 Provide RW90 X-LINK polyethylene insulated wire unless otherwise noted.
- .5 Wiring at 120/208 volts shall be 300 volt insulated.
- .6 Wiring at 600 volts shall be 600 volt insulated.

**2.05 Teck Cable**

- .1 Teck cable shall be aluminum armoured copper conductor with X-link insulation complete with fire retardant PVC jacket overall. Voltage rating shall be minimum 600 volt for #10 AWG and smaller, 1000 V for #8 AWG and larger.
- .2 Provide appropriately sized PVC duct in concrete for Teck cable entrances to buildings. Seal with duct seal.

**2.06 Instrumentation Wire**

- .1 Cable C1 from Pump House No. 2 to Well Level Sensor shall be 16AWG, 2 pair, shielded, 600vac rated wire in conduit. (ECS Wire P/N: E16-02PA1 or equiv.).

**2.07 Connectors**

- .1 Teck connectors shall be raintight. Provide Thomas & Betts "Spin on 2" connectors.
- .2 EMT connectors shall be bushed steel.
- .3 Connectors shall match the EEMAC standard of the box, fitting or enclosure they enter.

**2.08 Waterstop Sealant**

- .1 Provide GE RTV 108 general purpose silicone rubber adhesive sealant.

**2.09 Duct Seal**

- .1 Provide Iberville Duct Sealant DUCT-1.

**2.10 Flame Stop Sealant**

- .1 Provide Thomas & Betts flame-safe firestop compound.

**PART 3 EXECUTION****3.01 Conduit**

- .1 Exposed conduit shall be parallel or perpendicular to building lines.
- .2 Provide expansion joints where required.
- .3 Provide thermal breaks where required.
- .4 Support conduit to eliminate visible deflection.
- .5 All G.F.I. protected circuits shall be in rigid PVC conduit.
- .6 Conduit installed in areas where building finish is painted, shall be painted to match, with two coats of same colour, type and quality.
- .7 Conduit entering, or passing through an electrical enclosure or kiosk shall have locknut and washer on both sides of the enclosure or kiosk panel. Connection shall be to standard of the enclosure.
- .8 Holes in enclosures, for conduit, shall be made with a knockout.
- .9 Seal with fire stop sealant all points where wiring or conduit passes through fire separations.
- .10 Flexible conduit shall only be used where flexibility is required for future equipment changes or small equipment movement.

**3.02 Rigid Steel Conduit to PVC Conduit Adaptor**

- .1 Provide PVC female adapter fitting. Rigid Steel conduit shall be threaded into female adapter at points of transition.

**3.03 Duct**

- .1 Connections shall be watertight.
- .2 Slope to provide drainage.

**3.04 Waterstop Sealant Installation**

- .1 After all instruments and controls have been tested, seal cable entry between the following areas:
  - a) Hatchery Building and Outside
  - b) Pump House No. 2 and Outside
  - c) Ensure the JB at the wellhead is watertight
- .2 Apply with pump or gun.

**3.05 Control Panel Wiring**

- .1 Identify wiring at each end with tubular markers. Identification numbers shall match terminal numbers.
- .2 Provide wire numbers for all wires and terminals where numbers are not

---

	designated.				
.3	Colour code wiring	-	"Red"	for	120 VAC
			"Blue"	for	24 VDC
			"Yellow"	for	12 VDC

### **3.06 Spare Conductors**

- .1 Unused wiring in conduits or cable shall be clearly identified as spare with each conductor numbered individually.

### **3.07 Direct Buried Conduit and Teck Cable**

- .1 Bury all wiring to minimum depths noted in Canadian Electrical Code unless otherwise noted.
- .2 Mark location with warning tape 'Danger - Buried Cable' in trench half way between the wiring and grade.

### **3.08 Equipment Mounting**

- .1 Use 19mm good one side (G1S), exterior grade plywood where required to mount electrical equipment.
- .2 Paint plywood with three coats minimum, one primer and two base colour. Base colour shall match the surrounding wall or be white if the wall is unpainted.

### **3.09 Instrumentation Cable**

- .1 Ground shield at one end, unless recommended otherwise by the equipment supplier.
- .2 Test continuity of shield prior to connecting instruments.
- .3 Terminate armour in approved connector, if using armoured cable.

**DIVISION 26 – ELECTRICAL**

**SECTION 26 05 21 – WIRING DEVICES**

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**PART 1 GENERAL****1.01 Related Work**

- .1 Section 26 05 00, Common Work Results for Electrical.

**PART 2 PRODUCTS****2.01 Pull and Junction Boxes**

- .1 Provide pull and junction boxes appropriately sized where required.
- .2 Provide pull and junction boxes appropriately sized where required. (See Section 26 05 22 - Connectors and Terminations for larger boxes; such as the one on the Hatchery building).
- .3 Provide CSA approved, pressed steel construction, hot dip galvanized, where located on or near the ceiling and unlikely to be exposed to splashing or sprayed water. Larger boxes may be enameled and rated NEMA 3R, complete with grounding lugs, and screw-on or hinged cover and sized per Canadian Electrical Code requirements, where there is a potential to be exposed to sprayed or splashed water.
- .4 Provide labelled terminals in all control junction boxes with more than four junctions.

**2.02 Outlets and Switchboxes**

- .1 Size boxes to suit the number of conductors and connections required therein.
- .2 Use gang boxes as required for the number of switches. Check structural drawings for door swings, counter heights and locations, shelf locations, etc., prior to installing boxes.
- .3 Unless otherwise noted or specified herein, all outlets shall be installed flush.
- .4 Provide switch and receptacle boxes suitable for installation required.
- .5 In areas where conduit is surface run provide type F.S. boxes, constructed of same material as conduit.

**2.03 Receptacles**

- .1 Receptacles and matching plugs shall be in accordance with CSA configuration for non-locking receptacles unless otherwise noted.
- .2 Duplex receptacles shall be specification grade Leviton Cat. No. BR15-I, complete with stainless steel coverplates.

**2.04 Light Switches**

- .1 Single pole light switches shall be specification grade Leviton Cat. No. C5B1-15-I.
- .2 Three-way light switches shall be specification grade, Leviton Cat. No. CSB3-15-I.

**2.05 Wiring Connections**

- .1 Use insulated twist on type for #10 AWG and smaller conductors.
- .2 Use bolted type for #8 and larger. Use Burndy Compression fittings for connecting spade type terminals to wiring.

**2.06 Cover Plates**

- .1 Plates in finished areas shall be plain stainless steel, satin finished, with bevelled edges and not less than 1mm thick.

**PART 3 EXECUTION**

**3.01 Co-ordination With Other Trades**

- .1 Coordinate the placement of boxes and wiring in trenches will other trades.

**3.02 Mounting of Wiring Devices**

- .1 Where pull boxes are flush mounted, overlapping covers with flush head cover retaining screws, prime coated and painted to match wall or ceiling finish shall be provided.
- .2 Pull boxes and junction boxes shall have lamicoid labels as outlined in Section 26 05 00 "Equipment Identification".
- .3 All the foregoing notwithstanding, devices shall be located to suit the architectural or structural details of the area involved.



**DIVISION 26 – ELECTRICAL**

**SECTION 26 05 22 – Connectors and Terminations**

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**PART 1 GENERAL**

**1.01 Related Work**

- .1 Section 26 05 20, Wire and Box Connectors

**PART 2 PRODUCTS**

**2.01 Pull and Junction Boxes**

- .1 Provide pull and junction boxes appropriately sized where required.
- .2 Provide labelled terminals in the junction box at the wellhead.
- .3 Provide the following junction boxes as indicated herein and on the drawings:

Type 1 - Well Junction Box, Hammond P/N: C3R181810HCR. NEMA 3R Painted Galvanized complete with steel inner panel painted white.

Type 2 - Pull Boxes (NEMA 3R) to be installed on outside of Hatchery Building and Pumphouse No. 2, Hammond P/N: 1418N4CR6.

Type 3 - Pull Box (NEMA 3R) to be installed at Pump House No. 2 for the well level sensor wiring to keep the instrument wiring separate from the power wiring. Hammond P/N: C3R886HCR.

**2.02 Wiring Connections**

- .1 Use insulated twist on type for #10 AWG and smaller conductors.
- .2 Use bolted type for #8 and larger. Use Burndy Compression fittings for connecting spade type terminals to wiring.
- .3 Use terminal blocks in the well head junction box, per the detail on the drawings.
- .4 Use Penetrox Oxide Inhibiting Compound where copper and aluminum conductors are joined.

**PART 3 EXECUTION**

**3.01 Mounting of Wiring Devices**

- .1 Pull boxes and junction boxes shall have lamicoid labels as outlined in Section 26 05 00 "Equipment Identification".

**DIVISION 26 – ELECTRICAL**

**SECTION 26 05 28 – GROUNDING**

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**PART 1    GENERAL**

**1.01    Scope of Work**

- .1    Connect to existing system.
- .2    Ground all equipment in accordance with the Canadian Electrical Code.
- .3    Ensure any distribution and control transformer neutrals are grounded as required. Artificial neutrals and/or surge suppressors shall be grounded per manufacturer's instructions.
- .4    Ensure all metal enclosures for electrical equipment, are bonded to ground.

**PART 2    PRODUCTS**

**2.01    Ground Conductor - Electrode and Interconnections**

- .1    Provide #6 AWG bare stranded copper ground conductor.

**2.02    Ground Connections**

- .1    Use approved mechanical connector, conductor to equipment.

**2.03    Ground Conductor - Conduit and Ducts**

- .1    Provide appropriately sized stranded copper ground conductor in all non-metallic and flexible conduits and ducts.

**PART 3    EXECUTION**

**3.01    Connections**

- .1    Use Penetrox "E" joint compound on all connections.
- .2    Make connections with Burndy Hyground compression fittings.
- .3    Ground all non-current carrying metal parts of electrical equipment.

**3.02    Branch Circuit Grounding Conductor**

- .1    Circuits that are installed in conduit located in or below the main floor slab, or in direct buried conduit, shall have a ground conductor installed.
- .2    Where metallic conduit system is used as a grounding conductor, it shall have bonding jumpers where required and shall be continuously conductive.

**DIVISION 26 – ELECTRICAL**

**SECTION 26 24 01 – SERVICE AND DISTRIBUTION**

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package. Assumed to be about 65 amps full load with a service factor of 1.15). Note that the input line length is approximately 140 meters and the load line length from the VFD to the motor is approximately 120 meters; VFD supplier to confirm quoted line reactor and load filter is adequate at shop drawing stage.

There is no substitution allowed for the Yaskawa JVOP-180C LCD Operator unless it is no longer available. If substitution is needed, approval will be required from the project Engineer.

- .3 Requirements include:
  - a) Microprocessor based inverter logic, isolated from all power circuits.
  - b) Pulse Width Modulated (PWM) power electronic system.
  - c) Adjustable carrier frequency, including a low noise, low carrier frequency function.
  - d) Modbus RTU via RS485, or Modbus TCP/IP communications port. A door mounted programming/ monitoring port for a laptop to be connected.
  - e) Ethernet/IP Communication Card.
  - f) 4-20mA analog input, programmable for speed reference or PID Feedback
  - g) 0-10V or 4-20mA analog output, programmable for output frequency or current
  - h) 120VAC rated digital outputs, for running and fault status
  - i) Independent digital inputs for run control, external fault, external reset, and control selection
  - j) Control power loss ride through, capable of 2 seconds
  - k) Fault history, with the last 10 fault indications and time stamp
  - l) The following minimum protective functions:
    - Overheat
    - Motor overload (electronic overload)
    - VFD overload
    - Short circuit
    - Overvoltage
    - Undervoltage
    - Input phase loss
    - Output phase loss
    - Output ground fault
    - Overcurrent
- .2 Keypad/Operator Interface that provides plain language readouts of:
  - Output frequency
  - Output Voltage
  - Output current
  - Output power
  - I/O status
  - Heatsink temperature
  - Fault Conditions
  - Total running hours, resettable after pump maintenance if required.
- .3 The following equipment, in addition to the VFD, is to be included in the VFD panel:
  - Breaker
  - Line reactor (Confirm adequate for 140 meter long input line).
  - dV/dT output filter (Confirm adequate for 120 meter load line).

- 250VA control transformer (larger if required for internal equipment such as the cooling fans)
  - Cooling fans
  - Selector switches, pushbutton, push-to-test indicating lights, relays, terminals and fused terminals, and wireway as indicated on drawings
  - Contactors and controls to allow for bypass capabilities.
  - A Prosense digital panel meter to display the well level in meters. The meter shall be a DPM3-AT-A2R-H, which is a DFO standard, and no substitutes will be considered. The meter shall be programmed for a 4 – 20mA input signal and the readout will be the range of 0 – 19 meters. A nameplate shall be provided for “Well #5 Water Level in Meters”.
- .4 The VFD panel is a control panel, and the certification requirements listed in section 26 05 00 2.3 are applicable.
- .5 The Contractor is to coordinate and include the services of the VFD supplier and integrator in their tender. Services include on site commissioning by an approved manufacturer’s representative. Commissioning includes field start up services to program the VFD, and train Hatchery staff on VFD operation and general trouble shooting.

**2.03 Secondary Duct**

- .1 See section 26 05 20.

**2.04 Backfill Materials**

- .1 Install direct buried ducts per Canadian Electrical Code 12-012 and “bed” the ducts per 12-012 (4).
- .2 Trench backfill materials shall consist of granular material, which is free from stones larger than 150 mm, and relatively free from organic material. It shall contain no frozen soil, roots, or other objectionable material in quantities that might cause damage, excessive settlement or inadequate compaction.
- .3 Where native material is unacceptable for backfill purposes, the Engineer will direct the Contractor to dispose of the unsuitable material in designated on-site disposal areas, and to provide imported granular backfill. This imported backfill shall be an acceptable pitrun material free from stones larger than 150 mm organic, stumps, logs, peat, clay, silt and any material which cannot be compacted.
- .4 All duct, conduit and cable shall have a minimum of 75 mm of screened sand above and below.

**PART 3 EXECUTION****3.01 Feeder Routing**

- .1 The contractor shall route the feeder as noted on the drawings.
- .2 In the Hatchery Building, the area near the panel is unfinished ceilings and the portion near where the cable leaves the building is tee-bar ceiling; route the cable



as necessary in the Hatchery.

- .3 Provide a junction box on the outside of the Hatchery to adapt from teck cable to wire in conduit.
- .4 Provide 1 spare empty conduit with a pull string for future use between the Hatchery Building and Pump House No. 2, as shown on the drawings.
- .5 Provide a junction box on the outside of Pump House No. 2 to terminate the ducts and allow an access point into the building.
- .6 Provide spare empty conduits with pull strings for future use between Pump House No. 2 and the Well Pump junction box and then towards the future well, as shown on the drawings.

**3.02 VFD Mounting**

- .1 The VFD shall be mounted in Pump House No. 2 in a room where there was previously located a diesel genset. The concrete base for the genset may still be in place however, the base will be removed by others to ensure 1 meter of clear working space in front of the VFD. (Removal of the concrete base is not part of this contract).
- .2 Consider leaving adequate space on the wall for a future VFD of similar size for the future well located adjacent Well No. 5.

**3.03 Junction Box at the Wellhead**

- .1 Provide a junction box at the wellhead on a custom-made support structure complete with terminals in it to adapt from the pump cables supplied with the pump to the field wiring.
- .2 Ensure adequate space in the junction box for an equal number of terminals for the connection of a future well.
- .3 Enter the spare conduits for the future well into the junction box and tie-off the pull strings.

**3.04 Earthquake Restraint**

- .1 Provide earthquake restraint support bracing and anchor bolt fastening to prevent horizontal movement or tipping of any freestanding equipment.

**DIVISION 26 – ELECTRICAL**

**SECTION 26 70 00 – CONTROLS AND INSTRUMENTATION**

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**PART 1 GENERAL**

**1.01 Scope of Work**

- .1 The Contractor shall supply and install the following equipment and systems:
  - a) Level Transmitters & Accessories

**1.02 General Requirements**

- .1 All devices shall be designed for continuous operation. Field located devices shall be suitable for continuous operation in a wet atmosphere.
- .2 Provide, except where otherwise specified, the materials of construction necessary for satisfactory operation on the service specified. Any changes from specified materials must be approved by the Engineer in writing.
- .3 All instruments shall be factory calibrated to values stated in the documents, or as determined from process requirements.
- .4 All instruments and devices on panel fronts and all devices in the panel rear shall be identified by a lamicoïd legend plate or nameplate.
- .5 All process equipment packages which include control devices must provide interconnection and termination systems between all devices and equipments of the vendor's supply. This shall include, but not be limited to interconnecting tubing, piping and fittings, terminal strips for field connections, bulkhead plates for cable and piping terminations, local controls, block or isolation valves and all other control accessories as would normally be required on such an installation. Such installations must comply with applicable codes of good practice to ensure sound, reliable operation when installed. The supplier shall provide detailed installation instructions to the Contractor. This shall include wiring and mechanical drawings showing equipment installation in pipe.
- .6 The Contractor shall provide complete sets of internal and external wiring diagrams, trouble-shooting data and calibration manuals for each device supplied.
- .7 All instruments requiring AC power supply shall be for 120 Volts, 1 phase, 60 Hertz.
- .8 The well level sensor is 24vdc and will be powered from a supply provided by DFO from the Control Panel.

**1.03 Co-ordination with Mechanical Trade**

- .1 Level sensors and similar devices will be installed in the well by the mechanical trade and wired by electrical trade.

**1.04 Standards**

- .1 Equipment shall be CSA approved where standards have been established by that agency.

**PART 2 PRODUCTS**

**2.01 Well Level Sensor**

- .1 Provide submersible level transmitter at the well for potable water service, to the following specification:
  - a) 316L stainless steel construction.
  - b) 0.25% Full Scale accuracy.
  - c) Polyethylene, general purpose cable moulded to transmitter body (no splices).
  - d) Sealed gauge for field submergence to 25 m (80 ft), and rated for 2x overpressure.
  - e) Temperature range: -10 to +60°C.
  - f) Supply voltage 10-30 VDC.
  - g) 4-20 mA output for 0-25 m measurement range.
  - h) Cable length to suit installation - minimum length 30 m.
  - i) Cable hanger.
  - j) Surge and lightning protection built in per Keller or provide separately at upper end of cable.
  - k) Desiccant canister complete with desiccant for vent tube, install in JB.
  - l) Diameter: 16 mm.
- .2 Provide Keller Microlevel submersible level transmitter to the above specification or approved equal.

**PART 3 Execution**

**3.01 Well Level**

- .1 Level transmitters shall be wired through the new above ground junction box located beside the well head. Then routed into the VFD and level readout, with wiring continuing to the DFO Remote I/O panel.
- .2 Final connection in existing Control Panel to be performed by DFO Site Staff. Contractor shall ensure the wiring reaches the panel with 1m spare length.

## **Division 31 – Earthworks**

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**PART 1 - GENERAL**

- 1.1 General** .1 Permits: All permits to be obtained and paid by the Contractor.

**PART 2 - PRODUCTS**

- 2.1 Materials** .1 Topsoil: Materials shall be stripped down to full depth where it contacts non-organic soil, from the building, road and parking areas as shown on the Site Plan.

**PART 3 - EXECUTION**

- 3.1 Preparation** .1 Clearing:
- .1 Remove all shrubs, brush, other vegetation, debris and other items that would interfere with construction operations, unless otherwise indicated on the drawings. Roots shall be grubbed out to at least 600 mm below existing surfaces. Cleared items shall be removed from the site or otherwise disposed of by the Contractor. Refer to the site Plan for boundaries and extent of areas to be cleared.
  - .2 Note: Do not remove any trees without Departmental Representative's consent.
- .2 Rough Grading: Cut and machine grade the site area.
- .3 Finish Grading: Uniformly smooth grade all areas covered by the project, including excavated and filled sections and adjacent transition areas. The finished surface shall be compacted and free from irregular surface changes. The finish surface shall be at the established grade and shall be graded to drain water away from the building.
- 3.2 Protection** .1 Benchmarks: Provide for preservation of existing benchmarks and establishing new benchmarks. The Contractor should advise the authority concerned of any action that would affect the location of elevations of any geodetic monuments so that proper steps may be taken to protect or move them correctly.
- .2 Protection of Trees:
- .1 The Departmental Representative and Contractor shall meet at the site to review layout of the work on the site prior to any actual clearing work.

- .2 Protect all trees that are marked for preservation as shown on the drawings and on the site in a manner approved by the Departmental Representative.
- .3 Protect all branches, trunks and all roots of trees which are to be left undisturbed. Trees which are to be retained should be positively protected by means of fences or boxing.
3. Site Drainage: Provide for site drainage during the entire period of construction in an approved manner to avoid flooding elsewhere, and to avoid creating a nuisance to adjacent areas. Keep all excavations free from water during the entire progress of the work. Upon completion of project, reinstate the site.
4. Access Roads: Must be maintained to prevent the accumulation of mud on the roads.

\*\*\*\*END of SECTION\*\*\*\*



**PART 1 - GENERAL**

- |            |   |    |  |                    |
|------------|---|----|--|--------------------|
| <b>1.1</b> | <b>General</b>                          | .1 | Not used.  |                    |
| <b>1.2</b> | <b>Description</b>                      | .1 | This section specifies general requirements for supplying and processing of aggregates to be stockpiled or incorporated into work. Specific requirements for physical properties of aggregate properties are given in the related work sections.   |                    |
| <b>1.3</b> | <b>Related Work Specified Elsewhere</b> | .1 | Watermains   | Section 33 11 01   |
|            |   | .2 | Granular Base  | Section 32 11 23   |
|            |   | .3 | Granular Subbase   | Section 32 11 16.1 |
|            |   | .4 | Excavation, Trenching and Backfilling  | Section 31 23 01   |
| <b>1.4</b> | <b>Source Approval</b>                  | .1 | Source of materials to be incorporated into work or stockpiled requires approval.  |                    |
|            |   | .2 | Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least two (2) weeks prior to commencing production.   |                    |
|            |   | .3 | If, in opinion of Departmental Representative, materials from the proposed source do not meet, or cannot reasonably be processed to meet specified requirements, procure an alternative source or demonstrate that material from source in question can be processed to meet specified requirements. |                    |
|            |   | .4 | Should a change of material source be proposed during work, advise Departmental Representative two (2) weeks in advance of proposed change to allow sampling and testing.  |                    |
|            |   | .5 | Acceptance of a material at source does not preclude future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unsatisfactory.  |                    |
| <b>1.5</b> | <b>Production Sampling</b>              | .1 | Aggregate will be subject to continual sampling during production.   |                    |
|            |   | .2 | Provide Departmental Representative with ready access to source and processed material for purpose of sampling and testing.  |                    |

- .3 Bear the cost of sampling and testing of aggregates which fail to meet specified requirements.

## **PART 2 - PRODUCTS**

### **2.1 Materials**

- .1 Aggregate Quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material or other deleterious substances.
- .2 Flat and elongated particles are those whose greatest dimension exceeds five times their least dimension.
- .3 Fine aggregates satisfying requirements of applicable section shall be one, or a blend of following:
  - .1 Natural sand.
  - .2 Manufactured sand.
  - .3 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
  - .4 Coarse aggregates satisfying requirements of applicable section shall be one of following:
    - .1 Crushed rock or gravel.
    - .2 Gravel composed of naturally formed particles of stone.

## **PART 3 - EXECUTION**

### **3.1 Development of Aggregate Source**

- .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as approved by authority having jurisdiction.
- .2 Where clearing is required, leave a screen of trees between area and roadways as directed.
- .3 Clear, grub and strip an area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
- .4 When operating in stratified deposits, use excavation equipment and methods that will produce a uniform, homogeneous aggregate.

- 
- .5 When excavation is completed, dress sides of excavation to a nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.
  - .6 Trim off and dress slopes of waste material piles and leave site in a neat condition.
- 3.2 Processing**
- .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
  - .2 Blend aggregates if required to obtain gradation requirements specified. Use approved methods and equipment.
  - .3 Blending to increase percentage of crushed particles or decrease percentage of flat and elongated particles is permitted.
  - .4 Wash aggregates, if required to meet specifications. Use only equipment approved by Departmental Representative.
- 3.3 Handling**
- .1 Handle and transport aggregates to avoid segregation, contamination and degradation.
- 3.4 Stockpiling**
- .1 Stockpile aggregates on site in locations indicated or designated. Do not stockpile on completed pavement surfaces where damage to pavement may result.
  - .2 Stockpile aggregates in sufficient quantities to meet project schedules.
  - .3 Prevent intermixing of different materials.
  - .4 Reject intermixed or contaminated materials. Remove and dispose of rejected materials.
  - .5 Coning of piles or spilling of material over edges of pile will not be permitted.
  - .6 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.
- 3.5 Stockpile Clean-up**
- .1 Leave stockpile site in a tidy, well drained condition, free of standing surface water.
  - .2 Leave any unused aggregates in neat compact stockpiles as directed.

\*\*\*\* END OF SECTION \*\*\*\*

- 
- 1.0 GENERAL**
- .1 Section 31 11 41 refers to those portions of the work that are unique to the preservation of existing shrubs and trees. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
  - .2 This section is based on the "British Columbia Landscape Standard" published by the B. C. Society of Landscape Architects and the B. C. Nursery Trades Association. This standard is intended to set a level of quality which is to be equalled or bettered in the construction documents for each project. Guidance of a registered British Columbia Landscape Architect is recommended.
  - .3 The International Society of Arboriculture publication, Guidelines for Establishing Values of Trees and other Products shall apply where plant material values are required to be established.
- 1.1 Related Work**
- .1 Excavating, Trenching and Backfilling Section 31 23 01
  - .2 Roadway Excavation, Embankment and Compaction Section 31 24 13
- 1.2 References**
- .1 British Columbia Landscape Standard
  - .2 Canadian System of Soil Classification
  - .3 International Society of Arboriculture. Guide for Establishing Values of Trees and Other Plants, 1983.
- 2.0 PRODUCTS**
- 2.1 Materials**
- . 1 Native material: To Section 31 05 17 - Aggregates: General.
  - .2 Pit run gravel: To Section 31 05 17 - Aggregates: General.
  - .3 Pit run sand: To Section 31 05 17 - Aggregates: General.
  - .4 Drain Rock: To Section 31 05 17 - Aggregates: General.
  - .5 Drainpipe: 100 mm diameter corrugated plastic perforated tubing complete with snap couplings to CGSB 41-GP-31M or perforated PVC sewer pipe to CSA B182.1.
  - .6 Asphalted felt: to CSA A123.

- .7 Fertilizer: complete commercial fertilizer (10-6-4 or approved type) with 50% of elements derived from organic sources.
- .8 Wound dressing: horticulturally accepted non- toxic, non-hardening emulsion.

### **3.0 EXECUTION**

#### **3.1 Existing Trees**

- .1 Inspect with Departmental Representative and clearly identify on site all existing shrubs and trees shown on Contract Drawings or designated by Departmental Representative to be preserved. Establish barricades or suitable markings around such shrubs and trees.
- .2 Do not undertake construction procedures, stockpiling of materials or disposal adjacent to designated trees or areas to be preserved.
- .3 Do not undertake construction procedures which substantially alter natural drainage patterns. Provide interim drainage or irrigation as necessary to compensate for construction interference.
- .4 Where specified or shown on Contract Drawings apply fertilizer at rate of 50 g/mm of calliper to existing trees to be retained. Take calliper measurement 0.3 m above grade. Apply once early in growing season unless specified otherwise.
- .5 Distribute fertilizer equally into holes drilled 200-250 mm deep, spaced 600-750 mm apart and located in circular pattern between 2/3 and limit of each tree's branch spread. Water thoroughly after fertilizer applied.
- .6 Water retained trees 3 times during summer. Soak area immediately below tree crown sufficiently deep to reach feeder roots.

#### **3.2 Raising Grade Around**

- .1 Apply fertilizer as specified in 3.1.4 and 3.1.5, of this Section, before revising grade.
- .2 Install drainpipe on existing grade consisting of 8 spokes radiating out from trunk to limit of branch spread. Slope slightly away from trunk and connect ends to form shape of wheel.

Place uprights at both ends of each spoke to reach new grade level to provide aeration and means of watering.

- .3 Obtain Departmental Representative's approval before backfilling drainpipe.
- .4 Protect bark of buried portion of tree from abrasion by surrounding trunk with asphalted felt. Leave minimum 50 mm space between protective material and bark. Fill space with 9.5 mm drain rock.
- .5 Use drain rock fill to cover 150 mm over and around each side of drainpipe. Use pit run sand fill for remainder of drainage course between radial spokes to minimum depth of 150 mm. Use approved native material or pit run gravel fill to raise grade to required level. Fill vertical drains with 9.5 mm drain rock.
- .6 Compact fill without disturbing or damaging buried drainpipe. Use frost-free materials over frost-free ground conditions. Compact fill to 80% Modified Proctor density in compliance with ASTM D1557.

### **3.3 Lowering Grade Around Existing Trees**

- .1 Cut specified slope from edge of branch spread to new grade level. Grade topsoil berm for each tree at periphery of branch spread to hold water where required.
- .2 If excavation through roots is required, excavate by hand and cut roots with sharp axe, tree lopper or saw. Seal cut edges 10 mm in diameter and larger with wound dressing.
- .3 Apply fertilizer after excavation backfilled and grading completed. Do not permit root system to dry out at any time.

### **3.4 Pruning**

- .1 Selectively remove 1/3 of tree branches to reduce transpiration and compensate for dieback of roots in fill conditions and damage to root system in cut conditions.

### **3.5 Clean Up**

- .1 After construction and prior to final inspection remove all fencing and flagging. Remove any dead branches or dying limbs on trees at the direction of the Departmental Representative.
- .2 Replace any trees the Departmental Representative assesses as irreparably damaged as determined by an Arborist and

according to the requirements of the International Society of Arboriculture Guide for Establishing Value of Trees or Other Plants, 1983.

\*\*\*\*END OF SECTION\*\*\*\*

- 
- 1.0 GENERAL**
- .1 Section 31 15 60 refers to those portions of the work that are unique to the supply and application of materials for dust control. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- 1.1 Related Work**
- .1 Environmental Protection Section 01 57 01
- .2 Excavating, Trenching and Backfilling Section 31 23 01
- .3 Roadway Excavation, Embankment and Compaction Section 31 24 13
- .4 Reshaping Granular Roadbed Section 31 22 16
- .5 Granular Base Section 32 11 23
- .6 Granular Subbase Section 32 11 16.1
- .7 Reshaping Existing Subgrade Section 31 22 16
- 1.2 Samples**
- .1 Samples may be required.
- 1.3 Delivery, Storage and Handling**
- .1 Deliver calcium chloride to site in substantial and moisture-proof bags indicating name of manufacturer, name of product, net weight or mass, and percentage of calcium chloride guaranteed by manufacturer.
- .2 Store bags of calcium chloride in weather- proof enclosures.
- 2.0 PRODUCTS**
- 2.1 Materials**
- .1 Calcium chloride: to CGSB 15.1. Type 1-Regular (77%) or as liquid at 35% solution concentration.
- .2 Magnesium chloride as 29 to 35% solution concentration.
- .3 Water: to Departmental Representative's approval.



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- .4 Aqueous magnesium chloride or calcium chloride may be used provided application is not in an environmentally harmful manner.
  - .5 Lignosulphonates may be used subject to conditions specified in 3.2 of this Section.
  - .6 Used oil or "cut back" bitumen products not permitted.
- 3.0 EXECUTION**
- 3.1 Application**
- .1 Control dust at all times for duration of Contract.
  - .2 Apply aqueous solutions with distributors equipped with spray system that will ensure uniform application and with means of shut-off.
  - .3 Apply aqueous solutions at following rates:
    - .1 Calcium chloride (25%) at 2.4 L/m<sup>2</sup> on roads not previously treated and 3.0 l/m<sup>2</sup> for road stabilization.
    - .2 Calcium chloride (35%) or magnesium chloride (30%) at 1.6 L/m<sup>2</sup> on roads not previously treated and 2.0 L/m<sup>2</sup> for road stabilization.
  - .4 Apply flake calcium chloride at rate of 1.00 kg/m<sup>2</sup>.
- 3.2 Environmental Restrictions**
- .1 No application on slopes where precipitation may cause chemical to drain into watercourses.
  - .2 No application within 10 m minimum on either side of watercourses.
  - .3 No application of lignosulphonates in residential areas when air temperature exceeds 26°C.
  - .4 No application of lignosulphonates when rain is imminent as minimum drying time of six hours is required.

\*\*\*\* END OF SECTION \*\*\*\*

<b>1.1 GENERAL</b>	.1	Section 31 22 16.1 refers to those portions of the work that are unique to reshaping and compacting existing subgrade. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.	
<b>1.2 Related Work</b>			
	.1	Roadway Excavation, Embankment and Compaction	31 24 13
	.2	Aggregates: General	31 05 17
	.3	Dust Control	31 15 60
<b>1.3 Samples</b>	.1	Samples may be required.	
<b>1.4 Inspection and Testing</b>	.1	As required by the Departmental Representative and Specifications.	
<b>2.0 PRODUCTS</b>			
<b>2.1 Materials</b>	.1	Additional embankment material (subgrade fill) to be in accordance with Section 31 24 13.- Roadway Excavation, Embankment and Compaction and Section 31 05 17 – Aggregates: Generals.	
<b>3.1 EXECUTION</b>			
<b>3.2 Scarifying and Shaping</b>	.1	Scarify subgrade in accordance with width and depth shown on Contract Drawings.	
	.2	Pulverize and break down scarified material to 50 mm maximum soil clod size. Stones larger than 75 mm to be removed.	
	.3	Blade and trim pulverized material to elevation and cross-section dimensions shown on Contract Drawings.	
	.4	Where deficiency of material exists, add and blend in specified new material.	
	.5	Dispose excess material off-site.	
<b>3.2 Compaction</b>	.1	Compaction equipment to be capable of obtaining required densities in materials on project. Where existing subgrade constructed of imported material, compact to density not less than as specified by contract drawings, in compliance with ASTM D1557. Departmental Representative may	

- accept satisfactory proof rolling as evidence of acceptable compaction of existing native subgrade.
- .2 Shape and roll alternately to obtain smooth, even and uniformly compacted subgrade surface.
- .3 Apply water as necessary during compaction to obtain specified density. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is suitable for compaction.
- .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers.
- 3.3 Repair of Soft Areas**
  - .1 Correct soft areas by removing unsuitable material to depth and extent as directed by Departmental Representative. Replace with specified material and compact to specified density.
- 3.4 Finished Tolerances**
  - .1 Reshape compacted surface to within plus or minus 15 mm of specified grade and cross-section but not uniformly high or low.
  - .2 Ensure finished subgrade has no irregularities exceeding 15 mm when checked with a 3 m straight edge placed in any direction.
  - .3 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- 3.5 Maintenance**
  - .1 Maintain reshaped surface in condition conforming to this Section until succeeding material is applied or until reshaped subgrade is accepted by Departmental Representative.

\*\*\*\* END OF SECTION \*\*\*\*

**PART 1 - GENERAL**

- 1.1 **General** .1 Not used.
- 1.2 **Related Work Specified elsewhere**
  - .1 Watermains Section 33 11 01
  - .2 Hot mix asphalt concrete paving Section 32 12 16
- 1.3 **Definitions**
  - .1 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense tills, hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy construction equipment.
  - .2 Over-excavation: excavation below design elevation of bottom of specified bedding, and including backfilling of resultant excavation with specified material, as authorized by the Departmental Representative.
  - .3 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- 1.4 **Protection of Existing Features**
  - .1 Existing Utility Services
    - .1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
    - .2 Prior to commencing any excavation work, notify applicable owner or authorities, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work.
    - .3 Confirm locations of buried utilities by careful test excavations and/or radio detection equipment.
    - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of Departmental Representative before moving or otherwise disturbing utilities or structures.
    - .5 Record location of maintained, re-routed and abandoned underground lines.
    - .6 Any damage to existing utility services caused by the Contractor shall be rectified by the Contractor at his or her own cost.

.2 Existing Building and Surface Features:

- .1 The Contractor and Departmental Representative shall perform a condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.
- .2 Protect existing buildings and surface features which may be affected by work from damage while work is in progress and repair damage resulting from work.
- .3 Where excavation necessitates root or branch cutting, do so only with written approval of the Departmental Representative.

**1.5 Shoring, Bracing  
and Underpinning**

- .1 Comply with Section 01 35 29.06 – Health and Safety Requirements and applicable local regulations and to protect existing features.
- .2 Engage services of qualified professional Departmental Representative who is registered in province or territory in which work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for work.
- .3 At least 2 weeks prior to commencing work, submit design and supporting data.
- .4 Design and supporting data submitted to bear the stamp and signature of qualified professional Departmental Representative registered in the Province of British Columbia.
- .5 Professional Engineer responsible for design of temporary structures to submit proof of insurance coverage for professional liability except where Engineer is employee of contractor, in which case contractor shall submit proof that work by professional engineer is included in contractor's insurance coverage.

**1.6 Submission of Imported Material Specifications**

- .1 At least one week prior to commencing work, inform the Departmental Representative of proposed source of fill materials, proposed use/location within the contract and provide associated specifications/grading curves for review by the Departmental Representative.

**PART 2 - PRODUCTS**

**2.1 Materials**

**.1 Approved Trench/Native Material:**

.1 Approved trench/native material is selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials

**.2 Bedding Material:**

- .1 Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 Gradations to be within limits specified when tested to ASTM C136-84a and ASTM C117-84. Sieve sizes to CAN/CGSB-8.1-87 rather than ASTM E11-81.

Sieve Designation		% Passing		
25 mm	[100]	-	-	-
19 mm	[75-100]	-	-	-
12.5 mm	-	-	-	-
9.5 mm	[50-100]	-	-	-
4.75 mm	[30-70]	-	-	-
2.00 mm	[20-45]	-	-	-
0.425 mm	[10-25]	-	-	-
0.180 mm	-	-	-	-
0.075 mm	[3-8]	-	-	-

**.3 Imported Granular Fill:**

- .1 Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 Gradations to be within limits specified when tested to ASTM C136-84a and ASTM C117-84. Sieve sizes to CAN/CGSB-8.1-87 rather than ASTM E11-81.

Sieve Designation				
200 mm	-	-	-	-
75 mm	[100]	-	-	-
50 mm	-	-	-	-

37.5 mm	-	-	-	-
25 mm	[45-100]-	-	-	-
19 mm	-	-	-	-
12.5 mm	-	-	-	-
9.5 mm	-	-	-	-
4.75 mm	[25-70]	-	-	-
2.00 mm	-	-	-	-
0.425 mm	[5-25]	-	-	-
0.180 mm	-	-	-	-
0.075 mm	[0-10]	-	-	-

**PART 3 - EXECUTION**

- 3.1 Site Preparation**
- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
  - .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.
- 3.2 Stripping of Topsoil**
- .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
  - .2 Commence topsoil stripping of areas as directed by the Departmental Representative after area has been cleared of brush, weeds, and grasses and removed from site.
  - .3 Strip topsoil to depths as directed by the Departmental Representative. Avoid mixing topsoil with subsoil.
  - .4 Stockpile in locations as directed by the Departmental Representative. Stockpile height not to exceed 2 m.
  - .5 Dispose of unused topsoil as directed by the Departmental Representative.
- 3.3 Stockpiling**
- .1 Stockpile fill materials in areas designated by the Departmental Representative. Stockpile granular materials in manner to prevent segregation.
  - .2 Protect fill materials from contamination.
- 3.4 Cofferdams, Shoring, Bracing and Underpinning**
- .1 Construct temporary works to depths, heights and locations as indicated or approved by .
  - .2 During backfill operation:

- .1 Unless otherwise indicated or directed by the Departmental Representative, remove sheeting and shoring from excavations.
  - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
  - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at an elevation at least 300 mm above toe of sheeting.
  - .3 When sheeting is required to remain in place, cut off tops at elevations indicated or directed by the Departmental Representative.
  - .4 Upon completion of substructure construction:
    - .1 Remove cofferdams, shoring and bracing.
    - .2 Remove excess materials from site and restore water courses to conditions indicated or as directed by the Departmental Representative.
- 3.5 Excavation**
- .1 Excavate to lines, grades, elevations and dimensions as directed by the Departmental Representative.
  - .2 Remove concrete, masonry, paving, walks, demolished foundations and rubble, and other obstructions encountered during excavation.
  - .3 Excavation must not interfere with normal 45° splay of bearing from bottom of any footing.
  - .4 Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw. Seal cuts with approved tree wound dressing.
  - .5 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
  - .6 Dispose of surplus and unsuitable excavated material off site.
  - .7 Do not obstruct flow of surface drainage or natural watercourses.
  - .8 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.



- .9 Notify Departmental Representative when soil at bottom of excavation appears unsuitable and proceed as directed by Departmental Representative.
- .10 Obtain Departmental Representative approval of completed excavation.
- .11 Remove unsuitable material from trench bottom to extent and depth directed by Departmental Representative.
- .12 Where required due to unauthorized over- excavation, correct as follows:
  - .1 Fill under bearing surfaces and footings with concrete specified for footings.
  - .2 Fill under other areas with Imported fill compacted to at least 95% maximum density.
  - .3 Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.

### **3.6 Backfilling**

- .1 Do not proceed with trench backfilling operations until Departmental Representative has inspected installations.
- .2 Do not place backfill in freezing weather without written permission of Departmental Representative.
- .3 Backfilling around pipe and installation:
  - .1 Place bedding and surround material as specified by contract drawings and manufacturers instruction.
  - .2 Place layers simultaneously on sides of installed work to equalize loading.
  - .3 Do not backfill around or over cast-in-place concrete within 24 hours after placing.
- .4 Place backfill material in uniform layers not exceeding 300 mm in thickness up to restoration zone in traveled areas or top of trench in untraveled areas. Compact each layer before placing succeeding layer.
- .5 Compact backfill materials to the following Modified Proctor densities in accordance with ASTM D1557
  - .1 In untraveled areas, to a density at least equal to density of adjacent undisturbed soil.
  - .2 Where any part of the neat trench width is under a traveled area, to a minimum of 95% of maximum

laboratory density obtained using ASTM Method D698-70, Method D.

- .3 Use caution in the pipe bedding zone to avoid damage to the pipeline. Compaction of bedding material to be in accordance with manufacturer's instructions.

### **3.8 Inspection and Testing**

- .1 Testing of materials and compaction will be carried out by a independent testing laboratory, at the cost of the Contractor.
- .2 Perform nuclear densitometer test minimum every 150m length of installed pipe or conduit within road or travelled areas.
- .3 Contractor to pay all costs of testing and re-testing if compaction is below standard.

### **3.9 Restoration**

In untraveled areas:

- .1 Reinststate subbase in accordance with 32 11 16.1 Granular Subbase specification.
- .2 Reinststate base in accordance with 32 11 23 Granular Base specification.
- .3 Reinststate pavement to match existing or as otherwise stated on the contract drawings.

In gravel surfaced traveled areas:

- .1 Reinststate sub-base course with approved excavated material similar to the original road surface, or use imported pit-run gravel, as directed by Departmental Representative.
- .2 Gravel or approved material to be 75 mm minus, uniformly graded gravel.
- .3 Gravel sub-base to be 200 mm deep.
- .4 Provide a 100 mm minimum course of 20 mm minus, crushed, base material on the surface.

END OF SECTION

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- 1.0 GENERAL** .1 Section 31 23 17 - refers to those portions of the work that require rock removal. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- 1.1 Related Work** .1 Excavating, Trenching and Backfilling Section 31 23 01
- .3 Roadway Excavation, Embankment and Section 31 24 13  
Compaction
- 1.2 References** .1 Not used
- 1.3 Definitions** .1 Rock is defined as all solid rock in form of bedrock, masses, ledges, seams or layers and includes igneous rock of any sort, conglomerate, sandstone or shale, that requires breaking by continuous drilling and blasting before excavation and removal. Rock also includes rocks having individual volumes in excess of 1.0 m<sup>3</sup>, removed by blasting or other means.
- .2 Trench rock removal is defined as rock to be removed during excavation of utility trenches generally as shown on Contract Drawings.
- .3 Mass rock removal is defined as rock to be removed during roadway excavation, site grading, or other excavation work, generally, but not necessarily, in larger quantities, and not within the more confining limits of excavation specified for trench excavation.
- .4 Dense tills, hardpan, partially cemented materials, clay or frozen materials which do not require breaking by continuous drilling and blasting before excavation and removal are not classified as rock.
- 1.4 Qualifications** .1 Retain licensed explosives blaster holding valid Blasters Certificate to supervise and program blasting work, and to determine precautions, preparation and operations techniques.
- 1.5 Blasting Operation** .1 Submit to Departmental Representative for approval, written proposal  
**Proposal** of operations for removal of rock by blasting.

- 
- |            |                                       |    |   |
|------------|---------------------------------------|----|---|
|            |                                       | .2 | Indicate proposed method of carrying out work. Include details on protective measures, time of blasting and other pertinent details.  |
|            |                                       | .3 | No blasting to proceed without written approval of Departmental Representative.   |
| <b>1.8</b> | <b>Seismic Survey and Monitoring</b>  | .1 | Departmental Representative will arrange for assessment of adjacent buildings and structures to determine existing conditions and will provide building and structure owners with proposed blasting procedures and copies of assessment reports and seismic recording operations. |
|            |                                       | .2 | Cost of seismic survey and monitoring reports will be paid by Owner.  |
| <b>2.0</b> | <b>PRODUCTS</b>                       |    | NOT USED  |
| <b>3.0</b> | <b>EXECUTION</b>                      |    |   |
| <b>3.1</b> | <b>Blasting and Vibration Control</b> | .1 | Complete all blasting before any structural elements are installed within 15 m from blast holes.  |
|            |                                       | .2 | Minimize ground vibrations which may damage structures or shatter or damage rock mass to remain.  |
|            |                                       | .3 | Blasting not permitted within distance of 30 m of concrete or grout less than 24 hours after pouring.   |
|            |                                       | .4 | Maintain complete and accurate record of all drilling and blasting operations.<br><br>Submit records to Departmental Representative at end of each shift.   |
| <b>3.2</b> | <b>Rock Removal</b>                   | .1 | Strip rock of all earth.  |
|            |                                       | .2 | Notify Departmental Representative within reasonable time to enable Departmental Representative to obtain necessary measurements.   |
|            |                                       | .3 | Do blasting operations in accordance with municipal bylaws.   |

- .4 Remove rock to alignments, profiles, and cross sections as shown on Contract Drawings.
- .5 Locations where explosive blasting is no permitted, if applicable, are shown on Contract Drawings.
- .6 Use methods, techniques and procedures for control of all factors affecting operations in order to produce smooth and sound peripheral surfaces of all completed excavations, to minimize overbreak, and to avoid damage to adjacent structures.
- .7 Excavate trenches in accordance with Section 31 23 01 - Excavating, Trenching and Backfilling and to section shown on Contract drawings.
- .8 Excavate rock for concrete walls, columns and footings to horizontal surfaces not exceeding slope shown on Contract Drawings. Scale, pressure wash and broom clean rock surfaces to assist concrete bond.
- .9 Except as specified otherwise or as directed by Departmental Representative employ pre-shearing, cushion blasting or other smooth wall drilling and blasting techniques to achieve final excavation surfaces.
- .10 Remove boulders and fragments which may slide or roll into excavated areas.
- .11 Correct unauthorized rock removal at no extra cost, in accordance with backfilling requirements specified Section 31 23 01 - Excavating, Trenching and Backfilling.

### **3.3 Rock Disposal**

- .1 Dispose of surplus removed rock at an approved location off-site.

\*\*\*\* END OF SECTION \*\*\*\*

- 1.0 GENERAL** .1 Section 31 24 13 refers to those portions of the work that are unique to roadway excavation, embankment construction and compaction. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- 1.1 Related Work**

  - .1 Environmental Protection Section 01 57 01
  - .2 Aggregates: General Section 31 05 17
  - .3 Excavating, Trenching and Backfilling Section 31 23 01
  - .4 Rock Removal Section 31 23 17
- 1.2 References** .1 Not applicable.
- 1.3 Definitions** .1 Excavation classes: only two classes of excavation will be recognized:

  - .1 Rock excavation: To Section 31 23 17 - Rock Removal - 1.3.
  - .2 Common Excavation: To Section 31 23 01 Excavating, Trenching and Backfilling - 1.3.
  - .2 Waste material: material unsuitable for use in work or surplus to requirements.
  - .3 Borrow material: material obtained from areas outside limits of work and required for construction of embankments or for other portions of work.
  - .4 Embankment (subgrade fill): material derived from usable excavation and placed above original ground or stripped surface up to subgrade elevation.
  - .5 Imported embankment fill: approved granular material, supplied by Contractor and obtained from off-site sources, to be used for embankment fill up to subgrade elevation.
  - .6 Pavement structure: combination of layers of unbound or stabilized granular subbase, base, and asphalt or concrete surfacing.

- 
- .7 Subgrade elevation: elevation immediately below pavement structure.
  - 1.4 Protection of Work Property and Public** .1 Comply with General Conditions, Clause 4.3, Protection of Work Property and the Public.
  - 1.5 Blasting** .1 All blasting operations to comply with Section 31 23 17 - Rock Removal.
  - 1.6 Disposal** .1 Refer to Section 31 23 01 - Excavating, Trenching and Backfilling - 1.7 for re- use and off-site disposal requirements.
  - 1.7 Permits and Approvals** .1 Comply with permitting requirements before commencing any work.
  - 2.0 PRODUCTS**
  - 2.1 General** .1 Unless shown otherwise on Standard Detail Drawings or, where applicable, Contract Drawings materials specified in 2.2 of this Section are approved for their respective uses.
  - 2.2 Specified Materials** .1 Backfill for embankment fill (subgrade fill) to be:
    - .1 Approved native or imported granular material.
    - .2 Pit run gravel.
    - .3 Pit run sand.
    - .4 River sand.
  - .2 Pit fines, cyclone sand and overburden may be utilized if approved by the Departmental Representative, but will not be acceptable if moisture content is too high to permit compaction to the specified density.
  - 2.3 Materials** .1 Refer to Section 31 05 17 Aggregates: General for specifications for approved granular materials.
  - 3.0 EXECUTION**
  - 3.1 General** .1 Clear and grub limits of excavation and/or embankment fill.
    - .2 Strip all organic material to specified limits and specified depth or as directed by Departmental Representative. Do not handle

topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected. Remove all debris. Stockpile and place topsoil as specified.

.3 Surface drainage:

.1 Provide suitable temporary ditches or other approved means of handling drainage prior to excavation and during construction to protect construction area and adjacent and other affected properties. Provide siltation controls to protect natural watercourses or existing municipal drainage facilities.

.2 Comply with Section 01 57 01.- Environmental Protection.

**3.2 Excavation**

- .1 Notify Departmental Representative sufficiently in advance of excavation operations for initial cross-sections to be taken.
- .2 Notify Departmental Representative whenever unsuitable materials are encountered in cut sections and remove unsuitable materials to depth and extent as directed by Departmental Representative.
- .3 If, during excavation, material appearing to conform to classification for rock is encountered, notify Departmental Representative in sufficient time to enable measurements to be made to determine volume of rock.
- .4 Rock excavation: Rock excavation to Section 31 23 17. - Rock Removal.

**3.3 Inspection of Native Surface**

- .1 Prior to placing embankment fill, proof roll graded native surface, using fully loaded single or dual axle dump truck. Departmental Representative may authorize use of other acceptable proof rolling equipment. Remove soft or other unstable material. Replace with approved embankment fill and compact replacement fill as per contract drawings in compliance with ASTM D1557. (All following references to density imply compliance with ASTM D1557).

**3.4 Placing**

- .1 Place material only on clean unfrozen surface, properly shaped and compacted and free from snow or ice.



- .2 Begin spreading material on crown line or high side of one-way slope.
- .3 Place materials using methods which do not lead to segregation or degradation.
- .4 Place material to full width in uniform layers and compact to specified densities.
- .5 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .6 Remove and replace that portion of any layer in which material becomes segregated during spreading.
- .7 Where shown on Contract Drawings or as directed by Departmental Representative, scarify or bench existing slopes in side hill or sloping sections to ensure proper bond between new materials and existing surfaces.
- .8 Where fill material consists principally of rock:
  - .1 Place to full width in layers of sufficient depth to contain maximum sized rocks, but in no case is layer thickness to exceed 1 m.
  - .2 Individual rock fragments not exceeding 1.5 m in horizontal dimension permitted provided their vertical dimension does not exceed one third of fill section depth.
  - .3 Carefully distribute rock material to fill voids with smaller fragments to form compact mass.
  - .4 Fill surface voids at subgrade level with rock spalls or selected material to form an earth-tight surface.
  - .5 Do not place boulders and rock fragments with dimensions exceeding 150 mm within 300 mm of subgrade elevation.

### **3.5 Compaction**

- .1 Compaction equipment to be capable of obtaining required densities in materials on project.
- .2 Compact to density as per contract drawings.

- .3 Shape and roll alternately to obtain smooth, even and uniformly compacted layers.
- .4 Apply water as necessary during compaction to obtain specified density. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is suitable for compaction.
- .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers.
- .6 Finish slopes to neat condition, true to line and grade.
  - .1 Remove boulders encountered in cut slopes and fill resulting cavities.
  - .2 Hand finish slopes that cannot be finished satisfactorily by machine.

**3.6 Finished Tolerances**

- .1 Ensure finished subgrade surface within plus or minus 15 mm of specified grade and cross-section but not uniformly high or low.
- .2 Ensure finished subgrade surface has no irregularities exceeding 15 mm when checked with a 3 m straight edge placed in any direction.
- .3 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

**3.7 Proof Rolling**

- .1 For proof rolling use fully loaded single or dual axle dump truck.
- .2 Departmental Representative may authorize use of other acceptable proof rolling equipment.
- .3 Proof roll top of embankment fill upon completion of fine grading and compaction.
- .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .5 Where proof rolling reveals areas of unsuitable subgrade:
  - .1 Remove unsuitable embankment material to depth and extent directed by Departmental Representative.

.2 Replace with approved embankment material and compact in accordance with this section.

**3.8 Place Topsoil**

.1 Place, spread and grade topsoil as shown on Contract Drawings.

.2 Restore planted areas with topsoil, ground cover, and plants or shrubs to match existing planted areas as shown on Contract Drawings.

**3.9 Maintenance**

.1 Maintain finished embankment fill in condition conforming to this section until succeeding material is applied or until granular base is accepted by Departmental Representative.

\*\*\*\* END OF SECTION \*\*\*\*

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# **Division 32 – Roads and Site Improvements**

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**PART 1 - GENERAL**

- 1.1 **General** .1 Not used.
- 1.2 **Description** .1 This section specifies requirements for supplying, producing and placing gravel or quarried stone as a granular sub-base to lines, grades and typical cross-sections indicated on plans or as directed.
- 1.3 **Related Work Specified Elsewhere**
  - .1 Excavation, Trenching and Backfilling Section 31 23 01
  - .2 Granular Base Section 32 11 23

**PART 2 - PRODUCTS**

- 2.1 **Materials** .1 Granular sub-base material to Section 32 11 16.1 and following requirements:
  - .1 Gradation to be within following limits when tested to ASTM C136-76 and ASTM C117-80, (AASHTO T11-78 and T27-78) and having a smooth curve without sharp breaks when plotted on a semi-log grading chart to ASTM E11-70 (1977).

ASTM Sieve Designation	% Passing
75 mm	- 100
25 mm	55 - 100
4.75 mm	25 - 100
2.00 mm	15 - 80
0.425 mm	4 - 50
0.075 mm	0 - 8

- .2 Other properties as follows:
  - .1 Liquid Limit: ASTM D423-66(1972) (AASHTO T89-70) Maximum 25
  - .2 Plasticity Index: ASTM D424-59(1971) (AASHTO T90-70) Maximum 6
  - .3 Los Angeles Abrasion: ASTM C131-76 (AASHTO T96-77) Gradation 'A' Max % Loss by Weight 50

**PART 3 - EXECUTION**

- 3.1 **Inspection of Existing Sub-grade Surface** .1 Do not place granular sub-base until finished sub-grade is inspected and approved.

- 
- 3.2 Placing**
- .1 Place material only on a clean, unfrozen surface, properly shaped and compacted and free from snow or ice.
  - .2 Place granular sub-base materials using methods which do not lead to segregation or degradation.
  - .3 Place material in uniform layers not exceeding 200 mm when compacted or to such other depth as approved.
  - .4 Shape each layer to a smooth contour and compact to specified density before the succeeding layer is placed.
  - .5 Remove and replace portion of a layer in which material has become segregated during spreading.
- 3.3 Compacting**
- .1 Compact to a density of not less than 95% maximum dry density in accordance with ASTM D698.
  - .2 Shape and roll alternately to obtain a smooth, even and uniformly compacted sub-base.
  - .3 Apply water as necessary during compaction to obtain specified density. If sub-base is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.
  - .4 In areas not accessible to rolling equipment compact to specified density with approved mechanical tampers.
- 3.4 Finish Tolerances**
- .1 Finish compacted surface to within + 25 mm of established grade but not uniformly high or low.
  - .2 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.



- 3.5 Proof Rolling**
- .1 For proof rolling, use a fully loaded tandem dump truck.
  - .2 Departmental Representative may authorize use of other acceptable proof rolling equipment.
  - .3 Proof roll at level in sub-base indicated. If alternative proof rolling equipment is authorized, Departmental Representative will determine level of proof rolling.
  - .4 Make passes as directed by Departmental Representative.
  - .5 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.
- 3.6 Maintenance**
- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Departmental Representative.

END OF SECTION

**PART 1 - GENERAL**

- 1.1 **General** .1 Not used.
- 1.2 **Description** .1 This section specifies requirements for supplying, producing and placing crushed gravel or quarried stone as a granular base to lines, grades and typical cross-sections indicated, or as directed.
- 1.3 **Related Work Specified Elsewhere**
  - .1 Aggregates: General Section 31 05 17
  - .2 Granular Sub-Base Section 32 11 16.1

**PART 2 - PRODUCTS**

- 2.1 **Materials** .1 Granular base material to Section 32 11 23 and following requirements:
  - .1 Gradation to be within following limits when tested to ASTM C136-76 and ASTM C117-80 (AASHTO T11-78 and T27-78) and giving a smooth curve without sharp breaks when plotted on a semi-log grading chart.

ASTM Sieve Passing Designation	%
19.0 mm	100
9.5 mm	60 - 100
4.75 mm	40 - 80
2.36 mm	30 - 60
1.18 mm	20 - 40
0.30 mm	8 - 20
0.075 mm	2 - 7

- .2 Liquid Limit:  
ASTM D423-66(1972) (AASHTO T89-76) Maximum 25
- .3 Plasticity Index  
ASTM D424-59(1971) (AASHTO T90-70) Maximum 6
- .4 Los Angeles Abrasion  
ASTM C131-76 (AASHTO T96-77) Gradation 'A' Max. % loss by weight 45
- .5 Crushed fragments: at least 60% of fragments within the following size range to have at least 1 freshly fractured face.

**Passing**                      **Retained on**  
19.0 mm                      to                      4.75 mm

**PART 3 - EXECUTION**

**3.1 Inspection of Underlying Sub-Base or Sub-Grade**

.1 Do not place granular base until finished sub-base surface is inspected and approved.

**3.2 Placing**

.1 Place material only on a clean, unfrozen surface, properly shaped and compacted and free from snow and ice.

.2 Place using methods which do not lead to segregation or degradation of aggregate.

.3 Place material in uniform layers not exceeding 200 mm when compacted or to such other depth as approved by Departmental Representative.

.4 Shape each layer to a smooth contour and compact to specified density before succeeding layer is placed.

.5 Remove and replace that portion of a layer in which material becomes segregated during spreading.

**3.3 Compacting**

.1 Compact to a density not less than 100% maximum dry density in accordance with ASTM D698.

.2 Shape and roll alternately to obtain a smooth, even and uniformly compacted base.

.3 Apply water as necessary during compacting to obtain specified density. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

.4 In areas not accessible to rolling equipment, compact to specified density with approved mechanical tampers.

**3.4 Finish Tolerances**

.1 Finished base surface shall be within +/- 10 mm of established grade but not uniformly high or low.

.2 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

**3.5 Proof Rolling**

.1 For proof rolling, use a fully loaded tandem axle dump truck.

- .2 Departmental Representative may authorize use of other acceptable proof rolling equipment.
- .3 Proof roll top of base upon completion of fine grading and compaction.
- .4 Make passes as directed by Departmental Representative.
- .5 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent directed and replace with new materials in accordance with Section 32 11 16.1 and Section 32 11 23 at no extra cost.

**3.6 Maintenance**

- .1 Maintain finished base in a condition conforming to this section until succeeding material is applied or until acceptance.

END OF SECTION

- 
- 1.0 GENERAL**
- .1 Section 32 12 16 refers to those portions of the work that are unique to the supply and placement of hot-mix asphalt concrete paving. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- 1.1 Related Work**
- .1 Excavating, Trenching and Backfill Section 31 23 01
- .2 Granular Base Section 32 11 23
- .3 Granular Subbase Section 32 11 16.1
- 1.2 Material Certification**
- .1 Upon request. submit manufacturer's test data and certification that asphalt cement meets requirements of this section.
- 1.3 Submission of Mix Design**
- .1 Submit asphalt concrete mix design and trial mix test results to Contract Administrator for review at least one week prior to commencing work.
- 1.4 Inspection and Testing**
- .1 Testing laboratory to be approved by Departmental Representative.
- 2.0 PRODUCTS**
- 2.1 Materials**
- .1 Asphalt cement: to CGSB-16.3-M90, Grade 80 - 100.
- .2 Reclaimed asphalt pavement (RAP): Crush and screen so that 100% of reclaimed asphalt pavement material passes 37.5 mm screen before mixing.
- .3 Aggregates: to Section 31 05 17 – Aggregates: General and following requirements:
- .1 Crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.

- .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117.

Sieve Designation		Percent Passing				
		*Lower Course #1	*Lower Course #2	*Upper Course #1	Upper Course #2	*Fine Mix
25.0	mm	100	--	--	--	--
19.0	mm	--	100	100	--	--
12.5	mm	70 – 85	84 – 99	84 – 99	100	--
9.5	mm	--	73 – 88	73 – 88	--	100
4.75	mm	40 – 65	50 – 68	50 – 68	55 – 75	80 – 100
2.36	mm	32 – 53	35 – 55	35 – 55	38 – 58	64 – 89
1.18	mm	26 – 44	27 – 46	27 – 46	28 – 47	48 – 76
0.60	mm	18 – 36	18 – 36	18 – 36	20 – 36	32 – 60
0.30	mm	10 – 26	10 – 26	10 – 26	10 – 26	16 – 42
0.15	mm	4 – 17	4 – 17	4 – 17	4 – 17	6 - 23
0.075	mm	3 - 8	3 – 8	3 – 8	3 – 8	4 - 10

**\*Footnote to asphalt mix-type selection:**

Lower Course #1: Arterial and collector, lower course only.

Lower Course #2: Local, lower course only.

Upper Course #1: Arterial and collector, upper course only.

Upper Course #2: Local, surface course only.

Fine Mix: Skim patch on existing asphalt surface.

- .3 Coarse aggregate is aggregate retained on 4.75 mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C136.
- .4 When dryer drum plant or plant without hot screening is used, process fine aggregate through 4.75 mm sieve -and stockpile separately from coarse aggregate.
- .5 Do not use aggregates having known polishing characteristics in mixes for upper courses.

- 
- .6 Sand equivalent: to ASTM D2419. Min: 40
  - .7 Magnesium Sulphate soundness: to ASTM C88. Max % loss by mass after five cycles:
    - 1. Coarse Aggregate: 15
    - 2. Fine Aggregate: 18
  - .8 Los Angeles abrasion: Grading B, to ASTM C131. Max % loss by mass:
    - .1 Coarse aggregate, upper course: 25
    - .2 Coarse aggregate, lower course: 35
  - .9 Absorption: to ASTM C127. Max% by mass:
    - .1 Coarse aggregate, upper course: 1.75
    - .2 Coarse aggregate, lower course: 2.00
  - .10 Max% passing 0.075 mm sieve:
    - .1 Coarse aggregate, upper course: 1.5
    - .2 Coarse aggregate, lower course: 2.0
  - .11 Flat and elongated particles: (with length to thickness ratio greater than 3): Max% by mass:
    - .1 Coarse aggregate, upper course: 10
    - .2 Coarse aggregate, lower course: 10
  - .12 Crushed fragments: at least 60% of particles by mass within each of following sieve designation ranges, to have at least 2 freshly fractured faces. Material to be tested according to ASTM C136 and ASTM C117.

Determination of amount of fractured material will be in accordance with Ministry of Transportation and Highways' Specification 1-11, Fracture Count for Coarse Aggregate, Method "B", which determines fractured faces by mass.

Passing		Retained On	
25 mm	to	12.5 mm	
12.5 mm	to	4.75 mm	

.13 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.

.4 Mineral filler:

.1 Finely ground particles of limestone, hydrated lime, Portland cement or other approved non-plastic mineral matter, thoroughly dry and free from lumps.

.2 Add mineral filler when necessary to meet job mix aggregate gradation or as directed to mix

**2.2 Mix Design**

.1 Submit job mix formula to Contract Administrator for review and approval.

.2 Mix may contain up to a maximum 20% by mass of RAP without a special mix design. Contract Administrator may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.

.3 Design of mix: by Marshall method to requirements below.

.1 Compaction blows on each face of test specimens: 75

.2 Mix physical requirements:

Property		Pavement Course	
Marshall Stability at 60°C	kN min.	6.4	lower course
		5.5	upper course
			fine
Flow Value	mm	2-4	
Air Voids in Mixture	%	3-6	lower course
		3-5	upper course
		3-5	fine
Voids in Mineral Aggregate	%min.	13	lower



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			course 1
		14	lower course 2
		14	upper course 1
		15	upper course 2
		15	fine
	Index of Retained Stability	%min.	75

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- .3 Measure physical requirements as follows:
  - .1 Marshall load and flow value: to ASTM D1559.
  - .2 Air voids: to ASTM D3203.
  - .3 Index of Retained Stability: measure in accordance with Marshall Immersion Test (ASTM D1559).
  - .4 Do not change job-mix without prior approval of Contract Administrator. Should change in material source be proposed, new job-mix formula to be submitted to Contract Administrator for review and approval.

**3.0 EXECUTION**

**3.1 Plant and Mixing Requirements**

- .1 Batch and continuous mixing plants:
  - .1 To ASTM D995.
  - .2 Heat asphalt cement and aggregate to mixing temperature. Do not heat asphalt cement above 160°C.
  - .3 Before mixing, dry aggregates to a moisture content not greater than 0.5% by mass or to a lesser moisture content if required to meet mix design requirements.

- .4 Contract Administrator will monitor temperature of completed mix at plant and at paver after considering hauling and placing conditions.
- .5 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.
- .6 Feed cold aggregates to plant in proportions that will ensure continuous operations.
- .7 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job- mix requirements.
- .8 Store hot screened aggregates in a manner to minimize segregation and temperature loss.
- .9 Where RAP is to be incorporated into mix:
  - .1 Feed from separate cold feed bin specially designed to minimize consolidation of material. Provide 37.5 mm scalping screen on cold feed to remove oversized pieces of RAP.
  - .2 Ensure positive and accurate control of RAP cold feed by use of hydraulic motor or electric clutch and equip with anti-rollback device to prevent material from sliding backward on feed belt.
  - .3 Combine RAP and new aggregates in proportions as specified. Dry mix thoroughly, until uniform temperature within plus or minus 5°C of mix temperature is achieved prior to adding new asphalt cement. Do not add new asphalt cement where temperature of dry mix material is above 160°C.
- .10 Maintain temperature of materials within plus or minus 5°C of specified mix temperature during mixing.
- .11 Mixing time:
  - .1 In batch plants, dry mix for not less than 10 s. Continue wet mixing as long as necessary to obtain a thoroughly blended mix but not less than 30 s or more than 75 s.

- .2 In continuous mixing plants, mixing time as required but not less than 45 s.
- .2 Dryer drum mixing plant:
  - .1 Where RAP to be incorporated into mix, dryer drum mixer to be designed to prevent direct contact of RAP with burner flame or with exhaust gases hotter than 180°C.
  - .2 Feed aggregates to burner end of dryer drum by means of a multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.
  - .3 Feed RAP from separate cold feed bin designed to minimize reconsolidation of material.
  - .4 Meter total flow of aggregate and RAP by electronic weigh belt system with an indicator that can be monitored by plant operator and which is interlocked with asphalt pump so that proportions of aggregate and RAP and asphalt entering mixer remain constant.
  - .5 Provide for easy calibration of weighing systems for aggregates and RAP without having material enter mixer.
  - .6 Make provision for conveniently sampling full flow of materials from the cold feed.
  - .7 Provide screens or other suitable devices to reject oversize particles or lumps of aggregate and RAP from cold feed prior to entering drum.
  - .8 Provide a system interlock which will stop all feed components if either asphalt or aggregate from any bin stops flowing.
  - .9 Accomplish heating and mixing of asphalt mix in a drum dryer-mixer. Control heating to prevent fracture of aggregate or excessive oxidation of asphalt. Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with a printing recorder that can be monitored

by plant operator. Submit printed record of mix temperatures at end of each week, if required.

- .10 Mixing period and temperature to produce a uniform mixture in which particles are thoroughly coated, and moisture content of material as it leaves mixer to be less than 0.5%.
- .3 Temporary storage of hot mix:
  - .1 Provide mix storage of sufficient capacity to permit continuous operation, maintained at specified temperatures and designed to prevent segregation.
  - .2 Do not store asphalt mix in storage bins in excess of 12 h.
- .4 Mixing tolerances:
  - .1 Permissible variation in aggregate gradation from job mix (percent of total mass):
 

.1	4.75 mm sieve and larger	5.5
.2	2.36 mm sieve	4.5
.3	0.600 mm sieve	3.5
.4	0.150 mm sieve	2.5
.5	0.075 mm sieve	1.5
  - .2 Permissible variation of asphalt cement from job mix, 0.3%.
  - .3 Permissible variation of mix temperature at discharge from plant, 5°C.

### 3.2 Equipment

- .1 Pavers: mechanical grade-controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown as shown on Contract Drawings.
- .2 Rollers: sufficient number of rollers of type and weight to obtain specified density of compacted mix.
- .3 Vibratory rollers:

- .1 Minimum drum diameter: 1200 mm.
- .2 Maximum amplitude of vibration (machine setting): 0.5 mm for lifts less than 40 mm thick.
- .4 Haul trucks: of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
  - .1 Boxes with tight metal bottoms.
  - .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
  - .3 In cool weather or for long hauls, insulate entire contact area of each truck box.
  - .4 Trucks which cannot be weighed in a single operation on scales supplied will not be accepted.
- .5 Hand tools:
  - .1 Lutes or rakes with covered teeth for spreading and finishing operations.
  - .2 Tamping irons having mass not less than 12 kg and a bearing area not exceeding 310 cm<sup>2</sup> for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Contract Administrator, may be used instead of tamping irons.
  - .3 Straight edges, 3.0 m in length, to test finished surface.

### 3.3 Preparation

- .1 Adjust existing castings to new elevations and protect from asphaltic mix.
- .2 When matching new pavement with existing pavement make vertical cut between existing pavement and new pavement as shown on Contract Drawings.
- .3 Prior to laying mix, clean surfaces of loose and foreign material.

### 3.4 Transportation of Mix

- .1 Transport mix to job site in vehicles cleaned of foreign material.

- .2 Paint or spray truck beds with light oil, limewater, soap or detergent solution, at least once a day or as required. Elevate truck bed and thoroughly drain. No excess solution will be permitted.
- .3 Schedule delivery of material for placing in daylight, unless Contract Administrator approves artificial light.
- .4 Deliver material to paver at a uniform rate and in an amount within capacity of paving and compacting equipment.
- .5 Deliver loads continuously in covered vehicles and immediately spread and compact. Deliver and place mixes at temperature within specified range. Temperature of mix upon placement shall not be less than 125°C.

### 3.5 Placing

- .1 Obtain Contract Administrator's approval of base, existing surface, tack coat, or prime coat prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as shown on Contract Drawings.
- .3 Placing conditions:
  - .1 Place asphalt mixtures only when air temperature is above 5°C. Place overlay pavement only when air temperature is above 10° C.
  - .2 When temperature of surface on which material is to be placed falls below 10°C, provide extra rollers as necessary to obtain required compaction before cooling.
  - .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Place asphalt concrete in compacted lifts of thickness as shown on Contract Drawings:
  - .1 Levelling course(s) to thicknesses required but not exceeding 100 mm each.
  - .2 Lower course in layers not to exceed 100 mm each.
  - .3 Surface course in layers of maximum 60 mm each.

- .5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.
- .6 Spread and strike off mixture with self-propelled mechanical finisher.
  - .1 Construct longitudinal joints and edges true to line markings. Position and operate paver to follow established line closely.
  - .2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver. Work pavers as close together as possible and in no case permit them to be more than 30 m apart.
  - .3 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
  - .4 Correct irregularities in alignment left by paver by trimming directly behind machine.
  - .5 Correct irregularities in surface of pavement course directly behind paver. Remove by shovel or lute excess material forming high spots. Fill and smooth indented areas with hot mix. Do not broadcast material over such areas.
  - .6 Do not throw surplus material on freshly screeded surfaces.
- .7 When hand spreading is used:
  - .1 Approved wood or steel forms, rigidly supported to assure correct grade and cross section, may be used. Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
  - .2 Distribute material uniformly. Do not broadcast material.
  - .3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes. Reject material that has formed into lumps and does not break down readily.

- .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
  - .5 Provide heating equipment to keep hand tools free from asphalt. Avoid high temperatures which may burn material. Do not use tools at a higher temperature than temperature of mix being placed.
- 3.6 Compaction**
- .1 Roll asphalt continuously to average density not less than 97% of 75 blow Marshall density in accordance with ASTM D1559 with no individual test less than 95%.
  - .2 General:
    - .1 Provide at least two rollers and as many additional rollers as necessary to achieve specified pavement density. When more than two rollers are required, one roller to be pneumatic tired type.
    - .2 Start rolling operations as soon as placed mix can bear weight of roller without undue displacement of material or cracking of surface.
    - .3 Operate roller slowly initially to avoid displacement of material. For subsequent rolling do not exceed 5 km/h for static steel- wheeled rollers and 8 km/h for pneumatic-tired rollers.
    - .4 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 20 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing should not exceed compacted lift thickness.
    - .5 Overlap successive passes of roller by at least one half width of roller and vary pass lengths.
    - .6 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
    - .7 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.



- .8 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
  - .9 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
  - .10 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
  - .11 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.
- .3 Breakdown rolling:
- .1 Commence breakdown rolling immediately following rolling of transverse and longitudinal joint and edges.
  - .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.
  - .3 Operate breakdown roller with drive roll or wheel nearest finishing machine. Exceptions may be made when working on steep slopes or super-elevated sections.
  - .4 Use only experienced roller operators for this work.
- .4 Second rolling:
- .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
  - .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .5 Finish rolling:
- .1 Accomplish finish rolling with steel wheel rollers while material is still warm enough for removal of roller marks.

- .2 Conduct rolling operations in close sequence.

### 3.7 Joints

#### .1 General:

- .1 Remove surplus material from surface of previously laid strip. Do not dispose on surface of freshly laid strip.
- .2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as specified.
- .3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.

#### .2 Transverse joints:

- .1 Offset transverse joint in succeeding lifts by at least 600 mm.
- .2 Cut back to full depth vertical face and tack face with thin coat of asphalt prior to continuing paving.
- .3 Compact transverse joints to provide a smooth riding surface.

#### .3 Longitudinal joints:

- .1 Offset longitudinal joints in succeeding lifts by at least 150 mm.
- .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100°C prior to paving of adjacent lane. If cold joint can not be avoided, tack face of adjacent lane with thin coat of asphalt prior to continuing paving.
- .3 Overlap previously laid strip with spreader by 100 mm.
- .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with a lute or rake.
- .5 Roll longitudinal joints directly behind paving operation.

- 
- .6 When rolling with static roller, shift roller over onto previously placed lane in order that 100 to 150 mm of drum width rides on newly laid lane, then operate roller to pinch and press fines gradually across joint. Continue rolling until thoroughly compacted neat joint is obtained.
  - .7 When rolling with vibratory roller, have most of drum width ride on newly placed lane with remaining 100 to 150 mm extending onto previously placed and compacted lane.
  - .4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix. Place and compact joint so that joint is smooth and without visible breaks in grade. Location of feather joint as specified.
  - .5 Construct butt joints at locations and to details as shown on Contract Drawings.
  - .6 Wherever practical, locate joints under future traffic markings (paint lines).
- 3.8 Pavement Patching**
- .1 Ensure temporary and permanent pavement patching done by handwork conforms to all standards specified for machine placed asphaltic concrete.
  - .2 Subbase and base preparation as specified in Section 32 11 16.1 - Granular Subbase and Section 32 11 23 - Granular Base respectively, unless shown otherwise on Contract Drawings.
- 3.9 Sidewalks, Driveways and Curbs**
- .1 Hot-mix asphalt concrete sidewalks, driveways and curbs as shown on Contract Drawings.
  - .2 Machine place where practical.
  - .3 Ensure placement by handwork conforms to all standards specified for machine placed asphaltic concrete.
  - .4 Other than requirements relating specifically to Portland cement concrete, ensure hot-mix asphalt concrete sidewalks and curbs comply with all requirements of Section 03 30 20 - Concrete Walks.
  - .5 Ensure hot-mix asphalt concrete driveways comply with all requirements of 32 12 16 - Hot-Mix Asphalt Concrete Paving.

- 3.10 Finished Tolerances**
- .1 Ensure finished asphalt surface within 6 mm of design elevation but not uniformly high or low.
  - .2 Ensure finished asphalt surface does not have irregularities exceeding 6 mm when checked with a 3 m straight edge placed in any direction.
  - .3 Water ponding not permitted.
  - .4 Against concrete gutter, finished asphalt surface to be higher than the gutter by not more than 6mm.
- 3.11 Defective Work**
- .1 Correct irregularities which develop before completion of rolling by loosening upper mix and removing or adding material as required.
  - .2 If irregularities or defects remain after final compaction, remove upper course promptly and lay new material to form a true and even surface and compact immediately to specified density.
- 3.12 Clean-Up**
- .1 Remove lids or covers from all castings and clean any prime, tack coat or hot- mix asphaltic concrete from frames, lids and covers of all castings.

\*\*\*\* END OF SECTION \*\*\*\*

- 
- 1.0 GENERAL**
- .1 Section 32 31 13 refers to those portions of the work that are unique to the supply and installation of chain link fences and gates. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- .2 Industry standards to apply where details and procedures not specified.
- 1.1 Related Work** .1 Concrete Section 03 01 00
- 1.2 Shop Drawings** .1 Shop drawings are not required.
- 1.3 Samples** .1 Samples are not required.
- 2.0 PRODUCTS**
- 2.1 Materials**
- .1 Fencing: as shown on Contract Drawings.
- .2 Concrete mixes and materials: Section 03 01 00 - Concrete.
- .3 Chain-link fence fabric: 9 gauge (3.55 mm diameter) 50 mm mesh, galvanized, plastic coated or electro galvanized as specified in Contract Documents.
- .4 Posts and rails: to CAN/CGSB-138.2, Schedule 40 galvanized steel pipe.
- .1 Top and brace rails: 42 mm nominal outside diameter, wall thickness 3.55 mm.
- .2 End and corner posts: 75 mm nominal outside diameter, wall thickness 5.15 mm.
- .3 Line posts: 60 mm nominal outside diameter 3.90 mm wall thickness.
- .4 Gate Posts: 89 mm minimum nominal outside diameter or as otherwise specified.
- .5 Bottom tension wire: single strand, aluminum, galvanized, or vinyl coated steel wire, 6 gauge, (4.50 mm diameter).
- .6 Tie wire fasteners: single strand, vinyl coated or aluminum wire 9 gauge, (3.55 mm diameter).
- .7 Tension bar: 4.76 x 19 mm minimum galvanized steel.

- .8 Tension bar bands: 3 x 20 mm minimum galvanized steel or 5 x 20 mm minimum aluminum.
- .9 Gate frames: to ASTM A53, Schedule 40 galvanized steel pipe, 42 mm nominal outside diameter pipe for outside frame, 35 mm outside diameter pipe for interior bracing; or as otherwise shown on Contract Drawings.
  - .1 Fabricate gates with electrically welded joints, and hot-dip galvanize or paint with zinc pigmented paint after welding.
  - .2 Fasten fence fabric to gate with twisted selvage at top.
  - .3 Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.
  - .4 Furnish double gates with chain hook to hold gates open and centre rest with drop bolt for closed position.
- .10 Fittings and hardware: cast aluminum alloy, galvanized steel or malleable or ductile cast iron. Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail. Overhang tops to provide waterproof fit, to hold top rails and an outward or inward projection, as shown on Contract Drawings, to hold barbed wire overhang. Provide projection with clips or recesses to hold 3 strands of barbed wire spaced 100 mm apart. Projection of approximately 300 mm long to project from fence at 45° above horizontal. Turnbuckles to be drop forged.
- .11 Organic zinc rich coating: to CGSB 1-GP-181M.
- .12 Barbed wire: 2 mm diameter galvanized steel wire to ASTM A121 or aluminum coated steel wire to ASTM A585, 4 point barbs 125 mm spacing.

## 2.2 Finishes

- .1 Galvanizing:
  - .1 For chain link fabric: to CAN/CGSB-138.1
  - .2 For pipe: 550 g/m<sup>2</sup> minimum to ASTM A90.
  - .3 For barbed wire: to ASTM A121, Class 2.
  - .4 For other fittings: to CSA G164.

.2 Aluminum coating: For barbed wire: to ASTM A585, Class 2.

.3 Vinyl coating: 0.045 mm dry film thickness minimum.

### 3.0 EXECUTION

#### 3.1 Grading

.1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts. Provide clearance between bottom of fence and ground surface neither less than 30 mm nor more than 50 mm.

#### 3.2 Installation of Fence

.1 Install fence along lines as shown on Contract Drawings and in accordance with CAN/CGSB-138.3.

.2 Excavate post holes to dimensions shown on Contract Drawings.

.3 Space line posts maximum 3 m apart, measured parallel to ground surface.

.4 Space straining posts at equal intervals not exceeding 150 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade is greater than 150 m.

.5 Install additional straining posts at sharp changes in grade where shown on Contract Drawings.

.6 Install corner post where change in alignment exceeds 10°.

.7 Install end posts at end of fence and at buildings. Install gate posts on both sides of gate openings.

.8 Place concrete in post holes then embed posts into concrete to depths shown on Contract Drawings. Extend concrete 40 mm above ground level and slope to drain away from posts... Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.

.9 Do not install fence fabric until concrete has cured a minimum of 5 days.

.10 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface. Install braces on both sides of corner and straining posts in similar manner.

- .11 Install overhang tops and caps.
- .12 Install top rail between posts and fasten securely to terminal posts and secure waterproof caps and overhang tops. Connect rails with slip-on sleeves: use expansion springs at 40 m spacing.
- .13 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.
- .14 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 375 mm intervals. Knuckled selvage at top and bottom.
- .15 Secure fabric to top rails, line posts and bottom tension wire as detailed on Contract Drawings. Give tie wires minimum two twists.
- .16 Where specified, install barbed wire strands and clip securely to lugs of each bracket.

\*\*\*\* END OF SECTION \*\*\*\*



## **Division 33 - Utilities**

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**PART 1 - GENERAL**

- |            |   |    |   |                  |
|------------|---|----|---|------------------|
| <b>1.1</b> | <b>General</b>                          | .1 | Not used  |                  |
| <b>1.2</b> | <b>Description</b>                      | .1 | This section specifies requirements for supplying and installing watermains, fittings, services and appurtenances to lines, grades and dimensions shown on the Drawings or as directed by the Departmental Representative.  |                  |
| <b>1.3</b> | <b>Related Work Specified Elsewhere</b> | .1 | Excavation, Trenching and Backfill  | Section 31 23 01 |
|            |   | .2 | Concrete  | Section 03 01 00 |
| <b>1.4</b> | <b>Certification</b>                    | .1 | Provide Departmental Representative with certified copy of pipe tests, showing that pipe and gaskets meet specified requirements.   |                  |
|            |   | .2 | Include manufacturer's drawings and pertinent information and Shop Drawings where required.   |                  |
| <b>1.5</b> | <b>Scheduling of Work</b>               | .1 | Schedule work to minimize interruptions to existing services.   |                  |
|            |   | .2 | Submit schedule of expected interruptions for approval by the Departmental Representative and adhere to interruption schedule as approved by the Departmental Representative.   |                  |
|            |   | .3 | Notify building occupants a minimum of 24 hours in advance of any interruption in services.   |                  |
|            |   | .4 | Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.  |                  |
|            |   | .5 | Notify the fire department of any planned or accidental interruption to hydrants.   |                  |
| <b>1.6</b> | <b>Alternatives</b>                     | .1 | To promote development and use of new proprietary products to increase efficiency in installation and provide better service life, alternative materials to those specified will be considered if full descriptive data is submitted to the Departmental Representative in ample time to permit approval without delaying work. |                  |
|            |   | .2 | Such data must fully document description and specifications met by such alternative materials including certification from manufacturer that materials meet or exceed requirements for use intended and history, if any, of service in other installations.  |                  |

- .3 Variations to tendered price, if any, to be proposed when requesting use of alternative materials.

## PART 2 - PRODUCTS

### 2.1 Pipe and Fittings

- .1 Latest revision of all referenced specifications to govern.
- .2 Ductile iron pipe: to AWWA C151 (latest edition), cement mortar lined to AWWA C104 (latest edition).
  - .1 Joints:
    - .1 Mechanical, rubber gaskets with lead tip and double duck backing.
    - .2 Push-on joint with continuous rubber molded ring gasket.
    - .3 Grooved type coupling joint with malleable iron couplings and gaskets.
    - .4 Ensure electrical conductivity across joints.
  - .2 Fittings: to AWWA C110 (latest edition).
  - .3 Polyvinylchloride pressure pipe:
    - .1 Polyvinylchloride class rated pipe: to AWWA C900 (latest edition).
    - .2 Polyvinylchloride series rated pipe: to CSA B137.3 (latest edition).
    - .3 Ductile iron fittings: to AWWA C153 (latest edition).
    - .4 Joints: to be of the elastomeric gasket form.
  - .4 Polyethylene pressure pipe: nominal diameter less than 90 mm to CSA B137.1 (latest edition). Nominal diameter 90 mm or greater to CGSB 41-GP-25M.
    - .1 Polyethylene pipe sizes to be Iron Pipe Size (IPS) outside diameter.
    - .2 Insulation where called for to be 50 mm thick. Insulation to be jacketed in HDPE suitable for continuous exposure to sunlight.
    - .3 Polyethylene to polyethylene joints: to be thermal butt fusion or to AWWA C207 (latest edition) flanged with steel backing flanges.
    - .4 Cast iron fittings with flanged ends: to AWWA C110 (latest edition) for pipe size above 90 mm. Ends flanged to meet ANSI B16.1 (latest edition), 1 725 kPa flanges do not match AWWA C110 (latest edition) flanges and special order must be made if a match to ANSI B16.1 (latest edition), 1 725 kPa flange is required. AWWA C110 (latest edition) flanges

are rated for 1 725 kPa water service working pressure.

.5 Polyethylene fittings: to CSA B137.1 (latest edition) for pipe sizes less than 90 mm.

.5 Steel water pipe: to AWWA C200 (latest edition).

.1 Exterior finish: to AWWA C203 (latest edition), hot applied coal tar enamel.

.2 Interior finish: to AWWA C205 (latest edition), cement mortar lined, or coal-tar epoxy to AWWA C210.

.3 Pipe joints: to be mechanical joints, field welded slip joints, butt welded joints, field welded butt straps, flanged joints, threaded joints and grooved victaulic couplings.

.4 Flanges: to AWWA C207(latest edition).

.5 Pipe fittings: to AWWA C208 (latest edition), cement mortar lined to AWWA C205 (latest edition), and exterior protected with hot applied coal tar enamel to AWWA C203-89.

## 2.2 Valves and Valve Boxes

.1 Gate valves: iron body, bronze mounted, to AWWA C500 (latest edition).

.1 Valves to be solid wedge gate with non-rising stems.

.2 Ends to be flanged at junctions with cast iron fittings.

.3 Ends to be bell or mechanical at junctions with pipe. Joints to be formed with a mechanical seal equivalent to pipe joint.

.4 Position of the valve in line to be vertical.

.5 Stem seal: O-ring or stuffing box type.

.6 Valves to open on counter-clockwise rotation of the wrench nut.

.7 Extension pieces to be used where valve bury is deeper than 1.5 m.

.8 Thrust blocking to be provided on all valves.

.2 Valves: to open in direction corresponding to local standard. Counter-clockwise where no local standard.

.3 Cast iron valve boxes: Nelson type adjustable over a minimum of 450 mm, complete with valve operating extension rod, 30 mm diameter, of such length that when set on valve operating nut top of rod will not be more than 300 mm below cover. Provide stone ring beneath operating nut. Base to be large round type with minimum diameter of 300 mm. Top of box to be marked "WATER".

- 
- .4 Underground type indicator valve where required by Departmental Representative. Indicator post to accurately indicate position of valve.
  - .5 Air release valves: air release valves employing direct acting kinetic principle. Valves to be fabricated of cast iron body and cover with bronze trim, stainless steel floats with shockproof synthetic seat. Ends to be flanged to AWWA C110 (latest edition).
- 2.3 Service Connections**
- .1 Copper tubing: To CSA Hc7.6 (latest edition), Type K, annealed, for 1 MPa working pressure.
  - .2 Copper pipe joints: To be of compression type suitable for 1 MPA working pressure.
  - .3 Brass corporation stops: red brass to ASTM B62 (latest edition), compression type, having threads to AWWA C800 (latest edition).
  - .4 Brass inverted key-type curb stops: red brass to ASTM B62 (latest edition) compression type without drains. Curb stops to have adjustable bituminous coated cast iron service box with stem to suit depth of bury. Mark top of cast iron box "WATER".
  - .5 Double strap service clamps.
  - .6 Appropriate sized "tee" connections for services larger than sizes permitted for direct tap or service clamps. Tee connections to be fabricated of same material and to same standards as specified pipe fittings and have ends matching pipe to which they are joined.
  - .7 Pressure Reducing Valves to be Watts No. 5U with inlet and outlet threaded to suit individual services applications, if called for on the Drawings.
- 2.4 Hydrants**
- .1 Post type hydrants: to AWWA C502 (latest edition) with 65 mm threaded hose outlets, and 150 mm connection for main. Depth of bury as shown on Contract drawings..
    - .1 Hydrants to be painted red above ground.
    - .2 Hydrants to be Terminal City C-71 with pumper port as manufactured by Terminal City Ironworks with clockwise opening and standard pentagon operating nut, or equal.
- 2.5 Granular Bedding**

- 
- .1 Shall be in accordance with 31 23 01 Excavation, Trenching and Backfilling specification.
- .2 Concrete required for cradles, encasement, supports, reaction backing: to Section 03 01 00.
- 2.6 Chlorine**
- .1 The watermains are not to be disinfected with Chlorine.
- PART 3 - EXECUTION**
- 3.1 Preparation**
- .1 Clean pipes, fittings, valves, hydrants and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects. Remove defective materials from site.
- 3.2 Trenching, Backfilling and Restoration**
- .1 Trenching, Backfilling and Restoration to Section 31 23 01.
- 3.3 Concrete Bedding and Encasement**
- .1 Do concrete work to Section 03 01 00. Place as indicated or directed.
- .2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipes to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placement.
- 3.4 Pipe Bedding**
- .1 Place and compact granular bedding to dimensions indicated and provide continuous even support beneath and around the pipe.
- .2 Use bedding material as pipe support during laying and jointing.
- .3 Provide 100 mm (150 mm on rock) minimum bedding material beneath, 200 mm minimum around both sides of pipe and 300 mm above top of pipe as standard trench detail.
- .4 Under wet laying conditions use bedding stone.
- .5 Compact full width of pipe zone to at least 95% maximum density as per ASTM Standard D698 (latest edition), Method D.
- 3.5 Pipe Installation**
- .1 Lay pipes to AWWA C600 (latest edition) for cast iron and ductile iron pipe, and/or manufacturer's standard

- instructions and specifications. Do not use blocks except as permitted in 3.3.2. Contract bedding details shall govern.
- .2 Joint pipes to AWWA C600 (latest edition), AWWA C603 (latest edition), AWWA C206 (latest edition), and/or manufacturer's recommendations.
  - .3 Handle pipe by approved methods. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.
  - .4 Lay pipes true to line and grade. Take up and replace defective pipe. Relay pipe which shows undue settlement after installation.
  - .5 Face socket ends of pipe in direction of laying. For mains on a grade of 2% or greater, face socket ends upgrade.
  - .6 Joint deflection to be not more than half the pipe manufacturer's recommended maximum deflection.
  - .7 Protect installed pipes from ingress of dirt and water or other foreign materials. Whenever work is suspended, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
  - .8 Position and joint pipes with approved equipment. Do not use excavating equipment to force pipe sections together.
  - .9 Cut pipes as required for special fittings or closure pieces, in a neat manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave a smooth end at right angles to axis of pipe.
  - .10 Align pipes carefully before jointing.
  - .11 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
  - .12 Maintain pipe joints clean and free from foreign materials.
  - .13 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed to be removed, cleaned, lubricated and replaced before jointing is attempted.
  - .14 Complete each joint before laying next length of pipe.



- .15 Minimize deflection after joint has been made to avoid damage.
- .16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .17 Block pipes when stoppage of work occurs, in an approved manner to prevent creep during downtime.
- .18 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .19 Do not lay pipes when conditions are such that water may enter pipe.
- .20 Do not lay pipe on frozen bedding.
- .21 Protect pipework, hydrants, valves and appurtenances from freezing.
- .22 Upon completion of pipe laying and after the Departmental Representative has inspected work in place, surround and cover pipes with specified material placed to dimensions indicated or directed.

**3.6 Valve Installation**

- .1 Mount valves to manufacturer's recommendations in locations indicated.
- .2 Support valves located in valve boxes or valve chambers by means of a concrete block, located between valve and solid ground. Valves not to be supported by pipe.
- .3 Install 100 mm x 100 mm x 240 mm pressure treated wood post to mark location of valve box, if required by drawings. Align front face of post toward valve box and write distance to valve box on front face, using white enamel paint. Set post into concrete, 600 mm deep.

**3.7 Service Connections**

- .1 Construct service connections at right angles to watermain unless otherwise directed. Locate curb stops 300 mm from all existing houses, or as shown on the Drawings.
- .2 Tappings on cast iron or ductile iron pipe may be threaded without service clamps. Double strap service connections with galvanized malleable iron body and neoprene gasket cemented in place may be used. Tappings to conform to the following:

Pipe	Maximum Tap	Maximum Tap
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Diameter		Without Clamp	With Clamp
100	mm	20 mm	25 mm
150	mm	20 mm	40 mm
200	mm	25 mm	50 mm
250	mm	25 mm	50 mm
300	mm	40 mm	75 mm

- .3 Tappings on PVC pipe to be either PVC valve tees or bronze type service clamps. Service clamps shall have maximum outlet size 25 mm for pipe diameter 100 mm, 40 mm for pipe diameter 150 mm and 50 mm for pipe diameter 200 mm and greater. For larger services use valve tees.
- .4 Tappings for PE pipe shall be PE tapping tees.
- .5 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .6 Tap main at 2:00 o'clock or 10:00 o'clock position only, not closer to a joint nor closer to adjacent service connections than recommended by manufacturer, or 1000 mm, whichever is greater.
- .7 Leave corporation stop valves fully open.
- .8 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .9 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .10 Install curb stop with corporation box on services 50 mm or less in diameter. Equip larger services with a gate valve and cast iron box. Set box plumb over stop and adjust top flush with final grade elevation. Leave curb stop valves fully closed.
- .11 Place temporary location marker at ends of plugged or capped unconnected waterlines. Each marker to consist of a 50 mm by 100 mm stake extending from pipe end at pipe level to 60 mm above grade. Paint exposed portion of stake blue with designation "WATER SERVICE LINE".

**3.8 Hydrants**

- .1 Install hydrants at locations indicated or directed.

- 
- .2 Install hydrants in accordance with AWWA Manual of Practice M-17 (latest edition).
  - .3 Install gate valve and cast iron valve box on hydrant service leads as indicated.
  - .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation 75 mm above final grading in paved areas and 150 mm in unpaved areas.
  - .5 Place concrete reaction backing as indicated and specified herein, ensuring that drain holes are unobstructed.
  - .6 To provide proper draining for each hydrant, excavate a pit measuring not less than 1 meter by 1 meter by 50 mm deep and backfill with coarse gravel or crushed rock to a level 150 mm above drain holes, unless indicated otherwise on drawings.
  - .7 Place appropriate sign on installed hydrants indicating whether or not they are in service during construction.

### **3.9 Thrust Blocks**

- .1 Do concrete work to Section 03 01 00.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and solid ground as shown on Drawings or as directed by the Departmental Representative.
- .3 Keep joints and couplings free of concrete.

### **3.10 Undercrossing**

- .1 Excavate working pit outside right-of-way to be crossed.
- .2 Excavate working pit to a minimum of 50 mm below lowest invert of encasing pipe or structure.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.
- .5 Install heavy timber or steel frame backstop.
- .6 Place encasing pipe to exact line and grade indicated. Where practical, use 90 degree crossing. Crossing shall never be less than 45 degrees. When encasement pipe not required, delete 3.11.7 to 3.11.9 and 3.11.11 to 3.11.13.

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- .7 Install encasing pipe by jacking, boring or tunneling as indicated on Drawings.
  - .8 Encasing pipe not to be in tension.
  - .9 Joints for encasing pipe to be welded type.
  - .10 Provide Shop Drawings showing proposed method of installation for carrier pipe.
  - .11 Use approved blocking method to guide carrier pipe in true alignment.
  - .12 Clearance between blocks and encasement pipe to be maximum 10 mm when carrier pipe is in position.
  - .13 Join carrier pipe one length at a time outside encasement pipe. Push or pull carrier pipe into position.

### 3.11 Hydrostatic and Leakage Testing

- .1 Upon completion of construction of any section, which shall be defined as that pipeline and appurtenances located between any two adjacent line valves, make section ready for testing. Carry out testing in accordance with point 2 of this Section .
- .2 Before pipe is filled with water, pipe bedding, concreting of all valves and fittings and backfilling to be completed as required in this specification. Fill each section of pipe and allow to remain full of water for a period of at least 24 hours prior to commencement of any pressure tests. Submit pipeline to a test of 1.5 x working pressure applied at highest elevation in each section, with a minimum of 1380 kPa applied at lowest point of test section. Ensure that test pressure does not exceed pipe or thrust restraint design pressures. Maximum allowable leakage rate at test pressure to not exceed 1.25 litres per millimetre diameter of pipe per kilometre per 24 hour period . Minimum duration of test period to be 2 hours. Maximum test pressures should not exceed those specified in CSA B137.3.
- .3 Perform pressure and leakage testing of ductile iron piping to AWW C600 and AWWA M41.
- .4 Perform pressure and leakage testing of polyvinyl chloride (PVC) piping to AWWA M23 and AWWA C605
- .5 Perform testing of welded steel piping to AWWA C206 no leakage allowed .

- . 6 Should any test disclose excessive leakage, repair or replace defect and retest section until specified testing requirement is achieved .

**3.12 Flushing and Disinfection**

- .1 Do in accordance with AWWA-C601-81 or latest revision.
- .2 Flushing and disinfection operations to be under direct control of Departmental Representative. Notify Departmental Representative at least four (4) days in advance of proposed date when disinfection operations to commence.
- .3 Flush water mains through outlets as directed by Departmental Representative. Use sufficient flow to produce a velocity of 1.5 m per second, for 10 min., or until foreign materials have been removed and flushed water is clear.

- .4 Flushing flows to be as follows:

Pipe Size (mm)	Flow (L/s) Minimum
150 and below	38
200	75
250	115
300	150

- .5 Provide connections and pumps required.
- .6 Open and close valves, hydrants, and service connections to ensure thorough flushing.
- .7 When flushing has been completed to satisfaction of Departmental Representative, take at least one sample at the end of each main and branch. Samples to be taken from main stop and copper service line or blow-off. Do not take samples from hydrants or hoses of any kind.
- .8 Samples to be taken in sterilized sample bottles in accordance with the instructions of the Environmental Health Officer, Medical Services, Health & Welfare Canada. Submit for analysis to approved testing laboratory.

END OF SECTION

- 
- 1.0 GENERAL**
- .1 Section 33 40 01 refers to those portions of the work that are unique to the supply and installation of storm sewers and storm sewer service connections. Related appurtenances are included in other sections. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein
  - .2 All details of storm sewer facilities not specifically covered in this section to comply with ASTM and CSA standards and/or manuals of practice as specified in Contract Documents.
- 1.1 Related Work**
- .1 Excavating, Trenching, and Backfilling 31 23 01
  - .2 Manholes and Catch basins 33 44 01
  - .3 Concrete 03 01 00
  - .5 Aggregates: General 31 05 17
- 1.2 Samples**
- .1 Samples may be required.
- 1.3 Materials Certification**
- .1 Products having CSA certification to be used where readily available. Product to be certified to CSA standard(s) by an approved independent third party certification body accredited by the Standards Council of Canada and that is acceptable to the Departmental Representative. Products to be marked with certification body logo and CSA standard markings.
  - .2 At least 14 days prior to commencing work, submit to Departmental Representative the material manufacturer's recent test data and certification that materials to be incorporated into works are representative and meet requirements of this section. Include manufacturer's drawings where pertinent.
- 1.4 Scheduling of Work**
- .1 Schedule work to minimize interruptions to existing services.
  - .2 Maintain existing flow during construction.
  - .3 Submit schedule of expected interruptions to Departmental Representative for approval and adhere to approved schedule.
- 2.0 PRODUCTS**

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- 2.1 PVC Pipe, Mainline Smooth Wall**
- .1 Polyvinyl chloride pipe up to 1200 mm in diameter, DR35. Pipe to have minimum pipe stiffness (F/Y) of 320 kPa at 5.0% deflection, ASTM D2412. Pipe to be manufactured to specifications for pipe size ranges as follows:
    - 100 mm dia. - 375 mm dia. to ASTM D3034
    - 450 mm dia. - 1200 mm dia. to ASTM F679
 Pipes to be certified to CSA B182.2 for pipe size diameter 100 mm to 1200 mm
  - .2 Joints: To conform to ASTM D3212 pipe to include integral bell and spigot ends with stiffened wall section and formed groove for a rubber gasket; elastomeric gaskets to ASTM F477.
    - .1 Pipe joints to withstand minimum hydrostatic pressure of 345 kPa without leakage.
    - .2 Pipe joints in pipes with pipe stiffness less than 320 kPa to withstand 550 kPa
  - .3 Normal pipe length joint to joint to be 4.0 m.
  - .4 Maximum installed short term deflection not to exceed 5.0% of the base inside diameter.
- 2.2 PVC Pipe, Mainline Profile**
- .1 PVC Profile Pipe: PVC profile pipes and fittings conforming to ASTM F794 and certified to CSA B182.4. 200 mm to 1200 mm diameters. Fittings to be certified to CSA B182.2 and conform to ASTM D3034 and ASTM F679.
  - .2 Pipe to have a minimum pipe stiffness of 320 kPa at 5.0% deflection, when tested in accordance with ASTM D2412. Pipe to be marked to clearly indicate class rating as required under ASTM F794.
  - .3 Pipe to have factory assembled spigot gaskets and integral bell joint features; joints to conform to all requirements of ASTM D3212: elastomeric gaskets to conform to ASTM F477.
  - .4 Normal pipe laying length joint to joint to be 4.0 m.
  - .5 Maximum short term installed deflection not to exceed 5.0% of base inside diameter
- 2.6 Service Connection**
- .1 Storm sewer service connections to be 100 mm minimum diameter; maximum diameter as specified on Contract Drawings.
  - .2 Storm sewer service connections 100 mm and 150 mm diameter to be PVC type PSM DR 28 sewer pipe.

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- .3 100 mm and 150 mm DR 28 PVC storm sewer service connection pipe to have a minimum pipe stiffness of 625 kPa. Pipe to be Manufactured to ASTM D3034 and Certified to Canadian Standards Association to CSA B182.2.
  - .4 Storm sewer service connections greater than 150 mm diameter to be of size and material specified on Contract Drawings and to conform to applicable specifications for mainline pipe.
  - .5 Manufactured connections to non-reinforced or reinforced concrete mainline pipe to be made using sanded PVC pipe male end stub with integral bell by either:
    - .1 Stub grouted into neatly chipped hole in pipe wall by concrete pipe manufacturer. Grout to be Portland cement based grout.
    - .2 Stub epoxy resin cemented into neatly cored hole in pipe wall by concrete pipe manufacturer.
  - .6 Stub and bell orientation to be 45° to centerline of mainline pipe (wyes) for concrete pipe less than 1050 mm diameter. Orientation may be 90° to centerline of mainline pipe (tees) for concrete pipe 1050 mm diameter or larger. No section of service stubs to protrude past inside of concrete pipe wall.
  - .7 Manufactured wye connections to PVC mainline pipe to be made with extrusion molded PVC or fabricated PVC fittings Manufactured to ASTM D3034 and CSA B182.2
  - .8 Field installed Tees and Wyes
    - .1 In-situ installation of tees and wyes into concrete ,, open profile HDPE pipe, PVC pipe or steel spiral rib mainline pipe shall be made with approved PVC saddle installed to the manufacturers specifications into a neatly cored hole in the pipe wall
    - .2 Connections to profile PVC pipe or open profile HDPE pipe to be made with a preformed tee or wye fitting when connection is up to two sizes smaller than mainline pipe. For connections more than two sizes smaller than mainline pipe, an insertable tee for PVC pipe or open profile HOPE pipe is permitted. When an insertable tee is used, hole cut into mainline pipe to cut as few ribs as possible.
  - .9 PVC service connection pipe and fitting joints: push-on type comprised of integral bell with single elastomeric gasket to ASTM D3212 and ASTM F477. Normal pipe laying length joint to joint to be 4.0 m.



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- .10 Pipe and fitting joints for service connection pipe materials other than PVC type PSM sewer pipe to be as specified for applicable mainline pipe.
- 2.7 Perforated Drain Pipe**
- .1 Pipe to be 100 mm minimum.
- .2 PVC Pipe to be certified to CSA B182.1 for 100 mm and 150 mm diameters. For pipe diameters 200mm and larger, pipe to be certified to CSA B182.2 and CSA B182.4.
- .3 HDPE open profile drain pipe diameter 100 mm and larger to be certified to CSA B182.8.
- .4 Concrete pipe shall conform to either ASTM C76M (Reinforced) or ASTM C14M(Non-reinforced) with perforations conforming to ASTM C444-03"Standard Specification for Perforated Concrete Pipe".
- 2.8 Concrete**
- .1 Concrete mixes and materials required for bedding cradles, encasement, and incidental uses: to. - Cast-in-Place Concrete.
- .2 Concrete to be minimum 20 MPa.
- 2.9 Granular Pipe Bedding and Surround Material**
- .1 As shown on Contract Drawings.
- .2 Refer to – Aggregates: General for material specifications.
- 3.0 EXECUTION**
- 3.1 General**
- .1 Pipe bedding details, including granular surround (pipe cushion) and material specifications to be as shown on Contract Drawings.
- 3.2 Preparation**
- .1 Clean pipes and fittings of debris and water before installation. Carefully inspect materials for defects before installing. Remove defective materials from site.
- 3.3 Trenching**
- .1 Do trenching in accordance with - Excavating, Trenching and Backfilling.
- .2 Trench alignment and depth as shown on Contract Drawings.
- 3.4 Concrete Bedding and Encasement**
- .1 Do concrete work to – Concrete 03 01 00. Place concrete to details as shown on Contract Drawings.
- .2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 h after placing.

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- 3.5 Granular Bedding**
- .1 Fill over-excavation below design elevation of bottom of specified bedding with granular bedding placed and compacted in accordance with 3.5.2 and 3.5.5 of this Section. Drain rock may be used for backfill of over-excavation only with Departmental Representative's approval
  - .2 Place granular bedding material across full width of trench bottom in uniform layers not exceeding 150 mm compacted thickness to depth as shown on Contract Drawings.
  - .3 Shape bed true to grade to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipe.
  - .4 Shape transverse depressions in bedding as required to suit joints.
  - .5 Compact each layer full width of bed to minimum 95% Modified Proctor Density in compliance with ASTM D1557- (All following references to density imply in compliance with ASTM D1557.).
  - .6 For Spiral Rib Pipe, shape bedding to fit lower segment of corrugated pipe exterior so that width of at least 50% of pipe diameter is in close contact with bedding.
- 3.6 Pipe Installation**
- .1 Handle pipe in accordance with manufacturer's recommendations. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.
  - .2 Lay and join pipes to manufacturer's instructions and specifications except as noted otherwise herein. Concrete pipe as specified herein, PVC pipe and open profile HDPE pipe to CSA B18.11, Steel Spiral Rib Pipe to CAN3-G401 and in general compliance with Section 02723 - Pipe Culverts.
  - .3 Install pipes to the following tolerances:
 

Horizontal tolerances:	plus or minus 50 mm from specified alignment
Vertical tolerances:	Plus or minus 10 mm from specified grade. Reverse grade is not acceptable.
  - .4 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
  - .5 Commence laying at outlet and proceed in upstream direction with bell ends of pipe facing upgrade.

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- .6 Pipe on curved alignment
    - .1 .1 For Concrete , PVC , profile PVC and open profile HDPE pipe do not exceed permissible joint deflection recommended by pipe manufacturer.
    - .2 Smooth profile PVC pipe: for 100 mm to 300 mm sizes conform to required curvature by bending pipe barrel. In no case is radius of curvature to be less than 300 times outside diameter of the barrel.
    - .3 Spiral Rib Pipe: Conform to required curvature by bending pipe barrel in accordance with manufacturer recommendations. In no case is radius of curvature to be less than 45m for pipes greater than 450mm in diameter. Deflection at the coupler not permitted.
  - .7 Keep jointing materials and installed pipe free of dirt, water and other foreign materials. Whenever work is stopped, install removable watertight bulkhead at open end of last pipe laid to prevent entry of water and foreign materials.
  - .8 Cut pipes as required, as recommended by pipe manufacturer, without damaging pipe and leave smooth end at right angles to axis of pipe.
  - .9 Joints:
    - .1 Install gaskets as recommended by manufacturer on all pipe unless specified otherwise in Supplementary Specifications.
    - .2 Support pipes with hand slings or crane as required minimizing lateral pressure on gasket and maintaining concentricity until gasket is properly positioned.
    - .3 Align pipes carefully before joining
    - .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
    - .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted.
    - .6 Complete each joint before laying next length of pipe.
    - .7 Minimize joint deflection after joint has been made to avoid joint damage.

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- .8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
  - .10 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise specified.
  - .11 When any stoppage of work occurs, restrain pipes in an approved manner to prevent "creep" du ring down time.
  - .12 Plug lifting holes with approved prefabricated plugs, to pipe suppliers' recommendations for sealing methods.
  - .13 Make watertight connections to man holes. Use shrinkage compensating grout when suitable gaskets are not available. Core neat circular holes in walls of existing manholes. Do not hammer or chip except as approved by Departmental Representative.
- 3.7 Pipe Surround**
- .1 Upon completion of pipe laying and after Departmental Representative has inspected work in place, surround and cover pipes as shown on Contract Drawings.
  - .2 Hand place surround material in uniform layers not exceeding 150 mm compacted Thickness simultaneously on both sides. Do not dump material within 1 m of pipe.
  - .3 Compact each layer from pipe invert to underside of backfill to minimum 95% Modified Proctor Density.
- 3.8 Connections to Existing Mainline Pipes**
- .1 Use prefabricated saddles or approved field connection materials and techniques to connect service pipes to existing mainline sewer pipes. Ensure joint structurally sound and watertight without encroachment into inner circle of mainline sewer pipe.
  - .2 Where feasible, make connections to existing non-reinforced or reinforced concrete mainline pipe by coring or sawing circular holes in existing pipe Walls. Where not feasible, make as follows :
    - .1 Break in to pipe by drilling small diameter holes, spaced at approximately 50 mm along pipe axis, using a d rill or chipping gun. Use hammer to strike concrete adjacent to center holes to create small core , and similarly expand core dimensions of stub
    - .2 Core dimensions to allow maximum 20 mm clearance around stub at any point
    - .3 Trim stub to conform closely to shape of pipe interior when installed.

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- .4 Insert stub into core, ensuring that no portion of stub protrudes beyond interior of pipe.
  - .5 Prepare non-shrink, fast-setting cementitious CAN3-G401 to "dry pack" consistency. Pack grout tightly into void between stub and pipe.
  - .6 Hand finish interior and exterior CAN3-G401 surfaces to smooth surface.
  - .7 Allow sufficient time for strength development of grout prior to installation of connecting pipe or trench backfill.
- ..3 For new connections to existing PVC mainline sewers, drill hole in mainline to exact dimension of new connection. Use saddle or insertable tee for connections more than two sizes smaller than mainline. Insertable tee may be used for all types of gravity mains provided insertable tee designed for applicable pipe thickness is used.
  - .4 For new connections to existing PVC pipe or open profile HDPE pipe mainline sewers use preformed tee or wye fitting when connection is up to two sizes smaller than main line pipe. For these pipes, in-situ installation of tees or wyes involving cutting across pipe ribs not permitted. For connections more than two sizes smaller than mainline pipe, an insertable tee for PVC pipe or open profile HDPE pipe is permitted. When insertable tee is used, hole cut into mainline pipe to cut as few ribs as possible.
- 3.9 Backfill**
- .1 Place and compact backfill material in accordance with - Excavating, Trenching and Backfilling.
  - .2 Backfill requirements, including type of material and compaction requirements, as shown on Contract Drawings.
- 3.10 Service Connection Installation**
- .1 Install service connections to 3.6 and as shown on Contract Drawings.
  - .2 Backfill requirements, including type of material and compaction requirements, as shown on Contract Drawings.
  - .3 Where specified, install inspection chamber at specified location, set plumb and to specified elevation as shown on Contract Drawings as applicable. If inspection chamber located in driveway, lane or paved surface install cover or lid as shown on Contract Drawings.
  - .4 Saw cut adjacent curb on alignment of service connection and paint green.

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- 3.11 Cleaning and Flushing**
- .1 Flush completed storm sewer per - Cleaning of Sewers. Before flushing and testing, ensure sewer system is completely finished and make arrangements with Departmental Representative for scheduling of testing.
  - .2 Water may be supplied from Municipal fire hydrants upon application for a Hydrant Use Permit.
  - .3 Obtain municipal approval prior to discharging flushing water to municipal sewers or drainage ditches.
  - .4 Comply with Federal, Provincial and Municipal Environmental regulations in in regard to discharge of flushing water.
  - .5 Provide Departmental Representative with all required approvals prior to discharging flushing water.
  - .6 Remove foreign material from pipe and related appurtenances by flushing with water. Main to be flushed at water velocities as high as can be obtained from available water sources. Continue flushing at least until flow from most distant point has reached discharge point and until water discharged is clean and clear.
- 3.12 Inspection and Testing**
- .1 Video Inspection of completed storm sewers under 900 mm in diameter following completion of installation per - CCTV Inspection of Pipelines
  - .2 Should video inspection indicate apparent deficiencies, Departmental Representative may direct Contractor to perform additional testing as follows.
  - .3 Additional testing may include passing rubber ball, mandrel or test plug having a minimum dimension of 95% of base inside diameter of sewer pipe completely through pipes and appurtenances. A light test may be performed in lieu of ball test at discretion of Departmental Representative.
- 3.13 Installation Standards**
- .1 Repair all deficiencies and visible leaks.
  - .2 Repair procedures and materials subject to approval of Departmental Representative.
  - .3 Departmental Representative reserves right to require Contractor to replace defective installations at Contractor's sole cost.
  - .4 Test procedures, including video inspection, to be repeated and repairs made until satisfactory results are obtained.
  - .5 Acceptable Ponding

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- .1 Connections: 10 mm maximum ponding over 4m length of pipeline.
  - .2 Mainline Plastic Sewers
    - .1 300mm diameter or less: 20mm maximum ponding over 4m length of pipeline
    - .2 Greater than 300mm diameter: 30mm ponding over 4m length of pipeline.
  - .3 Concrete Sewers
    - .1 300mm diameter or less : 20mm maximum ponding over a 5m length of pipeline
    - .2 Greater than 300mm diameter: 30mm maximum ponding over a 5 m length of pipeline.
- 3.14 Connections to Existing Mains**
- .1 Make connections to existing storm sewer systems unless shown otherwise on Contract Drawings. Notify Departmental Representative minimum 48 h in advance of scheduled connection.
  - .2 Make connection in presence of Departmental Representative. To prevent damage to existing utilities, excavate last 300 mm over utility by hand.
- 3.15 Perforated Drain Pipe**
- .1 Where shown on Contract Drawings or where directed by Departmental Representative install perforated drain pipe adjacent to sidewalk or curb and gutter.
  - .2 Drain pipe to be 100 mm minimum.
  - .3 Connect to catch basins
  - .4 Install other perforated drain pipes as shown on Contract Drawings.
  - .5 Install sweep bend and cap at ground grade at upstream end of run.
  - .6 Install with perforations downward.

END OF SECTION

- 
- 1.0 GENERAL**
- .1 Section 33 44 01 refers to those portions of the work that are unique to the supply and installation of manholes, cleanouts, catchbasins, storm sewer endwalls, lawn drains and related appurtenances. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.
- 1.1 Related Work**
- .1 Excavating, Trenching and Backfilling
- 1.2 Samples**
- .1 Samples may be required.
- 1.3 Material Certification**
- .1 Products having CSA certification to be used where readily available. Product to be certified to CSA standard(s) by an approved independent third party certification body accredited by the Standards Council of Canada and that is acceptable to the Contract Administrator. Products to be marked with certification body logo and CSA standard markings.
- .2 At least 14 days prior to commencing work, submit to the Contract Administrator the manufacturer's recent test data and certification that materials to be incorporated into works are representative and meet requirements of this section. Include manufacturer's drawings where pertinent.
- 2.1 PRODUCTS**
- 2.1 Materials**
- .1 Concrete: To Section 03 01 00 - Concrete.
- .2 Concrete to be minimum 20 MPa or as specified otherwise on Contract Drawings.
- .3 Concrete reinforcement: to Section 03 01 00 - Concrete
- .4 Precast manhole sections: to be precast reinforced concrete to ASTM C478M complete with ladder rungs.
- .5 Precast "Tee" Sections: precast "Tee" sections constructed as an integral component of mainline pipe will be acceptable where shown on Contract Drawings as an approved alternative.
- .6 Manhole lids manufactured from precast reinforced concrete or PVC shall be designed to withstand H2O loading.
- .7 Cast iron frame and cover: as shown on Contract drawings and as specified in Municipal Specifications.



- .1 Frame and cover must conform to ASTM A48 and be designed to withstand H2O loading.
- .2 Frame and cover must bear manufacturer identification on castings
- .8 Ladder rungs to be:
  - .1 As shown on Contract drawings.
  - .2 To conform to ASTM C497, ASTM C478M load test.
  - .3 20 mm cold rolled steel, hot dipped after bending to.CSA G164, welded to reinforcing bars and cast with manhole sections or epoxy grouted into manhole walls.
  - .4 20 mm aluminum alloy #6351-T6 (CSA S157 and NBC 1977), complete with polyethylene anchor insulating sleeves and installed in 25 mm or 26 mm precast or drilled holes in manhole sections.
  - .5 Polypropylene encased steel ladder rungs: polypropylene ASTM D4101 steel core to be 1/2 inch dia grade 60 as per ASTM A615M.
  - .6 Distance from top of manhole cover to top rung to be maximum 500 mm where no handhold provided. Maximum distance may be extended to 660 mm where handhold provided.
  - .7 In compliance with all requirements of Worksafe BC.
- .9 Safety platform: to be installed as shown on Contract Drawings in all manholes in excess of 6 m deep.
- .10 Precast catchbasin sections:
  - .1 As shown on Contract drawings.
  - .2 To be precast reinforced concrete to ASTM C478M.
- .11 Catchbasin leads to be minimum 150 mm diameter and of PVC DR35.
- .12 Catchbasin lids: to be designed to withstand H2O loading.

- 13 Cast iron catchbasin frame and grate: as shown on Contract drawings or as specified otherwise in Specifications.
  - .1 Frame and grate must conform to ASTM A48 and be designed to withstand H2O loading.
  - .2 Frame and grate must bear manufacturers identification on casting.
- .14 Joints: make watertight using cement mortar or rubber gaskets to ASTM C443M.
- .15 Mortar:
  - .1 Aggregate: to CSA A82.56.
  - .2 Cement: to CAN/CSA-A8.
- .16 Adjusting rings manufactured to:
  - .1 Concrete to ASTM C478M.
  - .2 HDPE to ASTM D1248.
- .17 Concrete Brick: to CAN3-A 165 Series.
- .18 Drop manhole pipe: to be as shown on Contract Drawings.
- .19 Lawn drains to be: As shown on Contract drawings.
- .20 Concrete bags to be: Jute, burlap or synthetic bag of suitable size and texture filled to 2/3 capacity with mixture of 1 part Portland cement to 2 parts sand, thoroughly mixed, and weighing approximately 27 kg.
- .21 Concrete blocks: to be H type concrete construction blocks conforming to latest ASTM specifications.
- .22 Prebenched manhole bases:
  - .1 Where precast manhole sections are incorporated into precast base by bonding to concrete benching, use precast reinforced concrete manhole sections to ASTM C478M complete with ladder rungs above benching.

- .2 Where base benching is cast monolithically with manhole walls, reinforce wall and joint sections as specified in ASTM C478M.
- .3 Precast concrete base section minimum thickness to be 120 mm, measured from underside of base to lowest point in concrete channelling.
- .23 Pre-fabricated Corrugated Steel Pipe Manholes may be used with installation of Corrugated Steel Storm Sewers. Pre-fabricated Corrugated Steel Pipe Manholes to be as shown on the Contract Drawings and in accordance with the manufacturers specifications.

### 3.1 EXECUTION

- 3.2 **Excavation and Backfill** .1 Excavate and backfill in accordance with Section 31 23 01 - Excavating, Trenching and Backfilling.
- 3.2 **Concrete Work** .1 Do concrete work in accordance with Section 03 01 00 – Concrete.
- 3.3 **Manhole Installation** .1 Install manholes as shown on Contract drawings, concurrently with pipe laying.
  - .2 Ensure excavation free of water prior to placing concrete.
  - .3 Place minimum 100 mm of 25 mm bedding gravel compacted to minimum 95% Modified Proctor density in compliance with ASTM D1557.
  - .4 Construct base to ensure first precast riser section is set plumb.
  - .5 Set all inlet and outlet pipes to specified alignments and elevations.
  - .6 Connect concrete pipe into manhole using spigot or bell precast into manhole wall or, alternatively, grout pipe into pre-formed rough core in manhole wall using fast-setting grout.
  - .7 Connect PVC pipe into manhole using "manhole adapter ring" or approved equal.
  - .8 Ensure placement of concrete does not disturb connecting pipes.

- .9 Set remaining precast riser sections plumb with joints consisting of cement mortar or gaskets to ASTM C443M
- .10 Where possible, form channelling using half-sections of pipe or suitable fittings. Bench to direct flow parallel to main flow of sewer. Form top of benching as high as crown of sewer pipe. Finish concrete to smooth surface using steel trowel.
- .11 Brace capped inlets or stubs to withstand testing head.
- .12 Installation of Masonry & Cementitious Riser Rings:
  - .1 Allowable number of courses is three and minimum is one.
  - .2 Allowable products is; bricks, precast concrete risers, and cast-in-place form system
  - .3 Due regard must be observed to the maximum distance to the first step.
  - .4 Pre-wet all joints before placing Mortar.
  - .5 Butter inside and outside faces of brick with mortar to ensure neat even grout.
  - .6 Grout inside, outside and between courses or grade rings with mortar to ensure neat even finish.
- .13 Installation of interlocking High Density Polyethylene Manhole Adjustment Riser Rings.
  - .1 Insure base has a flat seating area, remove all protrusions.
  - .2 Dry stack (without sealant) necessary flat and bevelled rings to provide necessary grade and cross fall with casting.
  - .3 Apply a vertical strip of paint to allow identical reassembly, after disassembling casting and rings.
  - .4 Apply a 12mm bead of approved sealant to the underside circumference of the ring against the male lip. A second

bead is required for the base ring and may be applied directly to the concrete base.

- .5 Continue with step 4 until all adjustment rings are sealed together.
  - .6 Also place sealant on the top of the last ring prior to installing the casting
  - .7 Provide a dry mix around the stack, protecting the rings from contact with hot asphalt.
  - .8 Approved sealants as per the manufacturer, conforming to ASTM D1850.
  - .14 Plug lifting holes in pipe.
  - .15 Install drop structures where required to Contract drawings.
  - .16 Paint manhole covers if specified in Specifications.
  - .17 Ensure frames conform to design contour of pavement or existing surface.
  - .18 Pre-fabricated Corrugated Steel Pipe Manholes to be installed as shown on the Contract Drawings and to manufacturers specifications.
- 3.4 Cleanout Installaton** .1 Install cleanouts as shown on Contract drawings standards and installation procedures described in 3.3 of this Section
- 3.5 Catchbasin Installation** .1 Install catchbasins as shown on Contract drawings to general standards and installation procedures described in 3.3 of this Section.
- .2 Place minimum of 100 mm bedding gravel under base, compact to 95% Modified Proctor density.
  - .3 Install catchbasin leads in accordance with Section 02721 - Storm Sewers.
- 3.6 Lawn Drain Installation** .1 Install lawn drains as shown on Contract drawings.
- 3.7 End wall Installation** .1 Install concrete block endwalls as shown on Contract drawings using H type concrete construction blocks.

- .2 Install reinforced concrete endwalls as shown on Contract drawings or as shown otherwise on Contract Drawings and in accordance with Section 03 01 00 – Concrete.
  - .3 Precast concrete endwalls may be installed where shown on Contract Drawings as an approved alternative.
- 3.8 Grillage Trash Screens**
- .1 Where specified, install grillage trash screens as shown on Contract drawings.
- 3.9 Adjusting Tops of Existing Units**
- .1 Remove existing gratings, frames and store for re-use at locations specified in Specifications.
  - .2 Precast units:
    - .1 Raise or lower precast units by adding or removing precast sections as required.
    - .2 When amount of raise is less than 300 mm use standard manhole bricks. precast riser rings or cast-in-place form system.
  - .3 Cast-in-Place units:
    - .1 Raise cast-in-place units by roughening existing top to ensure proper bond and extend to required elevation with cast- in-place concrete.
    - .2 Lower cast-in-place units with straight wall by removing concrete to elevation indicated for rebuilding.
    - .3 Install additional manhole ladder rungs in adjusted portion of units as required.
    - .4 Re-use existing gratings, frames.
  - .4 Re-set gratings and frames to required elevation on not more than 3 courses of brick. Make brick joints and join brick to frame with cement mortar, parge and trowel smooth.
  - .5 Ensure adjustments conform to requirements regarding distance to first step.

- 3.10 Remove Existing Units** .1 Remove existing structures where shown on Contract Drawings. Backfill in accordance with Section 31 23 01- Excavating, Trenching and Backfilling.

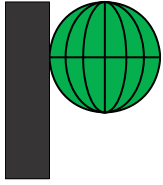
\*\*\*\* END OF SECTION \*\*\*\*

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# Appendix

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**PITEAU ASSOCIATES**  
GEOTECHNICAL AND  
HYDROGEOLOGICAL CONSULTANTS

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Our file: 3333

March 19, 2015

Fisheries and Oceans Canada  
Real Property & Technical Support Branch  
200 – 401 Burrard Street  
Vancouver, BC  
V6C 3S4

Attention: Mr. Tori Soames, Sr. Engineering Technician

Dear Sirs:

Re: Well Yield Assessment for Well #5, Inch Creek Hatchery, Dewdney, BC  
(Contract No. F1700-140653)

Piteau Associates Engineering Ltd. (Piteau) was retained by Fisheries and Oceans Canada (DFO) to assist with conducting aquifer pump testing with Well #5 at the Inch Creek Hatchery in Dewdney, BC in March 2015. The following letter report includes a summary of all work completed, and sets out analysis and interpretation of the test results.

**SCOPE OF SERVICES**

The work completed by Piteau was in general conformance with our proposal issued on February 12, 2015 and included the following tasks:

- assisting DFO with development of a statement of work for a contractor to be retained to conduct the aquifer pumping test;
- overseeing four-hour variable-rate and 24-hour constant-rate pumping tests with Well #5;
- monitoring water levels in a 150mm (6") diameter test well located 5.9m northwest from Well #5 before, during, and after the aquifer pumping tests;
- co-ordinating the collection of water chemistry measurements in Well #5 and water level measurements in four observation wells;
- analyzing data collected during variable-rate and constant-rate aquifer pumping tests and revising the estimated maximum sustainable long-term yield for Well #5; and
- preparing the following report with background information on Well #5, pumping test data and interpretations, water quality information, calculations of the sustainable well yield, and recommendations for commissioning and operation.



Fisheries and Oceans Canada  
Real Property & Technical Support Branch  
Attention: Mr. Tori Soames

- 2 - March 19, 2015

## **BACKGROUND INFORMATION**

The Inch Creek Hatchery is currently supplied with groundwater from four high-capacity wells located throughout the facility (Fig. 1). These wells draw from a very productive aquifer hosted within sands and gravels deposited by Norrish Creek. Inch Creek is a smaller watercourse situated to the west of Norrish Creek; it is fed by springs and upwelling groundwater.

Average outputs from the hatchery's four operating wells are as follows:

Well #	L/min	L/s	USgpm
1	7900	132	2100
2	5700	95	1500
3	4300	72	1150
4	1300	22	350
<b>Total</b>	<b>19,200</b>	<b>320</b>	<b>5100</b>

Well #5 (also identified by BC Ministry of Environment Well I.D. Plate No. 36376) will be used to provide supply redundancy at the hatchery, thus reducing risks associated with potential water supply interruptions with the operating wells. Groundwater from this well will not be used for drinking water purposes.

Well #5 was constructed between March and April 2014 using a Bucyrus Erie 22W cable tool drilling rig operated by Columbia Water Wells (CWW). A log for this well is included as Appendix A. It is 406mm (16") in diameter and is located in the southwest corner of the hatchery property next to a 150mm (6") diameter test well constructed in December 2013 (Fig. 1). The well is completed with 5.2m (17') of telescopic screen positioned in a layer of coarse sand and gravel between depths of 23.2 and 28.6m (76' and 93'). The design specified a screen slot size ranging between 2.5mm and 6.4mm (0.100" and 0.250").

Aquifer pump testing was conducted with Well #5 in June 2014 under the supervision of Piteau (2014<sup>1</sup>). The maximum pumping rate during this testing program was 75.7 L/s (1200 USgpm). Although the results indicated a well yield substantially greater than the test rate was possible, a maximum well yield of 85 L/s (1354 USgpm) was recommended to limit the velocity that groundwater enters the screen to 0.03 m/s (0.1 ft/sec) to conform with conventional design practices. It was further noted that to avoid triggering the need to complete an environmental assessment (in accordance with the *BC Environmental Assessment Act*), the maximum well pumping rate should be further limited to 74.9 L/s (1190 USgpm).

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<sup>1</sup> See August 15, 2014 letter-report.



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Following review by DFO, it was determined that a well yield greater than 85 L/s (1354 USgpm) would be desirable to provide supply redundancy at the hatchery. Piteau advised that this maximum yield was initially based on the broadly applied objective to limit the screen entrance velocity, and that a higher yield would be possible with only a slight increase in the potential for degraded long-term well performance. Piteau also advised that further aquifer pump testing at a higher rate would be needed to determine the actual safe yield. Accordingly, DFO commissioned the aquifer pumping test program described in this letter.

DFO have advised Piteau that after a detailed review, they have determined that an environmental assessment for Well #5 is not required on the basis that it will be used for supply redundancy purposes only, and will result in no net increase in the amount of groundwater to be withdrawn from the aquifer at the hatchery.

#### **SUMMARY OF 2015 AQUIFER PUMP TESTING PROGRAM**

Aquifer pump testing with Well #5 was completed by Precision Service and Pumps Inc. (PSP), who were contracted directly by DFO. All equipment required for the tests was mobilized to the site and set up on March 3 (Photo 1), and the tests were conducted between March 4 and 5. All equipment was demobilized on March 6.

The pumping tests were conducted using a temporarily installed, electrically powered 100-hp submersible pump with the intake positioned about 20.0m (66') below ground level. Power was supplied by a diesel generator, and controlled using a variable frequency drive. A flow control valve was positioned at the well head, and discharge was conveyed to Inch Creek, approximately 36m to the west (Fig. 1). The discharge rate was measured using an orifice plate device at the point of discharge.

Two 25mm (1") diameter PVC tubes were installed in the well to facilitate measurement of water levels in the pumped well using both an electric water level tape and a transducer-data logger. A small diameter pipe with a valve at the well head was used to divert a small stream of water through a flow cell for measurement of water chemistry parameters using a Horiba U52 multi-parameter meter.

Water levels in the 150mm (6") diameter test well (also identified by BC Ministry of Environment Well I.D. Plate No. 38464) situated 5.9m northwest from Well #5 were monitored using a data logger (Solinst Levellogger). Monitoring commenced 21 hours prior to the start of the variable-rate test. Additionally, hourly measurements were made during the pumping tests using an electric water level tape.



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Wells #1 through #4 were in continuous operation before, during, and after the aquifer pumping tests with Well #5. The PSP pump technicians monitored water level readings for these wells on an hourly basis. The pumping rate in Well #2 was increased by the operator about 2.5 hours before the end of the constant-rate test with Well #5.

The aquifer test program involved:

- A variable-rate pumping test was initiated at 11:20 AM on March 4. The well was pumped at rates of 42, 73, 102, and 139 L/s (659, 1150, and 1609, and 2206 USgpm) for intervals of 60 minutes each. The maximum drawdown observed at the end of the last step of the test was 10.5m (34.6'). Upon cessation of pumping, the water level recovered to within 95% of the pre-pumping level in less than one minute.
- A 24-hour constant-rate aquifer pumping test was initiated at 5:00 PM on March 3. A pumping rate of 139 L/s (2206 USgpm) was selected for this test based on the results of the variable-rate test. The maximum drawdown observed at the end of the pumping interval was 11.71m (38.41'). Water level recovery was monitored in the well for one hour after pumping stopped, and again the following day. Upon cessation of pumping, the water level recovered to within 95% of the pre-pumping level in less than one minute.

Water level and flow data for the variable-rate and constant-rate aquifer pumping tests with Well #5 are presented in Appendix B. Water level observations for Wells #1 through #4, and the 150mm (6") diameter test well, are also included.

A small flow of water pumped from Well #5 was diverted through a flow-cell for measurement of water chemistry parameters using a Horiba U52 multi-parameter instrument. Measurements were made hourly during the constant-rate test, and the observations are presented in Appendix C. Aside from some initial cloudiness in the discharge at the beginning of each step of the stepped-rate test, groundwater pumped during the variable- and constant-rate tests was observed to be clear.

## **ANALYSIS AND INTERPRETATION OF AQUIFER PUMPING TEST RESULTS**

### **Variable-Rate Test**

Figure 2 includes a plot of water level drawdown during the variable-rate test with Well #5. The upper portion of the figure includes a plot of the variable-rate test data and the lower portion shows pumping rate (Q) versus drawdown, and Q versus specific capacity (SC), which is the ratio of pumping rate to drawdown. Specific capacities ranged from 25.5 L/s/m at the end of the first step (Q = 42 L/s) to 13.2 L/s/m at the end of the final step (Q = 139 L/s).



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The negative slope on the Q vs. SC line indicates declining well efficiency as the pumping rate increased. This is a typical pattern; whereas drawdown resulting from head losses in the aquifer (aquifer loss) is generally directly proportional to pumping rate, the non-linear component is mainly due to head losses in the vicinity of the screen (well loss).

### Constant-Rate Test

Figure 3 includes a plot of drawdown during the pumping interval of the constant-rate test versus the logarithm of time, and, residual drawdown during the recovery interval (after the pump is shut off) versus the logarithm of the time ratio<sup>2</sup>.

The transmissivity determined from a straight-line fit to the early Well #5 pumping interval data using the Cooper-Jacob (1946<sup>3</sup>) method was  $6 \times 10^{-2} \text{ m}^2/\text{s}$ .

The water levels observed in the 150mm (6") test well before and during the pumping tests are shown on Fig. 4. Water levels in the upper portion of the figure are plotted against natural time, and in the lower portion the water levels during the constant rate test are plotted against the logarithm of time. The water level fell about 4mm during the 21-hour period preceding the pumping tests, and the maximum drawdown in this well during the constant rate test was 0.26m (0.9').

The transmissivity determined from drawdown data for the 150mm (6") diameter test well using the Cooper-Jacob (1946) method is  $1 \times 10^{-1} \text{ m}^2/\text{s}$ . Since the shape of the water level trend curve in the test well resembles the delayed yield curve for an unconfined aquifer, a more accurate estimate of the transmissivity was obtained by applying the Neuman (1975<sup>4</sup>) curve-matching approach to a log-log plot of the water level against time. The resulting transmissivity was  $6 \times 10^{-2} \text{ m}^2/\text{s}$ , which is the same as the value determined for Well #5.

Aquifer transmissivity ( $T$ ) is equivalent to the horizontal hydraulic conductivity ( $K$ ) multiplied by aquifer thickness ( $b$ ). Using the range in transmissivity values indicated above, and an aquifer thickness ( $b$ ) of 6.7m, the equivalent horizontal hydraulic conductivity of the aquifer sediments encountered at Well #5 is estimated at about  $9 \times 10^{-3} \text{ m/s}$ . This value is consistent with a well sorted sand and gravel, which is the type of material in which the well is screened.

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<sup>2</sup> time ratio =  $t/t'$  where  $t$  is time since start of test and  $t'$  is time since pumping stopped.

<sup>3</sup> Cooper, H.H., and Jacob, C.E., 1946. A generalized graphical method for evaluating formation constants and summarizing well field history. In American Geophysical Union Transactions, V.27, pp. 526-534.

<sup>4</sup> Neuman, S.P., 1975. "Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response." Water Resources Res., v. 11, p. 329-342.



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Maximum apparent drawdown in Wells #1 through #4 and the 150mm (6") Test Well during the constant-rate test with Well #5 were as follows:

<u>Well</u>	<u>Drawdown (m)</u>
#1	0.2
#2	0.5
#3	0.2
#4	0.3
150mm (6") Test Well	0.3

The magnitude of drawdown in Wells #1 through #4 was relatively small, and did not affect their pumping rates.

#### Well #5 Estimated Safe Yield

The safe yield for a well is normally determined as the lesser of the maximum sustainable rate that it can be continuously pumped for 100 days under the least favourable recharge conditions, or the recommended transmitting capacity of the screen assembly based on slot size and length. As previously indicated, the transmitting capacity constraint for Well #5 has been waived to achieve a safe yield that is closer to DFO's requirement. This is not unreasonable or unsafe, as recent literature, including research by the American Water Works Association, indicate that the 0.03 m/s (1 ft/sec) entrance velocity is highly conservative, and the numerical entrance velocity has been removed from their revised standard<sup>5</sup>.

The 100-day maximum pumping rate under the least favourable recharge conditions is determined using the aquifer pumping test results using the formula:

$$Q = D_{\text{design}} \times SC_{100}$$

where Q is the safe yield,  $D_{\text{design}}$  is the design drawdown, and  $SC_{100}$  is the specific capacity (ratio of pumping rate to drawdown) after 100 days of pumping.  $D_{\text{design}}$  is typically taken as 70% of the maximum available drawdown (difference between the adjusted lowest seasonal water table level and top of the aquifer), less allowances for seasonal lowering of the water table and drawdown interference caused by pumping of other wells.  $SC_{100}$  is the pumping rate during the constant-rate test divided by the extrapolated drawdown after 100 days of pumping.

Table I details calculation of the 100-day safe pumping rate for Well #5 and indicates a 100-day maximum pumping rate of 142 L/s (2250 USgpm). A short-term yield of up to 175 L/s (2775 USgpm) may be achievable at some times of the year by increasing the safety factor from

<sup>5</sup> Roscoe Moss Company, 2006. Technical Memorandum 006-6 Entrance Velocity: It's Importance to Well Design.





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70 to 80%, and eliminating the allowance for seasonal aquifer water level variation.

As pumping of Well #5 will not cause any increase in the net amount of groundwater withdrawn from the aquifer, its operation is not expected to have any noticeable effects on water levels or pumping rates from other operating wells at the hatchery, or flows in nearby surface watercourses.

### **WATER QUALITY**

Water chemistry observations made during the pumping test are summarized in Appendix C. Turbidity gradually decreased during the test while dissolved oxygen stabilized at about 60% saturation. At about 6.5, pH is relatively low, and on the lower border of the range set out in the Guidelines for Canadian Drinking Water Quality (Health Canada, 2014<sup>6</sup>).

The laboratory report for analyses of groundwater samples collected during the June 2014 pumping test with Well #5 indicated that groundwater from the well is exceptionally low in mineralization and is very soft. The concentrations of total dissolved solids (TDS) and hardness were 33 mg/L and 8.2 mg/L (as CaCO<sub>3</sub>), and the concentrations of all parameters analyzed were within limits recommended in the Guidelines for Canadian Drinking Water Quality.

Notwithstanding the foregoing results, groundwater from Well #5 should not be used for drinking water purposes without further analyses in accordance with the 2015 BC Ministry of Health (MOH) draft guidance document entitled "Guidance Document for Determining Ground Water at Risk of Containing Pathogens (GARP), Version 2"<sup>7</sup>.

The potential for the screens or other components in Well #5 to experience corrosion or encrustation has been addressed by calculating the Langelier Saturation Index (LSI), which is a measure of calcium carbonate solubility and the tendency for CaCO<sub>3</sub> to precipitate (encrust) and form mineral scale. LSI values greater than zero indicate that CaCO<sub>3</sub> is super-saturated and precipitation is likely to occur. When LSI = 0, CaCO<sub>3</sub> is in equilibrium and when the LSI is less than zero CaCO<sub>3</sub> is likely to dissolve. The calculated LSI for Well #5 is -3.2. This value indicates that water from Well #5 is undersaturated with respect to calcium carbonate; this water has tendency to remove existing calcium carbonate protective coatings in pipelines and equipment. In other words, there is a possibility for long-term corrosion of screens and other infrastructure due to the characteristics of the groundwater. This is also expected to be the case for Wells #1 through #4.

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<sup>6</sup> Health Canada, 2014. "Guidelines for Canadian Drinking Water Quality," prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment, October, [http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum\\_guide-res\\_recom/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php)

<sup>7</sup> BC Ministry of Health (MOH), 2015. Draft guidance document entitled "Guidance Document for Determining Ground Water at Risk of Containing Pathogens (GARP), Version 2," January, [http://www.health.gov.bc.ca/protect/pdf/garp\\_assessment\\_v2\\_consultation.pdf](http://www.health.gov.bc.ca/protect/pdf/garp_assessment_v2_consultation.pdf)



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## **COMMISSIONING AND OPERATION OF WELL #5**

### Pump Selection and Surface Installation

Use of a variable-speed drive pump in Well #5 is recommended as this will facilitate optimization of well operation under various demands. The pump intake should be positioned about 2m above the top of the well screen (depth = 21.2m or 69.4'). The maximum recommended long-term pumping rate for Well #5 is 142 L/s (2250 USgpm), but short-term rates of up to 175 L/s (2775 USgpm) may be achievable. The lowest operational pumping level should be the lesser of either 2m above the pump intake, or the net positive suction head allowance specified by the pump manufacturer. A low-level shutoff should be set at this depth to protect the pump in the event of overpumping.

In accordance with the Ground Water Protection Regulation, Well #5 should have a minimum of 30 cm casing stickup (above existing or modified ground surface), appropriate drainage away from the well, and completion with a secure well cap.

It is recommended that a pitless adapter be installed in conjunction with a new submersible pump.

### Chlorination

Well #5 should be chlorinated after the permanent pump is installed. As chlorinated water is toxic to fish, it must not be discharged to aquatic habitat, but rather into a soakaway pit in the ground.

### Well Operation

Operation of Well #5 should be controlled to prevent:

- Over-pumping: care should be taken to ensure that the start-up surge does not exceed design rates. For example, the pump could be designed to start against closed valves or against a full column of water. A foot valve would keep water in the column.
- Back-washing: unless during re-development.
- Flushing: if water is allowed to cascade in the well and the well becomes aerated, the well can become iron bacterial slimed within a few months. Thus, the start-up and the shutdown water must not be allowed to enter the well.
- Raw-hiding: if the pump is allowed to start and stop frequently, the well is "raw-hided". This may destabilize aquifer materials, resulting in increased sediment and potentially reduced efficiency. The discharge from the well should be correlated with system demand so that the



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pump operates for at least one hour after start-up and is idle for at least one hour after shutdown.

### Monitoring

Well #5 should be instrumented with a pressure transducer to provide a record of water levels and temperature under pumping and non-pumping operating conditions. A flow meter should be used to track the amount of groundwater pumped.

The efficiency and operational lifespan of the wells will be enhanced by a proactive maintenance program. This program should include downhole imaging, pumping tests, and rehabilitation when well efficiency has dropped by 10-15%.

### **CONCLUSIONS AND RECOMMENDATIONS**

This letter report describes a second aquifer pumping test program conducted with Well #5 at the Inch Creek Hatchery in Dewdney, BC. Results of analysis and interpretation of the testing results are also included. Key conclusions from this program of work are set out below.

The estimated long-term maximum yield for Well #5 is 142 L/s (2250 USgpm). A pumping rate of up to 175 L/s (2775 USgpm) may be achievable at some times of the year.

Groundwater from Well #5 is low in mineralization, very soft, and is of very good quality. The concentrations of all parameters analyzed are within limits recommended in the Guidelines for Canadian Drinking Water Quality (Health Canada, 2014).

Use of a variable-speed drive pump in Well #5 is recommended. The pump should be installed with its intake 2m above the top of the well screen (21.2m depth) and the pump should be capable of pumping at a rate of at least 142 L/s (2250 USgpm). All other recommendations on well commissioning and monitoring included in this report should be observed.

### **LIMITATIONS**

The completed work described in this letter report has been conducted using a standard of care consistent with that expected of scientific and engineering professionals undertaking similar work under similar conditions in BC. No warranty is expressed or implied.

This letter report is prepared for the sole use of Fisheries and Oceans Canada. Any use, interpretation, or reliance on this information by any third party is at the sole risk of that party, and Piteau accepts no liability for such unauthorized use.



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## **CLOSURE**

We trust this letter report provides sufficient information for your present needs. Should you require further clarification on any item, please contact the undersigned. The opportunity to be of service is appreciated.

Yours truly,

PITEAU ASSOCIATES ENGINEERING LTD.

**ORIGINAL SIGNED**

Arnd Burgert, P.Geo.  
Senior Hydrogeologist

**ORIGINAL SIGNED**

David J. Tiplady, P.Eng.  
Principal Hydrogeologist  
Vice President - Groundwater

AB/slc

Att.

## TABLE

**TABLE I  
CALCULATION OF SAFE YIELD FOR WELL #5**

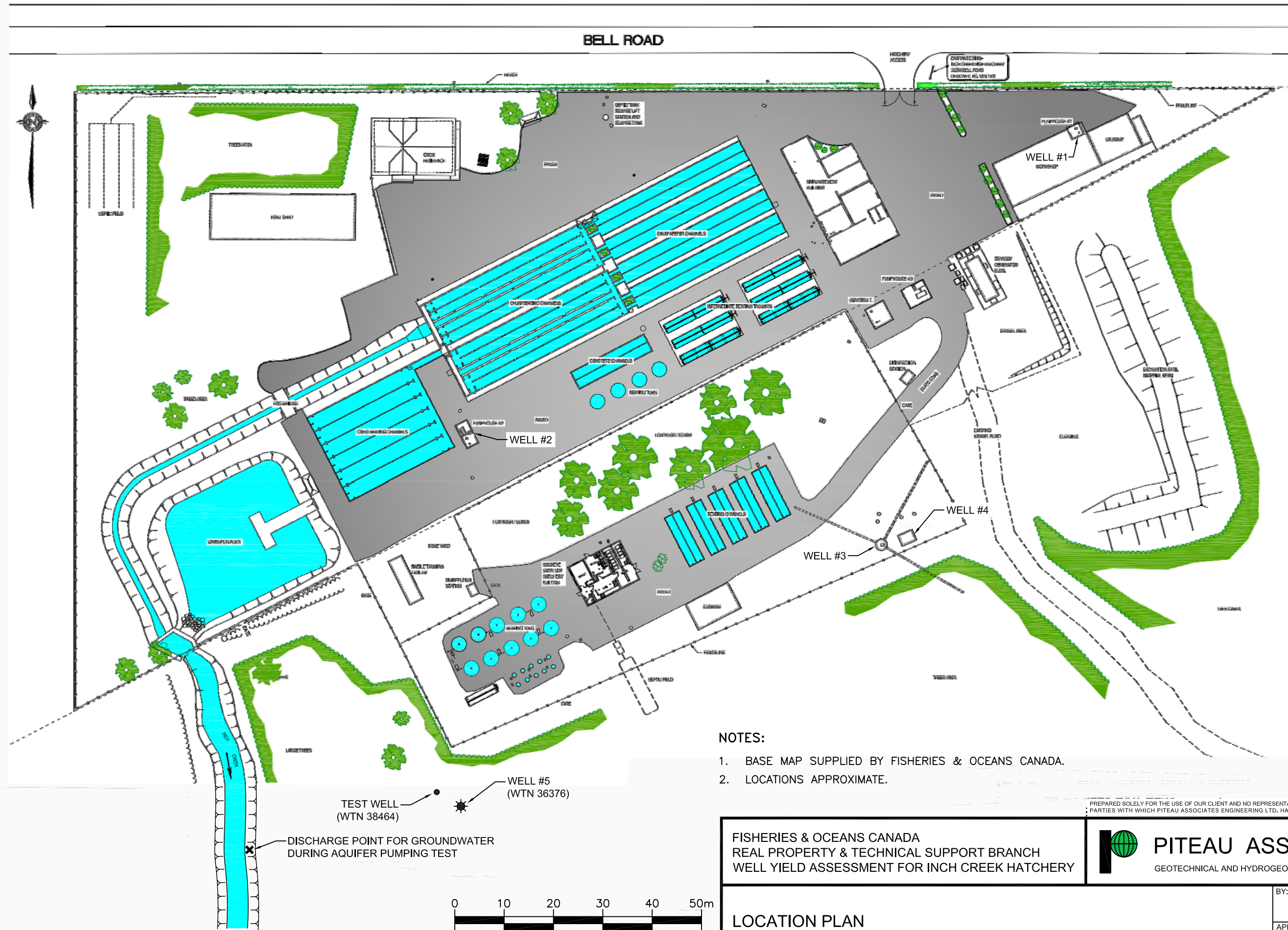
	PARAMETER	UNIT	Well #5
A	Static water level	m-bgl	3.7
B	Depth to top of screens	m-bgl	23.2
C	Available drawdown = $B - A$	m	19.5
D	Safety Factor (SF)		70%
E	Maximum allowable drawdown = $C \times D$	m	13.7
	<b>Allowance for interwell drawdown interference &amp; seasonal adj.</b>		
	resulting from operation of Wells #1, #2, #3, and #4	m	0.00
	seasonal adjustment	m	1.00
F	Total:	m	1.00
G	Maximum design drawdown ( $D_{max}$ ) = $E - F$	m	12.7
H	Test rate used for analysis	L/s	139.0
I	Projected drawdown after 100 days pumping at rate specified in (H)	m	12.4
J	Estimated 100-day $S_c = H / I$	L/s/m	11.2
K	Estimated 100-day safe pumping rate ( $Q_{100}$ ) based on well test = $G * J$	L/s	142
		USgpm	2250

H:\Project\3333\Aquifer\_Tests\March 2015\[Table I - safe yield calcs.xlsx]Table I

Notes:

1. m-bgl = metres below ground level

## FIGURES



**NOTES:**

1. BASE MAP SUPPLIED BY FISHERIES & OCEANS CANADA.
2. LOCATIONS APPROXIMATE.

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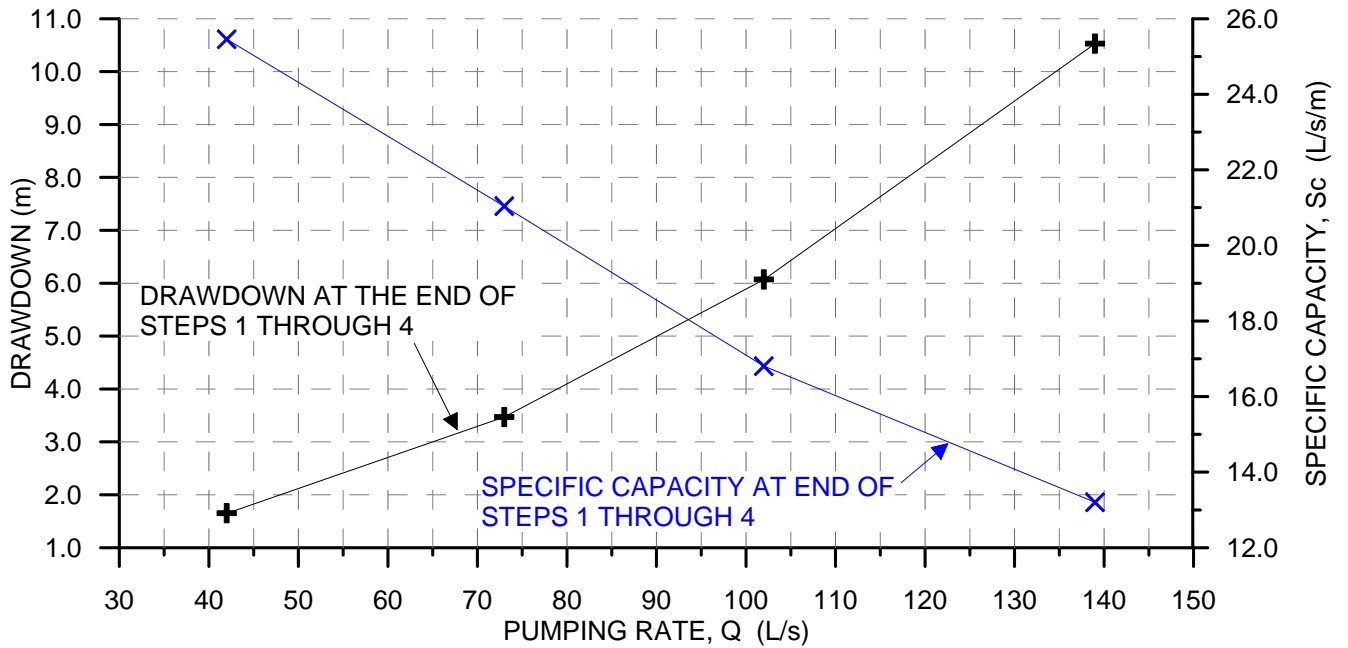
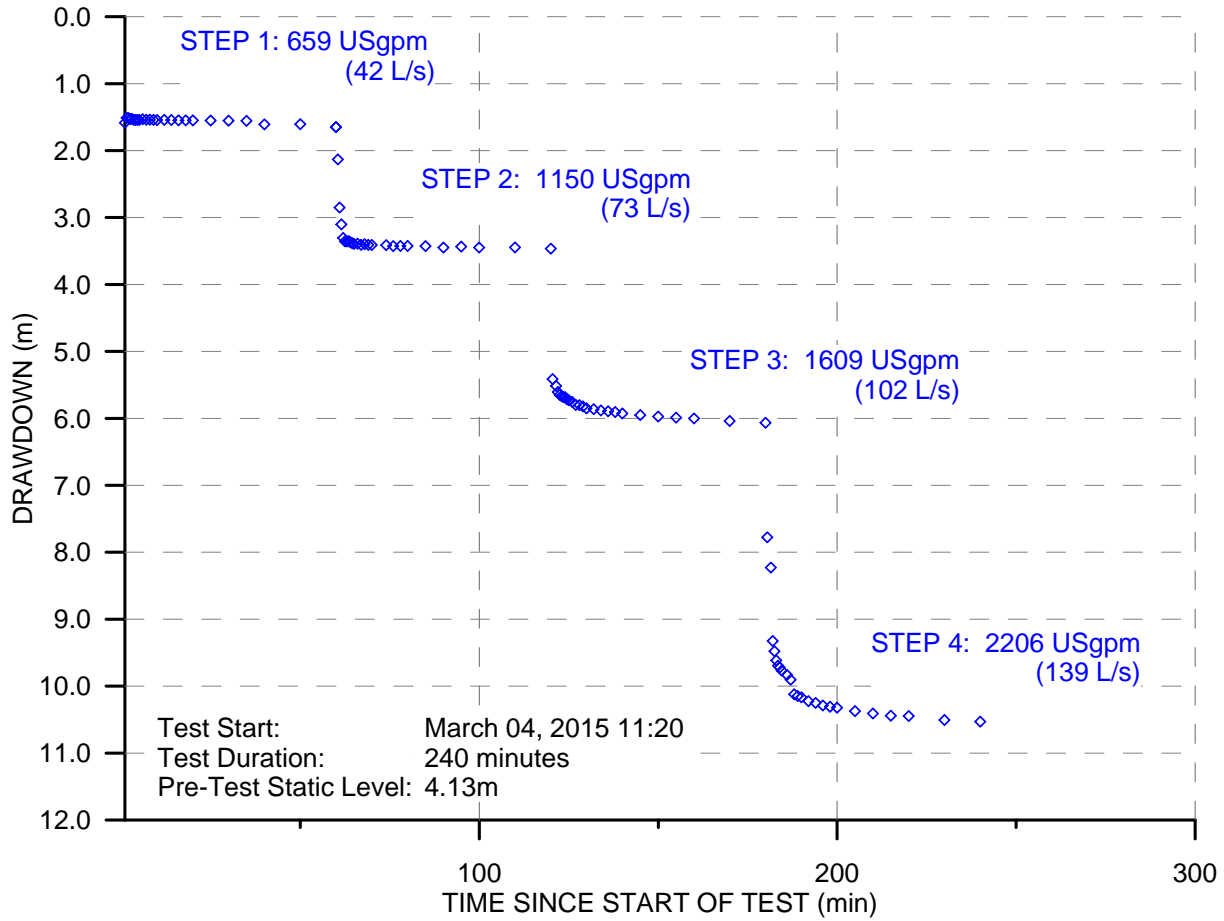
FISHERIES & OCEANS CANADA  
 REAL PROPERTY & TECHNICAL SUPPORT BRANCH  
 WELL YIELD ASSESSMENT FOR INCH CREEK HATCHERY

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 GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

**LOCATION PLAN**

BY:	DATE:
DJT/lf	JUL 14
APPROVED:	FIG:
DJT	1





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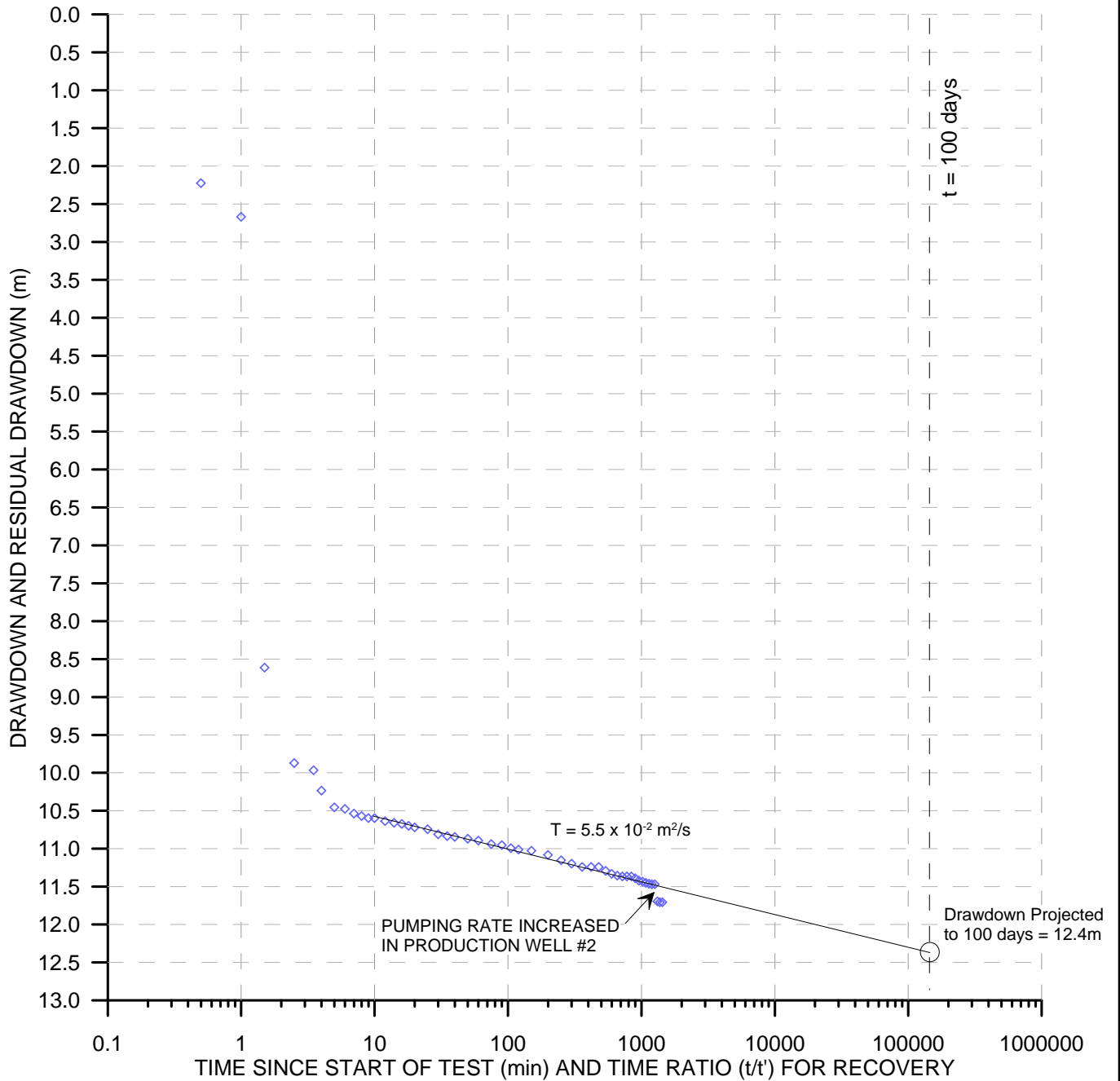
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 WELL YIELD ASSESSMENT FOR INCH CREEK HATCHERY



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**ANALYSIS OF VARIABLE-RATE PUMPING TEST WITH WELL #5**

BY:	GL/AB	DATE:	MAR 15
APPROVED:	AB	FIG:	2



Test Start: June 17, 2014 14:40  
 Test Duration: 24 hours (1440 minutes)  
 Test Rate: 74.9 L/s (1200 USgpm)  
 Static Water Level: 3.46m

**COOPER & JACOB (1946)**

$$T = \frac{2.303 \cdot Q \cdot 0.001}{4 \cdot \pi \cdot \Delta s}$$

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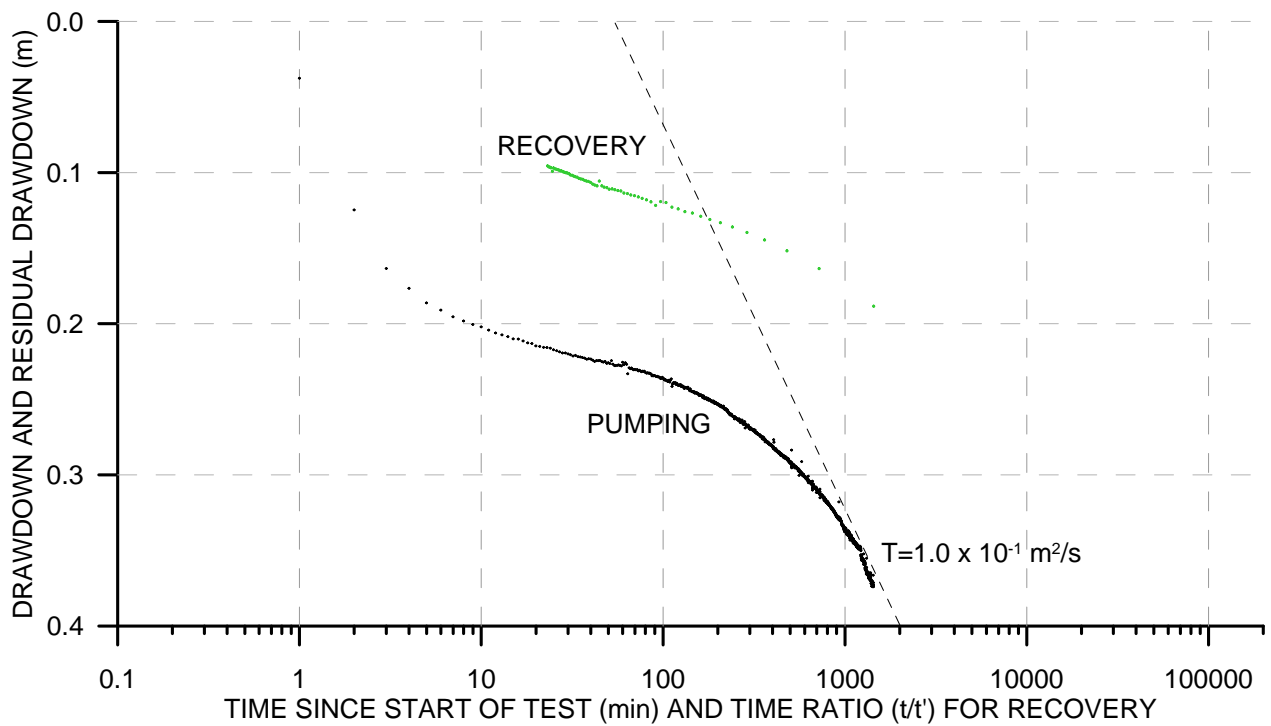
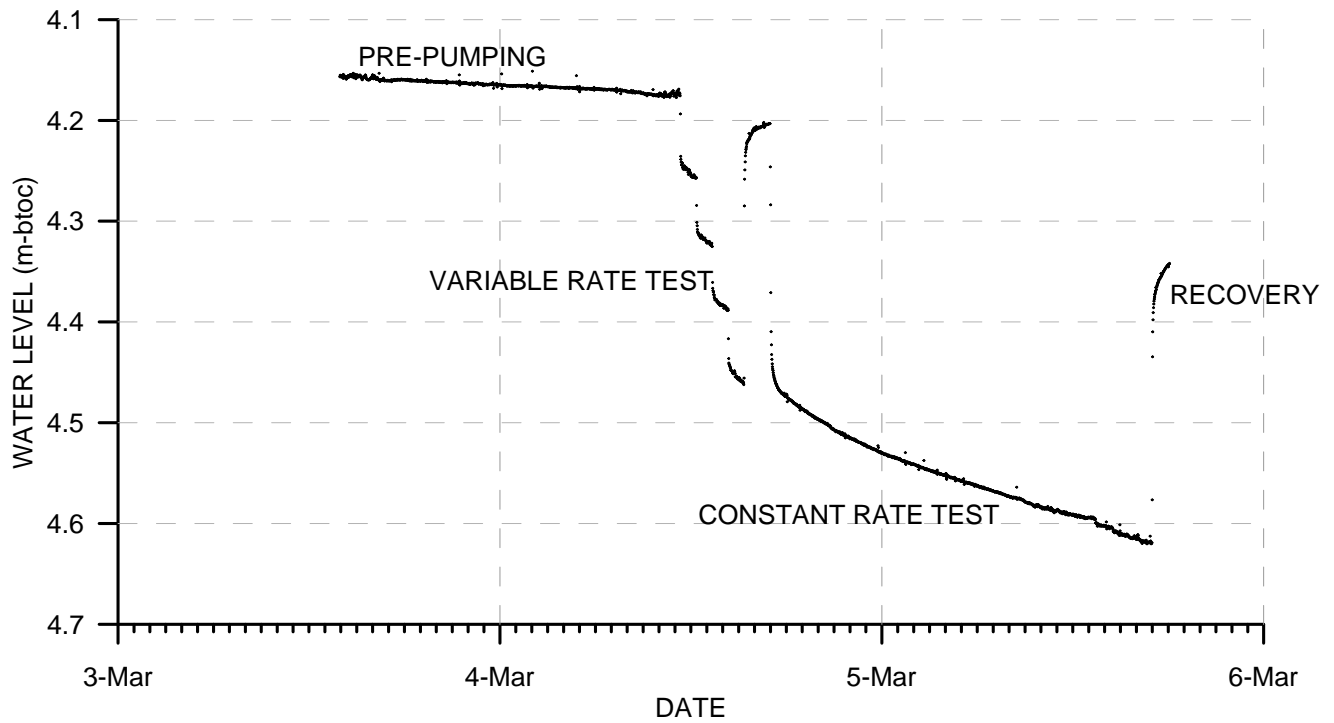
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**ANALYSIS OF DRAWDOWN DURING CONSTANT-RATE  
 AQUIFER PUMPING TEST WITH WELL #5**

BY:	DATE:
GL/AB	MAR 15
APPROVED:	FIG:
AB	3



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**ANALYSIS OF DRAWDOWN IN 6" TEST WELL  
 DURING CONSTANT-RATE  
 AQUIFER PUMPING TEST WITH WELL #5**

BY:	DATE:
AB	MAR 15
APPROVED:	FIG:
AB	4

## PHOTOS

FILE: P:\Photos\3333\March 2015 Site visit



**Photo 1.**  
Installation of the test pump in Well #5.



**Photo 2.**  
Orifice plate flow measurement device at discharge point during constant rate test  
( $Q = 139 \text{ L/s}$  [2,206 USgpm]).

**APPENDIX A**

**CONSTRUCTION LOG FOR WELL #5**



Well Construction Report  
 Well Closure Report

**COLUMBIA WATER WELLS**  
 25188 52 AVE ALD. B.C.  
 V4W 1G2

Ministry well ID plate number:  
 Ministry Well Tag Number: **36376 #**

Confirmation/alternative specs. attached  
 Original well construction report attached

Red lettering indicates minimum mandatory information.

Owner name: **D.F.O.** Mailing address: **INCH CREEK HATCHERY** Prov \_\_\_\_\_ Postal Code \_\_\_\_\_  
 Address for well location: Street no. **38620 Bell Rd** Street name **DEWDNEY B.C. VOM IHO** Town \_\_\_\_\_  
 Legal description for well location: Lot \_\_\_\_\_ Plan \_\_\_\_\_ D.L. \_\_\_\_\_ Block \_\_\_\_\_ Sec. \_\_\_\_\_ Twp. \_\_\_\_\_ Rg. \_\_\_\_\_ Land District \_\_\_\_\_  
 PID for well location: \_\_\_\_\_ (and) Description of well location (attach sketch, if nec): \_\_\_\_\_

Zone: \_\_\_\_\_ (and) UTM Northing: \_\_\_\_\_ m (or) Latitude: deg \_\_\_\_\_ min \_\_\_\_\_ sec  
 UTM Easting: \_\_\_\_\_ m Longitude: deg \_\_\_\_\_ min \_\_\_\_\_ sec

See reverse for notes & definitions of abbreviations.

Type of work:  new well  alteration  closure  
 Method of drilling:  air rotary  cable tool  mud rotary  auger  driving  jetting  excavating  other (specify): \_\_\_\_\_  
 Orientation of well:  vertical  horizontal Angle: \_\_\_\_\_ Ground elevation:  ft asl Method: \_\_\_\_\_  
 Class of well (see note 2 on reverse): \_\_\_\_\_ Sub-class of well: \_\_\_\_\_  
 For water supply wells, indicate intended water use:  private domestic  water supply system  irrigation  commercial or industrial  other (specify): \_\_\_\_\_

**Lithologic description or closure description** (see reverse on how to fill out)

From (ft bgl)	To (ft bgl)	Relative Hardness	Colour	Material Description (use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	3			FILL MIXED GRAVEL.		
3	16			F-C SAND + GRAVEL		
16	24			F-C SAND + GRAVEL SOME COB. GRAY WASH.		
24	34			F-C SAND + GRAVEL WITH SMALL COB. 6 TO 8 INCH. SIZE		
34	41			GRAY CLAY SOME STONES		
41	64			F-C SAND + GRAVEL WITH COB. BR. SILTY WASH (WATER)		
64	65			BROWN CLAY		
65	71			GRAY CLAY SOME GRAVEL.		
71	85			F-C SAND + GRAVEL COB.		
85	93			F-C SAND + GRAVEL COB. DRIVE'S LOOSER.		
93	94			F-C SAND + GRAVEL BR. CLAY SEAMS LESS WATER		

**Casing details**

From (ft bgl)	To (ft bgl)	Dia (in)	Casing Material	Wall Thickness (in)	Drive Shoe	Uncased Hole
0	19	20"	STEEL	375		
0	94-0	16	STEEL	375	16"	

**Screen details**

From (ft bgl)	To (ft bgl)	Dia (in)	Type (see note 12)	Slot Size
73-6	76-0	16"	K-PACKER + 1 FT RISER. S.S.	
76-0	79-0	16"	S.S.	100
79	90-0	16"	S.S.	150
90	93-0	16"	S.S.	250
93-0	94-2	16"	S.S. TAIL PIPE BOTTOM	10

Surface seal: Type: **BENTONITE CHIP** Depth (ft): **19'**  
 Method of installation:  Poured  Pumped Thickness (in): \_\_\_\_\_  
 Backfill: Type: **NATIVE** Depth (ft): **19-7 FROM TOP**  
 Liner:  PVC  Other (specify): \_\_\_\_\_ Thickness (in): \_\_\_\_\_  
 From: \_\_\_\_\_ ft bgl To: \_\_\_\_\_ ft bgl Perforated: From: \_\_\_\_\_ ft bgl To: \_\_\_\_\_ ft bgl

Screen type:  Telescope  Pipe size  
 Screen material:  Stainless steel  Plastic  Other (specify): \_\_\_\_\_  
 Screen opening:  Continuous slot  Slotted  Perforated  
 Screen bottom:  Bail  Plug  Plate  Other (specify): \_\_\_\_\_  
 Filter pack: Type and size of material:  
 From: \_\_\_\_\_ ft To: \_\_\_\_\_ ft Thickness: \_\_\_\_\_ in

**Developed by:**

Air lifting  Surging  Jetting  Pumping  Bailing  
 Other (specify): \_\_\_\_\_ Total duration: \_\_\_\_\_ hrs  
 Notes: \_\_\_\_\_

**Well yield estimated by: PUMP TEST BY OTHERS**

Pumping  Air lifting  Bailing  Other (specify): \_\_\_\_\_  
 Rate: **100 CPM** USgpm Duration: **GAS PUMP.** hrs  
 SWL before test: **10-4** ft (btoc) Pumping water level: **11-0** ft (btoc)

**Obvious water quality characteristics:**

Fresh  Salty  Clear  Cloudy  Sediment  Gas  
 Colour/odour: \_\_\_\_\_ Water sample collected:

**Well driller** (please print):

First name: **DARREN** Last name: **MITCHELL**  
 Registration no. of driller responsible (if applicable; see note 16): \_\_\_\_\_  
 Consultant (if applicable): \_\_\_\_\_

**Final well completion data:**

Total depth drilled: **94** ft Finished well depth: **94** ft bgl  
 Final stick up: **2-0'** in Depth to bedrock: \_\_\_\_\_ ft bgl  
 SWL: **10-4"** ft (btoc) Estimated well yield: \_\_\_\_\_ USgpm  
 Artesian flow: \_\_\_\_\_ USgpm, or artesian pressure: \_\_\_\_\_ ft  
 Type of well cap: **WELDED LID.** Well disinfected:  Yes  No  
 Where well ID plate is attached: **YES**

**Well closure information:**

Reason for closure: \_\_\_\_\_  
 Method of closure:  Poured  Pumped  
 Sealant material: \_\_\_\_\_ Backfill material: \_\_\_\_\_  
 Details of closure: \_\_\_\_\_

**Date of work:**

Started (YYYY/MM/DD): **MARCH 5/19** Completed (YYYY/MM/DD): **MARCH 27/19**  
 Comments: \_\_\_\_\_

## **APPENDIX B**

### **SUMMARY OF AQUIFER PUMPING TEST DATA**



**APPENDIX B**  
**WATER LEVELS IN WELL #5 DURING VARIABLE RATE TEST**

Date	Clock Time	Elapsed Time (minutes)	Interval Time (minutes)	Depth (m)	Drawdown (m)	Flow Rate (L/s)	Flow Rate (USgpm)	Comment
04-Mar-15	12:00:00	0	0	4.13	0.00			STATIC WATER LEVEL START PUMP
04-Mar-15	12:00:30	0.5	0.5	5.59	1.46			
04-Mar-15	12:01:30	1	1	5.72	1.58			51.5 IN. AT ORIFICE
04-Mar-15	12:03:00	1.5	1.5	5.64	1.51	42	659	WATER DIRTY DARK DARK BROWN
04-Mar-15	12:05:00	2	2	5.64	1.51			
04-Mar-15	12:07:30	2.5	2.5	5.66	1.53	42	659	EARTHY SMELL
04-Mar-15	12:10:30	3	3	5.66	1.53			1.5-2 MINUTES CLEAR
04-Mar-15	12:14:00	3.5	3.5	5.67	1.54	42	659	51.5 IN. AT ORIFICE
04-Mar-15	12:18:00	4	4	5.67	1.54			SUNNY, COOL, DRY
04-Mar-15	12:22:30	4.5	4.5	5.67	1.54	42	659	WATER CRYSTAL CLEAR
04-Mar-15	12:27:30	5	5	5.67	1.54			
04-Mar-15	12:33:30	6	6	5.66	1.53	42	659	SLIGHT RAMP UP AND DOWN ON DRIVE
04-Mar-15	12:40:30	7	7	5.67	1.54			51.1 IN. AT ORIFICE
04-Mar-15	12:48:30	8	8	5.67	1.54	42	659	
04-Mar-15	12:57:30	9	9	5.67	1.54			
04-Mar-15	13:07:30	10	10	5.68	1.55	42	659	51.1 IN. AT ORIFICE
04-Mar-15	13:19:30	12	12	5.67	1.54			
04-Mar-15	13:33:30	14	14	5.68	1.55	42	659	
04-Mar-15	13:49:30	16	16	5.68	1.55			WATER CLEAR
04-Mar-15	14:07:30	18	18	5.68	1.55	42	659	
04-Mar-15	14:27:30	20	20	5.68	1.55			51.1 IN. AT ORIFICE
04-Mar-15	14:52:30	25	25	5.68	1.55	42	659	
04-Mar-15	15:22:30	30	30	5.68	1.55			
04-Mar-15	15:57:30	35	35	5.69	1.56	42	659	CHANGE TO 8" PLATE
04-Mar-15	16:37:30	40	40	5.74	1.61			
04-Mar-15	17:27:30	50	50	5.74	1.61	42	659	
04-Mar-15	18:27:30	60	60	5.78	1.65			
04-Mar-15	19:27:30	60	0	5.78	1.65			INCREASE FLOW RATE; START STEP 2
04-Mar-15	20:28:00	60.5	0.5	6.26	2.13			
04-Mar-15	21:29:00	61	1	6.98	2.85			13.5 IN. AT ORIFICE
04-Mar-15	22:30:30	61.5	1.5	7.23	3.10			
04-Mar-15	23:32:30	62	2	7.44	3.31	70	1107	13.5 IN. AT ORIFICE
04-Mar-15	00:35:00	62.5	2.5	7.49	3.36			LIGHT BROWN TINGE
04-Mar-15	01:38:00	63	3	7.49	3.36			SUNNY AND WARM
04-Mar-15	02:41:30	63.5	3.5	7.48	3.35			
04-Mar-15	03:45:30	64	4	7.50	3.37			
04-Mar-15	04:50:00	64.5	4.5	7.51	3.38			
04-Mar-15	05:55:00	65	5	7.53	3.40	70	1107	SLIGHT BROWN TINGE
04-Mar-15	07:01:00	66	6	7.52	3.39			13.5 IN. AT ORIFICE
04-Mar-15	08:08:00	67	7	7.54	3.41			WATER CLEARING
04-Mar-15	09:16:00	68	8	7.53	3.40			SLIGHT DISCOLOURED
04-Mar-15	10:25:00	69	9	7.54	3.41	70	1107	13.5 IN. AT ORIFICE
04-Mar-15	11:35:00	70	10	7.54	3.41			
04-Mar-15	14:01:00	74	14	7.54	3.41	73	1157	14.75 IN. AT ORIFICE
04-Mar-15	15:17:00	76	16	7.56	3.43	73	1157	
04-Mar-15	16:35:00	78	18	7.56	3.43			WATER CLEAR
04-Mar-15	17:55:00	80	20	7.56	3.43	73	1157	
04-Mar-15	19:20:00	85	25	7.56	3.43			
04-Mar-15	20:50:00	90	30	7.58	3.45			
04-Mar-15	22:25:00	95	35	7.57	3.44			
04-Mar-15	00:05:00	100	40	7.58	3.45			
04-Mar-15	01:55:00	110	50	7.58	3.45	74	1167	15 IN. AT ORIFICE
04-Mar-15	03:55:00	120	60	7.60	3.47	74	1167	INCREASE FLOW RATE; START STEP 3
04-Mar-15	05:55:30	120.5	0.5	9.54	5.41			
04-Mar-15	09:58:00	121.5	1.5	9.65	5.52			BROWN EARTH SMELL
04-Mar-15	12:00:00	122	2	9.74	5.61	102	1609	28.5 IN. AT ORIFICE

**APPENDIX B**  
**WATER LEVELS IN WELL #5 DURING VARIABLE RATE TEST**

Date	Clock Time	Elapsed Time (minutes)	Interval Time (minutes)	Depth (m)	Drawdown (m)	Flow Rate (L/s)	Flow Rate (USgpm)	Comment
04-Mar-15	14:02:30	122.5	2.5	9.78	5.65			RUSTY RED COLOUR
04-Mar-15	16:05:30	123	3	9.80	5.67			
04-Mar-15	18:09:00	123.5	3.5	9.81	5.68	102	1609	
04-Mar-15	20:13:00	124	4	9.81	5.68			
04-Mar-15	22:17:30	124.5	4.5	9.85	5.72	102	1609	
04-Mar-15	00:22:30	125	5	9.86	5.73			
04-Mar-15	02:28:30	126	6	9.88	5.75	102	1609	
04-Mar-15	04:35:30	127	7	9.93	5.80			WATER CLEARING
04-Mar-15	06:43:30	128	8	9.93	5.80	102	1609	WATER STILL TANISH BROWN COLOUR
04-Mar-15	08:52:30	129	9	9.95	5.82			
04-Mar-15	11:02:30	130	10	9.98	5.85	102	1609	
04-Mar-15	13:14:30	132	12	9.99	5.86			
04-Mar-15	15:28:30	134	14	10.01	5.88	102	1609	
04-Mar-15	17:44:30	136	16	10.02	5.89			
04-Mar-15	20:02:30	138	18	10.04	5.91	102	1609	
04-Mar-15	22:22:30	140	20	10.06	5.93			NO SAND
04-Mar-15	00:47:30	145	25	10.08	5.95	102	1609	
04-Mar-15	03:17:30	150	30	10.10	5.97			
04-Mar-15	05:52:30	155	35	10.12	5.99	102	1609	
04-Mar-15	08:32:30	160	40	10.13	6.00			WATER CLEAR, NO SMELL
04-Mar-15	11:22:30	170	50	10.17	6.04	102	1609	
04-Mar-15	14:22:30	180	60	10.20	6.07			INCREASE FLOW RATE; START STEP 4
04-Mar-15	17:23:00	180.5	0.5	11.91	7.78	139	2204	
04-Mar-15	23:25:30	181.5	1.5	12.36	8.23			53.5 IN. AT ORIFICE
04-Mar-15	02:27:30	182	2	13.46	9.33			WATER RUSTY COLOUR
04-Mar-15	05:30:00	182.5	2.5	13.61	9.48	139	2206	
04-Mar-15	08:33:00	183	3	13.75	9.62			53.5 IN. AT ORIFICE
04-Mar-15	11:36:30	183.5	3.5	13.83	9.70	139	2206	
04-Mar-15	14:40:30	184	4	13.85	9.72			53.5 IN. AT ORIFICE
04-Mar-15	17:45:00	184.5	4.5	13.90	9.77	139	2206	
04-Mar-15	23:56:00	186	6	13.96	9.83	139	2206	
04-Mar-15	03:03:00	187	7	14.04	9.91			53.5 IN. AT ORIFICE
04-Mar-15	06:11:00	188	8	14.25	10.12	139	2206	
04-Mar-15	09:20:00	189	9	14.28	10.15			WATER CLEARING UP
04-Mar-15	12:30:00	190	10	14.30	10.17	139	2206	53.5 IN. AT ORIFICE
04-Mar-15	15:42:00	192	12	14.36	10.23			53.5 IN. AT ORIFICE
04-Mar-15	18:56:00	194	14	14.38	10.25	139	2206	AT 15:14:30 SAND TESTER .05 ML OF EXTRA FINE SAND
04-Mar-15	22:12:00	196	16	14.42	10.29			
04-Mar-15	01:30:00	198	18	14.44	10.31			
04-Mar-15	04:50:00	200	20	14.45	10.32			
04-Mar-15	08:15:00	205	25	14.50	10.37			
04-Mar-15	11:45:00	210	30	14.54	10.41			
04-Mar-15	15:20:00	215	35	14.57	10.44			
04-Mar-15	19:00:00	220	40	14.58	10.45			
04-Mar-15	22:50:00	230	50	14.64	10.51			63.85 USGPF
04-Mar-15	02:50:00	240	60	14.66	10.53			PUMP STOPPED

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## APPENDIX B WATER LEVELS IN WELL #5 DURING CONSTANT RATE TEST

Date	Clock Time	Elapsed time (minutes)	Depth to Water (m-btoc)	Drawdown (m)	Flow Rate (L/s)	Flow Rate (USgpm)	Comment
04-Mar-15	17:00:00	0	4.16	0.00			
04-Mar-15	17:00:30	0.5	6.39	2.23	44.2	700	VALVE UP
04-Mar-15	17:01:00	1	6.83	2.67	63.1	1000	8 IN. AT ORIFICE
04-Mar-15	17:01:30	1.5	12.77	8.61			
04-Mar-15	17:02:30	2.5	14.03	9.87			52 IN. AT ORIFICE
04-Mar-15	17:03:30	3.5	14.13	9.97			
04-Mar-15	17:04:00	4	14.40	10.24			52.5 IN. AT ORIFICE
04-Mar-15	17:05:00	5	14.62	10.45	139.2	2206	53.5 IN. AT ORIFICE
04-Mar-15	17:06:00	6	14.64	10.48			
04-Mar-15	17:07:00	7	14.70	10.54	139.2	2206	
04-Mar-15	17:08:00	8	14.73	10.57			
04-Mar-15	17:09:00	9	14.76	10.60	139.2	2206	SLIGHT VFD UP
04-Mar-15	17:10:00	10	14.76	10.60			
04-Mar-15	17:12:00	12	14.80	10.64	139.2	2206	
04-Mar-15	17:14:00	14	14.82	10.66			
04-Mar-15	17:16:00	16	14.83	10.67	139.2	2206	
04-Mar-15	17:18:00	18	14.86	10.70			
04-Mar-15	17:20:00	20	14.88	10.72	139.2	2206	
04-Mar-15	17:25:00	25	14.90	10.74			52.5 IN. AT ORIFICE
04-Mar-15	17:30:00	30	14.97	10.81	139.2	2206	
04-Mar-15	17:35:00	35	15.00	10.84			
04-Mar-15	17:40:00	40	15.01	10.84	139.2	2206	
04-Mar-15	17:50:00	50	15.03	10.87			
04-Mar-15	18:00:00	60	15.05	10.89	139.2	2206	14.73' OBS WELL
04-Mar-15	18:15:00	75	15.10	10.94			
04-Mar-15	18:30:00	90	15.12	10.95	139.2	2206	
04-Mar-15	18:45:00	105	15.15	10.99			8:00 PM SERVICE INTERRUPT LIGHT CAME ON
04-Mar-15	19:00:00	120	15.17	11.01	139.2	2206	
04-Mar-15	19:30:00	150	15.19	11.03			14.79' OBS WELL
04-Mar-15	20:20:00	200	15.24	11.08	139.2	2206	CROSS SHIFT WITH TIM
04-Mar-15	21:10:00	250	15.31	11.15			
04-Mar-15	22:00:00	300	15.36	11.20	139.2	2206	
04-Mar-15	23:00:00	360	15.40	11.24			
05-Mar-15	0:00:00	420	15.40	11.24	139.2	2206	42068
05-Mar-15	1:00:00	480	15.40	11.24			
05-Mar-15	2:00:00	540	15.45	11.29	139.2	2206	
05-Mar-15	3:00:00	600	15.49	11.33			SLIGHT RAMP UP ON DRIVE
05-Mar-15	4:00:00	660	15.52	11.36	139.2	2206	WATER IS CLEAR
05-Mar-15	5:00:00	720	15.53	11.37			
05-Mar-15	6:00:00	780	15.53	11.37	139.2	2206	
05-Mar-15	7:00:00	840	15.53	11.37			
05-Mar-15	8:00:00	900	15.55	11.39	139.2	2206	SLIGHT RAMP UP ON VFD
05-Mar-15	9:00:00	960	15.58	11.42			7:00 AM CROSS SHIFT WITH NICK
05-Mar-15	10:00:00	1020	15.59	11.43	139.2	2206	14.97' OBS WELL
05-Mar-15	11:00:00	1080	15.61	11.45			
05-Mar-15	12:00:00	1140	15.62	11.46	139.2	2206	

## APPENDIX B WATER LEVELS IN WELL #5 DURING CONSTANT RATE TEST

Date	Clock Time	Elapsed time (minutes)	Depth to Water (m-btoc)	Drawdown (m)	Flow Rate (L/s)	Flow Rate (USgpm)	Comment
05-Mar-15	13:00:00	1200	15.63	11.47			SLIGHT VFD UP 52.5-53.5" AT ORIFICE
05-Mar-15	14:00:00	1260	15.63	11.47	139.2	2206	
05-Mar-15	15:00:00	1320	15.86	11.70			15.21' OBS WELL
05-Mar-15	16:00:00	1380	15.87	11.71	139.2	2206	- AT 14:30 JAMES TURNED WELL 2 UP FROM 87.5% TO 88.5% - VFD UP FROM 52" TO 53.5"
05-Mar-15	17:00:00	1440	15.87	11.71			PUMP STOPPED
05-Mar-15	17:00:30	1440.5	4.65				RECOVERY
05-Mar-15	17:01:00	1441	4.52				
05-Mar-15	17:01:30	1441.5	4.45				
05-Mar-15	17:02:00	1442	4.42				
05-Mar-15	17:02:30	1442.5	4.39				
05-Mar-15	17:03:00	1443	4.38				
05-Mar-15	17:03:30	1443.5	4.36				
05-Mar-15	17:04:00	1444	4.36				
05-Mar-15	17:04:30	1444.5	4.36				
05-Mar-15	17:05:00	1445	4.35				
05-Mar-15	17:06:00	1446	4.34				
05-Mar-15	17:07:00	1447	4.34				
05-Mar-15	17:08:00	1448	4.34				
05-Mar-15	17:09:00	1449	4.34				
05-Mar-15	17:10:00	1450	4.33				
05-Mar-15	17:12:00	1452	4.33				
05-Mar-15	17:14:00	1454	4.32				
05-Mar-15	17:16:00	1456	4.32				
05-Mar-15	17:18:00	1458	4.32				
05-Mar-15	17:20:00	1460	4.31				
05-Mar-15	17:25:00	1465	4.31				
05-Mar-15	17:30:00	1470	4.31				
05-Mar-15	17:35:00	1475	4.30				
05-Mar-15	17:40:00	1480	4.30				
05-Mar-15	17:50:00	1490	4.30				
05-Mar-15	18:00:00	1500	4.29				
06-Mar-15	11:00:00	2520	4.13				

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**APPENDIX B**  
**WATER LEVELS IN 6" TEST WELL**  
**DURING CONSTANT RATE TEST WITH WELL #5**

Date	Clock Time	Elapsed time (minutes)	Depth to Water (m-btoc)	Drawdown (m)	Comment
3/04/15	16:58:00	-2.0	4.20	0.04	
3/04/15	17:00:00	0.0	4.25	0.00	PUMP STARTED
3/04/15	17:01:00	1.0	4.28	0.04	
3/04/15	17:02:00	2.0	4.37	0.12	
3/04/15	17:03:00	3.0	4.41	0.16	
3/04/15	17:04:00	4.0	4.42	0.18	
3/04/15	17:05:00	5.0	4.43	0.19	
3/04/15	17:06:00	6.0	4.44	0.19	
3/04/15	17:07:00	7.0	4.44	0.20	
3/04/15	17:08:00	8.0	4.44	0.20	
3/04/15	17:09:00	9.0	4.45	0.20	
3/04/15	17:10:00	10.0	4.45	0.20	
3/04/15	17:12:00	12.0	4.45	0.21	
3/04/15	17:14:00	14.0	4.45	0.21	
3/04/15	17:16:00	16.0	4.46	0.21	
3/04/15	17:18:00	18.0	4.46	0.21	
3/04/15	17:20:00	20.0	4.46	0.21	
3/04/15	17:22:00	22.0	4.46	0.22	
3/04/15	17:24:00	24.0	4.46	0.22	
3/04/15	17:26:00	26.0	4.46	0.22	
3/04/15	17:28:00	28.0	4.47	0.22	
3/04/15	17:30:00	30.0	4.47	0.22	
3/04/15	17:32:00	32.0	4.47	0.22	
3/04/15	17:34:00	34.0	4.47	0.22	
3/04/15	17:36:00	36.0	4.47	0.22	
3/04/15	17:38:00	38.0	4.47	0.22	
3/04/15	17:40:00	40.0	4.47	0.22	
3/04/15	17:42:00	42.0	4.47	0.23	
3/04/15	17:44:00	44.0	4.47	0.22	
3/04/15	17:46:00	46.0	4.47	0.23	
3/04/15	17:48:00	48.0	4.47	0.22	
3/04/15	17:50:00	50.0	4.47	0.23	
3/04/15	17:52:00	52.0	4.47	0.22	
3/04/15	17:54:00	54.0	4.47	0.23	
3/04/15	17:56:00	56.0	4.47	0.23	
3/04/15	17:58:00	58.0	4.47	0.23	
3/04/15	18:00:00	60.0	4.47	0.23	
3/04/15	18:10:00	70.0	4.48	0.23	

**APPENDIX B**  
**WATER LEVELS IN 6" TEST WELL**  
**DURING CONSTANT RATE TEST WITH WELL #5**

Date	Clock Time	Elapsed time (minutes)	Depth to Water (m-btoc)	Drawdown (m)	Comment
3/04/15	18:20:00	80.0	4.48	0.23	
3/04/15	18:30:00	90.0	4.48	0.23	
3/04/15	18:40:00	100.0	4.48	0.24	
3/04/15	18:50:00	110.0	4.48	0.24	
3/04/15	19:00:00	120.0	4.49	0.24	
3/04/15	19:10:00	130.0	4.49	0.24	
3/04/15	19:20:00	140.0	4.49	0.24	
3/04/15	19:30:00	150.0	4.49	0.25	
3/04/15	19:40:00	160.0	4.49	0.25	
3/04/15	19:50:00	170.0	4.50	0.25	
3/04/15	20:00:00	180.0	4.50	0.25	
3/04/15	21:00:00	240.0	4.51	0.26	
3/04/15	22:00:00	300.0	4.52	0.27	
3/04/15	23:00:00	360.0	4.52	0.28	
3/04/15	0:00:00	420.0	4.53	0.28	
3/04/15	1:00:00	480.0	4.54	0.29	
3/04/15	2:00:00	540.0	4.54	0.29	
3/04/15	3:00:00	600.0	4.55	0.30	
3/04/15	4:00:00	660.0	4.55	0.31	
3/04/15	5:00:00	720.0	4.56	0.31	
3/04/15	6:00:00	780.0	4.56	0.32	
3/04/15	7:00:00	840.0	4.57	0.32	
3/04/15	8:00:00	900.0	4.57	0.33	
3/04/15	9:00:00	960.0	4.58	0.33	
3/04/15	10:00:00	1020.0	4.58	0.34	
3/04/15	11:00:00	1080.0	4.59	0.34	
3/04/15	12:00:00	1140.0	4.59	0.35	
3/04/15	13:00:00	1200.0	4.59	0.35	
3/04/15	14:00:00	1260.0	4.60	0.36	
3/04/15	15:00:00	1320.0	4.61	0.36	
3/04/15	16:00:00	1380.0	4.62	0.37	
3/04/15	16:20:00	1400.0	4.62	0.37	
3/04/15	16:40:00	1420.0	4.62	0.37	
3/04/15	17:00:00	1440.0	4.58	0.33	PUMP STOPPED
3/04/15	17:01:00	1441.0	4.43	0.19	
3/04/15	17:02:00	1442.0	4.41	0.16	
3/04/15	17:03:00	1443.0	4.40	0.15	
3/04/15	17:04:00	1444.0	4.39	0.14	
3/04/15	17:05:00	1445.0	4.39	0.14	
3/04/15	17:06:00	1446.0	4.38	0.14	
3/04/15	17:07:00	1447.0	4.38	0.13	
3/04/15	17:08:00	1448.0	4.38	0.13	
3/04/15	17:09:00	1449.0	4.38	0.13	

**APPENDIX B**  
**WATER LEVELS IN 6" TEST WELL**  
**DURING CONSTANT RATE TEST WITH WELL #5**

Date	Clock Time	Elapsed time (minutes)	Depth to Water (m-btoc)	Drawdown (m)	Comment
3/04/15	17:10:00	1450.0	4.37	0.13	
3/04/15	17:11:00	1451.0	4.37	0.13	
3/04/15	17:12:00	1452.0	4.37	0.12	
3/04/15	17:13:00	1453.0	4.37	0.12	
3/04/15	17:14:00	1454.0	4.37	0.12	
3/04/15	17:15:00	1455.0	4.37	0.12	
3/04/15	17:16:00	1456.0	4.37	0.12	
3/04/15	17:17:00	1457.0	4.37	0.12	
3/04/15	17:18:00	1458.0	4.36	0.12	
3/04/15	17:19:00	1459.0	4.36	0.12	
3/04/15	17:20:00	1460.0	4.36	0.12	
3/04/15	17:21:00	1461.0	4.36	0.12	
3/04/15	17:22:00	1462.0	4.36	0.11	
3/04/15	17:23:00	1463.0	4.36	0.11	
3/04/15	17:24:00	1464.0	4.36	0.11	
3/04/15	17:25:00	1465.0	4.36	0.11	
3/04/15	17:26:00	1466.0	4.36	0.11	
3/04/15	17:27:00	1467.0	4.36	0.11	
3/04/15	17:28:00	1468.0	4.36	0.11	
3/04/15	17:29:00	1469.0	4.36	0.11	
3/04/15	17:30:00	1470.0	4.36	0.11	
3/04/15	17:35:00	1475.0	4.35	0.11	
3/04/15	17:40:00	1480.0	4.35	0.11	
3/04/15	17:45:00	1485.0	4.35	0.10	
3/04/15	17:50:00	1490.0	4.35	0.10	
3/04/15	17:55:00	1495.0	4.35	0.10	
3/04/15	18:00:00	1500.0	4.34	0.10	
3/04/15	18:05:00	1505.0	4.34	0.10	

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**APPENDIX B**  
**WATER LEVELS AND TEMPERATURES IN OBSERVATION WELLS**  
**DURING CONSTANT RATE TEST WITH WELL #5**

DATE	TIME	WELL #1		WELL #2		WELL #3		WELL #4		REMARKS
		WATER LEVEL m above pump	TEMP °C	WATER LEVEL m above pump	TEMP °C	WATER LEVEL m above pump	TEMP °C	WATER LEVEL m above pump	TEMP °C	
04-Mar-15	11:00	6.1	9.6	2.00	9.4	2.00	6.7	10.69	7.8	
04-Mar-15	12:50	6.1	9.7	1.90	9.6	1.99	6.7	10.61	7.9	
04-Mar-15	13:35	6.0	9.7	1.90	9.7	1.98	6.6	10.58	8.1	
04-Mar-15	14:46	6.0	9.7	1.80	9.7	1.97	6.8	10.54	7.9	
04-Mar-15	16:30	6.1	9.7	2.00	9.7	1.97	6.7	10.66	8.1	
04-Mar-15	17:30	6.0	9.6	1.80	9.7	1.95	6.6	10.53	8.1	
04-Mar-15	18:30	6.0	9.6	1.80	9.7	1.94	6.7	10.52	8.1	
04-Mar-15	19:30	6.0	9.6	1.80	9.7	1.92	6.6	10.50	8.1	
04-Mar-15	20:30	6.0	9.6	1.80	9.6	1.91	6.7	10.49	8.2	
04-Mar-15	21:30	6.0	9.6	1.80	9.6	1.90	6.7	10.49	8.2	
04-Mar-15	22:30	6.0	9.6	1.80	9.6	1.89	6.6	10.48	8.3	
04-Mar-15	23:30	6.0	9.6	1.80	9.6	1.89	6.6	10.49	8.3	
05-Mar-15	0:30	6.0	9.5	1.80	9.5	1.87	6.6	10.46	8.1	
05-Mar-15	1:30	6.0	9.5	1.80	9.5	1.87	6.6	10.46	8.1	
05-Mar-15	2:30	6.0	9.5	1.80	9.5	1.86	6.6	10.45	8.1	
05-Mar-15	3:30	6.0	9.5	1.80	9.5	1.85	6.6	10.45	8.1	
05-Mar-15	4:30	6.0	9.5	1.80	9.5	1.84	6.5	10.44	8.2	
05-Mar-15	5:30	5.9	9.5	1.80	9.5	1.83	6.6	10.43	7.8	
05-Mar-15	6:30	5.9	9.5	1.80	9.4	1.83	6.6	10.42	8.2	
05-Mar-15	7:30	5.9	9.5	1.82	9.4	1.82	6.6	10.42	8.0	
05-Mar-15	8:30	5.9	9.5	1.80	9.5	1.82	6.6	10.42	8.2	
05-Mar-15	9:30	5.9	9.6	1.80	9.6	1.81	6.6	10.41	8.2	
05-Mar-15	10:30	5.9	9.6	1.80	9.6	1.81	6.6	10.41	8.2	
05-Mar-15	11:30	5.9	9.6	1.80	9.7	1.80	6.6	10.40	8.1	
05-Mar-15	12:30	5.9	9.6	1.80	9.7	1.80	6.6	10.40	8.1	
05-Mar-15	13:30	5.9	9.6	1.80	9.8	1.79	6.6	10.39	8.1	ADJUST FLOW FROM
05-Mar-15	14:30	5.9	9.6	1.50	9.9	1.78	6.7	10.38	8.1	87.1 TO 88.51 WELL#2
05-Mar-15	15:30	5.9	9.6	1.50	9.9	1.78	6.6	10.38	7.9	1.5m / 9.7
05-Mar-15	16:30	5.9	9.6	1.50	9.9	1.77	6.6	10.37	8.0	
05-Mar-15	18:30	6.0	9.6	1.60	9.8	1.80	6.6	10.51	8.1	
06-Mar-15	12:30	6.0	9.6	1.90	9.8	1.89	6.6	10.69	7.8	

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**APPENDIX C**

**SUMMARY OF WATER QUALITY  
FIELD MEASUREMENTS**

**APPENDIX C**  
**WATER CHEMISTRY MEASUREMENTS MEASURED DURING CONSTANT-RATE PUMPING TEST WELL #5**

DATE	TIME	TURBIDITY NTU	DO %	PH	TDS g/L
04-Mar-15	17:11	9.10	107.5	4.568	0.018
04-Mar-15	17:30	2.90	78.5	6.120	0.016
04-Mar-15	17:50	2.70	68.2	6.090	0.017
04-Mar-15	20:00	2.90	86.2	6.300	0.017
04-Mar-15	21:00	3.20	74.4	6.370	0.018
04-Mar-15	22:00	3.30	63.8	6.390	0.011
04-Mar-15	23:00	3.30	65.2	6.380	0.010
05-Mar-15	0:00	3.30	58.3	6.530	0.011
05-Mar-15	1:00	2.10	62.7	6.550	0.017
05-Mar-15	2:00	2.50	54.4	6.580	0.017
05-Mar-15	3:00	2.50	55.7	6.580	0.017
05-Mar-15	4:00	2.70	66.3	6.570	0.017
05-Mar-15	5:00	2.20	54.0	6.570	0.011
05-Mar-15	6:00	1.70	53.7	6.570	0.018
05-Mar-15	7:00	1.40	55.7	6.540	0.017
05-Mar-15	8:00	1.20	53.7	6.580	0.011
05-Mar-15	9:00	1.20	63.3	6.610	0.017
05-Mar-15	10:00	1.00	56.6	6.620	0.011
05-Mar-15	11:00	0.07	56.6	6.620	0.011
05-Mar-15	12:00	0.07	57.9	6.620	0.011
05-Mar-15	13:00	0.04	57.9	6.630	0.011
05-Mar-15	14:00	0.00	58.5	6.630	0.011
05-Mar-15	15:45	0.00	56.3	6.510	0.011
05-Mar-15	16:00	0.00	56.3	6.460	0.011

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